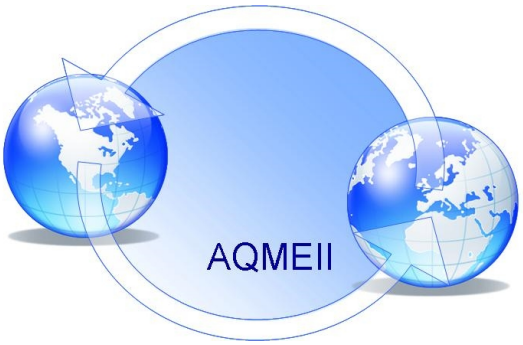

AQMEII-4 Regional-Scale Modelling of Deposition Processes

Introduction

We invite air quality modelers to participate in coordinated annual simulations for two years over Europe and/or North America.

AQMEII phase 4 will focus on deposition, therefore in addition to typical meteorological fields and gas and aerosol concentrations, participants will also be asked to calculate, store, and submit simulated wet and dry deposition fields as well as dry deposition velocity and its component resistances, for a suite of gases and particles for different land use/land cover types.

The goal of AQMEII phase 4 is to quantify and understand the variation in simulated deposition fields between multiple models under a typical and a special model application scenario.

The novelty for this phase relates to the fact that the nature and the scope of reporting for the phase 4 activity will have to go beyond previous AQMEII projects, yet will require many of the “standard” AQMEII output fields, since the operational evaluation is the starting point for any deeper analysis. The choice of deposition as the theme for the phase 4 activity will require, on top of the standard AQMEII style simulation, additional ones as described in the section “Planned Set of Simulations”.

It goes without saying that provision of less than the complete set of outputs requested for each of the three distinct sets of simulations described below will undermine the scope of the intercomparison, especially if these outputs are scattered amongst participants, leaving us with few common simulations per activity. We hope that most, if not all, of the groups participating in the annual AQMEII-4 3-D regional simulations will also participate in the other simulations. In particular, there would be little value for a group to participate in the one-hour 3D regional simulations without also participating in the annual 3D regional simulations.

The AQMEII-4 steering committee is mindful that considerable human resources go into this type of activity which include model preparation, model execution, and output transfer to the central ENSEMBLE data warehouse and analysis system. Therefore, the protocol for the simulations is being devised to minimize the anticipated effort on the part of the participants to the extent possible while also providing maximum insight into modeled deposition.

To help us determine the willingness of groups to take part in all of the ACQMEII-4 activities and which domains and/or periods you would be able to simulate, we ask that you respond to a survey (see end of notice.)

Planned Set of Simulations

1. AQMEII-style runs

Two full years of simulations are required by all participants. The years to be simulated will be 2009 and 2010 over Europe and 2010 and 2016 over North America. AQMEII will provide the necessary emission fields and lateral chemical boundary conditions. Meteorological fields will be simulated by each group. While each group will determine their own grid resolution and geographic projection, for analysis purposes gridded fields will be expected to be submitted on a common latitude/longitude grid with a grid spacing of 0.125 degrees. It is suggested that groups chose a native grid resolution that is comparable to this target resolution. Participants will also submit model output at a specified set of monitoring locations.

Science questions and goals

- How well do the simulated deposition fields agree with available observations?
- How do deposition fields differ between models and what are the key drivers of these differences?
- Do models with seemingly similar deposition schemes predict similar deposition? If not, why?
- How can an ensemble of simulated meteorological, concentration, and deposition fields, along with observations, best be used to calculate maps of total deposition and critical load exceedances?
- How does variability in simulated deposition translate into uncertainty in policy-relevant critical load estimates? How does this compare to the uncertainty caused by using different critical load data sets?

Information requested from participants

- Fields of meteorological variables, gas and aerosol concentrations, and wet and dry deposition
- Dry deposition velocity and all of its component resistances (needed to calculate partial conductances) for the total grid cell, and by the model land-use types used in the deposition calculation, for a suite of gases and particles
- Fractional area for each model land use/land cover type used in the deposition calculations, spatially transformed to a common grid as well as at specified monitoring station locations.
- Time-varying leaf area index information used in the deposition calculations, on the common grid and at specified monitoring station locations.
- Documentation of deposition algorithms, including parameter values specific for a given land use/land cover type used in the deposition scheme.

Anticipated work required of participants

Participants are expected to adapt the provided emission and boundary condition datasets to fit the requirements of their modeling system (possibly in collaboration with other participants using the same modeling system), prepare meteorological fields, and conduct two one-year simulations over Europe and/or North America. Model output fields will need to be processed into a common format, to be specified in Technical Specification Documents, that will be shared with participants. Software to prepare the common format will be provided to participants. It is anticipated that some of the expected output fields related to deposition (in particular deposition and resistance fields, broken down by different land use types) are not part of the standard model outputs and participants, and participants will thus need to modify their model code to allow output of these fields.

2. One-hour runs

The 3-D regional air quality models participating in AQMEII-4 will use different meteorological conditions, different land cover types and land cover maps, and different dry deposition schemes. As a result, it may be difficult to identify the key factors that drive differences in simulated dry deposition between the models, one of the AQMEII-4 science goals. We propose a small set of simple tests with the 3-D models that will evaluate dry deposition velocities under “standard meteorological conditions,” which will help interpret the full AQMEII-4 ensemble. Specifically, eight simulations lasting just one deposition time step (e.g. one hour) are requested. The eight simulations should be initialized with all combinations of the following:

- **Summer** (August 1, 2010; 25°C) vs. **Winter** (January 1, 2010, 0°C). Other surface conditions should be fixed at 1000 hPa, 70% RH, 5 m/s westerly wind, clear sky. (The final experimental protocol will specify additional variables that also affect

atmospheric stability.) These "standard" values of meteorological variables should be constant across the surface model domain.

- **Day** (12:00 GMT for Europe domain, 17:00 GMT for North America domain) vs. **Night** (00:00 GMT for Europe domain, 5:00 GMT for North America domain)
- **Dry** (dry leaves and unsaturated soil, but not water stressed) vs. **Wet** (wet cuticles, wet stomata, wet/saturated soil)

Essentially, participants are asked here to conduct a series of eight one-hour simulations with the relevant meteorological variables "overwritten" within their model codes reflecting the standard conditions described above. Models should otherwise be configured like the one-year simulations (e.g. land cover data). In subsequent analysis, pairwise comparison of the eight simulations will reveal the importance of these deposition drivers. Inter-model differences will show the effects of land cover datasets and deposition schemes.

Science questions and goals

- How does simulated dry deposition velocity vary across land cover types and between models under "standard meteorological conditions"?
- What are the effects of three key factors (day vs. night, summer vs. winter, and dry vs. wet) on simulated dry deposition velocity?
- How large are inter-model dry deposition differences under "standard" conditions compared to inter-model differences with varying meteorology?

Information requested from participants

Requested output fields (e.g. dry deposition velocity and resistances across the model domain) will be the same as the AQMEII-4 one-year simulations, requiring no additional set up.

Anticipated work required of participants

Beyond what is required of the AQMEII-4 one-year simulations, a small amount of work will be required to set up the eight "standard meteorological conditions" in each regional model system. This may require code changes to overwrite meteorological data with the "standard" values. Alternately, the "standard" values could be specified as meteorological initial conditions; over one time step, simulated meteorology should remain close to those initial conditions. The overall effort and computational burden will be very small compared to the one-year simulations.

3. Point Intercomparison runs

Point (i.e. box model or zero-dimensional) intercomparison. Participants will be asked to calculate dry deposition velocity and its component resistances for a suite of gases and particles under prescribed surface and atmospheric conditions. The goal is to reveal and understand the variation in dry deposition velocities between multiple models

under identical environmental conditions as well as the implications for air quality. This activity will also aid the larger AQMEII-4 3-D regional model intercomparison, in which models will use different surface and atmospheric conditions, as well as different dry deposition schemes. Toward this scope two type of simulations will be required:

Control simulation: We will provide hourly meteorological and environmental data representing one year at about four point locations. The provided data will be collected from eddy flux towers, some of which measure dry deposition of O_3 or other gases. Participants should calculate and submit dry deposition velocities under those conditions. Model predictions will be intercompared and evaluated against available deposition velocity measurements.

Perturbation simulations: Participants should recalculate and report dry deposition under several perturbations to the prescribed conditions. These perturbations will be selected later, but may include changes in surface type, leaf area, surface wetness, soil moisture, humidity, and other meteorological variables.

Science questions and goals

- How and why do current dry deposition models differ under identical environmental conditions?
- How well do these models predict measured deposition velocity?
- Quantify the sensitivity of dry deposition velocity to changes in individual environmental factors and surface conditions.

Information requested from participants

- Dry deposition velocity and its resistance/conductance components for numerous trace gases and aerosols. (Copy AQMEII-4 protocol. Dry deposition flux not required)
- Documentation of model algorithms, including parameter values
- List of variables used as model input

Anticipated work required of participants

The planning team will minimize the burden on participants by specifying all simulation conditions in a standard format (e.g. csv files). We anticipate the largest task for participants will be piping that input into the format required for their dry deposition program. To minimize that work, we will provide a wrapper program (e.g. python) to help automate that process, including all perturbation simulations. Since dry deposition algorithms are very fast, this activity has very minimal computational burden, even with several perturbation simulations. Participants will be invited to participate in the subsequent analysis and co-author the resulting publication.

The AQMEII-4 Steering Committee solicits your interest and feedback on these activities.

You will shortly receive an invitation to a Survey Monkey survey where you may express your intention to take part to activity 1, 2 and 3. The survey contains also a question (4) strictly addressed to North American participants. We look forward to receiving your responses

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