Retrieval of size-partitioned phytoplankton carbon via b_{bp} and the particle size distribution: limitations and ways forward

DR. TIHOMIR S. KOSTADINOV

CALIFORNIA STATE UNIVERSITY SAN MARCOS

LIBERAL STUDIES DEPARTMENT

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The PSD Links Optics & Biogeochemistry/Phyto Ecology

- Mie scattering theory solves the Maxwell equations for homogeneous spherical particles (can be extended to coated spheres)

$$b_{bp}(\lambda) = \int_{D_{\min}}^{D_{\max}} \frac{\pi}{4} D^2 Q_{bb}(D, \lambda, m) N_o \left(\frac{D}{D_o} \right)^{-\xi} dD$$

Particulate Backscattering Coefficient = Retrievable from space spectrally

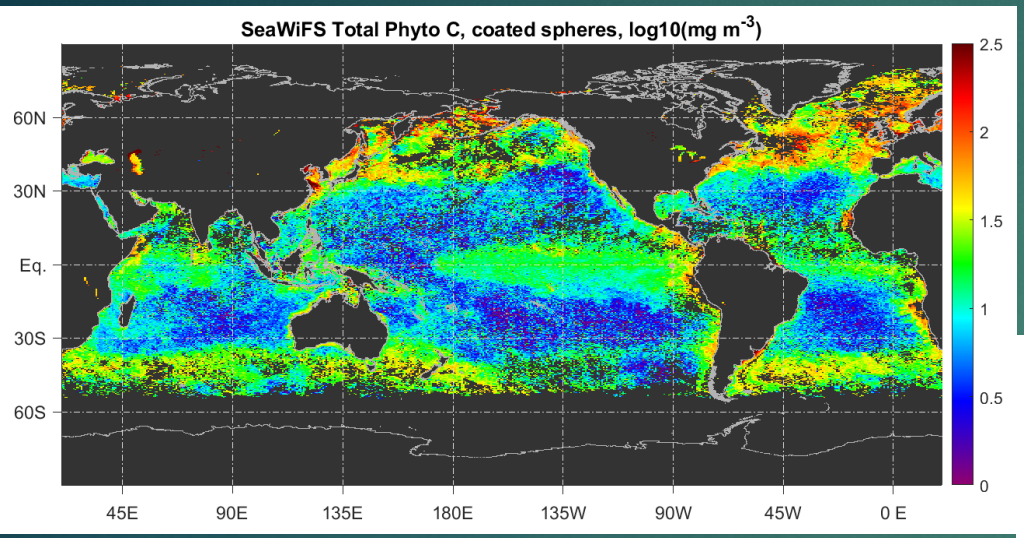
$b_{bp}(\lambda)$ efficiency solved by Mie theory

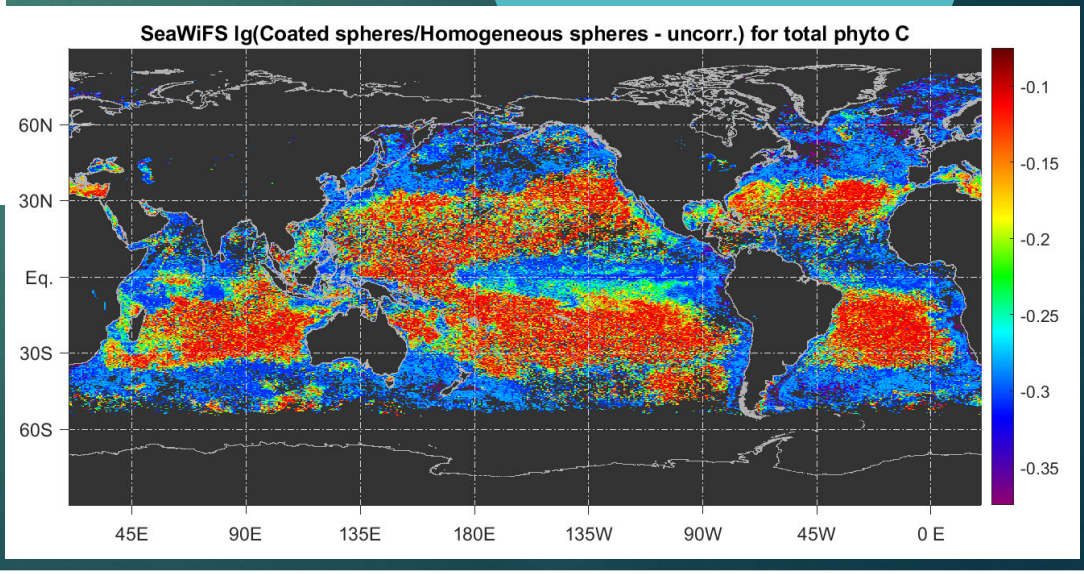
Goal of retrieval

- Single particle optical properties depend on:
  - Relative complex index of refraction $m_r(\lambda)$
  - Size relative to the incident wavelength
  - Shape & internal composition

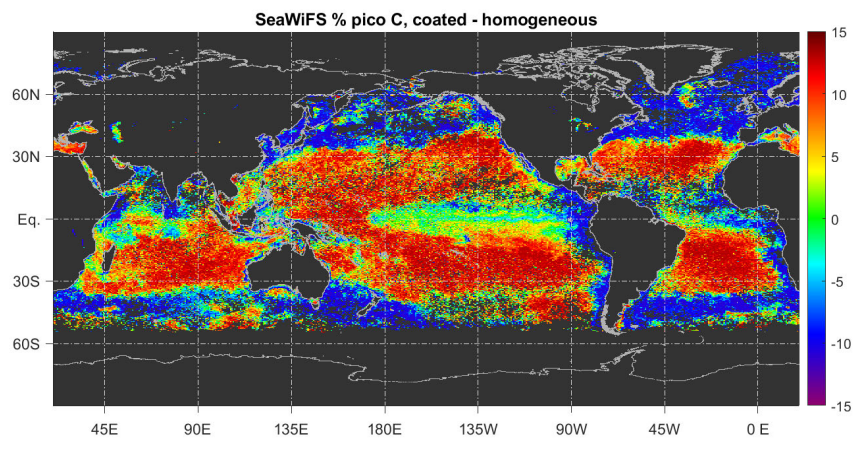
Kostadinov et al. (2009)

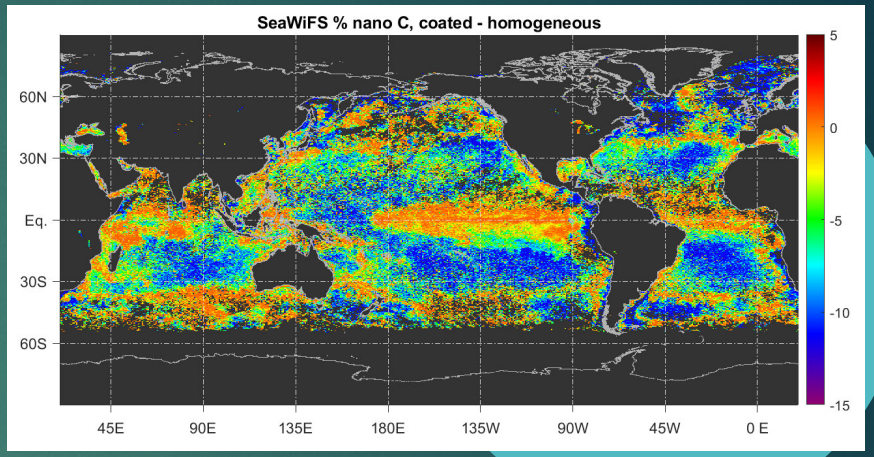
Total Phyto C Retrievals – Coated Spheres vs. Homogeneous Spheres



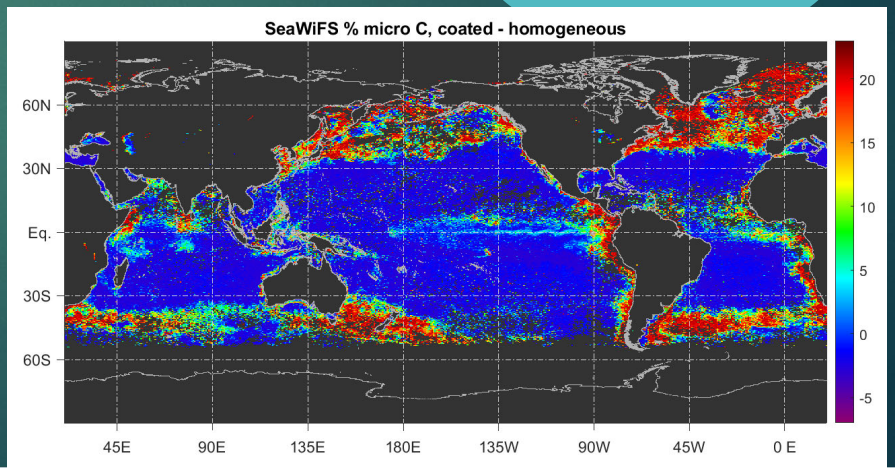


Differences in retrievals for the fractional C-based PSCs – coated vs. homogeneous spheres





Fractional PSCs are a function of the PSD slope, allometric coeffs, and Dmin/Dmax chosen. So this change reflects the change in the PSD slope LUT – higher slopes retrieved for high values, lower slopes for low values.



Challenges/Ways Forward

- Multiple particle populations with their IOPs need to be modeled & inverted for to separate phyto only/groups –
  - many variables to retrieve
  - hopefully hyperspectral will help, but limited number of degrees of freedom exist
  - uniqueness of the inversion problem
  - Lack of full understanding of the sources of b_{bp} - need to partition b_{bp} and use only b_{bp} due to living phyto in inversions for groups.
  - Need to relax assumption that living C fraction of POC is ~ 1/3
- Lack of PSD and (partitioned) phyto C data for validation & development
- Assumptions about the shape of the PSD.
- Need IOP models and retrievals accurate enough to achieve reliable b_{bp} spectral slope estimates
  - b_{bp} slope is a second-order parameter sensitive to bbp uncertainties and even to which pure water model is used
- Need scattering models accurate enough to reproduce real-world b_{bp} – extremely complex shape and composition of phytoplankton and other marine particles makes this hard.
- Incorporation of absorption & scattering information in a single retrieval

Thank You!