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GNSS coherent and incoherent reflected signals have the potential of deriving large scale parameters of ocean and ice surfaces, as barotropic variability, eddy currents and fronts, Rossby waves, coastal upwelling, mean ocean surface heights, and patterns of the general ocean circulation. In the reflection zone the measurements may derive parameters as sea surface roughness, winds, waves, heights and tilts from the spectral measurements. Previous measurements from mountain tops and airplanes have shown results leading to some of these parameters. Coming satellite missions, as CYGNSS, COSMIC-2, and GEROS on the International Space Station, have underlined the need for simulation studies highlighting the assumptions for the data retrievals and the precision and the accuracy of such measurements.

Forward simulation of the measured signals has often been used in the development of retrieval algorithms. The retrieval algorithms are used in the calculations of the geophysical parameters. This presentation describes a wave propagator that can be used to simulate GNSS reflected signals from ocean surfaces.

The theory of propagation of microwaves in the atmosphere is well established, and methods for propagation modeling range from ray tracing to numerical solutions to the wave equation. Besides ray tracing there are propagation methods that use mode theory and a finite difference solution to the parabolic equation. The presented propagator is based on the solution of the parabolic equation. The parabolic equation in our simulator is solved using the split-step sine transformation. The Earth's surface is modeled with the use of an impedance model. The value of the Earth impedance is given as a function of the range along the surface of the Earth. This impedance concept gives an accurate lower boundary condition in the determination of the electromagnetic field, and makes it possible to simulate reflections and the effects of transitions between different mediums. A semi-isotropic Philips spectrum is used to represent the air-sea interaction.

Simulated GPS ocean surface reflections will be presented and discussed based on different ocean characteristics. The spectra of the simulated surface reflections will be analyzed, and the results from the presented from the simulations will be compared both to measured GPS surface reflections and to similar results from a simulator developed by Zavorotny and Voronovich, based on a bistatic radar equation derived using the geometric optics limit of the Kirchhoff approximation. The analysis of both the simulated surface reflection signals and the measured reflection signals will reveal spectral structures of the reflected signals leading to the extraction of sea surface roughness, surface wind speed and direction.