Geophysical Research Abstracts
Vol. 17, EGU2015-14480, 2015
EGU General Assembly 2015

SWIFT: Semi-empirical and numerically efficient stratospheric ozone chemistry for global climate models

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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 (GCMs), Chemistry Climate Models (CCMs) and Earth System Models (ESMs). 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 between stratosphere and troposphere. The SWIFT stratospheric ozone chemistry model, focuses on the major reaction mechanisms of ozone production and loss in order to reduce the computational costs.
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 extra-polar 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 approach, which is used to construct the polynomial, is also referred to as repro-modeling and has been successfully applied to chemical models (Turanyi (1993), Lowe & Tomlin (2000)).
The procedure uses 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 per month. 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 concentrations itself. The ozone change rates in the lower stratosphere 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 (roughly 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 the ozone concentrations, instead of the 24h change rates, are fitted. The fitted polynomial for upper stratospheric ozone is dependent on the same variables, except the ozone concentration, naturally. This poster shows results of simulations employing the polynomial scheme and discusses constraints on the method.