Tropospheric Ozone as a Short-lived Chemical Climate Forcer

Kenneth E. Pickering, NASA/GSFC

Tropospheric ozone is the third most important greenhouse gas according to the most recent IPCC assessment. However, tropospheric ozone is highly variable in both space and time. Ozone that is located in the vicinity of the tropopause has the greatest effect on climate forcing. Nitrogen oxides (NO_x) are the most important precursors for ozone in most of the troposphere. Therefore, pollution that is lofted upward in thunderstorm updrafts or NO_x produced by lightning leads to efficient ozone production in the upper troposphere, where ozone is most important climatically. Global and regional model estimates of the impact of North American pollution and lightning on ozone radiative forcing will be presented. It will be shown that in the Northern Hemisphere summer, the lightning effect on ozone radiative forcing can dominate over that of pollution, and that the radiative forcing signal from North America extends well into Europe and North Africa. An algorithm for predicting lightning flash rates and estimating lightning NO_x emissions is being incorporated into the NASA GEOS-5 Chemistry and Climate Model. Changes in flash rates and emissions over an ENSO cycle and in future climates will be assessed, along with the resulting changes in upper tropospheric ozone. Other research on the production of NO_x per lightning flash and its distribution in the vertical based on cloud-resolving modeling and satellite observations will be presented. Distributions of NO_2 and O_3 over the Middle East from the OMI instrument on NASA's Aura satellite will also be shown.