Review of 'The role of blowing snow in the activation of bromine over first-year Antarctic sea ice' by Leib-Lappen and Obbard

Xin Yang, British Antarctic Survey (xinyang55@bas.ac.uk)

General comments:

This manuscript investigated the role of blowing snow in transporting salts from sea ice/snow surface into reactive bromine in the air. Lofted snow samples were collected on two 5.5 m towers located at different sites over first-year sea ice in the Ross Sea, Antarctic. Ice core and surface snow samples were also collected during the month-long campaign. They found that sea ice and surface snow Cl^-/Br^- mass ratios remains constant and equivalent to sea water, bromide depletion relative to chloride only occurs in lofted snow samples. Additionally, the lofted snow was found to be depleted in sulphate and enriched in nitrate relative to surface snow. To my knowledge, this is the first direct observation of bromine depletion in lofted blowing snow particles, and this result is well in line with previous theory/model predictions. Their findings are very interesting and indicative. For example, the observed greater depletions at greater heights, with almost no depletion when closer to the surface, strongly indicates different photochemical processes going on at different blowing snow layers; a much faster bromine activation at greater heights than at lower layer, due to more photons at higher layer. However, to figure out the exact process that controls bromine activation from blowing snow event, and relative contributions from lofted snow particles, sea salt aerosols produced, and snowpack on sea ice is a big challenge. Obviously, this manuscript reported only one case, I believed there are more observational data collected in both Antarctic and Arctic will be published later. Overall, this study is in time and welcome, and it will be of interest to the ice-snow-chemistry community. In addition, this manuscript was well written, thus I support publication after a minor revision.

Specific comments:

Lines 10-12: In abstract, the authors concluded 'this suggests that replenishment of bromide in the snowpack occurs faster than bromine activation in mid-strength wind condition'. However, in the discussion section (page 11994, lines 15-17), they texted 'the lack of recorded bromine depletion in the surface snow may indicate that either surface snow bromide concentration is quickly replenished or that blowing snow represents only a small portion of the surface snowpack.' I do not understand why the authors throw the second possibility away? Which I think it could be very possible if that area is lack of strong winds.

It would be very helpful if more meteorological information could be supplied for the 24-25 October case from nearby McMurdo station. They include wind speed, relative humidity (*RH*), temperature, and/or radiation. They may help us estimate the magnitude of the blowing snow event, and sublimation flux related.

Any further information, such as visibilities, that can be derived from webcam image during the BS event? What interested me is that the observation in fig3 shows a significant bromide depletion when height >~2m. Then why is that? Is 2m roughly the top of the blowing snow under a moderate wind speed? Can webcam image give us more information?

Have you checked satellite BrO images around 24 October? Any elevated BrO spot occurring around the Ross Sea?

Could you get snow samples (lofted and on surface) salinities? As salinity is another key factor that determine sea salt production.

Regarding to the bromine depletion profiles in fig.3, I suggest you thinking about plotting out profiles of depletion factors (*DFs*). *DFs*, rather than Cl^-/Br^- mass ratios, are very useful in modelling. You can use the formula shown below for *DF* calculation.

$$DF = \frac{\frac{Br^-}{Cl^-}(\text{in sea water}) - \frac{Br^-}{Cl^-}(\text{in sample})}{\frac{Br^-}{Cl^-}(\text{in sea water})}$$

At *DF*=0, it means no bromine depletion in particles, while *DF*=1.0 indicates a complete bromide depletion.