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Interactive comment on "Update of the SWIFT model for polar stratospheric ozone loss (SWIFT version 2)" *by* Ingo Wohltmann et al.

Anonymous Referee #2

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This paper describes a simplified but fast chemical scheme (called SWIFT) designed for the simulation of polar ozone depletion in stratospheric chemistry-transport and chemistry-climate models. The scheme is an update of the original SWIFT scheme which was based on fittings to satellite data. There are a number of improvements. First, denitrification is taken into account. Second, the equations system has been reformulated. The scheme parameters (i.e. vortex averaged reaction rates) are estimated by fitting them to simulations/diagnostics from a chemistry-transport model (CTM ATLAS) instead of fitting to satellite data. One of the main advantages is that the CTM provides all the relevant reaction rates and concentration fields of chemical species. In the old scheme, the parameters were estimated by fitting to the evolution of vortex averaged chemical species, notably ozone; it meant that the chemical rates included transport terms because the evolution of ozone in the vortex is not only driven

by chemistry but also by exchanges between vortex and mid-latitudes. The scheme is implemented in CTM and simulations are evaluated against a range of satellite chemical composition data (e.g. O3, HCl) and ATLAS simulations. Obviously, the SWIFT scheme is not as accurate as a full stratospheric chemistry scheme but is able to reproduce most of the features of polar ozone depletion. The paper is very detailed, well written and clear. This description of a new model is a textbook paper for GMD and, as recommended, the authors are providing the Forge link to the codes. I recommend publication with minor comments that the authors may wish to address.

Abstract: - SWIFT, ATLAS: acronyms? p1, l3: not anymore. Many climate models include a full stratospheric chemistry scheme.

p2, l1: many climate models are now able to calculate atmospheric chemical composition. CMIP5 did already include such models. However, within the framework of climate model inter-comparisons, it is much easier to interpret model differences when models have the same forcings (including for instance time-varying ozone fields). When each model calculates its own chemical composition, it is an additional degree of freedom in the system that complicates the analysis of model differences.

p2, l30: SWIFT cannot simulate the evolution of extra-polar ozone. Therefore, the claim that the model is able to represent ozone-climate interactions during climate change needs to be tone down, the authors are over-selling their scheme. The simulations are reinitialized using MLS satellite at the beginning of each winter. Somehow, a climate model would need an ozone scheme outside the vortex and the winter/spring period. If modellers want to implement SWIFT, this limitation should be clearly pointed out in the paper. I think a good and fast set-up for a climate model would be to have a linearized ozone scheme outside the vortex and SWIFT inside the vortex. Note that linearized ozone schemes also described polar ozone depletion but in a crude way compared to SWIFT and full stratospheric chemistry scheme.

p5, l5: The Wohltmann et al., xxx appears often in the paper. If the reference is not available, the authors should provide the details that are supposed to be found in this reference.

p5, l20: What is the point of providing pressure values with 5 digits after the comma?

p7: equation 4 is stating the obvious. There is an abundant literature about spatial averaging of the product of concentration fields. Why not write the full equation here? (A.B)= (A).(B) + covariance (A,B) with () representing vortex mean

Then (A.B)= (A).(B).(1 + Is) where Is is called the intensity of segregation. Is = covariance (A,B)/((A).(B))

You could use it to discuss the cases when (A.B) cannot be approximated by the product of (A) and (B). It only works when (A).(B) is much greater than the covariance (A,B). It depends on the level of correlation (or anti-correlation (segregation)) between A and B and on the levels of concentration fluctuations of A and B within the vortex. When it does not work, it is not just about having constant concentration within the vortex or the sunlight area. It also depends on the level of correlation between reactants. The estimation of coefficients in SWIFT takes into account this correlation, though not explicit here. A good case might be (ClO.NO).

p7, l26: not ‘can’ but ‘has to’.

p11, l11: What does ‘ClO and NO are not equally distributed’ distributed’ mean here?

p29, l4: ‘the interannual variability of the MLS measurements 5 are reproduced well by the SWIFT model runs’. this statement is a bit optimistic for the Antarctic (see Figure 16). There is little inter-annual polar ozone variations in the ATLAS-SWIFT compared to the MLS data whereas ATLAS-SWIFT appears to perform well in the Arctic (se figure 15).

p31, l21-22: remove the 2 sentences about the work in EMAC and ECHAM. This has not been discussed, let alone mentioned. No results are presented so statements of successful implementation and promising results will have to wait for the relevant

papers.

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