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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The high Arctic in extreme winters: vortex, temperature, and MLS and ACE-FTS trace gas evolution" *by* G. L. Manney et al.

Anonymous Referee #1

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1 Summary

The paper under review by Manney et. al. presents analyses of the three arctic winters, when the Canadian Arctic ACE Validation Campaigns took place. The aim of the paper is to provide a context for the validation as well as to show how ACE-FTS data reflect the meteorology of these winters.

These were extreme winters concernig the meteorological conditions: The winters 2003/04 and 2005/06 were dominated by very strong sudden stratospheric warmings, the winter 2004/05 was the coldest on the record in the lower stratosphere.

Lidar and radiosonde data from Eureka (Canada) obtained during the validation campaigns as well as satellite data from ACE-FTS, SABER and Aura MLS are used for the analyses together with several meteorological data sets (GEOS-4 and -5, ECMWF, UK Met Office).

The paper presents a very detailed overview of the meteorological situation during the three winters, starting with an analysis of temperature and PV in the upper stratosphere and working its way down to the lower stratosphere, showing the evolution of the polar vortex in the different years with the help of the GEOS-4 data. The evolution of the vertical temperature distribution is then compared with the results from MLS and SABER, showing quite impressively the vertical motion and change in temperature of stratopause and tropopause.

Comparisons between vertical profiles of temperature derived from satellite data, meteorological data and Eureka lidar and radiosonde show in general good agreement, although there are differences between observations and model data above 10 hpa.

A description of MLS trace gases completes the analyses. Presented are MLS H_2O,N_2O and CO showing the downward motion inside the vortices, especially during the winter 2004/05, and the influence of a strong SSW, interrupting the descent during the winter 2005/06. Vertical cross-sections of MLS HNO_3, HCl and O_3 show the effects of transport on denitrification, chlorine activation and chemical ozone loss. A comparison between ACE-FTS and MLS/SABER concerning temperature and trace gases shows good quantitative agreement.

2 General Comments

The paper is well-written, and presents interesting insights into the vortex evolution during three winters with extreme meteorological conditions. The authors manage

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successfully the difficult task to compare observations of different origin, precision and resolution with meteorological data sets. This is done in a quite impressive and comprehensive way. The paper is clearly outlined and well structured.

The figures in general are significant, although I think that figures 1 to 3 should be a bit larger to give more details. Furthermore I would like to suggest to use different colours for the lines in the figures 7 to 9. It is not so easy to distinguish between orange and light red, and using all the same symbols (dots in this case) does not make things easier.

The temperature evolution during the considered winter episodes, especially the change in the vertical profiles, indicates the dramatic changes that the stratosphere undergoes during SSWs. The influence of transport and dynamics on temperature and the distribution of various trace gases is shown very nicely. Although the findings may be not new, the synopsis of the meteorology of these winters together with the observations give a very interesting overview and therefore provides a good background for the special issue 'Validation results for the Atmospheric Chemistry Experiment (ACE)', arousing the readers curiosity about reading it.

3 Comments

One first comment about the citations: A lot of papers cited here are still submitted, to be submitted or in press. This is not too surprising (and not too much of a problem), since the paper under review is to appear in a special issue. But some of the most interesting features in the winter 2006 are described in the paper Manney et al. (2007b) submitted to GRL, which to my knowledge had not been published yet. I could not download it from the website mentioned, where this paper should be available. Since Manney et al. (2007b) seems to be very interesting concernig the issues raised in the paper under review, I would like to suggest to give more information about the 2006

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major warming in this paper, if Manney et al. (2007b) will not be published soon.

The authors use several different meteorological data sets. From the discussion of Figure 5 (and later Figure 13) it seems, that the GEOS-4 data set may be not the best choice, especially for strongly perturbed winters. Do other meteorological data sets (e.g. ECMWF, which is used in Figure 9) show better results compared to MLS and SABER? Looking at Figure 9, I would suggest to have a look at ECMWF data for the winters 2004 and 2005 as well, even if the high vertical resolution with 91 level came in operation as late as February 2006. Even the 60 level version may show better results for the altitude range above 1 hPa than GEOS-4.

If the GEOS-4 data have problems with accurately capturing the stratopause behaviour after the SSWs, and other data sets have not, would using a different data set then result in substantial changes concerning the synoptic overview?

A similar question arises regarding the discussion of the temperature cross-sections (Figures 10 and 11). If there are features (like stratopause double peaks or strong temperature gradients) which are not observed by SABER or MLS, but are modelled by GEOS-4 with a resolution of 1 x 1.25 degrees horizontal resolution, can the same features be found in the much higher resolved meteorological data like ECMWF?

Concerning Figure 6: I miss an explanation for the dotted lines in the upper panel. And maybe the Figure caption (as well as that of Figure 5) should include the fact, that these timeseries are for Eureka.

4 Typographical Corrections

Page 13, 1st para: Something went wrong with the first sentence. I guess there are to sentences, which have been merged, but something is missing in between...

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Page 15, 2nd para: Change 'day-to-day' into 'Day-to-day'...

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Interactive Comment