Retrieval of Precipitation from Spaceborne GNSS-Reflectometry

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Abstract

Spaceborne GNSS-Reflectometry has been demonstrated capable of providing accurate estimates of numerous geophysical parameters, most prominently ocean surface wind speed, one of the main science objectives of the NASA CyGNSS mission, a constellation of eight satellites launched in 2016. The ESA ECOLOGY project aimed to evaluate the latest CyGNSS product release following a number of incremental updates in the signal calibration approach. Beyond ocean wind speed, CyGNSS signal sensitivity to additional atmospheric and ocean parameters using reference data from the ECMWF ERA-5 reanalysis model is assessed. For the first time, the unprecedentedly large spaceborne catalogue from the eight CyGNSS receivers allows statistically satisfying data separation, providing an opportunity for a quantitative assessment of signal sensitivity to a number of additional geophysical variables including significant wave height (SWH), precipitation, and sea surface temperature (SST). CyGNSS Sigma0 is found to be highly dependent on both significant wave height and precipitation, with similarly strong effects at lower wind speeds (up to 4dB). In comparison, SST is found to have a significantly smaller impact (~0.6dB), albeit affecting Sigma0 equally at all ocean wind speeds. These results suggest that these additional dependencies may need to be accounted for in future inversion strategies to achieve better estimates of ocean wind speed. Conversely, these strong secondary dependencies pave the way to retrieving other geophysical variables such as precipitation above the ocean. Preliminary results of GNSS-R-derived rainfall estimates above the ocean presented in this work show good agreement with verification data from the Global Precipitation Climatology Project (GPCP).