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Arctic Sea-Ice Permittivity Derived from GNSS Reflectometry Data of the MOSAiC Expedition

Maximilian Semmling[1], Jens Wickert[2,3], Frederik Kreß[2], Mainul Hoque[1], Dmitry Divine[4], Sebastian Gerland[4], and Gunnar Spreen[5]

[1]German Aerospace Center DLR, Institute for Solar-Terrestrial Physics, Neustrelitz, Germany (maximilian.semmling@dlr.de)
[2]German Research Centre for Geosciences GFZ, Potsdam, Germany
[3]Technische Universität Berlin, Germany
[4]Norwegian Polar Institute, Fram Centre, Tromsø, Norway
[5]University of Bremen, Institute of Environmental Physics, Bremen, Germany

Sea ice is a crucial parameter of the Earth's climate system. Its high albedo compared to water and its insulating effect between ocean and atmosphere influences the oceans' radiation budget significantly. The importance of monitoring sea-ice properties arises from the high variability of sea ice induced by seasonal change and global warming. GNSS reflectometry can contribute to global monitoring of sea ice with high potential to extend the spatio-temporal coverage of today's observation techniques. Properties like ice salinity, temperature, thickness and snow cover can affect the signal reflection. The MOSAiC expedition (Multidisciplinary drifting Observatory for the Study of Arctic Climate) gave us the opportunity to conduct reflectometry measurements under different sea-ice conditions in the central Arctic. A dedicated setup was mounted, in close cooperation with the Alfred-Wegener-Institute (AWI), on the German research icebreaker Polarstern that drifted for one year with the Arctic sea ice.

We present results from data recorded between autumn 2019 and spring 2020. The ship drifted in this period from the Siberian Sector of the Arctic (October 2019), over the central Arctic (November 2019 until May 2020) towards Fram Strait and Svalbard (reached in June 2020). Profiles of sea-ice reflectivity over elevation angle (range: 1° to 45°) are derived with daily resolution considering reflection data recorded at left-handed (LH) and right-handed (RH) circular polarization. Respective predictions of reflectivity are based on reflection models of bulk sea ice or a sea-ice slab. The latter allows to include the effect of signal penetration down to the underlying water. Results of comparison between LH profiles and bulk model confirm a reflectivity decrease (about 10 dB) when surrounding open water areas is reduced (by freezing) and the ship drifts in compact sea ice.

Further results comprise estimates of sea-ice permittivity from mid-elevation range reflectivity (10° to 30°). The median of estimated permittivity 2.4 (period of compact sea ice) lies in the expected range of reported old ice type (mostly second-year ice). The retrieved reflectivity in the low-elevation range (1° to 10°) give strong indication of signal penetration into the dominating second-year ice with influence of sea ice temperature and thickness. We conclude that sea-ice

characterization in future can profit form GNSS reflectometry observations. The on-going study is currently extended to the further evolution of Arctic sea ice during winter and spring period of the MOSAiC expedition.