NOTES AND CORRESPONDENCE

Comments on "Interactions among Turbulence, Radiation and Microphysics in Arctic Stratus Clouds"

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Dr. Curry embarked on a herculean task in comparing and correlating turbulence, radiation and microphysical data and is to be complimented on producing a clear and very readable paper. One must, however, criticize some aspects of the analysis relating to microphysics:

First, the claim that fluctuations in supersaturation S could be reliably determined is one with which many cloud physicists might take issue. Simple or complicated, all computations suggest that typical maximum supersaturations are only a few tenths of one percent, and that only for a few seconds, while, for most of the cloudy lifetime of a parcel, the supersaturation is less than one-tenth of one percent (Fletcher, 1962). To determine experimentally such small values, a very high accuracy would be demanded—for water vapor density, errors could not exceed a few hundredths of a percent, while temperature errors would have to be less than a hundredth of a degree.

Second, the application of correlations, especially those involving updraft w, droplet concentration N, and supersaturation S, seems inherently ambivalent (even if one could accept the proposition that S had been obtained successfully). The paper states that, according to classical condensation theory, the number of droplets produced by condensation "depends on the spectrum of cloud condensation nuclei and on the supersaturation S." That statement is correct only if we identify S as the maximum value, S_m, attained by the supersaturation; that, however, is attained and decided during the first ten or so seconds of the condensation process, and there is no reason to expect that an observed supersaturation seen minutes or even hours later can in any way indicate what the value of S_m was. The same kinds of limitation exist with respect to updraft velocity w (or more generally cooling rate); it is the value prevailing during the short-lived initial stage of condensation that is crucial to determining maximum supersaturation, number of nuclei activated, etc. The updraft experienced at some other later time is hardly a good indicator of the earlier value.

It has been pointed out by Squires (1952) that a "quasi-steady-state supersaturation", S_q, can be derived from the conventional cloud physics equation for dS/dt,

$$dS/dt = \alpha w - \beta S \sum r$$

by setting the left-hand side to zero, giving the quasi-steady-state value S_q as $\alpha w/\beta \sum r$. Here $\sum r$ represents summed radii (of droplets) in unit volume; α, β are numerical factors. This supersaturation would, therefore, tend to be inversely correlated with droplet concentration N, and positively correlated with concurrent updraft or cooling rate. If, sometime after the initial nucleation stage, a parcel containing droplets was lifted at the rate w, the supersaturation would rise until it reached S_q, at which time it would cease to rise (and would commence to decrease, since the radii would slowly increase by condensation). One might expect a clustering of supersaturation values near S_q simply because of this effect and hence an *inverse* correlation between initial-stage maximum supersaturations S_m and the supersaturations prevailing later (i.e., high initial supersaturation → more cloud droplets → lower eventual "quasi-steady-state" supersaturation. Such considerations would seem to make highly ambiguous any attempt to draw conclusions from correlations between S, N and w, quite apart from the difficulty of obtaining S from measured temperature and water vapor.

REFERENCES

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