

Interactive comment on “Year-round records of bulk and size-segregated aerosol composition in central Antarctica (Concordia site) Part 1: Fractionation of sea-salt particles” by Michel Legrand et al.

Anonymous Referee #4

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The authors address a pressing topic; sea salt, its size distribution in aerosols and co-located gas phase measurements over annual cycles. The interpretation of sea salt records in Antarctica is relevant to sea ice distribution patterns recorded in glacial records. This manuscript contributes significantly to this discussion, demonstrating that approximately half the sea salt aerosol load comes from open ocean versus sea ice. The relationship of sea salt, aerosol acidification and the production of HCl and HNO₃ is also examined by considering denuder measurements of acid gases and their effect on aerosol characteristics. The authors argued that HCl emission from surface snow

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or differences in the lifetime of HCl versus sea salt transported from the coast drove differences observed between denuder and aerosol measurements. These results are novel and intriguing. This paper provides constraints to some long-standing questions regarding the source of anomalies in the ratio of Na to Cl in snow, whether and by how much Cl in aerosols is depleted in the continental Antarctic and in ice and the factors driving it. These points are all strong and convincing. Arguments about sea salt and biogenic sulfate however, are less well-rounded: likely this is because detail is provided in a separate manuscript dealing with sulfate and sulfate to sodium ratios. The manuscript is strong, but some sections, particularly with respect to sulfate and sulfate to sodium ratios need additional attention prior to publication.

Portions of this manuscript associated with interpretation of sulfate needs additional description (that perhaps can be found in the accompanying paper on sulfur-derived aerosol) to be fully understandable. Page 8 line 24 refers to quantifying biogenic sulfate using MSA and the relationship between MSA and sulfate on particles with a diameter <0.46 microns. This assumes that all non sea salt sulfate in aerosols <0.46 microns in diameter is biogenic. Is this because anthropogenic sulfate is negligible and volcanic sulfate is absent in the Antarctic interior? A previous study in the Arctic demonstrated that MSA in for aerosols <0.49 microns correlated with the presence of fine particles rather than with biogenic sulfate (Rempillo et al., 2010). In that study the surface of <0.49 micron aerosol, rather than biogenic sulfate, were the dominant factor affecting MSA formation. The authors need to demonstrate why anthropogenic and volcanic sulfate are not factors in MSA formation at this continental Antarctic site. Line 23 on page 8 “.. we therefore have corrected the concentrations of sulfate present on the upper stages of the impactor for the (nss rather than biogenic contribution)”.

On page 10 how were the values of 40% and 60% of travel time within the boundary layer determined? This is not evident from the examples of air mass back trajectories provided in Figure 11. Is there a reference or data to support a boundary layer of ~600 m for open ocean and over sea-ice in the Antarctic at this time of year? The discussion

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suggests a quantified analysis that is not shared with the reader which makes this section less convincing.

Line 30 on page 10 is confusing “A slight increase of the sulfate depletion in particles smaller than higher than one micron. . .”

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