Geophysical Research Abstracts
Vol. 16, EGU2014-14099, 2014
EGU General Assembly 2014

The Arctic sea surface microlayer: a source of atmospheric ice nuclei?

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The Arctic climate is changing faster than almost anywhere else on the planet and future warming is predicted to exceed global mean changes. Central to this climate sensitivity are changes in cloud cover, water content, ice content and particle size. Low level stratus clouds which are ubiquitous in the Arctic region, frequently exist in a thermodynamically unstable mixed phase state; hence they are sensitive to ice nuclei. A key limitation in our ability to quantitatively understand and model these clouds is the identity, concentration and efficiency of ice nucleating particles in the Arctic. One potential source of ice nuclei in this region is from the sea surface microlayer which is enriched in organic material and thought to become concentrated in aerosol particles produced through bubble bursting. During the summer of 2013 we sampled sea surface microlayer using a remote control rotating drum sampler during the Aerosol-Cloud Coupling and Climate Interaction in the Arctic (ACCACIA) cruise. The samples were brought back on board the RSS James Clark Ross where we used a droplet freezing instrument to test for ice nuclei in these samples. We found that the concentration of ice nuclei in the sea surface microlayer was massively enhanced over the bulk sea water and were able to freeze droplets up to -7 C. We found that the sea surface microlayer was active in 15 sites between 70 N and 83 N. Tests showed that these ice nuclei were sensitive to heat which is consistent with a biogenic origin of these nuclei. Using filters we were also able to show that the bulk of the ice nucleating particles were on the order of 100s nm. These results show that there is a reservoir of ice nucleating particles in the sea surface microlayer which have the potential to influence Arctic clouds.