Southeast Atmosphere Studies Workshop 2015

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Concentrations of atmospheric trace species in the United States have changed dramatically over the past several decades in response to pollution control strategies, shifts in domestic energy policy, and economic development (and emission changes) elsewhere in the world, in particular in developing countries. Accurate and reliable projections for the future atmosphere require that models not only accurately describe current atmospheric concentrations, but do so for the right reasons. Only through incorporation of the correct mechanisms can models be expected to project reliably the impacts from policy, energy, and climate scenarios. Efforts to properly design and implement the correct fundamental and controlling mechanisms in atmospheric models benefit from intensive observation periods (IOPs), when co-located measurements of diverse, speciated chemicals in both the gas and condensed phases are obtained. The summer of 2013, in particular during the Southeast Atmosphere Studies, provides an unprecedented opportunity for the atmospheric modeling community to come together to evaluate, diagnose, and improve the representation of fundamental atmospheric processes in climate and air quality modeling at varying temporal and spatial scales.

On June 8-10, 2015, more than sixty scientists from across the country attended a workshop at NOAA GFDL to share their understanding of the interactions between human activities, terrestrial vegetation,

air quality, and climate over the Southeast US. The major focus of this workshop was on the constraints provided to models by the recent measurements of gas- and aerosol-phase species during Southeast Atmosphere Studies (SAS, including SENEX, SOAS, NOMADSS and SEAC4RS), in order to improve modeling capabilities for ozone and particulate matter (PM) over the Southeast US. This effort is expected to improve understanding of the regional cooling over the Southeast US, which has been tentatively attributed to secondary organic aerosols formed by the interactions of biogenic emissions and anthropogenic pollutants. Recommendations were developed in each of the four workshop themes for modeling of atmospheric chemistry over this region:

Gas-phase chemistry (1) Up-to-date "standard" chemical mechanisms represent OH chemistry well over the observed range of NO_x concentrations. Detailed mechanisms based on recent laboratory chamber studies (mostly at Caltech) and theoretical studies (Leuven) for isoprene result in predicted OH that is in reasonable agreement with observations. Condensed mechanisms that approximate the detailed ones are expected to do the same. (2) Given the large emissions and high chemical reactivity of isoprene, its chemistry should be treated fairly explicitly, including more detail than for most other hydrocarbons. (3) NO_3 chemistry contributes significantly to both VOC oxidation and aerosol production. (4) The regions of peak NO_x and BVOC emissions are not collocated. As a result, the model resolution can impact the predictions~~As a result model resolution matters~~.

Aerosol chemistry (1) There is high confidence that a pathway for SOA formation from isoprene epoxydiol (IEPOX) should be included in models. However, since many of the parameters needed to predict IEPOX-SOA are uncertain, different modeling approaches could be beneficial. (2) There is high confidence that models should include SOA formation from nitrate radical oxidation of monoterpenes (with or without explicit nitrate functionality). Sesquiterpenes and isoprene may also contribute SOA through nitrate radical oxidation, but the contribution is expected to be smaller. (3) Models can help determine how important glyoxal (produced from isoprene, as well as from anthropogenic VOCs) is as a SOA precursor~~SOA formation from glyoxal (produced from isoprene, as well as from anthropogenic VOCs) should be included if possible~~.

Natural and anthropogenic emissions (1) Biogenic emissions from BEIS are generally lower and those from MEGAN, generally higher than from measurements for all campaigns. (2) Observations confirm a rapid decrease of ozone precursor emissions over past few decades. Thus, use of the correct scaling of anthropogenic emissions for a particular year is important for accurate simulations. (3) NEI2011 likely overestimates NO_x emissions from mobile sources based on fuel based estimates.

Regional climate and chemistry interactions (1) Annual mean temperatures during the 1930-1990 timeframe decreased by ~1 ^{o}C over the central and southeastern United States. Several studies have argued that patterns of sea surface temperatures in the North Atlantic may have caused this large-scale cooling. Trends in aerosol forcing may have also played a role. (2) Pollution episodes in the southeastern United States are correlated with high temperatures, low wind speeds, clear skies, and stagnant weather. Surface air quality over Southeast US may be to some extent

modulated by large-scale circulations, such the Bermuda High or Atlantic Multi-decadal Oscillation (AMO).

The workshop also identified a few open questions that are best addressed by the community of experimentalists and modelers working together. Detailed findings and recommendations will be presented in a final report to be delivered to the larger atmospheric chemistry and climate community.

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