

Reply

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In the preceding note Winston (1965) has given a discussion of our interpretation of the TIROS III radiation measurements. According to our analysis (Rasool, 1964) the TIROS III data imply either that there is an increase in cloudiness in the nighttime in the Southern Hemisphere and a decrease in the Northern Hemisphere or that the mean height of the clouds in the nighttime is higher in the Southern Hemisphere and lower in the Northern Hemisphere. He contends that the diurnal variation in cloudiness over oceans may be in the opposite sense; namely, a higher amount of cloudiness in the daytime than in the night. Table 1 and Fig. 1 of the preceding article derived from climatological estimates of cloudiness, are offered in support of this contention. We give arguments favoring the first alternative. Winston criticizes the possibility that nighttime cloudiness is greater on the grounds that it disagrees with ground based climatological results.

I would like to make the following comments on the climatological data cited by the author:

a) Most of the ground based climatological data for the Southern Hemisphere up to 50S are from stations situated on islands. It is well known that the diurnal variation of cloudiness over an island is not at all the same as over the oceans (e.g., see Haurwitz and Austin, 1944). Because of the differential heating between the ocean and land, the islands are known to have a maximum cloudiness in the afternoon. Moreover, the cloudiness estimates quoted by Winston are derived from two observing stations in the zone of 40S to 50S and six stations between 51S and 62S. The stations are also not well distributed in longitude. This limited number of stations is probably not a reliable basis for obtaining climatic means over latitude belts.

Also some data from the Northern Hemisphere has been used to make estimates of cloudiness at the corresponding latitudes of the Southern Hemisphere (Table I, footnote). If we reflect that the main issue here is the difference in cloud amounts between the Northern and Southern Hemispheres, such an analysis seems to be completely inconsistent with the main body of criticism.

b) Malkus has recently published a review of large scale ocean-air interactions (Malkus, 1962) in which it is stated that the "oceanic cloudiness (is) minimum around midday and maximum in the dawn and mid-night hours."

On the basis of these arguments we believe that the climatological data given by Winston are not conclusive.

The other important point which Winston raises is the question of degradation in the Channel 2 data from TIROS III. The radiative energy detected by TIROS III was found to decrease steadily with time. Bandeden (1963, private communication) determined the correction factors which must be applied to the degraded TIROS data to bring them up to the initial level. These correction factors have been communicated by Bandeden to the investigators of TIROS data and had been used in our computation.

Subsequent to the publication of our TIROS III analysis, we were able to carry out a similar analysis of the effective temperature measured by TIROS VII in the 8-12 μ channel. The period of analysis is 19 June through 31 August 1963, comparable with the period investigated by the TIROS III data (12 July-10 September 1961). The instrumental degradation of Channel 2 was smaller by a factor of four in TIROS VII than in TIROS III. The period of observation was 10 weeks and, therefore, long enough so that all parts of each latitudinal belt were measured both in the day and in the night. The number of observations in each latitudinal belt is of the order of 600,000, approximately half in the day and half in the night. In Fig. 1 we plot the difference (ΔT) between the mean surface temperature and the average effective temperature measured by Channel 2 of TIROS VII; as a function of latitude, separately for day and for night. Daytime is

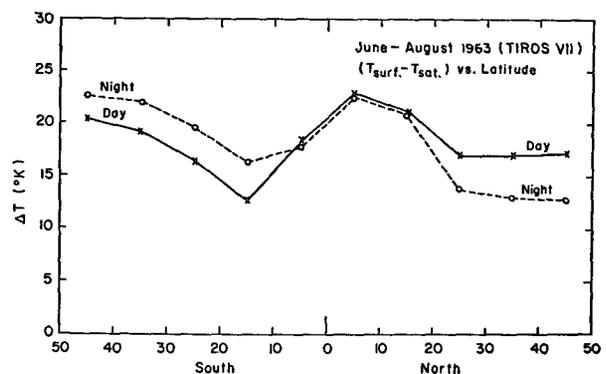


FIG. 1. The difference between the mean surface temperature and effective blackbody temperature measured by TIROS VII in the 8-12 μ channel, as a function of latitude, for day and for night.

defined as the period when the local solar zenith angle, at the time of observation, is $< 90^\circ$. The climatic means of the average surface temperature used in computing ΔT are the same that we used for Fig. 5 of the earlier paper (Rasool, 1964).

An examination of the TIROS VII data, presented in Fig. 1 shows the same qualitative pattern of variations in ΔT which we used as the basis for our earlier interpretations of nighttime increase in cloudiness over the Southern Hemisphere.

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Particle Growth by Coalescence

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In a recent, interesting article by Twomey (1964) the whole series of equations leading to and including the fundamental equation for the rate of change of a particle size distribution due to coagulation appear to be in error by a factor of 2. The second term after his Eq. (1) is equal to twice the rate of decrease of the number of droplets, and the following term is equal to twice the rate of increase. Therefore, the right hand side of his Eq. (2) and the two preceding, and the one succeeding un-numbered equation should be divided by 2. The equation is correctly given in the *Handbook of Aerosols* (1950). It is of some importance to know whether this error found its way into Twomey's numerical computations and thus doubled his calculated rate of growth.

As a matter of custom, it would be helpful if authors of numerical computations would give in their articles sufficient information to allow the checking of their work. Twomey, for instance, could state the algebraic form of his initial distribution and the necessary

numerical information to provide its reconstruction, and could indicate in which of the several possible ways he chose to "extend" Hocking's (1959) collection efficiencies "by logarithmic interpolation."

Incidentally, a numerical integration of what Twomey calls "the statistical equations for continuous size distributions" was performed by Zebel (1958) in dealing with the coagulation of aerosols.

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