Atmos. Chem. Phys. Discuss., 12, C646–C652, 2012
www.atmos-chem-phys-discuss.net/12/C646/2012/
© Author(s) 2012. This work is distributed under
the Creative Commons Attribute 3.0 License.

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Unusually low ozone, HCl, and HNO_3 column measurements at Eureka, Canada during winter/spring 2011" *by* R. Lindenmaier et al.

R. Lindenmaier et al.

rodica@atmosp.physics.utoronto.ca

Received and published: 15 March 2012

Anonymous Referee #2 Received and published: 25 February 2012

We thank the referee for his/her comments, which have helped improve the manuscript. In our reply below, the referee's comments are also included.

General comments: The authors show the unusually low ozone, HCl and HNO3 observed at Eureka, Canada during winter/spring 2011. For their evaluation, they use the data from FTIR instrument, Rayleigh/Mie/Raman lidar and PTU radiosondes. The results from last winter are compared to the large dataset recorded at the station during previous winter/spring since 1997 and to remove the dynamical processes in the

evolution of the various compounds a normalization with HF has been used. In order to assess the ozone chemical processing, the passive substraction method has been used with passive ozone from SLIMCAT chemical transport model.

The paper is well structured, clear and is addressing scientific questions within the scope of ACP. I recommend publication after minor revisions.

Specific comments:

Chapter 3 Vortex edge: As already mentioned by Referee #1, why the author do not use Nash criteria for vortex edge? How does this compare with Q diagnostics? I do not think that it is correct to use a fixed proxy for the inner and outer edge of the vortex throughout the winter/spring period. The value of the vortex edge should also change from one year to the other depending on the strength of the vortex. Can you comment?

For the comparison of Nash criteria with the Q-diagnostic, please read the response to Referee #1. The EqL, Q and sPV etc. edges are all based on model(s), albeit using assimilated meteorological data. For all methods, the results are approximate.

In this work, the Q-diagnostic and sPV were used to identify the vortex edge; both are valid, published methods for determining the vortex edge. For the latter, a specific value of scaled PV (sPV, see, e.g., Manney et al., 1994) is used as the definition of the vortex edge. Manney et al. (2007) compare edge identification using sPV with the PV gradient x windspeed criterion, and show that the two methods give similar results for the lower stratosphere during winter/spring. They also discuss how the PV gradient x windspeed method compares with the (only slightly different) method of Nash et al. (1996), and show that, again, the results are very similar for the regions we are interested in here. In our work, the Q-diagnostic and the sPV vortex edge identification methods were also compared to make sure that the results are similar, as described in the manuscript (Section 3.3). To conclude, all methods give similar results, especially compared to the expected uncertainties in the meteorological datasets on which they are based.

Manney, G. L., Zurek, R. W., O'Neill, A., and Swinbank, R.: On the motion of air through the stratospheric polar vortex, J. Atmos. Sci., 51, 2973–2994, 1994.

Nash, E. R., Newman, P. A., Rosenfield, J. E., and Schoeberl, M. R.: An objective determination of the polar vortex using Ertel's potential vorticity, J. Geophys. Res., 101(D5), 9471−9478, 1996.

We added the following text to Section 3.3:

"Vortex edge identification using a scaled PV (sPV, PV scaled so as to have a similar range of values at levels throughout the stratosphere) contour was used by Manney et al. (2007). This method is most robust in the lower and middle stratosphere when the vortex is strong and well defined, as was the case during winter/spring 2011. Results using sPV to identify the vortex edge agree closely with those using the PV gradient x windspeed criterion and other criteria (e.g., that of Nash et al., 1996), based on PV gradients (Manney et al., 2007)."

Regarding the different conditions from year to year, or during the same year: a PV gradient x windspeed or Nash-type criterion (both based on where the maximum PV gradient is), can lead to slightly different values under different conditions. Since these differences are quite small and not systematic from year to year, they were neglected.

Chapter 4 Ozone columns are usually measured in Dobson Unit. It is difficult for the reader to have ozone columns in mol/cm2. On figure 5, both units are indicated. On figure 7, I understand that it is difficult to add a second axis with DU but on figure 8, the right axis should be Dobson Unit and not temperature.

This is correct. The right axis on Figure 8 was indeed supposed to be DU. We replaced the temperature by DU on the second y axis on Figure 8.

Figure 7: I am surprised by the remarkable good agreement between 125 HR ozone and SLIMCAT ozone at the beginning of the period. Usually, due to the coarse vertical resolution in the SLIMCAT model for altitudes below the 350-K potential tempera-

ture level [Feng et al., 2007] a normalisation of SLIMCAT passive and active ozone is necessary, this normalisation can be sometimes as large as 100 DU. Please provide additional information.

Feng et al. (2007) showed that the SLIMCAT active run for the 460-K level overestimated the ozonesonde measurements at Ny Ålesund (by $\sim$0.3ppmv) at the start of the winter but agreed well at Sodankylä. The model also underestimated (maximum differences of $\sim$0.5ppmv) the observations around days 70-80 at both locations (Fig. S1). In contrast, very good agreement can be seen for Alert and Eureka for the same days 70 to 80 (Fig. S2, Feng et al., 2007). A normalization of SLIMCAT active ozone by a fixed amount would not improve the SLIMCAT/ozonesonde comparison in the case of Ny Ålesund for example.

The passive subtraction method is widely used to quantify chemical ozone depletion. Given the good agreement between the 125HR measurements and the SLIMCAT active run, we considered that this would be the best way to quantify the chemical ozone depletion at Eureka. Because of the low number of independent pieces of information that results from our retrievals, we compared ozone total columns measured by the 125HR with SLIMCAT passive and active total columns. The SLIMCAT passive and active ozone total columns were not normalized for our comparison.

To support our results, we added to Figure 7 (a) the ozonesonde measurements at Eureka during the campaign. These are in excellent agreement with the active run of the model and with our measurements. The good agreement of our measurements with the SLIMCAT active run is evidence of the good modeled ozone chemistry. It is true that the difference for the measurements on the edge and outside the vortex is larger than that inside the vortex, as mentioned in the manuscript, and this is the place where the model needs to be improved. If these points are excluded (the shaded region), the percentage difference between the measurements and the active SLIMCAT becomes 5.9$\pm$4.2%.

For more clarity, we also added the 125HR measurements to Fig. 8 (a).

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 1053, 2012.

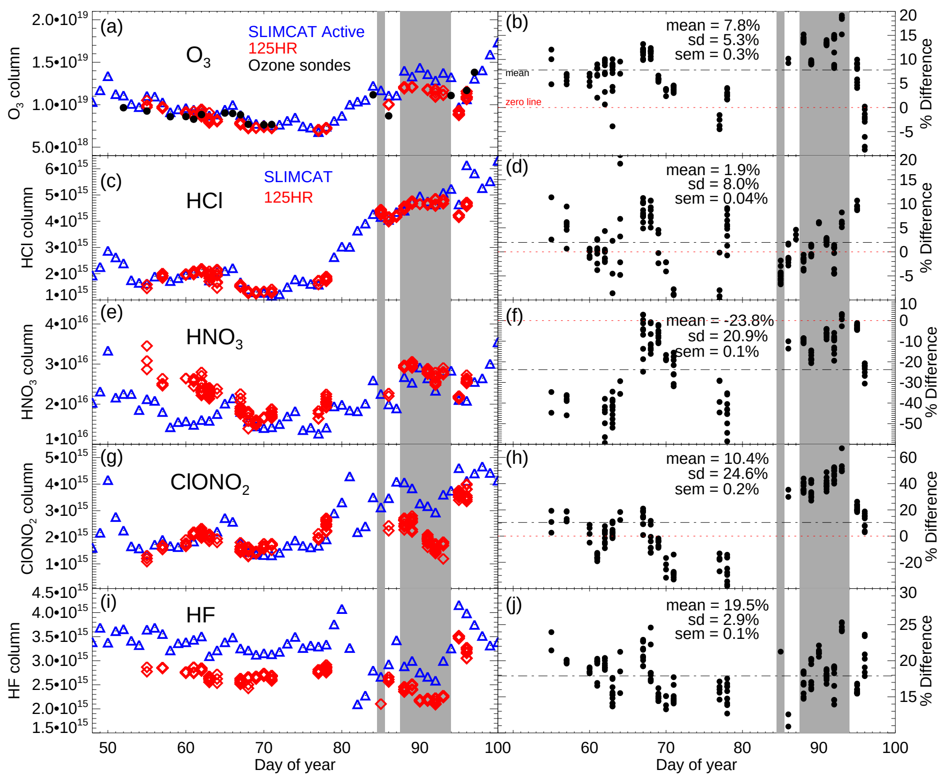

Fig. 1. Figure 7

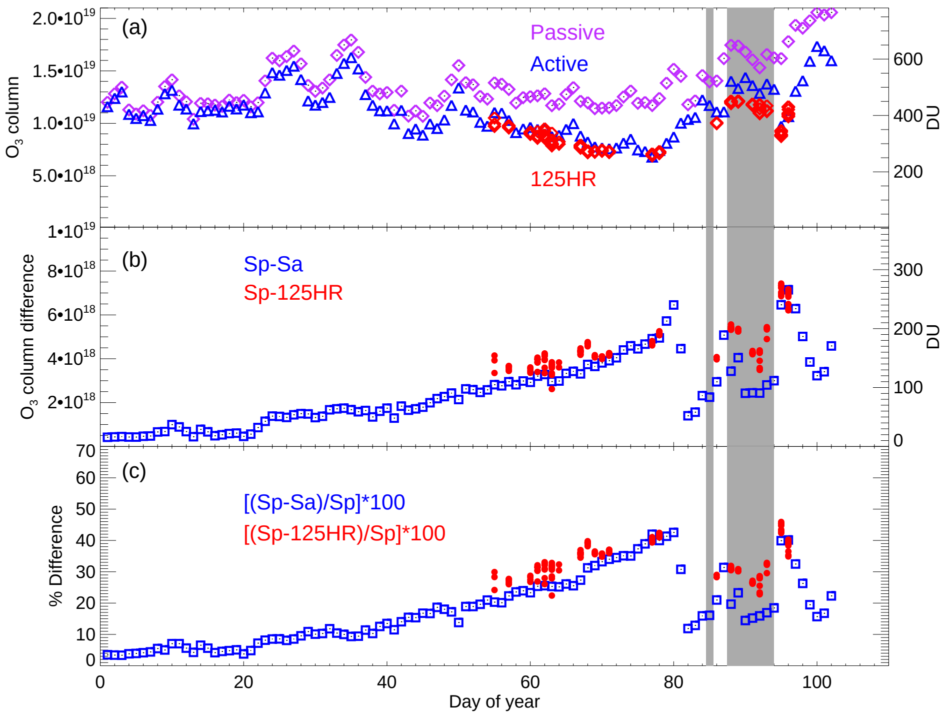

Fig. 2. Figure 8