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# Atmospheric Acidity over North America: GEM-MACH Simulations for AQMEII-4

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The fourth phase of the Air Quality Model Evaluation International Initiative (AQMEII-4) is a regional air-quality model intercomparison for North American and European domains, with a focus on acidifying deposition. The study protocol includes enhanced model outputs for acidic gas deposition resistances and conductances, and particle and aqueous phase deposition, and hence will provide an unprecedented estimation both of the variability in model predictions for the deposition of acidifying species, and indications of the reasons for model variability. All models make use of common lateral boundary conditions and emissions data. Model simulations are being conducted for the years 2009 and 2010 for the European domain, and 2010 and 2016 for the North American domain. Model outputs were reported on a common grid 0.125$^{o}$ grid cell size domain in each of these domains, as well as at the latitude and longitude locations of receptor observation stations in the ENSEMBLE database format, and are uploaded to a common database for comparison at the Joint Research Centre at Ispra.

The Global Environmental Multiscale – Modelling Air-quality and CHemistry (GEM-MACH) is Environment and Climate Change Canada's air-quality modelling system, and is a participant in AQMEII-4, with simulations taking place on a 10km grid cell size domain covering North America. Several GEM-MACH simulations are underway for the AQMEII-4 campaign, including both the model's research and operational configurations, based on the most recent version of the model code (GEM-MACHv3). The operational version of the model is optimized for rapid computation, making use of a 2-bin particle size distribution with occasional rebinning to/from 12-bin when necessary for improved particle microphysics accuracy. The research version of the model incorporates fully coupled chemistry (direct and indirect effects) with the P3 cloud parameterization, forest canopy shading and turbulence, revised anthropogenic plume rise, emitted and transported methane, modulation of particle crustal material by meteorology, the KPP/RODAS3 gas-phase solver, ammonia bi-directional fluxes, satellite-derived leaf area index

data, a 12-bin particle size distribution, a revised parameterizations for some of the gas-phase resistances, and six additional particulate species (base cations, iron and manganese).

In addition to providing a status update on the AQMEII-4 ensemble simulations, we focus here on the simulations of the research version of GEM-MACH, for the years 2010 and 2016. The annual total values of acidifying sulphur and nitrogen's deposition components will be compared for this time period, and the AQMEII-4 diagnostics will be used to show the relative contributions of GEM-MACH's gas-phase resistances and conductances towards total gas-phase deposition. The gas-phase values will also be compared to the annual average lowest model layer molar concentrations of the depositing species, to determine the extent to which acidity in the atmosphere tracks atmospheric concentrations. In addition, we will also examine the relative impact of base cations on average atmospheric acidity and deposition and the extent to which the transportable versus non-transportable fractions of fugitive dust emissions may influence net acidic deposition. We will also exceedances of critical loads based on the simulation totals of sulphur and nitrogen deposition and critical load ecosystem data.