Relating CYGNSS Observations to Soil Moisture Variations During The 2018 Hurricane Season

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NASA's Cyclone Global Navigation Satellite System (CYGNSS) is a GNSS-Reflectometry (GNSS-R) mission that was recently launched (December, 2016) to observe ocean winds and tropical hurricanes. The mission is a constellation of eight small satellites that operate at L-band, enabling more frequent revisits compared to a large, single satellite. Moreover, CYGNSS has a sufficiently large coverage over lands between 38° south and 38° north latitudes as well. Although the system is not dedicated to land observations, it has the potential to be utilized for the remote sensing of land geophysical parameters.

Soil moisture (SM), for example, is a key geophysical parameter that will unveil the Earth's hydrological balance if observed on a global basis. This can improve major Earth science applications such as crop yield or flood detection. SM can be retrieved from CYGNSS observations as GNSS-R deliverables are proven to be highly sensitive to SM variations in the case there is no high topographic relief. Retrieval can be handled by two major steps: (1) converting CYGNSS's delay-Doppler map of bistatic radar cross section into reflectivity since specular Fresnel reflection dominates diffuse scattering on land; (2) creating a model between CYGNSS reflectivity and SM in conjunction with the other land parameters such as surface roughness and vegetation water content (VWC).

This study aims to demonstrate quantitatively the correspondence between the CYGNSS observations and SM through the hurricanes, Gordon and Florence that led to high spatio-temporal SM variations over Mississippi-Louisiana-Arkansas, and North Carolina, respectively. SM measurements of the NRCS's Soil Climate Analysis Network (SCAN) sites and observations of satellite missions (such as NASA's Soil Moisture Active Passive) will be used for ground-truth. The Signals of Opportunity Coherent Bistatic Scattering Model (SCoBi) developed by our group will be used to quantify the effects of the land parameters on reflectivity.

The preliminary results indicate that a direct correlation between the magnitudes of the CYGNSS observations and SM measurements is not apparent. This is likely because surface roughness and topography relief, and vegetation vary largely within the field, which leads to different GNSS-R sensitivities and reflectivity responses to similar spatio-temporal SM levels. On the other hand, temporal changes in CYGNSS observations due to the hurricanes visually correspond to SM changes. These results indicate that SCoBi can be used to develop an inversion model for retrieving SM via CYGNSS reflectivity, thanks to its capability to take the effect of every land parameter into account.