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Ice-nucleating particles in springtime cold-air outbreaks associated with Arctic haze

Erin Raif¹, Sarah Barr^{1,2}, Mark Tarn¹, James McQuaid¹, Martin Daily¹, Steven Abel³, Paul Barrett³, Keith Bower⁴, Paul Field³, Kenneth Carslaw¹, and Benjamin Murray¹

¹Institute for Climate and Atmospheric Science, University of Leeds, United Kingdom

²National Centre for Atmospheric Science, University of Leeds, United Kingdom

³Met Office, United Kingdom

⁴Department of Earth and Environmental Sciences, University of Manchester, United Kingdom

Concentrations of ice-nucleating particles (INPs) were measured in springtime cold-air outbreaks over the Norwegian and Barents Seas using filter samples taken on board the FAAM BAe-146 aircraft. These measurements of INP concentrations were comparable to the highest INP concentrations previously observed in the Arctic and were similar to typical terrestrial midlatitude INP concentrations. This is important because shallow cloud systems such as those in mid- to high-latitude cold-air outbreaks are highly sensitive to INPs and are a highly uncertain contributor to cloud feedbacks.

To investigate the types of aerosol responsible for this high INP concentration, we used aerosol-size data from underwing optical probes to derive an active site density of the INP samples. By comparing to laboratory derived active site densities of different aerosol types, this suggested that sea spray was unlikely to be a dominant INP type and that there were likely to be strong biological and dust components to the INP population. Scanning electron microscopy with energy-dispersive spectroscopy used on selected filters revealed that sub-micron particles were dominantly sulphates and carbonaceous, while super-micron particles were dominantly mineral dust.

Samples taken above the cloud decks had greater active site densities than those below, and back-trajectory analysis and meteorological conditions suggested a lack of obvious local INP sources. We hypothesise that the high INP concentration is most likely to be associated with aged aerosol that has accumulated over the Arctic (Arctic Haze). These high INP concentrations imply that these clouds may have a more negative cloud-phase feedback than their Southern Ocean equivalents.