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Topic: Critical drivers for ocean salinity science and applications and the future need for high-resolution technologies

Title: Beyond L-Band: Wideband (0.4–2 GHz) Radiometry for Observing Surface Salinity in Cold Seawater

Abstract: The salinity of polar oceans is undergoing significant changes due to sea ice melt and increased continental runoff, which have resulted in a decrease in sea surface salinity (SSS) across most regions of the Arctic Ocean, intensifying upper ocean stratification. In the Southern Ocean, changes in the extent and thickness of Antarctic sea ice are also striking, and are also linked to SSS changes. These shifts profoundly impact ocean circulation, the ocean's capacity to absorb atmospheric heat and carbon, and ultimately, Earth's climate. However, current climate models struggle to accurately represent high-latitude water mass properties.

SSS is recognized as an Essential Climate Variable (ECV) by the Global Climate Observing System (GCOS). While current 1.4 GHz radiometer missions have revolutionized global SSS measurements at scales of 40–150 km with revisit intervals of 3 to 8 days, their sensitivity to SSS diminishes by a factor of ~3 between 30°C and 0°C, leading to large SSS uncertainties in polar regions.

L-band radiometry (1.4 GHz) has enabled global monitoring of SSS from space, but the errors of retrieved SSS are two to three times larger in cold waters than in warm waters due to reduced sensitivity of the radiometric signal to SSS. The CryoRad mission, an ESA Earth Explorer 12 mission idea selected for a Phase 0, features a radiometer with an extended frequency range of 0.4–2 GHz, designed to improve SSS measurement accuracy in cold waters. In this presentation, we investigate the potential of wideband passive microwave radiometry (0.4–2 GHz). Using a multi frequency Bayesian retrieval scheme, we show that wideband radiometry has the potential to reduce SSS uncertainties by a factor of 2 to 3 in cold and salty waters, and by more than a factor 4 for SSS around 20 pss. Wideband SSS retrievals would also be more resilient to radiometric calibration issues than L-band. Consequently, wideband radiometry could enable the detection of geophysical SSS anomalies in many polar regions where this is not possible with current Earth observation satellites. The lowest frequencies are the ones contributing the most to the uncertainty decrease. Our study highlights the need to pursue research into technical and methodological development for optimizing radiometric measurements in the low frequency range, and minimize the impact of Radio Frequency Interference, of the galactic signal and, during the day, of the sun. Wideband radiometry could represent a breakthrough with respect to L-Band radiometry for monitoring SSS variations in the polar regions where large climate variability is ongoing, under the interaction between the ocean, atmosphere and cryosphere.

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