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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analysis of global water vapour trends from satellite measurements in the visible spectral range" *by* S. Mieruch et al.

S. Mieruch et al.

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We appreciate the referee's comments and ideas and we have addressed all points raised in the revised manuscript. Also the referee's suggestions for technical corrections are implemented in the revised version.

A) The water vapour trends are relative insensitive to changes in cloud cover. In principle the AMC-DOAS algorithm provides a cloud free water vapour climatology, however it can be applied to partially cloudy scenes. Therefore also the trend is in principle a cloud free trend. A trend in the cloud cover at a specific sampling site (grid pixel), e.g. an increase, could yield to a change in the number of measurements, i.e. more measurements are rejected (due to more clouds) by the AMC-DOAS method. Since we are working with monthly mean data such an

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effect is not critical for the trends. We will discuss this point in the first part of Sec. 2 in the revised version, where we give a short overview about the retrieval method.

B) If we understand the referee right, the idea is to determine the differences of GOME and SCIAMACHY measurements for the overlapping time and use this information to adjust the data sets. This is a possible solution, but it introduces more uncertainties than estimating the level shift from the combined data set:

The overlapping time (with high quality data) ranges from January 2003 to May 2003, thus we can estimate (in the sense of arithmetic means) the differences between the two instruments. The calculation of the level shift on the basis of 5 months for the complete data set comprising 132 month (11 years) is highly uncertain. In contrast, estimating the level shift (in a least square sense) on the basis of the complete data is more reliable. We will expand the discussion on the combination of GOME and SCIAMACHY data in Sec. 3 in the revised version with the above argumentation.

Additionally it has to be noted, that the level shift is not only an instrumental effect, but also caused by atmospheric processes (high variability of H_2O). Therefore it is extremely important to use the complete data for calculating the level shift to account for the atmospheric conditions in every month.

We will follow the referee's suggestions to shorten the introduction by removing Fig. 2 with the discussion of the four scenarios. Furthermore we remove the paragraph on natural hazards and "rivers in the sky" in the introduction.

Introduction:

- We agree with the referee, that in addition to the surface temperature and surface type several other factors such as transport influence the H_2O column. (We mention the role of transport in the revised version.)

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- The two last paragraphs of Sec. 3 discuss the advantages and disadvantages of GOME and SCIAMACHY. As the referee suggests, we include also information on other instruments (SSM/I) at the end of Sec. 3 in the revised manuscript.
- We agree with the referee and will choose the (IPCC2007) as reference for the greenhouse effect. The Australian Bureau of Meteorology has its information from the IPCC 2001.
- We agree with the referee "small" is removed in the revised version, but we will not discuss the Clausius-Clapeyron relation, because it is not necessary for our trend study.
- The referee is right, we will remove the whole sentence and concentrate on the trends and not on the columns in the new version.

Data analysis:

- We absolutely agree with the referee's comment, that there might be systematic differences between the two instruments in respect to different resolutions and the cloud issue. We will discuss this point in Sec. 3 under the numbered item 2 in the revised version. Additionally we will include the spatial distribution of the level shifts in Sec. 5. It reveals a patchy structure of positive and negative level shifts. Over the equator and over rain forest regions, with most likely large cloud covers, the level shifts are mostly positive. This finding is consistent with the referee's argumentation, because the higher resolution of SCIAMACHY introduces a positive bias for the SCIAMACHY columns.

The combination of GOME and SCIAMACHY data

- To apply several statistical (mathematical) methods such as least square fitting, calculation of autocorrelation etc., the data have to be bijective functions. Therefore, we had to choose a discrete point in time for the interchange. In this case

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we chose the changeover from December 2002 to January 2003 (cf. Sec. 3). Furthermore the argumentation from B above has to be applied here.

- From the instrumental point of view we expect a higher amplitude for SCIAMACHY data, because due to the higher resolution higher peaks (negative as well as positive) of H_2O can be detected. We will include this argument in the revised version. We agree that this point is not so important when using monthly means. More important is the 30 minutes time delay and the high variability of H_2O and clouds. Although, the amplitude change is small (narrowly distributed around unity, which can be seen in Fig. 8) it has to be considered.
- Done. The cloud effects will be discussed in Sec. 2 in the revised version.
- We will keep this paragraph here, because Sec. 3 explains several detailed features about the data set which ends in the discussion on advantages and limitations. The introduction comprises more general information.

Methods:

- We added the subscript t, because the constant C_t is no more constant after the transformation to C_t^*. We will explicitly point out, that C_t^* is not constant.
- OK, we removed the sentence.
- We will include the spatial distribution of the level shifts and discuss its relation to the cloud cover in Sec. 5.3.
- Wagner et al.(2006) calculate GOME trends from globally averaged annual mean data with removed El Niño for the period of January 1996 to December 2002. We will discuss similarities and differences between our results and the Wagner et al.(2006) trends in the revised version in Sec. 5.3.

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Conclusions and discussion:

- Since we removed Fig. 2 also the discussion in the conclusions about the scenarios is removed. We understand the referee's concerns about the "long-term oscillation", because this argumentation is often a commonplace. However we leave the sentence on "long-term oscillation", because we think in this case it really supports the interpretation of the trends.

Figures:

- We skipped Fig. 2.
- We added H_2O anomalies to Fig. 3.

References

[IPCC(2007)] IPCC, 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, eds., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp.

[Wagner et al.(2006)Wagner, Beirle, Grzegorski, and Platt] Wagner, T., Beirle, S., Grzegorski, M., Platt, U., 2006. Global trends (1996-2003) of total column precipitable water observed by Global Ozone Monitoring Experiment (GOME on ERS-2) and their relation to near-surface temperature. Journal of Geophysical Research 111, D12102.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 11761, 2007.