The Effect of Air Temperature upon Net and Solar Radiation Relations[1]

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In a recent study of net and solar radiation relations at Guelph, Toronto and Ottawa, Polavarapu (1970) concluded that the net longwave loss of radiation increases with latitude, and that this, in turn, causes the net radiation to decrease at higher latitudes. He attributed the cause of this postulated effect to the assumption that a decrease in air temperature and precipitable water content of the atmosphere at higher latitudes results in a decrease in incoming longwave radiation.

We believe these statements to be approximately true for the time period Polavarapu investigated (May–October), but we additionally feel that the converse would be generally true for the other half of the year. Our reasons for these sentiments derive from a consideration of two formulations of the relation describing

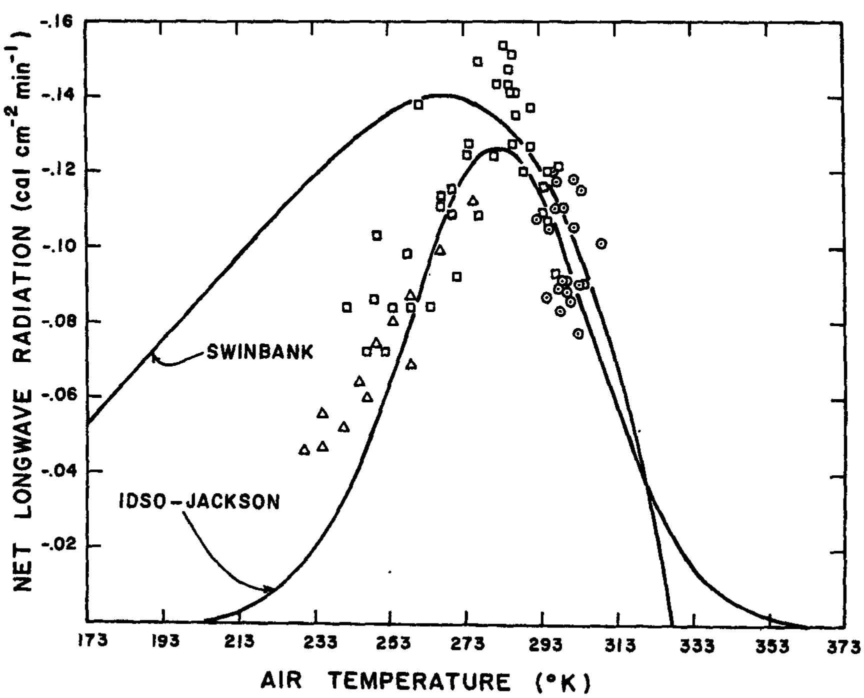

FIG. 1. Net longwave radiation at midnight on cloudless nights as measured at St. Paul (□), Phoenix (⊙) and Point Barrow (△), and as predicted from the Swinbank and Idso-Jackson equations for atmospheric thermal radiation as a function of screen level air temperature.

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longwave radiation from the atmosphere in terms of air temperature (Swinbank, 1963; Idso and Jackson, 1969). If these relations are utilized in conjunction with the assumption that the ground radiates essentially as a blackbody at screen level air temperature, the dependence of net longwave radiation on air temperature is given by the two curves of Fig. 1. Both of these curves predict that what Polavarapu postulates will be true only down to an air temperature somewhere near 273K, whereupon a reverse trend will begin.

In an attempt to verify this prediction, we could not make use of daytime radiation data, due to temporal and spatial variations in the albedo of snow, which have a much greater effect upon the net radiation than the temperature effects we were seeking. Thus, we collected data on net radiation at night, when the solar terms were absent and the net radiation was composed solely of thermal radiation.

The squares of Fig. 1 represent our observations at midnight on several cloudless nights at St. Paul, Minn. Similarly, the circles represent observations at midnight on several cloudless nights at Phoenix, Ariz. The underlying surfaces at both sites were short grass, except for the data points below 273K obtained at St. Paul when snow covered the ground. The assumption that ground and air temperatures were identical was found to be good to within ± 1C at Phoenix, but was not checked at St. Paul.

To extend the data to very cold conditions, measurements of Lieske and Stroschein (1968) at Point Barrow, Alaska, were included in Fig. 1 as triangles. Their radiation measurements were carried out with Funk (1959, 1962) net radiometers, those at Arizona utilized Fritschen (1963, 1965) net radiometers, while a ventilated net radiometer of the type described by Suomi *et al.* (1954) was used at St. Paul.

Considering the relation of the several data points to the two curves of Fig. 1 (particularly the Idso-Jackson curve), we feel that our sentiments expressed at the beginning of this note are probably valid. That is, in the winter months, the relations discovered by Polavarapu (1970) between net radiation and latitude, and net longwave radiation and latitude will be reversed from what he found for the summer months, the particular relation for each period being due to a general decrease in air temperature with increase in latitude.

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