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Making place in the anthropocene: cartography, data and ecological experience

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by

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Acknowledgments

Writing is of course always a deeply social affair even though it is conducted in largely solitary circumstances. As I approach the end of this dissertation project—the longest single work I have written to date—I have become acutely sensitive to just how true of a sentiment that is and how important a large group of people have been to this project over the years. I firstly would like to thank the generosity of my teachers, all of whom in some way have instilled in me a passion to learn about the world and who have provided invaluable support and guidance over the years. George Marcus, Pat Seed and Kris Peterson, this project's principle advisors, have been especially generous with their thoughts and time and have provided a degree of encouragement and support without which this work may not have come to fruition. More broadly, the entire faculty at UC Irvine that I have had the privilege to learn from—including Tom Boellstorff, Julia Elyachar, David Goldberg, and Bill Maurer—are certainly owed a debt of gratitude as are many of the professors—including Elizabeth Scharffenberger, Edward Mendelson, Bruce Robbins, Lydia Goehr, John Pemberton and Achille Varzi—who taught me as an undergraduate at Columbia.

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MBD
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Abstract

ABSTRACT OF THE DISSERTATION

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This dissertation approaches the current crisis of anthropogenic climate change from the perspective of place making practices. Through several years of ethnographic research focused in New York City, I explore a variety of communities that are each concerned with producing technosocial or phenomenological interfaces between the city and the planetary climate system. Through work done with a community of bioartists, the city's Mayor's Office of Data Analytics and the GeoNYC mapping meetup, I explore particular instances where individual experience of the city is given structure and shape. I then contextualize the work done at the level of the city with the ways in which the planet itself becomes available as an object of knowledge and as an experienced thing. By considering work done at the level of international policy, the history of science and the lived experience of climatologists I explore a complex set of practices that contribute to an understanding of the contemporary planet. Finally, I argue that in devising a response to climate change, attention must be paid to the relationships between a subjective experience of place and the broader planetary ontologies that we produce.

Chapter 1: Introduction

I arrived late the previous evening at a friend's house on the east side of Los Angeles. It had been a rather long journey and I quickly found my way to bed. As I awoke the next morning, the drawn curtains, gauzy in their way, seemed to take up the morning's confident beams and pass them along gently, even jubilantly. It felt to be on the early side, maybe seven o'clock? I turned over and felt my body against the hardwood floor; it seemed that the air mattress could hold me for only so long. Where was I again? Awkwardly, I shuffled out of bed and as I teetered into an upright posture, the contents of the studio reached out to me. An old microscope pilfered from her father's medical practice, stained slides from a garage sale, a rotary phone that had been consumed by a pile of glittering rags. The thought of coffee pulled me onwards through the house. The moldings of the kitchen and its broad enameled sink seemed at once to harbor a dream of appearing in a glossy magazine. But as we awoke together, the painted tiles appeared content to remember simply the many decades and many hands that had touched them. I placed a kettle on the stove and clicked it to life. My fatigue still threatening a return to bed—and knowing well what the old wives say about watching water boil—I stepped out into the garden to see what was to be seen. The smell of flowers—oh, if only I could give them names... gardenia perhaps?—struck me at once as I gently pulled the door closed.

It was just six days earlier that I had walked across the tarmac in Casablanca to board a flight back to New York. I had been living in Fes for the preceding six months, writing my graduate school applications and hanging around rug dealers in the old medina. On returning to the United States, I packed the car that I had stored at my parents' house in the coal rich hills of northeastern Pennsylvania and drove west.

Interstate 80 accomplishes something almost sublime, connecting, through an uninterrupted piece of engineering, an asphalt structure that spans from one of New York's rusting satellite cities in the east all the way across the continent to San Francisco in the west. To build a mile of interstate highway requires about 10,000 metric tons of asphalt, a mixture made up of ground rocks and bitumen, that sludgy part of crude oil which cannot be refined into gasoline or jet fuel. Its hard to really fathom just how long the procession of Panamax ships must have been to carry all of that material from million year old, mile-deep wells in Venezuela or Nigeria to this interminable strip tracing its way across the landscape. Surely, if one were interested enough, it could be figured out, but for me, at the other end of this highway, it was the memory of a straining 4-cylinder engine whirring as it climbed the Rockies and the pungency of fresh tar under a desert sun that seemed most salient.

The passage west across the US has a mythical quality to it in the American imagination. In the mid-nineteenth century, the famed publisher and politician Horace Greeley enjoined the public to embrace the nation's manifest destiny and to "go west… and grow up with the country". In the years to follow, bootleggers, beats and bourgeois road-trippers would come to bounce back and forth across the continent along its turnpikes and highways. In 2009 I was driving west in order to begin a PhD program in cultural anthropology at the University of California in Irvine. Anthropology was a field that I had comparatively little experience in at the time. My undergraduate studies focused mostly on continental European philosophy and I had been particularly drawn in by the kinds of theoretical explanations that have been imagined over the years to account for how and why things are as they are. Reading of history and consciousness in Hegel,

of reason and metaphysics in Kant, or of sense and perception in Mearleau-Ponty were all experiences that were quite meaningful to me, but also never entirely satisfying in a certain way. The wonderfully intricate conceptual scaffolds that were wrought to give name and presence and sense to some of these extremely profound mysteries of human life were also, somewhat paradoxically, seemingly estranged from the particulars of being a person in the midst of others. While in some ways, people's relationships to one another, and to the world at large, can be identified as an overriding concern in the history of philosophy, philosophical knowledge itself is generally produced at the level of logic or language, aiming for the universal at the expense of the particular. What drew me to anthropology, on the other hand, was the promise that it could engage with philosophical issues while also being embedded in an encounter and a tension with the subjects that it studies. As an anthropologist you have to go and be among people and increasingly those people read what is written about them. A web of actual human relationship becomes intrinsic to the knowledge that anthropology produces and my hope was that this could provide a conduit between the mysticism of abstraction that I found so appealing in philosophy and the humid sweat of a crowded street which felt to be the place that things actually began.

My original intent was to study the communities that were forming around synthetic biology, a field where the underpinnings of biological life were coming to be channeled through the discourses and practices of computer science. I was particularly interested in how life itself was being conceived of as a particular type of software system and how the practice of hacking was coming to represent a certain kind of resistance and intervention in that emergent phenomenon. I was curious about what it

meant to think of life in the same way as we think of computer programs. What would happen as these kinds of ideas grew and spread, as they seemed poised to do?

However, after I started graduate school, I became acutely aware of the crisis of anthropogenic climate change and decided to write a dissertation about how relationships between individuals, place and climate are produced. It was around this time in 2009 that the anthropocene—the idea that humans are acting on the planet as a geological force—became a term which had left the specialist world of climatologists and geophysicists to circulate in more public and ordinary ways. Each year seemed to set a new record for being the hottest in recorded history and the commentary around international treaty conventions seemed to raise to an ever more alarmist pitch. Unlike some of the people I have met in the course of researching this dissertation, I don't have a story about traveling to a rainforest to encounter the last survivors of a species on the brink of extinction, or about the unrelenting thunder that accompanies the collapse of an ice sheet as it sheers off the coast of Greenland. It was not a moment of sublime transformation that accounts for my turn to the climate. Yet there was something about moving to California, a place at the edge of the continent where tectonic plates, insatiable forest fires, drought and seemingly unchanging weather all felt to come together to mark it as one unlike any other I had experienced before. The presence of geology and the risk of disaster were palpable in a way that made me particularly attuned to where I was in an embodied and cartographic way. As I learned a new place and culture, sitting in hour-long processions of rolling combustion engines, something started to come into focus.

In some ways, the climate change story is a familiar one. Beginning in earnest during the 1980s, international concern was drawn to the possibility that human activity

was causing the planet to warm. Expansive monitoring networks were deployed to measure the concentration of greenhouse gases in the atmosphere and super computers were marshaled to extrapolate possible futures. As stories about the organization of societies became coupled with accounts of the systemic properties of the space they inhabited, a new kind of planet was being created. Perhaps for residents of Bangladesh, the threats of this planetary system became palpable with the swell of each wave slowly eating away at the shoreline. However, for many of the people consuming in the planet's most industrialized societies, this planetary system exists as a distant object, bound tightly within the folds of an intellectual appreciation.

It has become increasingly clear that this relationship between humans and the planet is not tenable. The earth is warming. Humans are releasing too much greenhouse gas into the atmosphere and, if current trends continue, by the end of this century temperatures are expected on average to increase between 2.5F°-10F°. This means that sea levels will rise between 1-4 feet, hundreds of millions of people will be displaced, and 1 in 6 species will be at substantial risk of becoming extinct. Today there is virtually no debate about the fact that the climate is warming and that it is doing so for anthropogenic reasons. Naomi Oreskes, a historian of science at Harvard, conducted a review of over 900 atmospheric and earth science papers and found that opinion in the scientific community about the role of humans in climate change was generally unanimous, with disagreement arising only around questions of degree and the rates and extent of change (Oreskes 2004). Despite this, political and social action across many different levels and scales has not been commensurate with the extent of the global risks. Why is this? How can the disconnection between knowledge and action be accounted

for? I believe that an important perspective on this question can be found by asking both how the environment and planet become knowable things, but also how these things come into relationship with the lived experiences of individuals.

Planet Earth, Gaia, the Pale Blue Dot. There are many names given to this planet that we live on. But how do these names and ideas of place underwrite our sense of where it is that we are? Because of the curvature of the earth it's impossible to see more than 3 miles straight ahead if you're standing at sea level. Something else happens to connect one's individual experience of the ground that they stand on, the bed in which they sleep and the places that they eat with this greater whole that is at risk. I, for instance, am sitting in a cafe on East 24th Street in Manhattan, atop rocks that formed 400 million years ago and mere blocks from where Herman Melville died 125 years ago. I know that this island is on the eastern coast of North America, that to the west are thousands of miles of landscape, and to the east thousands of miles of water that eventually will lead either to Europe or Western Africa. However, as a person in the world I haven't actually seen or experienced any of this. I've walked and driven around the city, sometimes catching a glimpse of some beautiful vista that suggests how the parts might fit into the whole. I've climbed into large aluminum tubes and traveled to other cities in other parts of the world, but most of that experience is marked by endless hours over well-worn carpets of fluffy clouds.

So how does it come to be that a relationship with the earth as a whole, or with any place in particular, becomes possible? This is of course a question whose answer is highly situated and contingent, demanding a care and attention to precisely whose relationships are being considered. There is the farmer whose family had fled to the Nile

Delta in the 1860s, away from the forced labor camps set up by the French to blast a canal through Suez. He looks out along the river where he used to play with his sisters when he was a boy, watching it consume a few meters each week of the land his family had tilled for generations. There is a 42 year old pilot from Kentucky flying a US Fire Service helicopter through a valley in the Rocky Mountains, thousands of acres of coal black totems behind him and a roaring orange ahead. He releases a load of water on the trees below, a splash on the inferno that they say is one of the biggest fires in Colorado's history. Place is never an obvious concept. There are family histories, vistas gleaned, maps examined, passports which open or close certain kinds of mobility that all go into the immense complexity of structuring how we experience where we are in the world. There is also a deep material history and cartographic genealogy. Supporting our sense of where we are is a whole history of cold war science and technology, of earth orbiting satellites, of systems designed to create awareness across the entirety of the planet's surface, of charting and mapping everything within a modern geo-coordinate system, of developing communication networks that would be globally resilient in the event of nuclear war. How we know where we are is a question perhaps as vast and complicated as the planet itself, should one push it to its poetic or philosophical frontiers. I shall try to chart a more modest course. In what follows I will work to engage with a spectrum of particular — but materially and conceptually interlinking — sites where the question of what it is to make place in the anthropocene is under active contestation and construction. Throughout I will be asking how we come to know where we are and how individual experience connects to an idea of the planet as a complex system with a climate that is in crisis.

An overriding concern of the present work considers how a failure to galvanize a response to the crisis of climate change may be intimately related to how we understand and relate to place. In what follows, through a focus on particular instances of world making, I will seek to develop an imaginative and conceptual vocabulary to help to think through what it means to make place in the midst of global climate change. Negotiating scale and perspective will be crucial throughout. While the construction of the planetary climate system and of an ontology of the earth itself as a blue marble spinning through space is certainly a part of the story, cities themselves become fecund sites for exploring the many ways place is produced. To anchor this investigation I conducted several years of fieldwork in New York City among a variety of groups who were in some way concerned with mapping and representing the city. Cities are fascinating sites to consider place making practices because many different scales and networks converge within them. The philosopher Brian Holmes has argued that if the anthropocene is to have a public space it is that of the metropolis. The metropolis not as a single place but rather as a "condition of relational awareness" that requires broad participation and which demands that the abstraction of large systems be wrestled with in the streets and in the company of others (Holmes 2016).

In many respects, I rely upon an idea of the cartographic to unify and situate the various place making practices that I examine throughout the dissertation. In New York City maps are everywhere, they are diffused throughout the environment, they are in the subway, on poles in tourist districts, on fliers, trodden underfoot, hoisted above crowds to advertise a nearby discount suit dealer. At once a work of measurement and analysis, of graphic and user design, they exist as objects, libraries, opinion and worldview. There is

something remarkable about the way that they appear to effortlessly absorb the vast amount of labor that goes into their production. Maps make up the city's fabric at the same time that they give a point of view on it. However, in many ways cartographic practice is moving beyond the map's traditionally visual form. There's an important intellectual history here which I will engage more deeply in the dissertation's third chapter—"The new cartographers"—but for the moment I want to highlight that I will be exploring the underlying rationality and performative aspects of maps as a pervasive technology that structures experience and presence in often unseen but profound ways. In the context of the climate crisis, maps and satellite photos become the representations of the very objects that are pointed to as being in crisis. This is one of the things that strikes me as most curious about the current situation. As the physical world is being ravaged, a digital doppelganger is being produced. In exploring the entailments of emergent, ecologically informed place making practices, my research will attend to the kinds of relationships that exist between individuals, maps and environment in the creation and transmission of meaningful urban space.

Chapter Overviews

In my first chapter, I engage with the idea of the anthropocene and the critical discourse that surrounds it by examining the scales, temporalities and subjects that it depends on. Looking at its history and present uses, I consider the anthropocene as a key-term in the context of how climate change is understood while arguing for the need to develop an attentiveness towards the stakes of naming something as complex as the current climatological moment. I am interested in unpacking how it is that we come to

know the anthropocene, a thing which requires a dizzying diversity of things to be brought together into a common frame, from fossil records, to satellite images, political economy, and ideas of normalcy and the human. In the latter half of the chapter, I seek to reengage the theoretical and historical issues that are inseparable from an idea of the anthropocene at the level of the sidewalk and the tangles of life that exist in New York City. Following an examination of the history of the gridded street plan in New York, I spend time among a community of artists whose practice depends upon making watercolor pigments from weeds foraged around the city. There is a kind of somatic training in this practice and I am interested in how it helps us to understand the mutual becoming across species that happens in the city's vacant lots and how this perspective can help us re-approach the intimate and global scales of the anthropocene. Throughout, I ask if the anthropocene as a concept is the right way of focusing attention and who exactly the anthropos imagined by the anthropocene is.

In the second chapter, I pivot to consider how emerging practices of data science and analytics are being called upon to map and model cities and their inhabitants. By shifting perspective from the broader anthropocene discourse and its experiential and theoretical implications for life on the street, I aim to examine how those streets themselves are in some ways being refashioned through data. Hurricane Sandy was a traumatic event for New York in 2012 and emerging ideas about the representational power of data to capture essential aspects of places, people and things became fused to the conversations around resiliency and governance that followed the storm. The chapter focuses on several interlinking sites. The first concerns the intellectual and institutional history of what has come to be called "data science". Many of the social relationships that

were involved in its popularization and development cut through New York City and particular attention will be paid to those as I seek to position its ontological and epistemological valences within a broader context. This emergence of data science as a named thing occurred at a time when Michael Bloomberg, the billionaire who made his fortune on financial information systems, was mayor. Bloomberg established a Mayor's Office of Data Analytics which served as an institutional structure for an emerging practice of data scientific place making to be enacted. Through a process which is both technological and institutional, the Data Analytics office reveals how a certain model of place making operates across many different kinds of epistemological frameworks, technologies of state administration and communities who live in their midst. In the latter portion of the chapter, I examine in more detail social genealogies of the kinds of data that are at issue by focusing on a moment where their production and circulation is under active contestation during a policy brainstorming session at the US Treasury Department. Collectively, this chapter aims to reveal how cities are being reconceived as data systems that can be managed along side the climate system.

Following this, the third chapter engages with the cartographic community in New York and examines another set of sites that are concerned with representing and structuring relationships with the city. In some ways, New York is both a place that exists in maps but which also produces them. The chapter is centered around the GeoNYC meetup, a monthly event that draws a hundred or so people together from across the city and which challenges a conventional idea of the map as a visual representation of territory. Members of the GeoNYC community come from a broad and diverse set of locations across the city, from graphics editors at the New York Times, to administrators

at the Sanitation Department who make sure trash is picked up, to engineers at Facebook that build systems to geolocate all of the things that happen on their platform. By engaging this community around mapping practices in New York, the goal of this chapter is to provide a finer view on how certain kinds of maps of the city are produced and what bearing this has on how cities are experienced. Maps are one of the key organizing logics through which the world is made knowable and subject to action and its important to critically interrogate the dynamics of these technologies, the communities that are shaping them and the practices that they enable or foreclose.

Juxtaposing the production of the experience of the city with that of the planet will lead us to the final chapter of the dissertation. I will move from an engagement with place making practices at the scale of New York City to consider how the planet itself is produced as an object of knowledge and as a thing which affords certain kinds of relationships. In this chapter I consider work written on the anthropology of the environment and the anthropology of disaster through a focus on the ways in which economics, international policy, computer modeling, and lived experience are drawn together to produce knowledge of a climate system that is in the throes of an anthropogenic crisis. To do this, I will examine different ways that the planet is engaged with from the context of the United Nations' Intergovernmental Panel on Climate Change, cap and trade markets, and the lived experience of a climate scientist who spent two tours in Antarctica. I will explore how the planet first became thinkable as a shared, experienced reality by engaging with the Foucault pendulum of the 19C and consider what it is to have a public that sits in relation with the planet. The pendulum, which purported to give direct proof of the earth's rotation, was a kind of data interface that

through the public act of witnessing made the modern planet, as an object spinning in space, thinkable to a variety of very situated publics in ways that it had not previously existed. Collectively, this chapter seeks to delimit some of the ways that the ontology of the planet is produced and to situate those practices within the lived reality of what it means to dwell at the dawn of the anthropocene.

The climate is so often presented as something that is there to be managed, something that can be broadly known as a variable in a complex earth system and which presents options for human striving and agency to interact with. This orientation towards the crisis of climate change relies heavily on an ability to predict the future states of the climate. But it is haunted by unknown unknowns. Scientists believe that there is a tipping point in the climate system even though they cannot precisely determine what it is because of the confounding aspects of complexity in the system. This is part of the current predicament. Paul Edwards argues that we might need to become comfortable with the fact that we will never be able to predict the climate's tipping point better than we can now: "just as with human history, we will never get a single unshakable narrative of the global climate's past. Instead we get versions of the atmosphere…convergent yet never identical" (Edwards 2010). My hope in this dissertation is to present multiple, entangled ways in which place is made in the anthropocene that can help reimagine and rescale the planetary in the contexts of people's lived reality. Ultimately, its not the models we contrive to understand the dynamics of carbon output and global warming that will be decisive but how we collectively imagine and inhabit where we are.

Chapter 2: The stories of the anthropocene

A long, long time ago—about 4.5 billion years it is estimated—clouds of gas and dust swirled around a newly formed sun. As the millennia grinded on, all of this material slowly began to collide and clump together, eventually giving birth to the earliest Earth. In its beginning, the earth was a smoldering place with flaming rocks constantly raining down from the heavens above. While its not known exactly when life began here, fossils of single-celled microorganisms have been dated to as far back as 3.5 billion years. The thin layer of breathable air that we so depend on today first emerged about a billion years later, the byproduct of bacteria living off of the CO2 rich atmosphere. Their run-away success, however, stripped so much greenhouse gas from the atmosphere that the planet cooled rapidly, becoming a "Snowball Earth," its surface coated in ice for millions of years.

The earth we know today, saturated with multi-cellular life, really began to emerge in force only 500 million years ago with the Cambrian Explosion. This rapid period of evolutionary development produced, within the course of just ten or twenty million years, the ancestors of nearly every major group of modern animal. It also inaugurated a series of five great extinctions where life on the planet would retreat to the brink of annihilation only to roar back, albeit in a very changed form, millions of years later. The most recent extinction event was the Cretaceous–Paleogene which occurred sixty-five million years ago when a 10km-wide asteroid slammed into the Yucatan Peninsula. However unfortunate this may have been for the dinosaurs and other animals on the earth at this time, the event set the stage for the first primates to begin to evolve over the course of a sixty million year sweep, eventually resulting in our own species,

homo sapiens, about 200,000 years ago.

And here we are, the abridged history of the planet and its forms of life. Its kind of a conventional story, the sort that is put up on placards in natural history museums or made into multi-part specials on public television. Carl Sagan famously popularized this kind of deep-time historical narrative in his 1980 television series Cosmos. Presenting the idea of a "cosmic calendar" to an audience that eventually reached 500 million people, Sagan asks his viewers to imagine that the entire history of the universe be put within the frame of a single calendar year. At this scale, each second of time is equal to 437.5 years of actual historical time, and each day equal to 37.8 million years. This was a very effective rhetorical strategy. Calendars are uniquely powerful technologies that are nearly ubiquitous the world over, in some way structuring daily life and providing one of the most fundamental means of official commensurability. Because of the way that calendars span one's public and intimate lives, the calendar as analogy is ready-made to cast a person in the fullness of their biography in the midst of Sagan's story. And the conclusion does strike one with the relative smallness of human history in a cosmic context: we are told that its 15 seconds since the first cities in Mesopotamia appeared, 4 seconds since the prophet Mohamed was born, and 1 second since Columbus arrived in the Americas.

When considering stories that are told to account for a human's relationship with a broader geologic or cosmic world, its important to remain attentive to what kinds of humans and ways of thinking about connections are assumed. In Sagan's work, there is a relationship to the universe that collapses all of human activity and concern into the grand sweeps of billions of years and is, in an almost religious way, intended to communicate a humility and a feeling of being a small part of a greater whole. A few years earlier the

designers Ray and Charles Eames produced a film at the behest of IBM titled Powers of Ten (1977) which tells a similar kind of story. Instead of the calendar, the Eameses focused on an idea of mathematics and scales, examining the entire universe from its smallest to largest scale in a sequential and deliberate way, as the engineer-god might peer through an omniscient telescope. In this view of the world, man remains the measure of all things, the starting point and the reference that pushes the individual to imagine other scales. The film begins with a scene of leisure, a man and a woman having a picnic on the banks of Lake Michigan. The camera looks down on the couple from above, slowly withdrawing in a continuous pan to a distance 10^24m, showing along the exponential path increasingly nested scales: the state of Illinois, the planet, the solar system, the galaxy, and so on. The camera then retraces its path, returning to the picnic scene only to continue zooming into the hand of the man, which rests sleepily on his stomach. Another 16 orders of magnitude take us to the surface of his skin, through his blood vessels, and down to the electrons of the atoms coursing through his body. The world is an awesome place with scales that push the imagination; with science, vision and mathematics, however, we can encompass and understand the greater, synoptic whole.

Both of these films contributed to the burgeoning environmental awareness in the 1970s, where things like Silent Spring (Carson 1962), Earth Day, and the Blue Marble photographs of the earth from space focused public attention on human's relationship with the environment and a bigger, more complex set of relationships. Today, this kind of deep historical accounting of the planet, and the kinds of imaginings and relationships that it affords, is focused in the idea of the anthropocene. In 1974, the International Commission on Stratigraphy (ICS) was created to establish a standard and global

geologic time scale, precisely defining all of the earth's eons, eras, periods, epochs, and ages against a common reference. Our current epoch is the Holocene. The Holocene began about 11,700 years ago, when the last epoch, a period of glaciation that covered 30% of the planet with ice, ended. In recent years, more and more attention has been drawn towards the idea that we may be in an entirely new geological epoch brought on by human activity. First popularized by Paul Crutzen in 2000, the idea of the anthropocene positions humans as actors with the power of a geophysical force, achieving a kind of parity with things like volcanoes, tectonic plates, the tilt of the planet with respect to the sun, and asteroids. In the midst of anthropogenic climate change, the anthropocene offers a perspective that we are not only changing the atmosphere, but causing changes to the physical planet itself that rise to the level of a geological time scale.

The idea of the anthropocene relies on an idea of geologic time as a way to account for the physical and material history of the planet. The main subfield of geology that deals with these kinds of issues is that of stratigraphy, or the study of the layers of rock that make up the surface of the earth. As an area of active scientific research it began in the late 18th and early 19th century with an attempt to classify the planet's crust into successive periods. This segmentation of the surface of the earth into historical periods of geologic time allowed for the history of the planet to be studied and told more precisely. As particular strata of rock were analyzed by their fossil and chemical compositions, it became possible to draw connections between layers of rock across national boundaries. As it turned out, the naming process of these geologic periods, eras and epochs was dominated by British scientists. The Cambrian period, about 500 million years ago, is named after the latinized version of Cymru, or the Welsh name for Wales. The Devonian,

after the county in the southeast of England, and the Permian after the Perm region of Russia which was the reference area used by the Scottish geologist Roderick Murchison to define it.

The question of whether the anthropocene meets the formal definitions of a geological epoch is still being debate by the International Commission on Stratigraphy. Yet despite its official limbo, the rhetoric and poetics of the idea have proved remarkably successful in capturing the imagination and defining many of the public debates around climate change. However, what is actually meant by suggesting a nexus between humans and the geological history is not at all obvious. The anthropocene depends on a complex set of ideas about scale, agency, responsibility, and ways of being.

The stakes of the scales and framing of the anthropocene start to become visible when discussions around the actual beginning of the proposed period are considered. Humans have had an impact on the environment for some time and suggestions about when the anthropocene should start range from the dawn of agriculture thousands of years ago, to the industrial revolution, to a not yet arrived moment in the future when our impact on the environment is even more severe than it is today. Paul Crutzen had initially suggested 1784, the year when James Watt designed the steam engine and inaugurated the current era of atmospheric carbon production. However, the Anthropocene Working Group of the ICS suggests a very precise moment: 05:29:21, 16 July 1945, the instant when the Trinity atomic bomb was detonated at Alamogordo, New Mexico. The event inaugurated a twenty year period of atmospheric nuclear weapons testing that has added to the planet's geological record a layer of radioactive isotopes discernible the world over (Zalasiewicz et al 2015).

The usual anthropocene story told in public forums says something like "since 1800 we have done many things that have altered the earth system, we have recently figured that out, and now we urgently have to listen to our scientists and enter a wiser age". The "we" here is now speaking at a special scale, imploring all of mankind to take stewardship of the earth system (Steffen 2011). Yet this narrative, by collapsing all of us in to a single species, has the effect of obscuring the asymmetries and inequalities amongst humans under a kind of sublime and totalizing idea of scale. This is a problem because as scales collapse a diversity of particular people, institutions and decisions into a global frame, many crucial factors and responsibilities are elided. In many ways, the history of human involvement in the climate system runs much deeper than industrialization. The genocides of pre-Columbian populations led to a reforestation of farm land that pulled so much carbon out of the atmosphere that it helped trigger a period of global cooling, at its most intense from approximately 1500 to 1750, known as the Little Ice Age (Dull, et al 2010). And even beyond this, when one actually examines who was releasing all of the carbon into the atmosphere, the anthropocene could just as easily be called the "anglocene", with the UK and the US having contributed 50% of all carbon emissions prior to 1980 (Bonneiul 2016), or the "capitalcene", with just 90 companies being responsible for the production of 63% of all carbon emissions since 1751 (Heede 2014). Some have even gone as far as to name it the "White Supremacy-cene", to zero in on the history of Euro-American domination, with its roots in slave labor in the southern United States and textile mills in Great Britain, as the key animating engine of the contemporary carbon economy (Mirzoeff 2016). In other cases, humans are almost entirely effaced in conversations of anthropogenic climate change when ideas like the

"technosphere" are introduced. Proposed by Peter Haff, the technosphere is imagined as an "interlinked set of communication, transportation, bureaucratic and other systems that act to metabolize fossil fuels and other energy resources…[it is] an emerging global paradigm, with similarities to the lithosphere, atmosphere, hydrosphere and biosphere" (Haff 2013). This kind of framing suggests that a collection of technology and human systems is somehow autonomous and not subject to human control. However, as Gabrielle Hecht argues, control and autonomy are not the same thing; we redouble the aloofness from the core of the anthropogenic problem if we look at ourselves like aliens from the outside (Hecht 2009). We need to find ways to integrate our subjectivity from the inside of this system and develop ways of accounting for climate change which are sensitive to a multiplicity of histories.

The anthropocene narrative also holds that while humans have been affecting the climate for some time, we today are the first generation to really know and be aware of this. Importantly, however, this is not accurate. As early as 1778, the famous naturalist Georges-Louis Leclerc, Comte de Buffon had written with self-reflection and prognostication that the "entire face of the earth bears the imprint of man's power, so man through wise management of the earth will alter the influence of its own climate, thus setting the temperature that suits it best" (quoted in Locher 2012). And years later, in a less exalted tone, the French minster of the interior commented that "France appears to have been increasingly subject to a marked cooling of the atmosphere, abrupt changes in the seasons and hurricanes, partially attributable to deforestation of our mountains and land clearing" (ibid). By arguing that we are the first generation to know that humans effect the environment, this narrative de-politicizes the history of the strategies used to

control this knowledge and prevent it from manifesting in a political consciousness. Fabien Locher and Jean-Baptiste Fressoz argue this point persuasively when they write that:

> "Using a somewhat simplistic vision of the past so as to emphasize our own excellence and reflexivity is problematic in a number of respects. By virtually denying the environmental awareness of past societies, it depoliticizes the long-term history of environmental deterioration while, by stressing the recent reflexivity as an intrinsic characteristic of our contemporary societies, such narratives tend to treat ecological concerns as a given and disregard the conflicts that have actually driven them." (Locher 2012)

How the event and the period are defined is of critical importance because it sets up the terms and valences of a larger debate and programs of action. Yet today the conversation around the anthropocene is still one that still seems to be grasping for its mooring. This struggle for explanatory frames to account for anthropogenic climate change has inspired calls for a reconsideration of the presence and relevancy of carbon, the atmosphere, and the earth system in the telling of human history. In some ways this is attended by a return to more materialist ways of thinking, a belief that we can't understand our past or future without reference to energy flows and non-human agencies. While this is something that for a long time was seen with suspicion—especially in anthropology where nature had long been evoked as a kind of casual and explanatory power to account for difference between geographically distinct cultures—there is now a renewed interest in conceptualizing nature alongside culture. Chakabarty argues for this point forcefully when he claims that the distinctions between human history and natural history are collapsing and that anthropogenic climate change forces us to severely qualify histories of modernity and globalization by considering histories of capital in direct conversation with the history of humans as a species (Chakrabarty 2008).

Yet, despite all of this, when we choose to focus on the anthropocene at all, there is something ironic about it. While anthropogenic climate change is rightly identified as the cause of the global changes that this planet is experiencing, it is in many ways a history of anthropocentrism, the policing of what it is that counts as human and a indifference to the natural world, which produced the current crisis we are now naming. Critical conversations around the anthropocene tend to question the centrality of the human and argue that continuing to place man as the primary actor in world history redoubles the structural and moral problems that have gotten us where we are. Indeed, as Donna Haraway argues, an idea of individual or human exceptionalism has been deeply, if not discredited, tempered in both the social and the biological sciences which increasingly recognize the fundamental inter-relatedness of things and that firm categorical foundations do not really exist (Haraway 2015). By casting the diversity of people and actors as a single anthropos, the framing works to collapse the agency of an individual or of a group into that of a force, a thing of physics that acts upon something merely as an object without sovereignty or purpose. This becomes a difficult position from which to enact change. So while rhetorically the anthropos in the anthropocene tries to unify, there there are significant problems in how it becomes legible or transposed onto national and individual action.

2.2 The anthropocene's public space

The view of the earth from space is one of the most commonly evoked images in discussions of the anthropocene. These "blue marble"-style photographs first entered circulation in the 1960s. One of the earliest and most famous was the "Earthrise"

photograph which showed the partially eclipsed blue orb of the earth rising up over the gray surface of the moon. It is through imagery like this that the earth system becomes viscerally thinkable; it is something we can visualize and relate to from the perspective of a towering height. We look down on an autopoietic planet in a delicate equilibrium that creates order out of disorder and which can accommodate stresses, up to a point. The earth scientist James Lovelock introduced the idea of calling this complex system Gaia, comparing the planet to a single living organism that preserved balance and order but which could also be temperamental, like a beast (Lovelock & Margulis 1974). It is this blue orb, taken as a whole, which provides the ontological scaffolding that defines the object of the planet that the explanatory and rationalizing frameworks of science are generally engaging with. This is the thing that the UN's Intergovernmental Panel on Climate Change and all of the leading earth sciences experts point towards as the object in peril, and what must be protected. It is us.

Yet, while the anthropocene requires the synoptic, gods-eye view of the satellite, its existence also troubles that kind of transcendent form of knowing. The subsumption of particulars into totalities can only get us so far. Whether its the billion year sweep of the deep history of the planet, the idea of the anthropos as a consolidated entity, or the entirety of the planet snapped in a single frame, there is a crisis of perspective and an urgent search for a better framework to account for how the social, the historical and the climatological fit together. The anthropocene is something that is dominated by a visual culture that is tied to the communication of geologists, charts, satellite photos, and the like. What could an alternate aesthetics of the anthropocene be? In some ways we can look to writers like Anna Tsing who grapple with the question of how this idea of a global

scale is actually produced and how different institutions and practices are involved. By understanding how an idea of the global operates and how it effectuates action and thinking, we can consider ways of critiquing and reframing how the global is articulated (Tsing 2011). However, one of the difficult things about the anthropocene is that its complexity and multidimensionality work to establish a kind limit to what we can know about it while also pushing us to carefully consider what scales and audiences we choose to engage and the need to be mindful of the outcomes and stakes of those decisions.

Brian Holmes provides an inspiration to think about this challenge when he argues that if the anthropocene is to have a public space it is that of the metropolis. The metropolis not as a single place but rather as a "condition of relational awareness" that requires broad participation and which demands that the abstraction of large systems be wrestled with in the streets and in the company of others (Holmes 2016). Indeed, what would it mean to not hold Gaia up, but the unwashed, tangled, overlapping intersections of the city? The anthropocene reminds us that the earth is not a mere substrate for human history that can be held as external and static. It pushes us to recognize that we are at the intersection of multiple histories, multiple ways of coming to know and to exist with an earth system that is rapidly changing. And so to respond to the provocation of the anthropocene, we must ask how we can preserve an awareness of being at a particular moment or intersection of histories in the ways that we make place in its midst.

To do this I want to start by engaging with the streets of New York City, and particularly with a community of artists and designers who, among a great many other things, make watercolor pigments and other recycled materials from the weeds and ecology of a city that they engage with as a place in uneasy relationship with nature. To

be a weed is to be a life form in tension with people; it also is often to be geographically from elsewhere, to be invasive. Drawn from all over the world, weeds place New York into a broader ecological and geographic context, but they also demand engagement on their own terms: they sprout from the crevices of the city's grid and they exist in direct relationship with how the city names its empty spaces and how it rationalizes nature. I want to begin here, along the streets before stepping back up into the atmosphere as storms come to buffet the city's coastlines and place new tensions on how the city is made as a place in the midst of climate change.

Part of the reason for doing this is to ask what it would mean to capacitate new forms of social and ecological imaginaries that do not rely upon the totalizing tendencies of the anthropocene discourse. By beginning an inquiry into how place is made in an era of anthropogenic climate change it becomes important to remain attentive to how place is experienced on the ground and to ask what opportunities exist for individual experience and connection. New York becomes an interesting place from which to query this relationship because it as at once a reflection of a modernist fantasy that sees nature as something which can be dominated and overcome, while also being buffeted by ever rising seas and needing to confront the limits of the modernist paradigms. I wish to ask what an alternative natural history of New York might be, one that focuses on the deeply symbiotic relationship both between humans and the ecological, between nature and the way things are named. At times the kind of myopia of city dwellers becomes almost a caricature: the homeless which appear like fixtures of the street instead of actual people, the putrid smells which one no longer notices, the fact that one can suppose oneself alone while wedged in a throng of people. These are the kind of things that Georg Simmel

puzzles over when thinking about what happens to subjectivity when the senses are assaulted by the chaos of the modern city. I wish to ask how it is that the environment is something that becomes thinkable in this context, how does it extend out of the context of every day life?

2.3 Cartographic weeds: making place in the grid

On January 5th, 1811 the Russian ship Frances docked at Pier 32 in New York City near the base of what would later become the Brooklyn Bridge. It had sailed from St. Petersburg laden with 249 tons of cargo that spanned a wide variety of finished and raw organic materials. Its manifest listed quilts, bales of hemp, hareskins, horse manes, bristles and other assorted items, germs of life from the other side of the planet. Ships of this kind arrived daily in New York. To open a copy of the New York Evening Post from the early 19C is to see a city preoccupied by waterborne commerce: ships arriving, ships for sale, ships for hire, bulk commodities being sold dock-side. 1811 was a defining moment in the city's history because it was the year that the Commissioner's Plan was adopted. Just a few years before British troops would invade the United States and set fire to the White House and just twenty or so years after the US constitution was adopted, New York was in a period of accelerating growth. With a population of around 100,000 people, the city would add that sum to its streets each decade in an ever increasing clip, cresting over a million inhabitants during the 1870s.

The Commissioner's Plan of 1811 set out to design and plan for this growth, ebulliently anticipating a destiny for the city that would make it one of the largest in the world, or at least, as the commissioners imagined it, the largest of any "spot on this side

of China". At this time, the city's urban development was concentrated along its southern tip, extending from the Battery at the bottom of the island to Houston Street about two miles to the north. The Commissioner's Plan was so deeply influential because it was the guiding document that set out the city's grided structure that has, over the last two hundred years, characterized and governed the development of its built environment. Through a grant of authority from the State government in 1807, the Commissioners of Streets and Roads was established to determine the master street plan for the island north of Houston Street. Over the next four years, the Commissioners set out to survey the entirety of Manhattan island. While this was a process resisted vigorously by those owning or claiming title to lands above Houston Street—with the chief surveyor being arrested at one time by the sheriff, and his crew, at another time, being driven from a parcel of land by a vegetable seller hurling artichokes and cabbages—by 1811 a plan had been devised. Avenues would be laid out east to west in a numbered sequence, main streets would be at least 100 feet wide and no street would be less than 50 feet wide.

The decision on the part of the Commissioners to make an entirely gridded street plan was at the time unique and has been said to signal "the death of the colonial tradition" of American city planning that had produced cities like Williamsburg, Savannah and Philadelphia (Coke 1968:14). This was controversial at the time—as evidenced by the qualifications and arguments in the commissioner's final report—but was proffered as an advancement over the "supposed improvements by circles, ovals, and stars" which were dismissed as mere useless embellishments not befitting the future imagined for the city. Instead, the Commissioners dispensed with such frivolity and argued that a rectilinear grid was the most suitable for New York because, as any city, it

was “to be composed principally of the habitations of men… [where] straight-sided and right-angled houses are the most cheap to build and the most convenient to live in.”

The ambivalence about this decision to make an entirely grided city, however, has persisted vigorously over the years. In a review of 19C laissez-faire urban planning practices, the historian Peter Marcuse has remarked that New York’s gridded plan “has been called unhygenic (because it ignores orientation to sun and wind), boring (because it is geometrically unvaried), asocial (because it provides so little public space), [and] inefficient (because it ignores topography altogether)” (Marcuse 1987:287). Indeed, writing earlier in the 20C, the urban theorist Lewis Mumford put a sharper point on the critique, positioning it within a longer history of the commodity and its attendant forms of alienation:

> “The resurgent capitalism of the seventeenth century treated the individual lot and the block, the street and the avenue, as abstract units for buying and selling, without respect for historic uses, for topographic conditions, or for social needs. The ideal layout for the business man is that which can be most swiftly reduced to standard monetary units for purchase and sale. From the seventeenth century onward, Western city extensions, as in Stuttgart and Berlin, in London and Edinburgh, were made in the same fashion... Such plans fitted nothing but a quick parcelling of the land, a quick conversion of farmsteads into real estate, and a quick sale... Urban land, too, now became a mere commodity, like labor: its market value expressed its only value ... the town planned on these lines could sprawl in any direction” (Mumford 1961:421).

However, beyond being a unit of spatial division, the grid upon which New York’s street plan is based is a figure which also looms large in a deeper intellectual history of post-Enlightenment thought. The art historian Rosalind Krauss, examining the fascination of 20C modern artists with the grid as a form of both visual representation and epistemological ordering, has argued that it has served as a way for artists to establish and explore a realm separate from and outside of nature. Engaging with the theoretical status

of the grid, and particularly how it functions as a form that both reinforces and opens up certain core dualisms, Krauss argued that:

> "Flattened, geometricized, ordered, it is antinatural, antimimetic, antireal. It is what art looks like when it turns its back on nature … In the overall regularity of its organization, it is the result not of imitation, but of aesthetic decree. Insofar as its order is that of pure relationship, the grid is a way of abrogating the claims of natural objects to have an order particular to themselves; the relationships in the aesthetic field are shown by the grid to be in a world apart and, with respect to natural objects, to be both prior and final." (Krauss 1979:50)

Whether functioning as part of a capitalist logic that renders landscape dividable and exchangeable in a market of financial transactions, or as a kind of ontological domaining of the world that attempts to segregate nature in a subordinate realm, the grid in New York City forms the stage setting and formal structure of everyday lived experience. Yet despite the potential of casting the grid as a totalizing and complete imposition, it exists in a more complex relationship to how the production of place is understood and enacted. That which is supposed to contain nature and render it suitable for human development and civilization might perhaps in practice become an occasion to explore the more complex dynamics that exist in between people, environment and the production of place.

In his work on government rationality and the definition of nature, James Scott has written about how what is counted and what is legible from the perspective of a state comes to inform and influence a great many things. Yet, there is always something that escapes (Scott 1998). Nature—while itself by no means an obvious concept—can be said to have a way of pushing back. I was interested in how the ecological intrudes on the very grid that supposedly resists it, what it is that sprouts through the cracks and how these disruptions can be used to reframe and understand social relations with the ecological. In

many ways, the city is often imagined as a place that is fundamentally opposite of nature:

> New York City is one of the most thoroughly altered landscapes imaginable, an almost wholly artificial environment, in which the terrain's primeval contours have long since been obliterated and most of the parts that resemble nature (the trees on side streets, the rocks in Central Park) are essentially decorations. (Owen 2009:12)

And yet it contains and lives in tension with its past. "Long stretches of road like the Bowery or Broadway are actually retracting ancient trails atop the summit of hills (later leveled out in the wake of property speculation), over water meadows and marshlands" (ibid).

On an afternoon in June, one of the first sultry days of summer where the humidity of the air seems to carry all the city's life on its back, I arrived at the Metropolitan Exchange building on 33 Flatbush Avenue in Brooklyn. My plan was to visit Genspace, a community biolab where the relationships between the ecological, cartographic and city life were being engaged with. What I found was a diversity of individuals and organizations that had been attracted to the building and which all shared an interest in practices which produce and mediate our experience of place and change. Through the gathering, cultivating and processing wild and feral species on an intimate scale, the project was aimed at encouraging a dialogue around the wider implications of labeling species as "alien", "exotic" or "invasive" and providing its practitioners with an occasion to experience their urban habitat in unexpected ways.

An Eastern Meadowlark sang out as I approached the stained concrete in front of the building's door. Birdsong can be hypnotic, alighting in the back of one's attention and causing a subtle change in awareness. But something didn't feel right. The heat radiating off the sidewalk and the clang of trucks roaring down the rough asphalt expanse of

Flatbush Avenue struck a sharp discord with the edenic harmony floating on the air. As I looked up to the corner above the door where one might ordinarily expect to find a security camera, I saw instead a speaker. Examining the portal further, I could find no plaques or anything of the sort to account for the mysterious emanations issuing from above. As I later found out, this speaker was part of an installation called “Birds of Brooklyn”, a network of about a dozen speakers that operated across the borough during the daylight and early evening hours. The goal of this sidelong intervention into public space was to recreate the aural landscape of the birds that had once lived in New York but which had since vanished. The artist who conceived of the network has written about how the connection between silence and the failing health of the planet’s ecosystems creates a negative space that is rich with meaning and portention.

The 7-story, 40,000 square foot Metropolitan Exchange building that I was standing in front of was constructed in 1917 as the headquarters of the B. G. Latimer & Sons Furniture Company. During the 1930s, the ground floor was taken over by the Corn Exchange Bank and, on the upper floors, various decorating shops and printing presses took up residence. As the years wore on, the neighborhood of Downtown Brooklyn, along with the city at large, slipped into a period of economic decline and saw a sharp increase in poverty and crime. By the 1970s, the building was sitting abandoned and was purchased by its current owner in 1978 for less than $250,000, a sum and possibility which is difficult to countenance from the present moment in a New York whose real estate has become a global asset for capital seeking anonymity or a safe harbor. The building languished for decades as part of a city urban renewal plan which threatened it with imminent demolition during which time it operated as a kind of artist commune.

A sign on the door gave a phone number for Genspace that visitors were instructed to call in order to gain entrance to the building. It was just before 6PM and the people who used the Metropolitan Exchange as a shared work place were starting to trickle out. Before I could get my phone out, a man opened the locked door and told me that the elevator was broken but that the seven flight climb to the lab was not as bad as it sounded. For years prior, I had lived in an old tenement in the city's Little Italy neighborhood which required me to walk up six flights of stairs many times each day, so, familiar with what was ahead, I took his word for it and began the ascent. It felt fitting that the elevator would be out. In a city where the median price for an apartment was over $1million, and gentrification and redevelopment proceed with a vigor that made them seem to be almost forces of nature themselves, the fact that such a place could exist was remarkable.

Upon entering the building's lobby, its dim air layered thickly with the soft musk of history, the uncanny feeling of a present absence which had been imparted to me outside by the song of the vanished birds gave way to something else. I felt to be in the midst of a kind of vivified memorial, a place where a strain of contemporary techno-futurism had lodged itself in the very material, limestone context of an artist squat that had somehow withstood the gale force winds of real estate developers. Climbing up to the top of the building revealed something of the character of its inhabitants and the kinds of things for which the building acted as a home and a back drop. On the ground floor a large room beyond the staircase was stocked full of furniture, architectural elements, decor and other bric-a-brac scavenged from around the city over the previous forty years by the building's owner. Antique drapes and chairs from the now closed Engineer's Club

in Grand Central Station, a grand mahogany table from the old Biltmore hotel, and an endless expanse of other objects resisted the resting of the eye on any one thing in particular, instead reminding me of the countless people and moments and quotidian scenes that these curated and discarded objects had in some way shouldered. Salvaged things can produce a kind of melancholy, but here they rest, out of context and out of place. I wondered if they would live again, circulating back out in to the city, or the places beyond, again participating in daily life.

My reverie had carried me up the first few floors of the building. Many of the occupants on the intervening floors were graduates of the MIT Medialab who have since set up shop on their own, carrying forth the flame of the future that such an institution trades in, now needing to make their own way in the world, cut off for the moment from the substantial military and commercial funds that made their apprenticeships possible.

The Metropolitan Exchange is home to many individuals and companies that bring a certain mixture of design and technology together. There is one studio which presents itself as "merging the physical and digital" and which has produced projects like a gravity harp for the Icelandic performer Bjork and a kinetic installation for a window display at the upscale New York department store Barney's to celebrate the 20th anniversary of Christian Louboutin, the couture shoe designer brought to popular attention by Meryl Streep's character in The Devil Wears Prada (2006). There is a not-for-profit architecture studio that advocates for "smart city design and ecological planning", the headquarters of an NGO called the Participatory Budgeting Project which provides technical assistance and organizational support to communities in the US who want to involve the public in determining how portions of city funds are allocated. On

one of the middle floors, Gimlet Media, the podcast startup spun off of This American Life by producer Alex Blumberg, has its offices alongside those of Seed Magazine, a science and culture publication.

As I reached the seventh floor I treaded a familiar path towards the back of the building, moving through a warren of electronics and metal working studios towards the glass enclosed space that contained the Genspace community bio lab. Over the last year I had taken several public classes that were offered at Genspace on topics ranging from basic synthetic biology skills to techniques for preparing popular molecular gastronomy dishes. Many of the other students had already assembled around the rough granite slab table in front of the lab's door. In a corner an old donated PCR machine—a device essential for amplifying DNA samples so that they can be sequenced or otherwise worked with—was humming loudly.

Genspace opened in 2010 as a not-for-profit focused on promoting citizen science and access to biotechnology. Through dozens of classes, public lectures and other initiatives, Genspace acts as a node connecting scientific institutions, practices around entrepreneurship, networks of artist-designers and educational institutions together. One of the lab's longest standing initiatives is its support of the NYC Urban Barcoding Project. Conducted in collaboration with the Cold Springs Harbor Laboratory and funded with a grant from the Arthur P. Sloan Foundation, the Barcoding project is a science education initiative focused on getting high school students to go out into the city and collect biological samples from plants and other organisms and to then examine the DNA they contain to identify the species. This is an approach to the classification of life which is fairly recent. Instead of examining the phenotypes of organisms (how they look or

what their color is), this kind of approach focuses on thinking of genotypes as the primary characteristic of life. This kind of pedagogy produces an orientation to the natural world that is firmly rooted in the notion that nature is a thing out in the world that can be brought back into the laboratory and examined for its unique barcode, the essential thing which marks its particular place in a taxonomic system, much like a barcode can be used to distinguish between a can of soup and a quart of milk in a grocery.

Today, however, we were gathered to make watercolor pigments from weeds that we would forage across the city. While exhibiting similar practices of fieldwork and the post-processing of biological material in the lab, the practice of producing these materials was to be also rooted in the senses, and in developing an experience of history and relationship with the city as a thing at the intersection of human activity and ecology. In many ways, this was an engagement with the biological that did not begin in the register of science but rather that of craft. Pamela Smith, a historian of science at Columbia, has written extensively about how there is something important in the pedagogy and articulation of a scientific history of knowledge that takes into account the phenomenology of the experience of craftsmanship. Through her Making & Knowing project at Columbia, sited in a age-worn chemistry laboratory that was furnished in a top-of-the-line, 1970s aesthetic, Smith works with graduate students to recreate the recipes and techniques found in a 16C manuscript from an unknown French artist-practitioner. Much of Smith's scholarship is concerned with recasting scientific historiography from one focused on exceptional individual scientists to one that begins with the neglected bodies and experiential interface that proved so inseparable from the creation of scientific forms of knowledge during the early modern period (Smith 2004). Writing about this

interdependence, Smith argued that:

> In the seventeenth century, many self-described 'new experimental philosophers' began to revise Aristotle's definition of knowing as the knowledge of causes and to declare instead that making was knowing; that is, a made thing was a known thing. By extension, to harness natural processes to produce objects and effects was to know those processes, objects, and effects, and thereby to co-opt the artisanal bodily engagement with nature in the development of an epistemology which held that making an imitation of nature was itself a form of knowing. (Smith 2014)

I was introduced to Pamela Smith a few weeks earlier by a dean of strategic initiatives at Columbia I had been put in touch with in connection to the data science work I had been doing. When I went to visit Smith at her lab a few days earlier, she told me a story about, of all things, fatty sand. One of the recipes in the book of secrets manuscript that the Thinking & Knowing project was trying to reproduce involved the making of an earthen mold that was important in making casts of living creatures. This however presented a problem because contemporary notions of fatness and leanness did not easily translate to the experience of touching soil. The body was an essential part of how knowledge of the natural world was communicated at this time. The manuscript speaks of things like chewing on tin to see if it crackles, suggesting that it is of a particular composition, or of adding an ingredient at the precise moment it is cool enough to touch quickly with the finger. Fatty earth, as the team discovered through further archival research, was a very particular thing. The buttery, unctuous clay that the artist practitioner had in mind was produced by the long fermentation of clay and wool together. In practice this kind of composition is usually found in sites where pastures abut places where mining activity had happened. Such a material is difficult to come across within the boundaries of New York, but the recipe in this particular manuscript gave instructions on where such soil could be found close to the small town in France where it

was written. A researcher in a partner French university was called upon to go on an expedition, walking down a path that abutted a still operating vineyard to a clearing off the main road. He sent a few kilograms of the material back to the Columbia lab in Morningside Heights and when the team there used the soil they found the resulting mold to have a sticky surface, drawing them into the physical descriptions of materials that were so embedded in the forms of knowledge at the time. The peculiar chemistry, or terroir, or land-spirits of the French soil seemed to do the trick. Knowledge seemed to be both embodied and geographic.

Yet at Genspace, the focus was more on thinking about pigment making as a kind of contemporary craft which more than anything casts its practitioners in a new kind of experiential relationship with the ecology of a city where sidewalks are caked with chewing gum and cigarette butts and lots are peppered with fast-food wrappers and dollar liquor bottles. The group that was assembled at 33 Flatbush was self-selected, having responded to an announcement on Genspace's email listserv. But in many respects the entire building was full of such passers-by, a group of people drawn together by some kind of interest in art and technology and the communities that form around it.

In the lab that evening were a diversity of backgrounds. There was a man from LA with a young, fresh face, just in New York for a few days. He was a designer at Pixar but was interested in learning how to engage architecture in more sustainable ways of making, to get back beyond the digital. There was a faculty member at Parsons, one of NYC's design schools, who was intrigued by the topic, a Canadian artist on a residency at the School of Visual Arts, the office manager of Genspace and her mother, among other people.

The class was organized by Cecilia, an environmental scientist and artist who lived in New York. As people continued to shuffle into the lab I began chatting with Cecilia and discovered that I actually knew her husband, a software engineer at Mapzen, an open-source mapping company that was building geospatial technologies in the city. Mapzen will reappear in a later chapter as an important site of new cartographic practice that exists within a broader network of mappers in the city's geo community. Her husband was also friends with another friend of mine, Vijayan, who happened to have a residency at 33 Flatbush that summer. Vijayan and Cecilia's husband knew each other through the art-sec community in the city. Art-sec is a pun on the term info-sec, an internet abbreviation of "information security" which draws together a field of people worried about things like encryption and keeping networks secure. Infosec professionals are the sorts of people who go to hacker conferences, contribute to open source operating systems, run internet service providers, and sometimes work as spooks for the NSA. Art-sec, on the other hand, refers to a diverse group of critical artists who use their practice to engage with questions of privacy, power and social relationship in the context of new technologies. The term was coined by Kyle MacDonald, an artist who had installed software on laptops in Apple stores to take snapshots of people using computers and upload them to a public tumblr blog. Whatever the merit of the "People staring at computers" project, it resulted in Kyle being reported by Apple to the US Secret Service and being very publicly investigated. The event became a bit of catalyst for reorienting some of the conversations around critical technology art practices within the community of mostly NY and SF-based artists that MacDonald was a part of. Vijayan, and this broader art-sec community, will also appear later in a later chapter when I return to 33

Flatbush to learn about a device he had contrived to download imagery broadcast from Landsat earth imaging satellites overhead.

Figure 2.1 Bird's eye view of the city of New York. Brooklyn. Williamsburg. 1859.

Once we were all assembled, Cecilia led us up to the roof to begin the event. As I climbed up I saw scaffolding covering the rear of the roof, seemingly in a state of semi-decay. The old man who owned the building was climbing up and down the narrow staircase to the elevator machine room, presumably trying to restore its operations. He presented a striking image, wild white hair and a full white beard gave him the visage almost of Walt Whitman, the poet and journalist who had lived for many years in the neighborhood. Towering up just beyond the edge of the roof was a 45-story condo building—finished just 2 years earlier as part of a much larger project of redevelopment

in Downtown Brooklyn—where a designer friend of mine lived. A project he led designing a new way-finding system called WalkNYC had just been installed in thousands of locations across the city. It was placed by subway stations and points of interest and featured a heads-up map projection that rotated the cartographic view of the city so that it extended in the same direction the viewer was looking. Justified as part of a city initiative to improve the experience of tourists, it was also imagined to help life-long city residents find their bearings in unfamiliar neighborhoods.

We walked up to the south side of the building to introduce ourselves and look out at the various parks and green patches we could see from our vantage on top of Flatbush Avenue. Cecilia told us a bit more about herself. She was born out west in the Rocky Mountains and had always been interested in nature, spending a lot of time growing up in the woods. When she moved to New York for graduate school she became fascinated by the ecological aspects of the city, unable to shake off a sense of non-human life as present and agential in the world around us. As the sun began to set, we went around sharing stories about the memories we had with nature when we were growing up and discussing logistics for the next day's explorations.

In the morning we regrouped in Bushwick, a neighborhood in Brooklyn that in its southern section has the largest hispanic community in the city, and on its northern side a sprawl of industrial warehouses and superfund sites. As we walked along we had to raise our voices to be heard as a procession of trash trucks slammed against the pot-holed asphalt of the street on their way to one of the city's main waste transfer stations on Varick Avenue. It was fortuitous because Sammy, one of the members of the group, moonlighted as a walking tour guide for Atlas Obscura, an online publication and

community which tries to connect people with forgotten histories and places in various cities around the world. Sammy began to tell us about what this neighborhood was like in the 19C, when acid factories and swill milk dairies dotted the waterfront.

As we walked along the street, Cecilia would point at various plants as we went. We stopped in front of a lot she introduced as an urban meadow, a former gas station and auto body shop, currently teaming with life but slated to be paved over as a playground by the city. As we wade into an opening in the fence around the lot, Cecilia points out different species. There is golden rod, mugwort, clover and paulownia. We bend down, reach out, crotch and investigate the different effusions of green and color. As we walk on, a certain kind of plant-attuned attentiveness starts to develop for the group with people dashing ahead and off to the side when splashes of color are sighted.

As we reach the end of the block, we had found over 30 different wild plants along the hundred or so feet, with more than 5 in a single crack of pavement along the side of a building. Cecilia brought the conversation around to what it actually means to call a lot vacant. In discussions of urban ecology, there are usually three types of landscape discussed. The first are remnant landscapes, the woods and bits of real nature that have been left over as a city was built around them. This idea, however, tends to efface the fact that, at least around New York City, Native Americans and a pre-urban European population lived and traveled amongst these areas. The second are managed landscapes, the parks and lawns that require human maintenance to survive and persist. The last are ruderal, or degraded, landscapes. These are usually how vacant lots are categorized, seen as highly distributed, abandoned spaces that fragment the broader ecosystem of a place. For animals like mice this can create real pockets of diversity.

Jason Munshi-South, an urban ecologist who has spent considerable time studying rat populations has found that there are genetic distinctions among mouse populations living in the far north of the city in Pelham Bay Park and those who live in Central Park—there's simply no way for them to sustain the journey in-between.

But ascribing a designation of 'vacant' to these lots overlooks the rich ecology and uses to which other species have put them. Plants that grow there are not spontaneous, but companions that grow in the shadow of human activity. Cecilia is fond of calling them urban meadows on our walk, calling attention to the fact that they help make the city livable, providing food and shelter for non-human animals, cooling the air, sequestering carbon, and adding greenery and color to neighborhoods which are often dominated by a drab, concrete built environment.

There is an entire ecological realm in what are often thought of as the concrete deserts that stretch between the manicured botanical gardens and sprawling parks of the city. And in a sense the attention that we are being trained in makes apparent a new layer of the city's structure, this plant community whose tendrils connect not only to the city's local ecosystem but which connect New York as a place to a much longer history of global circulation. Sometimes called "spontaneous plants", "wild urban greenery" or simply "weeds", Cecilia prefers to call these lifeforms "unintentional plants" and tries to call attention to what they teach us about adapting to hostile environments and about the migratory and global nature of life on this planet. Someone asks about Frederich Law Olmsted and the way that he would choose trees to be imported for the designs of his parks, with Central and Prospect being the two most famous in New York. We are in eyeshot of tiny, but strikingly blue, flowers growing out of the cracks beneath a chain link

fence. Cecilia draws us over. Invasive species travel in relationship with humans. The Asiatic dayflower is a summer annual whose flowers open from dawn to the early afternoon during which time they can be easily harvested. Asiatic dayflower is native to Japan and Northeastern China where it was used as a dye in wood block prints before the introduction of the synthetic Prussian Blue pigment. They first began their westward journey from Asia by way of St. Petersburg where they were cultivated as an ornamental plant. Cecilia tells us how a horticulturalist named Barberry saw them on a trip to Russia and brought them to the US to adorn Harvard's gardens. From there they continued spreading across the eastern and Midwestern United States, going feral. Today they are considered a super weed in the US because of their immunity to Roundup and their appearance in soy bean and corn fields in the Midwest.

2.4 Companion species for the anthropocene

Figure 2.2 Columbian-Asiatic Exchange (Pokeweed and Asiatic Dayflower), 2013

As the day wears on we return to Genspace to make our pigments. We had gathered Asiatic dayflower, Canada goldenrod, dandelion and other species. Cecilia had brought some frozen pokeberries she had harvested last summer which have a dark crimson color but which are only available in late August. Making watercolor pigment is a fairly simple process. First the plant sample containing the pigment is put into a mortar and pestle and, with a little distilled water, it is mashed up to release as much of the pigment as possible into the water. Next, the resulting liquid is strained through a series of sieves so that a relatively particle free colored liquid is left over. To this is added gum arabic to bind it together. Gum arabic is a tree sap produced by acacia trees in the Sahel of Northern Africa—an area in between the Sahara and the Sudanese Savannah—where it is harvested by nomadic people who sell it to middle men who bring it to a global market which mostly uses it for the production of cosmetics.

As we start to paint and play with the pigments we are making, Cecilia shows us some of the work she had made with them earlier. I was struck particularly by a series of maps which showed the migratory pathways of various invasive species that she had found in the city, painted with pigment that she had made from them. In a moment of reflection, Cecilia says that:

> "In Bushwick we are co-evolving with the weeds. The plants that survive and thrive here in dense human populations are those whose evolutionary strategies mirror our own. Tough, flexible, opportunistic, and increasingly global, these are plants who have thrown their lot in with ours…Weediness is a good tactic when things get unpredictable. We have untended greenery filling our empty lots and sidewalk cracks, responding along side us to the challenges of contemporary city life. I think of these plants as companion species for the anthropocene."

In many respects the event provided me with a new way of thinking about the relationship between ecology, cartography and urban life. Here we were, in 2016, on the

top floor of a building in Brooklyn, a dusty, run-down relic of the city's past, a place which seems to stubbornly resist all the changes going on around it while also providing a shelter for the production of a particular kind of high technology future. We were at once deeply enfolded in a kind of material and social history of New York City while also developing an attention to the ecological world that interpenetrates it. To return to Brian Holmes' provocation to think of the city as the public space of the anthropocene, what can we learn? How can we relate to the question of what nature is in the city—how it connects us to longer histories, and places far away. There is a confluence of histories, organisms, imaginaries, breezes, pollen, rumbles, coming together. This is not a node in a network, nor is it a tangle of threads; it is a warm summer night that rises up from the street to challenge the categories through we make place. To make pigment one must first walk the city and learn to read the cracks of the sidewalk. The weeds themselves contain maps, and there is something that cannot be separated between being on the right-angled concrete of the sidewalk and a four hundred year history of migration and travel that puts not only the Bangleshi-born next to the Senegalese-born but the greens of the Chinese ailanthus tree next to the reds of the European bittersweet nightshade. It raises new questions about making place in the city. What are the unseen interstices and how do they connect elsewhere? In the anthropocene, what is it to live with other species? How do history and life intersect and engage with each other? How do we become attuned to the networks of movement, organic and otherwise, in and out of the city, along its streets?

The experience provided an opportunity to think about the many ways of making a place in the anthropocene, from the rarefied sweeps of cosmological time to the growing of weeds in the sidewalk cracks whose very presence pulls the city into an interspecial

context of multiple possibilities and multiple histories. It opened up questions of what it is to be attentive to being in a place and the many lifeworlds that cut across it. Jakob von Uexküll, the early 20C zoologist, wrote extensively about the question of what it means to engage with the overlapping, co-presence of various forms of life, introducing, as he did so, a kind of phenomenological hermeneutics (Uexküll 2010). Uexküll work in zoology sought to dismantle the dominant paradigm that matured in the 19C of considering life in a hierarchical taxonomic tree. Instead of privileging this anthropocentric scheme for ordering and interpreting life, he proposed a phenomenological model. It imagined that each organism inhabited a discrete perceptual world that was hermetically set off from the worlds of other species. This perceptual realm or environment-world he referred to as the umwelt of an organism. As Uexküll has it, the umwelt is constituted only by a collection of marks or carriers of significance that are found by the organism in the world-at-large (in a space he calls the umgebung or the objective world). While distinct umwelts do not communicate or interact directly, they still enter into relationship. A classic example that Uexküll uses to articulate this point is that of the fly and the spider. The spider is essentially blind and it cannot measure the fly or assess its shape or velocity, yet it is able to construct a web coated with a viscous liquid that can capture it and provide a sufficient elasticity to hold it. What is more, the pattern of the web is constructed in such a way that it is proportioned precisely to the visual capacity of the fly, thus making it impossible for the fly's limited sight to detect. And so while the umwelt of the fly and the spider do not overlap—they are each, in a sense, excluded from the other's perceptual world—they are still able to maintain a relationship. In considering the question of how we should name the anthropocene, or

what kinds of conceptual and imaginative frames can be called upon to help make the complex tangle of the physical planet and human activity more ready to meet the crisis in which we find ourselves, the umwelt provides a suggestive start. How can we develop an analytic and a way of thinking which preserves the distinctness and particularity of a wide variety of perceptual frames while at the same time engaging with the ways in which they come to relate with one another? In the foregoing I have tried to open a multiplicity of ways of thinking about the city and making place in the midst of what is called the anthropocene. But this is only a beginning and a stage setting. In what is to follow, I will aim to begin to expand these suggestions of how we frame and relate to different practices of world making by considering more deeply how it is that the city as a local place of human dwelling, and the planet as a broad construction of something at risk from its changing climate, are produced.

Chapter 3. City of Bits: Data Science and Climate Science

3.1 The morning after Hurricane Sandy

When I awoke on Tuesday, the morning after the explosion of the Consolidated Edison transformers on 14th Street plunged Manhattan into darkness, I powered up my cell phone to see what I could learn about the storm's aftermath. While not entirely surprising—but portentous none the less—my telephone could not pick up a signal from any of the neighboring cellular networks. I dressed—finding, fortunately, that the tap water still worked—and bypassed the refrigerator on my way out the door. On the street in the city's Little Italy neighborhood a stray tourist family—presumably from one of the downtown hotels—wandered about in a confused daze. I started hiking north, supposing that things may be better up there. I saw a few other people on the street, studying their cell phones, entreating the glass face for some resumption of contact. After five or ten minutes of walking, I crossed over to the north-side of Houston Street and saw a couple strolling down the sidewalk with coffee cups piping in their hands. Excitedly, I approached them, asking where they had found their enviable beverages. A few blocks up Broadway, I was told, there were a few open delis. As I followed their directions, I was curiously struck by what I found. Some stray candles and a fluorescent torch shined faintly inside, not really illuminating the deli but rather giving a sense of its general dimensions. Behind the grill a man was making egg sandwiches while another boiled pots of water to pour into the self service coffee makers. It seemed that the gas was still on. The line of patrons snaked into the depths of the store and people chatted with civil confusion, or a frayed frustration, depending on their disposition. I paid cash for my coffee—the credit card machines of course requiring electricity, or at least cell phone

coverage, to work—and, much to my surprise, it was only $1.50, a price much lower than I am accustomed to paying. Continuing on my way, I walked another half of a mile north along Broadway until I reached Union Square. There was a strong police presence, with officers directing traffic and ConEd repair crews beginning to encamp on the park's south side. I powered on my phone again and saw that I was able to get access to my email. Picking up a bit of intelligence, I learned that the city had power in the West 30s and so decided to continue my northward hike through the spitting, chilly rain. When I finally reached the electrified zone, it was the sight of working traffic lights a few blocks away that first indicated to me that things were proceeding relatively normally up there. I stopped immediately at the first Chase bank I passed to withdraw a supply of cash. The lobby of the bank where the ATMs were located was filled with four or five people charging their cellphones, huddled around the vestibule's electrical sockets. I walked a few more blocks and settled myself at a pub for lunch. There was similar competition for spare electrical sockets here too, but I was able to get a warm meal and settle my check with a credit card. I was surprised in the days that followed not to observe much of a street based economy emerge in the city. I remembered that less than half an hour after it was announced Osama bin Laden was killed, or when there seemed to be even a scent of rain in the air, hawkers would appear on the street with American flags or umbrellas, depending upon the occasion. Yet no one showed up to sell candles or soup or flashlights that week.

Needless to say, Hurricane Sandy was a traumatic event for New York and New Jersey, causing more than 100 deaths, destroying whole coastal communities, crippling mass transit and leaving more than 8 million people without electricity. In many respects,

the storm made acutely visible the risks of climate change to the communities and governments of the region. The hurricane happened while Michael Bloomberg was the mayor of New York. First elected in 2001, Bloomberg was in the middle of his third term, a feat made possible by his success in having the city's term limit laws changed from their previous two term cap. Variously known as the "CEO-mayor", the "nanny-in-chief" (because of his efforts to ban large volume sugary sodas and other public health initiatives) and one of stop-and-frisk's biggest proponents, Bloomberg had a lasting impact on how the city organized the work of servicing its 8.5 million residents. Prior to becoming mayor, Michael Bloomberg ran the eponymous financial data company Bloomberg LP, whose desktop information terminals sit in the office of nearly every professional financial trader in the world. During the twenty years Bloomberg spent building his company prior to becoming mayor, he amassed a multi-billion dollar personal fortune that made him one of the wealthiest people in the world. Much has been written about Bloomberg's beliefs and style of management, one which focuses on statistics and decisions made through quantification, a spirit captured in numerous pithy phrases attributed to him like "in God we trust, all others bring data" or "if you can't measure it, you can't manage it".

As I will explore in the following chapter, while statistics and evidence-based management science has been practiced for a long time, an emerging concept of data science was developing at the time that Sandy hit which was vigorously adopted by the administration as a response strategy. In many respects the turn to data science that attended the crisis caused a redoubling of what were at the time nascent capacities across the city. Over the 11 years that Bloomberg was in office before Hurricane Sandy hit, City

Hall had been run in accordance with the management practices that the mayor had developed in the private sector where data, at least publicly, was discussed as the decisive arbiter of any policy or organizational decision. However, the disruption of critical infrastructure and the challenge of coordinating an emergency response (City Hall was, after all, without power for nearly a week) revealed the fragility of the access to data and the productive uses to which it could be put in the management of the city's operational resources. The extending and hardening of data networks were seen as a core response strategy to help with issues of resiliency in the future. In many respects, Sandy was a kind of catalytic event that revealed the limits of the city's ability to govern and remain aware of the activity occurring within its borders.

The result of this was a hybridization of the city as a place made out of data and which existed as a complex system that now needed to be reconciled with the predictions and models of climate forecasters. In New York City, data science emerged not only as a discourse and collection of human networks, but also a set of practices that are focused on constituting the city, its inhabitants, its trees and buildings, its sewers and cell phones through data. To engage an anthropology of data science, this chapter will focus on the work that is being done to imagine and model New York City as a kind of dynamic information system and the new notions of governance and resiliency that attend it as well as the profound effects these practices have on structuring individual experience.

There were many intersecting threads that account for New York's turn to data science and the broader intellectual and institutional currents that made it possible for the city to be conceived of as a data object. In what follows I will take a conceptual and institutional history of data science that in many ways anticipated and shaped the

establishment of the City's Mayor's Office of Data Analytics and how it became recast, in part, as a response to Hurricane Sandy. Following this, I will explore two ethnographic field encounters which will help to situate the application of data science in the ways in which places are produced and readied for action by a multiplicity of actors. The first examines how an idea of data science gets applied at the nexus of city administration, beliefs about the representative power of data, and an emerging configuration of actors who implement and make this possible. There are complex social and institutional things happening to recast the city as a data network which often exist somewhat below the surface, sited in organizational configurations, the ways in which work is structured and the plumbing that makes it all hang together. The valorization of data science within the context of New York's city government has become extremely agential and as a response to manage cities in the midst of climate change it remains important to be attentive to. The second is through an experience at an open data workshop that was held at the US Treasury Department. Its primary concern was how people and companies become representable as data objects and particularly how this is being done within a complex technological, regulatory and political field which is committed to making long standing practices of state administration legible and compatible with data science as a practice of world making. The work that is being done at this level of federal policy stands as an important conduit through which to understand how government is being reformed to accommodate the aspirations of data science and what this tells us about the contingent ways in which technologies and practices come into being. However, to better understand the dynamics of the emerging practice of data science and to position how New York is in someways being refashioned as a calculable object that can be exposed to

various analytic techniques, it is important to ask what is meant when we talk about "data science" and how it emerges from specific intellectual and institutional contexts.

3.2 The oracle speaks

In an often-referenced presentation given in 2010, then CEO of Google Eric Schmidt told an audience gathered in Lake Tahoe that the amount of data generated every two days was equivalent, byte-for-byte, to all of the data created between the dawn of civilization and 2003. Schmidt used the astonishment that the delivery of this figure stirred only as an opening. He quickly followed up: "we can, using AI techniques, predict where you are going to go… we can predict who you are" (Schmidt 2010).

A bold claim. Placing aside for a moment the technological triumphalism of Schmidt's broader remarks that afternoon, which posit the growth of networked computing as inevitable and outside of the political and social sphere, there is something important about the kind of equivalency that is taking place in his speech. By drawing together the increase of information being created daily and a claim to predictive – almost oracular – forms of knowledge, Schmidt gives voice to the grandeur of ambitions surrounding the collection and analysis of big data. This, of course, is not a discourse that is unique to Google. Over the last decade, vast sums of money have flowed into companies like Facebook, Twitter, Snapchat and others whose main raison d'etre is their ability to generate data about people, places and events which, it is believed, can be mined for financial value. Following a similar logic, the Edward Snowden disclosures of 2013 made it abundantly clear that the National Security Agency shares a similar view of the world as they pursue a global dragnet of telephone traffic and internet

communications (Greenwald 2014). Within data, it would seem, lay the promise of answers to important questions.

But what does it mean not only to position the creation of data as a kind of precondition for civilization, as Schmidt does, but to speak of all the data that was created between its dawn and the present? What does it mean to do so in terms of bytes and server farms? What kind of totality is that? And what relationships are suggested between the data and the things that created it? If images of the Sistine Chapel are included, is the smell of the towering place? The series of cracks by one of the southern doors whose shape may remind a supplicant or a janitor of a whispy childhood dream? What has escaped making an impression? If this data is held up to be a reflection of civilization, what do computers as products of twentieth century warfare, or the security practices surrounding data centers, which favor geographic invisibility and high security methods in the constitution of their spaces, or the 300M tons of carbon—a sum which exceeds the annual output of Turkey or Poland—burned to cool and power them have to do with it? Does the materiality of this data present a friction to a claim of transcendence? What exactly is this big data?

When one looks to the pages of the technical or business presses, there is no shortage of commentary on big data. As Schmidt testifies, there has been a more or less quiet, but none the less profound, expansion in the latter portion of the last decade in the volume of data that is being generated and, importantly, archived: everything from the license plates of cars traveling interstate highways, to point-of-sale transactions, the meandering of one's mouse around a web page, the calls to a sick parent. While some of these datasets are new, the trend of generating and archiving data is of course not. The

census and other datasets on natural, industrial and other facts have been operative for centuries at this point. As many scholars have shown, data has not only long been used in the service of the management of natural resources, planning colonial campaigns and the administration of industrial processes, but as part of a broader technique of power and ordering of the world (e.g. Foucault 2010, Scott 1999).

What is beginning to change in recent years, however, are the uses to which data is being put, the kinds of questions it is being asked to answer, and the concomitant ways in which individuals, places, political candidates, throughways and other things are made available as both objects of knowledge and things towards which action can be directed. In a quotidian sense as a privileged consumer, one is routinely brought into direct contact with big data: a routing algorithm considers the positional data from a slew of cellphones to predict traffic and the optimal path to drive across a city; a credit card advertisement is shown because of a certain type of pathway you traced through the internet; a waitress arrives with a complementary beer as you pull the lever on a slot machine after a run of bad luck. However, as the Snowden disclosures showed, it is increasingly impossible not to become directly subject to the archival and analytic logics of big data as the NSA continues to archive global telephone and internet traffic. In the context of the United States' drone strikes in the Middle East, missiles are often not aimed at people but rather at SIM cards exhibiting certain characteristics (Schaill & Greenwald 2014). We might ask what it means for the state to be prosecuting acts of war not against combatants, or infrastructure, but rather statistical signatures? The collateral damage from these strikes, and methods for evasion which include routinely swapping SIM cards across broad groups of people, certainly speak to the messy and material intersections of data analytics

and the world of dark skies and wedding parties.

3.3 Big Data?

Under the ontologies of data and the paradigms for their utilization that existed during and in the wake of the Cold War, data was deliberately collected and was used to validate or refute particular hypotheses (Edwards 2010). However, in this more recent turn, data is collected much more indiscriminately in part because it exists as a kind of engineered by-product of our increasingly digitally mediated lives and approached with open ended analyses looking for statistical correlation. Stored indefinitely in databases – the cost of which is not material to the parties concerned – the accumulation of this data, for banks, internet companies, intelligence services, political campaigns, retailers, and others, has attained such a magnitude that it had by the early 2000s begun to overwhelm both the technical and conceptual resources available to make it intelligible. In tandem with this trend of data accumulation and data infrastructure stress, however, search engine companies had been developing substantial technology and expertise around the problem of managing and querying data at a big scale, creating in the process important open source technologies like Apache Hadoop and commercial infrastructures like Amazon Web Services. The emergence of these two technological components in recent years has made it technically possible for this data to be harnessed, analyzed and rendered by much broader ranges of people than were previously able.

While the question of data has been in play as a field of scholarly and philosophical interest in varying forms since at least the eighteenth century (Hacking 1990, Shapin & Schaffer 2011, Scott 1999, Kant 1963), "big data" as an ontological

entity of its own is both quite novel in the world at large (e.g. Mayer-Schönberger 2013, Manyika et al. 2011) and its critical engagement within the social sciences is still relatively nascent (e.g. Boellstorff 2013, boyd 2012, Crawford 2013, Bowker 2005). In some respects the idea of "big" data (as a concept of scale) obscures what makes it unique and important as a field of ethnographic research. As scholars of science and technology have noted, technical apparatuses are not passive, ahistorical entities — as perhaps Eric Schmidt would have us believe — but rather things whose existence is predicated upon and shaped by the social ecologies of their emergence and whose presence in a social world often has complex and unanticipated interactions and effects (e.g. Edwards 1996, Turkle 1995, Mol 2002, Bijker et al 1994, Rabinow 1992). Big data itself, taken as a bruteness of scale, feeds into the belief commonly held in public discourse that masks technologies under the cloak of mere artifact. And while actors in the midst of big data would not contend that data is collected or relevant without an application – irrespective of whether or not that application has yet been imagined – there is on this first level an uncritical drive towards its enthusiastic accumulation. What is more, as Lev Manovich points out, "big data" is a term that inherently lacks a solidity in its referent (Manovich 2011). Yesterday's big data, that which required super computers and dedicated data centers, is today's mere data, something that can be engaged on a commodity desktop. It is in this sense that while scale, both in brute bytes and in the kind of data being accumulated, is where the idea of big data finds its harbor, the most relevant and engaging lines run between the data itself and the uses to which it is being put, the relationships to which it is giving rise. On technical, organizational, and disciplinary levels, new practices of knowledge making, new epistemologies and attendant ontologies,

are being drawn out of this data and are becoming operant as actors and modalities in the broader world. Big data is simultaneously effecting a change not only in what we can know about the social and physical worlds, but in so doing is changing also what we understand those things to be, as the tenor of Schmidt's earlier comments at least hint at.

Yet, undergirding these practices, behaviors and affordances is an intricate network of technical apparatuses, open source software communities, physical infrastructures of connection, digital interfaces, organizations and emergent conceptual paradigms. While the use and reliance upon big data has become a commonplace, whether visible or not, in the daily practices of those in advanced industrial societies, the expert communities who create, maintain and extend this data, and the socio-technical ecosystems in which they exists, operate at some remove from the quotidian incarnations of their efforts. Consequently, it is important to investigate how elites in the centers of data and computationally fecund organizations are developing paradigms and discourses for creating, interpreting and acting upon big data sets while those outside of these centers are being left without the resources to understand, engage or participate in these rapid and compounding changes.

3.4 Introducing Data Science

Whatever big data is—whether a group of technologies, beliefs about the representative power of data, a marketing concept designed to attract IT budgets, or a set of anxieties about an unprecedented accumulation of data—it is the data scientists who are often the people who wrangle, analyze, model and interpret big data. "Data science," as a noun, has been in circulation since the 1970s. In recent years, however, data science

has come to refer to interdisciplinary teams of statisticians, programmers, computer systems experts, and behavioral scientists that work within startups, established corporations, governmental organizations, and research labs to invent new tools and techniques for making these big data sets intelligible. Often working asymmetrically within organizations, data scientists are not generally expert at managing and maintaining large scale data infrastructures, but rather in bringing statistical methods to those data sets in order to generate explanatory stories or models about why certain things happen and then to communicate or to incorporate those models into broader technological or operational systems.

Data science, as does any emergent phenomenon, has a plural and complex history that challenges and exceeds any particular historiographic frame (Fischer 2007, Rabinow and Marcus 2008). For whatever else it may be, many of the organizing analytic principles of data science emerge from both the disciplinary history of statistics as well as from the intellectual history of probability as a way of ordering the world and rationalizing uncertainty. One of the most cited works in the disciplinary literature, the *History of the mathematical theory of probability from the time of Pascal to that of Laplace*, was written in the 19C by Issac Todhunter and tracks the history of statistics as a sequence of mathematical puzzles that were unraveled by a series of great thinkers (Todhunter 1865). While Todhunter's work is most valuable for its wealth of detail in engaging the intellectual development of particular methods, he also stands as a paragon of a particular historiographic frame for organizing the history of science that focuses on concepts and ideas to the radical exclusion of their sociocultural contexts (Pfaffenberger 1992). Some other notable histories have arisen in recent years that include the lives and

settings in which the statisticians were working, yet they continue to preserve the binary between an autonomous realm of ideas and a messy setting of culture as a backdrop (e.g. Hald 2005, Stigler 1986), a point critiqued by feminist scholars of science and technology for presuming a clean division between a neutral knowledge-gather and a passive and stable object of inquiry (Haraway 1991, MacCormack and Strathern 1980, Ortner 1972). However, by examining the ways in which statistics have been used to create and legitimate knowledge through social and political organizations, works by scholars like Ian Hacking and Mary Poovey recenter statistics in the context of changing epistemological regimes, examining how the proliferation of statistics as facts and frames grew to become explanatory in and of themselves, in many ways prefiguring an ordering of the world that data science presupposes (Hacking 1975, 1990, Poovey 1998).

There is also a strong disciplinary and professional history within computer science and data mining that is important for situating data science. An often cited inaugural paper is the 1962 piece by John Tukey entitled "The Future of Data Analysis" (Turkey 1962). Tukey, a researcher at Bell Labs and collaborator with John von Neumann and Claude Shannon, is a relevant figure in the history of information theory and cybernetics credited with, among other things, coining the word "bit" (Brillinger 2002). In "The Future of Data Analysis," Tukey highlights the divergence between statistical knowledge as it is advanced in pure mathematics and its beneficial incorporation into techniques for analyzing data. To remedy this gap, he makes a call for data analysis to be thought of intrinsically as an empirical science, rather than grist for statisticians who are interested in inferring the general from the particular. In rather stark and paternalistic terms that call to mind a midcentury American culture in an intellectual

panic after Sputnik and McCarthy, Tukey calls for "daring" and a "facing up" to more realistic problems when utilizing statistics to create knowledge about the world:

> "Finally, we need to give up the vain hope that data analysis can be founded upon a logico-deductive system like Euclidean plane geometry (or some form of the propositional calculus) and face up to the fact that data analysis is intrinsically an empirical science. Some may feel let down by this, may feel that if data analysis cannot be a logico-deducive system, it inevitably falls to the state of a crass technology. With them I cannot agree. It will still be true that there will be aspects of data analysis well called technology, but there will also be the hallmarks of stimulating science: intellectual adventure, demanding calls upon insight, and a need to find out "how things really are" by investigation and the confrontation of insights with experience." (Tukey 1962:62)

This rejection of pure formalism and positioning of empirical science as almost a challenge of masculinity in being able to face the "really real" as the organizing object of statistical experimentation provided an important early voice in the discipline. With the first experiments using computers to model weather only a few years in the past, the ideas of exploratory data analysis that Tukey advanced were only just becoming technically possible. By using statistical methods in a way that not only sought to model, but as practices of exploration and inquiry, this intersection for statistics and computation left data analysts developing informal theories about social organization and dynamics. The cycle between theorizing about social reality, designing new strategies for acquiring data, and using models and computers to test hypotheses became the chartering methodology of a practice that has only recently come to be known as data science.

During the 1970s and 1980s a field of practice begins to take shape under this general paradigm of utilizing statistics as an investigative tool in an empirical science of data analysis. An important intellectual hub arose in 1977 with the foundation of the International Association for Statistical Computing, an organization with the ambition of linking "traditional statistical methodology, modern computer technology, and the

knowledge of domain experts in order to convert data into information and knowledge" (“About IASC” 2014). From this period onwards, statistics came to be used not only as an actuarial or administrative analysis of data but rather as an active and promiscuous enframing of the world that was increasingly involved in experimentation and the development of new kinds of truths. In some ways this practice did not enter a more public view until 1994 when a cover story in Businessweek on database marketing told what at the time was a new story of consumer data and how analytics techniques were being used to segment individuals and to treat them differently based on models of actions and responses (“Database Marketing” 1994).

"Data science," as a term that one reads about in the New York Times or in the Harvard Business Review, emerged much more recently and more suddenly. In January 2009 Google's chief economist Hal Varianha gave an interview to the McKinsey Quarterly that over the next year or two was cited quite broadly in an ever proliferating crop of blog posts and thought pieces announcing the rather sudden arrival of data science (Varianha 2009). Varianha's claim that "the sexy job in the next ten years will be statisticians", which was given in the context of a sweeping commentary on the rise of data and computation as a natural step along a progressive chain beginning with the industrial revolution, was referred to widely as a bit of supporting evidence that the age of the data scientist had suddenly arrived.

3.5 The emergence of data science in New York

Many of the most prominent figures in the New York data science community, who were among the most instrumental voices in the popularization of data science as both a

buzzword and a community in 2010-2012, were in fact a network of friends and collaborators, many of whom were based in New York City. As a community it began to emerge publicly in 2010 when Hilary Mason (then chief scientist of the popular link shortening site bit.ly), Chris Wiggins (then Columbia applied mathematics professor, currently chief data scientist at the New York Times), and Drew Conway (former member of the US intelligence community, then PhD student at NYU and organizer of a popular statistics Meetup) wrote a series of widely circulated blog posts trying to define what exactly data science was. In tandem with this, they very deliberately drew together a community of people within the city through a series of Meetup events and informal drinking after hours in offices and in bars. While this new term started to spread, articles began appearing in the popular press declaring data science the 'hottest job you haven't heard of', Drew Conway, Hilary Mason and others were organizing the first DataGotham conference.

DataGotham was held only twice, in the autumns of 2012 and 2013, but helped to actualize and legitimize both data science as a community in New York and to claim a share of its intellectual and market relevancy. The conferences were held in the auditorium at the New York Academy of Medicine and attracted several hundred attendees. Financial sponsorship came from a wide range of interests: IA Ventures (one of the more prominent venture capital firms in the country), In-Q-Tel (the CIA's venture capital firm and its arm for liaising with the tech world), Foursquare (the company whose service allows people to broadcast and certify their geographic location) and NYU's Stern School of Business. Speakers came from a variety of places, but largely concentrated in relatively young, venture capital backed technology companies and academic

departments. However, also among the featured speakers was the director of the newly established NYC Mayor's Office of Data Analytics. Occurring just a few years after data science had begun both to be a topic of conversation, as well as a banner that preexisting practices began to be organized under, the conference was important for making visible and public the fact that data science and a community of practitioners had arrived in New York.

Since 2010 a tremendous amount of interest and attention has adhered to the idea of data science as a field of practice, with many prominent universities launching degree programs and chief data science roles appearing all over centers of power from the Fortune 500, to investment funds and startups, to places like the World Bank, the Obama election campaign, and elsewhere. Data science was able to assume such a broad reach so quickly in part because its still in some senses a very loosely defined thing and also because its been able to absorb talent from adjacent disciplines (e.g. physics, bioinformatics, statistics, applied mathematics) and utilize cloud based computing resources to the point where a small group can relatively quickly and easily analyze something like the totality of company's transaction data, a feat unimaginable ten years ago.

Listening to the self-confidence and promises of data scientists speak can quickly cross registers. Big data is a socio-technical phenomenon that is attended both by the hopes of progressive, almost utopian capabilities and also by the fears of intrusive, potentially totalitarian erosions of personal privacy. Uniting all of these incarnations is some form of belief that the world is a complex system that hitherto dominant forms of analysis are unable to fully address. There is some kind of an aesthetic, a process of

analytic creation that is guided by an underlying belief in the hidden nature of the world, a world where uncertainty can be bridled, forged into a representation that creates a sense where previously none existed. The extent to which this radical novelty is at once believed and also historically and anthropologically more complex animates a thrust of this project. To explore the nuances of what data science looks like in practice, we will return to the aftermath of Hurricane Sandy and examine how data science got installed in the mechanics of city government.

3.6 Stormy data

On the morning of October 28, 2012, Mayor Bloomberg signed an executive order declaring a state of emergency in New York City and requiring everyone living in low lying areas of the city to evacuate their homes. Some people in those areas, however, either chose not to evacuate or were unable to do so, leaving a huge population of people in danger when the storm's impact was greater than expected. In the immediate aftermath of the storm, hundreds of thousands of people in the city were left without power and many were trapped in place due to flood waters. This caused a pressing crisis for the city which needed to not only do an assessment to understand the extent of the damage, but which also needed to identify vulnerable people who would be in danger if they did not receive immediate assistance. The risks were piling up: elderly or immobile people were stuck in high rise apartments without elevators as their reserves of prescription medicines dwindled and a nor'easter snowstorm was set to arrive a few days after Sandy left, bringing below freezing temperatures and leaving people in unheated homes at risk. The breakdown in communications meant that the city did not have access to accurate, timely

data from power utilities, telecommunications companies, fuel providers, gas stations, and other sectors that provide critical services. In the days that followed there was a mad scramble to re-establish an awareness of what was going on.

While it had uneven coverage, some of the city's own data systems were still available for this purpose. For instance, all of the buildings in the city have Automated Meter Readers that regularly transmit water usage to the city's Department of Environmental Protection's billing databases and these were used to identify homes in flooded areas that were still occupied after the evacuation order went out but before power was lost. In one story I was told by an informant, there was a major issue identifying which specific high rise buildings or households in the Rockaways (a long peninsula in Queens which extends along the Atlantic Ocean) were without power. The way that the city wound up figuring it out was by working with the Long Island Power Authority to gain access to database exports of daily electricity usage and then to match that against information that the city had in one of its own Department of Buildings databases. All of this happened in an ad hoc way in a scramble to develop an emergency response. A government employee working in City Hall in the days immediately after the storm told me that "it wasn't perfect by any measure due to system damage but it did locate pockets of several hundred elderly and disabled who weren't in high rises (where most of the scrutiny was going initially) [and it] definitely saved some lives and reduced misery." And indeed, in a report published seven months after the storm analyzing the City's response to Sandy, it was found that "the ability to collect and synthesize accurate data in storm-battered neighborhoods was critical to understanding and addressing the most urgent needs following the storm" (Gibbs and Hollowell 2013).

In many respects the failure of the city's physical infrastructure and the urgent scramble to establish a situational awareness and to begin to dispatch help to those in need made visible to the city the absence of a data infrastructure. While imperfect, the city's ad hoc work to gather data from essential service providers like power and water utilities demonstrated that crisis responses could be much better targeted and quickly deployed when disparate sources of data could be integrated and analyzed. There were even examples of the city working with other third-parties like the mobile phone application GasBuddy to supplement information gathered by the police department on the availability of gasoline across the city, a commodity which had become scarce after its regional supply chain was severely disrupted. However, Sandy also revealed crucial breakdowns in the flow of information between different actors. In its after action report, the city cited its inability to gather data from various actors as a particular problem that frustrated response efforts. For instance, the Federal Communication Commission collects data on outages in the cellular network, but there did not exist a robust technological and also organizational way for that data to be shared.

As the storm waters receded and a sense of normalcy began to be restored, discussions around climate change began to favor a discourse of resiliency. This refocus of the conversation around climate changed honed in on things like reforming building codes, underscoring the need for regional coordination in infrastructure development, planning for affordable housing and economic development aid, and funding local government's capacity for long term disaster response planning. The need for broader coordination across many levels of government and in-between the public and private sector became more apparent and efforts were made through task forces to establish the

relevant human and social networks to make this happen (Ladislaw 2013). However, the need to have robust data networks was also well recognized. Shortly after Sandy, President Obama issued an executive order—"Preparing the United States for the impacts of climate change"—that placed special emphasis on a new mandate for federal agencies to make data available that are relevant to climate issues and decision making (Obama 2013). This fits into broader discourses around a notion of open government data that I will discuss later in the chapter.

In New York City analytics formed a core component of the city's resiliency plan. The success of the nascent effort in City Hall led to the establishment of a Mayor's Office of Data Analytics and the appointment of a Chief Analytics Officer to manage it. A core part of the office's mandate involved the establishment of a data network across the city and in between the city and critical service providers to establish continuous, consistent, and reliable data exchanges. However, beyond simply connecting this data, the Mayor's Office of Data Analytics was charged with using it to change the way that the city was imagined and managed. To accomplish this, however, a lot of preliminary work had to be accomplished.

3.7 The Mayor's Office of Data Analytics

The New York City Mayor's Office of Data Analytics (MODA) provides a lens to consider how the city was reconceived as a place that could be mirrored in a complex data network. Importantly, it also provides occasion to consider how this kind of thinking is instantiated in the messy and complex realities of governmental politics and bureaucracy as well as the material friction of what it means to provide city services to

over eight million people. MODA was organized under the premise of a "civic [as distinguished from military] intelligence office… to more effectively address crime, public safety, and quality of life issues…[by using] analytics tools to prioritize risk more strategically, deliver services more efficiently, enforce laws more effectively and increase transparency." ("NYC executive order 306E quoted in Flowers 2013). First directed by Michael Flowers, a former Department of Justice prosecutor who came into contact with battlefield analytics while coordinating trial logistics and hunting for mass graves during the prosecution of Saddam Hussain in Baghdad's Green Zone, the work of MODA is deeply tied to a utilitarian vision of results and efficiency (Copeland 2015a). When in Iraq, Flowers—also a speaker at the first Data Gotham conference—was responsible for moving witnesses in and out of the Green Zone and began working alongside military personnel who were using data analytics to predict where roadside bombs were likely to be so that convey routes could be planned more efficiently (ibid). Bringing this particular inflection of the city as a place and system governable through data from Iraq to New York stands as an important context to study how the histories and genealogies of particular techno-scientific practices are complex and connected to multiple historical and material genealogies. Much has been written about the flow of surplus military equipment from the wars in Iraq and Afghanistan to domestic police departments in the US, but the flow of applied data science from IED detection to the administration of local government has I believe not been fully appreciated (cf Zamora 2014).

In 2013, *The New York Times* wrote a flattering story about MODA calling it a kind of "digital Sherlock Holmes," evoking at once the figure of the newly industrialized 19C city as a place of teeming crowds that required new forms of knowing and detection,

as well as the seemingly effortless application of empiricism and logic that Holmes' intellect brought to the solution of even the most intractable mysteries (Feuer 2013). In the case of MODA, the stories that circulate about it describe a small group of geeks in the city government that are able to do things like find buildings that are at a high risk of being in violation of safety codes, or to locate businesses illegally dumping cooking oil or to detect when a building's lights or heat has gone out. The office's forerunner received particular accolades in the response to the crisis brought on by Hurricane Sandy where it was able to help locate vulnerable populations of people who may be trapped in un-electrified apartment blocks and to coordinate the restoration of city services.

But behind all of these practices of trying to carve some thing or some process out of data is a lot of messy work, a lot of obscured plumbing and infrastructure (Starr 1999). Within organizations there is a tremendous amount of both social and technical work that needs to be done merely to ready the data for use. Data is not only stored across a plethora of incompatible systems, but those systems are embedded in social structures with their own sets of interests and antipathies towards one another that make the linking of data an inherently political process. Within the national security community, a tremendous amount of legal and intellectual work had to be done to justify the legitimacy of data gathering. And within public government a whole technocratic imaginary has to be advanced which equates the openness of particular sources of data with some kind of growth in economic or social welfare.

This was something that MODA recognized from the outset. Writing in its annual report, the office noted that "aggregating cross-agency data is often first a political, legal, and cultural discussion" (Flowers 2013). Data systems in the city had developed over

decades, often embedded in agencies with career civil servants who often took an arms-length approach to the revolving door of political appointees that accompany any given mayoral administration. In my discussions I found that there was often a sense of territoriality and protection of particular offices' data resources. For instance, the New York Police Department insists on maintaining its own email servers that are separate from the shared IT infrastructure of the city, meaning that all of their correspondence goes to @nypd.org email addresses instead of the @nyc.gov email systems that service the rest of the government.

Much like the attention to hardening critical transportation and energy infrastructure that took place in the city after Sandy, MODA sought to design its operations in a way that would be durable and hardened against changes in the political climate. The major infrastructural initiative that MODA undertook was the creation of something called DataBridge, a citywide data-sharing platform that integrates hundreds of databases in real time from over 20 city agencies and external organizations including places like 311, Department of Buildings, Department of City Planning, the Fire Department, Consolidated Edison and NYU's Center for Urban Science and Progress. DataBridge grew up during the last years of the Bloomberg administration and was conceived of as a repository of operational data that could be used both centrally by MODA as a way of understanding the effect of policy decisions or to coordinate disaster response, as well as internally by various departments across the government and, for a limited subset, to the general public through an open data portal. By finding particular use cases or applications that enabled component agency databases to be integrated into DataBridge, a system was thereby created that would make that data perpetually available

across the entirety of the City government.

Core to making DataBridge a reality was devising a way for all of these different datasets, created for different reasons and with different ontological models of the city, to become commensurate. Speaking about this problem in an interview recently, MODA's director responded to a question about the many different ways that exist across New York City databases for recording the physical location of the things the data describes:

> Latitude and longitude, post code, building number, housing number, utility account number. There's dozens of ways in New York City… of saying "Where am I?". But the answer to that question invariably involves [asking] "Why do you want to know?" …That was why I felt it didn't make any sense to spend a lot of iron on hammering out a universal identifier first. …I think rather a problem-driven approach served us quite well. (Quoted in Copeland 2015b)

The reason for such a diversity in geographic identifiers relates to the context in which the data systems were produced. Firemen and policemen want to know where the front door of building is if they are called out on an emergency. The tax authorities think about the city in terms of parcels and have segmented it into unique borough-block-lot identifiers. Utility companies think in terms of subterranean infrastructure and of the GPS coordinates describing junction boxes and the lines tracing out pipes or power cables. DataBridge made data science possible and makes the city thinkable as a massive data system because it is successful at linking together different agencies' unique identifiers to a shared cartographic identifier. It became in a sense the geographic rosetta stone and the shared library that enabled, as MODA declared its vision, "the City to Know what we know, and act accordingly".

3.8 Data Science intersects with climate science

Weather as an object of formal knowledge, along with the planetary climate

system of which it is a part, has historically been firmly rooted within the domain of big institutional science (Edwards 2010). Networks of national laboratories and super computers, of international data collection infrastructures and earth orbiting sensors, all come together to create models of the atmosphere in which weather is simulated and forecast, papers are written, and knowledge about a particular kind of planetary climate produced. Yet in constituting New York City as a place enmeshed in a set of systems, the millennia-long models of climate science are being brought into encounter with data science as an emergent knowledge-making practice. The data scientists, while participating in a similar western scientific epistemological framework, are operating from a different set of organizing principles than the climatologists, working within a field that values correlation and a pragmatic ability to reliably predict something over the rigorous understandings and theoretical frameworks of traditional scientific methodology. Yet they both intersect to shape and to create the city. As this confluence comes at a time where these data science driven models are uniquely able to become operationalized as a result of analytics departments being set up broadly across the city, it is an important phenomenon to study.

As Sandy showed, flooding is a major risk to New York over the next century as the consequences of anthropogenic climate change become more tangible. The city has over 520 miles of coastline, a span that exceeds that of Miami, Boston, Los Angeles and San Francisco combined. As part of its response to the risks presented by rising seas, the city established the New York City Panel on Climate Change (NPCC) and the Climate Change Adaptation Task Force (CCATF) which are focused both on engaging the scientific community to synthesize what recent research portends for the city and also on

harnessing data science and analytics in order to plan operational responses and to manage the risk to the city's people and infrastructure. According to the projections of the NPCC, local sea levels may rise up to 11 inches in the 2020s and 31 inches in the 2050s. This fact, coupled with more frequent and intense storms, have informed the city's long term strategic planning.

A major issue that was surfaced by Sandy—and which is crucial to resolve in order for data science and climate science to be used together to design for the city's future resiliency—was that the FEMA flood maps for New York were out of date. Indeed, the hurricane caused flooding to an area that was more than 1.5x the size of the 100-year flood plane that had been defined in FEMA's 1983 study of the city. After putting in a request with the federal agency to update its analysis, the city produced its own map of the five boroughs by procuring an aircraft that was equipped with a LiDAR (light detection and ranging) sensor that created a high resolution, three dimensional model of the entirety of its 300 square miles of surface area. The city partnered with the Swiss Reinsurance Company and MODA to build on this information to develop operationally focused models of what future storms may have in store. Swiss Re is one of the worlds largest natural catastrophe reinsurance firms, and they used data from the National Hurricane Center on 1,200 hurricanes and tropical storms that had occurred in the Atlantic over the last 150 years. Applying statistical methods to turn the trajectory of those 1,200 storms into over 200,000 possible storm scenarios, they developed a model to determine the angle at which future storms might hit the city and the storm surge and wind speeds that would be associated with them. Factoring in the New York Panel on Climate Change's projections for sea level rise, Swiss Re and the city developed various

climate change scenarios. These, in turn, were analyzed along side data drawn from MODA's DataBridge to model specific city level risks, looking at the potential disruptive and economic impacts to things like buildings, transportation, telecommunications and utilities. Together, these models are now influencing where and how climate resiliency and urban development funds are being applied across the city, with an every-day impact on the built environment and administrative practices. These longer range models are deployed along side more retrospective ones driven by MODA in the wake of Hurricane Sandy's damage that are being used by the Mayor's Office of Housing Recovery Operations to merge city and federal data in the allocation of $648 million dollars of federal grant money.

3.9 Evangelizing urban data science: Bloomberg's influence beyond the mayoralty

Beyond his tenure as mayor in New York, Michael Bloomberg has been very active in trying to install his philosophy of data driven management across the world through a variety of institutional and financial mechanisms. In recent years the UN published a report declaring that more than 50% of the world's population lived in cities, a number they projected would grow to 66% by 2050 (UN 2014). Beyond this concentration of people, today cities are also responsible for 70% of greenhouse gas emissions globally. This was a trend that many across the globe had long recognized and which led to the founding of the C40 Cities Climate Leadership Group in 2006. A membership organization of over 80 cities across the world, C40 arouse out of a frustration with the response of national and international organizations to effectively address the threats of anthropogenic climate change. It seeks to refocus the climate conversation around cities

and act as a facilitator of member cities adopting efforts to curb emissions. While he was mayor in New York, Bloomberg also served as the chairman of the C40 and worked in the city to implement policies that are projected to reduce greenhouse gas emissions by 30% by 2030 through a focus on analytics driven reformations to building codes.

After leaving public life, Bloomberg sought to redouble his influence on local politics both in the United States and abroad. While this has involved him funding a range of political action committees and other initiatives, a particular area of focus has been on extending the reach and practice of data science to the administration of cities outside of New York. Through his Bloomberg Philanthropies arm, the former mayor has poured $42 million into a program called the What Works Cities Initiative. Administered through a network of organizations that span the academic and NGO sectors, including Results for America, the new Center for Government Excellence at Johns Hopkins University and Harvard University's Government Performance Lab, What Works Cities provides financial grants to cities between 100,000 and 1 million residents who wish to implement data science driven city analytics programs.

Initiatives like these have created a measure of controversy around the former mayor. Critics argue that he is an out of touch plutocrat who is trying to hoist "New York values" on middle America. Supporters, however, see more of a messianic figure. The *Economist*, writing about Bloomberg's legacy claim that some see him as a pioneer of a new politics:

> Books with such titles as "If Mayors Ruled the World: Dysfunctional Nations, Rising Cities" argue that cities have almost magical powers to transcend partisan gridlock. To boosters, cities encourage pragmatic problem-solving, because mayors are accountable for tangible tasks like collecting rubbish, fighting crime or fixing schools. They quote a former New York mayor, Fiorello LaGuardia, who said: "There is no Democratic or Republican way of fixing a sewer." They look

> forward to Mr Bloomberg going global as a mentor to mayors, via such bodies as C40, a network of big cities taking steps to reduce greenhouse-gas emissions. (Economist 2013)

Yet, such ambitions to transcend politics are never actually quite possible. As we recognize that politics are always embedded in the complex relationships through which everyday life happens, it provides an opportunity to probe more deeply into what sleight of hand may be at work when data analytics are proposed as apolitical when applied to fixing a sewer or collecting the trash.

One of the institutional and intellectual legacies that Bloomberg left behind in New York was the establishment of NYU's Center for Urban Science + Progress. Founded in 2012 as part of New York University, but with substantial financial support and involvement from the City, CUSP describes itself as a research center and laboratory that "observes, analyzes, and models cities to optimize outcomes, prototype new solutions, formalize new tools and processes, and develop new expertise/experts" ("About CUSP" 2014). Treating New York City itself as a laboratory, CUSP collaborates in the design--and at times leads the development--of new data collection infrastructures in the city. This "instrumentation" of the city, as it is termed, is a complex socio-technical process that involves an amalgam of interpersonal and institutional negotiations between the various holders of these data and those who want to analyze them that are extremely important for understanding how particular data driven narratives of the city are fashioned. In many respects CUSP reflects the kinds of ambitions that are often invested in new data science technologies. As the Center's director—a theoretical physicist by training, former chief scientist for British Petroleum and presenter at the first Data Gotham—articulated its mission at the moment of CUSP's founding: "it feels like these

kinds of technologies allow us to acquire data on cities with unprecedented granularity, coverage and variety making cities a whole new subject of study from what they were even 5 years ago. In many ways it feels like Galileo first turning the telescope on the heavens or Van Luewen first looking at a living cell in a microscope".

Positioning data analysis in the context of a long history of sight as a privileged epistemological category, as the Center's director does, evokes a set of important questions about how the city is being imagined as a totality that can be viewed and subjected to study (cf. Woolfe 2009). Having graduated its first class of 25 students in July 2014, CUSP's pedagogy focuses on the professionalization of new urban data scientists to harness analytics techniques in order to address a broad range of governance problems facing cities, whether managing homeless populations, increasing energy efficiency, or informing urban planning. As the rhetoric of neoliberalism over the last two decades has grown substantially, allowing citizens to be thinkable as consumers, and governments as service providers in a competitive market, it is important to remain attentive to how data and the patterns to be found therein are being asked to serve as proxies for citizens and metaphors of systems to serve in the place of communities and thick local worlds (Clarke 2007). In addition to offering graduate degrees in applied urban science and informatics, CUSP is entangled in the financial and government life of the city in many ways. Established under a tax incentive plan led by former New York mayor Michael Bloomberg, CUSP is both given preferential access to sensitive sets of city-held data and in fact counts among its students many people who were formerly, or would become upon graduation, employees of the New York City government. This marks the Center as having a unique position with respect to the technocratic governance

of the city which is important to study as an emerging conduit connecting beliefs about the representative power of data and the structures of public administration. It also demonstrates the complex interrelationships between organizations at many different scales and across many different levels of public and private sector actors. These things, of course, are not at all unique to the situation in New York but rather circulate through much broader networks.

3.10 Making data open

In considering how things are made out of data it has been important to take into account a much longer history both of the epistemologies that support data analytics practices as well as the organizational history of how data science, a term which did not really exist prior to 2008, became such a powerful concept for organizing thought, fantasy and action in recent years. In studying data scientists at work there is a lot of active energy that goes into defining how things can be made out of data, and to what uses they can be put. In a sense there is a kind of vernacular theory, as Thomas McLaughlin has it, where "theories are frequently ad hoc and implicit, emerging through interactions with organizational structures, technical systems, and economic incentives, which makes them ideal objects for ethnographic inquiry" (McLaughlin 1996).

To engage with some of these latent theories, I wanted to investigate further the practices that surround the production and circulation of data that these emerging data science communities depend on. How is it that information which is gathered in the ordinary processes of government action becomes transformed and made ready for use by data scientists? What kind of nexus exists in between discourses around data science and

the production and circulation of new forms of data? While there is certainly a technical component to this conversation, I want to focus specifically on the ways in which these kinds of possibilities are produced through the intersection of private industry, government policy and the particular actors that shuttle in between them. In order to explore this dynamic, I wanted to zoom in on a moment where open data was in the midst of being defined, contested and produced.

In June 2013 I traveled to Washington DC to participate in a summit at the US Treasury Department. While the topic under discussion was nominally about access to credit for small and medium sized businesses, in many key respects it exposed a complex network of both policy making practices and histories of underwriting and segmenting populations that I use to explore how individuals and companies become considered knowable and predictable through data. The specific example that I will consider has to do with the release and exchange of both public and private data that can be used by data scientists to help improve the flow of credit in the United States. In many ways this discussion will anticipate a topic I will cover in a later chapter concerning the ways in which economic actors are produced and conceived in plans to use free market dynamics to reduce global carbon emissions through mechanisms like cap and trade.

In important ways, the summit at the Treasury occurred within a context that was enabled by a broader conversation and history around an idea of open data. Dating back at least to the International Geophysical Year in 1957-8 when a large-scale, international effort to collect and share research about the planet gave rise to the first formal system for exchanging scientific data (Belanger 2010), open data has in more recent years become a tangle of ideas around governance, innovation, citizenship and personhood. Following a

rise to prominence that is reminiscent of that seen with "data science," the origin tales of open data's current manifestation are often sited in a meeting held in Sebastopol, California in December 2007 (Chingard 2013). The meeting was attended by thirty of the tech world's intellectual elite including Tim O'Reilly, a publishing mogul who helped popularize the open source and web 2.0 movements, Lawrence Lessig, the legal scholar behind Creative Commons, Aaron Swartz, a celebrated internet activist who invented RSS and recently committed suicide while in the midst of a government prosecution for attempting to publicly release all of JSTOR, and many others from places like the Electronic Frontier Foundation, Stamen Design, Google, and the Omidyar Network (Malamud 2007).

The output of the Sebastopol meeting was a definition of open data—self-consciously produced in the spirit of the open source software community's definition of itself—with the goal of having it endorsed by all of the US presidential candidates that were running for office in 2008 (Lessig 2007). At the heart of the definition was a principle that all government data not subject to privacy, security or privilege limitations should be freely released in an open, machine-readable format ("8 Principles" 2007). While the definition of open data reads in ways that are legible to more generally discussed democratic ideas of inclusiveness and openness, there is a broader sense in which ideas of technological systems and modes of sociality are being smuggled in to reimagine the basis of a public sphere (cf. Kelty 2008, Turner 2010, Escobar 2004, Zandenberg 2010). Leveraging the tremendous amount of social, political and monetary capital held by this tech community, these concepts of open data have spread remarkably wide in the last seven years with (1) the creation of Code For America (a Teach for

America or Peace Corps like program with more than 5,000 participants who bring open data principles to local governments during short fellowships), (2) hundreds of open data initiatives at many levels of government, both in the US and abroad, (3) the founding of the White House's US Digital Service and the GSA's 18F as Silicon Valley inspired technology consulting firms within government, (4) and a presidential executive order in 2013 terming open data a 'national asset' and calling for all data in the federal government to be open by default.

The rise of open data's popularity as a concept in recent years has in large part been tied to thinking of citizens, government and companies as in some ways representable through data while also imagining a technologically sophisticated public who will be able to harness that data to fix the ills of society in ways that government itself cannot. In so doing, a wide array of heterogeneous data hybrids, collected across a vast range of contexts and socio-technical networks, are being reappropriated to produce a proliferation of possible publics by data scientists. In what follows I will begin by examining the process of provisioning new data and imagining an economic subject with access to capital at the summit at the Treasury Department. However, data is not only being used to demarcate and create publics in the context of a computer mediated analytic gaze. It also is deeply involved in creating a public that has a relationship to a planet with a climate that is deeply in crisis.

During a September 2014 speech at the United Nations Climate Summit in New York, President Obama announced that, as part of its open data policy, the US would release data on global terrain elevations as well as other datasets from US technical agencies "to help vulnerable populations around the world strengthen their climate

resilience" ("President Obama Announces" 2014). Pairing public datasets with a rhetoric of global citizenship, and of empowerment to adapt to an ever increasing risk of climate-induced disaster, is a distinctly contemporary phenomenon intersecting discourses of cataclysm, transparency and the modeling of people, places and systems. When thinking about how these processes are also being marshaled to constitute New York City as a place in the Mayor's Office of Data Analytics and the Center for Urban Science+Progress, there is an important story about how the intersections between data, place and imagination are being conceived. A contextualizing critical lens can be gleaned from cartographic scholars who, addressing resonant representations of spatio-cultural systems, have shown both how mapping practices, as they instantiate a particular view of the world, re-inscribe and depend upon networks of power (Harley 2002, Crampton and Krygier 2006) and also that the map itself is a profound epistemological device that makes space intelligible in encompassing yet contingent ways (Jacob 2006). But how are data and models being used to provision a public that has a relationship with the planet as a whole, be it from the visceral, human costs of a "hundred-year storm" like Sandy or in the synthesized planetary models considered by the UN's Intergovernmental Panel on Climate Change?

3.11 An invitation to the Cash Room

The air hung thickly around my suit jacket as I stood on Centre Street that June morning looking for a taxi. Day was just breaking and I was on my way to Penn Station to catch a 6 o'clock train to Washington DC. Trucks could be heard rattling thunderously to the south along Canal Street as they skipped across the island, trying to get far afield

before the rush started in force. A vacant cab appeared and I was soon on my way up Sixth Avenue towards 34th Street, carried along by a cascade of computer controlled traffic lights operated from a Department of Transportation building in Queens.

New York's Pennsylvania Station is a bustle of activity even early in the morning. Between the Long Island Railroad, New Jersey Transit and Amtrak over 600,000 people circulate through the dim corridors beneath Madison Square Garden each day. At peak times, more than a thousand people are boarding or exiting trains every 90 seconds, distinguishing the station as one of the busiest transportation hubs in the United States. That morning I entered on Seventh Avenue and strode down a long passage punctuated with kiosks and shops that led towards the departure tracks. As I approached the ticket machines, I became aware of the trilling of some baroque music that was being piped in over the public address system, at once attracting me and calling to mind all the research that must go into figuring out how to best pacify public transit riders. While selections from the Ring Cycle seemed unlikely to follow in the playlist, my eye drifted towards two soldiers standing remarkably still in the midst of people darting here and there, assault rifles on their shoulders and a very inviting labrador retriever at their feet.

About a week earlier I had received an invitation to an event that was being hosted by the United States Treasury Department and the Small Business Administration (SBA) from someone in government that I had been recently introduced to by a venture capitalist I had been chatting with. The "Summit on Capital Access Innovation" was the third in a series co-hosted by Treasury and SBA since 2009. The purpose of the summit was to bring together companies and organizations that, taken together, provided a fair representation of the actors that in some way facilitate access to credit for small

businesses. In the aftermath of the financial collapse of 2008 this was a particularly acute problem and the Obama administration was focused on finding ways to increase fluidity in this part of the credit system under the axiom that small businesses are core drivers of new jobs and, collectively, a crucial engine of economic growth. If the past was any predictor, the summit promised to be at least consequential: according to the former SBA chief Karen Mills, the discussions of the past two summits served as the foundation of the Small Business Jobs Act in 2010 and the Jump Start Our Businesses Act in 2012, important pieces of legislation that resulted in the deployment of tens of billions of dollars (Leiber 2013).

While social systems of economic value (e.g. Malinowski 2001, Maurer 2005, Maurer 2006, Elyachar 2005) and of banking (e.g. Holmes 2013, Ho 2009, Riles 2004) form a core set of concerns in the anthropological literature, I had very little understanding of the actual mechanics through which the credit system as a macroeconomic construction became a real or an inaccessible thing for individual businesses. It certainly has been well argued that market exchanges are always deeply marked by social relations (Mauss 2002, Gregory 1982), and that there is something deeply twined between exchange and information relationships between people—as Clifford Geertz fascinatingly depicted in his study of a Moroccan bazar (Geertz 1978)—yet I wondered what kind of sociality was being imagined at the Treasury. The workshop that I was invited to participate in was entitled 'Big Data Implications for Small Business Capital Access,' which sounded right up my alley. Excitedly, I wrote back and accepted the invitation.

The event organizer's prompt response caused me to be somewhat taken aback:

"please send me your DOB, SSN, and your name as it appears on your ID". Something to do with getting cleared by the Secret Service, apparently. Since I had committed my Social Security number to memory some years ago, in the midst of filling out college applications, it has had a kind of magical, almost taboo quality about it (cf. Crump 1992). The number, and flimsy paper card on which it was first printed, were always to be guarded with the utmost seriousness. Should the number fall in to the wrong hands, you could be cleaved in two, haunted by a doppelgänger who can empty your bank accounts, liquidate your real assets, and drain every penny of credit available to you. It can take years upon years to close such a breach, if its even possible, and you will probably never fully recover. At least, these are the kinds of things one hears. But then again, I supposed, if you cannot trust in an unencrypted email sent to a treasury.gov email address, what can you really trust at all? So I sent off the requested details.

Standing at the other end of this data pipeline, I walked up to the visitor checkpoint of the Treasury building and handed my driver's license to an officer of the Secret Service's Uniformed Division. As the man typed away at the computer in front of him, I wondered what was on that screen and about the nature of the scrutiny I was placed under. It called to mind the experience of crossing international borders, and the expectant moments before the stamp is slammed down on your passport. But before I could even finish the thought, I was heading through the metal detector on my way to a long table lined with a row of silvery coffee urns.

Coffee in hand, I started looking around at people's chests, squinting at name tags. As the event was to start shortly, I moved from the hallway into the Cash Room where the morning's talks were to be delivered. The Treasury Department's Cash Room—a

place whose name becomes an easy mark whenever it shows up in the media—is a vast chamber built in the style of a roofed Italian palazzo. In the 1860s it was the scene of President Grant's inaugural reception, a grand affair that turned sour at the end of the evening when the ticketing system for the coat check broke down and an ensuing wild hunt for overcoats left many of the nation's most prominent citizens with only champagne to stave off the bitter January cold. For the next century, the Cash Room functioned primarily as a "banker's bank," supplying area commercial banks with coins and currency from Treasury vaults but also providing services to the public in the form of government check cashing and the redemption of silver and gold certificates. This secondary function made the Cash Room a subtle kind of nexus point for everyone who handled US paper currency between 1878 and 1964. Still backed by gold or silver, the Cash Room was the place where that paper money could by exchanged for metal coin ("Treasury Cash Room" 2013). While I found the symbolism of this quite consequential—being present in this node of history, exchange and state power—I was anxious to discover how the mobile concept of big data would come to finding a mooring here (cf. Gupta 2012, Hetherington 2011, Hull 2012).

I found a seat towards the back of the room, among the staffers and other comparatively less distinguished looking faces, as Treasury Secretary Jacob Lew welcomed the audience. After what seemed to be the usual kinds of introductory remarks, Lew began to talk about how the Treasury was excited about the potential for new kinds of "innovative lending practices" to help fill the gap left in the credit system after the 2008 financial crisis made banks much more reserved about lending. Lew painted a picture of "alternative measures to assess a business' ability to pay back a loan" that

considered a broad range of previously unconsidered datapoints like “real-time shipping schedules, records held in a business' accounting software, and even social media to determine creditworthiness.” By pointing to examples of this already being done by a crop of new companies, Lew made the key equivalency that brought big data and economy together: “these new financing models make it clear that greater access to information can translate into greater to access to credit.” The role that the Treasury could play, Lew suggested, was to help develop infrastructures for linking the data that small and medium sized companies already report to the government for taxation purposes to the lenders who can utilize it to lend more money.

There have been several anthropological and sociological studies of the techniques and practices through which people and companies become subjects for whom the possibility of credit exists. For instance, Alya Guseva and Akos Rona-Tas examined how credit card issuers in the US engage in a relationship between lender and borrower mediated by calculation substantially more formally than places like Russia where trust and social networks hold more relevancy in determining creditworthiness (Guseva and Rona-Tas 2001). Andrew Leyshon and Nigel Thrift have argued that “forms of governmentality based on new practices of knowledge” rooted in data collection practices cause people to “come alive” with respect to banks as the medium of software replaces a dependence on the individual to supply information about themselves (Leyshon and Thrift 1999). And Donncha Marron examined the ways in which credit scoring becomes a “technocratic form of expertise that allows lenders to treat borrowers at the level of populations” in ways that almost always break down when applied to a particular case and which has a colonizing effect by placing the individual in a proliferating set of

complex risk segmentations (Marron 2007).

However, while these investigations explore how data and networks of quantification have changed banking and lending practices in fairly broad terms, Martha Poon takes a much more focused approach by studying the 50-year institutional history of the Fair, Isaac Company as she traces the development of the FICO credit score. She anchors her analysis on how credit became conceived of as a problem of data and of probability not within an academic discourse, but rather through practitioners operating on the ground with an emergent set of domain expertise. In so doing, she demonstrates how statistics became re-articulated when bought into a new context with a new set of problems, following in a tradition of critical studies of statistics (cf. Gigerenzer et al., 1989, Hacking 2006, Porter 1986). Focusing in on the Fair, Isaac Company becomes not only the means for "unpacking a theoretical point about the varieties of calculative effects that credit analytics models can have on markets, but it is simultaneously an exploration of the consolidated configurations that fuse the market for consumer analytics with markets for consumer credit together…[one] of the actual apparatuses that most strongly shape the conditions of contemporary US consumer credit consumption" (Poon 2007:285). Yet this summit was being held expressly in the context of a broken credit market, one in which FICO was seen as increasingly less useful for lending decisions, and in which big data was being evoked as a way to make people and companies knowable again. I stood up, thinking of Poon's focus on the messy emergence of FICO, as the Treasury Secretary told the audience that the time had come to break out into working sessions.

3.12 "Big Data Implications for Small Business Capital Access"

The windowless room was set with about a dozen round tables covered in white tablecloths. In the front of the room was an easel with an oversized pad of paper on it. I took a seat towards the front so that I could easily face both the staged area as well as the rest of the participants in the room. As people continued to shuffle in, I tore into one of the paper lunch boxes that were available by the entrance: sliced deli turkey on a roll, a bag of Lay's potato chips, an oversized chocolate chip cookie.

As the session was called to order, we were playfully made aware of the fact that it is a rarity that the Treasury finds budget for catering so hopefully we were enjoying the meal. As the two leaders of the session introduced themselves, I quickly googled them in an attempt to find my bearings in this unfamiliar milieu. The first was Chris Bishko, a former investment banker turned venture capitalist for the philanthropically minded investment fund established by eBay founder Pierre Omidyar. The second, Mitch Jacobs, was the founder and CEO of OnDeck Capital, one of the more successful of a recent crop of alternative small business lenders who, according to some of their critics, use the sheen of new technology to practice what amounts to a kind of algorithmic usury (Colao 2013).

Chris and Mitch framed the workshop as an open-ended session intended to elicit and organize feedback regarding what the Treasury Department should be doing from a policy, open data publication, and organizational perspective to address the concerns and frictions faced by those present in the room. In short: what can the Treasury do to help you lend more money? I was interested to learn that neither Chris nor Mitch were directly tied to the government, but rather both enmeshed in issues around data and lending from rather atypical and highly interested locations in the private sector. But they were to be

our ambassadors and our advocates somewhere in the upper floors of this solid building where, presumably, policy briefs were written, other debates had, and orders dispatched.

There were about thirty or forty people present in all, and as we went around introducing ourselves I found myself intrigued with the cross section of organizations and titles that were assembled. There were executives from the most prominent start-up small business lenders like Lending Club, Kabbage, and OnDeck, mid-level representatives from big companies like Amazon, SAP and Morgan Stanley, some government folks from places like the Export-Import Bank of the United States, two major venture capital firms—Union Square Ventures and Draper Fisher Jurvetson—and a big contingent from Dunn and Bradstreet, a large incumbent provider of proprietary company data for use in credit underwriting. Prior to this workshop, I never had a clear sense of what the on-the-ground realities of those interfaces between the public and private sectors could be like. And, I imagine, this has something to do with the way information flows: researching this summit a year after its occurrence I could find almost nothing written about it with the exception of a brief mention on the Treasury website and a handful of tweets and corporate communications, despite the fact that it was attended by hundreds of high profile individuals from across the public and private sectors. For a moment often characterized for the amount of data it produces, it can sometimes feel remarkable to encounter a blank spot on the map.

As the discussion got underway and the large pad of paper at the front of the room began to be filled by Chris, several key themes began to emerge. The first focused largely on issues regarding the clarification of rules around data sharing and how data could be used in the process of underwriting a loan. Many of the people in the room wanted to use

new kinds of data that were not clearly addressed in traditional regulation—including rules recently passed by the freshly established Consumer Financial Protection Bureau, and the older Fair Credit Reporting Act from 1970. As it turned out, many participants were actively involved in internal debates around what kind of data was legal to use, especially when it came to using data on individual principals in accessing the credit risk of a company. The second set of questions had to do with privacy and data sharing rules. Could, for instance, third parties like payment processors be compelled to put infrastructures in place that made it easy for companies to share with potential creditors trusted data about their business operations. Or, from the company side, what kind of data could creditors ask for or otherwise obtain to incorporate into their underwriting models.

The second theme to emerge focused around the question of the status of a company and a lender's ability to verify its standing. In the United States, corporations are primarily governed by fifty distinct secretaries of state, all of whom have different ways of making information about the standing of corporations within their jurisdiction available. There was interest in the IRS using its position as the central tax authority to serve not only as a kind of verification service to attest to a company's legitimacy (a role today played by Dunn and Bradstreet), but also as a facilitator of data sharing, providing infrastructures to allow businesses to easily share filed tax returns as authenticated records for creditors to consider. It was here that the brainstorming started to reveal how metaphors of software are being brought to government services. The suggestion came that the IRS act as a kind of trusted network providing programatic access to information for verifying companies as well as APIs for companies to share trusted versions of their tax filings. This soon led to a third theme which involved a generally unfocused, but very

broad call for more open data about companies to be released. It was imagined that the Treasury should be focused on facilitating the opening up of government held data for the purposes of providing more information that creditors could consider in their underwriting algorithms.

As the conversation continued, more and more a picture of the credit underwriting process as one situated in the middle of, and built in a sense out of, connecting and manipulating data became manifest. What's more, it became manifest in such a way that also revealed the complex institutional and technological environment that served as a changing but core background upon which companies became knowable, risks were assayed and credit flowed. It was striking to be, in a sense, in public behind closed doors, in a place where the polish of the public relation oratory gave rise to a more informal exchange, providing another valence to the idea that "technology is social before it is technical" (Deleuze 1988).

This encounter at the Treasury provides a small window onto how a roving and voracious appetite for data forms a kind of common sense for an emergent set of analytics driven alternative lenders. It also provides an occasion to ask about the constitution of data driven credit underwriting technologies at a time of their emergence or collective reconsideration. While the representatives of the companies at the workshop were in some ways negotiating for more data about companies to be public, and for a greater set of liberties to analyze that data in ways that won't be interpreted as discriminatory under current regulations, questioning what publics are thereby being produced out of data presents distinct analytic challenges especially when considering the boundaries of the systems at play. As Pfaffenberger pointed out in his 1992 article calling

for an anthropology of technology, there has been a long history of giving sociotechnical objects a kind of autonomy with respect to society, as opposed to thinking of them as in many ways deeply socially marked and constituted (Pfaffenberger 1992). There has, however, of course been a tremendous amount of theoretical work done in fields like STS and in feminist studies of science that makes something like a credit underwriting system understandable not as mere data, software and computation but rather as a technological system (Hughes 1983), an actor network (Law 1987; Callon and Latour 1981), a hybrid (Latour 1993), a sociotechnical systems (Trist and Murray 1990; Kaghan and Bowker 2001) or even a cyborg (Haraway 1991). Yet as Boellstorff and others have argued, determining precisely where to analytically delimit a particular object has substantial "ontological, epistemological and political consequences" and should be carefully considered when framing an object of study (Boellstorff 2012). What's more, as Marcus and Starr have variously argued, if technologies exist somehow between and across multiple networks, and if they are in some senses relational and even ecological, then it becomes essential to follow the contours of these networks and lines of connection in studying them (Marcus 1995, Star 1999).

3.13 What are data publics?

I needed to get back to New York for a meeting so I decided to take a mid-afternoon return train after the big data workshop concluded. I made my way back to the lobby in front of the Cash Room and, stepping out beneath a towering limestone portico, realized that it was in fact raining quite torrentially. Having brought no umbrella, I gazed out across hundreds of feet of security barriers and open plaza. My hand was already

reaching into my left breast pocket as I decided to order a taxi using Uber, another big data technology which, instead of trying to constitute drivers as individuals, seeks to absorb them into an application interface, rendering their labor invisible (cf. Irani and Silberman 2013). Presented with a cartographic view of my location, I for the first time realized that I was standing on what was the north side of the building and that the White House was only a few hundred feet behind me and to the left. As the phone's GPS system locked onto various satellites overhead, the wide radius of a transparent blue circle guessing my general location from nearby cellular antennas narrowed to a crisp dot in front of the Treasury. The application predicted that a driver would be able to arrive in approximately 6 minutes, so I tapped and sent a request to the screens of all the nearby drivers, waiting for one of those black car icons to accept the job.

Data was certainly all around. My morning taxi ride would by the day's end be in a database of the NYC Taxi and Limousine Commission, associating the owner of the taxi medallion, the hack license of the driver, and the pick up and drop off locations of my trip. As I entered Penn Station, I caused a foot traffic counter to increment by one as my image started streaming into vast archives of security camera footage. Were the bits making up my head subjected to facial recognition algorithms, querying another database full of state enemies? I withdrew my ticket from the Amtrak kiosk, connected and disconnected from cell phone towers along the Northeast corridor, was entered into a Secret Service visitor log and sent off to Google my questions and curiosities throughout the day. The summit at the Treasury provided a view on how a multitude of networks are at play in the work of making a public that is intelligible to credit markets out of government data. At stake are questions of how people and companies can be constituted

through data and what kinds of logics and statistical epistemologies can be applied to them. There are of course very complex socio-technical, as well as deeply historical, assemblages at stake both in determining what is recorded and the consequences that attend the production of particular kinds of subjects, objects, and relationships.

Data scientists often claim to reject pre-established categories and relations in their work, arguing that the data can speak for itself through the midwifery of applied mathematics. Yet in practice there are not only sets of exploratory and framing questions that are brought to the data which complicate claims for an objective, emergent voice but also sets of institutional and social networks — as, for instance, in the NYC's Mayor's Office of Data Analytics analyzing city services databases to identify at populations at risk after Hurricane Sandy — and some sense of a fixed reality that the data is supposed to be capturing. Yet the process of producing these models is often played out in ways that are opaque to the things and people they are describing. Where do things break down and fall apart? In what particular ways is data collection and analysis an interpretive undertaking? How can the model be understood when pushed in to confrontation with the thing that its describing? "There are people in those pixels," a data scientist working with remote sensing data opined at a cartography MeetUp in NYC, suggesting the importance of treating data with care.

There certainly are valuable contributions from the literature that can be examined to help frame this line of questioning. In various ways, ideas about "imagined communities" wrought out of various material and communicative practices have shown the moorings of a sense of shared presence and belonging that can be used to ask what it means to be in public among data (e.g. Anderson 1991, Cohn 1996, Comaroff 1998).

Extending these ideas into a more spatially focused realm, Ferguson and Gupta have examined how through "images, metaphors, and representational practices the state come[s] to be understood as a concrete, overarching, spatially encompassing reality." And further how by claiming a spatial reality states are able "to secure their legitimacy, to naturalize their authority and to represent themselves as super to, and encompassing of, other institutions and centers of power" (Ferguson and Gupta 2002:981-2). In thinking through the pairing of space, power and presence, it is interesting to consider how these ideas apply to the way in which the planet becomes an ontologically salient thing that both allows a public to refer to it in particular ways but which also informs an experience of it.

Both the Global Positioning System (GPS) and the weather data produced by the National Oceanic and Atmospheric Administration (NOAA) are widely cited as the two most successful examples of open data (Manyika et al. 2013). They stand not only as extremely complex, government-sponsored socio-technical systems, but also as important devices that structure individual experience and encounter with the physical world for millions of people. In different ways, they have both also played important parts in buttressing and enabling the scientific research which has shown that the planet is undergoing anthropogenic climate change. Yet, for many of the people consuming in the planet's most industrialized societies, this planetary system still exists as a distant object, bound tightly within the folds of an intellectual appreciation without a clear feeling of immediacy or presence. In a sense there is a crisis of creating a public around climate data. But in what sense does data, qua numbers in a spreadsheet or photos from a satellite, become constitutive of a public? I will explore this question in more depth in

the next chapter as I return to the city as a place of cartographic practice where the stakes of mapping become acutely visible.

Chapter 4. The New Cartographers

4.1 Searching for Null Island

In the Gulf of Guinea, about a thousand miles off the western coast of Africa, lies Null Island. Situated in a lonely stretch of ocean where the equator meets the prime meridian, Null Island receives millions of visitors each year from all over the world. The official history is a peculiar one: the island's indigenous population of over 4,000 people has been formed and reshaped over the centuries, developing a unique nullish dialect that combines English, Portuguese, Yoruba and Igbo. According to the government's tourism website, the island has in recent years uncovered great reserves of bauxite within its territory and has enjoyed a natural resource boom that has given it the distinction of having the highest per capita ownership of Segway scooters anywhere in the world as well as near universal iPad ownership.

However, as a point of fact, Null Island does not exactly exist. Located at the latitude/longitude coordinates of 0,0, Null Island is in a sense a metaphor for the idiosyncrasies of geospatial technologies and the unintended effects that design decisions can have. This spot in the middle of the ocean is the default set of coordinates that digital mapping technologies like Google Maps use when it can't figure out where to locate a particular piece of data that it is presented with. For anyone who has tried to take large amounts of messy data and map them, inevitably some little bits will drift down to Null Island. The problem arises because of confusion between a null value in a database (meaning that there is simply no data available) and occasions when there is in fact a value of "0" present. So when there is no data, or when there is uncertainty over where a particular place might be, the result is often rendered geographically as 0,0. For this

reason, it is quite possible that Null Island would appear as the most photographed place on earth.

What started as a programming quirk later became named as a specific place and began to take on a life of its own. Null Island was first introduced as a specific 1-meter square patch of land in 2009, when the maintainers of Natural Earth, a public domain map database that produces an important reference set for digital cartographers, included it in their version 1.3 release. Null Island's metadata within the Natural Earth dataset indicates that it should never actually be shown when drawing a map, instead being used only for the analysis of bad data. In the moment of its introduction, Natural Earth's maintainers mention that because the scale of the island was set so small, being only 1-meter squared, it would only be drawn at an extremely high zoom level, one that "would require over 288 billion million tiles with a total storage requirement of more than 3.5 billion million megabytes which verges on Borges' essay 'On Exactitude in the Sciences'" (Natural Earth 2009). In their release notes introducing Null Island the authors link directly to the passage that captured their reverie about the cartographic artifact:

> In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters. In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography. (Borges 1998)

Null Island however, took on even more of a Borgesian aspect as it grew to develop a life of its own. People across the broader mapping community vigorously

adopted the concept, inventing a natural geography of the island, creating a website for its tourism bureau and producing t-shirts and other bits of ephemera. It has been written about across a range of places, from the Wall Street Journal to the Library of Congress' blog as well as numerous other publications (e.g. Hotz 2016, St Ong 2016). "People talk about it as a mythological place—being banished to Null Island," Tim St. Onge a cartographer at the U.S. Library of Congress has said (Quoted in Hotz 2016). "It is becoming shorthand for all the weird data-processing issues that we bump into," Michal Migurski, a product manager at the NY-based Mapzen remarked. He went on: "Null Island is almost a way to say we all make mistakes" (ibid). But even locating the place where mapping systems breakdown is not itself a straightforward proposition. A cartographer at the large commercial mapping company ESRI has gone as far as to highlight that the specific place where Null Island is situated is itself an artifact of a particular way of making cartographic projections and has produced a map of 5,718 alternate positions for Null Island based on other projection schemes (Field 2016). If you were to actually travel to the location 0,0—as defined by the commonly used World Geodetic System 84 standard for cartographic projection—you would find "Soul," a NOAA weather observation buoy that collects data on temperature, wind speed and other variables as part of the PIRATA network in support of climatic and weather forecasting models. Finding one's place, it seems, is never an entirely straightforward affair.

Yet, these kinds of quirks in the design of cartographic systems have real effects in the world. In the 2012 election season in Wisconsin, many people were close to being disenfranchised as a geocoding system located their homes on Null Island, and thus outside of any voter rolls in the state (Stein 2012). In Los Angeles, City Hall was set as

the default point in the city, thus making it appear that there was a huge crime wave around the building when hundreds of crime reports were wrongly geolocated. However, sometimes results can be even more dire. About an hour outside of Wichita, Kansas is a ranch owned by the Vogelman family which has lived there for over 100 years. As it turns out, it is also located at the geographic center of the continental United States. In 2012, a company called MaxMind started selling a product to law enforcement agencies that would take an IP address—the unique series of numbers given to each device contented to the internet—and provide information on its geographic location. When the system wasn't sure where to place an IP address it would select a point right in the middle of the country. This has meant that over the last several years the Vogelman ranch has been raided by the FBI, Federal Marshals, and the IRS on so many occasions that they have nearly lost count (Hill 2016). Over the centuries, unknown parts of maps have been embellished with dragons or other fantastical creatures; today, it seems, sometimes maps can create their own monsters.

It has long been understood that maps are complex socio-technical objects, important as tools for colonialism, governance and many other activities. However, with the rise of location-aware smart phones and a proliferation of internet services, maps are increasingly being built into the organizing logics and operations of those systems, shifting away from a primary reliance on the visual form of the map. According to a study by the United Nations, 3.5 billion people have internet-enabled phones (ICU 2016). This means that in addition to continuously generating geospatial data on their locations, half of the world's population are either direct or indirect users of geospatial technologies. However, the underlying infrastructure that makes those maps work is still

in an on-going process of change and development. Because maps — both the visual kind and the kind that exists is social graphs and geospatial databases — are one of the key organizing logics through which the world is made knowable and subject to action, its important to critically interrogate the dynamics of these technologies, the communities that are shaping them and the practices that they enable or foreclose.

In recent years a collection of private companies (e.g. Google, Facebook, ESRI), of open source communities (e.g. Open Street Maps, Mapzen) and government agencies (e.g. United States Census, National Reconnaissance Office) have been working to produce their own proprietary models of the world — its streets, its political boundaries, its points of interest, its consumers, its dissidents. The digital mapping infrastructures they are variously developing are extremely important because they determine what kinds of things can or can't be seen, how one can interact with the geographic world through digital technologies, and who has the right to participate in a digitally geospatial world that forms the basis for much of what happens both on and off-line.

There is a rich scholarly tradition of critically deconstructing and situating the many valences and influences that cartographic practices have. Emerging from a distinct intellectual tradition than many in STS and anthropology, scholars of critical cartography have intervened in a dominant discourse around maps, common since the Renaissance and certainly still present today, that posit them as more or less correct relational models of terrain (Harley 2001). Instead, they argue that mappings are not only conduits for imposing a rationalist geometry on the world, facilitating colonial conquest and articulating control over nature, but also extremely important in making the territories we inhabit thinkable as territories in the first place (Wood 1992). Yet, one of the things these

historically and critically erudite analyses lack is an attentiveness to how maps become enlivened through human practices to inform and shape the experience of the territory, and so critical cartography is in some ways insufficient for theorizing the subjective experience of the urban system enabled by cartographic representation. In some respects this gap has been filled by the anthropology of the environment where scholars show that political economy, gender and narrative substantially contribute to the cultural imagining of place (Cruikshank 2005) and that the perception of the environment when mediated through maps is fundamentally situated and incorporated in the bodies and histories of individuals (Ingold 2000). This literature, however, focuses largely on individual practice and cultural symbolism without reference to the influences attached to the organizing logics of cartographic representation. While science and technology studies partially remediates this gap by demonstrating that the worldviews produced through scientific facts emerge from specific configurations of social and historical factors, rather than simply mapping to objective reality, I want to investigate more deeply the situated contexts from which mapping emerges.

In New York I found an occasion through which to examine how cartography is being practiced by a diverse set of communities and where maps are at once designed and experienced. In a sense, maps are both diffused throughout the environment of the city, making up its fabric, while at the same time giving a point of view on it; New York is a place that both exists in maps and which also produces them. The *New York Times* creates maps daily, often acting as a site where editorial story telling and the technology and craft of cartography exist in a sustained conversation. The Parks Department is currently leading a census of every tree on public property in the city by distributing GPS

enabled iPads to volunteers who amble around an appointed block, building up a database of geotagged trees. Over the summer of 2015, the General Assembly hall of the United Nations held host to the annual conference of the Open Street Map Foundation, a group of thousands of volunteers who contribute to and maintain the largest open source map in the world, a critical tool for both humanitarian disaster response and the venture backed technology world. Facebook's New York office is where they base their Places division, the group responsible for the cartographic model where Facebook situates all of the interactions that someone has with their platform.

In many respects groups like these operate largely on their own and without any particular context or reason to be aware of each others' existence, working largely independently under their own set of concerns and motivations. In considering how to ethnographically engage with this shifting landscape, I became involved with GeoNYC, a Meetup which describes itself as "an open, friendly, educational salon of geospatial ideas and projects" and invites anyone who has "ever wonder[ed] at the power of maps to visualize and transform our worlds" to join. With close to 2,000 members on its meetup.com page, the four-year old group regularly draws more than 100 people to its monthly events. Over the years I have met a tremendous spectrum of interesting cartographers whose work pushed me to rethink what could reasonably be included under the heading of cartographic practice and how a spectrum of previously unconnected practices are converging around the making of place.

To give a sense to some of the people I have met and how they push outwards on a sense of the cartographic, I'll mention just a few of the presenters that I encountered. There was Niels, the Dutch programmer who was working at the New York Public

Library on "an experimental design and technology team working to re-imagine The Library for the Internet age." He spoke about a project the library is working on to take old insurance atlases and city business directories and translate them into a set of APIs and other tools so that the information they include could be used by developers of technology applications, effectively making a dusty archive legible to contemporary mapping technologies. In another instance, there was a team from Weill Cornell Medical College which discussed a study where they took samples from across the NYC subway system in order to map its microbiome. While the headline take-away from the study had to do with the fact that the team had found bacteria for bubonic plague, meningitis and other nasty diseases, the project was unique because it was the first time genetic samples from such a large urban system had been gathered, effectively creating a massive genetic map of the city's subway ecology. The same evening, a product manager for Strava, a navigation application designed for bicyclists, spoke about how they enabled users to participate in a map-based social network where they could share route and travel time information as they passed through the city and connect with friends who were out biking. Starva comes out of the world of venture capital backed technology companies where investors hope that this platform and data can be used to make money one day. But in the immediate term, Strava provides its data to governments to help with city planning, to quantify changes in behavior of bicyclists and to advocate for policy changes to promote bicycling.

In 2015 I volunteered to be one of the co-organizers of GeoNYC. Recently, I met Sam, one of the other GeoNYC organizers, for drinks in the Flatiron neighborhood, a few blocks west of the townhouse in which Herman Melville spent his last days in 1891

before dying in bed of heart failure. We arrived around 5:30pm, still a couple of moments before the post-work happy hour crowd would flood in and fill the place to the gills. The bar itself was an impressive rectilinear slab of faux white marble that stretched thirty feet end-to-end, bringing into relief the soaring ceiling and modernist geometries of this hip re-interpretation of a back country whiskey shack. Somehow, the contradictions or affectations that this implies no longer strike me as unusual, but rather intrinsic to the background hum of the gentrifying wave which has been remaking the city for decades now. While I had been attending GeoNYC on and off for the last couple of years, I was curious to get a sense from Sam about how it started and what vision they had for the community they hoped to build.

Sam: When I got involved, there was not a lot of momentum with GeoNYC and I don't think they even had a regular schedule. I don't know why but I took it under my wing. I was convinced—and this is a topic I could talk about non-stop—I really think that New York City is a Geo center. If you look at every other city that's doing some sort of Geo work, for instance, DC obviously has a long history with Geo but everything in DC, kind of the common denominator in DC, is the government and the kind of mapping is all connected to government motivations. Whether that's war or it's humanitarian relief, it's about the government. If you look at San Francisco, there has been a lot of innovation happening in the mapping space as well but I feel like the common denominator in San Francisco is about start up culture and design.

Me: Making a better dating app or whatever it is.

Sam: Yeah, so to speak. I feel like they have a dominant type of industry out there and that is the filter through which they see the world. Another spatial center is in Colorado and I think a lot of the ...

Me: The USGS [US Geological Survey] stuff?

Sam: Yeah, I think NASA's actually out there and you have a lot of the larger range macroscopic points of view that’re in Colorado. I think what's so fascinating to consider New York City as--I wouldn't say *the* center, but *a* center of Geo-- is that you really do, for all of its craziness and things that are great about New York, there is such a diversity of different kinds of

people, different sorts of industries. Mapping, as you pointed out in the first question is so part of every thing that we do. Whether it's personally navigating to get to a place, or professionally how all these concepts of technology and movement are happening, mapping is part of every industry and every person. I think New York represents that diversity. And I don't want to… diversity might be an overused word but there really is a diversity of motivations that are happening in New York City.

Me: Yeah, that's what I love about GeoNYC, they way that you're able to bring together a guy who does mapping at Facebook with a guy that does mapping with the Sanitation Department to make sure the trash gets picked up. There is a real spectrum.

Sam: Yeah, when I decided to really focus on GeoNYC as something that I wanted to contribute to, that was my vision. I really think New York is a Geo center and to have a New York City reflection of that. I think that while there may be more specialized groups that are meeting up to talk about Open Street Map or crisis mapping or for real estate, there is no entity that's bridging all those things.

Me: What is the map, what's going on?

Sam: Yeah and I think it doesn't even necessarily have to be—I've been calling it more of a data visualization focused event because people get a little nervous and are like oh, I don't do mapping. But, yeah you do do mapping.

I think part of the reason why we've been able to maintain a momentum, and I think continue to get better and better, is because we do have this really broad reach and that it's not just about another government agency and how they use mapping data. It's super broad. That's just tapping into what New York offers.

I really enjoyed—I don't know if you went to this one—the gay and lesbian and transgender Meetup we had. That was really out of my comfort zone as well. We had eight speakers. That's how nervous I was.

Me: That was, no, this wasn't at the Open Street Map conference?

Sam: No but what I realize is that the person who kind of helped me frame the night, mapping is something that's telling a story. It's sort of like, it's almost a privilege to be able to map yourself and to map your story. I think this gay, lesbian, transgender community, hasn't historically been a community that wants to be mapped or found out. They want to be invisible and keep their space. The environment around LGBT issues is changing and its almost now becoming a time to map and tell your stories.

Me: I love the guy who did the map of New York City gay bars.

Sam: Oh, so you were there. Yeah.

Me: I saw him talk at the Open Street map conference at the UN.

Sam: It was so powerful. This is a community that doesn't tell their stories. If you want to tell their stories, you do it by ... It's part of storytelling, that you also map the stories as well. I didn't realize how powerful a project it was until I saw him present why it's important. I'm like oh, this is really important. It's a privilege to map and it's also a privilege to provide tools to do better storytelling and mapping. I think that's a part why, again, the hypothesis that we work with. More people should be empowered to tell their map.

The maps Sam was talking about were part of a queer history mapping project called "OUTgoing: Mapping the Hidden History of New York's Gay Nightlife." In many ways this map was an oral history project, but one with a deeply spatial poetics about it. Writing about OUTgoing in a blog post, Lee, its creator, frames the project in terms of the after-dark of the queer community in New York in the 1970s and 80s :

> "Lesbian, gay or trans, they went through the 1970s disco sexfest, followed by the brutality of the AIDS crisis which changed the lives of every LGBT person. The stories from iconic spots like the Anvil, Bonnie and Clyde's or Studio 54 are unfamiliar now—spectacular, cruisy dance floors; dark leather bars; and a network of bathhouses. I'm a night owl and find the vice side of New York to be much more to my liking. Today's gay nightlife experience feels sterile and conservative in comparison, and leads me to relive the past through stories."

Lee's story is itself a case study in contemporary cartographic practice. Once the motivation to make the map crystalized, Lee went on a "data-gathering spree and grabbed every in-business location tagged 'gay bar' in the five boroughs from Yelp's API, then went to the internet to find as many discussions of past gay nightlife as [he] could." This was followed up with an exploration of the New York Public Library's archives of "gay guides," or slim travel guides for newcomers to the city's LGBT scene. But beyond this there's a kind of mournfulness to the project. An acute awareness that after the ravages of the AIDS epidemic and the passage of decades there are less and less people around who

can tell the story of these times. Through all of this I came to realize that in New York there was a tremendous amount of activity and practice going on to produce different kinds of models of the world. But all of this begs the question: what is it to map *from* a place? Usually this question is asked in relation to one's subject position but the case of cartographic practice in New York also opens up an interesting set of questions pertaining to what it means to exist in a local community that is producing global models. But these models can both be global in so far as they represent larger systems, but also in so far as they present other points of view or ontological orderings of the world.

4.2 "What makes Paris look like Paris?"

In what follows I want to explore in more detail this question of how places are made up in relation to our maps. I want to ask what we're capturing with these systems, what it means to create models of place. In trying to understand how we relate to the planet and make place during the anthropocene I want to examine how these increasingly important new cartographic practices come to imagine and engage with the city. What kind of data do they use? What sorts of models and epistemologies do they depend on? How do they emerge from specific institutional configurations and how in turn does this come to inform the possibilities for individual experience? I'm going to come at what is admittedly a very big question through a particular case study. I met a man at a GeoNYC event who was a computational geography researcher at Google. While he couldn't discuss the particulars of his work in great depth, as we were talking he pointed me toward a team who was working on similar issues at Carnegie Mellon and which had recently posed a kind of curious question: What makes Paris look like Paris?

I want to engage with this question, and the broader context in which the team was working, in two ways. Firstly through the work of George Orwell and his language, politics and poetics, drawing us along his way of framing and imagining such a question and wading through the attending messiness and rough edges. Then I will consider a paper — "What makes Paris look like Paris" — that was published by the computer vision team at Carnegie Mellon late in 2015 and which emerges from the concerns of the field of computational geography. By looking at what the team did and putting it in the context of the more humanistic approach to this question that was posed by George Orwell, I want to query more generally what is at stake when we move from the particular to the general and how those decisions get encoded into systems in often invisible ways. Finally I will consider how this might help us think through some long standing questions about anthropological praxis. In many respects this question starts to poke at that of place making. Place is something we have an innate sense, even if what it is that really makes a place a place, its *placeness*, can remain somewhat elusive to a clear articulation.

So to begin we may ask: is place a mere brute fact, a collection of bits and atoms at a particular latitude and longitude? Is it a figure of the imagination, the sidelong fantasies and impressions that makes up one's experience of being somewhere? For its part, anthropology has been concerned with place since its origin in the 19C and its early encyclopedic attempts to gather information on peoples and cultures that were interesting, in large part, because of their physical remoteness and apparent difference with their authors' quotidian familiarity. Early concerns with cataloging distant people's tools, rituals and myths evolved into ones increasingly interested in the explanatory systems

that could be used to account for the diversity and dynamics of human societies. With Bronislaw Malinowski in the early 20C, the question of place moved from a background concern of anthropology's to something much more present, inescapable and messy. The opening of Malinowski's seminal work, *The Argonauts of the Western Pacific*, famously puts the anthropologist (and the reader along with him) alone on an exotic beach with a pile of equipment, smelling the air and feeling the anxiety of being alone in an unfamiliar place. From this, the experience of the anthropologist who spent years among different cultures became inseparable from the authority and knowledge he produced. No thermometer or astrolabe could do what the anthropologist did; you had to be there and you had to spend a part of your life.

For a while there was a concern that anthropology had become stuck on the beach. Conceiving of culture as something that was bound to a particular people in a particular place had the intellectual effect of ghettoizing the discipline's objects of study, denying them a broader relationship to a world that was defined in one way or another through Eurocentric frames. The rise of globalization and its attendant forms of capitalism, communication and transportation are often credited with destabilizing the relationship between anthropology and place. When you hike for weeks to a village in the center of Papua New Guinea and stumble, drenched in sweat, into a young girl wearing a little league t-shirt from the South Side of Chicago, the idea of a pristine, contained place apart from everything else receives a serious challenge.

There is an important and interesting intellectual history here but for the moment I am going to set it aside in order to drive more immediately towards this question of what it is that makes a place. In some ways George Orwell can serve as a guide in this line of

investigation when we consider his *Down and Out in Paris and London* (1933). Written in a realist style that draws on the tropes both of travelogue and reportage, *Down and Out* chronicles a period of time when Orwell slips from being merely poor to being in the throws of poverty. In many respects, the book is an admixture of biography and critical reflection that provides a portrait of comparative poverty in two different European capitals. Throughout, the visage of the city, and the stories of the people that Orwell meets, compose a vivid depiction of the precarious lives of the urban poor during the interwar period. From its opening scene along the Rue du Coq d'Or (a "very narrow street--a ravine of tall, leprous houses, lurching towards one another") where, at seven in the morning, the proprietor of a boarding house shouts in the street at a lodger who persists in squashing the bugs on his room's thickly layered, squalled wallpaper, the story immerses the reader thickly in the urban space and social worlds of the down and out.

Being as much about the city as it is the experience of being down and out, the descent into poverty exists as a passage into a parallel world that interpenetrates the city street but which is only noticed when one's net worth can be measured in a handful of centimes and the clothes on one's back. As Orwell tells it, there is a process of discovery associated with poverty, not only of personal experience and the attendant logistical complexities, but also of a changed city and a changed set of social relationships. In the slums of Paris, where your landlady lives downstairs, constantly watching, and you pass your barber and tobacconist on the street, a dwindling supply of money casts a dye into the network of your social relations. Your laundress asks you why you haven't sent your clothes out lately and your vague answer leaves her thinking that you're sending your clothes elsewhere, thus earning you an enemy for life. You walk down the street and see

a well-heeled acquaintance coming towards you and you dash into a cafe, spending your day's food budget on a coffee that a fly from some distant sewer promptly decides to die in. You go to the baker to buy your day's bread and the clerk cuts a bit extra asking if you wouldn't mind spending a few pennies more and you bolt out in a panic, realizing you have only enough for the amount you ordered, wandering the streets for hours until you build up the nerve to try again, knowing you can never return to the block of the first baker. The stomach has a psycho-geography of its own it would seem.

Figure 4.1 Actions Glorieuses et Faits d'Armes du Général Cambronne

For Orwell, poverty transforms the city not only into a new configuration of places of risk and comfort and boredom, but it also causes the moving in and out of focus of different configurations of relationships. Just when Orwell thinks he is about to go totally to the dogs, he remembers his friend Boris, one of the shining personalities of the

tale that does as much as the physical description of place to create the sense of being in the city. Boris was a captain in the Second Siberian Rifles during the Great War and had been left penniless after his family fell on the wrong side of the Russian Revolution. A solidly built, loquacious and romantic fellow, Boris was leaden with nostalgia for the soldiering life. His favorite cafe was the *Gloserie des Lilas* in Montparnasse because the public square in front of it had a statue of a famous military commander from the Napoleonic Wars. Orwell and Boris used to travel there often, but Boris would always insist they get off at the slightly distant Cambronne metro station. He liked the association with General Cambronne, who, when he was called on to surrender at Waterloo, replied simply: "*Merde*!" An illness had struck Boris some time back, costing him his enviable income as a waiter in one of Paris' finer hotels and his dreams of one day setting up his own restaurant.

Much of Orwell's time in Paris is marked by the misadventures the two men have trying to find work. After days of living off of stolen food, Boris is able to get Orwell a job as a dishwasher in one of Paris' fashionable hotels. In a place that might earn many stars today in both Yelp! and the *Guide Michelin*, Orwell approaches the hotel to find the *chef du personnel*: "The Hôtel X was a vast, grandiose place with a classical facade, and at one side a little, dark doorway like a rat-hole, which was the service entrance." The bifurcation in architecture and physical space is only accentuated further as Orwell is escorted into the underbelly of the vast, grandiose place:

> He led me down a winding staircase into a narrow passage, deep underground, and so low that I had to stoop in places. It was stiflingly hot and very dark, with only dim, yellow bulbs several yards apart. There seemed to be miles of dark labyrinthine passages--actually, I suppose, a few hundred yards in all--that

> reminded one queerly of the lower decks of a liner; there were the same heat and cramped space and warm reek of food, and a humming, whirring noise (it came from the kitchen furnaces) just like the whir of engines. We passed doorways which let out sometimes a shouting of oaths, sometimes the red glare of a fire, once a shuddering draught from an ice chamber. As we went along, something struck me violently in the back. It was a hundred-pound block of ice, carried by a blue-aproned porter. After him came a boy with a great slab of veal on his shoulder, his cheek pressed into the damp, spongy flesh. They shoved me aside with a cry of '*Sauve-toi, idiot!*' and rushed on. On the wall, under one of the lights, someone had written in a very neat hand: 'Sooner will you find a cloudless sky in winter, than a woman at the Hôtel X who has her maidenhead.' It seemed a queer sort of place.

So what is it that Orwell is suggesting makes a place a place? The comparative work in *Down and Out* happens in the latter half of the book when Orwell makes the passage from Paris back to the British capital. His luck had changed: an old friend in London had found a job for him taking care of an invalid and forwarded enough money for him to retrieve the clothes he had pawned and to make the passage back. In that netherworld of the English Channel, Orwell meets a newly married Romanian couple traveling to England for their honeymoon. A full belly and a few coins in his pocket had totally transformed the visage of the city, a place seemingly refracted through one's level of hunger and destitution. He extolls the virtues of England to the young couple:

> They asked innumerable questions about England, and I told them some startling lies. I was so pleased to be getting home, after being hard up for months in a foreign city, that England seemed to me a sort of Paradise. There are, indeed, many things in England that make you glad to get home; bathrooms, armchairs, mint sauce, new potatoes properly cooked, brown bread, marmalade, beer made with veritable hops--they are all splendid, if you can pay for them. England is a very good country when you are not poor; and, of course, with a tame imbecile to look after, I was not going to be poor. The thought of not being poor made me very patriotic.

But this patriotism soon gives way when it turns out that Orwell's employer had travelled abroad for a month and that consequently no pay would be forthcoming. The

dreary tea shops of London, where toast and margarine are the stock fare, leave Orwell pining for the spirited energy of the French bistros, where even if starvation was more common, there felt to be the possibility of a temporary exuberance. He traded his suit for some rough clothing and a shilling:

> I stayed in the streets till late at night, keeping on the move all the time. Dressed as I was, I was half afraid that the police might arrest me as a vagabond, and I dared not speak to anyone, imagining that they must notice a disparity between my accent and my clothes. (Later I discovered that this never happened.) My new clothes had put me instantly into a new world. Everyone's demeanour seemed to have changed abruptly. I helped a hawker pick up a barrow that he had upset. 'Thanks, mate,' he said with a grin. No one had called me mate before in my life--it was the clothes that had done it.

At a level of abstraction, there's something worthy of exploring in the subject position and voice through which Orwell attempts to capture and compare the situated experiences of poverty in Paris and London. One does not easily escape language. While only able to attend because of a scholarship, Orwell was a graduate of Eton College, a school long recognized as the cradle of the British ruling class. It certainly shows. *Down and Out* is told in a grammatically immaculate prose that stands in contrast to the rough banter of the vivid, if at times tragic, raconteurs of the English and French working classes that Orwell lives among. But it would be unfair to cast Orwell as a voyeur seeking a thrill in the slum. Throughout a long journalistic career Orwell has always exhibited a kind of complex and ambivalent relationship to his own subjectivity and class and the inescapable mark that his education had left on him. Born in India, the son of an official of the Indian Civil Service who was active in the opium trade, Orwell wrote extensively about the experience of being of a "lower, upper-middle class," of those shabby-genteel families for whom Kipling was perhaps a poet laureate and the prosperity of the Victorian

era a nostalgic memory underscored by the stark austerity of the interwar depression. In many ways, *Down and Out* is not only an examination of the distinguishing characteristics of Paris and London but an inquiry into how class is spatialized and how its elisions and margins take shape. Whether its in the charitable work houses of London or the attics of Paris, class itself has a kind of geography in Orwell.

But what are we to make of Orwell's method of evoking place? His story is about immersion and lived experience. To read Orwell is to be told a story, to hear an account, to meet fellow travelers of the road, to reflect on hunger. But its also to know that everything will be alright. No one died in the gutter. We are, after all, reading a well composed account of the vicissitudes of the road. In this way there is something simulated about *Down and Out*, a kind of way of visiting the bottom without having to get dirty along the way. This is of course a general kind of critique leveled against depictions of social problems that are packaged for middle class audiences. What's more interesting is how Orwell goes about accomplishing this. Through force of language there is a manner in which the life worlds of Orwell's interlocutors preserve a kind of autonomy — they appear as enlivened and differentiated individuals even if visible only as something might be from the window of a passing train. There is an inseparable link between people, built environment and the experience of stress and hunger. An important aspect of Orwell's story is a rich articulation of how the city is constantly transforming, routed in ways that pass through the gut and the pocketbook of the observer. His method rests on first hand lived experience and an ability to tell the vivid particulars of individuals and places in a way that evokes a broader story about class and injustice. But how does that translation happen between the particular and the general? Orwell

privileged the stories of those he met, the visceral and shifting experiences of being in place, and a reading public that is attuned to clear prose and which needs to be cajoled into action. How does the particular of experience relate to the reaching and encompassing of an idea of place? How is place made from the particular? How does the idea of place hang together as a coherent whole? Who gets to make place? What makes Paris look like Paris?

Figure 4.2 Chihuahua or Muffin

In 2015 a team of computer vision researchers at Carnegie Mellon proposed a different kind of answer to this question. Alexei Efros is one of the team's principle advisors. A recognized leader in the academic community around computer vision, Efros

speaks in a thickly welcoming, conspiratorial kind of English that reminds one of his early years spent in St. Petersburg. On a warm, February afternoon he gave a presentation to the Electrical Engineering and Computer Science (EECS) department at Berkeley about the work his team had recently published at the crossroads of computational geography, computer vision and machine learning. The key question the team was trying to answer in *What Makes Paris Look Like Paris* was how could you use a computer to look at a photograph and determine the city in which it was taken. Early in his presentation, looking out over a crowded amphitheater of faculty and graduate students, Efros flashed a powerpoint slide with two lines from a Jorge Luis Borges story:

> "It irritated him that a dog at 3:14 in the afternoon, seen in profile, should be indicated by the same noun as the dog at 3:15 seen frontally."
>
> "My memory, sir, is like a garbage heap."
>
> - *Funes, The Memorious*

I found the choice of literary reference interesting. It is of course not every day that people with advanced degrees in computer science quote from rather obscure Borges stories. Intrigued, I dug up an old anthology when I got home. *Funes, the Memorious* is a post-humous account of three encounters between the Borgesian narrator and Ireneo Funes, a young man living in a dusty ranching town outside of Montevideo. After their first meeting the narrator learns that Ireneo had fallen from his horse, suffering paralysis below the waist but also acquiring a strange and profound change to his memory. Ireneo now recalls every detail of everything that he sees, from the flowing outline of a single cloud seen six months ago to its topographic similarity with the grains of leather running along the spine of a book he had glanced at in passing.

While there are a lot of directions to take a story where one of the main characters undergoes such a change, the conclusion that Borges draws is intriguing, especially in the context of a computer vision researcher's presentation. Having a perfect memory entraps Ireneo in the experience of details, inducing almost a vertigo of particulars. Ireneo could not abstract, he was "almost incapable of ideas of a general, Platonic sort". And thus, his memory was like a garbage heap and he was utterly frustrated by the effort of calling a face, with its infinity of particulars changing moment to moment, by a single word.

In 2014 the highest court in the European Union ruled that people had "the right to be forgotten," the right to ask for certain personal information to be removed from the indices of public search engines. With *Funes* we can imagine the other side for a moment, the experience of being deprived the right to forget and the ways that one may flail about for the shelter of an abstraction to stem the torrent of particulars. To hear Alexi Efros retell the story one might wonder if there wasn't something about *Funes* that resonated with him in a personal way. In his discussion of the story, he expresses almost a sympathetic relationship with both the designers of algorithms and the labor of algorithms themselves. The travails of Ireneo stand as a kind of analogy to those faced by both the labor of producing algorithms—the kind of sympathetic relationship of tuning and tinkering that goes into making them work—and the interiority of the computer, touching all of the details, dwelling close to the particulars, producing the sweat and effort of abstraction.

However, there's a more immediate reason that Efros cites this couplet from Borges. He wants to highlight one of the core challenges faced by his team in the process of trying to uncover 'What makes Paris look like Paris.' The analogy he's making

gestures towards the core research problem of learning categories—those Platonic sorts of ideals—from a garbage heap of details. To see how frustrating this could be for the designer of algorithms, consider the image above. If you have a pile of photographs but don't have any prior concepts of what a chihuahua or a bagel looks like, then you are left with the challenge of trying to unify a huge set of particulars into a consistent thing. The struggles of Funes are those both of the computer vision researcher and the algorithm churning away through all of that data. It is with this preface that Efros begins to frame the core ambition of the team's project:

> "Given a large repository of geo-tagged imagery, we seek to automatically find visual elements, for example windows, balconies, and street signs, that are most distinctive for a certain geo-spatial area, for example the city of Paris. This is a tremendously difficult task as the visual features distinguishing architectural elements of different places can be very subtle. In addition, we face a hard search problem: given all possible patches in all images, which of them are both frequently occurring *and* geographically informative?"

We move from subjectivity, social structure and experience in Orwell, to a focus on architectural detail and pattern searching. While we will dig into this relationship that computer vision researchers presume between data and place in a moment, let's first consider how this feat that Efros is talking about actually happens. I will try to summarize the team's work in a general way and then explore some of the particulars which are of interest to how machines are being used to characterize place. In the process of so doing the hope is to develop an important point of contextualization with the place making work that Orwell does and to have a platform from which to query more generally what is at stake in contemporary practices of place making. Often in conversations about advanced technology, a mythology of omniscient algorithms tend to obscure the common ground of the actual practices, infrastructures and labor involved. To try to quiet this

impulse, I will stay for a moment rather close to the details, aiming to help contextualize *how* a particular kind of algorithmic place making happens before then proceeding to contextualize it in a more critical way.

As is probably clear enough, at a high level, the goal of the Carnegie Mellon team is to be able to take an image and to determine where it was taken based on nothing else but what's in the picture itself. The general approach they are taking to accomplish this feat is to take photographs from lots of different cities and to analyze them to find patterns that are both frequently occurring and unique enough to a particular place as to be geographically discriminative. For instance, concrete sidewalks are of course common sights in many cities around the world, but not at all unique to any city in particular. Conversely, the shape of things like news stands or mailboxes might have more locality, or "geo discriminative" information, in them. While a hulking red London mailbox, or an Art Nouveau Paris Metro entrance may be obvious examples of this, the presence of a bidet, a particular kind of light switch and the shape of a sink may place a photograph of a bathroom undoubtedly in France for someone who has spent a lot of time there. The goal of Efros' team is to recognize and formalize those kinds of things automatically.

It is important to recognize, of course, that there are limits to this kind of magic. The image under consideration has to have something in it that contains something geographically distinctive. So a close up photograph of a McDonalds french fry might contain no information in the image itself that would help to situate it in any one specific country out of the 118 in which McDonalds operates. The optimistic computer vision researcher, however, might hold out the hope that because cooking oils are procured locally, the peculiar crackling on the surface of the potato might actually relate to the

kind of oil it was fried in. With enough example photos of french fries from different places, these patterns might be discernible and useful for determining what country or what city the slice of potato was fried. While this is almost certainly pushing a sense of optimism about what's possible rather towards the limit, its useful for illustrating the concept of "feature detection". While we may think of fried potatoes as coming in a handful of different types — smooth, crunchy, blistered, rough, soggy — machines can analyze photos and find patterns and commonalities for which there are no words and which are perhaps not at all commensurable with our imagination or perception. They are relationships and groups which exist mathematically but not necessarily phenomenologically. These are the clouds and the leather spined books which so irked dear Funes.

Now, with that preamble and set of provisions out of the way, let us jump in. How exactly *does* one go about figuring out where a photograph was taken just by feeding it into a computer program? To answer this, and to understand the Carnegie Mellon team's work, we will need to approach both the data and the algorithm separately.

The first challenge is to get the data.

The first step is to get a collection of images that would be useful as a representative sample of the idiosyncrasies of different cities. The Carnegie Mellon team decided to download 10,000 pictures from Google Street View for Paris and eleven other different cities. This decision diverged somewhat from common practices in the computer vision community to use a source like Flickr, a popular image sharing website used by tens of millions of people. Flickr, however, was determined to be the wrong kind of

image repository. Mostly used as a place to store photo albums and snapshots, the images there were found to over-emphasize popular, touristic sites in cities and not provide a representative sample of what a city actually looked like. The city for Efros' team is more than what its pedestrians casually photograph.

Google launched its Street View product in 2007. Using specially built cameras mounted on top of conspicuously decaled automobiles, Google hires people to meticulously drive along each and every road in a particular area. As they do so, an array of cameras snaps a 360-degree, panoramic view along the road. In 2012, Google reported to have taken photos of this kind along 5 million miles of roads, covering 39 countries and about 3,000 cities. When Street View launched it created a roar of privacy concerns, centered largely around capturing people in potentially compromising situations and challenging ideas of the right to use public space in the context of the mass trawling of data (Kiss 2009). As a training set for a model that is designed to be able to recognize what makes Paris, or any city, distinctive, its an interesting choice. What makes Street View photography good for training a model — the fact that it provides consistent, regularly spaced images along the facades of buildings — also marks it as a very particular kind of perspective: this is the world as seen from the window of automobile. A lot has been written on the ways in which automobiles — with all of their carbon dioxide and other pollutants — have transformed the planning and design of cities. However with the kind of work Efros' team is doing, the loop feeds back and it is the city as seen from the passenger seat of an automobile which becomes the perspective from which the city comes to be algorithmically defined. (To date, Google has announced no plans to release a Gutter View product.)

After programmatically downloading 120,000 images for the 12 cities, the first thing that the team has to do is convert them into a form on which their algorithms could work. In the design of an algorithm like this, images are understood by computers not as whole pictures, but as a collection of all the individual pixels. Each pixel itself is a bit of data that represents its color, brightness, position and other attributes. By treating the pixels of an image each as a collection of numbers, they then can be compared using all of the tools of mathematics. For instance, knowing that olive green may be represented by the number 500, lime green by the number 510 and pink bubble gum by the number 780 allows one to use basic mathematics to recognize that the greens are closer to each other than to the pink, knowing only about numerical distance and nothing necessarily about color itself. One must of course remain attentive to how exactly things are being represented as numbers, but suffice it to say, at this stage in the process the lament of poor Ireneo Funes seems to be compounded even further: instead of a million images, you now have a million numbers about a million images.

The second challenge is to categorize and bucket that data

Once all of the images are in a form where they can be processed by a computer program, the next challenge is to figure out which features or aspects of the images are the most unique and useful for determining geographic origin. To find these visual structures the team cuts each image up into little squares and tries to categorize them into clusters of similar squares (see figure below). The idea is that something in the relationship between all the numbers that make up the pixels of each square can be used to figure out how they relate to each other. As Efros posed it: "We have to figure out

these visual structures that often don't even have names. This looks Parisian, there is a certain *je ne sais qua* that makes it look like Paris."

Figure 3. Left: Randomly sampled candidate patches and their nearest neighbors according to a standard distance metric. Right: After sorting the candidates by the number of retrieved neighbors that come from Paris, coherent Parisian elements have risen to the top.

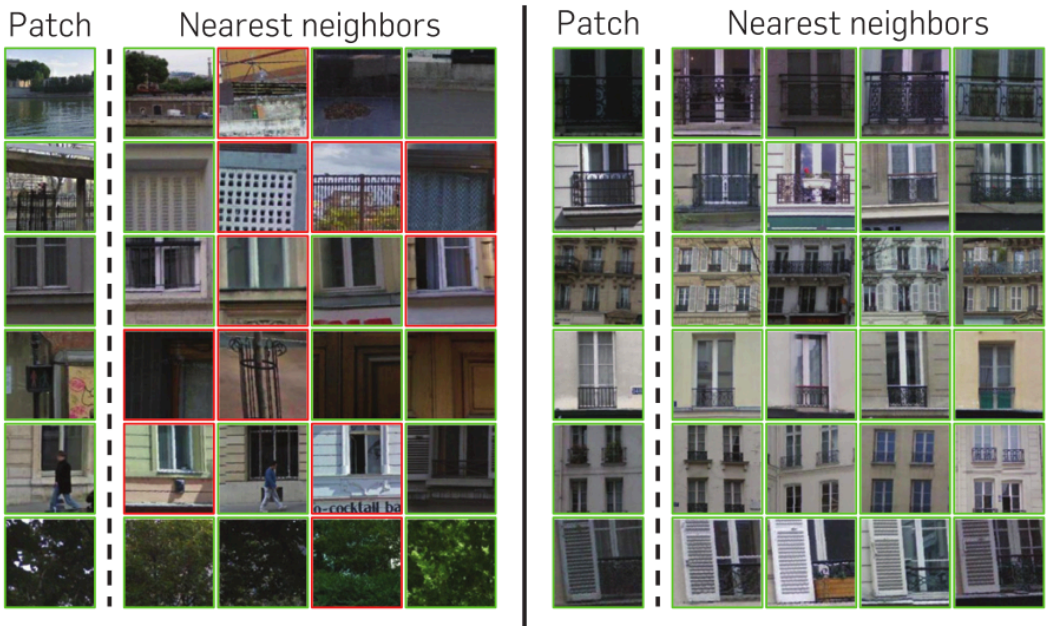

Figure 4.3 Nearest neighbor clustering

In general, the process of trying to figure this out is called clustering. The basic idea of clustering is pretty simple: based on some criteria categorize things into different buckets. If a group of people were asked to cluster a shelf of books, one person might make 26 piles, one for the first letter of each title, another might sort them by genre, by the color of the spine, by the sex of the author, by those which contained more than 500 pages and those which contained less. Each of these different techniques leads to much different final results, some useful, some not, depending on what one cares about or

wants to do. Now that the images are represented as arrays of numbers, the question becomes how should they try to find and cluster the patterns that exist mathematically.

Many different computer algorithms exist for doing this. Much like the case with the books above, the academic literature in computer vision is full of different ways that people have tried to cluster the numerical representations of images that could be useful for different purposes. When attempted by Efros' team, many of the standard approaches proved unsuccessful in producing useful clusters. The problem turned out to be that there weren't any good pre-established ways to focus in on the specific kinds of clusters that would be useful for a geo-discriminative analysis. For instance, a common technique in computer vision is to use a commercial clustering algorithm called SIFT which is good at identifying the edges of objects in a picture. However, the kinds of things it tended to cluster on proved to be too abstract to be useful. Instead of automatically surfacing things that were obviously from Paris, it found dusty corners and patches of color that might be relevant in a particular sample of images but which weren't seen as truly capturing something unique to Paris that could be applied elsewhere. Other techniques, like K-means clustering, were tried to overcome the abstract biases of SIFT. These algorithms tried to consider images more holistically when clustering them, an approach which had proven very good at recognizing famous buildings or landmarks in the past. However, they tended to drown out the small, particular elements like street signs or mailboxes which where deemed so important for a use case like this.

To overcome these issues, Efros' team started to manually sort and explore the small patches they had produced from the Street View photographs. They found that most were uninteresting, showing things like clouds, cars, the sky. So to feed their classifier,

they tried to exclude those patches by taking only ones that had the most color contrast in them — presumably containing some interesting patterns — and clustered them using a 'nearest neighbor' algorithm. In this context, what they're basically doing is asking the question: "for each of these images, what are the least amount of pixels I can change to make it look like another of the images". In other words, which images are visually closest together? This is a kind of technique that is used in things like spell checkers when the distance between words is compared. For instance, the distance between "cat" and "hat" would be 1; you only need to change a single letter. But the distance between "cat" and "Matt" would be 2, because you have to change the first letter and add a fourth. This is the kind of logic that goes in to comparing photographs using nearest neighbor techniques to determine which are most similar. How many pixels do I have to change to get a photograph of a coffee mug to look like a tea cup? How about to make it look like a rhinoceros? Its complicated to calculate a data set's nearest neighbors and there are lots of standard algorithms that various researchers have come up with over the years to do so as quickly and efficiently as possible. (Interestingly, the very framing of the nearest neighbor problem—a classic in 20C mathematics—has its origin in the problem of figuring out how to most efficiently get "The Traveling Salesman" to all the places he needs to drive to sell his wares. Echoing the usage of Street View photographs, residues of mid-century fantasies of automobiles, gender and economy appear in the most unexpected places.)

After figuring out the nearest neighbors of each patch to understand how they cluster together, the team looked at the clusters where most of the patches were from Paris instead of any of the other 11 cities. By taking this approach, the team could select

visual attributes that were common in Paris while also being unique relative to all the other cities they had imagery from. Reviewing the clusters manually, the team selected a few hundred that contained configurations of architecture and sidewalk objects that intuitively seemed to make sense.

The third challenge is classifying and predicting

Before jumping into the third part of the team's approach, let's review what's happened so far. From their lab in Pittsburgh, the Carnegie Mellon group has used Google's Street View to download a sample of images from 12 cities across the world. They cut them up into smaller squares and used a nearest neighbor algorithm to cluster them into unique groupings. They then manually selected a few hundred of those groups which were both unique to particular cities and which had architectural elements that they believed to be geo-informative.

Now they are ready to move on to the machine learning part of the process and train a distinct classifier for each of the clusters that they identified. In basic terms, a classifier presents itself as a very simple program: you give it some input (in this case a sample patch from a photograph) and it returns a number indicating the probability of it being like the samples it was trained on. By doing this for each of the clusters of images the team identified, the resulting classifiers can be used to give any new image an over all score of the likelihood that it is from a particular city based on which of the classifiers register high scores.

In this instance, the team used something called a binary classifier (particularly something called a SVM, or support vector machine). In general terms, a binary classifier

is an example of supervised machine learning. What that means is that the classifier is presented with a corpus of training data where certain patches are identified as examples of the things that the designer wants the classifier to recognize. Binary classifiers work in kind of an interesting way because they introduce a mathematical concept of space. The various features of the images that were coded into numbers (i.e. saturation, hue, brightness, etc) are plotted as coordinates much like one might plot numbers on a graph, but instead of plotting them just in two-dimensions, the plotting could happen in any number of dimensions. Then, utilizing higher level mathematics, the classification algorithm attempts to draw a boundary line separating the cluster of points from the positive examples in the training set from the negative ones. That way, when a new image is presented to the classifier it can make a binary decision on how likely it is to fall on the positive or negative side of the boundary that it identified.

As Efros describes the process that the team went through to train the binary classifier in this case, he noted that there were times when it needed to be nudged a bit. In one example, a cluster of images from Paris was identified that showed a building number against a prominent stone background. As Efros joked, referencing a theme of institutional politics, "the model didn't get the memo about the sign." The classifier was over privileging the peculiar lines separating the building masonry instead of the building number plaque itself. They discovered this upon manual review of the classifier's output and to remedy it they added weights to particular aspects of the images and re-trained the classifier using the augmented input. In cases like this they would re-run the classifier three times because it was found that after that many iterations the bias was fully incorporated into the resulting model. In such contexts there is always a fear of "over-

fitting" a model, or overly determining what the model is sensitive to based on a particular set of training data. To remedy this, the team used a technique called cross-validation which meant they would hold some of the training data in reserve and make sure that the model never saw it. By doing this they could test the classifier against a new corpus of data to make sure that it was still working as they intended.

4.3 Placing place in context

In a nutshell (or perhaps a whole nut tree, as the case might be), this sums up the approach that the Efros team took to answering the question 'what makes Paris look like Paris'. Upon designing a test to measure the accuracy of their classifiers, they were shown to work 83% of the time. While there's something impressive about this accomplishment, its important to recognize that the Efros team's work is part of a much broader field of people trying to algorithmically define place. If Orwell's writing was, in part, a political project interested in changing the perception of familiar geographic locales by offering readers an imaginative conduit in between the bourgeois and impoverished classes, how are we to understand the context of the place-making work that Efros' team produced?

To begin to answer this question, its important to situate the research both within the institutional and social milieus from which it emerged. In 2014, Carnegie Mellon received over $380 million in sponsored project funding, much of which came from corporate and state security related sources. Ever since Dwight Eisenhower very publicly brought attention to the massive military-industrial complex that grew out of the total war of the 1940s, the tangle of interests and funding that connect the university to industry

and the military have been commented on extensively. However, while this may at times be referred to as if it were a singular thing, the dynamics and interrelations of these interests are of course more nuanced and in a constant state of change.

In recent years, the financial and social networks binding academic computer science departments with corporate interests have undergone profound change. When it comes to the kind of work Efros' lab was doing, there are deep ties to Silicon Valley. Increasingly, companies like Google, Facebook and Uber are sponsoring in-house research centers and hiring large number of faculty members from academic departments (Thompson 2015). This is relevant not only because it exerts a strong influence on the kinds of topics that receive research attention, but also because they highlight an important way in which universities, as well as the public at large, are at a structural disadvantage to participate in big data research relative to the corporations that control the networks through which data is generated and captured.

During the Autumn of 2015, the Orange Institute, a think tank funded by the French telecom company of the same name, hosted a delegation of "passionate and innovative" technologists and business executives for a highly structured tour of various sites in New York City. New York was the fourteenth global city that the institute had visited (previous locations included Beijing, Madrid, Los Angeles, and Seoul) with the expressed mission of enabling the group to "learn about and prepare for the rapid transformations that digital innovations are spawning in our networked society". On a bright day in November, a tour bus brought the delegation to Building 92 of the Brooklyn Navy Yard for a session entitled the "Algos of New York". The Navy Yard is a sprawling 200 acre complex on the northern shore of Brooklyn, nestled in between the Manhattan

and Williamsburg bridges. Originally built in 1801, the Navy Yard was a site of military ship building, employing as many as 70,000 people at its peak during WWII until its eventual closure in the 1960s. In 2001 the Navy Yard began its current incarnation as an industrial park focused on manufacturing and sustainable development, echoing increasingly common tropes around the revitalization of rusted urban districts through the public support of projects that are envisioned to produce jobs more suitable to the 21C.

One of the headline speakers presenting that morning to the 40-person strong Orange delegation was Yann LeCun, the director of AI Research at Facebook and the founding director of the NYU Center for Data Science. LeCun, a former Bell Labs engineer and one of the world-leading experts in computer vision and machine learning, was a professor at NYU before being approached by Facebook to establish the company's artificial intelligence lab in New York. LeCun presents an interesting aspect to the story about how Efros' team approached the question of what it is that makes a place look like itself.

Over two billion photos are uploaded to Facebook each day. This staggering volume of imagery is possible for Facebook because they have developed into an important network through which people maintain their social relationships with their friends and family. This "network effect" (the fact that people use Facebook because so many other people do) is prized by market investors who see in it a defensible and durable part of the company's value. Because so many people use it—the logic goes—it would be impractical for a competing service to overtake them (Shapiro and Varian 1999). This of course also puts Facebook in a particularly privileged position when it comes to being able to access the kinds of image data that Efros' team relied upon in their

work, highlighting the fact that, despite the dense social and financial networks connecting academic computer science research and for-profit technology companies, the difference in the way that they access computing resources and data is of vital importance.

The output of Efros' team's work was a proof of concept, a demonstration that a certain approach to geo-locating images based only on their content was possible. However, it is at companies like Facebook where such concepts become deployed in broader networks and actually begin to have an agency to make place on an on-going basis (cf. Geiger 2014, Seaver 2013). At this scale, things go much further than in Efros' experiment. Every image uploaded to Facebook (except in the European Union, where the locality of regulation introduces a friction to the company's global network) is put through two classifiers: one to identify the things and activities in the image, the other to recognize the faces of the people and how they're connected. In addition to doorways and balconies, now place is being filled with individuals doing things with one another.

Approaches in computational geography are inextricably tied to and dependent upon the access to particular corpuses of data. They need a mass of particulars to draw from as a prerequisite before any of the abstraction and analysis of machine learning can be applied. But where do those particulars come from? A lot has been written in critical studies of software and informatics about how particular behaviors and subjectivities and encoded in the design of software which raise many important questions. If place is in part made through the ways that it is photographed and the networks through which those images circulate, what kinds of places are being made? What gets photographed for the algorithms to ingest? What logics of sight and representation get encoded into those

images either by their individual authors or through the limits and affordances of the tools used to produce them? What are the networks that hold the data? What are the implicit biases of the models which interpret it? Who determines the metrics that are used to judge the efficacy of those models? We see the facades of the hotels, but how about the bowels?

Practices of algorithmically defining places emerge from somewhere very specific. They are born out of research money that wants to trace the provenance of a photo on a cell phone confiscated in Karachi or to sell an ad to someone who is reminiscing about a trip of summers past. This is not a world indexed to hunger, which shows the unseen, which is particular and human; it is the perspective of specific infrastructures and networks produced through specific interests. So how do we reconcile the approaches to capturing and defining something distinctive about place in the work of Orwell and the computer vision researchers? We move from subjectivity, social structure and experience in Orwell, to a focus on architectural detail and pattern searching. Computer vision researchers think that data can describe place in ways whose accuracy can be mathematically defined as doing a better or worse job of capturing some essential reality. Yet the context within which this work happens tends to situate data analysis within intellectual networks that are only partially sensitive to the bias or presupposition that data carries with it, tending to treat it instead as an objective reflection of some singular context of truth.

4.4 Connecting the dots

In many respects, these kinds of issues have been wrestled with by anthropology

since the 1980s. While knowledge systems in general have been a concern of anthropology for some time, and their status as science has received sustained study (e.g. Malinowski 1922, Evans-Pritchard 1976), the conceptual primacy of Western modes of knowledge production and world ordering went largely unexamined in the discipline for much of its history. Giving a call for anthropology to consider not only knowledge systems, but technologies as deeply cultural things, scholars like Bryan Pfaffenberger have lamented a long history of neglect on the topic dating back to Malinowski's declaration that technology was a scientifically sterile topic and to Kroeber & Kluckhorn's rejection of material culture as a legitimate object of study on the grounds that the artifact was epiphenomenal to the underlying cultural form (Pfaffenberger 1992, Malinowski 1935, Kroeber & Kluckhorn 1952). Pfaffenberger's critiques were enabled by the emergence of constructivist approaches in science and technology studies in the 1970s and 1980s which began to shift attention from the decision making processes of engineers or scientists (e.g. Latour 1976) to a focus on more complex social encounters across various networks that went into the stabilization of new objects (eg. Bijker et al 1987, MacKenzie 1990). The idea of sociotechnical systems conceived of the social and the technological as a "seamless web" (Hughes 1986) and prepared the way for actor-network theories that considered not only the agency that objects have between the social and the material but also how politics become embedded in their design (Winner 1986, Feenberg 1999).

These kinds of actor-network theories have always had an uneasy relationship with their own status as theory (Mol 2010), preferring instead to identify as an analytic and orientation, what John Law describes as:

> A disparate family of material-semiotic tools, sensibilities and methods of analysis that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterize the webs and the practices that carry them (Law 2009).

As such, ANT has been marshaled to illustrate how technological objects come to be fixed in particular ways (e.g. Pinch and Bijker 1987) and how they prefigure certain subjectivities or ways of being (e.g. Cowan 1987, Oudshoorn & Pinch 2003). However, even though ANT allows for a kind of semiotic view on modern binaries like nature-culture and technology-society (e.g. Latour 1991), it has been critiqued on multiple counts by feminist scholars of science and technology for its disregard of gender (Wajcman 2000), its treatment of power inequalities (Casper & Clarke 1998, Star 1991) and for its lack of political engagement (Fortun 2013, Harding 2008, Bloor 1999). Even though to a certain extent many ANT and feminist scholars share an intellectual legacy from post-structuralism and constructivism (e.g. Law 1999, Haraway 1991, Butler 2004), the aloofness exhibited by many actor-network theorists towards the politics of inequality create an on-going critical tension (Harding 2008).

So how do we go from theory to trying to make sense of things encountered in the field? Theorists like Karen Barad, Michel Callon and others who study socio-technical phenomena help us ask questions about the connections, constituents and politics of both the world at large and the production of knowledge about it. Yet, a distinct set of challenges certainly arise when positions that obtain on discursive or theoretical grounds come to intersect with the valanced complexities of producing ethnographic knowledge (Clifford 1999). Certainly since the 1986 publication of *Writing Culture* focused and intensified a period of self-scrutiny in anthropology, involving both the poetics and

politics of ethnography as well as its representational practices and authority, a substantial body of work has arisen to grapple with these challenges (e.g. Fortun 2001, Biehl 2004, Maurer 2005, Masco 2005, Peterson 2014). Yet, as Marcus and others argue, while the period after *Writing Culture* has proven fecund for the production of experimental forms of ethnography, the predominant arc may have slipped into the baroque in ways that beg a consideration of ethnographic knowledge production beyond the monograph (Marcus 2007). Questions of how to study the processes through which people and places are being constituted by cartographic and data scientific practice adds a particular challenge in terms of research design. It is straight forward enough to locate sites where these kinds of technocratic imaginaries are being practiced, but it remains more difficult to engage with the plurality of ways that the world so defined and conceived becomes present in the lives of individuals.

In some ways, answers to this challenge have been found in a turn to phenomenology and embodiment. A rich field of research has arisen to consider how these heuristics as ways of examining the continuity between theoretical frameworks and the fecund realities of the field (e.g. Hayward 2010, Hunt 2008, Jain 2007, Alter 1993, Csordas 1993). By taking lived experience and a physically and sensuously situated view on ethnographic knowledge production, substantial research has been produced exploring communicative practices and intersubjectivity, among other themes and topics (e.g. Benkatesan 2011, Downey 2011, Rice 2011). In general, there is an attempt one finds in this literature to re-engage other modes of knowing and knowledge production that treat the body not as a text-like entity that can be measured, but as a living entity through which we actively experience the world (Desjarlais 2011, Jackson 1983, Stoller 1997). As

Tim Ingold writes in trying to anchor the possibility of knowledge in the processual and the embodied:

> By becoming knowledgeable, I mean that knowledge is grown along the myriad paths we take as we make our ways through the world in the course of everyday activities, rather than assembled from information obtained from numerous fixed locations. Thus it is by walking along from place to place, and not by building up from local particulars, that we come to know what we do. (Ingold 2010)

When considering the dichotomy in between the map and the territory that it depicts, this orientation suggests that we hold the practice of mapping tightly in the lived realities of its users. A major philosophical thinker that grounds a lot of anthropology's engagement with phenomenology can be found in Merleau-Ponty's picture of an embodied, synthetic ontology that rejects an empiricist view of objects as something already constituted that our sensory organs merely perceive. Influenced by Husserl's argument that "all consciousness is consciousness of something", in Merleau-Ponty our perception ends in objects themselves, which, before they have some kind of determinacy as objective, consist of "the infinite sum of an indefinite series of perspectival views in each of which the object is given but in none of which it is given exhaustively" (Merleau-Ponty 2012, 164-15). What draws this kind of pre-object into an object is a perceptual synthesis of a subject, of a body as a field of perception and practice. Here we have a way for accounting for the world that certainly presupposes a kind of fixed underlying reality, but which challenges the possibility of ever knowing that object in any way that isn't deeply relational and embodied.

Yet, phenomenology, in focusing on how we come to know as embodied subjects moving through the world, leaves open the problem of negotiating the multiple scales across which this happens. In *Partial Connections,* Strathern undertakes an extended

narrative tracking through both ethnography and anthropological theory in order to explore the mechanics and philosophical implications of cross cultural comparison (Strathern 2005). It is not itself exactly a book about the perspectivalism inherent in comparison (it is written in a "post-plural" conception of the world) but rather an exercise in enacting for the reader the incompleteness, but insightful fragments, to be found through making partial connections. According to Strathern, in any shift from the general to the particular (and vice-versa) one has both a loss and a gain of information which are in someway equal). This follows from Strathern's suggestion that when we shift scales from, say, an individual exchange to an economy, the world presented to our mind changes and propels us to follow new questions yet all the while maintaining a similar (and infinite) quantity of complexity. What emerges from this is a point born from experience, a "relativising effect of multiple perspectives [that] will make everything seem partial [while] the recurrence of similar propositions and bits of information will make everything seem connected" (Strathern 2005:xx). The thought shape that Strathern chooses to pair with this central problematic is the fractal nature of Cantor dust. Cantor dust is remarkable because it both retains similar semi-chaotic patterns regardless of the scale at which it is observed and because these patterns exist because they share a similar logic of generation. It is in this manner that she suggests a therapeutic point: "loss of knowledge [exists] as part of the data, not as loss of the data" (Strathern 2005:97). In other words, partiality is the name of the game.

A key point Strathern makes in *Partial Connections* is that the phenomenon of scale is in some ways an artifact of Western intellectual concerns (a point she explores through a consideration of Melanesian actors already immersed in a world of connection,

allowing the reader's mind to replace the smith's hammer forging new connections for the Melanesian illuminator's quill embellishing those already present). This is brought to the fore most centrally through a consideration of the ethnographer as a kind of under-acknowledged cyborg, existing neither as a single person nor as more than one, she is constituted by a composite of partial selves that neither issue from nor extend into any organic wholes. It is in this sense that Strathern seeks to develop an epistemology based upon compatibility--as between two circuits--instead of on a presumption that the interface can be overreached and commensurability between scales obtained.

In many ways it feels like much of the spirit of what Strathern argues for has been absorbed into the post-1980s matters of course (Cussins 1996, Thompson 2005, Moser 2008, Akrich and Pasveer 2000). Her geometry of the fractal is good to think with, but in its complexity perhaps threatens to estrange us from being present. There does seem to be something to the phenomenology of different scales that can mark them out as unique because of their different affective resonances (the old pack mule of a single death v. the statistics of a disaster could be looked towards) that suggest variances in the very nature of complexity. She helps us see how all conceptual thought is in some way comparative – calling on the example of discontinuities to be found in texts when their apparent flow is deconstructed.

Perhaps an alternative model to think through engaging connection in discontinuity or among shifting lines of continuity can be found in *city a-z*, an assembled collection of pieces commissioned by Steve Pile and Nigel Thrift (Pile and Thrift 2000). The book itself is a kind of experiment in writing (mind, not "about", but simply writing) the city that emerges out of cultural geography, a field also in the midst of a crisis of

representing their objects of study. Many different pieces of evidence, or shards of the urban, are marshaled in short essays arranged alphabetically in the book's pages: from poetry to prose, from statistics to diagrams, from angry rhetorical pieces to eulogies, noisy theoretical analysis to quiet stories of city life. As it is conceived in a largely experimental mode, the book is inherently playful, its numerous essays thematized and linked by possible points of connection through a table of contents rendered as a London Underground map (e.g. the 'Technology' and 'Nature' lines juncture at the 'Sewage' stop) but throughout is caught in a tension between understanding the act of writing the city as not quite reportage, nor one dealing with a picture of the city as a "text without a source" (Pile and Thrift 2000:17).

Trying to grasp the city (read: the modern city) within a single object of study is one fraught with paradox, contradiction, and partiality, seemingly resolvable only by tunneling into a particular point of focus. It is in this sense that *city a-z* represents a kind of operationalization of the problem of partial connections, although retaining too much of a modernist ambition for itself, it seems to puzzle only at the fact that putting the parts of the city together will never add up to the whole. The ambitions, however, remain admirable even if the exercise of experimental representation a bit lackluster; in a way, *city a-z* seeks to examine the kinds of imaginative access that may exist from one spatio-conceptual space into others. As it has been centered in urban theory, the street acts as a kind of master trope--perhaps Pile and Thrift's version of our inauspicious beach landing--where the nexus of the city could be gleaned through an endless turnover of perceptions and connections. In the street, in the movement of people through cities, one of the dialectics that seem to afford a point of departure for these cultural geographers is the

conceptual act of drawing the city as planned space into encounter with the complex of practices actually undertaken by its inhabitants.

However, it brings a question to mind: could the writing of ethnography be thought of as the design of a sort of city? If we can establish a view towards the unexpected encounters and uses to which cities are put in that vibrant mixture of reality that always eludes the plan, if we can think of how practices of writing space are made legible in the encounter, then could we attempt a form of writing that exists as both map and territory? Ostensibly, our ethnographies provide a map of sorts to their object of study, a way of organizing and orienting the professional reader (the consultable record?) to some matter of human import. Yet, as we have seen, often these details are washed away so that the cartograph can be filled in anew, the landscape leveled while the highways left in tact for a new development. But perhaps we can take a cue from the city planners who divide benches so that the homeless cannot stretch out on them and spike building so that birds cannot perch and excrete. Perhaps we can draw the territories into our maps so that the weight of the buildings defy an easy abstraction and the shade of the trees calm the desire to do so, inviting instead a moment's pause and a sidelong dream. But through such an act we may simply become mired in an idealistic program. Perhaps we can think of the ethnographic form as city as deliberately creating a space for encounter, providing the setting but not the plot. As this is a kind of transitive act, culling the indeterminate vicissitudes of fieldwork into a fixed, textual occasion, we can perhaps consider an analog from the medical sciences.

It sometimes happens that certain functions of the inner ear that allow one to balance become inoperative. This, as would be expected, is extremely debilitating

because one can no longer manage in an upright position. A recent technique to resolve this problem involves the temporary installation of small electrodes on the patient's taste buds. Wirelessly connected to another apparatus that the patient wears on his head, these electrodes fire in different configurations to indicate that the body is loosing its balance in a particular direction. Over time, the patient develops some sixth sense that enables them to stop using the apparatus and conduct their bodies through space without toppling over. One reading of this technique could present it as a kind of enforced self disciplining, lamenting one more instance of the medical gaze penetrating ever deeper into the body. However, it could be viewed another way as a metaphor for the communication of something essentially unrepresentable (a sense of balance being different than an accelerometer's measurements) through an entirely unexpected channel. Yet in a way, the phenomenologists may tug at us, disputing the fidelity of the communication by claiming that while there has been a functional installation, the real sensation of balance has become something entirely different for the patient. And while this is perhaps to be expected, at least we are now equipped to walk around, exploring as we will the world before us. In a sense what I am suggesting is a silent foregrounding of those sensations and vague ideas that dwell somewhere between our head and our fingers when we recall the world for the purposes of analyzing and configuring it. In so doing, the hope would be to invite not only visiting trade delegations to inspect the mechanics of our ethnographies but residents who will retain a post box and perhaps plant a garden.

4.5 A view from where?

There was a light fog hugging the ground in Cape Canaveral late in the evening of

September 25, 2005. As midnight approached, loud speakers began to blare a tinny message and anticipation filled the air. At 11:37PM, a rolling, cotton ball cloud poured across the horizon, burning soft orange as a Delta II rocket launched by the US Air Force began its 20,000km trip to a medium earth orbit. This particular rocket was carrying a satellite called USA-183, a Global Positioning System satellite designed by Lockheed Martin that serves as one in a constellation of thirty-six satellites that currently make up the system. As I write this ten years later, USA-183 is flying over the coast of Newfoundland and is one of four satellites that my cell phone is receiving a signal from.

People who have traveled into space are often said to experience an "overview effect." Conjuring up a rhetoric of the sublime, stories about feeling the uniqueness and vibrancy of our planet against the indifferent blackness of space are often framed as something akin to a mystical experience when retold in memoirs and documentaries. USA-183, on the other hand, is a machine that receives its power from the sun and which broadcasts radio waves downward to the planet's surface. Devices like this are crucial for enabling our understanding of where we are, at least in a certain very partial way of posing such a question. Yet none the less, GPS systems are extremely important in the organization of human society; they provide metadata and prefigure the possibilities of very particular kinds of null absences. In a sense, harkening back to Borges, the entire landscape does now have a map—go to any spot on the planet and these sorts of satellites will address you, implying a whole network of relationships. But like Borges' fable, written on a parchment of the kind he would have us imagine was found behind a shelf in an old book shop, the question remains: can we read from it, there are many maps hidden in the landscape, built at different times and with varying degrees of presence and

memory. If our maps have in some way failed us, how can we begin to make place again in the midst of a global unraveling? If the anthropocene can in some ways be understood as a failure of making place and relating to a complex global and social environment, what does it mean to be working to produce a world digitally at the same time as it is undergoing an ecological disaster? To explore this question further, in the next chapter I will begin to plumb more deeply into how it is that the planet is produced as a contingent object that enables and forecloses a wide range of both experiential and practical relationships. In so doing, the hope is that we can begin to ask how the manners through which our presence to our local surroundings is structured can be re-engaged with respect to this pale blue dot that we need to make into a place of a shared future.

Chapter 5. Making Planets

5.1 Introduction

Unbeknownst to us until recently, all of the fossil fuels that we have been extracting from the subsurface, hoisting into our combustion chambers and igniting in order to build a civilization, have been emitting a slew of invisible gasses that collect in the atmosphere—like a blanket we are told—causing the planet to warm. As mathematical constructions of the planet's climate system are marshaled to engage this phenomenon, the planet is depicted as an object governed by law, one that is presumed to be predictable across a gradient of risk. Yet in the same breath, it takes on the aspect of the Hebrews' Yahweh, threatening floods and all variety of earthly terror to those who transgress its order of the universe. It is a story told at once in figures represented as cold, hard objective science while also in the language of apocalyptic imagery. As the UN International Panel on Climate Change reports, sea levels may rise by several meters, flooding costal and river delta population centers, pulling many island nations back beneath the oceans from which they sprang, totally submerging the better part of Bangladesh (IPCC 2013). As if this were not bad enough, drought and famine will ensue in the highlands, affecting billions. Twenty to thirty percent of animal species will face a substantial risk of extinction. In order to make sense of this story, a dizzying scope of connections are articulated and pictures begin to form: billions of individual actions, turning on the air conditioner, driving to work, shipping fresh fruit from South America, manufacturing plastics, the decomposition of cow dung, amongst a nearly endless list of others, all converge to draw the individual into a global system of historical knowledge, present action and future risk.

The main international agreement that has been devised to respond to this threat is the United Nations Framework Convention on Climate Change (UNFCCC). The convention entered into force in 1994 and was signed by 192 nations, representing nearly every nation-state on the planet. The stated objective of the treaty is to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent *dangerous* anthropogenic interference with the climate system" (UNFCCC 1992: Article 2, emphasis added). While what precisely constitutes dangerous interference is not defined in the treaty, it does institute a requirement for industrially developed nations, so-called Annex 1 polluters, to develop and report "a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases" (UNFCCC 1992: Article 12). These two main points drive the basis of the climate change discussion: develop a quantitative basis to monitor and predict the effects of greenhouse gas build up and apply some conversion to discover when that build up becomes dangerous. The main body appointed to organize that task is the International Panel on Climate Change (IPCC) who collects scientific findings about the likelihood of certain changes to the atmosphere and the correlated consequences they will have on the terrestrial biosphere. However, the UNFCCC does not provide for any binding and specific emission targets or any means of accomplishing and enforcing them. Rather it provided a framework to consider the problem while deferring specific judgments to subsequent protocol treaties.

The Kyoto Protocol has been the main supplement to the UNFCCC to date and has recently been given an eight year extension during the 2012 UN Climate Change Conference in Doha while a successor protocol is developed. Kyoto, under pressure from the US, decided that the best course of action was to avoid direct regulation of

greenhouse gas emissions in favor of a market based mechanism of cap and trade. Under this system, a tradable pool of emission permits would be distributed to industrial polluters who would either reduce their emissions, thus earning a profit from their surplus allowance, or be forced to purchase permits on the open market to cover their excess emissions. While the US pulled out of the Kyoto agreement in 2001, this basic market-based approach for managing the risk of catastrophic climate change remains the dominant paradigm for formulating a response strategy and it has been given a new international mandate with the adoption of the 2015 Paris Agreement (cf. Upton 2016, Betsill and Hoffmann 2011, Sandor et al. 2002). There are currently numerous cap and trade markets in the developed world, most notably the European Union's Emissions Trading Scheme, a direct result of Kyoto, as well as regional markets in California, the northeastern United States, and seven regional markets being piloted in China (Galbraith 2014). However, while none of them include a large enough collection of polluters to be effective in containing climate change, there is a fevered pitch calling for a trading system that would be broadly acceptable.

In the wake of the Cold War's threat of nuclear annihilation as well as more recent fears around themes of global terrorism, virulent pandemic and financial crisis, the sociocultural constitutions of disaster have become of increasing interest to many anthropologists. Writing in this vein, Joseph Masco and Hugh Gusterson separately examine practices of nation building in the United States through the evocation of images of nuclear catastrophe and their powerful organizing force in the militarization of every day life (Masco 2008, Gusterson 1999). Masco further explores these themes by analyzing how the setting for these images intermingled with a modernist, mid-century

American desert as a place where ecology and a Cold War imaginaries intersect (Masco 2004a), giving rise to metaphors of mutation to understand the biosocial transformations surrounding nuclear testing (Masco 2004b). Andrew Lakoff traces how in recent years the trope of 'preparedness' came to displace ideas around prevention when it comes to structuring action in the face of epidemiological risks in the United States. By tracking the interplay of techniques originally developed for military scenario based planning, Lakoff presents a complex portrait of the logics underlying disaster response, which hold key resonances with conversations around climate change (Lakoff 2008). Celia Lowe, similarly engaged with questions of pandemic, explores the emergence of multi-species sociality around the H5N1 influenza as it became visible in a plurality of ways during an outbreak across the Indonesian archipelago (Lowe 2010). The aftermaths of ecological disaster also form an area of focus, with Adriana Petryna's work examining the articulation of the Chernobyl disaster in the histories and lives of Ukrainian informants (Petryna 1995) and David Bond's study of how the Gulf of Mexico was transformed into a scientific laboratory in the wake of the disaster BP oil spill (Bond 2013).

In what follows I will examine the multiple ways in which science is marshaled to produce a particular kind of planet, one possessed of a climate system which is on the verge of an irrevocable disaster, of coastlines ready to be breached by an ever-rising ocean. This is a story of multiple temporalities and multiple subjectivities. Because economics is the dominant social science used to frame the climate crisis, we will begin by focusing on what kind of economic agent it presumes and how certain calculative agencements are being formed to create carbon trading markets and to conjoin them with mathematical representations of the planet. We will see the trader imagined as a

countervailing force to the planet's passions, constructed through a delicate synchronic balance of interests. However, this task requires that the planet's interests be precisely defined. Mathematics, mediated through super computers, crunching through vast quantities of heterogeneous data from orbiting satellites and arctic ice cores, will transform time along a vast continuum of scales in order to tell the story of the planet's possible future states. Subsequently, these stories, entire narratives and the immense interrelationships of action that went into their authorship, will be shattered into statistical fragments, droplets of time that capture complete worlds by animating individuals to unfurl them into emotionally terrifying futures that impel them towards action. Finally, all of these temporalities that fuel the construction of alternative planetary futures will be sucked back into the present when the social cost of carbon is used as a metric for determining the present value of future risk and setting the optimal price of carbon in the marketplace. However, all of these complex processes presume the planet as an obvious kind of object. We will travel back to the 19C to examine a moment when the spherical planet circling the sun moved from an object of scientific knowledge to one with a broad public consciousness. We then will lastly consider the planet not as an abstract entity but a thing encountered in visceral and very personal ways. Whatever we mean when we speak about a global climate crisis would not be thinkable without a grapple on the rock and ice of the planet itself, so we will journey to the bottom of the earth with a climatologist as he bores into millennia old ice, searching for data. Through following these various strands of time and subjectivity the hope is to sharpen our view of the their contingent and heterogeneous nature and to question what alternatives may exist in the complex tangle of relationships that present to us the planet in crisis.

5.2 A Time for Self-Interest: Re-Formatting the trader's clock

> "Climate change presents a unique challenge for economics: it is the greatest and widest-ranging market failure ever seen."
>
> --Report of Sir Nicholas Stern to the UK Prime Minister

The current solution proposed in the form of a cap and trade market for greenhouse gas emissions requires, in broad terms, the construction of, and a symmetrical relationship between, two models. The first one describes the planet, faithfully representing the sort of input/output relationships that it is prone to exhibit. The second one describes the economic behavior of firms and traders, how they calculate their best interests and decide upon courses of action. The goal is to bring these two into alignment so that the output of the economic model, measured in terms of carbon emissions, intersects with some acceptable input into the planetary model. While these are extremely complex analytic creations, it is important to explore them with some care. The trader and themes of economic rationality have been a focus of recent anthropological work in the study of risk and cultures of finance (Zaloom 2004, Comaroff and Comaroff 2000, Appel 2014, Ho 2009, Graeber 2011) as has, in the sociology of finance, the application of methods drawn from STS to the study of markets and economic actors.

Michel Callon's work is useful for establishing a framework for thinking about the relationship between performativity and effect as well as engaging the type of economic agent that cap and trade assumes. Callon tells us that "economics, in the broad sense of the term, performs, shapes and formats the economy" (Callon 1998:2). Callon argues this because, in his view, man is not by nature a calculating agent. Rather, through a network of economic theories and material devices, he is *equipped* with the ability to calculate. To

take an example, we could say that the Black-Scholes formula did not discover the actual value of an option as a kind of law of nature. Rather, the formula, and its subsequent circulation and prominence, created an entire context in which people began to think about how a derivative could be valued and, in a sense, created its own conditions for being somewhat true. It operated as a piece of calculating technology that was inscribed into software programs, the minds of traders, the flows of capital and the riches and ruin of many.

In so doing it played a part, along with the dynamics of countless other market devices and the general contingencies of reality, in shaping what economy is and could be. The fact that the formula was something made up and not an intrinsic part of how markets naturally operate—as if such a nature existed—does not devalue it but instead repositions the way it, and markets, are understood, a thematic common to this STS-inspired approach (cf. Mitchell 2002, Mackenzie and Millo 2003, Thrift 2005). What is relevant is that for a time it was true that an options derivative would have the value determined by the formula. Even if it was not its 'true value', the truth or falsity of the formula is not what is at stake; rather what is of concern, from a pragmatic perspective, is that it channels and shapes cause and effect in the material world of people and things. Success and failure are given as much credence as truth and falsity. The difficulty that performativity provides to cap and trade markets is that while models of climate and economy will perform certain contexts, the ultimate object of their gaze, the planet itself, intrinsically holds the underlying asset of concern. The outcome of the market's undertaking will rely ultimately upon how the engines of the models can perform a world synchronic with the underlying planet. So the question becomes: what kind of planet is

being performed and, relatedly, how is the economic agent that is being performed through the construction of the carbon trading market meant to intersect with it?

To circle more deeply into these questions, we should recognize that "this equipment," as it is conceived in these kinds of performativity-driven models, "is neither all in the brains of human beings nor all in their socio-cultural frames or institutions" (Callon 1998:6). It rather emerges from the networks that form between agents and the possibilities or foreclosures that their calculative devices provide to them. It is precisely this latter condition, this foreclosure that results from formatting the world within certain definable and discrete set of variables, that allows action to be taken at all, even in circumstances of extreme uncertainty. This follows because the context that calculative devices bring with them circumscribe the world and in so doing contain what can be sensed and recognized as a world, recalling a theme of partiality that underwrites many of the broader thematics in discussions of cross-cultural comparison and feminist theory (e.g. Strathern 1992, Hardaway 1988). They format it into a particular shape, and it is only once this is done that the world becomes intelligible enough to act within. However, there are always relations which defy formatting: a calculative device presents only one of many possible worlds. Those things that are not present in the formatted world are collectively called externalities. It is this impossibility of total framing that carbon trading at once recognizes by trying to price the invisible consequences of greenhouse gas emissions, but which also is troubled by when trying to select certain attributes for inclusion as price determinants.

It is these instruments of calculation that allow things that were previously externalities to be brought into the world that is contained within economy. But what

kind of world is being enframed by cap and trade, and how? Certainly the theory upon which carbon trading operates is familiar to economics. Establish a supply of credits matched to a certain aggregate output of greenhouse gases (how it is done and what is implied will be treated later) into a market with a higher level of demand. Economic law, as it is conceived in this context, would suggest that if these credits are transferrable, then the market will generate a means of providing them at the most efficient cost, a theme with a long intellectual history dating back at least to the 17C (cf. Locke 1691, Smith 1776, Ricardo 1821). However, let us step back and articulate what is being asked of this economic law. The situation, as we have noted, is that the atmosphere is filling with gases with the consequence that bad things will likely happen. The response is the belief that a system can be created that will channel the frenzied pursuit of self-interest in such a way that it will countervail its tendency to move the biosphere towards destruction. The fact that it is imagined that we have such a force at our disposal itself has a long history. In a way it harkens back to a model of economic thought that predates the legacy left to the contemporary imagination by Adam Smith, as Albert Hirschman forcefully argues in his volume tracing the intellectual justifications for capitalism before its eventual triumph. Taking some account of this history will be instructive when considering the type of trader that carbon markets seek to perform.

In *The Passions and the Interests*, Hirschman traces the rise of capitalism during the 17th and 18th centuries to an endogenous progression of ideological positions about the moral and political status of commercial activity. Prior to the 17th century, such activity was perceived as a vice ridden enterprise that was fed by the baser of human passions. Hirschman identifies a conceptual innovation—first appearing in St. Augustine

and then later in Machiavelli, Spinoza, Mandeville and Hume—that created a hierarchy among the human passions that would allow some to be played off others in order to countervail and bridle their more pernicious tendencies (cf. Augustine 2012, Machiavelli 1988, Spinoza 2006, Mandeville 1997, Hume 1994). Those passions that could be harnessed for good became known as interests and were relied upon to serve the function of moderating human activity in ways that religion and political architecture were no longer perceived as able to do. The notion of interest wedged itself into the historical passion-reason binary that characterized intellectual currents at the time and, subsuming the best parts of each, emerged by the 18th century as the key paradigm for understanding the problems of politics and economy. From Hirschman we can see that "once money making wore the label of 'interest' and reentered in this disguise the competition with the other passions, it was suddenly acclaimed and given the task of holding back those passions that had historically been thought less reprehensible" (Hirschman 1977:41-2). Interest was so valorized in the Enlightenment context of the 18th century because having a model of humans as interest-driven meant that they would be constant and predictable and, in turn, governance and statecraft could be treated as a mechanistic system.

Hirschman points to how prior to Smith's *Wealth of Nations* there was a view that self interest would ultimately prevail in moderating government's relationship to its subjects and its neighbors, not only in neutralizing the human's internal passions (Smith 2000). Specifically, he traces this from the political philosophies devised by Montesquieu and James Steuart where the self-interest of rulers was considered something that could countervail their proclivity towards brutal excess and domination (cf. Montesquieu 1989, Steuart 1966). It was a system that put certain strictures on the agency of the noble. At

the end of Hirschman's story, Smith tables the intellectual focus on self-interest moderating the passions of rulers by focusing exclusively on the economic benefits that the pursuit of wealth would bring, instead of the political disasters that it would avert. In so doing, the general increase in material well-being came to occupy the attention of economists and politics for the next two and half centuries. However, under the current specter of cataclysmic climate change, we are in a sense resurrecting this model of countervailing interests as the prime virtue of capitalist systems. The planet, or at least some assemblage of human society and the planet, is being framed as possessing an interest to maintain a certain average global temperature, to support our livelihoods and contribute to the general increase of our material wellbeing. At the same time, the planet is also cast as something of a passionate overlord, a capricious entity that unless it is properly supplicated may blindly destroy its inhabitants. There exists now a potential state of war where the interests of the two sides must be brought into equilibrium if there is any hope of peace. To accomplish this, the opponent must first be built.

5.3 Crystalline time: planets in machines

A crystal oscillator is an electronic circuit that allows microprocessors, ranging from those found in wrist watches to those in massive super computing arrays, to observe the passage of time. If one were to get a hold of such an oscillator and slice it open, inside she would find a tiny rectangle of specially manufactured quartz crystal. Were she to further peer into this crystal she would observe a highly regular pattern of silicon dioxide molecules extending into all of the three spatial dimensions, everywhere maintaining the same order. Coming back up to the surface, she would notice somewhere around the

perimeter of this rectangle a small electrode. In an instant, a voltage of electrons comes coursing through it and the crystal is suddenly distorted, charged like a spring full of potential energy. But an instant later the electrode's voltage drops off to zero. As this happens, the crystal begins to resonate, its structure shuttering like a tiny tuning fork. With each cycle of its deformation the crystal itself generates a small electrical current that pulses out of another electrode off towards a neighboring circuit. Because of the uniformity observed in the structure of silicon dioxide molecules, this oscillation will occur at precise intervals, dividing a second into tens of millions of iterations. The resulting clock signal, in turn, allows the processor to coordinate the billions of calculations that it undertakes each second.

This basic engine of time undergirds all of the subsequent temporal manipulations that attend the modeling of planets in computers. In order to inquire about what kind of temporalities are being performed, we can examine what goes into making a climate model. In general terms, the climate is disaggregated into five subsystems which collectively are understood to determine its behavior: the atmosphere, the biosphere, the ocean, the cryosphere (ice and snow) and the geosphere (rocks and soils) (Mathez and Webster 2013). By coupling atmospheric models, which account for the lion's share of retained solar radiation, with the other four, predictions about the future warming trends of the planet are determined. On the atmospheric level, the entire volume of the gases and water vapor are reduced to regions on a 3-D grid that, in simulations current today, measure 200km in the horizontal direction and 1km in the vertical (Neelin 2010). The values of the various parameters in each region—including temperature, humidity and wind speed—are determined by satellites and weather stations with a resolution of once

every thirty minutes across much of the world. This resolution, known as a timestep, provides part of the main input, for the current instrumental record of data, into atmospheric models. Variables that occur at more narrow temporal and spatial resolutions undergo a process of parameterization where a further source of heterogeneous data about the general behavior of things—most centrally clouds—are manipulated mathematically to determine average behavior that then accompanies the timestep inputs. (McGuffie et al. 2014).

Supplementing the current instrumental record for atmospheric inputs (reaching back, with an expected decrease in resolution and accuracy, to the nineteenth century) is a historical record. One of the main sources of this historical record comes from fieldworkers who dispatch to the planet's frontiers, inhospitable places like Greenland and Antarctica, where they drill out cores hundreds of meters deep from deposits of ice. Encased in these cores are breaths of air from centuries past that can be sipped out and fed through machinery that determines their chemical composition. The field time of these expeditions (which, from interviews I have done, is often pervaded with such quiet that is perceptibly marked out by the beating of one's own heart; see the section 'Boring under the ice' below) intersects with that of the cryological record and is readied to enter computer time.

Combining mathematical instructions spanning millions of lines of code and vast archives of digitized historical data, super computers are used to unite the 'timeless' laws of thermodynamics that inform their programs with computation that can simulate decades of model time each day. Each time the calculations are performed, the model is given a hypothesis of a possible future and outputs a mathematical picture of what that

future might look like. The scale of this imagining is staggering. For instance, an initiative hosted at climateprediction.net distributes and coordinates a piece of software that turns the computers of volunteers into nodes in a distributed parallel super computer. According to a recent statistic on their site, they had over 56,000 computers running different variations of different climate models, having iterated through more than 49 million years in all. The goal of the project is to employ the public to calculate slight differences in input variables to discover how sensitive the models are, and what kind of alternative futures can be expected.

While all of these temporal acrobatics are being marshaled to simulate a model that attempts to describe possible planets, they are also conferring to it a measure of calculative agency: if we give it too many more gigatons of carbon, it is going to get very hot. In developing a countervailing calculative agency, pitting economic models into a power struggle with planetary ones, we encounter a situation similar to one described by Michel Callon in a chess match between Kasparov and IBM Deeper Blue. In this instance, Callon speaks of a "'parasiting' of one calculative agency by another which imposes (a part of) its calculation tools and rules, and consequently forces the host agency to engage in its own calculation" (Callon 1998:45-6). For Kasparov, he had to imagine himself in the computer's position, calculating as he imagines it would. By extension, there is a sense in which cap and trade market models are parasitic to climate models: seeking to appropriate the calculus of the planet, economic models become dependent upon it. But to uncover the engines of this dependency we may find that "we only fully understand our models when we have identified all the specific stories that they can encompass or tell about the world" (Morgan 2001:380, cited in Pryke 2007:584).

How then are economic models parasitic to the "mathematical stories and abstractions [that] form key elements in [their] calculative agency" (Pryke 2007:578)?

5.4 Shattering time: The panicked propulsion of agencement

The specter of climate change is animated by a discourse of risk. The prime mover that impels the search for a solution emerges from the conjunction between emotion and statistics, both on the point of urgency that has positioned climate change as an exigent issue and at the level of the market devices that are being designed in order to mitigate it. If we are to talk about a calculative agencement, emerging from a network of socio-technical relations, activating certain possibilities by framing the world in a particular way, then would it not also be instructive to consider what feelings they induce and how those contribute to the project's animation? Indeed, I would argue that there are both material and emotive possibilities that are being configured. A useful way to engage this emotive aspect is through Kathleen Woodward's idea of statistical panic. Before discussing its details, I would suggest as a proviso that while Woodward develops the idea of statistical panic at the level of a singular modernist culture and a singular postmodernist culture, we can engage the frame that she presents, holding it up as we would a prism to the sun, examining what light filters through, without fully accepting the premise upon which it is based.

Woodward sees statistics as a type of social technology which induces certain structures of feeling. Drawing from Frederic Jameson's idea that image fragments, as a characteristic form of a postmodern aesthetic, are able to emit complete narratives, she

suggests that the statistic, a highly particular and constructed fragment, provides a similar function, "a way of understanding our lives and the world condense[d] into a single figure" (Woodward 2009, Jameson 1991). In this picture, there is always a temporal orientation to the statistic. While it pulls its force from the past and is used to make a certain kind of sense of an event or moment in time, it is often "in the process…creating the contours of history" (Woodward 2009). Yet, these contours are always oriented toward the future, laden with a sense of risk or threat. This is something that Woodward observes within the content produced by the mass media, saturated as it is with statistics about everything from the prevalence of cancer, to the rate of new home construction, to the popularity of political candidates. In all of these contexts, statistics operate as probabilities that are cast into possible and alternative futures. Combining to induce a certain structure of feeling, they "engender insecurity in the form of low-grade intensities that, like low-grade fevers, permit us to go about our everyday lives but in a state of statistical stress" (Woodward 2009:181).

She traces this structure of feeling—created, as it is, through the circulation, representation and reception of statistics—to the modernist aesthetic that was typified by the "cinema of attraction" (cf Branigan and Buckland 2013). This movement took on the type of strongly non-narrative form that characterized the idea of what cinema was until 1906-1907 when it eventually underwent a narrative turn. The quintessential example that she draws on is the Lumière brothers' 1895 film *Arrival of a Train at the Station*. The sequence of images follows the prompt of the title: a congregation of spectators positioned in front of an approaching train. Woodward tells us that viewers reacted with terror and panic, that the film functioned by eliciting a "response of shock of the new"

(Woodward 2009:183). However, this shock of the new, this fear of the unknown outcome of the technological and social changes occurring during the nineteenth century, gave rise to a sense of boredom, a blasé attitude to use Simmel's term (1971). *Arrival of a Train at the Station,* by personifying the locomotive, one of the key emblems of change, at once represented a fear of the unknown while, as a piece of cinema portraying time and space, also created a context for eliciting it and eventually contributing to its normalization through a sense of boredom.

Woodward sees this structure of feeling, oscillating between boredom and panic, as the modernist legacy to the contemporary statistic. At times the statistic's ability to give form to the past, through suggestions of the future, does give it a real sort of agency in the day to day life of individuals' understandings of themselves. This is especially the case when statistics become subjectively activated, moving from a boredom that acknowledges the presence of risk but is not impressed, to a moment when it becomes intimately implicated in one's sense of self: there's only a 1 in 5 chance its cancer. What we come to fear is risk itself as our attention becomes fixated on the probability of a threat more than the object of it.

How might we think of the statistic's agency in the context of climate change? The often cited Sir Nicholas Stern Report to the ministers of the UK government headlined with the warning that: "The level of 550 parts per million CO2 equivalent could be reached as early as 2035. At this level there is at least a 77% chance - and perhaps up to a 99% chance, depending on the climate model used - of a global average temperature rise exceeding 2°C" (Stern 2007). While couched in the terms of a rational assessment, all of the temporalities involved in the formulation of this statement are shattered, coalescing in

the impetus that a better than 77% chance may contain. All of the subsequent mobilization of policy and public support rest on the emotive agencement of this number, how a quantification passes through the subjectivity and prepares it for interface with market devices born from the intersection of climatic and economic models. However effective statistics like these are in bringing future risk into the embodied concern of the present, there still remains the need to pull its financial consequences into a present calculus.

5.5 Timing the market

> Ramsey described pure time discounting as 'ethically indefensible and [arising] merely from the weakness of the imagination'. Pigou referred to it as implying that 'our telescopic faculty is defective'. Harrod described it as a 'human infirmity' and 'a polite expression for rapacity and the conquest of reason by passion'.
> (Stern 2007)

Once the panic has settled in, and "this reality", as the Director of the IPCC refers to it, shapes the underlying contours of the world, policy makers rely upon cost-benefit analyses to translate a gradient of risk into a program of action (Pachuari 2009). Manipulations of time provide a major pathway for formatting uncertainty and imagining a world wherein action can be taken. For instance, to maintain temperature rises in the range of 2.0-2.4 degrees, the alternate future recommended by the IPCC and agreed to in principle by G8 leaders as an acceptable level of danger, we are told that "the cost of mitigation by 2030 would not exceed 3% of the global GDP…the so-called prosperity expected in 2030 would be postponed by just a few months" (Pachuari 2009). Just a few months. How do we arrive at this seemingly innocuous sacrifice in time? What is at issue here is balancing the cost of mitigation against the economic costs that a range of

valuation techniques ascribe to the climate model forecasts. In order for action to be taken under a cost-benefit analytic, the marginal cost for abating each additional ton of carbon must be less than or equal to the forecasted damage that each additional ton of carbon will bring. When these intersect, the target market price for a carbon credit is determined and, in turn, it provides the metric through which governments will regulate the pool of credits made available (Randal, et al. 2007). However, it is not as if the economic costs of each ton could be priced individually, as perhaps a cubic meter of garbage could be in a landfill of a fixed cost and a fixed capacity. To create a way of framing this cost a device called the Social Cost of Carbon (SCC) has been devised.

The SCC is an estimate of the marginal economic cost of each additional ton of carbon dioxide emitted. Peer-reviewed estimates gathered by the IPCC give an average value of $43 per ton of carbon with a standard deviation of up to $83. However, other economists put the SCC in a much broader range from less than $1 per ton to over $1500. As of 2013, the United States uses the price of $37 per ton in pricing the costs and benefits of government policy, an increase over the $24 used since 2010 but still a highly controversial figure (Greenstone, et al 2013). The IPCC attributes much of this variation to "uncertainties in climate sensitivity, response lags, discount rates, the treatment of [social] equity, the valuation of economic and noneconomic impacts and the treatment of possible catastrophic losses" (Randal, et al 2007). However, the IPCC further refines this point by suggesting that much of the uncertainty in the estimates of the SCC can be traced to the discount rate chosen, a point we will examine in a moment (Randal, et al 2007).

In general terms, the first step in the SCC's calculation is to quantify the monetary

value, in terms of global GDP, of each incremental increase of temperature over a given period of time and then to divide that by the number of tons of emissions that would cause it. This period of time requires a model of how long emissions will remain in the atmosphere as its basis. As Donald MacKenzie has shown in an article tracing how a variety of greenhouse gases are made commensurable with CO2, the time constants chosen are in a sense arbitrary because they do not reflect the full interrelationships between gases in the atmosphere (MacKenzie 2009: 445-446). However, this ascription of a life-time to a molecule, provides only part of the SCC. A bevy of unrepresentable relationships still provide a substantial basis of overflow. One is asking to price the lives of future generations of humans, of the likelihood of some sea change in energy production, the value of a disappearing coral reef against that of the increased profits earned by arctic shipping firms. By what means does one frame these imaginary things that can find no immediate representation? What gravity can pull the future into the present? Economic theory has a device for completing such a task: the net present value (NPV). The NPV, called by Marx "fictitious capital," is one of the essential technologies that organize the operations of firms (Marx and Engles 2007). As a frame, it renders the future commensurable with the present by terms of a discount rate. We can imagine, for example, if Intel is considering the acquisition of a patent that it intends to seek licensing royalties from in the future, it will come up with a total value of those royalties and then discount it by a certain rate. For instance, if the total cash flow is anticipated to be $100M over 10 years, the firm might use a discount rate of 10%, perhaps its cost of capital in the debt markets, to bring that value into the present. Arriving at a figure of approximately $60M, they are in a position to render the future in terms of the present. The discount rate

selected is, of course, absolutely crucial because it is the main source of gravity in this equation.

But what discount rate should be used to make our great grandchildren commensurate with our own present interests? This has been a prime focus of theoretical/ethical debate within economics (Tol 2008, Pearce 2003, Guo et al. 2006). The discount rate is composed of two components: a "rate of pure time preference" and an over all rate of GDP growth. This former component contains two considerations. First, because people in the future are assumed to be richer, then additional economic benefits are presumed to be less valuable to them. Second, neoclassical economic theory holds that people would rather enjoy an economic benefit earlier, rather than later, because of the uncertainty that they will be alive later to enjoy it. The Stern assessment took a very controversial position and set the rate of pure time preference at 0.1% (almost zero, but allowing "for example, for the possibility that, say, a meteorite might obliterate the world") (Stern 2007). They defend this from an ethical position that believes the welfare of the future ought to be equivalent to that of the present. However, some prominent economists see this "a radical revision of the economics of climate change" and call for a total discount rate closer to 5% (Nordhaus 2007:384). The choice in rate is of enormous importance because it is the lens that focuses the future on the present and directly comes to bear upon how crisply that hazy, distant point resolves before our attention. If we do not see the future clearly enough, then our present actions will be insufficient.

A few years ago, delegates from all over the world gathered in Copenhagen to negotiate a global treaty to mitigate anthropogenic climate change. Displayed

prominently beside the keynote podium was a large television, a black background with bold red capitals, a glistening technoscientific plea: "TIME TO ACT IN COPENHAGEN 0:00:00:00". The count down, a phenomenon so often associated with the launch of rocket ships and the impending detonation of a bomb, is used to place negotiators on the precipice of time. It has been carefully measured out yet has all but slipped away. It is in this utterance that all of the afore discussed temporalities have converged for a moment. The world has been meticulously shaped across millions of years of computer time, placed into a synchronicity with the predictable timing of self-interested market behavior, discounted into the present and pushed, the hope is, into a panicked moment of zero time. Because cap and trade markets appear to be the preferred course of action for policy makers, the construction of these temporalities have a crucial impact on what kind of market is formed and whether or not it will be effective in coupling with the underlying calculus of the planet's warming trends. However, with 2016 set to be the hottest year on record, the outcome of this approach is anything but assured.

As we have seen, the response to climate change that occurs at the level of institutions and markets depends on shifting concepts of economics, risk and temporality. However, in a sense, they also presume the planet as an ontological given, eliding the deeper history and practices through which such a thing became thinkable. In what follows, I will explore more closely how such a planet, a thing which prefigures certain possibilities of relationship, has come about. To do this I will examine a moment when the modern planet is in some senses being created.

5.6 Tracings of a modern planet

At once an idea, a performance and an artifact, Leon Foucault's pendulum experiment first appeared in Paris in 1851, but within two years had spread as far afield as Chicago and British Ceylon. The Foucault pendulum was the first device that allowed for the direct experience of the earth's rotation and was a very public spectacle that made the planet available to collective witness through a kind of technoscientific co-imagination (Murphy 2005). The years following its invention saw a springing forth of many planets and many sciences that were marshaled to create publics around the planet. What I want to explore is not how the pendulum experiment radically changed the ontology of the planet by providing a novel enframement to the Euro-American imagination; rather, I want to examine things a bit closer to the ground and consider what the pendulum is asked to do as it is summoned to speak in a variety of circumstances. In the course of so doing, I will consider how these inextricably linked quasi-objects of the planet and the pendulum (Latour 1993), traveling with great rapidity over the course of several months, came to re-form in a plurality of circumstances in the making of a modern planet. Admittedly, this line of approach will present me with the methodological concern of treating texts as more or less disentangled from the specificity of their context, giving them perhaps an undue level of autonomy in my analysis. However, I hope to soften this critique by asking the claims that I make to speak only to a narrow set of questions. Namely, when I encounter the pendulum in the specific circumstances of a particular text, from what kind of ontological framing does the planet effuse? When the pendulum becomes active in language, what momentary shards of possible planets can we glean? What kinds of planets does the pendulum trace upon its evocation and for what

kind of public does the planet appear?

5.7 Witnessing the planet

> The phenomenon develops calmly, but it is inevitable, unstoppable. One feels, one sees it born and grow steadily; and it is not in one's power to either hasten it or slow it down. Any person, brought into the presence of this fact, stops for a few moments and remains pensive and silent; and then generally leaves, carrying with him forever a sharper, keener sense of our incessant motion through space. —Léon Foucault writing about the reception of his pendulum, 1851. (Quoted in Tobin 2003:148)

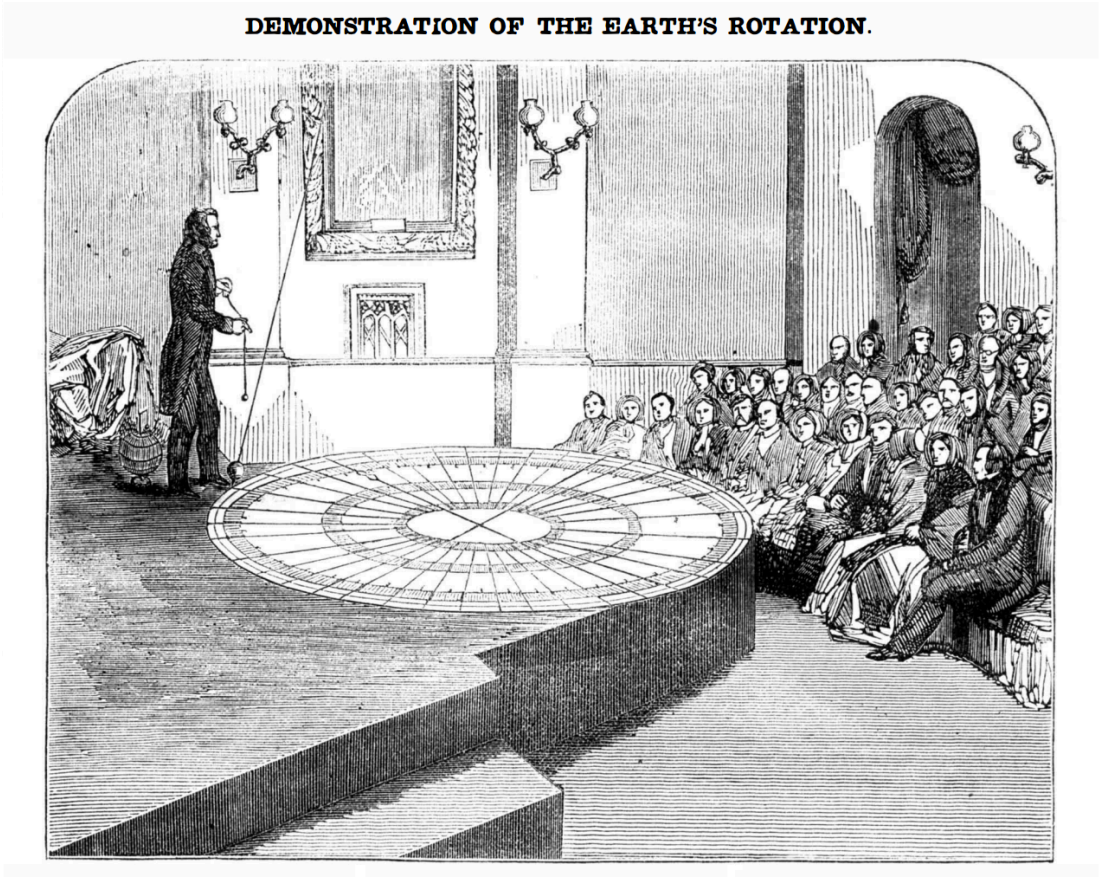

Figure 5.1 Demonstration of the Earth's Rotation

In February of 1851, Léon Foucault sent out invitations to the membership of Paris' *Academie des Sciences* announcing a demonstration of his pendulum experiment: "You

are invited to see the Earth turn…tomorrow, from 2 to 3pm" (Tobin 2003:141). As we can glean from his later writings, at least for Foucault, the experience was anything but mundane. Smuggling in resonances with what Latour characterized as the feelings of pure historicity that mark the experience of modernity (Latour 1993), Foucault seemed to have been able to strip away the black smut and roaring clang of progress and replace it with an almost mystical expression of planetary consciousness. As we follow the spread of the pendulum across Europe and America, and then onward to the colonies, we will find that while perhaps Foucault's expression is rendered in a more lofty register, the promises and experiences offered by the pendulum left few unmoved in the consultable record.

The planet earth, as an object of Western scientific knowledge, was by no means a particularly nebulous thing in 1851. At this time, there was virtually no controversy in the scientific societies about the fact that humans lived on a spherical planet that revolved around its axis daily, all the while revolving around the sun once every year. In 1838 any lingering doubts about this point were largely put to rest when a stellar parallax (the apparent movement of a more distant star relative to a closer one that can only be explained by different orbital positions of the earth) was observed by Friedrich Bessel (Timberlake 2012). Yet it was a distant certainty that was obtained, one mediated through many levels of instrumentation and calculation. Surely the planet had been measured, its rotation directly suggested by eighteenth century expeditions to Peru and the Arctic that produced proofs of equatorial bulging and polar flattening, expected phenomena if the earth was indeed spinning (Conlin 1999). But as Laplace, one of the period's leading scientific authorities—to the extent that even Kentucky's *Louisville Journal* would later

call on his ghost to give the pendulum a definitive interpretation—suggested in *Mécanique Céleste*: "although the rotation of the earth is now established with all certainty available in the physical sciences, a direct proof of this phenomenon would be of great interest to mathematicians and astronomers" (Laplace 1829). It is this direct proof that was promised by the pendulum, and, as it would turn out, it would be of interest to a much broader audience than merely the men of science.

Before continuing a discussion of the pendulum, it may be beneficial to give a simple textbook account of what it actually is so that there can be some means to ground what will follow. The pendulum experiment begins by tracing out on a surface—usually the floor—a circular gradation of degrees. Suspended by a cable attached above the center of this circle is a spherical bob. To conduct the demonstration, the bob must be pulled back to a starting point and released. Upon so doing, it will swing back and forth, tracing out a particular line. Over time, that line will begin to shift in a direction that is dependent on the hemisphere in which the experiment is conducted. The only reason that can be given for the rotation of this line around the circle is that, (1) the earth is rotating and (2) it is rotating at slightly different speeds at every point in between the poles and the equator. To illustrate this point by reference to the extremes, we can imagine that near the north pole, the earth may need to travel a distance of only 50 miles to complete one rotation in 24 hours whereas on the equator it must travel 25,000 miles during the same period of time. So while the different speeds at which the earth rotates on the northern or southern side of a room are not perceptible to us, as they perhaps would be standing in different places on a merry-go-round, the pendulum accrues and compounds these different speeds in a way that causes it to shift the orientation of its swing (Aczel 2003).

While this is just a thumbnail sketch, we will find that the pendulum brought with it much more than a mere necessary conclusion from a set of empirical observations. There was something in the mesmerizing movements of the pendulum's swing, shifting just below the register of perception with each period, that seems to have attached itself to the new planetary ontology that it was tracing out. Indeed, as the pendulum instantiated a kind of epistemological interface that made the planet's "incessant motion through space" knowable, it brought something of the character of that experience to bear on the object it created. But we must ask: what kind of thing was the pendulum? At times it was sanitized of the human touch, being set on its tracings through the burning of a woolen thread. At times not. The pendulum was an object that spread through newspapers, that was at times precisely described and at others adapted to whatever materials lay close at hand. It was an object of empire and interface. It made worlds, but it never was merely an object.

5.8 Come and see the earth turn

The symbolism of place that inaugurated these pendulum demonstrations is striking. The first public demonstration, the February 1851 installation in the Paris observatory, was held under the dome of its Meridian Room, on whose tiled floor was a sketch of the north-south line of the Paris Meridian. Having been recalculated by way of field expeditions undertaken earlier in the century, the Observatory marked the origin point of this meridian. As the very fulcrum of French exploration and colonialism, the line was used to trace out the maps of the empire, bringing all of the world to the reference of metropolitan Paris. However, after the experiment was under way, the pendulum's circumscriptions around this longitude soon provided another set of

coordinates. The experiment came to the attention of Louis-Napoléon Bonaparte who decreed that a new pendulum should be built and installed in the Panthéon the following month for the benefit of the general public. The Panthéon itself, built in the 18C as a church dedicated to Saint Geneviève, Paris' patron saint, was shuffled back and forth between secular and ecclesiastical domains during the revolutionary period, purporting at the time of the Second Republic to represent the preeminence of humanist ideals. Following the June Days of 1848, when a revolutionary force barricaded themselves in the building before being brutally expelled, the Panthéon had remained closed for years until Louis-Napoléon's intervention to publicly associate himself with the device that let you see the earth turn, ten months prior to his orchestration of a coup d'état.

As the Panthéon demonstration opened in March 1851, flu, floods and a general ill climate were said to mark Paris. Despite this, crowds streamed in to bear witness. By July of that year, "pendulum mania," as *Putnam's Monthly* later put it, was spreading internationally (Putnam's 1856:419). A "monster pendulum threatened to become essential to every respectable household," as demonstrations were set up in London, Dublin, Ghent, Vatican City, Rio de Janeiro, and scores of others places from Cincinnati to Ceylon (Putnam's 1856:419). But what was it about being present before the oscillating pendulum that was so compelling? Newspaper reports from March and April, when French and British demonstrations were proliferating, all had something of the sublime to attribute to the experience. As *The Times* of London put it: "the experiment excited the astonishment of every beholder, and many eminent scientific gentlemen who were present expressed their great delight in witnessing a phenomenon which they considered the most satisfactory they had witnessed in the whole course of their lives"

(International Monthly 1851:296).

Hundreds of pendulums were set up all across the world in the years to follow. In nearly every subsequent public demonstration of the pendulum some lecturer or series of articles was provided by way of supplement. A lot of work had to be done so that people encountering the pendulum would be able to make the connection from their immediate experience to the planet itself as a moving object. These often required some rapid movements on the part of the reader who within a single paragraph must hold the whole globe in mind and transport herself from the exact point of either of the poles, and then back down again to the equator (e.g. Converse 1851). This is not the frigid north, or the savage tropics, just points on the globe brought to mind to account for a phenomenon. These abstract displacements of a geographically imagined sphere are essential to nearly every description of the pendulum that seeks to explain why it proves what it does. This kind of mental gymnastic was previously relegated to navigators and cartographers, not a part of the common experience. Considering these circumstances of first encounter in an abstract way, the observation of the pendulum seems to have instantiated a particular kind of interior space for the viewer. Upon passing into a chamber housing the pendulum, the observer is presented with something that purports to be a direct manifestation of the planet's motion. Back and forth, back and forth it swings. The eye follows as the mind tries give an account of how the pendulum accomplishes what it claims. But a considerable amount of work had to be done in order to render this perception immediate; one had to learn how to see, and equally how to feel, this giving of shape and form to the ontology of a planet.

Surveying the records of pendulum demonstrations, we find that while all of them

took the cloak of scientific authority, only some were about the "good science" of rigorous method, revealing instead deeply culturally and symbolically marked manifestations. Indeed, turning our attention to the United States, we will find these pendulums transecting a full gambit of core social spaces: capitol buildings, court houses, railway depots, Civil War monuments. One of the first reports of the pendulum in America was published in May 1851 by *Scientific American*. On the top of the page is an engraving that features a doctor, smartly clad in a black frock coat, standing atop the stage of an auditorium as he burns a string that will release the pendulum before a rapt audience of men and women. However, the editors reserve judgement remarking that, unfortunately, it "is now the subject of much controversy in England, [where] some are stating that [the demonstration] is fallacious, others proving it to be the reverse." However, all will soon be resolved by an ascendant American science. An experiment at the Bunker Hill Monument in Massachusetts, "its firm and substantial character and the protection it will afford from all extraneous influences, [making it] probably the best place in the country" to conduct such an experiment, is soon to be underway (Scientific American 1851). To mark to occasion, in a manner sure to elicit derision from the members of any reputable scientific society, "the weight to be suspended is a canon ball which was fired from one of the British ships during the battle of 17 June 1785". The ball was recovered and installed as the mesmerizing orb, marking the ascendance of the American republic and its keen mastery of science. Yet, the experiment not yet being conducted, the remainder of the article is dedicated to an extended quotation by a reader who constructed a pendulum on his farm, and in which his "barn floor" is continuously invoked to represent the ground of the immovable earth. Readers are invited to join in as

"common practical men" and transform their own homesteads into points of communion with the celestial sphere. (Scientific American 1851)

Indeed, this populist version of the pendulum spread in fact quite broadly. Accompanying nearly all of the articles reporting on the pendulum and explaining how it worked were instructions for readers on how to construct this kind of "DIY conduit" to the hidden planetary system. In *The New York Times* we find an ontological formation of the planet that is being even more directly inculcated, diagrammed and stitched into everyday life. Within the confines of one's apartment, a "very simple apparatus" can be built. The author coaxes us to recover from the "open mouthed wonder" we may have experienced if we saw the recent demonstration given at Columbia University. If you really want to be modern, if you "really want to get the scientific thrill up and down your back, such as Galileo felt," then fret not because "the whole experiment can be done perfectly well with only a card, a thread and an old bottle for instruments." And indeed, these are not passive objects at all, for we must take care to let the bottle *suggested as a ready at hand weight* expend its desire and "untwist itself as much as it wanted". To be sure, the scientist would have no shortage of reasons for why an experiment such as this is not really science. But if it is not to be called real science, then what kind of science is being conducted by the bourgeois of a gilded age New York? (Thomas 1908)

In January of 1852, the *Christian Examiner and Religious Miscellany*, a magazine associated with the New England Unitarian sect and whose editors were deeply influenced by American transcendentalism, published a twenty-page article about the United States Coast Survey. After proceeding in an ebullient tone about various methods to measure coastal topography and other geographic features, we are eventually brought

to a rendition of how survey teams record the precise latitudes of their observations. These are strong and masculine Americans, happy in the wilderness. Indeed, the author implores us: "the tedium of astronomical routine observations is not so great as is generally supposed," there is a transcendent excitement to be had. He continues to make his case: "those who have looked with interest upon the repetitions of Foucault's pendulum experiment can understand the interest of the observer who sees the earth's motion upon its axis made manifest in the…motion of a star across the field of his instrument". The pendulum is evoked as a bridge, as a way to make commensurable the reader's understanding of the character of the work being done to expand the boundaries of the Republic with his own encounter with the pendulum. They become similar kinds of citizens sharing an experience of a wondrous science carving out new worlds. And it seems that these demonstrations and explanations persisted for the generation that experienced them. If you look back into the archival record, you will hundreds of examples of the experience of witnessing the pendulum used as a metaphor to explain the marvel of some one or another scientific or engineering advance. Nowadays if we do encounter one of these pendulums it seems to be mostly devoid of meaning, accompanied only by dusty plaque in a science museum. But for a time, we had a very particular kind of planet residing in the minds' of people.

5.9 Planetary imaginaries

In the foregoing I have explored a set of thematic ways in which the pendulum was summoned in the aid of tracing out a plurality of different planets. When the pendulum was inaugurated, it was situated within the purifying metaphysics of Western science,

championing observation and deduction as the pathways to true knowledge. Yet beyond abstract argumentation, a lot of work was required to suture the pendulum to the immediacy of perception in order for it to be presented as a demonstration of the planet's rotation. As these attempts were made, the novelty of the pendulum as a kind of epistemological interface was articulated through the experience of its reception and into highly particular moments of translation, expressing very situated planetary ontologies. From the pendulum's tracing of the Paris Meridien, allowing the experience of the planet to be born from the cradle of empire, to its domestication in the home of the everyman who can feel this thrill himself, the pendulum as a kind of data interface that occasioned the production of dynamic publics and hybridized objects.

There certainly is a process of creating and recreating publics with respect to the planet that have extended far beyond the 1850s. Images of the earth from space—from the first grainy image in 1946 taken by a V-2 rocket seized from the Nazi's and launched from the New Mexico desert, to the more famous blue marble photograph of the Apollo 8 mission—provide us with another example of a planetary ontology in the making. These images of our blue speck in the blackness of space went a long way towards providing something of the imaginative feedstock through which we make sense of the planet. In the 1970s, when into the mix of this object "planet earth" came the threat of global climate change, this conceptual background began to shift again. Yet the kinds of data interfaces available to articulate and imagine this led to the instantiation of particular kinds of partial planets. The infrastructure for studying the climate makes it necessary to calculate pollution on an aggregate level, without any meaningful monitoring on a regional let alone an urban or building scale. The result of this is that not only is the local

generally effaced in the databases that drive forecasting models and policy decisions, but also that many of the most forceful arguments about the risks of climate change are made through graphs and charts that require a particular kind of aptitude to understand.

In what follows I want to delve more deeply into the labor that goes into producing a modern planet. As we have seen, there is a tremendous set of intellectual histories, institutional configurations, subject positions and computing infrastructures that go into producing the planetary climate crisis as something that we can relate to. Yet I am interested in understanding things closer to the ground. What is it to be present at the planet's frontier, on the frontline of the data flows that make our understanding of it possible? How can experiences here help us frame the dynamics of the broader whole?

5.10 Boring under the ice

Julie Cruikshank in *Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination* presents a multilayered and historical portrait of the mountains and glaciers that border the Gulf of Alaska (Cruikshank 2010). We are first brought into encounter with this Arctic terrain in the 18C, a time significant both because it was the end of the Little Ice Age and because it marked the moment when European explorers first came into contact with the Tlingit people of the Pacific Northwestern coast. Engaging this period and moving onward to the present day transformations of the region into a UNESCO world heritage site, Cruikshank undertakes an "anthropology of encounter" which investigates the narrative traces—those of oral histories and of written records—that accumulate from such meetings and subsequently transform in new time periods and before different audiences. As a whole, *Do Glaciers Listen* provides a sense

of instability and intimacy about the environs of the Bay of Alaska. It is a composite spun from an immense variety of sources: from the Tlingit's cosmology and history present in oral tradition, to encounters recorded by 18C French explorers, writings of 19C American adventurists and military personnel, the negotiating tables where the British and Russians carved the space up, and the designation of the region as a protected park. What emerges from these accounts is an intimate feeling of not exactly the history of a place, but rather a familiarity with the multiplicity that exists across successive observer positions and practices (cf Mol 2003, Strathern 2005).

These observer positions, as I am calling them, are explored by Cruikshank through a reconsideration of what local knowledge is. Taking it not as the metaphysically bounded world of a particular people, Cruikshank suggests that local knowledge is "tacit knowledge embodied in life experiences and reproduced in everyday behavior and speech" and which can be reconstructed from historical narratives (Cruikshank 2010). This approach examines how local knowledge is at once socially situated while also being porous, changing in the encounter between peoples and landscapes. What she focuses on is how narratives from both Euro-American and aboriginal sources operate as a kind of "co-existing" practice and, grafted atop a specific geographical location, serve to inform and reveal something about the epistemological consequences of encounter. Her investigations lead her to view "landscape [as] a work of the mind…its scenery is built up as much from strata of memory as from layers of rock."

What is interesting in Cruikshank's work is the perspective she offers on how to study the accrual of meaning around a specific geography. She is trying to pair records of events and of topography with landscape, and the work of her analysis consists largely in

an attempt to map the open-ended dynamics of these correspondences. Her investigations reveal how many narratives do not agree or diverge and she uses this to illuminate the contingency and uncertainty of multiple histories. When considering how scientific knowledge about the global climate is produced, I am particularly interested in the field scientists who travel to the earth's furthest frontiers in order to gather information that becomes the feedstock for climate models, statistical panic and an international debate on climate change. Is there something in the experience of *being there* that transforms researchers' understandings of themselves, their work and the planet? Antarctica seems an ideal context to explore the kind and the consequence of relationships that researchers developed with their field sites both because of its unparalleled remoteness and the extreme hostility of its landscape.

To explore this question I conducted an in-depth oral history with Toprak, a Turkish climatologist who had completed two research trips to Antarctica. What I found was a story of isolation characterized by both social and environmental factors that resulted in a newfound intimacy with the self that far outlasted the visceral experience of the field. His particular work took him all over the world where he collected air samples that he brought back to his lab in order to determine the composition of the gases that they contained. In Antarctica he was accompanied by ice drillers who would bore three inch-wide holes more than a hundred meters into the ground so that he could collect samples of air from the various layers of ice, spanning hundreds of years in all.

After a few preliminary email exchanges, I met with Toprak at a café beside Croul Hall, the University of California, Irvine's main earth sciences laboratory. My goal was to let Toprak speak as much as he would, trying to present him with as open ended a

set of prompts as possible. Toprak emerged from the building fifteen minutes late but, because classes were in session, the area was largely deserted and I spotted him immediately. He had very closely cropped hair, bordering upon shaved, that ran almost seamlessly into his face's days old stubble. We shook hands and exchanged some perfunctory greetings. Walking over to the café counter, I tried to give him a sense of who I was and a bit more detail on why I wanted to speak with him.

We sat on a bench peripheral to the café's main bustle and I asked him if, instead of taking notes while we spoke, he would mind if I recorded our conversation. Having no objection to this we preceded to speak for the next hour and a half. The beginning of our conversation was a fairly technical discussion of his work, dealing with what Toprak saw as an important preliminary. As I tried to guide the conversation around to his trips to Antarctica, and how he felt about them, I initially encountered some resistance. Even as I tried to clarify my interest in *his* experiences, Toprak would answer me in general terms, explaining the circumstances of an Antarctic research trip as they were generally understood. Fortunately, I found as we went on he became much more willing to reveal himself in a more personal manner. Speaking with Toprak presented some particular challenges for me as an interviewer. As will be clear from the transcript, he would respond easily to my questions and at some length. This of course is ideal. However, in the flow of his responses I felt that there were branches of the conversation that were constantly being closed off, that, in following the flow of the interview and letting him speak, opportunities to naturally bring things up were inevitably being passed over.

While I did not get the sense that Toprak was tiring from our interview, I did realize that we had been speaking for quite some time. After he finished answering a

question about his relationship with the contractors at one of the research stations, I suggested that I must be keeping him from his work. And with that our interview concluded. He pulled his phone from his pocket, noted the time and shook my hand. He should indeed be getting back to work. He hoped he was able to help me. The moment felt very abrupt and seemed to fit with the on/off sense in which I felt he had delivered many of his answers. While I did not expect to make a friend from the encounter, it was striking to have heard all of this personal information about Toprak without having said much at all about myself, leaving without any tangible sense of rapport. Reviewing the tape later accentuated the feeling. In the constant back and forth—writing up my thoughts, reading the transcript, revisiting the animated voice on my recordings—I was struck by what my work consisted of: taking a fluid moment and trying to give shape to it, all the while working with the figments of a stranger.

5.11 Arrival

On 17 December 2008 Toprak boarded a commercial flight at LAX bound for Christchurch, New Zealand, the first leg of a journey that would take him to the Amundsen-Scott South Pole Station. Toprak tells me that when he arrives in Christchurch, a small city of 300,000, it is teeming with scientists and support staff bound for Antarctica. The austral summer provides only ten to twelve weeks during which the weather is potentially good enough to conduct research. Because of this, around the turn of the New Year the downtown pubs and hotels are full of anxious people hoping that conditions will permit them to make their flights down to McMurdo Station, the main

beachhead for US research in Antarctica. Toprak was lucky: he had heard of people who had to turn back home because the weather caused them to miss their allotted time for use of the station's scarce resources. A few days later, after a seven-hour flight crammed with other travelers in the roaring din of a propeller driven, US military cargo plane, he landed at McMurdo. Toprak, as he suggests many others do, took an immediate disliking to the place. "It's like a military station," a boring place that "looks like a mining town" with "dust so bad it scratches your eyes."

McMurdo is a sprawling complex of buildings that can house over 1,000 people at the peak of the season. Toprak, a native of Turkey, was struck by how "everything America does down there is big." The buildings are massive, but "the machines especially…you look at the Kiwi's [New Zealander's] base a few miles away and they have regular Toyotas…but everything on the American base is like a monster truck." Life at McMurdo, Toprak told me, was like being back in college with cramped, dormitory style living quarters. Most of the three days he spent there were consumed with work: making sure that all of his equipment had made it from Christchurch, that it all was functioning and that research tasks were clearly marked out for his team.

I wondered what the mood of life was like at McMurdo, how its residents made a sense of home for themselves there. When I asked Toprak, he told me that:

> *"Food is really the most important thing. Everybody talks about food. Like when the freshies come—and freshies are like vegetables and fruit—they are very valuable. In the beginning of the season when they first open, when the icebreakers come and they open a passage it is like 'oh, there is some fresh fruit, let's go for it'."*

It is a striking image, this connection between a 25,000 ton ship, smashing through sheets of ice, laden with the fruit of distant trees, and the mess hall at McMurdo where the

promise of something fresh can provide hope and solace for the day. I tried to get more from Toprak about this, some more personal or emotional revelation about what exactly it is to be in such a place where food can help to assuage some deeper discomfort. Yet, I would have to wait until Toprak brought me with him to the South Pole Station. The answers that he gave were sticking quite closely to the 'you' pronoun, illustrating a general case of what he experienced, but telling me little of himself.

5.12 A Space Station: Stilts above the Flat White

On Christmas Eve Toprak escorted his equipment to McMurdo's airfield and boarded a three-hour flight to the Amundsen-Scott South Pole Station. Recalling his arrival, he tells me:

> *That was tougher because South Pole is high, so you get on a plane and then you land and its like usually the elevation, the pressure, air pressure, is about 10,000 feet. So you land there and its like much colder, the wind is blowing in your face, and the cold… You get off the plane, you climb up the stairs to the station, you try to catch your breath, you realize, you know, the altitude makes the air so thin.*

The South Pole Station was brand new when Toprak arrived. Christened in January 2008, the finishing touches were still going on a year later. The old station sat some distance away, a big white dome slowly being buried by the snow. The new station was mammoth by comparison, complete with a full court gym and sauna. "It's impressive," Toprak told me, "it really feels like a space station." Placed high on stilts so that the never thawing snow can pass cleanly beneath it, saving the station from the entombment that overcame the old dome, Toprak is assigned a private room, a definite improvement over McMurdo. However, at the edge of the planet, even amenities are tenuous. Toprak's room had an

internet connection, but it was dependent upon satellite uplinks that were only available a few hours a day. What is more, the satellites are well past their service life and it is anticipated they will begin burning up in the atmosphere imminently, leaving Antarctica without its prime link to the rest of the world. What was it like to be so cut off from home, having to rely on a tenuous link that works only in spurts and which may fail at any moment? I would soon get some hint.

The base was essentially closed down for the Christmas holiday, with all usual operations halting so that the residents could relax and enjoy a festive dinner together. South Pole Station, like McMurdo, is stratified by both time and class. Ordinarily, support staff and scientists do not interact much and when they do come into contact it is only with those others who are on the same shift schedule. With 24-hour sunlight and 24-hour operations on the bases, the residents are broken up into night and day shifts, ordinarily passing one another as strangers on their way to or from bed. For the Christmas party, however, everyone was together. It was a big event and "everyone tried to dress up as much as they can". Toprak brought with him a dress shirt, wrinkled from its storage in his backpack, and delighted in the wine and good food. Yet he was impatient to get out to the field. Somewhat frustrated that they "would not even drag our cargo out to the site" that day, Toprak felt that he "really didn't have any time for just relaxing".

5.13 Sun Dogs and a Big White Desert

Toprak was to spend three weeks camping at a work site a few miles away from South Pole Station. The day after Christmas, he, another research scientist and two

drillers set off for their site. In addition to the tents in which they were living, the site had two larger structures. One of them was dedicated to their scientific equipment, containing the pumps that would pull air out of the well they drilled and the flasks that would store it. The other structure was a rest and social area where there was a stove for preparing tea and snacks. As to the surrounding landscape, it was "like a big white desert." There would be frequent wind gusts that would gather up plumes of ice that the sun would sometimes break through and create spectacular halos called sundogs:

> *If the sun is up, if everything aligns right you can see light shooting off to the sides and the bottom and you usually get a circle around it with rainbow colors all around the sun… Sometimes it does a really bright arc type thing very close to the surface of the ice, close to the horizon. And they would like let everybody know on the radio, 'Oh everybody there is a new sundog, go watch it'.*

What is it to be standing out on the ice, waiting as the drill bores into centuries old ice, when out of the radio's static comes word of a sundog to the southwest? Jolted out of reverie, spinning around to the left, what does it feel like? I would hope to get some indication from Toprak before our interview concluded. I would hope to get him to speak more in the first person.

Living in the camp can be taxing. Toprak recounted to me how quickly any lingering modesty that one might bring from their "other life" is forced out of them. One must be warm in order to fall asleep, and if they wake up in the middle of the night having to use the bathroom, they are faced with a choice: they can lose half an hour getting out of bed, dressing, stepping out to relieve themselves then coming back in to warm up, or they can use a pee bottle. With a hearty chuckle, Toprak suggested that he had no problem making the adjustment. But such a lifestyle does take its toll: "The

problem with the camping is that you really get nothing. After a couple of weeks, you didn't shower, you didn't, it's like it starts to get into you a little bit, you want to be like 'God, I just need some running water'." Toprak told me that he would practice yoga to help his body adjust. It helped him because "I can just not think about anything, so you feel relaxed." But, more than the spartan lifestyle and the inconveniences of living in such an inhospitable place, there is a more subtle—yet none the less penetrating for it—demand on one's spirit. What is it to actually be in Antarctica?

> *I've been on ships before, it's not that different. Ships are a little different. It's almost the same thing, in the sense that you are essentially confined, very spatially confined. Like over here you get in your car… your reach is much larger than it is in those situations. In the ship is the same thing. You can't get out of the ship and it gets smaller every day. Research ships are not that big to begin with. In Antarctica it's the same thing. In the campsite there is nothing that you normally do.*

In the campsites "people get very irritable." Time is tight and, with equipment inevitably failing, the difficulty of the work environment tends to put people on edge. Reflecting on his team's experience during this trip Toprak says: "I've never seen a field trip that everybody just got along, you know. It just doesn't work that way, but in the end we got what we wanted done, and everybody is still talking to each other, so, you know, we did well."

Toprak was reluctant to recount any specific stories about his interactions with his team or of any of the drama that occurred. I wondered why this was. Perhaps he thought it wasn't appropriate, a "what happens in Antarctica stays in Antarctica" attitude? Toprak had worked with the other scientist and the two drillers a few years earlier on a larger project in Western Antarctica. I wondered what the nature of their interactions had been

during those weeks in the field, what the tenor of the social life may have been. Toprak told me that he was able to maintain good terms with everyone because "I would stay in my own world." What sort of world was he embracing? How did the experience of being in Antarctica shape it?

I was struck by the fact that Toprak did not seem to really know the people that he was with, where they came from, much personal detail at all. Yet he spoke fondly of being able to meet many different "types of people" that you "definitely don't meet…here [in California]." It seemed that there was something more than social isolation that characterized the experience. I sensed that there was something about being immersed in the silence of nature, the absence emanating from the flat whiteness, of having a vast plane before you, but only a very limited reach. Probing, I asked Toprak if he felt that it was possible to experience the same feeling of personal isolation in a city where one is entirely a stranger:

> *No, because, it's too crowded. Here* [in California] *its too many people in your living quarters and you are going to be living with a bunch of people around you. It's always noise and the cars, traffic… There is just, I don't know, I don't think it's about knowing people, but the very existence of everything around you that makes the whole experience different. In Antarctica you can really hear the silence. You, just realize it's never really quiet here.*

At the edge of the world even in the midst of others you are "all by yourself". When I arranged to meet with Toprak I hoped to find out how *being there* changed his understanding of the world and his studies of it. What I found was an experience of isolation, a confrontation with the vastness of the landscape that forced Toprak into the world of his self. Drilling into the ice, taking breaths of air from centuries ago, was intimately tied to a fracturing of Toprak's understanding of himself. How did this

experience change Toprak? In the concluding section of this history I will let Toprak give an account in his own words.

5.14 What is it to hear the silence? Returning home.

The first thing I did when I got back was I broke up with my girlfriend. *How come?* I don't know. Because you have time to think about a lot of things that, and then you… I don't know… You really spend a lot of time with your self because there are really no distractions around. You know, you are just all by yourself and you couldn't even listen to a lot of music or anything. So when all of that stuff goes away you start basically, the issues that you try to ignore surface. You start thinking about that, I started, you know, realizing 'Oh maybe it is this and that. Why have I not been thinking about it this way?' or something like that. And then you know it's very different, it really gets you out of your environment and puts you in a different place…You just come back a different person…Actually I felt more and more independent both times I went there, when I came back I felt like I, I was, I felt stronger, being on my own, being alone… I guess that's why people get sucked into to it. I've met a lot of people over there who are loners, essentially. Even like the people who winter over, it'd be a couple, but you see that there is only two people in their world. They are not like city dwellers. I was born and raised in a big city and been in big cities all my life, in places with people all over, but these people are all, they are just live life on their own. And then you start getting used to that. There is good things about it, there is bad things about it. Right? I don't know, so like the first time I came back I just wanted to be alone. I felt like I needed to

rediscover myself, because I'd been not alone for a long time… I really changed after that too.

And it was similar both times? Right, second time I kind of knew... I mean I kind of just, you know I enjoy it more… First time you just don't quite know how you are going to deal with it. But second time I was experienced… then it's all, you know, it really is valuable experience because… everything is like difficult… There are folks who live in Alaska and that is how their winter is like and their winter is like 8 months long and that's what they do and that's what they deal with in their everyday life. It's just you get used to it, it becomes a part of your life, you do things routinely and then they don't feel as difficult anymore. Then you come back and you feel like you want to live a little differently, and then if you like see people who aren't like that you don't want to be with them anymore.

5.15 Conclusion

In the foregoing we have seen many different ways in which the planet—the site and setting for what is being called the anthropocene—has been fashioned in a way that affords particular kinds of relationships. The international organizations and planners of cap and trade markets come to understand the planet as a thing which is viewed primarily through the lens of an input/output relationship; too much carbon goes into the system and too much warming comes out. Under this paradigm, the planet becomes a counterparty to a market in carbon credits where a certain model of rational economic actors needs to be brought into synchronicity with the thermal properties of greenhouse

gases. This model tends to efface the underlying lifeworld of the planet itself, and assumes it to be an obvious, pre-existing entity. With the experiments and the circulation of the Foucault pendulum, we come to see a moment when a plurality of planets were produced as objects of knowledge for a wide range of publics across a variety of situated contexts. In this instance, we can start to understand that whatever we might think we know about the planet emerges from a particular interaction of individual experience and laboriously constructed imaginative interfaces. And finally, we have come to understand that the very production of knowledge about the planet, at a time before it is subjected to a massive assemblage of technoscientific discourse and networks of supercomputers, begins in an intimate encounter with the landscape and the self.

Throughout these occasions, the very ontology of the planet becomes a shifting ground, one inseparable from the epistemological contexts out of which it is produced. We exist in a dynamic relationship with the things that we come to know, and the crosscurrents that underwrite their possibility is always shifting and tightly coupled with how we presume to know them. The planet's inherent multiplicity presents us with both crisis and opportunity: as we seek to rise to the challenge of a planet whose habitability for humans is rapidly deteriorating, we must perhaps invent it anew, to find a grapple that affords both the intimate and the technoscientific, the depth of history and the immediacy of its extremes.

Chapter 6. Conclusion

Were one to approach New York City at night from the air, she would probably fly along one of four corridors that the Federal Aviation Administration has specified as permissible approach paths to the city's three airports. Lights would shimmer, powered by more than 11 gigawatts of electricity drawn from the huge dam at Niagara Falls, the nuclear turbines at Indian Point and dozens of coal and gas fires. Waves would invisibly lap at its 538 miles of coastline, far from view. Taken from this height, New York City can easily slide into an abstraction, a spider network of roads dotted with orange and white beacons. Nowhere present are the city's 58,000 documented homeless people, the annualized violence of its 49,000 felonies nor the 124,000 embraces of a new mother first holding her infant—just purple gray clouds and the anticipation of landing.

A sense of place is a wily thing. It is not only in an on-going state of generation but it also seems to exist somewhere in-between a person's individual experience and the stories and structures that are called on to tie it all together into a single, intelligible world. A major critique of relying on an idea of the anthropocene as a way of framing climate change is that it deflects attention away from things like the history of capitalism, thereby muddling a clear vision of the etiologies most central to the current crisis. As I discussed in the first chapter, there are a wide variety of ways of naming the event of climate change. Across all of them attention is paid to who the "we" reflected in the anthropos is and how that can be used to frame the relevant relationships, responsibilities, and paths forward. Because economics is one of the dominant organizing paradigms for disciplining and managing populations, it has been relied upon to explain and establish the incentive structures needed to drive human behavior in a direction that produces

acceptable inputs into climate models. Inseparable from this is the production of particular kinds of individualized subjects who can, each unto themselves, shoulder the responsibility of action. One must reduce, reuse and recycle; each of us are individually responsible for the planet's future. But if the critiques of mainstream political or scientific narratives around climate change have anything in common, it is that they efface important relationships across species and across inequalities, thereby reinforcing the problematic variations of human exceptionalism that have gotten us where we are today.

I chose to anchor this dissertation around a simple question: how do the planet and the climate crisis become things that are thinkable in the first place, and what specific practices and techno-social configurations contribute to the particular ways that one can access or inhabit this place which is at risk? I believe that by sharpening a perspective on techniques for both spatializing and experiencing the climate, an important new area of approach can be developed when it comes to relating and responding to the current crisis. This has proved a challenging line of inquiry because any conversation that deeply engages human experience always risks being overwhelmed by the poetics and particulars to be found in the fullness of any individual subject's life. I have tried to respect the depth and situatedness of particular lifeworlds by focusing my attention at a slight remove and exploring an idea of the cartographic, which I call upon in a fairly broad way as set of practices and material configurations which structure and inflect how place can be thought of and engaged with. The city, specifically, has been a generative context in which to pursue this investigation because, as I believe Brian Holmes rightly argued, the condition of relational awareness that the tangle of people, material environment and ecology produces provides a position from which to consider what it is

to dwell collectively in the anthropocene. Throughout my fieldwork in New York City and its environs I tried to remain attentive to the social and technical practices that went into readying the city and the planet as particular kinds of ontologically inflected places and to ask what possibilities and constraints this offers for human experience. My motivation for the investigation was to ask whether or not in some ways our collective failure as humans to live sustainably within the geophysical and interspecial worlds we inhabit can be approached through the perspective of what is left out or foreclosed in the ways we inhabit and make place.

Throughout this investigation, scale has been one of the most vexing issues as I have considered how one moves in-between particular phenomenological encounters and broader systemic perspectives that seek to obtain at the level of the city, the economy, the species, or any number of other world-ordering scaffolds. In the first chapter I analyzed the critical conversations around the idea of the anthropocene—including the perspectives, temporalities and subjects that it depends on—before introducing the idea of the city as one of the anthropocene's key public spaces. Of central concern in this chapter was how the planet becomes something we can talk about as a particular kind of object that is in crisis. How do we come to relate to something which is at once so distant and abstract, but which we are also always standing in the midst of? Engaging with things at the level of the planet requires the traversal of many different scales and many different ways of creating both scientific and social truths. When an idea of the anthropocene is mentioned, conversations and imaginations are primed to consider the *longue durée* of the planet as a multi-billion year old thing, and this era of human produced climate change is positioned as something that acts at the sweeping level of such a perspective.

To talk of the anthropocene we must hoist ourselves up to the heavens to re-watch the history of the earth—as we might a filmstrip on an old projector—considering it from afar in order to make sense of where we have gotten today. This, however, surfaces issues of what it means to gaze upon the history of the earth from a transcendent and separate point of view and who it is exactly that is imagined to be doing the looking. To speak of an "anthropos" collapses a diversity of human experience and action into a single, special, totality. How the event and the period are defined is of critical importance because it sets up the terms of the larger debate around climate change while opening and foreclosing certain ways of making place in its midst. While conducting fieldwork for this dissertation in New York City, I sought out communities that construct meaning for themselves at the intersection of urban and planetary life. I found a group of artists at a community biolab in Brooklyn whose practice involved cultivating an attentiveness to things like weeds and other bits of life that thrived in the places where the city's modernist ambitions to dominate nature had failed. The work that they do exploring the social lives of non-human lifeforms in the city poses important questions about what it means to capacitate new forms of social and ecological imaginariness that do not rely upon the totalizing tendencies of the anthropocene discourse. I use the experience of tracing out the biome of the city grid along side this group to explore the complex dynamics that exist between people, environment and the production of place. The recentering of attention on non-human lifeforms in the urban environment produces the possibility of an analytic that preserves the distinctiveness and the particularity of a wide variety of perceptual frames while at the same time engaging with the ways in which they come to relate with one another.

Using this as a stage, I then move to consider other modalities through which the city's relationship with the ecological is produced. The second chapter examined the way that data science and climate science as distinct knowledge making practices intersect in the administration of New York City to constitute it as a particular kind of place in the wake of Hurricane Sandy. By surfacing the local history of data science in New York and its appropriation by the Mayor's Office of Data Analytics, I explore both how urban space is being refashioned through a reliance on the representative power of data and how this becomes present to individuals living in the city. Sandy created an occasion for many nascent threads—from the emergence of data science as a field of practice to an increased currency in the idea that systems and statistics could be used as metaphors and heuristics for a great many things—to come together. Through this we see the city in a way hybridized, conceived of as complex system made up of data that needs to be analyzed and reconciled with the predictions and models of climate forecasters. Yet in examining how data was used in the context of the city's response to climate-related disaster, I argue that it is essential to remain attentive to how data-driven analyses are at risk of being positioned as explanatory in themselves and that there is a pressing need to explore the more complex networks of practice and power at play when things are made intelligible through data. It's important to understand how this data is produced and what kinds of exchanges and transformations it undergoes in order to become readied for use within the context of emergent data science projects. By focusing on the genealogies and institutional practices around specific flows of data and how they converge to represent the built environment and the inhabitants of New York, I sought to offer a view of how the city is conceived of as a dynamic information system and the new notions of

governance and resiliency that attend it.

While data is playing an increasingly important role in the way in which the state conceives and governs its territory in the midst of anthropogenic climate change, there are competing voices and models simultaneously emerging to frame other ways of imagining and engaging with the city. In the third chapter I considered a community that has formed around the monthly GeoNYC Meetup in New York, an event that draws together a diverse array of people who are engaged in the process of place making. The hundred or so participants that regularly assemble in an office in the Flatiron neighborhood come from a broad range of professional positions, spanning locations as diverse as the City's sanitation department to the graphics desk at the New York Times. In ways that can be seen both to intersect with the work of the Mayor's Office of Data Analytics while also providing a much broader and personal gamut to understand the relevancy of new forms of place making, the community at GeoNYC actively engages both in discussing and sharing unexpected ways that people around the city are producing maps as well as in focusing attention around the politics of mapping which inevitably renders certain things visible at the expense of others. As cartographic practice expands beyond the traditional visual form of the map to a variety of geospatial technologies that are embedded in everyday city life, this group provides a rich nexus to consider how the affordances of urban space are being reconceived. If the New York City Commissioner's Plan of 1811 was so influential in the ways that the city grew in the 19C, then what agency are the maps that define the city exhibiting today? A rich tradition of critical cartography pushes back against the idea that maps are just more or less correct models of terrain. Indeed by engaging in these issues, we can ask how it is that maps become

enlivened through human practice to inform and shape the experience of the territory. I argue that in many cases access to the data networks that maps increasingly rely upon is privileged and uneven. Therefore, as these emerging mapping practices are increasingly important in the representation of place and the experiences they afford, it remains essential to be attentive to the dynamics through which maps are produced. In the particular practices of mapmaking that I examine, I show that because maps are increasingly being encoded in the logic of digital infrastructures, new ways of conceiving and interacting with place are being made durable in often unnoticed ways. This presents an important site for further research when reconsidering ways of communicating and orienting publics towards the ecological aspects of the places we inhabit.

In the final chapter I move from the social and technical spaces of the city to consider the processes and practices through which something like the planet and its global climate crisis become thinkable, returning to some of the themes of the first chapter but situating them within more specific sites. I explore a variety of subjectivities and temporalities as I consider the work of the United Nation's Intergovernmental Panel on Climate Change (IPCC) over the last 25 years. Core to the work that groups like the IPCC undertake is an idea of the planet both as a set of geophysical systems that are governed by predictable scientific laws, but also an aspect of the planet which is apocalyptic and can exhibit cataclysmic and capricious behavior. The thrust of the IPCC's efforts to address climate change depend upon an idea of an economic agent whose interests can be made commensurate with those of the planet so that he is incentivized to emit precisely the amount of carbon that the planet can absorb without causing a dangerous rise in global average temperature. Statistics and other forms of condensed

narrative are called upon to communicate the urgency of the threats and to define what danger means in this context, but they have not been entirely successful. To consider the imaginative interfaces in between a public and the planet, I go back to the 19C to uncover the story of Leon Foucault's pendulum experiment. I argue that this internationally publicized and repeated public scientific performance created in some ways a shared imaginary of the modern planet as it was called upon to provide viewers with the first ever direct proof of the earth's rotation on its axis. By drawing out a particular sense of what it means to have a public relationship with the planet, I then travel to the bottom of the earth through a series of oral histories with climatologists who have spent time in Antarctica. Here, at the same time that breaths of air frozen in millennia old ice cores are being harvested as data inputs into global climate models, an intimate and affective relationship to the planet and a sense of place becomes inseparable. Collectively, the chapter argues for a sharpening of our view on the contingent and heterogenous nature of the constituents of planetary ontologies and questions what alternatives may exist in the complex tangle of relationships that present us with a planet in crisis.

In many ways, the anthropocene makes a demand on us to re-examine how we relate with the natural world. There is something engulfing about the objects of the environment; we need to only look around or up, breathe the air, to be in the midst of them. It has a kind of alterity, this planet, which is as much a present thing with its own indifferent 4-billion year private history, as it is an object constructed through social discourse and by human hands. An evocation of the anthropocene reminds us that the earth is not a mere substrate for human history that can be held as external and static but is rather something that, as we shift perspective, is in fact inseparable from us. To date,

this climatological planet has proved a protean thing that has received a proliferation of explanatory frames. Geologists personify earth in the form of the goddess Gaia, with aspects which alternate between computable risks and violent terror. Economists and policymakers frame the climate in terms of uncertainty and probability, hoping to manage unknown unknowns. Critical theorists remind us to remain attentive to who is included in a special "we" or in an anthropos to avoid obscuring the situated histories and patterns of thinking that produced the current crisis. Throughout this work, in both explicit and implicit ways, I have been grappling with questions related to ontology and epistemology. If there is some intimate link between how we know and what kinds of things can be known, then what of the natural world is being left in the shadows and what is being rendered socially visible? The fears of global thermonuclear war that haunted the latter half of the 20C posed a vision of catastrophe that would be total and unthinkable. Today, climate change presents a different kind of event. Attenuated over time, gradual in its effect and always a bit statistical in its causality, climate change has become a condition of the present that recedes in and out of view, like the swelling banks of a river, slowly dragging expectations of normalcy into a new orbit. The compounded effects of this and the rate at which we discount the livelihood of future generations will have extremely material effects, even if they don't feel immediately and presently palpable. I have tried to show in the foregoing how knowledge of the world is always situated in place, and that our experience and awareness of the places we live in are in large part influenced by how we come to know and interact with them. My hope is that by being more mindful of how relations between the human and the ecological are made visible we will be able to make a place which can sustain us through the anthropocene.

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