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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Transport of mesospheric H_2O during and after the stratospheric sudden warming of January 2010: observation and simulation" *by* C. Straub et al.

Anonymous Referee #3

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In the manuscript "Transport of mesospheric H20 during and after the stratospheric sudden warming of January 2010: observation and simulation" by Straub et al.(ACPD 2011), the authors combine ground- and space-based water observations in the middle atmosphere with analysis and model data. Based on this suite of data, the development of the observed H20 distribution during and following the SSW in January 2010 is interpreted in terms of large-scale mixing and vertical as well as meridional transport. The manuscript is well written and provides a thorough analysis of the transport. However, uncertainties in both observations and model data are not given which could have an effect on the interpretation. The manuscript needs some revision before publication.

Specific issues: 1) ECWMF operational analysis are used for backward trajectories. Trajectories in the middle atmosphere driven by analysis data suffer from strong dispersion both horizontally and vertically (Schoeberl et al. JGR 2003). Here, it was critical whether the vertical wind was derived kinematically or diatabically. Recent ECMWF analysis have improved this over-dispersive behaviour, visible in the "age of air" (Monge-Sanz et al. GRL 2007). Again, an important role comes to the matter of vertical winds, which produce more realistic ages when calculated diabatically. The authors should discuss this problem in light of their data usage.

2) The reliability and uncertainty of the model data has to be discussed in more detail, both for ECMWF with its poorly resolved mesosphere but also for WACCM-SD with its nudging terms. In this matter, it might be of interest to examine Nezlin et al. (Tellus 2009) who point out that scales smaller than total horizontal wavenumber 10 are not well represented in the mesosphere even from a perfect data assimilation system.

3) The uncertainties of horizontal winds in the mesosphere from ECMWF and WACCM-SD cast serious doubt on the concept of trajectories in the mesosphere, since only the large-scale will be appropriate for exact trajectories. The role of uncertainties in the ECMWF and WACCM-SD data should be discussed and included in the trajectory calculations. Due to the general uncertainties in the advecting winds, it might be considered to show directly the winds, e.g. the vertical residual wind.

4) page 32817, it should be discussed that the operational ECMWF system was updated on the 26 January 2010. http://ecmwf.int/products/data/operational_system/evolution/evolution_2010.html
This update could have a severe impact on the before-after interpretation of the middle atmospheric flow based on ECMWF. In connection with this, the reviewer would like to see a comparison of the zonal wind from WACCM-SD with ECMWF which could be added to Fig. 2. This would confirm that both data sources support the same transport interpretation. Alternatively to the operational ECMWF data, the authors could use ERA-interim reanalysis data (Dee et al. QJRMS 2011).

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Minor issues: 1) page 32813, please provide a reference for Aura/MLS.

2) page 32813, define abbrevation VMR here as well. For the reader's comfort, it should be repeated here after the definition in the abstract.

3) page 32813, line 24, consider "usually at least 25 oC in a week or less)".

4) page 32813, line 28, "or" seems unfitting. Please reformulate.

5) page 32814, line 11, consider "the disappearance of the high-latitudinal transport barrier"

6) Consider removing abbrevation definitions for EOF and TTL, since they are hardly used.

7) page 32813, line 11, typo "Solomon"

8) page 32817, line 8, the reference to "Monge-Sanz et al. 2007" seems not appropriate here, as it just uses the data to examine the age of air. It could be used in line 17. Instead a reference for the ECMWF data assimilation system should be used.

9) page 32817, a new paper is available on the Brewer-Dobson in ERA-interim (Seviour et al. QJRMS 2011).

10) page 32818, line 11. What is meant by 1% of the meteorological fields? Is only every 100th grid-point used? Please specify.

11) page 32819, line 8. Same is true for WACCM-SD trajectories, since it is not a free model run, but nudged in the troposphere-stratosphere.

12) page 32819, line 17, how many profiles are typically used in order to derive the air parcel's water vapour.

13) page 32820, line 1. WACCM has more reliable physical description of the mesosphere. Whether the data of the nudged WACCM-SD is more reliable remains to be shown. If WACCM-SD are more reliable in the mesosphere, why not use the data for

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the backward trajectories?

14) removed comment

15) page 32822, line 27, only qualitative agreement. Can this agreement be quantified?

16) page 32823, line 10, please provide the measurement uncertainty.

17) Fig. 7. Why is the agreement not so good at 1hPa, while it looks better for the trajectories in Fig. 8?

18) page 32824, line 7-8, In my opinion the comparison of the Lagranto/ECMWF trajectories is not conclusive to state a validation. The problem is that the water distribution is very smooth, in fact for 0.3 and 0.1 hPa it is pretty uniform inside or outside the polar vortex (Fig. 4). So, the exact latitude origin cannot be stated from the water vapour VMR and no conclusive validation can be given on basis of the results. The only information seems to be whether the water vapour comes from within or outside of the polar vortex. This puts relatively low requirement on the precision of the trajectories. This problem should be discussed. Also, the trajectories in Fig. 9 should be understood in this light, ie. forced by the "reliable" large-scale component while "small-scale" variations could cause large changes to the actual "true" origin of the parcels.

19) Fig.1 seems unnecessary, given that Fig. 4a yields a good representation of the mean distribution.

20) Fig.3 and text: Please give the exact date of the 2009 warming.

21) page 32826, line 16, typo "indicates"

22) page 32826, line 19 and 23, next page line 1, please give also height in km for comparison with Fig. 6.

23) Section 6.2.3, for the interpretation of the descent, it seems more natural to examine directly the vertical residual velocity as a function of time and height. Please provide also a value of the descent rate for this method.

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24) please provide errors for your estimates of descent rates.

25) Fig. 5, Is the increase in vertical displacment linear in time? It might be useful to plot the displacement per day.

26) Fig. 6, Please use also discrete color steps in the color bar.

27) Fig. 8 (left), colors are difficult to separate. Consider a clear marker for 60 degrees in order to separate the arctic and midlatitudinal air.

28) Fig. 9, pressure notation in figure and caption are not in sync.

References:

- Dee DP, Uppala SM, Simmons AJ, Berrisford P, Poli P, Kobayashi S, Andrae U, Balmaseda MA, Balsamo G, Bauer P, Bechtold P, Beljaars ACM, van de Berg L, Bidlot J, Bormann N, Delsol C, Dragani R, Fuentes M, Geer AJ, Haimberger L, Healy SB, Hersbach H, Holm EV, Isaksen L, Kållberg P, Köhler M, Matricardi M, McNally AP, Monge-Sanz BM, Morcrette J-J, Park B-K, Peubey C, de Rosnay P, Tavolato C, Thepaut J-N, and Vitart F. 2011. The ERA-Interim reanalysis: configuration and performance of the data assimilation system. Q. J. R. Meteorol. Soc. 137: 553–597.

- Schoeberl, M. R., A. R. Douglass, Z. Zhu, and S. Pawson (2003), A comparison of the lower stratospheric age spectra derived from a general circulation model and two data assimilation systems, J. Geophys. Res., 108(D3), 4113, doi:10.1029/2002JD002652.

- Nezlin, Y., Y.J. Rochon, S. Polavarapu, 2009: Impact of tropospheric and stratospheric data assimilation on mesospheric prediction. Tellus, 62A, 154-159.

- Seviour, W. J., N. Butchart, and S. C. Hardiman (2011), The Brewer-Dobson circulation inferred from ERA-Interim, QJRMS, published online, doi:10.1002/qj.966

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32811, 2011.