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Modeling Studies to Evaluate Background Ozone and Regional Haze

Background

There is large day-to-day variability in background ozone and natural haze levels in the western U.S. Background levels of ozone can approach or exceed the level of the ozone NAAQS on some days. The Regional Haze Rule requires states to quantify the natural level of visibility and requires states to adopt emission control measures needed to make reasonable progress towards natural visibility conditions at Class I areas. Thus, it is important that the models used for ozone and regional haze planning be evaluated to assess how well they simulate background ozone and natural haze levels. In rural and remote areas of the western U.S., the largest contributors to ozone and haze include both natural sources and long range transport of non-U.S. anthropogenic emissions. Thus, this topic area is closely related to other research priorities including global model evaluation and wildfire and ammonia research. Ozone and haze are grouped together here because the same photochemical model simulations can be used to evaluate both topics.

Problem Statement

There is large uncertainty in natural levels of haze with current estimates based on limited measurement studies performed in the 1970s and 1980s. Photochemical models are often biased low for ozone from April to June in the intermountain west and may also perform poorly in simulations of ozone in wildfire plumes. EPA's draft recommended approach for using IMPROVE data for regional haze planning purposes does not attempt to separate international from domestic impacts, despite modeling studies that suggest international impacts can dominate at some Class I areas. The draft recommended approach also attributes between natural and anthropogenic using limited observations of the speciation of natural particulate matter. Both of these aspects of the data analysis could be improved by additional, robust modeling analyses.

Research Topics

- Perform more rigorous model performance evaluation studies for episodic ozone and haze conditions that are most relevant to air quality planning efforts.
- Evaluate source contributions to ozone and to speciated PM2.5 that contributes to haze.
- Design new studies to evaluate the effects of model vertical resolution and exchange between the troposphere and boundary layer.
- Perform comparisons of source attribution results from CAMx PSAT and CMAQ ISAM source apportionment tools.

- Perform comparisons of boundary condition data derived from hemispheric CMAQ to other global models.
- Develop methods for specifying background and boundary concentrations over complex terrain: Specifying background and boundary conditions over complex terrain is not strait forward. Direct interpolation from layers of a global hemispheric model to a local model often creates an imbalance along the lateral boundaries of the local model.
- Evaluate effects of updates in CMAQ 5.2 on background O3 and regional haze (e.g., new NO soil model, ammonia and aerosol updates).
- Perform more diagnostic model evaluations using special field study data and week-day/week-end effects.
- Evaluate effects of model horizontal and vertical resolution for both meteorological and air quality models.
- Use results of FIREX, FIRECHEM and FASMEE field studies to improve model performance for effects of wildfires on ozone and regional haze.
- Perform dynamic model evaluation studies to assess how accurately models reproduce the effects of large emissions changes in VOC, NOx and SO2 across the western U.S. from 2000 to the present, in conjunction with potentially rising background levels.
- Participate in the analysis of the California Baseline Ozone Transport Study data: Ozonesonde, ozone lidar, and aircraft data were collected during the summer of 2016 in California. One objective is to evaluate global hemispheric models by comparing study data to model output. Even though, measurements were made during the summer, information learned from the analysis and model evaluation may be applicable to the winter ozone and PM study.

Desired Outcomes

- Develop updated estimates of natural haze levels at Class I areas.
- Develop improved estimates of international transport and U.S. contributions to regional haze, both anthropogenic and natural.
- Develop improved estimates of day-to-day and regional variability in U.S. background ozone levels.
- Evaluate the accuracy of model simulations in predicting the response of ozone and haze to historical emissions changes and develop improved models for predicting future changes.
- Develop a GANTT chart of planning and research milestones.
- Short term goals: improved modeling platform for RH SIPs due in 2021.
- Long term goals: improved modeling platforms for RH SIPs due in 2028 and 2038.
- Coordinate development of emissions inventories (both international and U.S. emissions) to be used in future research and planning modeling platforms.