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Interactive comment on "Balloon-borne stratospheric BrO measurements: comparison with Envisat/SCIAMACHY BrO limb profiles" *by* M. Dorf et al.

Anonymous Referee #2

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Review of 'Balloon-borne stratospheric BrO measurements: comparison with Envisat/SCIAMACHY BrO limb profiles Dorf et al. ACPD 2005

This paper presents a comprehensive set of BrO profile measurements with the aim of making these available to the satellite community for the purposes of satellite validation. This is a valuable contribution to the field of remote sensing of BrO and I encourage its publication in ACP. It is a well-written paper, coordinating a large number of groups with different techniques and methodologies. Validation of satellite measurements is extremely valuable and this paper paves the way for BrO.

A major weakness of this work is the inversion technique employed for the SAOZ measurements, with developments now in the field of profile retrievals since the early SAOZ work ie [Hendrick, et al., 2004], and Butz et al. 2005 who are coauthors on this work, this could be improved upon.

This paper focuses on the SCIAMACHY profile retrieval of the Harvard group, with this work in review. The published results of the Bremen SCIAMACHY group should be acknowledged and compared - [Sinnhuber, et al., 2005]. This could be reviewed in the introduction along with other methods of measuring BrO. This balloon data set will provide a useful foundation for validation of other satellite measurements of BrO such as OSIRIS (potential for profiling) and more recently OMI(column). A paragraph in the introduction of the satellite instruments that have/intend to measure BrO from space would add to this paper.

The DOAS technique section 2.1.2 is slightly confusing - the DOAS spectral retrievals and then profile inversion technique employed. The DOAS technique section 2.1.2) quotes the three different methodologies 1) direct comparison of SCDs Harder (a look up table with no weights??) and 2) Least squares with constraints (which constraints?) Butz and 3) Pundt 2002 using onion peeling. A table of the different balloon experiments (ie introduce the names LPMA/DOAS, TRIPLE (in situ), SOAZ (these are the three names used for the rest of the paper)), and their different analyses ie. technique solar occulation, vs limb sampling, spectral window and fitting method ie Aliwell, vs Windoas, cross-sections used. Then the profile inversion technique; least square unconstrained, constrained least squares, or onion peeling. Indicate whether multiple scattering is included, whether the photochemistry is included in the profile inversion (check boxes maybe?). SOAZ neglect both of these effects? A line of the table also could be devoted to the SCIAMACHY retrieval, it would make it clearer to the reader which spectral analyses are used and which profile inversion technique and what approximations are employed etc. Is the direct method of Harder 2000 ever used?

An error is quoted from the Pundt 2002 paper for the effect of neglecting the photo-

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chemistry and multiple scattering. Figure 2 in this paper (Dorf) displays a photochemical change that is larger than any of the cases shown in figure 5 of Pundt, (ascent finishing at ˜90) thus the error of neglecting the photochemical change might be larger for these balloon flights than those quoted in Pundt 2002. Do the authors have an idea how large this error is? Since the inversion of Butz takes photochemistry and multiple scattering during the ascent into account could the SOAZ flights be reanalyzed with this retrieval? Or at least could the Butz retrieval be used to quantify the error in neglecting multiple scattering and photochemistry in the ascents etc? The use of the onion peeling technique would also increase this photochemistry error sensitivity as the subtraction of the amount in the upper levels with less BrO (due to the photochemical conversion) would result in more BrO being assigned to the lower levels? A large portion of this paper is devoted to explaining why photochemistry is important (which it is and is handled in a novel and rigourous way mostly) for satellite validation exercises, yet performing the balloon profile retrievals neglecting photochemistry is slightly contradictory.

Perhaps of greater concern is the neglecting of multiple scattering in the inversions, especially for assigning the amount of BrO above the float, since multiple scattering acts as an offset in the modelled AMFs. Could a more accurate error be assigned, or could the inversion be performed with multiple scattering included using the models of some of the other coauthors ie Hendrick, Butz etc.

Minor comments: The order of the affiliations should be matched with the order of the authors. Quoting unpublished results of Dorf on line 20 page 13013 is not necessary as published results are available for this number. 60-70% for BrO/Bry of Lary (1996) seems high - check by comparing with SLIMCAT used in this work, and [Avallone and Toohey, 2001]of 0.45-0.6 for the measured partitioning of bromine. Pg 13016 line 2: sentence beginning ‘However, the large diurnal variation... even if a perfect match of both observations ie. In one altitude range at one time.’ If you could measure at the same time, you would measure at the same SZA, the problem perhaps is the duration of different observations? The balloons taking ~1hour 20 and the satellite being a much shorter measurement. Page 13024 line 19: and 22 mismatch should be match?? Figure 3 has no backward match with SCIAMACHY - remove panels? Is this the only Triple match? Page 13033 line 10 fo should be for

Avallone, L. M., and D. W. Toohey (2001), Tests of halogen photochemistry using in situ measurements of ClO and BrO in the lower polar stratosphere, Journal of Geophysical Research Atmospheres, 106, 10411-10421. Hendrick, F., B. Barret, M. Van Roozendael, H. Boesch, A. Butz, M. De Maziere, F. Goutail, C. Hermans, J. C. Lambert, K. Pfeilsticker, and J. P. Pommereau (2004), Retrieval of nitrogen dioxide stratospheric profiles from ground-based zenith-sky UV-visible observations: validation of the technique through correlative comparisons, Atmospheric Chemistry and Physics, 4, 2091-2106. Sinnhuber, B. M., A. Rozanov, N. Sheode, O. T. Afe, A. Richter, M. Sinnhuber, F. Wittrock, J. P. Burrows, G. P. Stiller, T. von Clarmann, and A. Linden (2005), Global observations of stratospheric bromine monoxide from SCIAMACHY, Geophysical Research Letters, 32.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 13011, 2005.