cc: Rich
Ian

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February 20, 1997

Joseph Tikvart
U.S. Environmental Protection Agency - OAQPS
Mail drop 14
Research Triangle Park, N.C. 27711

Dear Mr. Tikvart:

Massachusetts DEP is presently preparing an ozone model equivalency demonstration for the CALGRID model. CALGRID model performance will be compared to UAMIV performance for 4 high-ozone episodes in the New England Domain. The eddy diffusivity parameter will be set to 1 m^2/s, as discussed in the enclosed technical memorandum authored by Gary Moore. The CALGRID model will employ the same isoprene chemistry code as that recently used for UAMV for OTAG modeling runs, and BEIS2 will be employed to generate biogenic emissions.

Massachusetts would like to use CALGRID for ozone SIP attainment modeling analyses. For the equivalency demonstration, should UAMIV be used with BEIS1 emission files or BEIS2 emission files? Is there anything else we should undertake?

Thank you in advance for any guidance you can provide.

Very truly yours,

Barbara Kwetz

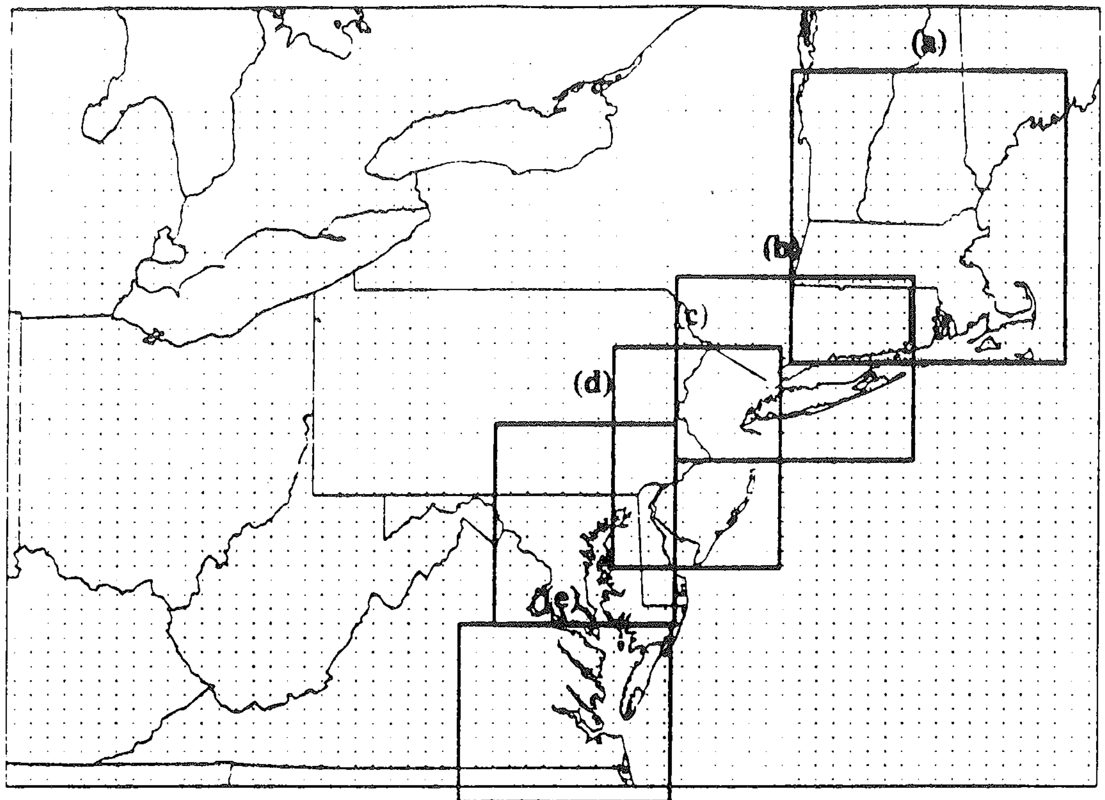
Barbara Kwetz, Director
Division of Air Quality Control

C - D.Conroy, U.S.E.P.A. Region I

C - S.Dennis, MA DEP

UAM DOMAINS NESTED WITHIN GRIDDED ROMNET REGION

(N 45.00, W 69.00)



(N 36.33, W 85.00)

(a): New England UAM Airshed
SW corner (120 km E, 4570 km N) Zone 19, 68x68 cells

(b): New York UAM Airshed
SW corner (480 km E, 4440 km N) Zone 18, 58x46 cells

(c): NJ-Philadelphia UAM Airshed
SW corner (400 km E, 4305 km N) Zone 18, 42x55 cells

(d): Baltimore-Washington UAM Airshed
SW corner (250 km E, 4235 km N) Zone 18, 46x50 cells

(e): Virginia UAM Airshed
SW corner (734.876 km E, 4002.832 km N) Zone 17, 53x49 cells

TECHNICAL MEMORANDUM

Minimum Vertical Eddy Diffusivities Above the Mixed Layer

by

Gary Moore

The UAM family of models treats the top of the mixed layer as an impermeable lid to turbulent mixing by setting the vertical eddy diffusivity, K_z, to a very small value in the range 0.01 - 0.04 m^2/s. CALGRID, on the other hand, uses a much larger default value of 1.0 m^2/s which allows for reasonable growth of the mixed layer due to turbulent entrainment. The purpose of this memorandum is to indicate why a larger value of K_z should be used as a user defined default.

In numerical modeling of the planetary boundary layer, one of the difficulties is to specify a vertical eddy diffusivity for heat that will produce realistic temperature inversions. Too large a value and inversions would never form, too small a value and unrealistic gradients in temperature would build up over time. In the mid 1960's, researchers such as Deardorff (1967) were experimenting with a number of parameterizations which related the vertical eddy diffusivity to the bulk potential temperature gradient. In Figure 12 of Deardorff (1967), the eddy diffusivity as a function of potential temperature gradient is plotted for a number of eddy diffusivity models. For large, positive potential temperature gradients the mean value that is approached is 10^4 cm^2/s (1 m^2/s). Under extremely stable-light wind conditions smaller values can be estimated; however, it is noted that F class dispersion corresponds to a K_z of about 1 m^2/s.

A reasonable question is, what is the lower bound? If we consider a strong nocturnal surface inversion as an extreme case, we can turn to tower based measurement programs. Hosler's (1969) measurements of radon concentrations on a tower indicated values of 0.5 - 1.0 m^2/s during stable inversion periods over 1-4 hour periods. Another source of information is the BAO studies of nocturnal stable layers (e.g. Kaimal 1983). If the vertical eddy diffusivity of heat can be assumed as a surrogate for material, then under relatively stable conditions one has the relation;

$$K_\theta = F\sigma_w(\sigma_w/N)$$

where F is approximately 0.2. If we assume a mean value of 20 m for σ_w/N and a reasonable mean value of 0.25 m/s for σ_w (see Kaimal (1983) page 21 - Figure 1.11), the result is a thermal eddy diffusivity of 1.0 m^2/s.

The extremely small values assumed by the UAM family of models are not reasonable for the CALGRID model and might lead one to question whether they are appropriate for UAM.

References:

Deardorff, J.W., 1967: Empirical Dependence of the Eddy Coefficient for Heat upon Stability Above the Lowest 50 m. *Journal of Applied Meteorology*, **6**, 631-643.

Hosler, C.R., 1969: Vertical Diffusivity from Radon Profiles. *Journal of Geophysical Research*, 74:28, 7018-7026

Kaimal, J.C., 1983: Studies of Nocturnal Stable Layers at BAO. U.S. Dept. of Commerce, Report Number Four, January, 1983.