

Interactive comment on “Enrichment of submicron sea salt-containing particles in small cloud droplets based on single particle mass spectrometry” by Qin Hao Lin et al.

Anonymous Referee #1

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General Comments: 1. The introduction (starting around line 77) is improved, but the reader would still benefit from a brief, referenced paragraph that discusses the link between particle size and cloud droplet size for a given chemical composition. I think this will really help lead into the discussion of enrichment. It is not abundantly clear to the reader is the Twohy 1989 result is that small particles grow to small droplets and large particles grow to large droplets, independent of composition, or if the connection to small droplets is via $(\text{NH}_4)_2\text{SO}_4$ and to large droplets through NaCl. This is the foundation of the manuscript and could be made much more clear. Essentially, this should be a concise introduction to the physics behind how chemical enrichment in large (or small) cloud droplets could come about. 2. I think it would be tremendously

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helpful to have a figure (comparable to figure 3A, but for particles) that shows the number fraction of sea-spray (or sea-salt as termed here) as a function of particle size for the ambient aerosol (not cloud residuals). This distribution could then be compared to the cloud residual distribution to identify enrichment. The paper currently argues that compositional differences in submicron SSA drive the observed changes in the cloud residual number fractions. This may be true, but more detail on the ambient aerosol distribution would help support (or refute) this argument.

Specific Comments Line 43: I don't think that Cochran et al is an appropriate primary reference for this statement. Line 52: I'm not sure how well founded this sentence is. The uncertainty in the CCN activity of sea-spray aerosol is much more a function of variance in the size distribution of SSA than its composition outside of the smallest SSA. There remain open questions as to why the hygroscopicity of SSA is so high given the organic content. See Collins et al., GRL 2016 (<https://doi.org/10.1002/2016GL069922>) Line 58: Given that SSA is largely organic, consider changing from sea salt aerosol to sea spray aerosol. Line 64: I don't think the conclusion of Wang et al 2015 is that the enrichment does not always occur. The conclusion is that the fraction of aliphatic organic material in SSA has some level of variability given surface ocean composition. Figure 4 is extremely complicated. I would recommend a more detailed figure caption that defines what "mixing fraction means". Is one to interpret that a value of 1 (or red) for nitrate is that all of the particles detected at this size have nitrate?

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