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

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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 is retrievable from space spectrally.

- 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 $\sim 1/3$
- 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 $b_{bp}$ 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!