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HF radar observation of wave processes above, on, and under the ocean surface

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HF radar is widely used to measure ocean currents and, to a somewhat lesser extent, to provide estimates of wave height and the directional spectrum of surface gravity waves. Its two principal forms –HF surface wave radar and HF sky wave radar –exploit the corresponding propagation modes to sample the space-time geometry of the ocean surface over regions of the order 104 km2 and106 km2 respectively, with spatial resolution typically 100-101 km, sensing echo contributions from metre-scale phenomena up to synoptic-scale and updating on a timescale of seconds or minutes. Surprisingly, despite the proliferation of HF radar systems, with perhaps 500 HF radars presently in operation, on every continent, the scope of the standard remote sensing missions has remained almost unchanged since the first commercial systems were deployed some 40 years ago. This contrasts with the intrinsic measurement capabilities afforded by developments in radar and computing technology, which have improved by orders of magnitude. To counter this conservatism, the HF radar research group at the University of Adelaide is pursuing an ambitious research program seeking to expand the palette of missions, using state-of-the-art computer modelling of a wide variety of oceanic and atmospheric processes, together with advanced electromagnetics, to establish the associated HF radar signatures and to develop advanced signal processing techniques for extraction of this information from radar echoes in real-time. In several cases, the predictions have been validated with experimental measurements. This paper will review these recent developments, illustrated by examples including the detection of internal waves, the observation of nonlinear wave interactions including the Benjamin-Feir instability and Fermi-Pasta-Ulam recurrence, the non-adiabatic wave field response to tropical convective cells, and the prospect of detecting algal blooms and related surfactant effects.

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Chemical fractionation of fine particle–bound metals on haze–fog days and its contribution to human health risks in a megacity of China

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Information on chemical partitioning of airborne metals, particularly during haze–fog episodes, is limited. Fine particulate matter (PM2.5) was collected during a severe haze–fog event in winter and non–haze fog periods in summer and fall from a typical Chinese mega-city, Nanjing. The particulate-bound metals (Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, Pb, Sr, Ti, V, and Zn) were chemically fractionated by using a four–step sequential extraction procedure and human health risk was assessed. During the haze–fog episode, PM2.5 was extremely elevated with a mean concentration of 281 $\mu g/m^3$, whereas the mean PM2.5 concentrations in summer and fall periods were 86 μg/m3 and 77 μg/m3, respectively. All elements showed obviously higher concentrations and many metals exceeded the relevant limits on haze–fog days. K, Na, Sr, Zn, Mo, Ca, Cd, Mg, Mn, Cu, Ba, Cr and As all showed relatively high proportions of the soluble and exchangeable fraction and strong bio-accessible potential. High temperatures and humidity may increase the bio–accessible fraction of many particulate-bound metals. The hazard index for potential toxic metals was 0.115 and lower than the safe limit (1). However, the combined carcinogenic risk was 1.32×10−6 for children and 5.29×10−6 for adults, with both values being higher than the precautionary criterion (10−6). Results of this study can provide information for the geographical behavior and risk mitigation of airborne metals.

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