Atmos. Chem. Phys. Discuss., 8, S10500–S10505, 2009
www.atmos-chem-phys-discuss.net/8/S10500/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "An evaluation of the simulation of the edge of the Antarctic vortex by chemistry-climate models" *by* H. Struthers et al.

Anonymous Referee #1

Received and published: 17 January 2009

In this paper, mostly already existing diagnostics are used to compare meteorological reanalysis and an existing total column ozone database with results of five coupled CCMs. The paper would gain more value if the analysis based on meteorological data would be extended, as discussed below. This would also help to justify statements in the text, which are partly not very well supported. Also model analysis and the comparison with observations can be improved.

The evaluation of CCMs based on diagnostics is proposed to quantify how various CCMs describe atmospheric conditions. The diagnostic kappa, as used here, helps to quantify the strength and shar pness of the polar vortex. This study shows that most CCMs do not reproduce kappa very well. A deeper understanding of this diagnostic can be helpful and could be addressed in more detail in this paper. After major revision, the paper can be an important contribution to our understanding of dynamical processes in the Antarctic polar vortex.

Introduction:

Page 20158: Line 5: The Montreal Protocol and its amendments lead to a reduction of the increase of halogens in the stratosphere and not to the removal of halogens from the stratosphere.

Line 26. A study by Tilmes (2007), which is mentioned later in the paper, should be referred to in the introduction, because this study introduces very similar analyses of those used here. A comprehensive evaluation of polar processes in Arctic and Antarctica, as well as the evaluation of the strength of the polar vor tex and temperature evolution based on obser vations and models results, was performed there.

Chapter 2:

Page 20160, line 20ff: The diagnostic used here, kappa, is defined as the product between the gradient of the potential vorticity and the wind velocity with regard to equivalent latitudes. It would be appropriate to add some more references at this point: This diagnostic is used often (e.g., Bodeker 2002, Tilmes 2006, Tilmes 2007) to describe the location of the vortex edge, and to define the strength and sharpness of the transport barrier of both the Northern and Southern Hemisphere polar vortex.

Line 8ff: The explanation to use the 550K level is not correct. Ozone depletion occurs between 350-600K in the Antarctic polar vortex and, therefore, the consideration of additional lower levels is suggested.

Chapter 3:

Please add a reference to Table 1 in this chapter where the models are described.

Chapter 4:

In general, Chapter 4 could be improved, if the authors put more effort into the analysis

ACPD

8, S10500–S10505, 2009

Interactive Comment

of the evolution (with years) of the strength and width of the transport barrier (see below). This analysis should be the basis for the comparison with model results. It would be desirable to extend the analysis to the Arctic vortex as well, however probably too much to ask.

Figure 1: It is interesting to compare the variation of column ozone, kappa and temperatures along equivalent latitudes. However, the figure as well as the interpretation should be improved.

Panel 1a: It can be problematic to compare October averaged column ozone values for various years, if one winter (2002) was characterized by an early breakup. The breakdown time of the vortex varies between the years and can result in changes of ozone values for the October averages. Further, it is more precise to derive column ozone within the vortex considering all theta levels between 350 and 600K.

Panel 1b/c: The same problem exists considering the October average for kappa and temperature. Assuming the lifetime of the vortex increases with the years, a strong vortex barrier exists longer in the season. If the vortex weakens later in the year, kappa averaged over October would show a stronger peak. Therefore the maximum of kappa would increase even though the strength of the transport barrier during the time of a strong vortex might not have changes. This can be explored in considering other months (August, September, November) in addition to October averages.

Further, the location of the vortex (the area inside the vortex edge) is shown to be constant between 1980-2005 in considering 5 year averages. But is this true if considering single years and different theta levels?

Page 20164, line 16: If I understand it right, the definition of the vortex edge in this paper is defined exactly the same as described in Nash (1996) and Tilmes (2006)?

Line 24-26. Can you explain, why there is a wider gab between the vortex edge and the 220 DU contour after 2000? There might be a problem with the definition of the edge

ACPD
8, S10500–S10505, 2009

Interactive Comment

of the vortex in considering only one theta levels, since the vortex in 2002 for example was not very stable.

Page 20165, line 2: It would be interesting to look at different column ozone contour levels besides the 220 DU. As shown before in earlier studies, the depth of the ozone hole is saturated in the polar vortex after about 1990. What about the minimum column ozone within the vortex (for example values below 150 DU)?

Line6: I do not agree with the statement: Therefore the position and width of the vortex edge and thus the size of the dynamical vortex is insensitive to the concentration of ozone within the vortex.

Definitely, this is not true for Arctic conditions, where column ozone is significantly larger than for the Antarctic and the vortex is smaller. Further, changes in column ozone were more significant between 1960-1990 and therefore it would be interesting to explore earlier years.

This analysis could be improved a lot if the authors

1. considers various Theta levels , for example to derive the ozone column, and analyzed kappa and temperatures additionally on lower theta level

2. considers different month to compare the evolution of Kappa and temperature

3. analyzes values of kappa and temperatures for single years to identify variability and long-term changes of the strength of the vortex and the location

An additional diagnostic could be considered to include in the study, the lifetime of the vortex. The research question could be addressed whether changes in column ozone influence the lifetime of the vortex, because temperatures stay cold for a longer time period.

Chapter 5.

Section 5.1

ACPD

8, S10500–S10505, 2009

Page 20165, line 20: The location of the vortex edge in the 5 models varies between 60-65.7 degrees, why not giving the entire range here?

Page 10266: line 25ff: This discussion does not belong in this Section, since the WACCM model is not included in this analysis. It could be moved into the Introduction.

General comments to Section 5.2-5.3

The main conclusion of Section 5.2 and 5.3 is that the characteristics of air masses changes across the vortex edge, (defined as the peak in kappa), which is not very new. In general, the depth of the column ozone in a model is strongly dependent on how the model represents the vortex temperatures, amount of halogens and chemical reactivity etc. Clearly, cold vortex temperatures are simulated within the polar vortex. Therefore, it is not surprising that the gradient of the column ozone agrees with the location of the edge of the polar vortex (the peak of kappa), where the vortex can be assumed to be isolated.

Instead at least one CCM (for example SOCOL) could be used to address the question raised in this study: The question is, whether changing column ozone values effect the location and strength of the Antarctic polar vortex. Therefore, why not considering kappa, temperatures and the lifetime of the vortex for the years between 1960-1990, a period where the column ozone has significantly changed in the Austral Spring polar vortex?

Section5.2 last 2 paragraphs, should be removed, because of no new contribution to the analysis.

Conclusions (and Abstract) need to be rewritten after performing more analysis. Therefore single sentence are not addressed here. In general, the statement is not proven that the position of the dynamical vortex is insensitive to the concentration of the column ozone within the vortex, as discussed above.

ACPD

8, S10500–S10505, 2009

Interactive Comment

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 20155, 2008.

ACPD

8, S10500–S10505, 2009