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Retrievals of infrared surface emissivity over Greenland and implications for Arctic climate change

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We present retrievals of infrared spectral surface emissivity made from the Tropospheric Airborne Fourier Transform Spectrometer (TAFTS) and Airborne Research Interferometer Evaluation System (ARIES), flying over Greenland during March 2015. To the best of our knowledge these represent the first ever aircraft based measurements of snow and ice emissivity spanning the full far (FIR: wavelengths > 15 microns) and mid (MIR) infrared. We describe the flight campaign and instrumental setup as well as the retrieval method, including the quality control performed on the observations. The results indicate that the snow and ice surfaces overflown have emissivities that show distinct spatial and spectral variability and can be substantially less than 1. The impact of these factors is often not considered in state-of-the-art climate models which typically assume either black or grey body surface emission. However, recent modelling work has shown that including more realistic estimates of snow and ice emissivity may play a key role in determining the pace of Arctic climate change via a so-called 'ice-emissivity feedback' mechanism.

Comparison with the theoretical snow/ice emissivities used in these modelling studies shows that when considering the FIR alone, they are able to match our retrievals within uncertainties. However, when we include the contemporaneous retrievals from the MIR the theoretical representations struggle to capture the observed behaviour across the full infrared. Our results highlight the need for improvements in our understanding of the radiative behaviour of snow/ice surfaces including further observational characterisation, ideally including in situ measurements of the underlying surface conditions.