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The impact of different complexity in aerosol and chemistry modules on the aerosol predictions within the global online modeling system FIM-Chem

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The global Flow-following finite-volume Icosahedra Model (FIM), which was developed in the Global Systems Division of NOAA/ESRL, has been coupled online with aerosol and gas-phase chemistry schemes (FIM-Chem) of different complexity. The simplest aerosol modules are from the GOCART model that includes only simplified sulfur chemistry, bulk aerosols, and sectional dust and sea salt modules. The photochemical gas-phase mechanism RACM was included to determine the impact of the additional complexity on the aerosols simulations. Further sophistication within the aerosol modules includes secondary organic aerosols (SOA) based on the VBS approach. Within the aerosol and chemistry modules FIM-Chem handles wet and dry deposition, simple aqueous phase chemistry, biogenic emissions, biomass burning, dust and sea-salt. FIM-Chem is able to simulate and forecast aerosol, gas-phase tracers and SOA at various spatial resolutions and with different levels of complexity. We compare the more sophisticated chemistry and aerosol packages (RACM_MADE-VBS, GOCART_RACM) with the simpler package (GOCART) that uses the default climatological model fields for OH, H_2O_2, and NO_3. We find reductions of sulfate that are on the order of 40 to 80% over the eastern US and are up to 40% near the Beijing region over China. In both locations, there are large reductions in the main source regions, but small increases for larger areas downwind. The PM2.5 and PM10 concentrations show enhancements over the major polluted areas. ESRL produces experimental 7 day forecasts twice a day in real-time on 60km global resolution. Over the next year FIM will be replaced with FV3, the dynamic core of the Next Generation Global Prediction System (NGGPS).