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Validation of satellite ice surface temperatures in the Arctic and the relationship to 2 meter air temperatures

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Traditionally, the availability of in situ observations of ice surface temperature is very limited and therefore satellite observations are very important for obtaining a spatially broad and continuous measurement of the ice surface temperature. However, today there is no fiducial reference measurement ice surface temperature (FRM IST) dataset that can be used for routine validation of satellite IST products. To establish the uncertainty budget for instruments in the Arctic, an inter-comparison of ice surface temperature drifting buoys and a field inter-comparison experiment were conducted. The uncertainty budget includes contributions from the uncertainty on the in situ measurements, uncertainty on the satellite IST products and spatial, temporal and vertical variability. The uncertainty budget was based on observations from ice drifting buoys in Qaanaaq, Greenland and radiometric IST skin observations from an automatic weather station. It was showed that the cumulated effects of the components not associated with uncertainties in the satellite IST retrievals can reach more than 5 °C. Results also showed that the most suitable FRM observations for satellite validation are traceable radiometric observations from an FRM radiometer measuring at subhourly intervals.

In addition, the relationship between ice surface temperature and near surface air temperature (IAT) has been analyzed using in situ data from different deployments at the Greenland Ice Sheet, Arctic Ocean, and Alaska. The diurnal, seasonal, and inter-annual variability is resolved and the temperature differences are analyzed with respect to clouds, wind, and shortwave radiation. IST and IAT are often well coupled, and the two temperatures can be close (<1°C) at particularly times and during certain conditions. The assessment indicates the best agreement between IST and IAT around noon and early afternoon in spring and fall. Strong winds, overcast conditions and large solar insolation tend to weaken vertical stratification. However, IST and IAT often differ by several degrees or more, with the largest differences occurring during winter and night where the surface cools faster than the atmosphere. The findings will inform data users on the difference between IST and IAT and help developing methods to estimate IAT using satellite ISTs.