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Long-Term Trends in Stratospheric Trace Gases

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Following a few decades of ozone decreases, partly driven by chemical loss due to increasing halogens, we expect that globally stratospheric ozone will start to 'recover'. However, in order to understand ozone trends and confirm, for example, that any observed increase in ozone is due to decreasing halogens, we need to understand long-term trends of many other trace gases. These include radical species directly involved in ozone loss, and long-lived species which can indicate changes in circulation. A prerequisite for this understanding is therefore long time series of observations. Indeed, for studies like this the usefulness of any dataset increases greatly as the length increases.

In this talk I will use a global 3-D chemical transport model (SLIMCAT) to investigate the long-term trends in a number of species of stratospheric interest. The model has been run in a range of experiments from the late 1970s until the present day forced by ECMWF analyses. Comparison will be made with a range of data including ground-based observations from the Network for the
Detection of Atmospheric Composition Change (NDACC), within the framework of the EU GEOMON project.

A notable problem in using an off-line model for studies of chemical trends relates to inhomogeneities in the meteorological (re)analyses used to force the model. Even single reanalysis datasets such as ERA-40 can produce spurious interannual variations in CTM fields probably due to changes in datasets which are assimilated by the NWP system. I will show comparisons of model runs forced
by ERA-40 and the new ERA-Interim reanalyses.

For comparisons of chemical species I will focus on stratospheric NO2 and halogen species. For NO2 the basic model, which also includes aerosol variations specified from satellite data, does not perform well in reproducing the observed annual cycle at a range of stations. However, this discrepancy is largely caused by transport errors (again via the analysed winds) and can be successfully removed by using chemical data assimilation of a long-lived tracer (HALOE CH4) to
constrain the stratospheric transport.

For halogen species I will compare time series of groundbased HCl, ClONO2 and HF at a range of stations. I will discuss how well the model, constrained by observed tropospheric halogen source gases, can reproduce observed changes (decreases or slowing of growth) in recent years. Implications for diagnosing long-term ozone trends, or dynamical trends, from off-line models will be discussed.