SPARC Workshop SHARP2016

Fast stratospheric ozone chemistry for global climate models: The extra-polar SWIFT module

Daniel Kreyling, Dr. Ingo Wohltmann, Dr. Ralph Lehmann, Dr. Markus Rex

Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung

daniel.kreyling@awi.de

The SWIFT model is a fast yet accurate chemistry scheme for calculating the chemistry of stratospheric ozone. It is mainly intended for use in Global Climate Models and Chemistry Climate Models. For computing time reasons these models often do not employ full stratospheric chemistry modules, but use prescribed ozone instead. This can lead to insufficient representation of the chemical/dynamical coupling between stratosphere and troposphere.

SWIFT consists of two sub-models. 1) Inside the polar vortex, the model calculates polar vortex averaged ozone loss by solving a set of coupled differential equations for the key species in polar ozone chemistry. 2) The extrapolar regime, which this poster is going to focus on. Outside the polar vortex, the complex system of differential equations of a full stratospheric chemistry model is replaced by an explicit algebraic polynomial, which can be solved in a fraction of the time needed by the full scale model.

The procedure uses training data from the Lagrangian stratospheric chemistry and transport model ATLAS and yields one high-order polynomial for global ozone loss and production rates over 24h. The stratospheric ozone change rates can be sufficiently described by 9 variables. Latitude, altitude, temperature, the overhead ozone abundance, 4 mixing ratios of ozone depleting chemical families (chlorine, bromine, nitrogen-oxides and hydrogen-oxides) and the ozone volume mixing ratios itself. The ozone change rates in the lower stratosphere (roughly up to 30km), as a function of these 9 variables, yield a sufficiently compact 9-D hyper-surface, which we can approximate with a polynomial. In the upper stratosphere (above 30km) the ozone chemical lifetime becomes shorter than the transport time scales, thus the ozone concentrations are determined by the local atmospheric conditions. We therefore introduce an additional regime in the upper stratosphere, where a polynomial for the equilibrium ozone mixing ratios is constructed.