5.058 Quantifying and Reducing Uncertainty in Model Studies of Tropospheric Composition.

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Abstract:

Projections of future atmospheric composition change and its impacts on air quality and climate are heavily dependent on chemistry-climate models that allow us to investigate the effects of changing emissions and meteorology. These models are imperfect, as they rely on our understanding of the chemical, physical and dynamical processes governing atmospheric composition, on the approximations needed to represent these numerically, and on the limitations of the observations required to constrain them. Model intercomparison studies, like those initiated through HTAP, ACCMIP and CCMI, show substantial diversity in results that reflect these underlying uncertainties, but little progress has been made in identifying the weaknesses in process understanding or representation that might lead to improved models and to better scientific understanding. Observations provide a valuable constraint for models, but it is generally not possible to isolate and evaluate the effect of individual processes in the troposphere due to the interaction of processes occurring on similar spatial and temporal scales.
Model emulation and uncertainty analysis provide a new method of identifying and quantifying the main sources of uncertainty in current models. We apply a multi-variable perturbation approach to quantify the sensitivity of ozone and OH to important climate-relevant variables, poorly-characterized processes and uncertain anthropogenic emissions, using two independent global chemistry transport models, the FRSGC/UCI CTM and the GISS GCM. We show a clear sensitivity of tropospheric ozone to atmospheric humidity and precursor emissions which is similar for the models, but note large differences for methane lifetime, highlighting substantial differences in the sensitivity of OH to primary and secondary production. This approach allows us to identify key areas where model improvements are required while providing valuable new insight into the processes driving tropospheric composition change.