Pulsed & Gated FMCW Waveform for Simultaneous Observables with Coastal HF Radar

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The use of commercial High Frequency Surface Wave Radar (HFSWR) for mapping coastal ocean surface currents introduced in 1982 and has since proliferated into extensive coastal HFR networks around the world. Surface current maps reveal spatially robust and temporally refined features of ocean circulation that, when used in conjunction with other tools and data layers, are a key component in numerous applications, including emergency search and rescue operations, oil spill response, hurricane tracking and analysis, oceanographic research, and numerical model assimilation. Other coastal HFSWR observables include wave parameters, tsunami detection, and vessel tracking, each of which has different temporal and spatial resolution requirements.

Surface current maps are measured and averaged over time scales of 20 –60 minutes for most applications. However, tsunamis with periods of 20 –40 minutes requires much more rapid updates, on the order of 2 –4 minutes. Vessel tracking also requires similar timed updates to properly track changes in position and heading. Wave parameters such as significant wave height, wave period and direction require longer averaging. While the SeaSonde® HFSWR is best known for its compact cross-loop antenna design, it is its waveform that is uniquely adaptable to a wide variety of spatial characteristics and timescales. By employing a pulsed and gated Frequency Modulated Continuous Wave (FMCW) transmission with nanosecond sweep timing accuracy, a single coastal station can simultaneously process all the above observables at their optimum time scales.

The precise sweep timing allows for multiple systems in the same region to transmit on the same frequency, reducing the amount of bandwidth required for a network and allowing all systems to operate simultaneously and continuously, which is critical for tsunamis and vessels. Each sweep is processed for range and stored locally, allowing for multiple processing threads to read variable numbers of sweeps over time scales that depend on the observable. In addition to the precise, continuous sweeping, the shaped pulsing is also a critical component of the waveform. It allows for closer spacing of transmit and receive antennas at a single site for systems below 11 MHz and combined transmit and receive antenna above 11 MHz. In addition, it allows for close spacing of multiple stations in confined areas of high resolution by timing stations to maximize bistatic sea echo and minimize the direct bistatic transmissions. The most recent benefit of pulsing is allowing for ITU–mandated call sign capability that can be broadcast without interruption of data collection and heard as Morse code on a simple AM receiver.

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