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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Zonal asymmetries in middle atmospheric ozone and water vapour derived from Odin satellite data 2001–2010" *by* A. Gabriel et al.

Anonymous Referee #2

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The authors have assembled global, time-mean fields of temperature and two trace species; they use these to look at the transport processes that maintain stationary waves in the two species. The topic of this paper is worthy of investigation. The authors are on the right track but some additional work is needed to pull together the results and generate some solid conclusions.

The analysis approach uses a lot of assumptions and does not thoroughly justify each one so the reader can lose confidence along the way. In my view, there are two points that are problematic: 1) derivation of w* from observations and even from model or analysis fields is known to have large uncertainties, and 2) not enough information is

given for the reader to tell what processes are most important.

The organization of the paper needs improving. Specifically, when the analysis results from Figures 1 and 2 are presented, there are brief statements of the mechanisms. I found that these are not well explained here and are not supported by evidence. The explanations and evidence are given later. The paper would read better if the explanations were grouped, either at the time the results are first presented or in a separate section. If the latter, which is closer to the present organization, you could just say (especially with respect to ozone, which has been much more extensively studied than water) that the ODIN results are consistent with other observations of ozone waves and their relationship with temperature waves.

To give a better idea of the processes that are controlling the wave structure, it would be very useful if the terms in the balance equations (for potential temperature as well as for H2O and O3) were given individually. Instead of O3*(TR), could you give O3* due to vertical transport, O3* due to v_g*, etc? In addition, the importance of different transport processes could be compared to their relative importance in the temperature equation.

Although there are some other contributions (discussed in the paper), the primary non-symmetric source for all three fields is the loss rate. This should be easy to incorporate into your equations since it is linearly proportional to the field itself (i.e. as a Newtonian cooling for temperature and a chemical loss coefficient for O3 and H2O). It may not make a large difference where transport is dominant but it can shift the phase of the derived waves or, for example, help explain a phase shift in the trace species relative to T. You will find that in the upper stratosphere, the timescale for O3 loss is very fast.

Specific comments

It is unfortunate that the discontinuity in the water vertical structure comes just at the altitude where there is a switch in the measurement used to construct the profiles. I am willing to believe that the observation is basically correct but the burden should be

on you, as the authors, to eliminate doubt that this is a data artifact.

Eq. 3 is a highly unreliable method for determining w* from observations (or even from model output like ERA). It is very sensitive to noise, interpolation, and averaging. Since it is central to your analysis, here are a few suggestions that could help constrain the calculation. 1) As suggested above, include a linear damping term (Newtonian cooling for temperature). 2) Apply the comparable equation to H2O and O3 and derive a w* from each of them. How do the w* differ? Can you show which contribution is responsible for the differences? 3) Skip the derivation of w* altogether and, by equating it in the different equations, look at the consistency between the three different expressions. In other words, equate the right hand side of Eq. 3 with the right hand sides of equivalent expressions involving H2O and O3.

Minor comments

p. 4169; l. 22: Waves two and three are always present as well. Perhaps change the wording to "Other wave modes (particularly wave two and wave three) are also present and can become dominant as a precursor. . ."

p. 4170, l. 13: You need to be more explicit here: "may have a substantial influence on atmospheric circulation patterns in the troposphere".

The captions for Figures 1 and 2 should be revised. For example, Figure 1.1 identifies SON as autumn; Figure 1.2 says "as in Fig. 1.1" although SON is now spring.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 4167, 2011.