

## ***Interactive comment on “Evaluation of stratospheric chlorine chemistry for the Arctic spring 2005 using modelled and measured OCIO column densities” by H. Oetjen et al.***

**H. Oetjen et al.**

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We would like to thank the reviewer for his/her detailed comments. In the following we address the points that have been raised:

Referee comment: The authors conclude in the abstract that ‘overall, good agreement is found’ and in the summary ‘The agreement is excellent...’ which is not really well enough supported by the data comparisons shown in this paper. It helps that the uncertainties are quite high (uncertainty in SCIAMACHY OCIO is estimated to be 30% or higher and for groundbased OCIO quoted as 20% for 90 SZA) and I agree that the comparison is qualitatively good but quantitatively not quite as convincing (certainly

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not excellent) for the following reasons: 1) The g.-b. instrument operating at Bremen is not sensitive enough to detect the low amounts of OCIO present at the small SZA during the SCIAMACHY overpass and hence no direct comparison is possible for this station. 2) Based on Figure 3, the comparison at Ny-Alesund seems not that great for the first time period (high chlorine activation) of about 2 weeks (roughly 12-26 Feb), it then is excellent for the next time period of about 2 weeks (26 Feb – 14 March, modest chlorine activation), and for the 3. period (roughly 14-30 March) both instruments agree that there is no more OCIO. 3) Also based on Figure 3, at Summit the most days the g.-b. data set is substantially higher. So overall, there seems to be only one time period (with modest chlorine activation) at 1 of the 3 sites when the agreement is truly excellent and meaningful. At high chlorine activation, the g.-b. instrument sees generally more OCIO than the satellite. This could be discussed in a bit more detail in the text. And the agreement should be described more adequately in the relevant parts of the manuscript.

Author’s reply: In response to the reviewer’s comments, we’ve toned down the description of the agreement between the different data sets as well as added some more details there. Especially, more details are added concerning the higher ground-based data in comparison to the satellite due to the different sampling volumes of the two instruments. For the satellite observations, all data within a radius of 200 km around the station are averaged. At high latitudes, this introduces a low bias in the satellite data early in the year as more data are available in the brighter southern part of this area where OCIO is already more photolysed. At the same time, the ground-based data are biased to larger SZA at the beginning of the measurement period (see below and the discussion in the manuscript).

Referee comment: Page 26547, lines 8-9: The authors state that ‘in Ny-Alesund, apart from the first few days, the agreement... is excellent.’ As discussed above and based on Fig 3, it looks more like the first 2 week period is showing a rather pronounced offset between g.-b. and SCIAMACHY data, at least while the chlorine is stronger activated.

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That should be taken into account in the text.

Author's reply: We have changed the wording here. See also reply above.

Referee comment: Page 26549, lines 14-15: The authors state: 'However, the model generally underestimates the OCIO columns. This effect increases towards larger SZA but also with increasing chlorine activation.' In the next section (page 26550, lines 20-21) the authors state: 'At 90 SZA, the measurements exceed the modelled columns by 30% on 24 Feb and by about 40% on 4 March, respectively.' Doesn't this contradict the first statement (i.e. increase in the underestimation with increasing chlorine activation and not the other way around)??

Author's reply: The reviewer pointed out that the statement that the model-measurement discrepancies increase with increasing chlorine activation contradicts the particular values on the two days of the case studies. This is indeed true and hence we added a figure in the manuscript to show the relative differences between model and measurements and also moderated our description by changing the follow-up sentence into "On average, over the time period of strong chlorine activation until March 8th, the modelled columns are too low by  $(7\pm 12)\%$  at  $88^\circ$  SZA,  $(27\pm 12)\%$  at  $90^\circ$  and  $(42\pm 24)\%$  at  $92^\circ$  SZA." to give a better account of the actual variability of the differences.

Referee comment: Page 26552, lines 25-28: If the higher forward rate constant based on Boakes et al. would be used – which obviously would not lead to an improvement but rather the opposite – by how much would the modelled OCIO change?

Author's reply: As pointed out by the reviewer, using the forward rate constant based on Boakes et al. would increase the difference between model and measurements. The modelled OCIO would decrease by  $\sim 6\%$  at  $90^\circ$  SZA. We have added this information to the manuscript.

Referee comment: Pages 26553, lines 11-13 & page 26554, lines 26-29: Could a mix

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of several scenarios lead to a better simulation of the OCIO diurnal variation as well as absolute amount?

Author's reply: It is likely that some odd combination of several model scenarios can be found that better reproduce the measurements than any of the individual sensitivity studies. However, the choice of this combination would be arbitrary and hence was not further followed up here besides the one combination that was described as optimal for the ClO/Cl<sub>2</sub>O<sub>2</sub> chemistry by von Hobe et al. (2007). This combination did not lead to changes sufficient to explain our measurements.

Referee comment: Page 26557, line 4: 'The agreement is excellent...' As discussed above in some detail, I don't think that is a realistic statement and needs to be adjusted.

Author's reply: As stated above, this has been rephrased in the revised manuscript.

Referee comment: Figure 5: Why do the model results for 90 SZA start later than the measurements?

Author's reply: In figure 5 (please note, in the revised manuscript fig. 6) the model results in general start later than the measurements due to the way how the measurements are averaged over a range of  $2^\circ$  SZA. This was already discussed in the manuscript in section 3. Since the SZA range covered during one day is rapidly changing after the end of the polar night, the first few days of measurements indeed do not represent the exact given SZA, but are in fact rather an average of only a few measurements at  $(\text{SZA}+1^\circ)$ .

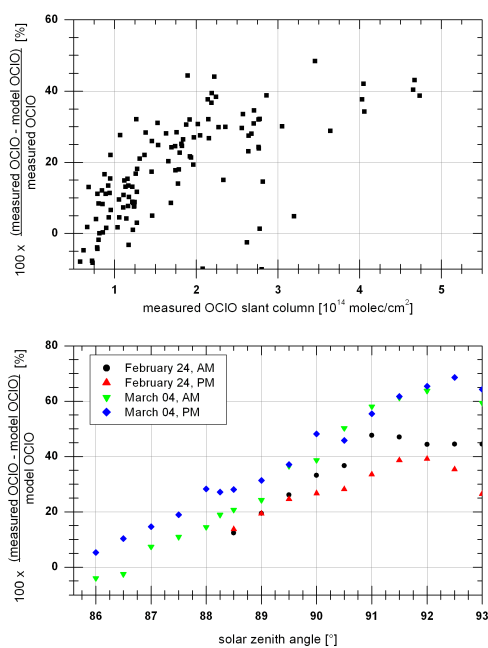
Referee's technical comments.

Author's reply: All changes suggested by the reviewer in the technical comments section have been implemented.

Caption for attached figure: The relative differences between modelled OCIO columns and ground-based data for Ny-Ålesund. Top: all data until March 8th as given in figure 6. Bottom: differences for two selected days. The relative differences between

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**Fig. 1.** The relative differences between modelled OCIO columns and ground-based data for Ny-Ålesund.

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