## Studies of GNSS-R Ocean Altimetry Using Full DDM-based Retrieval

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Global Navigation Satellite Signals Reflection (GNSS-R) observations can be used for measurements of sea surface height (SSH). Many previous studies have examined the method, and have focused on the use of delay waveforms (DW) in the retrieval of SSH information from GNSS-R measurements. The delay waveform is one "cut" from a complete Delay Doppler Map (DDM), which is defined as the amplitude/power distribution of the reflected signal in a 2-D array of delay offsets and Doppler shifts around the specular point.

This paper presents results from a simulation study of GNSS-R sea surface height retrievals, and compares the SSH retrieval performance between DWbased and full DDM-based approaches. The simulation is performed using a model for GNSS-R returns that includes the appropriate link budget, geometric, and noise effects. A description of the simulation approach, which incorporates both thermal and speckle noise and their approximate correlations among DDM pixels, will first be provided. The method is based on direct simulation of incoherently averaged DDM powers, so that greater efficiency is achieved in the Monte Carlo retrieval study. Retrieval results are obtained using a maximum likelihood retrieval method, in which the "distance" of an observed DDM from constructed "template" quantities is used to determine the retrieved SSH value. Retrieval results for the DW and DDM methods using both P- and C/A codes for various wind speeds will be presented. The presentation will discuss the results obtained as well as their implications for future GNSS-R altimetry missions. Tradeoffs in retrieval accuracy versus the spatial resolution of the retrieved SSH will also be discussed for the DDM and DW methods.