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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.

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Response to Referee #1

We thank Referee #1 for comments and suggestions. We have revised the manuscript (text and figures) including the points of referee #1 as listed below. In particular, we have included some more statements why the results of our paper are significant for the scientific community (see response to Major Comment 1). We have also extended the discussion of the comparison between the transport approach and the observed fields

to make this point clearer (see response to Major Comment 2). For clarity we would like to note here that, from the beginning, the intension of these comparisons was not to present a more or less complete agreement between the transport approach and the observations but to provide an estimation and discussion of the different processes generating these wave patterns. For more clarity we revised slightly the text of Section 2.1 and for the descriptions of the used equations. Please note that we avoid the terminus "model" because our examination is not based on a numerical model but on an approximated steady-state linear solution of the transport equation.

Response to Major Comments

1. The results of the paper are indeed significant for the scientific community. As far as we know, there is a strong gap in understanding the configuration and origin of the stationary wave one patterns in O3 and H2O, although they are (a) an interesting phenomena in the atmospheric circulation system, (b) an important factor for interpreting and understanding local measurements of stratospheric and mesospheric parameters, and (c) a possible tool for validating general circulation models with interactive chemistry, which are used for ozone layer predictions and climate scenarios but which usually underestimate the stationary wave component. Therefore it is important to estimate the different processes generating the observed zonal asymmetries in order to specify possible model improvements, e.g., regarding the zonal asymmetries in tracer transport. As we mentioned in the paper, assimilated ozone data were used to estimate the effects of the radiation perturbations due to zonally asymmetric ozone on atmospheric circulation (e.g. Gabriel et al., 2007; Crooks et al. 2008), but there is still strong uncertainty on the reliability of these ozone data which are produced at least by the model of the assimilation system. The surprisingly strong effects of zonally asymmetric ozone were also identified based on simulations with general circulation models including interactive chemistry (e.g. Gillet et al., 2009; Waugh et al., 2009), but – as mentioned above – these models usually underestimate the stationary wave patterns. Therefore it seems to be evident that the examination of zonal asymmetries

in ozone, water vapour and other important absorbers based on model-independent measurements like Odin satellite data are significant for the scientific community. We revised the manuscript to make these points clearer from the beginning.

2. From the beginning the intension of the linear transport approach was not to reproduce the observations completely, but to identify the important processes generating the wave patterns, as far as they can be derived from the used data. We have revised the manuscript to make this point clearer and to avoid misunderstandings when comparing the transport approach with the observations. We agree completely with Reviewer #1 that the linear transport approach does not capture exactly the observed amplitudes of the wave one patterns in O3 and H2O, and also does not reproduce specific features in the spatial structure of the tracer distributions. We have mentioned these points and discussed them. However, in the revised manuscript we provide now a more detailed analysis of the tendencies and of the linear solutions (see updated Figures 4.1-4.2, 5.1-5.2, 6.1-6.2 and related discussion in Sect. 3). The updated figures show more clearly that the horizontal tracer transport by the geostrophic flow is indeed one of the most important factors generating the wave one patterns in O3 and H2O, of course not fully in agreement with the observations but similar in amplitude and phase. We have checked and improved our manuscript once more to avoid any statements that could lead to the impression of an overstated agreement between the transport approach and the observations, and to pronounce more clearly that the differences help to identify the processes which are absent in the transport approach.

Response to Minor Comments

1. All of the figures have now the same vertical scale (0-100km). We have also rearranged the figures, i.e. in Section 3 there is now O3*(TR) for NH and SH (Figures 5.1-5.2) and then H2O*(TR) for NH and SH (Figures 6.1-6.2).

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