A Numerical Evaluation of Radiation Fog Variables[1]

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ABSTRACT

A numerical model of radiation fog was developed in order to test the sensitivity of variables comprising the model, and evaluate its capability for forecasting the onset of fog from standard radiosonde weather data. Four case studies were considered that included both fog and no-fog occurrences. The variables examined—initial surface temperature and moisture conditions, eddy exchange profiles, radiative flux divergence, and dew formation—were all found to influence critically the model's performance. Prediction of fog occurrence and temperature were reasonably encouraging provided a judicious (though somewhat arbitrary) choice of eddy mixing values was made.

1. Introduction

A simple numerical fog model has been developed with the intention of testing certain influential variables and eventually refining it for the forecasting of radiation fog. Other radiation fog models have been developed previously, notably by Fisher and Caplan (1963), Zdunkowski and Nielson (1969), Pilié *et al.* (1972), and Zdunkowski and Barr (1972). A main purpose of these studies was to see if the models could produce a reasonable simulation of fog variables, particularly evolving temperature profiles, depth of fog, and liquid water content. Few observed data were available to test the models against actual events, and input data often consisted of assumed typical conditions. This model was run with actual radiosonde data as initial conditions and the results then compared with surface observations up to the time of fog formation: the latter event in essence marked the end of realistic simulation as droplet radiation effects are not presently included in the model. Four radiation cases were considered: two that were associated with fog formation and two that were not.

A comparison of the features of the various models is given in Table 1. A major factor in any model of this type is the coefficient of eddy exchange (K) of momentum and heat. In the atmosphere K varies with time as a complicated function of many parameters, including air mass stability and wind shear. The relationship of K to these parameters is not well understood, especially in the stable thermal stratifications characteristic of radiation fogs. Maximum K values used or generated in prior models differ by as much as two orders of magnitude. In this model K was prescribed and allowed to vary with height but not time; several K profiles were examined in order to attempt to define representative magnitudes and heights of maximum K values within the boundary layer. As shown in Table 1, the CAL model (Pilié *et al.*) was the first to incorporate the effects of dew, whereas the Zdunkowski and Nielson model was unique in treating cooling by radiative flux divergence. Both factors were included in this (SUNY) model and their respective importance evaluated.

2. Description of the model

The system modeled consisted of three general regions: the soil down to 1.71 m, the "lower atmosphere" from the surface to 1294.3 m, and the "upper atmosphere" from 1294.3 m to 100 mb. An expanding type grid system was used in the lower atmosphere and the soil, providing the finest resolution close to the surface where gradients are more pronounced, with the first level above the surface at 1 mm and the first below it at 1 cm. The lower atmosphere has 34 levels including the surface while the soil has 12. The data for the initial conditions of the atmosphere were taken from National Weather Service radiosonde data[3] close to sundown and were imposed on the grid system. It was necessary to include the upper atmosphere in order to correctly calculate net radiation and radiative flux divergence. The levels in the upper atmosphere were the same as those reported in the radiosonde data, while the corresponding temperatures and humidities

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were assumed to remain constant for the duration of the 10–12 h model run.

The equations for the change of potential temperature (θ) and specific humidity (q) for the lower atmosphere were

$$\frac{\partial\theta}{\partial t}=\frac{\partial}{\partial Z}\left[K(Z)\frac{\partial\theta}{\partial Z}\right]+\left(\frac{\partial\theta}{\partial t}\right)_R, \quad (1)$$

$$\frac{\partial q}{\partial t}=\frac{\partial}{\partial Z}\left[K(Z)\frac{\partial q}{\partial Z}\right], \quad (2)$$

where Z is the height and the subscript R refers to the effect of radiative flux divergence. K is assumed to be the same for heat and moisture. In the soil, temperature (T) was the corresponding conservative quantity used with the equation for heat flux:

$$\frac{\partial T}{\partial t}=K_s\frac{\partial^2 T}{\partial Z^2}, \quad (3)$$

where K_s is the coefficient of thermal diffusivity of the soil and is assumed to be a constant equal to 3.7×10^{-7} m^2 s^{-1}. [Air density is assumed to be constant in (1)–(3).] Continuity of heat flux was maintained at the air-soil interface by stipulating the condition:

$$-F_n+c_pK_{sfc}\rho_a\frac{\partial\theta}{\partial Z}-c_sK_s\rho_s\frac{\partial T}{\partial Z}=0, \quad (4)$$

as given by Zdunkowski and Nielson (1969). In the above equation F_n is the net radiative heat flux from the earth's surface, c_p and c_s are the specific heats of air at constant pressure and of the soil respectively, and ρ_a and ρ_s are the densities of air and soil. In order to maintain continuity at the surface, the condition that $\theta_{sfc}=T_{soil}$ is required. This is accomplished by defining potential temperature as

$$\theta(Z)=[T(Z)]\left[\frac{P(1)}{P(Z)}\right]^{\kappa}, \quad (5)$$

where $P(1)$ is the pressure of the surface and κ is R/c_p. In the soil, the temperature of the lowest grid level (-1.71 m) was assumed to remain constant. The boundary conditions at the top of the lower atmosphere (1294.3 m) were

$$\left.\begin{aligned}\frac{\partial\theta}{\partial Z}&=\text{constant}\\ \frac{\partial q}{\partial Z}&=\text{constant}\end{aligned}\right\}. \quad (6)$$

At the surface, before saturation, the vertical moisture flux is taken as zero; after saturation the condition is maintained that $q=q_s[T(t)]$, where q_s is the value of specific humidity at saturation.

TABLE 1. A comparison of the features of some fog models.*

Model features	F & C	Z & N	CAL	SUNY
Eddy diffusion K	X	X	X	X
Advection	X			
K as a function of time	X		X	
Radiative flux divergence of vapor		X		X
Radiative flux divergence of droplets		X	X	
Air-soil coupling		X	X	X
Dew formation			X	X
Radiosonde data inputs	X	X		X
Emphasis on forecasting fog occurrence				X

* F & C, Fisher and Caplan; Z & N, Zdunkowski and Nielson; CAL, Pilié *et al.* of Calspan; SUNY, State University of New York.

The system of equations for potential temperature and specific humidity were approximated by the Crank-Nicholson finite-difference method. Unequal grid spacing was used such that each layer was 1.5 times the one below it. The resulting tri-diagonal coefficient matrix for these equations was solved by Gauss elimination optimized to take advantage of the tri-diagonal form of the matrix. The implicit nature of the difference equations and the method of solution of the matrix made it possible to use 1-min time steps in the integration of the equations.

Temperature changes due to the radiative flux divergence of water vapor were calculated by the method of Brooks (1950). The values of emissivity of water vapor used were those presented by Zdunkowski and Johnson (1965). In these calculations the effect of CO_2 was ignored, which according to Brooks produces only a 3% error.

The net flux at the earth's surface (F_n) was calculated using the method presented by Fleagle and Businger (1963). The effect of CO_2 on the net radiation is taken into account by adding $0.184\sigma T^4$ to the return radiation of the atmosphere (Haltiner and Martin, 1957).

After saturation at the surface, the amount of dew produced is modeled by calculating the flux of water (F_w) to the surface:

$$F_w(t)=K_1\rho_{a1}\left(\frac{\partial q}{\partial Z}\right), \quad (7)$$

where K_1 is the value of diffusion at 1 mm, ρ_{a1} the density of air at the surface, and $(\partial q/\partial Z)$ is approximated by a three-point derivative centered at the first level above the surface. The mass of dew (D) per unit area and time interval is calculated by integration of the flux of water over time. The amount of liquid water produced above the surface after fog formation was calculated by the well-known method of McDonald (1963).

TABLE 2. Height (Z_M) and magnitude (K_M) of the K maxima for the various K profiles used.

Profile	K_M ($m^2 s^{-1}$)	Z_M (m)
K_A	1.50	75.75
K_B	0.05	9.97
K_C	0.05	1.96
K_D	0.01	9.97
K_J	0.01	1.96
K_K	0.01	75.75
K_L	0.005	9.97

A convenient method of mathematically expressing K profiles with realistic shapes was described by Agee *et al.* (1973). Their formulation, employed in the model, is

$$K(Z)=a[\exp(-bZ/Z_T)-\exp(-bcZ/Z_T)], \quad (8)$$

where Z_T is the height of the planetary boundary layer, while a, b and c are constants that can be determined if the magnitude K_M of the maximum value of the eddy diffusion coefficient, the height Z_M of this K maximum, and Z_T are prescribed. The only change to this formulation was to add a constant that represented the molecular value of diffusion at the surface (2.1×10^{-5} $m^2 s^{-1}$).

Ideally one would like to use some method of calculating the K profile as a function of height and time from a relationship including the effects of stability and the shear of the mean wind. A scheme capable of doing this has been given by Zdunkowski and Barr (1972). However, the method is difficult to use with radiosonde data because of the lack of low-level information and the necessity of making a set of somewhat arbitrary assumptions in establishing the initial conditions. The results of Zdunkowski and Barr suggest that the time variation of K maxima are small. Because of our interest in investigating a wide range of values and heights of the maximum value of K, we chose to specify the profile as a fixed function of height independent of time.

3. Presentation and discussion of results

The model and prescribed variables were tested by their ability to duplicate radiational effects in the following three ways: (i) occurrence or non-occurrence of fog, (ii) the time of fog formation, and (iii) how well the predicted and observed temperatures and dewpoints matched. The time of fog formation in the model was taken to be the time when liquid water occurred at any level above the surface.

To accomplish this task four fall cases of strong evening radiation were run with the model using several K profiles. In addition to simulations made with the complete model, some runs were also made to test the importance of various elements of the model. These included a run with no radiative flux divergence, some with no dew formation allowed, and one with the net radiation held at 25% of the theoretical blackbody value and no radiative flux divergence.

By including both fog and no fog occurrences, a better analysis of variables was obtained, and clearly any predictive fog model must be able to discriminate the two results. In all cases, clear or nearly clear skies were reported throughout the night or up to the time of fog formation. The Albany Airport cases were as follows:

I. 23 September 1958 (fog case)
II. 11 September 1970 (no fog case)
III. 14 October 1968 (fog case)
IV. 2 September 1958 (no fog case)

The Roman numerals will be used as designators for the various cases.

Table 2 gives a list of the various K profiles examined, including the values of K_M and Z_M. The letter designators in the table will be used to identify the K profiles henceforth. Fig. 1 is a graph of profile K_B and is given as an example of the typical shape of the K profiles used.

All runs were considered to begin at 0000 GMT (2000 EST) and comparison with the Albany County Airport data was started at that time. The level in the model at a height of 1.3 m was used for these comparisons as it is nearest to the height (4 ft) of the customary Stevenson-screen weather data.

a. *Case I. 23 September 1958 (fog occurrence)*

This first case was treated in some detail as it represented perhaps the most typical local radiation fog.

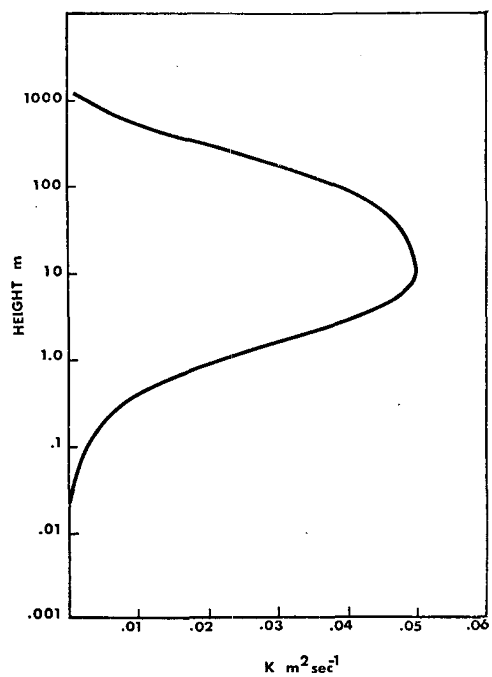

FIG. 1. Eddy coefficient profile K_B.

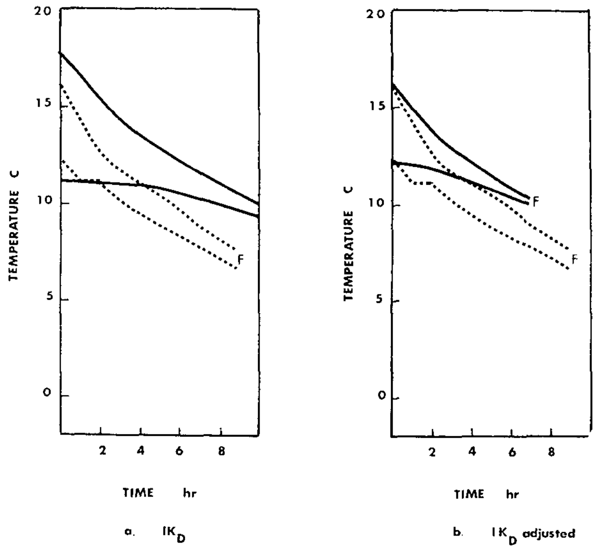

FIG. 2. Temperature and dewpoint temperature vs time for Case I model runs (solid) K_D (0.01; 10) and K_D adjusted, and for Albany Airport Stevenson-screen data (dashed).

At the airport, fog formed at 0500 EST or 9 h after the prior evening's radiosonde release.

1) THE EFFECT OF DEW FORMATION

Fig. 2 compares the temperatures and dewpoints given by the model using profile K_D (0.01; 10)[4] to those recorded at the airport. As indicated, the predicted temperature-dewpoint trends produced by the model did not simulate observations very well. Most important, the model did not produce a fog.

The discrepancy between the starting conditions of the model and the Stevenson-screen data is due to differences between the radiosonde release point and time (usually 45 min prior to the hour) and the 2000 EST airport data. To determine the importance of the initial conditions, some runs were also made with the surface radiosonde temperature and dewpoint "adjusted" to (replaced by) the screen data at 2000. This appears justified under the reasonable assumption that, for time periods of less than an hour, the temperature of the air a few meters above the surface does not change appreciably. Fig. 2b is a plot of the results of the same K profile but with adjusted data. In this run fog formed in 6.75 h, only about 2 h sooner than observed, and the temperatures and dewpoints match somewhat better also. The dewpoint falls off more in the adjusted run; this is a direct result of the higher relative humidity at the start which causes dew to begin forming sooner.

The rate of dew formation depends on the magnitude of K as well as the height of maximum eddy motion. In an attempt to simulate the actual dewpoints and fog formation more closely, runs were made with several other K profiles. Dew formed in the various runs for different K profiles shown in Fig. 3. As indicated in Table 2, K_B (0.05; 10) has a K maximum at the same level as K_D but five times greater in magnitude. The curves in Fig. 3 show that although the K_B run started forming dew at a later time than K_D, the rate of dew formation was higher and K_B deposited more total dew (55.6 m^{-2}; off scale) after 10 h for the adjusted case. While the resulting dewpoint trace was slightly improved, the crucial model test of forming a fog was not met. Conversely, weaker mixing as reflected by profile K_L (0.005; 10) produced a fog too soon (after about 5 h) and with unrepresentative dew accumulation although the temperature trends were somewhat better (next section).

Zdunkowski and Nielson, who did not allow dew formation in their model, were able to generate fogs after an elapsed time of approximately 1–2 h. In order to examine further the importance of dew, a run was made using profile K_D (0.01; 10) with no dew permitted. As just discussed, when dew was allowed to form (a modest 15 g m^{-2} after 10 h in this case) fog did not occur. Without dew depletion fog formed in 4 h, much sooner than it should have (9 h).

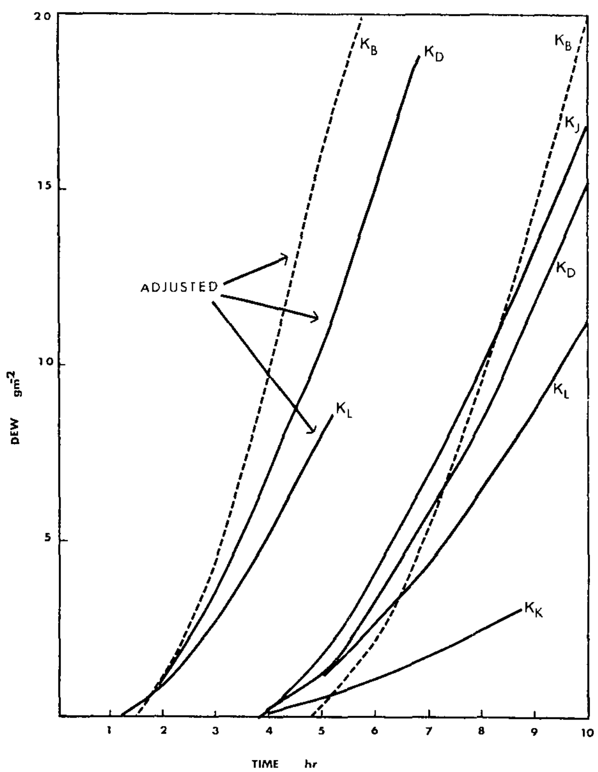

FIG. 3. Amount of dew per square meter vs time for Case I for various K profiles. ("Adjusted" curves refer to replacement of the surface radiosonde data by more relevant NWS Stevenson-screen measurements.) The dashed profiles produced the maximum amount of dew.

[4] For clarity, parenthetical values express the mixing value maximum and approximate corresponding altitude, e.g., 0.01 m^2s^{-1} and 10 m.

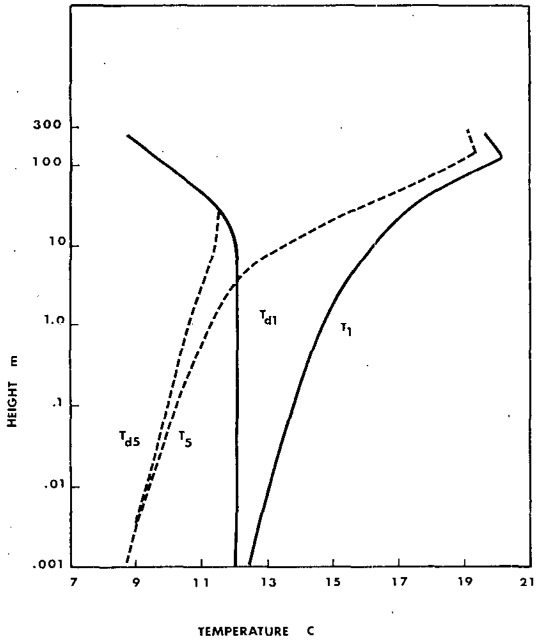

FIG. 4. Temperature and dewpoint temperature vs height for profile K_D (0.01; 10) after 1 h (solid) and 5 h (dashed).

The loss of atmospheric moisture through dew can extend to appreciable heights, leading to a dewpoint inversion as shown in Fig. 4 (K_D, adjusted data). The solid lines (T_1, T_{d1}) are for 1 h which is just before the onset of dew, while the dashed lines represent conditions 5 h after the start of dew formation. The dewpoint dropped by approximately 4°C at the surface with lesser decreases occurring up to a height of 20 m.

Data on the amounts of dew formed under or near the conditions simulated by the model are not plentiful. Pilié *et al.* state that measurements they made showed dew deposition rates of 25 ± 5 g m^{-2} h^{-1} up to 1 h prior to fog formation. They indicate these values lie about midway in the range of measured values discussed by Geiger (1971), the latter pertaining primarily to forests. Rosenberg (1969) reports total dew amounts of from 0 to 520 g m^{-2} on bare soil under irrigation at Mead, Neb., with an August nightly average of $\sim$180 g m^{-2}. Marlatt (1971) reports average total amounts ranging from $\sim$25 to 150 g m^{-2} at five stations in the high plains and foothills in central Colorado. The sites were representative of open field areas. A survey by Wallin (1967) suggests that the above values are consistent with those from several global sites.

Not entirely clear is how much of the reported dew comes from the soil as compared to the air, indications being that the former can exceed the latter in the fall (Geiger, 1971). Nevertheless, based on the prior information it appears that the amounts of dew produced by the model are too small. Due to the importance of dew as a "governor" on fog formation, it is felt that this may be a deficiency of the model.

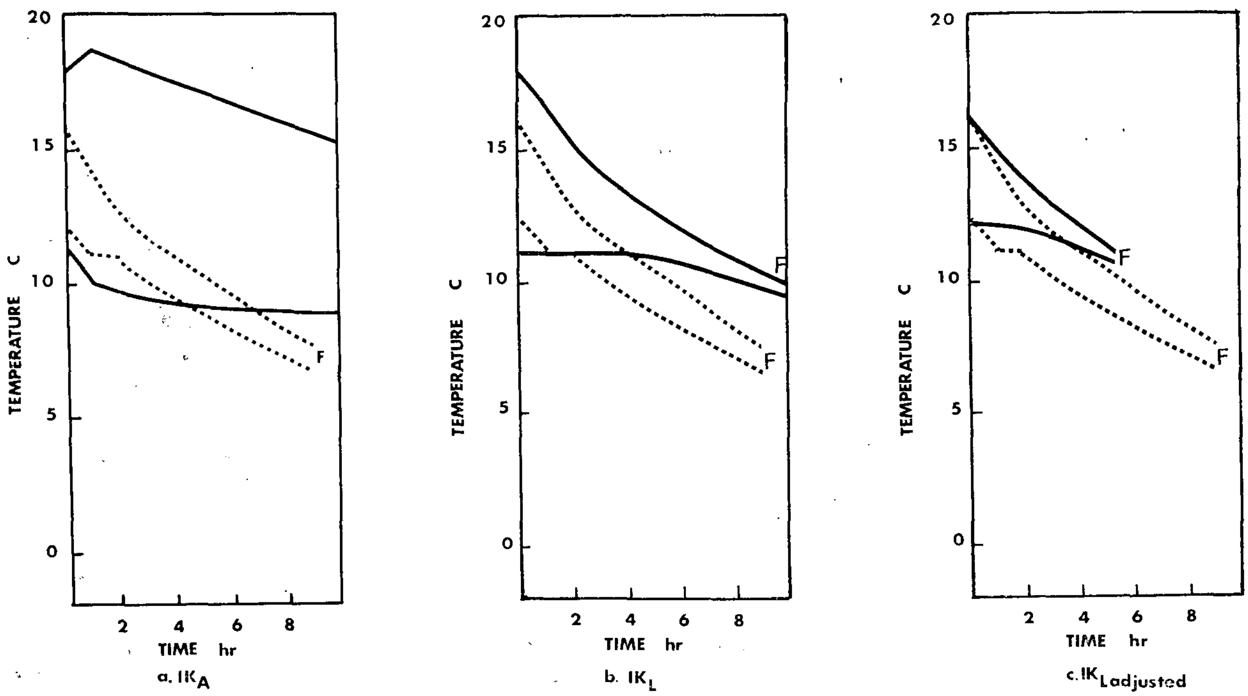

FIG. 5. Temperature and dewpoint temperature vs time for Case I model runs (solid) K_A (1.5; 75), K_L (0.005; 10) and K_L adjusted, and for the Albany Airport Stevenson-screen data (dashed).

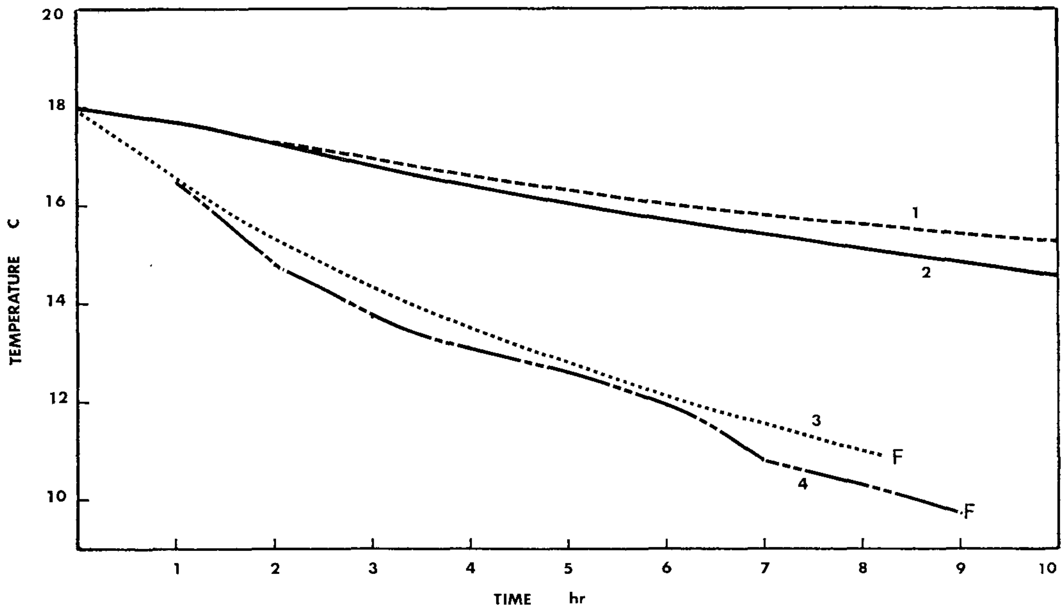

FIG. 6. Temperature at 1.3 m vs time for three Case I model runs and actual data with profile K_K: no radiative flux divergence (1), 25% net surface radiation (2), full model (3), and actual data (4).

2) The effect of maximum eddy exchange values and levels

In order to examine the effects of large mixing coefficients and higher peak levels, the model was run with profile K_A (1.5; 75), which is a rough approximation to the Zdunkowski and Nielson values. The results of this simulation are shown in Fig. 5a. The initial dewpoint drop is due to a redistribution of the water vapor by the large mixing coefficient. The large values of K caused the cooling to be distributed over a much deeper layer which limits cooling near the ground. The dewpoint was not reached at the ground even after 10 h and no dew formed. Thus it appears that such large mixing coefficients, while typical of neutral lapse rates, are not representative of general radiation fog.

In contrast to such large values of K, lesser mixing should allow more cooling near the surface. Fig. 5b shows the results of a run with profile K_L (0.005; 10), whose K maximum is half as large as the comparative profile K_D. Fog formed in this run after 10 h or one hour later than at the airport. Less dew was deposited with K_L than K_D (Fig. 3), and the temperature fell more near the surface allowing fog to form. Fig. 5c shows the results of an adjusted run with K_L, wherein fog formed prematurely after 5.25 h. The results suggest that a profile close to K_L and K_D (K_M=0.005–0.01 m^2 s^{-1}) is a reasonable choice for this case. Such low mixing values are compatible with the very scarce data that exist for stable low-level conditions (Priestley, 1959).

The CAL model generated K profiles with K maxima in the lowest few meters of the atmosphere. Run K_J (0.01; 2) did not produce a fog even though the temperature and dewpoint approached each other closer than on many other runs. K_J had one of the higher dew deposition rates. Although its K maximum is small, the mixing values near the surface were relatively large owing to the shallow height of the maximum. Therefore, more water vapor was transported to the surface from the lower part of the atmosphere. Raising the level of K maximum to 75 m while keeping its magnitude the same as K_D and K_J (profile K_K) enabled fog to form and gave a good description of the ambient temperature trace at 1.3 m; conversely, the small amount of dew formed (Fig. 3) and the dewpoint curve were not considered representative of observed conditions.

In summary, increasing the height of maximum mixing had the effect of decreasing dew amounts and raising the likelihood of forming fog. Decreasing the degree of turbulent mixing (for Z_M=10 m) had the same effect, with K values $\lesssim$0.01 m^2 s^{-1} favoring fog formation. Pilié *et al.* (1972) reported a similar K value threshold with their fog model.

3) The effect of radiative flux divergence

In order to test the importance of radiative flux divergence, runs were made with and without this variable using profile K_K (0.01; 75). Another run with K_K was also made forcing the net radiation of the surface to remain at 25% of theoretical blackbody and also not allowing radiative flux divergence. This last condition is the one used in the CAL model up to the time of fog formation. Fig. 6 shows the differences in the cooling at 1.3 m for these three runs as compared to the observed data. It is apparent that the model including radiative flux divergence provides a con-

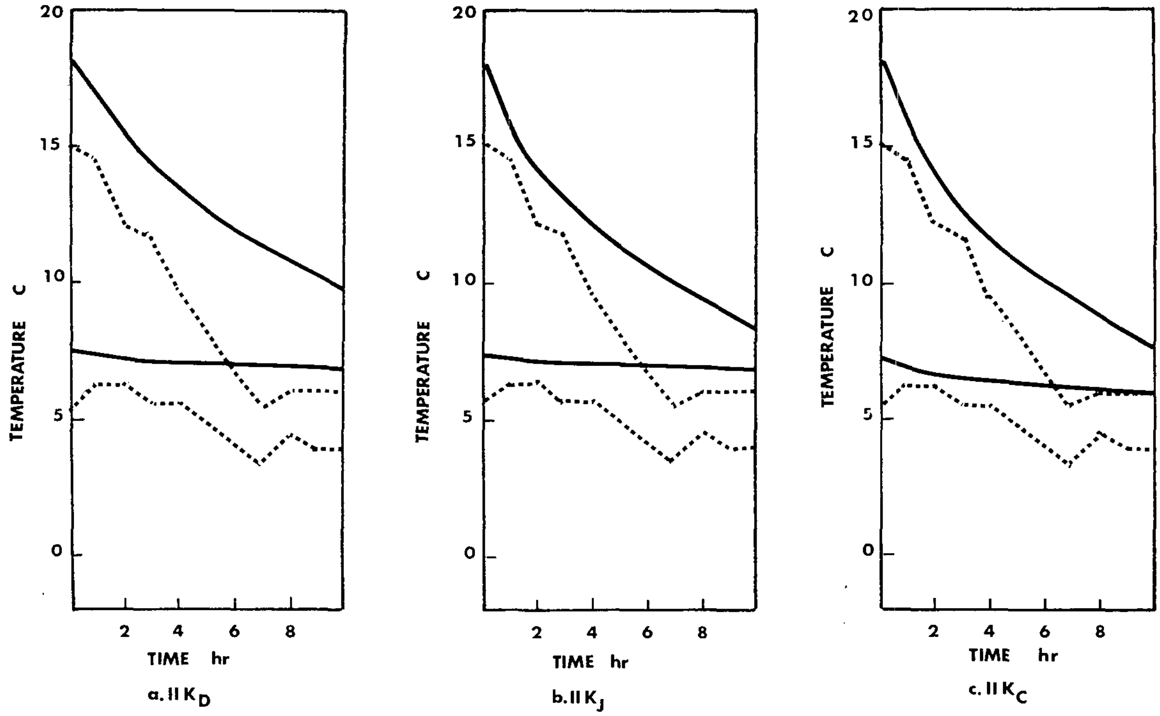

FIG. 7. Temperature and dewpoint temperature vs time for Case II model runs (solid) K_D (0.01; 10), K_J (0.01; 2 m) and K_C (0.05; 2), and for the Albany Airport Stevenson-screen data (dashed).

siderably better simulation of observed temperature changes. The run with the full SUNY model started with 24.95% surface net radiation loss and had decreased to 20.18% at the time of fog formation. In the shallow region where flux divergence normally contributes to warming (below about 10 cm), the fixed 0.25 net radiation produced lower temperatures than the other two runs. However, above 10 cm the full model including radiative flux divergence produced considerably more cooling than the other 2 runs.

Summarizing the various model runs described to this point, the following generalizations appear valid:

1) Initial temperature and dewpoint conditions assumed or occurring at sundown have a pronounced effect on the onset time of fog.

2) As Emmons and Montgomery (1947), Rodhe (1962) and Pilié *et al.* (1972) have pointed out, dew can dramatically influence the formation of fog. It is an essential ingredient of any realistic numerical fog model. Though sometimes overlooked, the absolute humidity or dewpoint at low levels is not conservative in stagnant radiation conditions but decreases as dew occurs.

3) Fog formation is quite dependent on eddy exchange coefficients, both with regards to maximum K values and to the height of maximum mixing. For this case, K_M and Z_M values in the vicinity of 0.01 m^2 s^{-1} and 10 m provided reasonable simulations.

4) Small changes in net outgoing radiation also influence fog formation such that radiative flux divergence must be accounted for or be parameterized quite accurately.

b. Case II. 11 September 1970 (no fog)

Six runs were made on this no-fog case, with eddy profiles K_D, K_J, and K_K. This was a very dry situation and almost no dew formed in any of the runs. All showed, as typified by simulations K_D (0.01; 10) and K_J (0.01; 2) in Fig. 7, negligible lowering of the dewpoint as a result of the lack of dew. This reproduces well the actual data wherein the dewpoint fell only 1.5°C. If allowance is made for the apparent differences in the initial conditions, run K_J (0.01; 2) was the best simulation, while K_C (0.05; 2) and K_K (0.01; 75) were somewhat inferior.

Runs were also made with stronger mixing profiles K_B (0.05; 10), K_B adjusted, and K_C (0.05; 2). The K_C run, as shown in Fig. 7c, proved an excellent simulation if as before the initial condition adjustments are taken into consideration. Both K_J and K_C are profiles with K maxima at 1.96 m. Because these two runs gave the best results, it would appear that this is a reasonable height for K maximum in this case; however, it should be noted that the model results were less sensitive to mixing height than in fog Case I. Winds at and below 950 mb were somewhat stronger in this case, which is consistent with the higher K_M values though not consistent with the shallower mixing layer. It appears

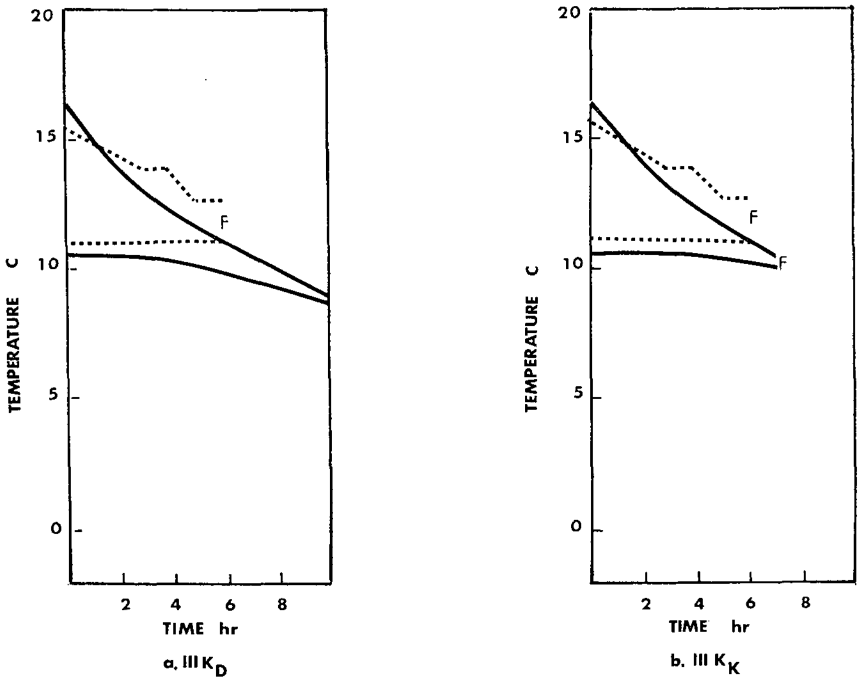

FIG. 8. Temperature and dewpoint temperature vs time for Case III model runs (solid) K_D (0.01; 10) and K_K (0.01; 75), and for the Albany Airport Stevenson-screen data (dashed).

that the dry initial conditions strongly governed this model simulation.

c. Case III. 14 October 1968 (fog situation)

This case was different from the others with regard to conditions prior to the start of the run. Although the sky at 1500 was reported clear, the visibility did not exceed 9 mi. There was fog the previous night that did not dissipate until 1100; in fact, fog occurred on the previous five nights. It is felt that because of this long period of stagnant conditions a relatively deep mixing layer could very well have developed. This is supported by the temperature inversion that existed up to 992 mb and the moderate winds of 8 m s^{-1} through this level. Case I had an inversion also but only to 1000 mb and winds of about half this magnitude.

Two runs were made with profiles K_D (0.01; 10) and K_K (0.01; 75), as shown in Fig. 8. The results with the elevated mixing-level profile K_K ($Z_M = 75$ m) yielded a rather excellent simulation. The approximate time of fog formation at the airport was after about 6 h versus a model prediction of 7 h. The K_D run ($Z_M = 9.97$ m) formed a fog after 10 h and 15 min. It is rather encouraging that in spite of the abnormally prolonged nature of this series of fog days, the model was able to predict it quite well. However, a sound choice of K was required.

d. Case IV. 2 September 1958 (no fog)

Four runs were made on this no-fog case. The results of the better simulations K_B (0.05; 10) and K_C (0.05; 2) are shown in Fig. 9. A K_D (0.01; 10) run—not shown—was somewhat poorer than K_B. The K_B run yielded the best temperature-dewpoint spread while the K_C run followed the actual data more closely. Encouragingly, neither of these simulations formed a fog.

A run with profile K_C was also made but dew was not allowed to form. Fog occurred after 4 h, again showing

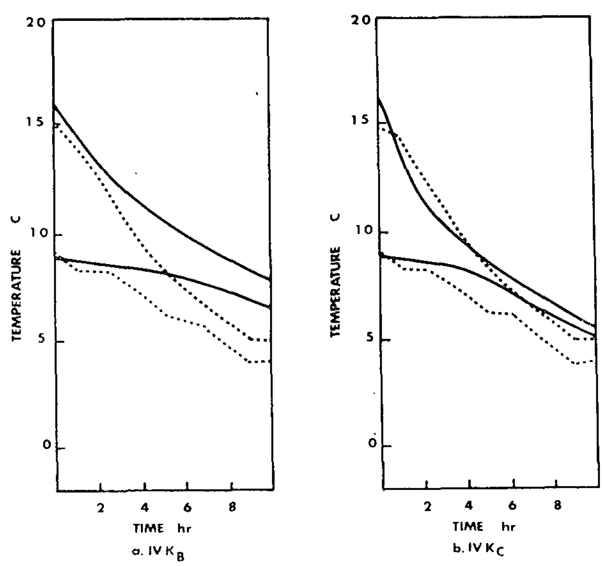

FIG. 9. Temperature and dewpoint temperature vs time for Case IV model runs (solid) K_B (0.05; 10) and K_C (0.05; 2), and the Albany Airport Stevenson-screen data (dashed).

the importance of dew deposition in the governing of fog formation.

4. Conclusions

The main objective of this study was to develop a numerical model for studying the effects of dew formation, radiation and eddy mixing on radiative fog formation. The following conclusions were suggested by numerous model simulations of two fog and two no-fog situations:

1) The initial conditions of the atmosphere were extremely important with regard to fog occurrence and the model's performance, especially the initial temperature and dewpoint conditions near the surface.

2) The height and value of the K maximum that gave the best results vary according to the low-level atmospheric conditions, as would be expected. A reasonable average value for the magnitude of K maximum for the examined fog conditions appeared to be near 0.01 $m^2 s^{-1}$. The effective height of K maximum varied considerably. In moderate wind conditions with a deep inversion, the 75 m height gave the better results; in less stable conditions with lighter winds, the 2–10 m height appeared to be more satisfactory.

3) Dew formation was extremely important in influencing both the occurrence and time of formation of radiation fog. It must be included in any realistic radiation fog model.

4) Radiative flux divergence of water vapor was shown to be an important consideration in a model of this type. Cooling rates from 0.5°C to a few degrees per hour due to radiative flux divergence occurred in the lowest 10 m. Ignoring this cooling can make the difference as to whether or not the model generates fog.

5) The model was able to predict fairly well the occurrence and non-occurrence of radiation fog provided an appropriate K profile was used. It also was possible then to predict the time of occurrence to within a few hours of the actual time. In general, the modeled temperature and dewpoint decreases with time occurred at too slow a rate when compared with the actual data.

In summary the accurate numerical simulation of fog is quite sensitive to all of the variables tested. The greatest uncertainty pertains to eddy coefficient profiles under stable conditions characteristic of strong radiation. More information on the specification or appropriate generation of this variable as well as characteristics of the dew (from the air) process are needed before a truly objective method of predicting fog occurrence can be realized. Subsequent effects of droplet radiation and sedimentation, not considered in this study but treated by others, clearly must be included to model fog intensity and duration.

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