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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristics of tropospheric ozone depletion events in the Arctic spring: analysis of the ARCTAS, ARCPAC, and ARCIONS measurements and satellite BrO observations" *by* J.-H. Koo et al.

Anonymous Referee #2

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Review for the manuscript entitled: "Characteristics of tropospheric ozone depletion events in the Arctic spring: Analysis of the ARCTAS, ARCPAC, and ARCIONS measurements and satellite BrO observations" by J.-H. Koo et al.; MS No.: acp-2012-359

The manuscript describes a comprehensive set of ozone measurements in the Arctic and correlates them to BrO data. Also a rather extended discussion of satellite-derived tropospheric BrO measurements is given. The manuscript contains valuable information on both, tropospheric O3 and BrO and is thus within the scope of ACP.

However, there is a fundamental issue that has to be resolved before the manuscript can be published in ACP: In this manuscript 6 new tropospheric partial column BrO "products" are introduced, none is validated and the products differ very substantially from each other. Before any conclusions can be drawn where satellite-derived tropospheric BrO partial columns are involved (and the majority of the conclusions in this manuscript are based on BrO tropospheric partial columns) these products must be validated and the authors must settle on a single product. This will require a thorough discussion on the relative merits of the different products. Another solution could be using an established, validated product instead of 6 new ones, for instance the BrO product developed by Choi et al. (2012, see literature list in the manuscript). In fact, according to the acknowledgement Sungyeon Choi was involved in analyzing the satellite data, why not using that BrO-product? Alternatively tropospheric BrO data from satellite and the discussion based on the data (correlation analyses) could be removed from the manuscript.

Detailed additional comments:

Page 16230, Lines 13-24: Are the diurnal variations average variations of all days during April 2008? What exactly is the meaning of a diurnal variation in the 10th percentile (i.e. values that are exceeded 90% of the time) of an average (?) diurnal variation. This needs through discussion.

Figure 2 and Page 16231 lines 8ff: Only one of the 6 satellite BrO – retrievals is shown (GOME2-SCIA2ND), in the suppl. Material two more are shown (OMI-SCIA2ND, GOME2-20th) of which the latter (GOME2-20th) deviates significantly from the other two. What about the remaining three evaluations (see p. 16228, lines 18, 19)?

Figure 3 and Page 16231 lines 23ff: The time-lagged correlations are found to be "generally consistent" between the 3 trop. BrO products. However, there are 6 trop. BrO products (see p. 16228, lines 18, 19), what are the criteria to select just these three? When the lower correlations for Alert are due to larger uncertainties in sat.

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products at higher latitudes, why is R for OMI-SCIA2ND so much larger?

Page 16232, para. starting in line 6: The behaviour of ODE – back-trajectories and non-ODE – back-trajectories (Fig. 4) is interpreted in local chemistry or transport (or a bit of both), respectively, being dominant at the particular site. It is not explained whether this fits with the local conditions.

Fig. 5: The (largely blue) colour code below panels (a) and (b) appears to indicate the trop. BrO columns. This should be said. Results from at least OMI-SCIA2ND (Fig. S7) are twice as high, they can not be said to be "similar", at best one could argue that the patterns are similar. But since the trop. BrO column distributions are largely uniform this is not very meaningful. So what could be learned from Fig. 5?

Page 16234, lines 13 ff: A stable boundary layer not only reduces exchange of O3-depleted air masses (in other words: flow of O3 from above to the surface), but also serves to keep the level of "catalyst" (i.e. HOBr) hight thus enhancing the efficiency of the "bromine explosion" mechanism.

Page 16235, line 10 and Fig. 7: The text refers to "the vertical profiles of ozone . . .", the figure caption to "mean profiles". How many profiles are averaged? Over which period of time? At which time of day did the launches take place? The temperature "laps rate" is probably the vertical gradient of the potential temperature?

Page 16236, line 20 and Fig. 8: The increase of the O3-Theta correlation with altitude is an interesting finding indeed, but why does it reflect the "increasing thermal stability"? Would not higher thermal stability mean stronger increase of Theta with altitude and thus weaker O3-Theta correlation than at the surface?

Page 16236, lines 22ff and Fig. 9: Vertical profiles of R are shown, what is the reason for the variation of r with altitude? Is there a BrO vertical profile or is BrO assumed to be constant and all variation comes from the O3 profile? If yes it should be stated in the manuscript and then the meaning of "correlation" must be explained, is it temporal

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correlation? Since the nature of the correlation is not clear it is difficult to judge what a correlation might mean.

Pages 16238 to 16240: The discussion of the trop. BrO column retrieval is not very convincing: Apparently there is little correlation between satellite BrO and in-situ data (page 16239, lines 10ff). In this situation using many different retrieval algorithms for the trop. Partial BrO column will not help since none actually correlates. The statement that 3 satellite products were selected that "showed good correlations with in situ measurements of bromine compounds (BrO, Br2+HOBr, and soluble Br)" is cryptic in this context: The satellite instruments measure BrO and no other Br-species, also, is there correlation or not?

In summary, the main difficulty with this manuscript are the not-validated tropospheric partial column BrO "products" derived from satellite data combined with the fact that the conclusion drawn from the 6 different products sometimes differ significantly. Possible solutions to this dilemma are listed above, they require major revision of the manuscript.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 16219, 2012.