Hydrosol optical properties refractive index physical quantities

Website: https://www.bco-dmo.org/dataset/766421
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Project
» Collaborative Research: Inferring Marine Particle Properties from Polarized Volume Scattering Functions (Marine Particle Optics)

Contributors	Affiliation	Role
Yang, Ping	Texas A&M University (TAMU)	Principal Investigator
Zhang, Xiaodong	University of North Dakota (UND)	Contact
Biddle, Mathew	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

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Dataset Description

The hydrosol dataset is a look up table for the single scattering properties of hydrosol. It covers the range of refractive indices and sizes of natural hydrosol.

Methods & Sampling

The invariant-imbedding T-matrix mathod(IITM)[1] is used to compute particles with equivalent volume sphere radius from 0.001~2.0 um. The physical geometric optics method(PGOM)[2] is used to compute particles with equivalent volume sphere radius from 2.1~300.0 um. The particle geometry is generated with the "irregular hexahedral ensemble" method[3]. Single scattering properties of a single particle is obtained by averaging a 20-irregular-hexahedron ensemble.

Data Processing Description

BCO-DMO Processing Notes:
- combined all isca.dat files
- created a column for file name from which the data was gathered
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- sorted data by filename and eq_vol_sphere_rad columns

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Related Publications

Bi, L., Yang, P., Kattawar, G. W., & Mishchenko, M. I. (2013). Efficient implementation of the invariant imbedding T-matrix method and the separation of variables method applied to large nonspherical inhomogeneous particles. Journal of Quantitative Spectroscopy and Radiative Transfer, 116, 169–183. doi:10.1016/j.jqsrt.2012.11.014
Methods

Sun, B., Yang, P., Kattawar, G. W., & Zhang, X. (2017). Physical-geometric optics method for large size faceted particles. Optics Express, 25(20), 24044. doi:10.1364/oe.25.024044 https://doi.org/10.1364/OE.25.024044
Methods

Xu, G., Sun, B., Brooks, S. D., Yang, P., Kattawar, G. W., & Zhang, X. (2017). Modeling the inherent optical properties of aquatic particles using an irregular hexahedral ensemble. Journal of Quantitative Spectroscopy and Radiative Transfer, 191, 30–39. doi:10.1016/j.jqsrt.2017.01.020
Methods

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Parameters

Parameter	Description	Units
wavelength	wavelength	micometers (um)
eq_vol_sphere_rad	equivalent volume sphere radius (107 sizes in [0.001;300])	micrometers (um)
part_vol	particle volume	micometers cubed (um^3)
part_proj_area	particle projected area	micometers squared (um^2)
ext_efficiency	extinction efficiency	unitless
single_scatt_albedo	single scattering albedo	unitless
asymetry_factor	asymmetry factor	unitless
filename	filename of the file where the data was extracted	unitless

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Project Information

Collaborative Research: Inferring Marine Particle Properties from Polarized Volume Scattering Functions (Marine Particle Optics)

NSF Award Abstract:

Understanding biogeochemical cycles and their interaction with the climate system requires quantifying the various forms of materials in the global ocean. In particular, the chemical composition and size distribution of living and non-living particles in the ocean have an enormous impact on marine ecosystems, including the dynamics of marine food chains, the vertical transmission of solar energy, and the transport of organic matter and trace elements. These particle characteristics not only affect but reflect changes in many biogeochemical processes in the ocean. In this project, a team of scientists will launch a set of technical and numerical modeling innovations that will allow them to determine key biogeochemical quantities from optical observations of the angular distribution of scattered light. The project will involve an interdisciplinary team of experts, who will theoretically model the optics of marine particles, develop an innovative advanced mathematical modeling scheme, and then laboratory- and field-test and validate the approach for observing marine particle properties.

When perfected, the technique should see a broader application, as it will be designed to be amenable to operation on ship-borne and autonomous platforms with the potential to provide estimates of the particle size distribution and composition at high temporal and spatial resolutions. It should thus benefit different fields requiring detailed knowledge of aquatic particles (biogeochemistry, biology, optics). The project will also provide for the training and support of graduate and undergraduate students as well as public educational outreach, including a special effort to reach Native Americans in North Dakota.

The goal of this project is to derive water-column quantitative particle size and composition information from in situ unobtrusive volume scattering function (VSF) measurements to characterize marine biogeochemical particulate stocks. The angular patterns of the scattered intensity and polarization state of the scattered light by particles can be described in terms of a 4x4 Mueller matrix (S) that is intrinsically determined by the sizes, shapes, composition, and structures of the particles. The particle properties can be, therefore, potentially inferred from measurements of S. Unfortunately, the complete Mueller matrix of oceanic waters has been seldom measured. Even the most commonly measured component, the volume scattering function (element S11) representing the angular distribution of unpolarized light, was scarcely measured until recently, followed by development of an inversion technique to derive size distributions and composition of particles from the VSF. Recently, a commercial product, LISST-VSF, became available for measuring the Mueller matrix components S11 (VSF), S12 (linear polarization), and S22 (cross-polarization), potentially providing an avenue to obtain a much more detailed characterization of particles. This project will incorporate the additional information provided by S12 and S22 using recent advances in scattering modeling to further constrain the inversion with the following: (i) better knowledge in particle shapes using S22 (spherical vs. non-spherical); (ii) reduced uncertainty using both S11 and S12; and (iii) further improved capability to characterize particles in the size range of 0.02 to 200 um. The study should greatly enhance our ability to quantify size distributions and refractive indices (closely linked to particle densities) for particle groups such as phytoplankton cells, detrital particles, organic particles, mineral particles, bubbles, and emulsified oil (if present).

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459180

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