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Interactive comment on "Three-dimensional model study of the arctic ozone loss in 2002/2003 and comparison with 1999/2000 and 2003/2004" *by* W. Feng et al.

Anonymous Referee #1

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Summary:

This paper describes a number of SLIMCAT model simulations of the NH winters of 1999–2000, 2002–2003, and 2003–2004. The authors have added the CCM radiation package to SLIMCAT. The model simulations are performed in both a low resolution mode ($7.5^\circ \times 7.5^\circ$) and a higher resolution mode ($2.8^\circ \times 2.8^\circ$). The simulations show that the higher resolution CCM model more credibly matches observations.

Overall Assessment:

This is a good paper that demonstrates the quality of the SLIMCAT model as an analysis and assessment tool. The authors have integrated the model simulations with observations to demonstrate the power of the model.

The main point of the paper is that the addition of the CCM radiation, extension to the ground, and higher resolution lead to a much more credible simulation of trace gases and ozone loss. However, this is obscured by an overemphasis on validating the simulations with the Ny-Ålesund observations and with discussion on actual differences between the 3 simulated winters.

Section 4.1 is somewhat confusing. The main point of the section is the variation between the 3 winters. However, there is a confusing mix of winter differences and model simulation differences in this section. Figures 2 and 3 confuse the issue by mixing discussion of the 3 simulated winters with discussion of simulation differences.

The paper needs to be revised into clearly differentiated sections on 1) the simulated winters, and 2) model simulation differences and their causes.

Suggested Changes:

a) Revise section 4.1 by removing the discussion on model differences. Focus this section on only the differences between the winters and degree of ozone loss.

b) In section 4.2, before jumping to comparisons with Ny-Ålesund observations, show some plots of the averaged properties of the simulations. It is unclear that the simulation-observation comparisons are truly representative of major model differences. For example, the authors should show figures of N_2O vs. time that have been averaged inside the vortex for all 3 winters. These figures should include differences between the runs D1 and D2. This will give the reader a better idea of how the 2 runs diverge over the course of the winter. Do the same to show how model resolution improves the simulation.

c) Data comparisons should be shown to differentiate between model simulations. Fig-

ACPD

4, S2755–S2758, 2004

ure 5 is an excellent example that can be used to differentiate the simulations. Figure 4 is a poor example that doesn't help the reader differentiate.

d) Move section 4.4 before the comparison to ozone losses in 4.3. Since Cl_x activation leads to ozone loss, the paper ought to read better. Comparisons to the ClO instrument on the Geophysica would help the discussion.

Other changes:

Simulation nomenclature. I was constantly flipping from Table, to text, to figure to recall what each simulation represented. Suggest revising the A, B, C, D, E table to:

A – ML (MIDRAD, Low resolution)
B – CL (CCM, Low resolution)
C – CH (CCM, High resolution)
D1 – CH02 (CCM, High resolution, 2002–2003)
D2 – MH02
E1 – CH03 (CCM, High resolution, 2003–2004)
E2 – MH03

Figure 1 et al., Use of the white boxes for contour labels obscures the plot, but I like the use of both color and contours. If possible, use a different type of contouring that eliminates the box.

Figure 2. The authors have chosen to use the evolution of modeled N_2O and CH_4 at Ny-Ålesund station for the three winters 1999/2000, 2002/2003 and 2003/2004. This figure would be more useful if N_2O and CH_4 were plotted as vortex averages. While the movement of the vortex over and near Ny-Ålesund is nicely shown in the plot, it's difficult to judge from these plots whether the constituents are fundamentally different in the core of the vortex, or whether the mean vortex is simply positioned differently.

P. 5051, lines 7–20. You should discuss the differences in these tracers for the entire

ACPD
4, S2755–S2758, 2004

vortex over the course of the winter in addition to the location of the vortex with respect to the Ny-Ålesund station.

P. 5053, lines 15–20, “Downward transport is strongly underestimated by the SLIMCAT run using MIDRAD (run D2)....” This comparison to the December 16 MkIV is not a good figure to demonstrate this point. The D1 run seems to have excessive downward transport from the N_2O and CH_4 profiles (panels a and d of Figure 4). The D1 and D2 runs seem to bracket the observations in Figure 4. The D1 run is better for N_2O, while the D2 run is better for CH_4. It seems to me that O_3 and HCl are poor tracers since they have chemical effects. While I agree that the CCM radiation scheme produces more downward transport, this figure does not show that this transport is a major improvement over MIDRAD.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 5045, 2004.