Abstract View

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Albedos and Glitter Patterns of a Wind-Roughened Sea Surface

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ABSTRACT

The downward albedo (irradiance reflectance) r_- and the upward albedo r_+ of a random air–water surface, formed by capillary waves, are computed as a function of lighting conditions and wind speed by Monte Carlo means for incident unpolarized radiant flux. The possibility of multiple scattering of light rays and of ray-shielding of waves by other waves is included in the calculations. The effects on $r_\pm$ of multiple scattering and wave shielding are found to be important for higher speeds ($\gtrsim$10 m s^{-1}) and nearly horizontal light ray angles of incidence ($\gtrsim$70°). The Monte Carlo procedure is used to generate reflected and transmitted glitter patterns as functions of wind speed and sun position. These results are used to check the procedure's patterns against observed patterns. A simple analytic first-order model of glitter patterns and irradiance reflectance, which assumes a binormal distribution of water facet slopes, is tested against the relatively exact Monte Carlo results. Regions are defined in wind-speed and incident-angle space over which the first-order model is acceptable. Plots of the Monte Carlo $r_\pm$ are drawn as functions of wind speed and angle of incidence of light rays. The albedos $r_\pm$ are also found for various continuous radiance distribution simulating overcast skies and upwelling submarine light fields just below the air–water surface. Good agreement is found, were comparison can be made, between the computed albedos and albedos measured over the ocean surface.