High-Resolution Wet-Tropospheric Path Delay Retrieved from Flights of the High-frequency Airborne Microwave and Millimeter-wave Radiometer (HAMMR) over Coastal Areas and Inland Water

Steven C. Reising*[(1)], Xavier Bosch-Lluis[(1)], Pekka Kangaslahti[(2)], Alan B. Tanner[(2)], Shannon T. Brown[(2)], Sharmila Padmanabhan[(2)], Victoria D. Hadel[(1)], Thaddeus P. Johnson[(1)], Karen Ng[(1)], Oliver Montes[(2)], Chaitali Parashare[(2)], Behrouz Khayatian[(2)], Douglas E. Dawson[(2)], Todd C. Gaier[(2)] and Behzad Razavi[(3)]

(1) Microwave Systems Lab, Colorado State Univ., Fort Collins, CO 80523 USA
(2) Jet Propulsion Laboratory, NASA/Caltech, Pasadena, CA 91109 USA
(3) University of California at Los Angeles, Los Angeles, CA 90095 USA

Past and current precision spaceborne ocean altimeters, including the Jason series, have co-located nadir-viewing 18-34 GHz microwave radiometers to correct the radar signal for wet-tropospheric path delay. Due to the significant footprint sizes at these microwave frequencies, the accuracy of wet path delay retrievals is significantly degraded within approximately 40 km of the world's coastlines, and retrievals are not provided over land.

The NASA/CNES/CSA Surface Water and Ocean Topography (SWOT) mission, a Tier-2 U.S. National Research Council Earth Science Decadal Survey Mission, is now in formation and planned for launch in late 2020. An important new science objective of SWOT is to improve the spatial resolution of satellite altimetry and to extend it from the open ocean into the coastal zone and over inland water. The addition of 90-175 GHz high-frequency, wide-band millimeter-wave window channels to current Jason-class 18-34 GHz microwave radiometers will improve the spatial resolution of wet path delay retrievals for the same size of reflector antenna. This has the potential to extend wet-tropospheric delay retrievals to coastal areas, measure its variability over the 120-km wide swath of SWOT's Ka-band Radar Interferometer and enhance the potential for over-land retrievals.

To address these needs, Colorado State University (CSU) and NASA/Caltech Jet Propulsion Laboratory (JPL) have designed, fabricated and demonstrated the High-frequency Airborne Microwave and Millimeter-wave Radiometer (HAMMR) instrument with 25 channels from 18.7 to 183 GHz. The new airborne HAMMR instrument (1) provides a calibration and validation instrument for the SWOT, Jason-3 and Jason-CS missions that is complementary to JPL's AirSWOT, (2) assesses wet-tropospheric path delay variability on the order of 100-m spatial scales, and (3) provides high-frequency millimeter-wave radiometers with internal calibration that can be integrated into future space missions, including potential future CubeSat demonstration missions. The HAMMR instrument was deployed on Twin Otter aircraft for nearly 68 flight hours over 7 U.S. states and nearly the entire West Coast of the U.S. Analysis is in progress to study the fine-scale variation of wet path delay over a wide variety of atmospheric conditions.