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The effects of year-to-year variability and trends in stratospheric climate on the chemistry driving ozone depletion

Laura Revell (1,2), Greg Bodeker (3), Petra Huck (1), and Bryce Williamson (2)

(1) NIWA, Christchurch, New Zealand (l.revell@niwa.co.nz / p.huck@niwa.co.nz), (2) The University of Canterbury, Christchurch, New Zealand (bryce.williamson@canterbury.ac.nz), (3) Bodeker Scientific, Alexandra, New Zealand (greg@bodekerscientific.com)

A chemistry climate model (CCM) simulation from 1960 to 2005 has been performed in which the contributions of 15 chemical destruction cycles, as well as the odd-oxygen Chapman cycle, to the ozone budget have been tracked. The simulation, using the Niwa-SOCOL CCM, conforms to the CCMVal-2 REF-B1 simulation boundary conditions which include transient changes in greenhouse gas (GHG) concentrations and in ozone depleting substances. The contributions of the 15 cycles to ozone destruction are accumulated into monthly means within each model grid cell. These contributions are typically examined as a function of latitude and altitude/pressure.

In addition to forced trends in stratospheric temperatures resulting from changes in GHG concentrations and from ozone depletion, the CCM simulation includes the effects of unforced year-to-year climate variability. By clustering the CCM chemical cycle diagnostics according to this variability (e.g. by seasonal mean stratospheric temperatures, or the breakdown date of the stratospheric vortex) the effects of this variability on the effectiveness of the chemical cycles driving ozone depletion can be diagnosed. These inter-annual variations are superimposed on long term trends in stratospheric dynamical variables which have also been diagnosed for their effects on trends in the chemistry affecting ozone depletion. Such analysis provides key insights into the interactions between inter-annual climate variability, long-term climate trends, and the chemistry responsible for ozone depletion.

In future we will apply this method to Niwa-SOCOL REF-B2 simulations, and different GHG concentration scenarios to identify the sensitivity of stratospheric ozone to increasing GHG emissions and climate change.