Abstract View

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Monte Carlo Calculations of Radiative Transfer in the Earth's Atmosphere-Ocean System: I. Flux in the Atmosphere and Ocean

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ABSTRACT

The upward and downward flux at various levels in the atmosphere and ocean is calculated by a Monte Carlo method which includes all orders of multiple scattering. A realistic model of the atmosphere-ocean system is used. In the atmosphere, both Rayleigh scattering by the molecules and Mie scattering by the aerosols as well as molecular and aerosol absorption are included in the model. Similarly, in the ocean, both Rayleigh scattering by the water molecules and Mie scattering by the hydrosols as well as absorption by the water molecules and hydrosols are considered. Separate single-scattering functions are calculated from the Mie theory for the aerosols and the hydrosols with an appropriate and different size distribution in each case. The scattering angles are determined from the appropriate scattering function including the strong forward-scattering peak when there is aerosol or hydrosol scattering. Both the reflected and refracted rays, as well as the rays that undergo total internal reflection, are followed at the ocean surface, which is assumed smooth. The ocean floor is represented by a Lambert surface. The upward flux as measured either just above the ocean surface or at the top of the atmosphere shows a significant dependence on the turbidity of the ocean water. The upward and downward flux is calculated at various wavelengths from 0.40 to 0.65 μ and for three ocean models: clear, medium turbid, and turbid. The dependence of the flux on the albedo of the ocean floor is presented. The upward as well as the downward flux is larger just below the ocean surface than just above it at those wavelengths with relatively little absorption by water molecules and under those conditions when there is relatively little scattering from the hydrosols. The ratio of the upward to downward flux in the ocean at points away from boundaries is of the order of 0.1 in transparent regions of the spectrum for a clear ocean, but decreases rapidly as either the turbidity or wavelength increases.

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