Comments on Falk and Sinnhuber manuscript titled 'Polar boundary layer bromine explosion and ozone depletion events in the chemistry-climate model EMAC v2.5.2: Implementation and evaluation of AirSnow algorithm'

General comments:

This work reports an implementation of a simple treatment of bromine release and cycling on sea ice and snow in a global chemistry-climate model ECHAM-EMAC, following the work of Toyota et al. (2011). Then the author and co-author run the model for a whole year (2000) to validate the model by comparison with satellite GOME-SLIMACAT tropospheric BrO VCD and surface ozone observation at some selected sites in both the northern and the southern hemispheres. What they concluded is that the Toyota et al scheme of bromine release from snow works in general, as the model could reproduce the spatial patterns of BrO VCD as shown in the satellite data, and simulate surface ozone depletion events. They also pointed out some discrepancies between model and obs. For example, most of simulated ODEs are seen in the northern hemisphere, rather in the south.

However, I find that the validation of the model is too simple, though it mainly follows the method applied in Toyota et al. (2011). For example, they only compare model's monthly mean BrO VCD (in April and September) with satellite data. They did show any TEMPORAL comparison between them. I would suggest the author and co-author select some sites, such as those for ozone comparisons in figure 4-5 (Alert, Barrow, Summit, Palmer, Arrival Height and the southern Pole), and get corresponding model BrO VCD according to the satellite overpass time to give a scatter plot basing on the whole year data, as did in Yang et al. (2010). This kind of comparison could allow us examine the TIMING of the bromine release mechanism, though the time resolution will not better than ~24hrs. To allow a better comparison, a lead-lag (or lagged) relationship, e.g. by 1-2 days, of the model BrO can be used. By doing so, we could have a better understanding of the mechanism proposed/applied in the model.

My second major concern is the missing of sea spray acting as a bromine source to the troposphere in the modelling. The release of bromine from sea salt aerosols has been parameterised in various global chemistry models (e.g. Yang et al. 2005; Breider et al., 2009; Paralla et al, 2012). Why this kind of source is not included in the EMAC? Maybe this part is out of the topic of the manuscript (on air-snow emission), but a discussion covering this issue should be given.

For the above reasons, I would suggest a major revision to this current version before I suggest consideration of publishing it on GMD.

Specific comments:

P2L1: a review paper by Abbatt et al. 2012 should be cited here.

P2L22: removal the pair of bracket in '(boundary)'

P2 L23: why italic 'online' is used here?

P3 L 20-21: Some discussions should be given to explain why such as a higher value (7.5%) of molar yield at solar zenith angle >85° (comparing to 0.1% at dark) is introduced in the model, though this number is from Toyota et al paper. This parameter is one critical parameter to allow enough bromine releasing from snow to match the observation. Either a justification, e.g. reference, or a caution must be given to remind readers of what is going on here.

P6 figure 2 and P7L1-2: is the EMAC BrO VCD shown here a total of tropospheric and stratospheric BrO? If so, then a tropospheric column value should be worked out to make a direct comparison with satellite-based tropospheric BrO.

P7L1-9: as mentioned in the general comment, just a spatial comparison for BrO is not good enough, a temporal comparison between daily satellite BrO VCD and corresponding model BrO should be given here to allow a further examination of the bromine releasing mechanism applied.

Abbatt, T. P. D.; Thomas, J. L.; Abrahamsson, K.; Boxxe, C.; Granfors, A.; Jones, A. E.; King, MD; Saiz-Lopez, A.; Shepson, P. B.; Sodeau, J.; Toohey, DW; Toubin, C.; von Glasow, R.; Wren, S. N.; Yang, X.; Halogen activation via interactions with environmental ice and snow in the polar lower troposphere and other regions. *Atmospheric Chemistry And Physics*, **12**, 6237-6271, [doi:10.5194/acp-12-6237-2012] 2012.

Breider, T. J., M. P. Chipperfield, N. A. D. Richards, K. S. Carslaw, G. W. Mann, *and* D. V. Spracklen *(*2010*),* Impact of BrO on dimethylsulfide in the remote marine boundary layer, Geophys. Res. Lett., 37, *L02807, doi:*10.1029/2009GL040868.

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Yang, X., R. A. Cox, N. J. Warwick, J. A. Pyle, G. D. Carver, F. M. O'Connor, *and* N. H. Savage *(*2005*),* Tropospheric bromine chemistry and its impacts on ozone: A model study, J. Geophys. Res., 110, *D23311, doi:*10.1029/2005JD006244.