MULTI-ANGULAR MULTI-SPECTRAL POLARIZED REFLECTANCE FROM COASTAL WATERS FOR THE SEPARATION OF WATER ORGANIC AND INORGANIC PARTICULATE COMPONENTS

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ABSTRACT

Polarized solar radiation reflected from water bodies contains useful additional information about inherent optical properties (IOP), concentrations and size distributions of water constituents if compared with unpolarized data [1-3]. Study of polarized light components includes information about their spectral dependence, impacts of the illuminating and viewing angles, relationships with IOP, surface roughness, etc., both for the ocean itself and for the ocean-atmosphere system. Therefore, potential use of multi-angle polarimetry can be analyzed in the context of optical water properties, including the choice of appropriate sensor orientations and the minimization of sun glint effects. Detailed analysis of multi-angle polarization characteristics above open ocean waters was provided recently [2]. The impact of the mineral particles, typical of coastal water compositions, on the polarization parameters and possibility of the development of inversion algorithms based on these relationships were discussed before [1,3,4]. Much less data are available about experimental studies of multi-angle spectral polarized radiance due to the complexity of measurements and the difficulties arising in the separation of the water leaving radiance from the surface reflectance. Thus, recent experimental multi-angle studies include combined results of polarized reflectance both from particles inside the water and from the water surface [5].

In order to study polarization characteristics from coastal waters in more details, a modified hyperspectral radiance sensor from a Hyperspectral profiler (Satlantic) with very high sensitivity was used. The radiometer scanned the angular features of the polarized light in a given vertical plane defined by its azimuth angle relative to the Sun for viewing angles from -70 to +70 degrees in the main scattering plane for several stations in Jamaica Bay and Hudson River, NY, with varying concentrations of chlorophyll and mineral particles. Another Satlantic sensor measured simultaneously downwelling irradiance spectra for further normalization of the spectral data. Total reflectance spectra (GER Spectroradiometer), as well as water absorption and attenuation spectra (WET Labs AC-S instrument) were also measured at the same stations together with chlorophyll concentration [Chl] and organic and inorganic components of total suspended solids (TSS) from the water samples. Strong sun glint and sky effects that occurred in the main scattering plane were minimized by LSQ fitting procedure, which included matching of measured total reflectance spectra with calculated ones. The latter were simulated through a coupled air-ocean polarized radiative transfer code [2] using a four-component water model, which comprised of water itself, CDOM, phytoplankton-like and mineral-like particles whose size distributions and relative concentrations affect the polarization signatures of the backscattered light. The corresponding input values of [Chl], CDOM absorption at 400 nm and mineral concentrations were taken from measurements of water samples at the same stations.

Results of measured spectra of water leaving polarization components were compared with simulated spectra at various viewing angles in order to assess the deviations of measured polarization characteristics from calculated ones, as well as the sensitivity of these deviations to coastal water parameters. The results of the analysis are also used to develop design criteria for effective polarization sensors aimed to measure above and underwater characteristics of polarized light in coastal regions.

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