Atmos. Chem. Phys. Discuss., 9, C12227–C12232, 2010
www.atmos-chem-phys-discuss.net/9/C12227/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Hygroscopicity and chemical composition of Antarctic sub-micrometre aerosol particles and observations of new particle formation" *by* E. Asmi et al.

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Received and published: 22 April 2010

We would like to thank the Referee for the comments and suggestions, which have truly improved our manuscript. These comments have been answered below.

Comment: I am a little concerned as to the choice of hygroscopic growth factor for the 'marine organic'. You have assumed a growth factor of 1.4 for the 'marine organics', quoting the growth of some individual compounds such as dicarboxylic and multifunctionals. It is true that individual organic compounds can exhibit relatively high growth factors. However, this seems relatively high when compared to other real world ensemble measurements as presented in papers such as that by Sweitlicki et al 2009 (Tellus.

Series B, 2008, vol. 60, no 3 (173 p.)/ Good et al 2009 (Atmos. Chem. Phys. Discuss., 9, 22619-22657, 2009) to name but two. The argument could be had, of course, that these previously reported values are not representative of the marine environment. They are, however, commonly found for ensemble SOA mixtures in multiple environments. Similarly, the recent paper by Allan et al (Atmos. Chem. Phys., 9, 9299-9314, 2009), suggests a lower value is more indicative of the marine environment. Without knowing relative portions of compounds such as carboxylic acids, it is not possible to say how representative these proxies can be of the ensemble mixture. How would reducing the growth factor to match those studies change the outlook of the conclusions? Alternatively, would errors in the reported concentrations of inorganic ions from the filter measurements allow for a reduction in organic growth factor.

Reply: You are correct. The problem is really that the measurements of marine organic aerosol hygroscopic properties are rare. Often seen trend is that remote organics have higher HGF (more oxidised) than those, coming directly from anthropogenic sources (more hydro-carbon like). Most of the previous measurements are made at sites where anthropogenic organics influence, more or less, on the particle hygroscopicity. The selected value of 1.4 was actually less than obtained in measurements by Hersey et al., 2009. It is also less than HGF values of many dicarboxylics and multifunctionals, which are really the only organic compounds measured to be present in Antarctica. However, due to large uncertainties regarding this value we made an additional calculation assuming only 20% of the mass was organic with HGF of 1.2. This leads to almost the same HGF value as our previous estimate with 30% of ORG with 1.4 HGF. This scenario is added in Fig. 13 to give an estimate of the range of the organic mass fraction.

C: Page 27312 Lines 8-10: here you discuss the notion that aerosols remain in a 'liquid' state at low relative humidities. This has indeed been found in laboratory and ambient studies, particularly when concerning aerosols with a significant organic contribution. Results suggest that the more complex the system becomes, the bigger the tendency

to remain in a liquid state. Rather than providing reference to the behaviour of ammonium sulphate, since you are dealing with more complex compositions, the authors should at least reference some of the more recent findings in relation to this. Whilst the difficulty in quantitatively linking those results with the present study are understood, the reader should be made aware of these developments.

R: This is a good remark, we added some discussion on the efflorescence behaviour of aerosol mixtures to the revised version.

C: Page 27316: Point 2. The effect of RH on the chemical characteristics of aerosol not only manifests itself through an increase in surface area but through consideration of aqueous phase reactions. It would be nice to at least reference a few studies, most likely chamber studies, which aim to elucidate on these impacts.

R: We added some references studying the heterogeneous aqueous phase chemical reactions in/on the particles to remind the reader on these, clearly RH dependent, effects on particles chemistry.

C: Page 27322: Line 21 onward. In this section you present % contributions from different inorganic salts but do not indicate how they were calculated. The ratio of, for example, ammonium bisulphate to sulphuric acid depends on the ratio of sulphate to existing cations. Some mixing rules are presented in the literature. The authors should state how these values were derived or at least assumed. This may link in with the broad statement given at the top of this review.

R: These calculations were shortly described in section 2.2.2. For clarity, we referred to these calculations in the text as well.

C: Page 27324, section 3.8. Here you present growth factor values for common inorganic salts, however since you are dealing with sub 100nm particles, how you accounted for the Kelvin effect?

R: The Kelvin effect was taken into account in the presented HGF values. The differ-

ence between flat surface and 90 nm particles was only some percents. Taking into account the experimental uncertainties regarding different H-TDMA setups and variance of the HGF values in the literature, we believe the Kelvin effect correction did not play a significant role.

Technical corrections:

C: Page 27306 Line6. Suggest change to 'particulate hygroscopicity and volatility can..'

R: corrected

C: Line 24: Change to 'nucleation of particles has recently been linked to..'

R: corrected

C: Line 25: Change to 'organic material is required to explain observed behaviour'

R: corrected

C: Line 26: Change to 'Oceanic dimethyl..'

R: corrected

C: Line 27: Change to 'while the ocean can also be a source for both primary and secondary organics'

R: corrected

C: Page 27306 Line 5: The sentence 'the particle hygroscopic and volatile properties' would make more sense written as 'Particulate hygroscopicity and volatility have been examined..'

R: corrected

C: Line 9: Change to 'To our knowledge..'

R: corrected

C: Line 19: By ‘towards southwest’, I presume you mean ‘facing southwest’

R: corrected

C: Line 23: Place comma after ‘data’.

R: corrected

C: Line 25: Replace ‘exists’ with ‘was available’.

R: corrected

C: Page 27312 Line 6: Replace ‘typical to the summer season’ with ‘typical of the summer season’

R: corrected

C: Page 27314: Line 6: This sentence dosnt make sense. What do you mean with regards to ‘together but critically’ ?

R: corrected

C: Page 27315: Line 25: Would suggest changing to ‘particulates in summer are likely to contain sulphates of marine origin’

R: corrected

C: Page 27316: Line 9: Replace ‘additional’ with ‘another’

R: corrected

C: Page 27317: Line 1: ‘organic species chemical reactions’. Are you solely referencing gas phase reactions?

R: This was rephrased to include both gas phase and heterogeneous reactions.

C: Line 12: ‘lacking the deliquescence behaviour’. Would suggest changing to ‘do not exhibit deliquescence’.

R: corrected

C: Page 27318: Line 7: replace ‘achieved’ with ‘calculated’

R: corrected

C: Page 27320: Line 26: I don’t entirely agree with the phrase ‘less hygroscopic organic vapors’. I understand what you mean but I think you should rephrase appropriately.

R: rephrased

C: Page 27321: Line 12: ‘it turn out..’ does not constitute good English. Suggest changing to ‘Interestingly, these highly..’

R: corrected

C: Line 22: replace ‘model’ with ‘models’ or ‘modelling studies’. Also the line ‘particles of similar type of hygroscopic and volatile properties’, should be changed to ‘particles of similar hygroscopicity and volatility..’

R: corrected

C: Page 28326: Line 6: Change ‘was as well’ to ‘close’

R: corrected

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 27303, 2009.