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Fast stratospheric ozone chemistry for climate models: The polar SWIFT model

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The importance of interactions between climate change and the ozone layer has long been recognized (e.g. Thompson and Solomon, Science, 296, 895, 2002). Hence, it is desirable to account for these interactions in climate models. Since coupling a full stratospheric chemistry module to a GCM is computationally very expensive, ozone is usually prescribed in the type of climate models that are used in the IPCC reports.

The SWIFT model is a fast yet accurate chemistry scheme for calculating the chemistry of stratospheric ozone depletion in polar winter in GCMs designed to improve on this situation. The model is based on a set of coupled differential equations, which simulate the polar vortex averaged mixing ratios of the key species involved in polar ozone depletion. The model is driven by only two input parameters: the fraction of the polar vortex in sunlight and the fraction of the polar vortex below the temperatures necessary for the formation of polar stratospheric clouds. We present the formulation of the model and validation results.

In contrast to other fast ozone schemes for climate models like Cariolle or Linoz, the SWIFT model is not based on a Taylor series expansion, but on a set of differential equations representing the main processes changing polar ozone. This has the advantage that the model can cope with the non-linearities occuring in polar ozone chemistry and the evolution of ozone is not only based on the current state of the atmosphere, but also on the meteorological history. Since the model equations are closely based on the real atmospheric processes, we expect our model to behave realistically under a wide range of conditions.