Atmos. Chem. Phys. Discuss., 10, C6138–C6143, 2010
www.atmos-chem-phys-discuss.net/10/C6138/2010/


Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Variability of the nighttime OH layer and mesospheric ozone at high latitudes during northern winter: influence of meteorology" *by* A. Damiani et al.

**Anonymous Referee #1**

Received and published: 5 August 2010

The paper presents some new observations related to the chemistry and dynamics in the high latitude middle atmosphere during the NH winters of 2005-2009. The OH concentration observations are entirely new and the mesospheric O3 as measured by MLS for these periods has not been discussed previously. Observations of temperature and carbon monoxide are presented as well. The discussion puts these observations into the context of the unusual late winter periods observed during 2006 and 2009, which have been discussed in several previous papers.

The new observations make important contributions to the body of knowledge needed to put together a comprehensive view of the interactions that took place during these

years. The unique contributions from the present paper are 1) to show the variations of the distribution of OH and discuss its role in the chemistry of the Ox and HOx system, 2) to give quantitative determination of the cross-correlations of OH, T, and O3, and 3) to demonstrate the similarities in some aspects of the chemical response to the dynamical events of 2006 and 2009 to the chemical perturbations due to SPE events during 2005.

The explanation of the composition anomalies that occurred during 2006 and 2009 is complicated because it involves transport, temperature dependent reaction rates, and reactive gases with chemical time scales that vary widely with altitude and can depend on the composition of other species. All of the aspects are discussed in the paper. However, it seems to me that the discussion makes the situation seem even more complicated than it already is. This can be addressed with some reorganization; suggestions are given in comments 3-4, below.

The following comments address many aspects of the text of the paper. The figures are well-chosen to illustrate the phenomena under investigation.

Comments:

1. The paragraph from p. 14586, l. 27 to p. 14586, l. 23 contains a lot of information but is so densely packed that it is not easy to read. Here are some suggestions. Split it into two paragraphs at l. 9. The sentence beginning “In Polar Regions...” contains a statement about variability that is contradicted by the results presented in the paper; perhaps this could be qualified to be less general or to encompass the range of variability observed. At l. 13, end the sentence after “odd-hydrogen” and, in the following sentence, be explicit about what is being transported. It seems to me that rather than “at mid latitudes”, you mean “in the sunlit atmosphere”.

2. The mechanism for the impact of transport on OH* emission layer is not explained correctly (p. 14587; l. 14-16). The limiting contribution to the O3+H reaction is normally O3, not H. Here is a more accurate statement: When [O] decreases, the production



ACPD

10, C6138–C6143, 2010

of O3 falls off because it is generated through the reaction between O and O2; consequently, also the production of OH is reduced.

3. The scenario of changes due to the SSW events and aftermath are described three times: in the introduction (p, 14588, l. 5 ff.), in the data analysis section, and in the discussion section. I suggest consolidate these. In the introduction, the brief description is hard to follow without the figures, which are only described later. You could just say that MLS data show changes in OH, ozone, etc. that are consistent with previous observations but that provide new information and details that can help fill in the picture of the dynamical-chemical processes acting during these periods. The rest of the detail could be moved to the appropriate parts of one of the later sections.

4. Also, I suggest that you should decide whether Section 3 should only present the observations or also discuss their implications for the processes involved. If the latter, then maybe it would be best to integrate the discussion in section 4 into section 3 and not have a separate discussion section. Otherwise, you could move some of the discussion about the figures to the discussion section. My personal preference is to see the results discussed as they are presented but this is up to you.

5. It is not clear what features you are referring to as the "further mesospheric ozone variability" on p. 14592, l. 16.

6. The discussion does not address or explain the reasons for the higher correlation coefficients during active years. Is this just a signal to noise issue or is there something more? Please comment.

7. Reference to the "vortex core" during SSW (p. 14595, l. 25) does not mean much considering that sudden warmings are characterized by a major displacement and/or splitting of the polar vortex.

8. Without additional information, I think it is not possible to distinguish between a reduction in the downwelling and an actual upwelling (cf. p. 14596, l. 6; l. 16).



ACPD

10, C6138–C6143, 2010



9. Please explain the negative values of ozone (p. 14598, l. 12) by, for example, adding a few sentences to Section 2. However, in addition, perhaps change the wording here to “ozone abundance is so low that the concentrations are below the noise level of MLS, resulting in a mix of positive and negative values . . .”.

10. Please be more specific about the “low concentrations of atomic oxygen” (p. 14598, l. 21). At least above about 80 km, O has a long lifetime and has its highest abundance in the polar night due to downwelling. The destruction of ozone is also quite rapid (models calculate chemical timescales of minutes).

11. Terms like middle mesosphere and upper mesosphere are not precise since both the stratopause and mesopause heights are highly variable. It would be better to give altitude and/or pressure ranges. This is especially the case for the present study because the focus in on a region that could be classified as either upper or middle mesosphere and is sometimes even below the elevated stratopause. For example, p. 14586, l. 14-15, but many other instances as well.

12. The paper would be easier to read if words were spelled out rather than using abbreviations. The examples I had trouble following were PR, DY, and QY.

13. Throughout, I suggest change “drop” to “descend” or “descent” when referring to layer position. “drop” is ambiguous because it is also used to indicate quantity; a drop in the OH layer could mean either a movement in its location or a decrease in its concentration.

Editorial suggestions

page line

14584 15 Give an approximate altitude range for the third ozone peak.

19-22 The sentence is unclear. Suggested revision: During these periods, there was an upward displacement of the OH layer coupled to changes in ozone and carbon monoxide. These perturbations were strongest during the SSW of January 2009; coin-



ACPD

10, C6138–C6143, 2010



cident upper mesospheric temperatures were the lowest recorded over the late winters of 2005–2009.

14586 6 Begin a new sentence at the parentheses: ". . . typical atmospheric conditions. (Slight hemispheric . . ."

19 "main path" for what?

14587 13-14 "transport at lower altitudes" Do you mean "transport to lower altitudes"? Please say what altitudes.

21 Do you mean "emission rate" rather than "production rate"?

14589 24 Begin a new sentence at the parentheses: ". . .results. (Experimental. . ."

14590 6 Figure 1 shows the time series, not the trend (which would be the derivative of the time series).

19 Suggest change "usually not affected by" to "below the usual position of".

14591 1 "representative of the OH distribution inside the mesospheric polar vortex" This has not been demonstrated and cannot be without additional data. I suggest drop this sentence.

14592 4 Specify downward transport.

14594 23-24 Be more explicit; such as "the layer of ground state OH, normally situated about 5 km below the Meinel band emission layer".

14595 3-5 Suggest change "Although only some studies linked the temperature to the OH layer at 82 km because" to "Although there has been only limited observational evidence determining the link between the temperature and the OH layer at 82 km because".

14596 29 Delete "enhanced" and replace "that is not coupled with large" with "but reduced".



ACPD

10, C6138–C6143, 2010



14597 10-11 Begin a new sentence at the parentheses: "... by CO. (See ...".

---

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 14583, 2010.



ACPD

10, C6138–C6143, 2010

Interactive Comment