Abstract for poster presentation at EGU 2023 session NP5.4 on "Coupled Data Assimilation, Observations, and Uncertainties in the Earth System"

Title: **Analysis of airborne-derived sea ice emissivities up to 340 GHz in preparation for future satellite missions**

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Passive microwave radiometers onboard polar-orbiting satellites provide global information on the atmospheric state. The underlying retrievals require accurate knowledge of the surface radiative properties to distinguish atmospheric from surface contributions to the measured radiance. Polar surfaces such as sea ice contribute up to 400 GHz to the measured radiance due to the high atmospheric transmissivity under cold and dry conditions. Currently, we lack an understanding of sea ice parameters driving the variability in its radiative properties, i.e., its emissivity, at frequencies above 200 GHz due to limited field data and the heterogeneous sea ice structure. This will limit the use of future satellite missions such as the Ice Cloud Imager (ICI) onboard Metop-SG and the Arctic Weather Satellite (AWS) in polar regions.

To better understand sea ice emission, we analyze unique airborne measurements from 89 to 340 GHz obtained during the ACLOUD (summer 2017) and AFLUX (spring 2019) airborne campaigns and co-located satellite observations in the Fram Strait. The Polar 5 aircraft carried the Microwave Radar/radiometer for Arctic Clouds (MiRAC) cloud radar MiRAC-A with an 89 GHz passive channel and MiRAC-P with six double-sideband channels at 183.31 GHz and two window channels at 243 and 340 GHz. We calculate the emissivity with the non-scattering radiative transfer equation from observed upwelling radiation at 25° (MiRAC-A) and 0° (MiRAC-P) and Passive and Active Microwave radiative TRAnsfer (PAMTRA) simulations. The PAMTRA simulations are based on atmospheric profiles from dropsondes and surface temperatures from an infrared radiometer.

The airborne-derived sea ice emissivity (O(0.1km)) varies on small spatial scales (O(1km)), which align with sea ice properties identified by visual imagery. High-resolution airborne-derived emissivities vary more than emissivities from co-located overflights of the GPM constellation due to the smaller footprint size, which resolve sea ice variations. The emissivity of frozen and snow-free leads separates clearly from more compact and snow-covered ice flows at all frequencies. The comparison of summer and spring emissivities reveals an emissivity reduction due to melting. We will also conduct evaluations of emissivity parameterizations (e.g. TELSEM^2) and provide insights into observations at ICI and AWS frequencies over Arctic sea ice. Findings based on the field data may be useful for the assimilation of radiances from existing and future microwave radiometers into weather prediction models in polar regions.