USING MESOSCALE MODEL DATA AS INPUT TO AERMOD

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1. INTRODUCTION

In recent years there have been dramatic advances in high performance desktop computing as computer hardware has decreased in cost at the same time that computing speeds, memory and disk storage have increased. This increased computing capability has given many dispersion modelers the capability to run mesoscale models that produce high-resolution three-dimensional meteorological data (Lyons et al. 1997). The dispersion model AERMOD (EPA 2000a), which is on track to be the model of choice for short-range regulatory scenarios (EPA 2000b), has the capability of utilizing more advanced meteorological information such as that produced by a mesoscale model.

We have developed a technique to extract data from the mesoscale model RAMS, ingest it into the AERMOD meteorological preprocessor AERMET, and then run AERMOD to produce concentration output. For this paper we made a series of AERMOD runs using RAMS data as input and compared the results with AERMOD runs made using surface and upper air data from National Weather Service (NWS) observations. We compared model results with field tracer observations. The results show the advantages of using mesoscale model data as input into AERMOD but they also show some of the limitations as well.

2. MODEL CONFIGURATION

2.1 RAMS

RAMS was developed to model physiographically-driven weather systems such as land/sea breezes, and thermally driven mountain circulations. Summaries of RAMS features and recent meteorological applications can be found in Pielke et al. (1992).

When making regulatory dispersion model runs, modelers often must use observations that are not spatially or temporally representative. For example, observations taken at a surface location tens of kilometers away and upper air observations taken hundreds of kilometers away may be the best available. In addition, dispersion models that require hourly data must use upper air data that is only available every twelve hours and surface data that may only be available every three or more hours. Surface data in the United States is usually available every hour but in foreign countries it is often only available every three or six hours. A mesoscale model provides a way to fill these data gaps. It also provides additional data parameters that are not routinely measured at NWS sites but which can be used by AERMOD (e. g friction velocity). The extracted RAMS parameters were:

- cloud fraction
- mixing height
- temperature
- dew point
- snow depth
- precipitation
- relative humidity
- friction velocity
- sea level pressure
- sensible heat flux
- vertical velocity
- long wave radiation
- short wave radiation
- potential temperature
- u-, v-wind component
- roughness length

These listed variables were extracted for a single horizontal point using the GRAB interpolate feature of RAMS/REVU (Bell et al. 2000). Vertically, RAMS data were grabbed for 19 RAMS levels (the current AERMET limit) at the one location up to approx. 2000 m AGL.

2.2 AERMET

To accept the data generated by RAMS, AERMET was configured to input meteorological data as “onsite” data rather than “surface” or “upper air,” which is the mode for inputting NWS data. Surface parameters were sea level pressure, atmospheric pressure, mixing height, sensible heat flux, friction velocity, roughness length, precipitation amount, net radiation, and cloud fraction. Upper air parameters at each level were height, wind direction, wind speed, vertical velocity, temperature, dew point, and relative humidity.

3. CASE STUDY

3.1 Field test data

To test our routines for inputting RAMS data into AERMET, we used data from the Indianapolis field study conducted from 15 Sep.-11 Oct. 1985 (Hanna et al. 1997). The field study involved SF_6 releases from the 83.8 m stack at the Perry K power plant located in downtown Indianapolis. Data were taken in 8 or 9-hour blocks for a total of 19 blocks over the 27-day program. Concentrations were measured on a network of about 160 ground-level monitors on arcs at distances ranging from 0.25 to 12.0 km from the stack.

3.2 RAMS Data

RAMS was configured with 4 nested grids with a fine grid of 1-km horizontal spacing and a telescoping vertical spacing at 0, 22, 46, 72, 100, 141, 200, 300 meters, and extending to 25796 meters. RAMS was run with full microphysics and was initialized and provided with boundary-condition meteorological data from 2.5-degree, six-hour Reanalysis data (Kalnay et al. 1996).

3.3 AERMET Data

We created AERMET surface and profile files using two different methods. First, we created AERMET files using RAMS data as onsite data using the methodology described above. Next, for comparison purposes we generated the AERMET files using NWS surface and upper air data. For this experiment special surface and

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upper air data sets were available. However, to simulate a routine regulatory situation we obtained surface and upper air data from a source that a modeler might use in conducting an analysis. (WebMET 2001). Surface data was obtained in CD-144 format from Indianapolis International Airport located 11 km from the source and upper air data was obtained in TD-6201 format from Dayton-Wright-Patterson AFB, OH located 160 km from the emission source.

3.4 AERMOD Configuration

We made comparison AERMOD runs using the AERMET data from RAMS and from NWS. Emission data used for Test 1 for the Perry K stack was emission rate of 4.94 g/s, stack temperature of 501.6 K, stack velocity of 12.0 m/s, and stack diameter of 4.72 m. Receptors were located at the test sampler locations.

3.5 Results

Sample results of the AERMOD modeling are presented in Figures 1 and 2. These results show that for this case, the AERMOD-NWS run predicted the plume direction better than the AERMOD-RAMS run but AERMOD-RAMS did better at predicting the downwind maximums observed at the 1.5 and 3 km arcs. Both AERMOD runs under-predicted concentration maximums. We are still in the process of compiling results and statistics of this case and will present more comprehensive results at the conference.

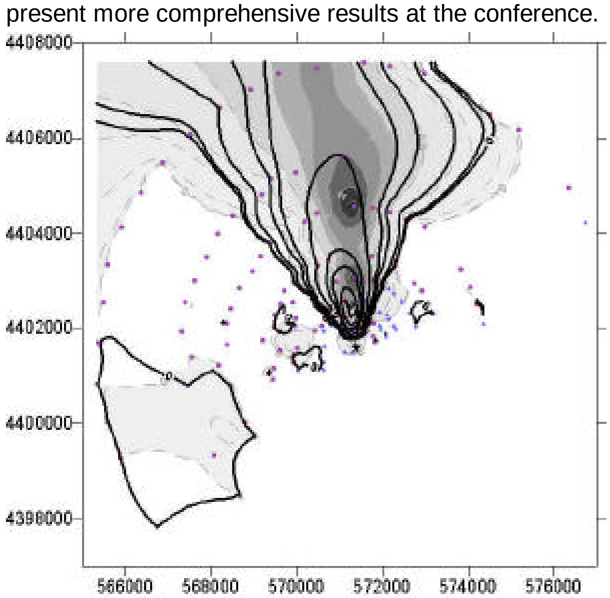

Figure 1. Observed (shaded) and AERMOD-NWS-predicted (dark lines) concentrations (μg/m^3) for Indianapolis field study for 1100 LST, 16 Sep. 1985. Axes are UTM coordinates

4. CONCLUSIONS

From our experience with this case and other RAMS to AERMOD applications, we found the advantages of using RAMS data are:

- Increased data density in time, space and number of parameters.
- RAMS accounts for diurnal and terrain effects.
- RAMS produces smooth hour-to-hour wind directions reducing the "spotlight" effect seen in short duration AERMOD-NWS runs.

Disadvantages of using RAMS data are coarse initialization boundary conditions can lead to inaccuracies in the RAMS fields. One remedy for this is to nudge the RAMS model run with local surface and upper air data at frequent intervals if available.

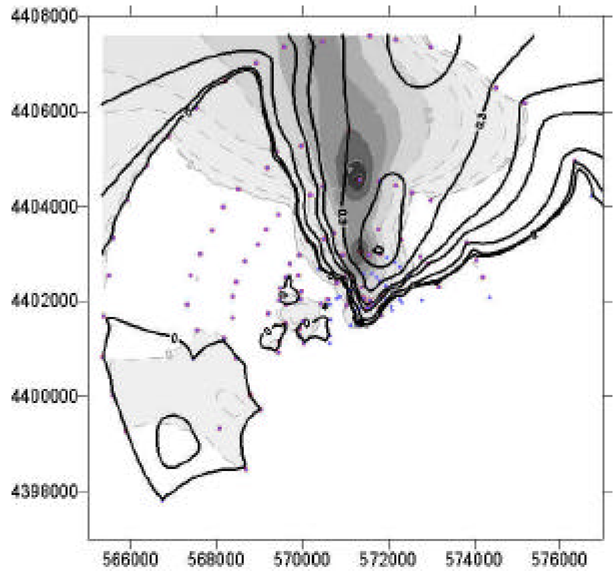

Figure 2. Same as Fig. 1 except for AERMOD-RAMS (dark lines).

5. REFERENCES

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