An examination of Tables 1 and 2 indicates quite clearly that actual wind direction distributions are not always Gaussian, which is of no surprise to the reader, I am sure. The significance of Table 1, however, is that the discrepancy between “exact” and “estimated” \( \sigma \)'s is small for \( \sigma \)'s up to about 30 degrees. Thus, as long as the wind direction distributions are nearly Gaussian over the observational period of interest, a significant increase in computational ease is obtained at the expense of a very small decrease in accuracy by treating the wind directions as unit vectors.

In a digital data processing system coupled with a standard wind direction sensor, one needs only to compute the sine and cosine of the sensor input value, and henceforth works only on the sums of the sines and cosines to obtain the wind direction fluctuation statistics. One could also couple sine-cosine potentiometer outputs directly from a wind direction sensor to a digital or analogue data processing link and accomplish the same objective. In neither case is there any concern about the mathematical discontinuity at north since the trigonometric functions defining \( \sigma(L) \) and hence \( \sigma^*(\theta) \) are not double-valued at true north.

The most significant feature of Table 2 is that the largest discrepancies between “true” and “approximate” standard deviations occur when the standard deviations are large. Such situations occur most frequently in practice under “light and variable” wind conditions, a meteorological condition which is extremely far from being the “steady-state” condition normally assumed for continuous point source diffusion problems. There is no completely satisfactory prediction method presently known for such non-steady-state cases, and hence the large underestimate of the “true” \( \sigma(\theta) \) by the unit vector method might not be considered too serious. For if one blindly applies any diffusion prediction model using \( \sigma^*(\theta) \) as a predictor to such a non-steady-state case, he will bias the prediction towards a conservative estimate, since downwind concentrations are inversely related to \( \sigma(\theta) \). This sort of bias is usually considered desirable in practical applications for situations about which limited knowledge exists.

In general, for diffusion applications, it might be considered advantageous to use the approximate \( \sigma^*(\theta) \) rather than the true \( \sigma(\theta) \) regardless of the computational advantages gained by using \( \sigma^*(\theta) \). For \( \sigma^*(\theta) \) will always be less than \( \sigma(\theta) \), a result similar, in algebraic sense at least, to that obtained using the filtering technique proposed by Hay and Pasquill. Of course, high frequency filtering may still be accomplished before computing \( \sigma^*(\theta) \), if desired.

Finally, it should be mentioned that the mean wind direction defined as \( \tan^{-1}(\sin\theta/\cos\theta) \) is identical to the mean wind direction obtained from the arithmetical mean of the wind direction data as long as the data fit a Gaussian distribution. Here, as in computing the standard deviations, great simplicity is obtained by requiring only sums of \( \sin(\theta) \) and \( \cos(\theta) \).

REFERENCES

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Condensation on Shielded Net Radiometers

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How does the deposition of dew or condensation on shielded net radiometers affect the measurement of net radiation? This question has bothered the proponents of shielded net radiometers. The occurrence of dew in the Phoenix area is relatively rare; however, moderate dew deposition occurred on 17 February 1962 and heavy dew deposition occurred on 21 February 1962. The purpose of this note is to discuss the effect of these two occurrences of dew deposition on shielded net radiometers upon the measurement of net radiation.

The results pertain to five miniature net radiometers (Fritschen, 1963) which were located 10 cm above an evaporating, bare soil surface. At 0718 MST 17 February and at 0620 MST 21 February, the condensation was removed from two of the miniature net radiometers

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(different two each day). The average of the indicated net radiation from the radiometers covered with condensation was plotted versus the average net radiation from the radiometers without condensation (Figs. 1 and 2). A straight line was drawn from the point where all radiometers were covered with condensation to the origin and then to the point where condensation had disappeared from the three radiometers. This method was used to reduce possible sampling and instrumental errors.

The total differences in net radiation between the curves and straight lines were found to be 4.47 ly and 5.84 ly for 17 and 21 February 1962, respectively. The net radiation indicated by the net radiometers without dew for the same periods was 20.61 ly and 87.80 ly. The resulting errors were 22 and 7 per cent for the periods reported. However, these errors in measurement of net radiation would be 2 and 3 per cent for daily net radiation of 200 ly and 182 ly, respectively.

The measurements made before sunrise indicated very little difference in net radiation; however, these measurements were too few to be conclusive.

The measurements made after sunrise can be compared with the effect of raindrops. MacDonald (1951) investigated the effect of raindrops upon an Eppley pyrheliometer and found that the change in output was less than 1 per cent. MacDonald's results pertain to solar radiation at large sun angles only, whereas the results presented here pertain to solar radiation at small sun angles, atmospheric and terrestrial radiation. Pre-
sumably internal reflection from the droplets would increase with lower sun angles.

Funk (1959) proposed to avoid the problem of dew formation by using an intermittent heater located outside of the radiometer to raise the temperature of the radiation windows above the dewpoint. This approach was experimentally investigated by cementing a 100-ohm circular heater to the phenolic resin ring located between two planar polystyrene sheets within a miniature net radiometer (Fritschen, 1963). The study consisted of subjecting two miniature net radiometers (one containing the heater) to a flow of warm, moist air while in an artificial long-wave radiation chamber. The results obtained are shown in Fig. 3 where the protection (dewpoint—radiational temperature) and the error in net radiation induced by the heater are plotted as a function of power requirement. In all cases reported, condensation was present on the nonheated radiometer. Without considering the power requirement, it is apparent that the induced error is not justified by the protection obtained. In fact, the induced error appears to be larger than the errors resulting from the presence of condensation.

In summary, the errors in measured net radiation resulting from the presence of condensation on shielded net radiometers may be considered negligible compared to other errors such as sampling and instrumental. The use of a heater within a miniature net radiometer to prevent deposition of dew appears to induce a larger error than the presence of condensation.

REFERENCES

