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Airborne Demonstration of Microwave and Wide-Band Millimeter-Wave Radiometers to Provide High-Resolution Wet-Tropospheric Path Delay Corrections for Coastal and Inland Water Altimetry

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Current satellite ocean altimeters include nadir-viewing, co-located 18-34 GHz microwave radiometers to measure wet-tropospheric path delay. Due to the size of the surface instantaneous fields of view (IFOV) at these frequencies, the accuracy of wet path retrievals is substantially degraded near coastlines, and retrievals are not provided over land. Retrievals are flagged as not useful within approximately 40 km of the world's coastlines. A viable approach to improve their capability is to add wide-band high-frequency millimeter-wave window channels in the 90-180 GHz band, thereby achieving finer spatial resolution for a limited antenna size. In this context, the upcoming NASA/CNES/CSA Surface Water and Ocean Topography (SWOT) mission is in formulation and planned for launch in late 2020. The primary objectives of SWOT are to characterize ocean mesoscale and sub-mesoscale processes on 10-km and larger scales in the global oceans and provide measurements of the global water storage in inland surface water bodies and the flow rate of rivers. Therefore, an important new science objective of SWOT is to transition satellite altimetry from the open ocean into the coastal zone and over inland water.

The addition of 90-180 GHz millimeter-wave window-channel radiometers to current Jason-class 18-34 GHz radiometers is expected to improve retrievals of wet-tropospheric delay in coastal areas and to enhance the potential for over-land retrievals. In 2012 the Ocean Surface Topography Science Team Meeting recommended to add high-frequency millimeter-wave radiometers to the Jason Continuity of Service (CS) mission.

To reduce the risks of wet-tropospheric path delay measurement over coastal areas and inland water bodies, we have designed, developed and fabricated a new airborne radiometer, combining three high-frequency millimeter-wave window channels at 90, 130 and 168 GHz, along with Jason-series microwave channels at 18.7, 23.8 and 34.0 GHz, and validation channels sounding temperature and water vapor near 118 GHz and 183 GHz, respectively. For nadir-viewing space-borne radiometers with no moving parts, two-point internal calibration sources are necessary, and we have matured the technology to provide sufficient power with such sources at 90 to 170 GHz millimeter-wave frequencies. This instrument development and subsequent flight demonstration will (1) assess wet-tropospheric path delay variability on 10-km and smaller spatial scales, (2) raise the technology readiness level (TRL) of high-frequency millimeter-wave radiometry with direct detection and internal calibration to improve wet-tropospheric delay estimation over both coastal and inland water areas, and (3) provide an instrument for calibration and validation in support of the SWOT and Jason-CS missions. The first airborne demonstration of this instrument aboard a Twin Otter Aircraft near Grand Junction, CO, USA, is planned for the March-April 2014 time frame.