Comments on "A Comparison of Radiative and Actual Nocturnal Cooling over Grass and Snow"

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Nkemdirim (1978) reports comparisons of actual and radiative cooling rates from measurements over a grass and a snow surface. The paper, however, seems to include some errors and deficiencies of methodology and interpretation which require comment.

1) The data are not entirely nocturnal. Observations were begun at 1500 MST at a location where the sun must have been above the horizon. This is not a minor point, since shortwave radiation effects on the radiometers considerably reduce their ability to discern vertical radiative flux density differences to the accuracy required.

2) The radiative (C_R) and actual (C_A) cooling rates for the two surfaces given in Table 2 appear to bear no relation to those plotted in Fig. 1. In particular, the actual cooling rates (up to approximately 7°C h^{-1}) in Fig. 1 seem to be in error. There is also no explanation why the number of data points differs between the table and the figure.

3) If we assume that the more reasonable data in Table 2 are those intended, they do not support the suggestion that the relationship between C_R and C_A is nonlinear, nor that the relationship is better defined over snow. Using the data in Table 2 linear rather than log-linear regression yields the better statistics with respect to the coefficient of determination and standard error. However, there is little justification for imputing any significance to results from such a small sample.

4) The use of observations from a single "night" and the inability to take simultaneous measurements over the two surfaces detract from the generality of the conclusions that can be drawn. Despite the claim that the atmospheric conditions were very much alike on the two nights, it is virtually certain that significant differences existed. Examination of the relevant synoptic charts reveals that an air mass change occurred in the intervening period and, although the author suggests the water vapor content was similar for both

nights, the significant temperature difference ($\sim 20^\circ\text{C}$) could have produced differences in moisture phase (e.g., in the concentration of ice crystals). Similarly, cloud differences existed between the two nights and it should be noted that C_R appears to become smaller coincident with the appearance of cirrus cloud over the grass site.

There seems to be some misunderstanding regarding the assumption of no phase change which must be invoked if Eqs. (2) and (7) are to properly represent the energy balance of the air layer. It is only necessary that this assumption applies *within each observation period*. The fact that phase changes may have occurred *between the nights* of the study in concern would not have invalidated the formulations but, as argued above, it may have produced dissimilar radiative cooling rates.

Therefore, given the methodology of the study, it seems doubtful that the observed differences of C_R and C_A between the two surfaces (nights) can be unequivocally attributed to inherent surface characteristics because there remains room to doubt the exact similarity of atmospheric radiative characteristics. Such a conclusion should not be construed to mean that it is doubted that cooling rates over the two surface types differ. It does bring into question, however, the ability of this study to elucidate the critical surface characteristics (e.g., surface emissivity), or the relative importance of different atmospheric processes (e.g., turbulence versus radiative flux divergence) as contributors to cooling differences, as the conclusions of the paper appear to claim. The problem is an interesting one which deserves careful study.

REFERENCE

- Nkemdirim, L. C., 1978: A comparison of radiative and actual nocturnal cooling rates over grass and snow. *J. Appl. Meteor.*, **17**, 1643-1646.