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Sławomir B. Woźniak, Sławomir Sagan, Monika Zabłocka, Joanna Stoń-Egiert, Karolina Borzycka



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Light scattering and backscattering by particles suspended in the Baltic Sea in relation to the mass concentration of particles and the proportions of their organic and inorganic fractions

*Sławomir B. Woźniak**, Sławomir Sagan, Monika Zabłocka, Joanna Stoń-Egiert, Karolina Borzycka

Institute of Oceanology Polish Academy of Sciences, Powstańców Warszawy 55, 81-712 Sopot, Poland

** corresponding author (e-mail address: woźnjr@iopan.gda.pl)*

Abstract

The empirical relationships were examined of spectral characteristics of light scattering and backscattering by particles suspended in seawater in relation to the dry mass concentration of particles and the bulk proportions of their organic and inorganic fractions. The analyses were based on empirical data collected in the surface waters of the southern and central Baltic Sea at different times of the year. It was found that the average scattering and backscattering coefficients, normalized to the dry mass concentration of particles for all our Baltic Sea data (i.e. mass-specific optical coefficients), were characterized by large coefficients of variation (CV) of the order of 30% at all the visible light wavelengths analysed. At wavelength 555 nm the average mass-specific scattering coefficient was ca $0.75 \text{ m}^2 \text{ g}^{-1}$ (CV = 31%); the corresponding value for backscattering was $0.0072 \text{ m}^2 \text{ g}^{-1}$ (CV = 29%). The analyses confirmed that some of the observed variations could be explained by changes in the proportions of organic and inorganic fractions of suspended matter. The average organic fraction in all the samples was as high as 83% of the total dry mass concentration but in individual cases it varied between < 50% and up to 100%. Simple, two-variable parameterizations of scattering and backscattering coefficients were derived as functions of the organic and inorganic fraction concentrations. The statistical relationship between the backscattering ratio and the ratio of the organic fraction to the total dry mass of suspended matter was also found: this can be used in practical interpretations of *in situ* optical measurements. In addition, the variability in particle size distributions recorded with a Coulter counter indicated its potentially highly significant influence on the light scattering properties of particles suspended in Baltic Sea waters.

Key words: light scattering and backscattering coefficients; backscattering ratio; suspended particulate matter; organic and inorganic fractions of particulate matter; particle size distribution

1. Introduction

Generally speaking, seawater is a complex mixture of chemically pure water and various constituents. The latter can be organic or inorganic (mineral) in nature, auto- or allogenic in origin, vary greatly in concentration, be dissolved or take the form of suspended particles of different size, shape and internal structure. The interaction of visible light with such a medium is usually highly complicated. This complexity results from the fact that elementary optical processes, like absorption and light scattering by different seawater constituents, can occur simultaneously (see e.g. books by Kirk, 1994; Mobley, 1994; B. Woźniak and Dera, 2007, Jonasz and Fournier, 2007). Unlike dissolved substances, suspended particles, which the present work focuses on, may not only significantly

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