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Title

Variability of Arctic sea-ice thickness using PIOMAS and the CESM Large Ensemble

Permalink

<https://escholarship.org/uc/item/54b9c1rk>

Journal

Journal of Climate, 31(8)

ISSN

0894-8755

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Publication Date

2018-04-15

DOI

10.1175/jcli-d-17-0436.1

Peer reviewed



AMS
American Meteorological Society

Supplemental Material

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1 **Supplemental Material for “Variability of Arctic sea-ice thickness using**
2 **PIOMAS and the CESM Large Ensemble”**

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ABSTRACT

¹² This document contains supporting figures for the main document.

13 **S.1: Future projections of sea-ice volume**

14 Predicting the timing of the first ice-free summer is of significant interest for scientists and numer-
15 ous stakeholders. The most common definition of “ice-free” is a threshold of sea-ice extent (SIE)
16 falling below 1.0 million km² (e.g., Wang and Overland 2012; Overland and Wang 2013; Jahn
17 et al. 2016). Here we define an arbitrary threshold for the timing of the first September sea-ice
18 volume (SIV) dropping below 1000 km³ to determine the spread in the RCP8.5 LENS simula-
19 tions (strong emission scenario; 2006-2080). Between all future ensemble members we find a
20 spread larger than one decade, which suggests the timing is subject to large uncertainties from
21 internal variability (Fig. S.4). Averaging out all of the ensemble members (and hence the noise),
22 the ensemble mean suggests the SIV threshold is first crossed in the mid-2040s. This timing is
23 fairly consistent with a recent study using LENS by Jahn et al. (2016), which estimated the SIE
24 “ice-free” predictability and found a spread of approximately two decades in a single emission
25 scenario. However, it should also be noted that there is little to no predictability for using SIV
26 with the timing of the first SIE “ice-free” summer (<1 million km²) (Jahn et al. 2016).

27 **References**

- 28 Jahn, A., J. E. Kay, M. M. Holland, and D. M. Hall, 2016: How predictable is the timing of
29 a summer ice-free Arctic? *Geophysical Research Letters*, doi:10.1002/2016GL070067, URL
30 <http://doi.wiley.com/10.1002/2016GL070067>.
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32 *physical Research Letters*, **40** (10), 2097–2101, doi:10.1002/grl.50316, URL <http://doi.wiley.com/10.1002/grl.50316>.

³⁴ Wang, M., and J. E. Overland, 2012: A sea ice free summer Arctic within 30years: An update from
³⁵ CMIP5 models. *Geophysical Research Letters*, **39** (18), n/a–n/a, doi:10.1029/2012GL052868,
³⁶ URL <http://doi.wiley.com/10.1029/2012GL052868>.

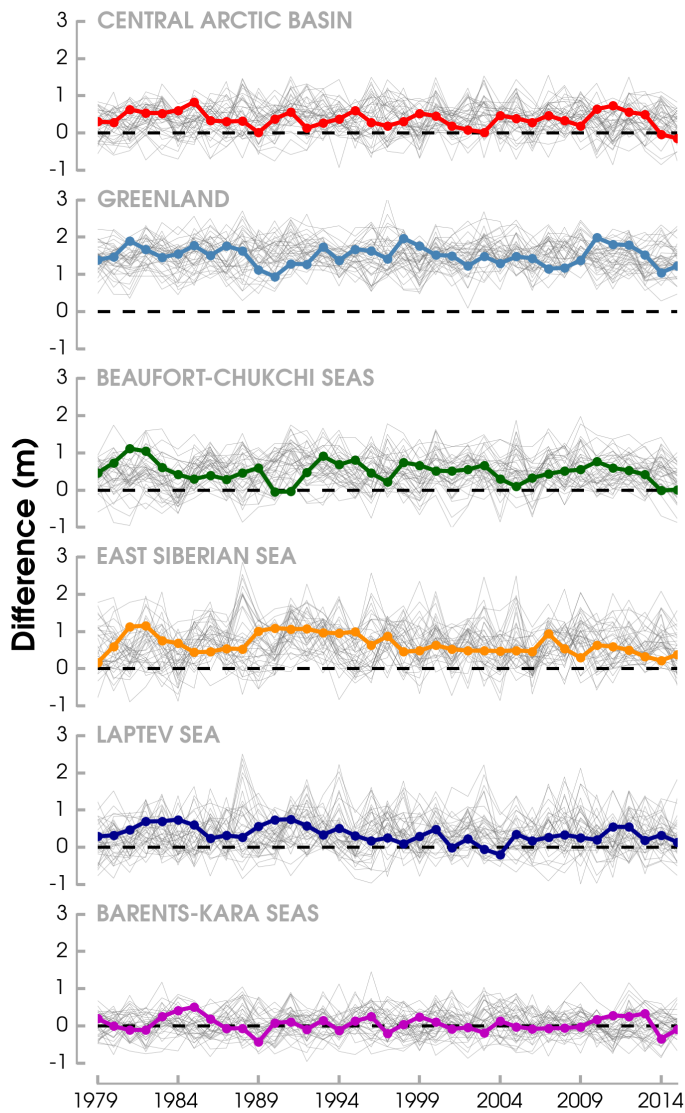
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40 East Siberian Sea (ESS), Laptev Sea (LV), Barents and Kara Seas (B-K) 6

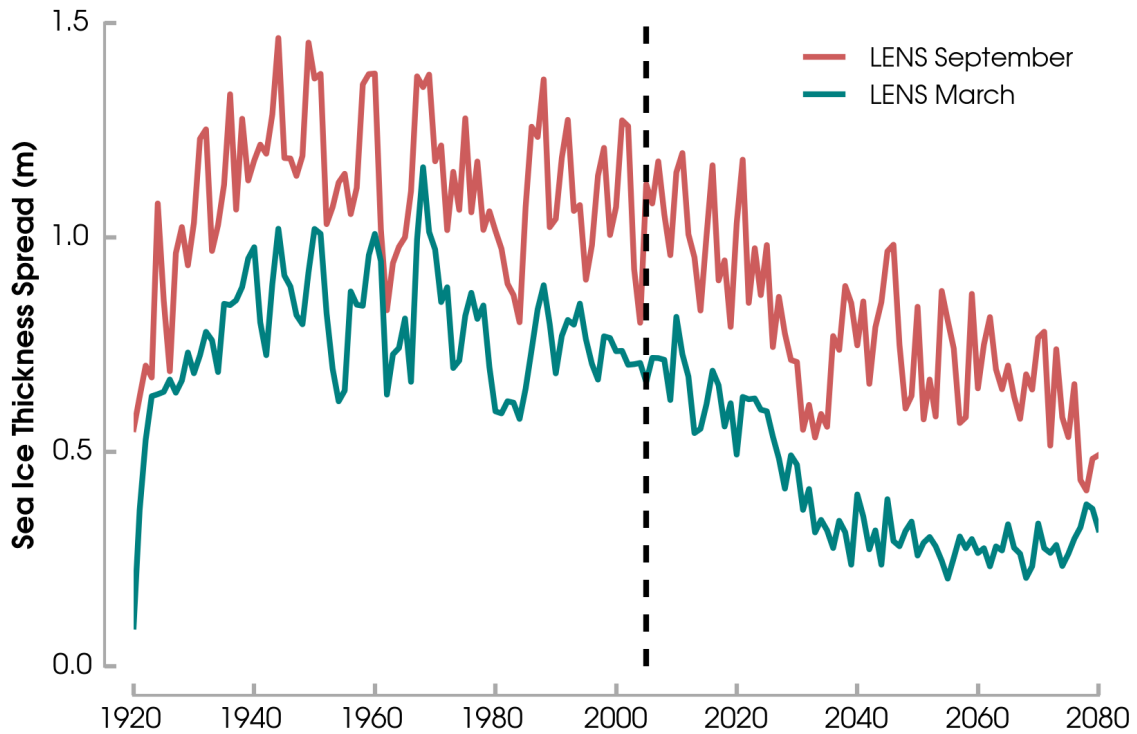
41 **Fig. 2.** September sea-ice thickness differences between the LENS mean and PIOMAS over the
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47 LENS projection. 8

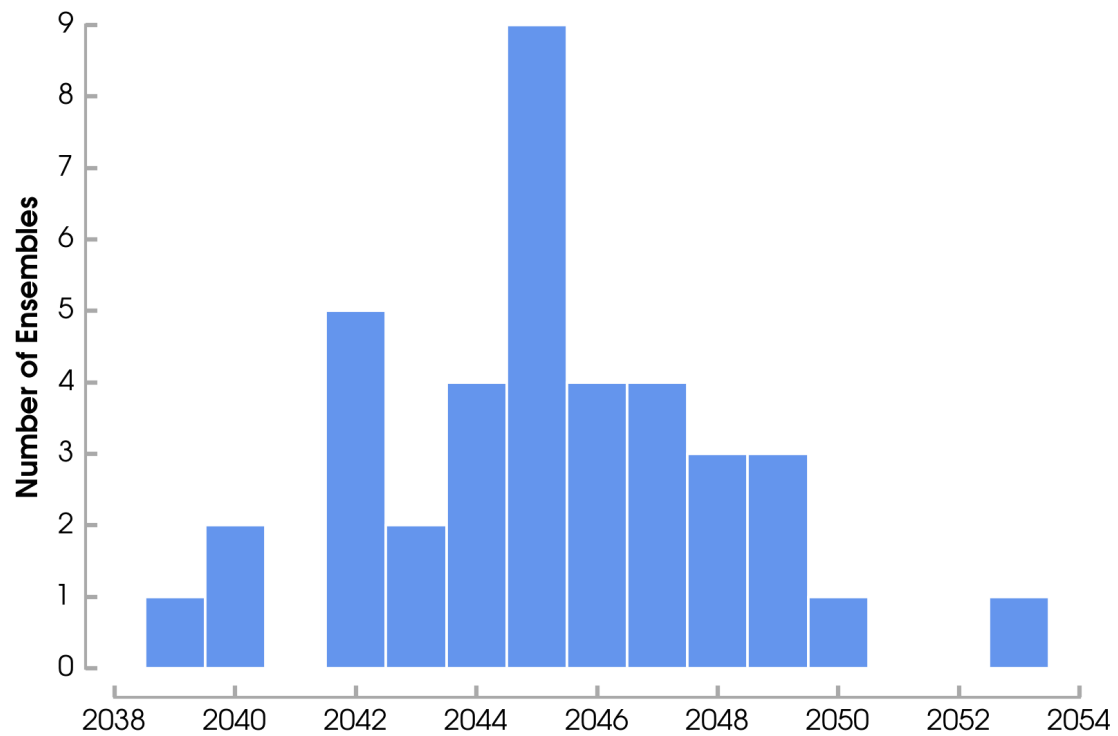
48 **Fig. 4.** Frequency (histogram) of the timing for the first September with sea-ice volume less than
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53 Fig. S.2. September sea-ice thickness differences between the LENS mean and PIOMAS over the 1979 to
 54 2015 period. Individual ensembles are shown by each gray line. Regions are an area weighted average for mean
 55 grid cell thicknesses of at least 0.15 m.



56 Fig. S.3. Difference between the maximum and minimum mean sea-ice thickness from LENS during Septem-
57 ber (red line) and March (blue line). Sea-ice thickness is an area weighted average north of 65°N. The dashed
58 vertical line separates the historical simulation from the future LENS projection.



59 Fig. S.4. Frequency (histogram) of the timing for the first September with sea-ice volume less than 1000 km³
60 as evaluated per each LENS ensemble member.