

Rhodes et al. use a chemical transport model to examine the importance of the sea ice source of sea salt aerosol (SISS) relative to the ocean source of sea salt aerosol (OOSS) in the Arctic. They compare their model to observations of sea salt aerosol in the atmosphere and high resolution Na⁺ measurements in Greenland ice cores. I found this paper very hard to follow and in the end it wasn't clear what was learned from their modeling exercise beyond what others have published.

Because the processes responsible for the emission of SISS into the atmosphere are not well understood, the authors "tune" their model to best match the aerosol observations. In the discussion of all of the different parameters that can be tuned, the manuscript would greatly benefit first from an explicit description of the parameterization for SISS (i.e., show the actual equations, and define all of the variables). Without it, it is very hard to follow the discussion of the model tuning.

It seems however that some of the model tuning has to do with the treatment of aerosol deposition in the model, not just the SISS emission parameterization, the discussion of which is also confusing. Not all of the terms in Equation 1 are defined. What is $\alpha^{C PC_L}$ and $\alpha^{N PN_L}$? Is this somehow related to α_C , α_N , PN_L and PC_L ? It looks like there must be a mix up of subscripts and superscripts in either the equation or the text. Does the model calculation of dry deposition include gravitational settling of the larger ($r > 4 \mu\text{m}$) particles? If not, it should. The modeled wet deposition seems to be missing some important processes (Page 13). It's also not clear if the modified snow precipitation directly influences wet deposition, or if the modeled wet deposition uses the "incorrect" precipitation.

I think what is new about this manuscript is the comparison of the model with Greenland ice core Na⁺ observations. However, this is probably the most ambiguous part of the paper, and it's not clear to me what they learned from this exercise. They are comparing modeled versus observed seasonality, although it seems that the seasonality of ice core Na⁺ is unclear as it was determined assuming constant snow accumulation rates, which is probably not consistent with reality. Also perhaps the seasonality is not well preserved in the observational record because of factors such as snow redistribution and sastrugi (page 14). In the end it seems that the model shows little skill at simulating the observed seasonality of ice core Na⁺, although it's questionable whether the "observed" seasonality represents the true seasonality of Na⁺ deposition to the Greenland ice sheet. The second paragraph of the summary (section 6) I think attempts to articulate what they learned from the model/ice-core observation comparison, but I still cannot figure out what was learned from this exercise. Given that this is the main new contribution of this paper, the paper should be substantially revised to better articulate their scientific contribution.

More minor issues:

Page 2 line 30: The last sentence of this paragraph needs a reference.

Page 5 Lines 16-17: Provide a justification for the choice of 0.3 psu.

Page 5 Line 21 and elsewhere: What does “snow age” mean? This should be defined. It’s not clear how this should impact SISS.

Page 9 lines 8-9: How was scenario #3 parameterized? Did you simply reduce salinity by 50%?

Page 9 Line 17: Define NRMSD the first time used.

Page 11 line 1: Unfinished statement. What are you comparing the model simulations to?

Specify “snow accumulation” instead of just “accumulation” throughout the manuscript.

Page 14 line 24: What is a “Greenland ice core simulation”? Do you mean model simulation?

Page 15 line 25-26: Be sure to specify that this is for today’s climate. Perhaps it would be different in a different climate.

Figure S1 should be in the main text.

When Figure 3 is presented in the text, it is not yet clear what your “base case” simulation is, which I think is what the blue line is in the figure. This information should be presented in order.

Figure 7: What are the yellow and other 3 green colors? The acronyms should be restated in the figure caption.

Figure 8: The model-observation comparison appears good here probably because of the large (2 order-of-magnitude) range in the color bar. The observations themselves cover a much smaller range, so the color bar should be scaled according to the range of the observations. Also I’m not sure this is the appropriate figure type to show because of the uncertainties in the SISS parameterizations. It would be best to have a figure that communicates the full model range using all of your sensitivity simulations.