Session: B9 Oral presentation

Radiative forcing from tropospheric and stratospheric ozone 1850-2100

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Offline radiative forcings have been calculated, using tropospheric and stratospheric ozone over the time period from the pre-industrial era (1850), through present-day (2009) and up to 2100. Historical ozone fields come from the AC&C/SPARC ozone database for CMIP5 and use both observations and models; future ozone fields come purely from model simulations. For the stratosphere, a multiple linear regression analysis of SAGE I II observations and polar ozonesonde measurements for the period 1979-2005 is used; the regression includes terms representing equivalent effective stratospheric chlorine (EESC) and the 11-year solar cycle variability. Stratospheric time series are extended back to 1850 using regression fits combined with extended proxy time series of EESC and solar variability. Future stratospheric ozone comes from 13 CCMs driven by the SRES A1B climate scenario and the A1 adjusted halogen scenario. For the troposphere, modelled ozone fields come from two models (NASA-GISS PUCCINI and CAM3.5) driven by historical emissions developed for CMIP5 that merge seamlessly with the four future Representative Concentration Pathway (RCP) scenarios. The tropospheric ozone radiative forcing (RF) from the 1850s to the 2000s is 0.23 W m-2, lower than previous results. The lower value is mainly due to (i) a smaller increase in biomass burning emissions; (ii) a larger influence of stratospheric ozone depletion on upper tropospheric ozone at high southern latitudes; and possibly (iii) a larger influence of clouds (which act to reduce the net forcing) compared to previous radiative forcing calculations. Over the same period, decreases in stratospheric ozone, mainly at high latitudes, produce a RF of -0.08 W m-2, which is more negative than the central Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) value of -0.05 W m-2, but which is within the stated range of -0.15 to 0.05 W m-2. The more negative value is explained by the fact that the regression model simulates significant ozone depletion prior to 1979, in line with the increase in EESC and as confirmed by CCMs, while the AR4 assumed no change in stratospheric RF prior to 1979. A negative RF of similar magnitude persists into the future, although its location shifts from high latitudes to the tropics. This shift is due to increases in polar stratospheric ozone, but decreases in tropical lower stratospheric ozone, related to a strengthening of the Brewer-Dobson circulation, particularly through the latter half of the 21st century. Differences in trends in tropospheric ozone among the four RCPs are mainly driven by different methane concentrations, resulting in a range of tropospheric ozone RFs between 0.4 and 0.1 W m-2 by 2100. Additional individual model results from the CCMVal and ACCMIP projects will be compared with the results from the CMIP ozone database, to help quantify uncertainties and inter-model differences.