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ROUTINE SPECTRAL MEASUREMENTS OF INFRARED RADIATION FROM THE ATMOSPHERE

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Routine Spectral Measurements of Infrared Radiation From the Atmosphere

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ROUTINE SPECTRAL MEASUREMENTS OF INFRARED RADIATION FROM THE ATMOSPHERE*

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Infrared radiative cooling is a natural process continually underway in our environment. Thus, this process contributes in an important manner to the heat balance of buildings. An increase in radiative losses during the summer or a reduction of radiative losses during the winter will reduce energy consumption. A quantitative knowledge of the infrared radiative transfer between the atmosphere and a building's surface requires detailed information regarding the angular and spectral distribution of the radiation from the atmosphere. Routine information of this type has apparently never been gathered; most observations are limited to several days in time. The filter spectrometer system described here is intended to provide data records at 30 minute intervals for weeks and months of continuous operation.

The spectrometer design incorporates a Barnes Corporation model 12-880 radiometer equipped with an eight-position filter wheel, germanium lens, and pyroelectric detector. Of the eight filter positions, one is an open hole and one is a closed hole used to determine the instrument's zero offset. The remaining 6 filter positions contain infrared interference filters with "halfpower" cuton and cutoff points given in microns by (8.1, 13.7), (8.3, 9.1), (9.4, 9.9), (10.0, 11.4), (14.0, 15.8), and (16.6, 21.6). In addition to a stepping mechanism which allows the filter wheel to be positioned automatically, the instrument contains a rotating mirror assembly which allows the instrument's 2° field of view to be directed into the vertical direction or into a 70°C black body cavity. The entire instrument is under microprocessor control and is accessible to Lawrence Berkeley Laboratory through a MODEM telephone link. The accumulating data is transmitted over this link at intervals of one to three days.

Three radiometers are located in the field at the time of this writing. Systems were installed at Tucson, Arizona in August, 1978; at San Antonio, Texas in September, 1978; and at Gaithersburg, Maryland in November, 1978. At the end of January, 1979, these instruments will be recalled for maintenance, and will be modified to make radiance measurements at several non-zero zenith angles. The instruments will then be relocated in the field for the summer of 1979, to obtain data during periods of high air conditioning load.

The Figures show preliminary samples of the radiometer data, superimposed on calculated spectra for similar meteorological conditions (identical air temperature and dewpoint). The measured radiances are assumed to be constant within each filter passband, or to be a segment of a black body curve, whichever is more appropriate. The calculated spectra are obtained from a modification of the computer program LOWTRAN 3B.[1] This program produces low-resolution infrared transmittances based on the water vapor, carbon dioxide, ozone and temperature along atmospheric paths. A careful use of Kirchoff's law permits an evaluation of the corresponding infrared radiances. Except as constrained by surface air temperature and humidity, the atmospheric constituents were assigned typical midlatitude summer values. Thus the agreement obtained here is an indication that reasonable accuracy can be obtained from calculations which do not employ radiosonde data.

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1. J. Selby et al., "Atmospheric Transmittance from 0.25 to 28.5μ: Supplement LOWTRAN 3B". Available from the U.S. National Technical Information Service, Springfield, Virginia 22161.

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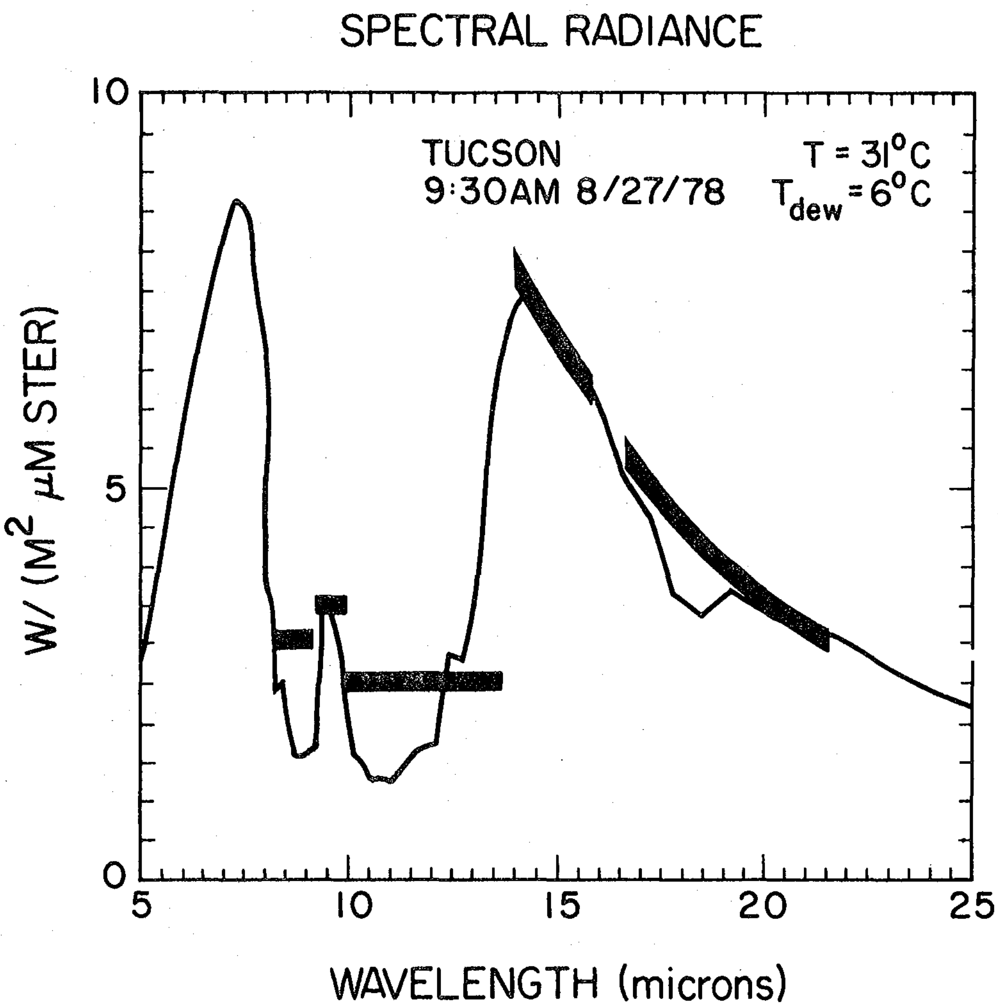

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Figure 1: Spectral radiance, computed and measured for clear sky conditions at Tucson, Arizona. The 10.7 micron filter is absent. Radiance in the 9.9 to 13.7 micron band is deduced from the 8.1 to 13.7 filter, after adjusting for the filters at 8.7 and 9.6 microns.

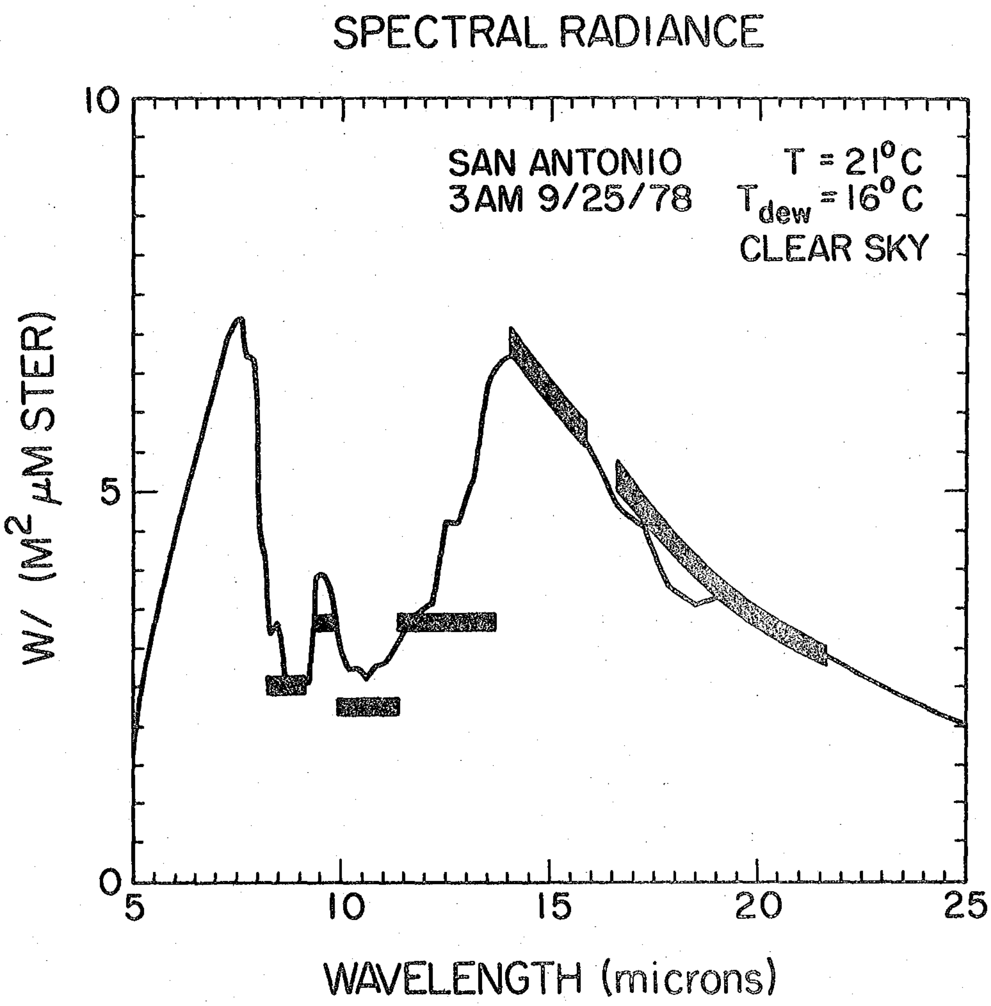

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Figure 2: Spectral radiance, both computed and measured, for clear sky conditions at San Antonio, Texas. Radiance in the 11.4 to 13.7 micron band is deduced from the 8.1 to 13.7 filter, after adjusting for the filters at 8.7, 9.6, and 10.7 microns.

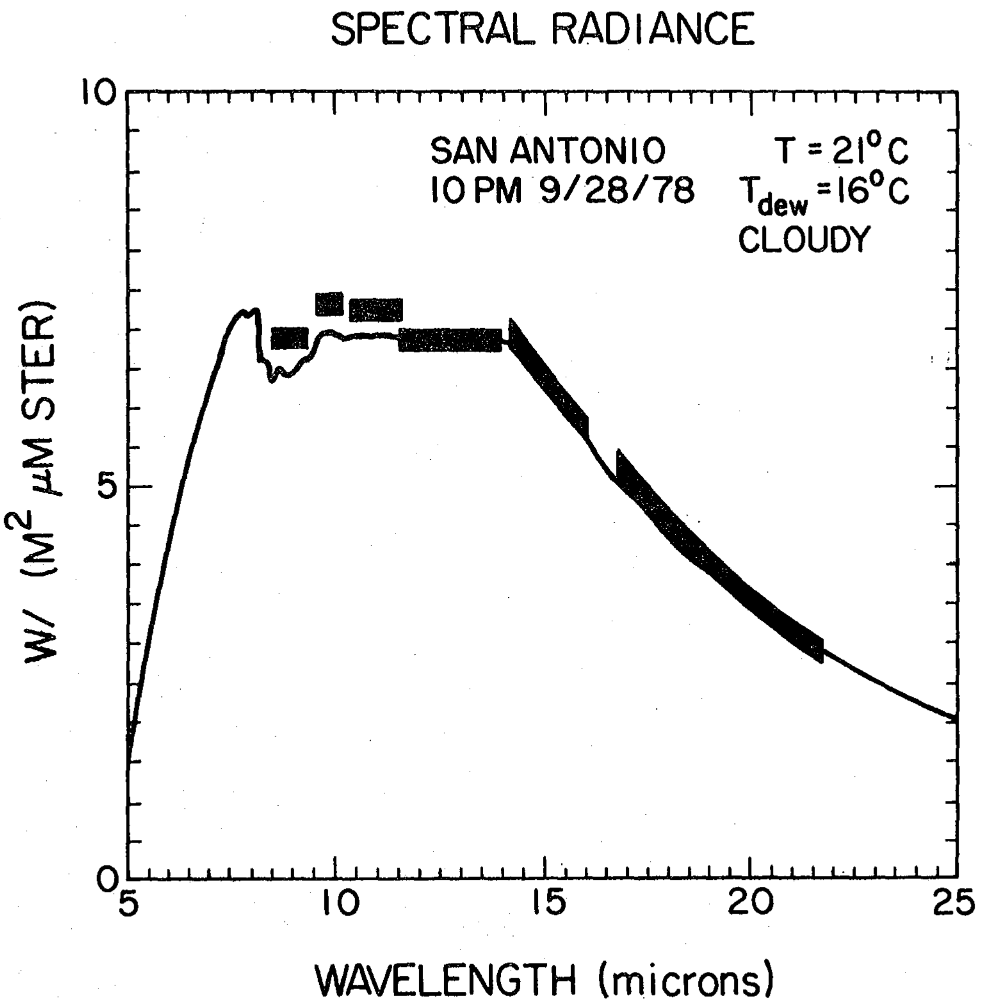

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Figure 3: Spectral radiance, computed and measured under conditions virtually identical to those of Figure 2, but with a cloud in the field of view. In the computed spectrum, the cloud is regarded as a black body with an elevation of 4 km.

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