

HF Radar for Large Area Sea Mapping with Ground-Ionosphere-Ocean-Space (GIOS)

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Knowledge of the sea is of primary importance for both ship transportation and HF radar clutter prediction. A new concept has been developed called HF Ground-Ionosphere-Ocean-Space (GIOS) which can view vast regions of the Earth's surface. Ground HF transmissions are reflected by the ionosphere to illuminate the ocean over a few thousand kilometers. HF receivers on low-earth-orbit satellites detect the radio waves scattered by the sea and land surface. Using the theory of radio wave scatter from ocean surfaces, the GIOS data is then processed to yield the directional wave-height spectrum of the ocean. The GIOS technique has several advantages over existing remote sensing methods. First, a large area of the ocean can be sampled to yield the wave-height characteristics with high, km-scale resolution. This measurement scale matches the grid size used in physics-based oceanographic models. The wave height spectrum can be directly compared with temporal frequency spectrum obtained with buoys at specific points in the ocean volume. Furthermore, the GIOS technique uses HF waves which penetrate the dense rain found in hurricanes. Microwave attenuation inside strong sea storms blocks mapping of the sea surface.

The GIOS program at NRL is being developed using both experimental and theoretical methods. To test the GIOS concept, ground HF transmissions from over-the-horizon radars were employed to scatter sky wave signals from the ocean to radio receivers in low-earth-orbit. The HF receiver (RRI) on the Canadian ePOP/CASSIOPE satellite has collected radio signals scattered from the ocean illuminated by ground transmitters in the US, Australia and Northern Europe. This satellite has two dipole antennas in a crossed configuration to measure HF waves below 18 MHz. Right and left hand circular polarization is synthesized from the data from the in phase (I) and quadrature (Q) data provided by the RRI digital instrument. For the ground HF transmission source, the Relocatable Over the Horizon Radar (ROTHR) system in Chesapeake Virginia was used to illuminate the ocean extending from coast of Florida to south of Jamaica. Range and Doppler processing of the radar waveforms yields an ocean scatter map at each time in the ePOP orbit.