**Atmospheric
Chemistry
and Physics
Discussions**

Interactive
Comment

Interactive comment on "Synoptic-scale meteorological control on reactive bromine production and ozone depletion in the Arctic boundary layer: 3-D simulation with the GEM-AQ model" *by* K. Toyota et al.

Anonymous Referee #1

Received and published: 30 December 2010

Toyota et al. present an interesting study investigating Arctic bromine chemistry. I recommend publication in ACP after several (mostly minor) comments have been addressed.

- page 26212:

"Cl-, which is typically 2 to 3 orders of magnitude more abundant than Br- in seawater and polar snowpack"

This implies that the Cl-/Br- ratio in seawater is variable. However, the Cl-/Br- ratio is a

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

very well defined number for sea water (e.g. Millero et al., Deep-Sea Res. I, 55, 50-72, 2008). Only for the snowpack this ratio shows some variation.

- page 26216:

"The sea-salt aerosols are assumed not to serve as a source of halogens"

Why are halides in sea-salt aerosols not considered? Is it assumed that they are not important? Would it be possible to switch them on in the model and check if they have an effect on the results? As long as they are not included in the model, it is not possible to analyse their importance.

- page 26216:

"...our simple scheme of bromine chemistry but without chlorine chemistry."

It is a pity that chlorine chemistry is not included because it is very important to understand the oxidation of NMHCs in polar regions. I understand that adding chlorine is probably beyond the scope of this study. However, maybe it could be done as the next step of the model development.

- page 26216:

"Zhao et al. (2008) developed another version of GEM-AQ"

As far as I understand, both this work and Zhao et al. (2008) use GEM-AQ as their base model and implemented halogen chemistry. Also, there is some overlap in the list of authors of this work and Zhao et al. (2008). Was there a reason for splitting the model development? If yes, are you planning to merge the versions again?

- page 26217:

"Br2 is emitted to the atmosphere at a rate prescribed from the dry deposition fluxes of HOBr, BrONO2 , HBr and O3"

The aqueous-phase reaction HOBr + HBr produces Br2 only at low pH. Is this taken

into account? I am not aware of a mechanism that acidifies brine created from sea-water.

- page 26222:

"Run 1 is to simulate a benchmark case without bromine chemistry"

The term "Benchmark" is normally only used for analyzing the model performance, see e.g.:

http://en.wikipedia.org/wiki/Benchmark_%28computing%29

Thus, it is probably better to call Run 1 the "base case" or "reference case" instead.

- page 26228:

"It appears that surface ozone mixing ratios [...] were depleted much too frequently [...], indicating either the irrelevance of frost flowers as a source of reactive bromine or inaccuracy in the PFF algorithm employed by Kaleschke et al. (2004)."

It should be noted that PFF only represent conditions that _potentially_ create frost flowers. Maybe the discrepancy can be reconciled when considering that PFF are just an upper limit for the occurence of real frost flowers.

- page 26235:

"There are more than a few reasons to believe that heterogeneous bromine activation is favored at lower temperatures:"

Here, several reasons are listed again which have already been mentioned on page 26213. Is there a reason why shifting the equilibrium constants of R10 towards Br2 formation is not mentioned here again?

- page 26235:

"decreasing alkalinity via carbonate precipitation from freezing seawater as envisaged theoretically by Sander et al. (2006)"

Although Sander et al. (2006) was only a theoretical study, it could be mentioned that CaCO3 precipitation was indeed found in the Arctic by Dieckmann et al. (The Cryosphere, 4, 227-230, 2010).

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 26207, 2010.

Interactive Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper