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A quantitative analysis of the reactions involved in stratospheric polar ozone depletion

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We present a quantitative analysis of the chemical reactions involved in polar ozone depletion in the stratosphere, and of the relevant reaction pathways. While the reaction pathways involved in polar ozone depletion are well known, quantitative estimates of the importance of single reactions or reaction cycles are rare. In particular, there is no comprehensive and quantitative study of the reaction rates averaged over the polar vortex under conditions of heterogeneous chemistry so far.

Mixing ratios and reaction rates are obtained from runs of the ATLAS Chemistry and Transport Model driven by ECMWF ERA Interim reanalysis data. An emphasis is put on the partitioning of the relevant chemical families (nitrogen, hydrogen, chlorine, bromine and odd oxygen) and activation and deactivation of chlorine. We show time series of reaction rates averaged over the polar vortex in winter and spring for all relevant reactions and indicate which reaction pathways are responsible for the vortex-averaged net change of the key species involved in ozone depletion, that is ozone, chlorine species (ClOx, HCl, $ClONO_2$), bromine species, nitrogen species (HNO_3, NO_x) and hydrogen species (HO_x). We focus on one Arctic winter (2004/2005) and one Antarctic winter (2006) in a layer in the lower stratosphere around 54 hPa.