4.098 Equilibrium climate and air pollution responses to greenhouse gases, anthropogenic emissions and ozone changes from 1970 to 2010 under different EDGAR emission scenarios.

Early Career Scientist

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Abstract:

Using the fully-coupled Earth System Model (CESM1), simulations were carried out to investigate climate response at equilibrium to Greenhouse gas (GHG), anthropogenic aerosol and ozone (troposphere plus stratosphere) changes from 1970 to 2010, with anthropogenic aerosol emissions from the Emissions Database for Global Atmospheric Research (EDGAR 4.3.1) retrospective emission inventory and tropospheric and stratospheric ozone prescribed from CMIP5. Each simulation was run for sufficient years to allow the model to reach equilibrium (typically ~150 years), and only the last 40 years of each run were analysed. Radiative forcings, from 1970 to 2010, from GHG, anthropogenic aerosol and ozone changes, were diagnosed to be 0.96, -0.20 and -0.03 W m^{-2}, respectively. The results indicate that the global mean temperature at equilibrium is much warmer than the reality in 2010, and especially the Polar Regions (e.g. 3 K more over the Arctic). Changes in thermal and hydrological fields feature large spatial variability due to anthropogenic aerosols and ozone, which are related to changes in atmospheric circulations, heat and moisture transport. In addition, significant changes in climate extremes (especially temperature extremes) in accompany with thermal and hydrological responses are found, and the underlying mechanism are still being investigated.

We have also performed further experiments with fully interactive chemistry (CAM5-CHEM) forced by the EDGAR retrospective scenarios that estimate emissions changes associated with technology advancements and increases in energy consumption over 1970-2010, to investigate how these drivers of emission change have affected climate extremes and air pollution. The full chemistry model allows us calculate how ozone responds in these scenarios, rather than using prescribed fields, and hence allow us to analyse changes in air quality, including extremes, associated with the emissions' drivers.