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ADVANCES IN SPACEBORNE MICROWAVE RADIOMETERS

Abstract

Passive microwave radiometer systems, such as SSM/I, AMSR-2, AMSU, WindSat and GMI, have been providing important Earth observations for over 30 years, including by not limited to surface wind vector, atmospheric and surface temperature, water vapor, clouds, precipitation, snow and sea ice. These data are critical for weather forecasting and the longevity of the record, along with careful calibration, has also enabled the extraction of climate records. These sensors have typically been developed at high cost and deployed on large spacecraft. It is anticipated that more frequent revisit time will be required to initialize future evolutions of numerical weather prediction models, driving sensor constellations. A cost-feasible solution for a constellation will lie in smaller, lower-cost but equally capable sensors manifested on free-flying small-satellites which can open the door to new possibilities and an avenue for sustainable passive microwave observation. Among the possibilities are deployment in constellations to shorten revisit time to improve weather forecasting or routine deployment of single sensors over time to ensure an unbroken long duration climate record.

This talk will summarize the current state-of-the-art in small-satellite compatible, compact microwave radiometer systems and concepts for the future. JPL has developed radiometers for several recent spaceborne missions including Sentinel-6, SWOT, TEMPEST and STP-H8. We will describe the on-orbit performance of two mm-wave radiometers systems, TEMPEST (2018-present) and the High-Resolution Microwave Radiometer (HRMR) on Sentinel-6 (2021-present). TEMPEST and HRMR operate from 90-182 GHz. HRMR is the first mm-wave radiometer to use internal electronic calibration sources in space, an innovation that supports faster calibration to mitigate systematic noise (1/f noise) and also enables calibration without the need for mechanical scanning. We will also discuss the on-orbit performance of the recently launched (2022) Compact Ocean Wind Vector Radiometer (COWVR), which is a new 18-34 GHz conical microwave imager that is suitable for deployment on a small satellite. It has a simplified design compared to legacy conical microwave imagers and is therefore less costly to produce and can be accommodated on an ESPA-class satellite. COWVR will operate on the ISS from 2022-2025. COWVR leverages radiometer technology matured for the radiometers on the Jason-2/3 and SWOT missions. We will discuss results from these new radiometers as well as future concepts for spaceborne missions that build upon their designs, including digital radiometer architectures that allow the radiometer systems to work in the presence of radio frequency interference (RFI) and measure more of the microwave spectrum.