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Ocean Surface Roughness (Extended Abstract)

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Ocean Surface Roughness

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1. Introduction

Wind generated waves have many impacts beyond ride quality for mariners and damage to breakwaters and off-shore structures. While numerous air-sea interaction investigators [1], [2], and [3] have shown that waves can influence wind direction and influence storm intensity, Johns Hopkins University Applied Physics Laboratory (JHUAPL) researchers are looking at the influence of ocean waves on radar propagation. Researchers at JHUAPL have shown how clutter results from the interaction of the radar signal with the sea surface as the signal propagates from the radar to the target and back [4]. Effective detection of the target hinges on the design of appropriate clutter filters that separate the target signature from unwanted clutter.

In order to understand how surface waves impact RF propagation and sensor performance for air and surface defense problems, JHUAPL researchers have used the TRIAXYS™ Mini Directional Wave Buoy, which was first developed for use by the U.S. Navy. JHUAPL researchers have used this small (0.6m diameter) and lightweight (60kg) buoy, which is easily deployed by two people from the R/V CHESSIE, torpedo recovery boats, and patrol boats to accurately characterize ocean surface roughness. An example of this buoy is shown in Fig. 1 and a deployment diagram is provided in Fig. 2. Data includes time, location, average wave height, mean spectral period, maximum wave height, significant wave height, significant period, mean wave period, peak period, and wave steepness.

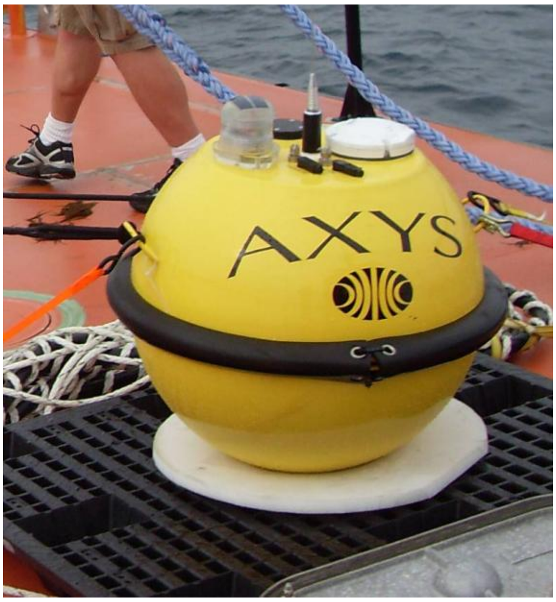

Figure 1. TRIAXYS™ Mini Directional Wave Buoy aboard a torpedo recovery boat

Measurement of wind waves are important since they are a primary contributor to ocean surface roughness, which is of critical importance to the interpretation of air-sea interaction processes. TRIAXYS™ Data Viewer Software is used to evaluate the frequency content of the waves, which permits partition of swell (low-frequency energy) and wind chop (high frequency energy.

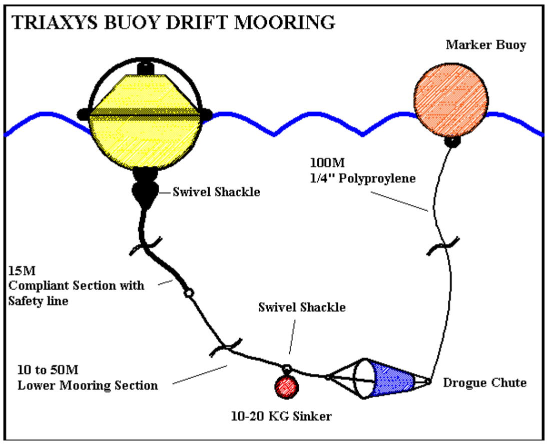

Figure 2. TRIAXYS Buoy Drift Mooring.

2. Conclusions

Understanding ocean surface roughness supports the development of physics-based models that evaluate radar scattering from small surface targets. Surface roughness measures are used in APL's radar propagation model, the Tropospheric Electromagnetic Parabolic Equation Routine (TEMPER), along with characterization of atmospheric refraction to compute propagation factors that are used in radar simulations and system performance studies.

3. References

[1] Nichols, C.R. and R.G. Williams, 1998. Variability of Winds across the Surf Zone. in Proceedings of the MTS/IEEE Oceans Community Conference, Baltimore, MD, 15-19 November 1998, 5 pp.

[2] Donelan, M. A., B. K. Haus, N. Reul, W. J. Plant, M. Stiassnie, H. C. Graber, O. B. Brown, and E. S. Saltzman, 2004. On the limiting aerodynamic roughness of the ocean in very strong winds, Geophysical Research Letters, Vol. 31, pp. 1-5.

[3] Zhang, Weiqing, William Perrie, Weibiao Li, 2006. Impacts of waves and sea spray on midlatitude storm structure and intensity. *Mon. Wea. Rev.*, 134, pp. 2418–2442.

[4] Awadallah, R. S., J.Z. Gehman, J.R. Kuttler, and M.H. Newkirk, 2004. Modeling Radar Propagation in Three-Dimensional Environments, *Johns Hopkins APL Technical Digest*, Volume 25, Number 2, pp. 101-111.