

Interactive comment on “Ammonia in the summertime Arctic marine boundary layer: sources, sinks and implications” by G. R. Wentworth et al.

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Received and published: 21 November 2015

Wentworth et al present a neat study of the ocean-atmosphere and aerosol-gas phase partitioning of ammonium/ammonia in the high Arctic, considering the interactions with melt-ponds and seabird and fire emissions. As they point out, observations of the multiphase ammonia system at high latitudes are few and far between so this dataset represents a considerable addition to our knowledge and understanding of the system.

The modelling element, which demonstrates the potential significance of point sources of ammonia, in particular seabird colonies adds a useful extra dimension to the study.

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The data and arguments are clearly presented and for the most part very easy to follow and the findings are insightful and scientifically reasonable.

Apart from some adding some more details to the methods and and other minor comments / corrections listed below I recommend publication of this manuscript as-is.

As a point of interest the authors may wish to explore briefly the hypothesis presented in Johnson and Bell, 2008 (<http://www.publish.csiro.au/?paper=EN08030>), which suggests that away from strong local sources of ammonia, the gas phase concentration is likely to be controlled by the partial pressure of ammonia over the aerosol (akin to the compensation point concept applied by Wentworth et al to the ocean / melt pond surface). As level of neutralisation goes up, the partial pressure (compensation point) increases. This therefore suggests that the reason that NH₃ is higher in the summer not simply because of the seabird emissions but additionally due to the lack of aerosol aciditiy to take it up, therefore ‘pushing’ it into the ocean. The reverse situation was postulated in Johnson and Bell 2008 - whereby acidic sulfate emissions in the remote marine boundary layer would reduce the compensation point over the aerosol and lead to a consequent emission from the ocean, but the principle is basically the same.

Specific comments/ corrections

p29977 - expand on T dependence - not just solubility but also acid-base partitioning is strongly T dependent, making it a ‘double whammy’ effect

p22978 - re lifetime and transport - the authors should also consider the lifetime and potential for transport of aerosol NH₄ - could this have more of an influence?

Methods (p22980 - 29981) - some clarification needed for the uninitiated to this method:

- why use H₂O₂ in the acceptor stream? Why not use a typical acid for ammonia trapping - oxalic acid, HCl or similar?

- samples collected by hygroscopic growth - surely these are less than 2.5 μ M not larger than 2.5 μ M? The >2.5 μ M fraction of aerosol has been impacted ‘out’ of the sampler?

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- is there a 22m line for each of the denuder and supersaturation chamber? What is its diameter / what is it made of? Is this part of the system continuous flow i.e. are the 10ml samples collected in the lab manually and fed into the ICs? What is the flow rate? How is the volume of sample collected in the supersaturation chamber related to concentration in the atmosphere?

- Seawater/melt pond NHx - a bit more detail on the method would be useful - what working reagent mix was used, what was the working reagent to sample volume ratio? How long were samples incubated for after inoculation with working reagent? How were matrix effects and background fluorescence accounted for in the calibration/analysis? It is stated that melt pond samples were analysed within 10hrs but seawater ones within 1 hr - why difference? Was this 10 hrs til inoculation or 10 hours incubation after inoculation with working reagent?

Potentially all such methodological details could be put into the supplementary material.

p29988 - discussion of Fig 3 and the fluxes is a little brief and rather unfocussed. Maybe better in the discussion, expanded on a little?

p29989 - sentence beginning 'On the other hand...' is a bit hard to follow - suggest replace 'nanoequivalents' with 'concentration' and move '(NHx \approx NH3) to after 'SO4²⁻'.

Also on this page - the discussion of neutralisation could do to be tightened up a bit - NH4:SO4 = 1 isn't 'neutralised' - given a simple system of simply H2SO4 and NH4, neutral pH should be achieved at NH4:SO4 = 2:1, not 1:1. However, I would argue that pH 7 always counts as neutralised, whatever the NH4:SO4 ratio is? There are obviously other sources of acidity which can affect pH as well as NH4/SO4 neutralisation.

Figure 1 - what does purple colour mean? (I guess it means no data) - please clarify in legend

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 29973, 2015.

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