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Development of a permittivity sensor for melting probes to explore terrestrial and extraterrestrial cryospheres

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We will present the design of a permittivity sensor that can be attached to a melting probe and measure the respective ice properties during the melting process, yielding in a comprehensive permittivity profile. Melting probes were already successfully applied in terrestrial cryospheres, such as alpine glaciers and Antarctica. Further applications to cross the ice shield on Dome C in Antarctica or even on icy moons in the outer solar system, such as Europa, are already planned e.g. within the TRIPLE project line funded by the German aerospace center. A sensor measuring the permittivity of the surrounding ice in situ during melting could provide valuable data about the ice properties. The respective density of the ice is correlated with the permittivity, or volcanic ash layers can be identified through permittivity measurements. Another usage of the data could be to correct distance measurements from radar travel times within the ice.

The sensor is designed to operate in the frequency range of 0.1 - 1.5 GHz and works in the range of the near field, which is defined to be within one wavelength, corresponding to the frequency. The concept of this sensor is based on an open coaxial probe, which is connected to the medium of interest. The measurement principle and calibration techniques, as well as first lab measurement results of ice and other materials will be presented. A comprehensive data set on effects of porosity, salinity and impurities of lab-manufactured ice samples on the permittivity will also be given. These data will help to interpret the taken permittivity profiles of glaciers on further missions.

We will also show how the device can be integrated into a melting probe, such as the TRIPLE melting probe. One major challenge is to ensure good contact to the ice during measurement. The diameter of a melting hole often results to be several cm larger in diameter than the melting probe itself. A mechanism that extends the sensors of the melting probe and press it onto the ice for measurements is being developed.