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ANALYTICAL STUDIES OF SCATTERING AND EMISSION BY THE SEA SURFACE

R.J. Wagner, Project Manager
Theoretical Physics Group

Geography Programs
Earth Sciences Division
OFFICE OF NAVAL RESEARCH
Department of the Navy
Arlington, Virginia 22217

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TRW SYSTEMS GROUP
One Space Park
Redondo Beach, California 90278

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An appropriate form of the sea surface wave height spectrum ~~was sought~~. Two forms were considered, one proposed by Pierson and one by Wu. The Pierson spectrum, investigated first, is represented by a continuous function defined over four regions of wave number space: an inertial sub-range of the gravity wave spectrum, a "transition" range joining the inertial sub-range and the capillary range, the capillary region, and the viscous range. The viscous region, in which the spectrum falls off very rapidly with increasing wave number, corresponds, according to Pierson, to surface structure smaller than about 0.01 cm. Little energy is contained in these high frequencies, and the spectrum may be set equal to zero in the viscous region. The wavenumbers corresponding to the start of the transition and capillary regions are, in Pierson's spectrum, wind-speed dependent. The second moment of the spectrum should give values of the mean square surface slope as a function of wind speed which resemble the quasi-empirical relation of Cox and Munk. Poor agreement was obtained, however, so an alternative spectrum proposed by Wu was investigated. This spectrum is basically a Phillips-type spectrum with a K^{-3} dependence in both the gravity and capillary regions but with a discontinuity at the start of the capillary region (that is, there is no transition region). The spectrum is set equal to zero in the inertial and viscous regions; the start of the capillary range occurs at the constant value of $K_c = 360\ m^{-1}$ while the effective cut-off of the spectrum (i.e., the start of the viscous range) is wind-speed dependent. The Wu spectrum was modified by adjoining to it the inertial-range spectrum of Pierson and also using the angle-dependent function of Pierson (as developed by Coté) to form the directional wave number spectrum. The second moments of this spectrum are in good agreement with the Cox and Munk results for the total slope variance, although a somewhat greater upwind/crosswind asymmetry is calculated. This modified form of the Wu spectrum will be used to describe the statistics of both the large and small-scale components of the composite surface model.

The effect of the small-scale surface structure on the emissivity is to be calculated using the Rice perturbation method. The "solutions" in the perturbation method are the Fourier coefficients of the scattered electric field vector, and to calculate the emissivity from these solutions using standard methods requires reconstruction of the spatial fields, derivation of the scattering coefficients, and finally a solid angle integration over all scattering directions. One of the contract tasks was to circumvent this lengthy and cumbersome procedure by deriving an equation which expresses the polarized emissivity directly in terms of the perturbation solutions, for any order of perturbation. This task has been completed. The small-scale roughness correction to the flat-plane emissivity can now be programmed for evaluation using the standard second-order perturbation solutions given in the literature. (In checking the published equations an apparently unrecognized error was found and corrected.)

The following reports were issued:

"Analytical Studies of Scattering and Emission by the Sea Surface," Final Report #17608-6006-R0-00, March 7, 1972, by R.J. Wagner and P.J. Lynch.

"Emission and Reflection from Anisotropic Random Rough Surfaces," Technical Report #17608-6005-R0-00, March 1972, by P.J. Lynch and R.J. Wagner.