Detection of Dominant Scattering Modes Over Land and Ocean Surfaces Using CYGNSS Level-1 Delay Doppler Maps

Mohammad Al-Khaldi[1], Joel T. Johnson[2], Scott Gleason[1],
Eric Loria[3] and Yuchan Yi[2]

[1]University Cooperation for Atmospheric Research, Boulder, CO, USA
[2]The Ohio State University, Columbus, OH, USA
[3]Jet Propulsion Lab, NASA, CA, USA

In spite of the Cyclone Global Navigation Satellite System (CYGNSS) mission's primary objective being the estimation of ocean surface winds, a number of investigations have highlighted the usefulness of the land specular scattering measurements its eight satellite constellation provides for remote sensing land surface properties such assoil moisture and composition, vegetation cover, and surface roughness.

Analyses of the nature of CYGNSS's land observations, however, suggest that they exhibit a variety of behaviors, with some measurements dominated by coherent reflection, some by incoherent scatter, and some by a mixture of the two. The prevalence of either is directly dependent on the properties of the reflecting surface. Since coherent returns typically arise due to reflection off smooth surfaces, they can introduce measurements with peak amplitudes many times larger than incoherent returns introducing significant variability within available CYGNSS measurements and limiting their correlation to the set of surface properties of interest. This is further complicated by the correspondence of each type of return to distinctly dissimilar spatial scales thereby significantly complicating GNSS-R land retrieval algorithms.

In support of GNSS-R remote sensing activities using CYGNSS's land data set, this presentation describes the development of a coherence detection methodology that applies to the constellation's Level-1 delay-Doppler Map (DDM) measurements thereby enabling the detection of coherence globally. The primary indicator of coherence that the algorithm uses is a 'power ratio' metric that quantitatively describes the extent of power spread in delay-Doppler space using ratios of integrated power within different portions of CYGNSS Level-1 DDMs. Because of this definition, the algorithm is also able to minimize the effects of calibration uncertainties on the coherence estimates it provides. The presentation will describe the results of extending this detection methodology to a multi-year CYGNSS dataset highlighting comparisons of the detector's estimates to 'gold standard' reference measures of coherence based on CYGNSS's Raw I/F mode datasets, the frequency with which fundamental scattering modes are observed, and their correspondence to surface properties. The usefulness of the detector will also be explored over ocean surfaces.