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Optical impacts of oceanic coccolithophore blooms

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Abstract

Blooms of coccolithophores, particularly those of the species *Emiliania huxleyi*, cause light in the surface ocean to behave in an unusual fashion, producing distinctive bright "white waters," apparent from ships and readily detected by remote sensing. The brightness is caused by scattering of light from calcium carbonate platelets (coccoliths). Here we present the results of a modeling study, giving precise calculations of how the coccolith light scattering changes the behavior of light in the water. The results from a Monte Carlo optical model are closely compared to data from the CD60 cruise for a coccolithophore bloom south of Iceland in 1991 [*Holligan et al*., 1993], and the model is then used to extrapolate from the observational data to predict diverse optical properties that were not measured. Model performance was also tested by comparison of results with those from other, more established optical models. The model results demonstrate clearly that coccoliths cause (1) an increase in the emergent flux (the water-leaving radiance), (2) brighter, more intensely heated water in the top few meters, and (3) darker, less intensely heated water deeper down. Implications of these effects for phytoplankton productivity and for climatology are discussed. Coccolith light scattering is estimated to contribute to global annually averaged planetary albedo by a maximum of ~0.13%, equivalent to only a small globally averaged radiative forcing of ~0.22 W m^{-2}.

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