PM10 Modeling Protocol Summary

Modeling tools have advanced in the years between the development of the current PM10 SIP in the late 1980's and today. The existing SIP is based on receptor modeling and county-wide roll-back of PM10, SO2, and NOx. In consultation with EPA Region VIII, DAQ has decided to base the attainment demonstration for this new SIP/Maintenance Plan on a grid-based aerosol modeling approach using UAM. The attainment/maintenance demonstration will be based on the results this model.

UAM-AERO, an urban-scale grid-based aerosol model developed by the California Air Resources Board, will be used to analyze the airshed for two historical episodes during 2001 and 2002. Because there have been no violations of the PM10 NAAQS since 1995, the historical episodes do not represent excessive PM10 concentrations. In addition, availability of PM10 data is sparse in the 1990's due to relatively clean air quality during this time period. Since aerosol modeling is still in its infancy, relative to photochemical ozone modeling, guidance on model performance evaluation is not yet firmly established. The modeling protocol documents the activities associated with conducting the PM10 modeling and evaluating the model's performance prior to its use in emissions control strategy testing.

The state of Utah is required to develop a plan to demonstrate that it is able to maintain ambient air quality conditions for PM10 below the federal 24-hour standard for specific years in the future for the nonattainment area. To aid in meeting the goals of this study DAQ sought contract support for 1) the development of the emissions inventory, 2) highly resolved prognostic meteorological fields, and 3) consulting for modeling analysis of both input and output data sets. DAQ provided the modeling expertise for the general development and running of UAM-AERO through a multi-phased effort to apply an aerosol grid model to the Wasatch Front area.

To provide oversight, a Technical Review Panel (TRP) was formed and retained throughout the effort. This TRP was made up of representatives of a wide variety of entities that could be affected by, or would have a specific interest in, the application of UAM-AERO results; e.g., EPA, local government agencies, transportation, industry, environmental groups, MPOs, etc. Throughout this process briefings to the TRP were to be made by a combination of letter mailings, routine reports, and meetings at the DAQ office. These meetings provided a forum for the DAQ modeling team to personally brief members of the DAQ staff and TRP members.

Choice of Models

UAM-AERO employing CB-IV chemistry has been used as the aerosol model in the PM10 SIP modeling. UAM-AERO is an extension of the widely used photochemical model, the Urban Airshed Model (UAM), Version IV, which has been adapted to treat aerosol processes. DAQ chose to use this model because of extensive staff experience using UAM-IV for ozone analysis and because the chemical mechanism in UAMAERO has been tested more extensively than for other models (Seigneur and Pai, 1999). The key feature of the UAM-AERO model is that it provides a common framework in which

to evaluate relationships between ambient concentrations of both ozone and particulate matter (PM), and their precursor emissions. (Kumar and Lurmann, 1996; Lurmann, et al, 1997) Assistance with setup and evaluation of UAM-AERO was obtained from an experienced contractor.

Given the complexity of the local mountainous terrain, in close proximity to two large bodies of water (Utah Lake and Great Salt Lake), DAQ initially used a high-resolution prognostic meteorological model to develop the meteorological inputs to the UAM-AERO. Specifically, scientists at the University of Utah Department of Meteorology and NOAA Cooperative Institute for Regional Prediction developed meteorological input data for the UAM-AERO. This effort involved running a prognostic mesoscale model – the Penn State/NCAR mesoscale model (MM5). In subsequent and current modeling analysis the MM5 model was replaced with a simpler diagnostic wind model to more effectively characterize the inversion episodes.

Processing of the emissions data sets assembled for point, area, and mobile sources was accomplished through use of the Sparse Matrix Operator Kernel Emission (SMOKE) modeling system. This emissions handling system was developed by EPA for integration into the Models-3 Air Quality Modeling System. SMOKE outputs were modified for input into UAM-AERO. Because winter time episodes will be modeled, estimates of biogenic emissions will not be included in the analysis. The emissions data sets were created and initially evaluated by an experienced contractor in consultation with DAQ.

Overview of the Modeling Project

The Utah Division of Air Quality (UDAQ) has not monitored an exceedance of the PM_{10} NAAQS in Salt Lake County, Utah County or Ogden City during wintertime inversion events in the past six years. PM10 data collected during the 6-year period suggests that at all sites (Utah and Salt Lake Counties and Ogden City) wintertime inversions occur simultaneously and produce the highest PM10 concentrations outside of “special events”. Only special events, such as, the July holidays and spurious wind events produce higher PM10 concentrations. Furthermore, the top 2 non-flagged PM10 values recorded at Ogden City since 1996 are captured in the February 1-8, 2002 candidate modeling episode discussed below. Therefore, Salt Lake County, Utah County, and Ogden City were evaluated using the same PM10 episodes.

Several “special event” PM10 NAAQS exceedences have occurred during the last 6 years. Several events have occurred during July 4^{th} related firework activities near Ogden City while the other “special events” occurred during late winter and spring at Magna and the Kennecott Mine tailings pond. The tailings pond PM10 exceedences developed during dry high wind events. These conditions are very different than the stagnant inversion conditions that often plague the Wasatch Front with elevated PM10 levels.

The episode selection criteria for UAM-AERO modeling addresses only the primary meteorological conditions that produce elevated region-wide PM10 concentrations. No

attempt was made to model the wind blown fugitive dust events related to BACM failures at the Kennecott Mine tailings pond.

During this six-year period, three meteorologically significant inversions occurred without associated exceedances of the PM_{10} NAAQS. Consequently, UDAQ believes that Salt Lake County, Utah County and Ogden City are candidates for re-designation to attainment of the PM_{10} NAAQS. UDAQ plans to submit a Maintenance Plan supported by UAM-AERO photochemical modeling to demonstrate that Utah County, Salt Lake County and Ogden City do not currently exceed the PM_{10} standard and will not exceed it in the future during winter-time inversion events. The modeling effort relies upon using recent, representative inversion episodes for the modeling baseline. This document discusses the episode selection process for the Maintenance Plan modeling.

Modeling guidance ("Draft Guidance for Demonstrating Attainment of Air Quality Goals for PM2.5 and Regional Haze" EPA, Draft 2.1, January 2, 2001) recommends that modeling episodes are chosen from the three years following the implementation of the PM2.5 NAAQS. This recommendation is identical to the 8-Hr ozone modeling guidance. Because the emissions inventory is collected annually, by reviewing the past three-year period UDAQ will apply this standard to the choice of episodes for Maintenance Plan modeling. Monitoring and meteorological data during the most recent three-year period (1999-2002) indicates three inversion periods accompanied by elevated PM_{10}. The data available from the most recent three-year period are significantly more abundant than has been available prior to 1999. These data (both meteorological and monitoring) are crucial elements for the successful completion of a photochemical modeling effort.

**** Complete protocol available at:**
http://www.deq.state.ut.us/eqair/sip/pm10sip/modeling/modprot.pdf