JOURNAL OF COMPUTATIONAL PHYSICS 4, 144–145 (1969)

NOTE

Fortran Program for Computing the Transient and Steady-State Modifications of a Raindrop Size Distribution Due to Evaporation and Coalescence

In a rainstorm, the size distribution of raindrops at any position ($\bar{r}$) and time (t) may be characterized by a continuous function, $N(a, \bar{r}, t)$, such that $N(a, \bar{r}, t)\, da$ gives the number of drops in the radius interval a to $a + da$ per unit volume of air. Several authors have studied the modification (due to evaporation and coalescence) of this distribution function, assuming either one-dimensional steady-state conditions, or spatially-homogeneous conditions. In either case, the number of independent variables is reduced from five to two, and distribution histories may be computed by numerical integration of the equations which describe the coalescence and evaporation processes.

However, we know that neither steady-state nor spatially-homogeneous conditions are usual in nature. Strong variations in raindrop concentration often occur in both space and time. Within a sample of raindrops collected on the earth's surface, one may find drops which departed from cloud base as much as ten minutes apart. Since significant changes may be occuring at cloud base over such a time span, it may be important to include both space and time dependence in modeling the coalescence and evaporation processes within a falling raindrop size distribution.

We have adopted a model which includes radius, altitude (z), and time as independent variables in order to obtain a more realistic simulation of natural rain. In particular, a numerical scheme is presented for solving the following problem. Given

(i) the temperature, pressure and relative humidity profiles of the atmosphere $[\theta(z), p(z), f(z)]$, and

(ii) the raindrop size distribution function and raindrop temperatures at cloud base $[N(a, z_{cb}, t), T(a, z_{cb}, t)]$,

find the raindrop size distribution function, $N(a, z, t)$, and raindrop temperatures, $T(a, z, t)$, for all the radii, altitudes, and times of interest.

The assumptions used in modeling the physical processes are:

(i) the atmosphere is fixed and one-dimensional in that the ambient temperature, pressure, and relative humidity are functions of only the altitude;

(ii) the raindrops fall vertically at their terminal velocity, and obey the water vapor and heat transfer differential equations given by Best [1];

(iii) the transient evaporation and coalescence processes are considered simultaneously.

A report [2] has been prepared in which (a) the model and equations representing evaporation and coalescence processes within a raindrop size distribution are presented; (b) a computer program for the transient and steady-state solution of these equations is described in detail; and (c) the FORTRAN IV listings are included. This report may be obtained from the authors.

References

1. A. C. Best, *Quart. J. Roy. Meteor. Soc.* **92**, 93–104 (1952).
2. F. F. Abraham and S. K. Jordan, IBM Scientific Center Technical Report No. 320-3233, Palo Alto, Calif. (1968).

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Printed in Belgium