Retrieval of Wet-Path Delay from SSMIS Observations over Coastal and Inland Water Regions using the Brightness Temperature Deflection Ratio Method

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Currently, wet-tropospheric path delay measurements over inland water and coastal areas are extremely sparse. They are generally limited to twice-per-day radiosonde launches and a few ground-based GPS or radiometer path delay measurements, as well as radar measurements of phase delay to a small number of fixed targets on the ground. Knowledge of the wet-tropospheric path delay is needed to correct altimeter measurements for the Surface Water and Ocean Topography (SWOT) mission concept, accelerated by NASA and planned for launch in 2019. The hydrological objective of SWOT is to provide global height measurements of inland surface water bodies with area of greater than 250 m^2 and flow rate of rivers with width greater than 100 m. In addition, information on total precipitable water vapor under nearly all weather conditions will help with initialization of numerical weather prediction models. Currently, 18-34 GHz microwave radiometers provide wet-path delay corrections for the Jason series of nadir-viewing altimeters. The higher spatial resolution of the Ka-band Interferometric Radar planning for SWOT requires a smaller instantaneous field of view of the on-board radiometers. The extension of microwave radiometers up to higher millimeter-wave frequencies (70-170 GHz) provides smaller footprint sizes proportional to wavelength.

In this work, we present wet-path delay retrievals from the brightness temperatures measured by the Special Sensor Microwave Image/Sounder (SSMIS) using the Brightness Temperature Deflection Ratio (BTDR) method. This new algorithm retrieves wet-path delay without the use of *a-priori* data by using background contrast in the ground scenes while avoiding the need for specific knowledge of their characteristics. The algorithm uses the ratio of differences, otherwise known as a deflection ratio, in brightness temperatures measured by the radiometer for two adjacent scenes to resolve the transmissivity of the atmosphere due to water vapor. This transmissivity is mapped to wet-path delay using state-of-the-art absorption models, including the Rosenkranz 1998 absorption model, which was adapted from Liebe's original Millimeter-wave Propagation Model (MPM). The transmissivity of the atmosphere is found by minimizing a cost function derived from the radiative transfer model and radiometric measurements using the sum of squared errors with using two degrees of freedom. An error analysis technique to assess the self-consistency of the retrieval is used to estimate the error of the BTDR retrieved wet path delays. Retrievals are demonstrated over a number of coastlines and inland bodies of water and compared to independently derived total precipitable water products from the GPROF 2010 algorithm using measurements from SSMIS and other space-borne microwave and millimeter-wave radiometers.