

Radiophysics and the geometry of the sea surface

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Abstract

The interface between the atmosphere and the ocean plays a fundamental role in human affairs, yet, although it has been the subject of countless studies, our understanding of its structure and dynamics falls far short of what is needed for many applications. This situation is due, in large part, to the limitations of our observing methods, even though there have been huge advances in sensor design and signal processing. Apart from obvious constraints such as coverage and resolution, a more fundamental limitation arises whenever the relationship between the quantities accessible to measurement and the physical variables of interest is ambiguous, or insufficiently sensitive. This consideration continues to motivate the search for techniques which are as ‘direct’ as possible, and which avoid, or at least minimise, assumptions about the phenomenon being observed. In particular, we must deal with the dichotomy between deterministic or pre-statistical measurements, on the one hand, and statistical characterisations, on the other.

By far the most successful methods, in terms of coverage, coverage rate, precision and logistic convenience, are those based on electromagnetic scattering or radiation from the sea surface. We include in this family, both active and passive techniques, covering the frequency range from the upper MF-band ($\sim 10^6$ Hz) to optical band ($\sim 10^{15}$ Hz). Clearly this covers a wide variety of sensors. In practice, the most detailed measurements of sea surface geometry on the length scales of dominant interest, which is to say $10^{-2} - 10^2$ m, are those derived from radar observations, though there are exciting developments occurring in the areas of lidar, sunglint analysis, visible spectrum radiance and microwave radiometry. In some cases the validation of these new methods will open the way for exploitation of large archived datasets which have hitherto yielded only a small part of their bounty.

This paper will survey the present situation in electromagnetic remote sensing of the geometry of the sea surface, including its dynamical behaviour and description. Results from a number of representative observational techniques will be presented, together with an assessment of perceived shortcomings and a personal view of the key questions now confronting researchers.