Atmos. Chem. Phys. Discuss., 11, C14762–C14766, 2012
www.atmos-chem-phys-discuss.net/11/C14762/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Total depletion of ozone reached in the 2010–2011 Arctic winter as observed by MIPAS/ENVISAT using a 2-D tomographic approach" *by* E. Arnone et al.

Anonymous Referee #1

Received and published: 27 January 2012

1) General comments:

The manuscript by Arnone et al. presents a detailed analysis of the 2010-2011 Arctic winter observation of the MIPAS instrument. A unique pole-covering dataset of trace gas measurements and polar stratospheric clouds observations allows a comprehensive analysis of this unique winter in respect of ozone depletion and evolution of the polar vortex in general. The paper is well written, some technical changes will improve the quality of the manuscript (see comments below). From my point of view there is only one but really critical point to address in more depth before publication is possible in ACP. The detection of PSCs above 30 km altitude seems unrealistic in respect to the

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current state of research. The detection method and applied thresholds are not validated at such altitudes. Consequently the presented results are not reliable. However, MIPAS is very sensitive for the detection of optical thin clouds and it is definitively worth but also essential to investigate these indications for high altitude PSC events in more depth. The authors have to convince the reviewers and the scientific community that these events are not artefacts of the data analysis.

2) Detailed comments:

PSC observation above 30 km:

The selection of your threshold values and upper altitude are not correctly cited in the manuscript (section 2.3). Spang et al. (2005) used CI=4 between 14 and 30 km, below and above they choose CI=1.8. The more 'relaxed' definition by Arnone et al. of CI=4.5 above 30km may produce false detections. This problem becomes already obvious in Fig. 2 of Spang et al. 2005, where above ∼28-30km the CI profile starts to become noisy and CI-values close to 4.5 are possible for observation in winter 2002/3. The noise is caused by the very low stratospheric temperatures in polar vortex and corresponding low signals in the measured spectra. More recent analyses by Spang et al. (2011) take this problem into account and end up with significant smaller threshold values above 30km (Fig. 3). The authors should address the described difficulties in their analysis by checking the individual CI-profiles and the corresponding spectra. Latter should show for cloudy cases a significant radiance offset in respect to the baseline. I expect that none of the detected high PSC events will withstand such a detailed analysis. If the results show still a significant amount of high altitude PSCs, then it would be a remarkable result and should addressed in more detail in the manuscript (e.g. comparison with CALIPSO coincidences).

Title:

I go along with reviewer #2 and suggest a change of the slightly misleading term 'total depletion of ozone' in the title. Please address the limitation on specific atmospheric

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layer.

Introduction:

Please explain the term 'Volume of PSC' in more detail, which is not really the volume of PSC formed in the polar vortex but a proxy of potential PSC formation by a simple temperature threshold.

Section 2:

The orbit parameters of Envisat are changed since end of 2010. This should for example produce a drift in orbit node (equator crossing time, etc.). Please clarify.

Section 2.3 PSC detection and composition:

- Cloud Index technique for PSC detection is first published by Spang et al. (2001).
- Please address that the classification by Höpfner et al. is based on modelled cloud spectra.

Section 2.4:

Is it not the sPV gradient which defines the vortex edge? Have you checked the vertical distribution of sPV?

Section 3:

I have some concerns about how the data gaps by PSC are handled in your analysis / 2-D approach with fixed latitude-altitude grid. You should note somewhere close to the introduction of Figure 3 and 4, if and where PSC may hamper the trace gas observations in the vortex. E.g. Fig. 5 suggests extensive PSC coverage on March 8, but Fig. 4 shows no data gaps in the trace gases. Is this an effect be the different altitudes?

Section 3.1:

- The discussion on N2O and CH4 is slightly confusing, please specify e.g. 'impact of

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chemistry on CH4'

- Can you define the date of the final warming, if yes, then please add.

Section 3.2:

- I can not follow the arguments of 'clear STS cases' and/or signatures. The classification is not able to discriminate 'clear' STS events, only STS/mixed clouds, which can include NAT or are even dominated by NAT particles with r>3microns.

- What is the reference or argument for the 'at least 40%' NAT particle clouds?

Section 5:

The last paragraph of the conclusion is confusing me. I don't get the point you like to address. What do you mean with 'scattered low values'?

3) Technical Comments:

p33194: 'Eventually, Arctic ....' sounds quite unspecific.

p33195: change '..., unapodised' to '... (unapodised)'

p33197, l25: 'optically' thick clouds and 'estimated' instead of derived

p33198, l27; reference for the definition of the NAT index should be added (Spang and Remedios, GRL, 2002).

p33200: 'Figs. 1 and 2' may change to Fig. 1 and 2

p33200, l15: The formula for T_NAT is based on lab measurements, please delete the term 'empirical'.

p33202 l7: I suggest '... based on the method described by Höpfner et al (2006).'

P33204 l17: the term 'spectral signatures' is misleading for the data presented in Fig. 5

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P33204 l24: . . . ‘optically’ thick

P33205 l12: you should give a reference for the statement of large NAT particles.

4) Figures:

Fig. 1: Some numbers for white contours of N2O would be helpful

5) References:

Spang, R., Arndt, K., Dudhia, A., Höpfner, M., Hoffmann, L., Hurley, J., Grainger, R. G., Griessbach, S., Poulsen, C., Remedios, J. J., Riese, M., Sembhi, H., Siddans, R., Waterfall, A., and Zehner, C.: Fast cloud parameter retrievals of MIPAS/Envisat, Atmos. Chem. Phys. Discuss., 11, 33013-33094, doi:10.5194/acpd-11-33013-2011, 2011.

Spang, R. and Remedios, J.: Observations of a distinctive infra-red spectral feature in the atmospheric spectra of polar stratospheric clouds measured by the CRISTA instrument, Geophys. Res. Lett., 30, 1875, doi:10.1029/2003GL017231, 2003.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 33191, 2011.

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Interactive Comment