

# Bio-optical relationships in high-latitude seas

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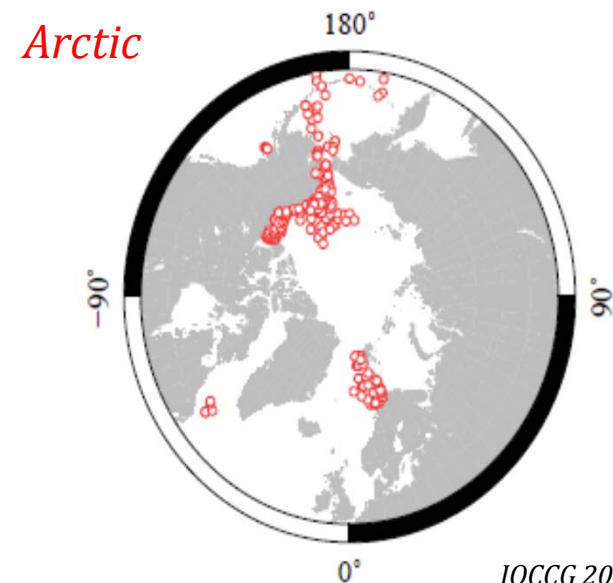
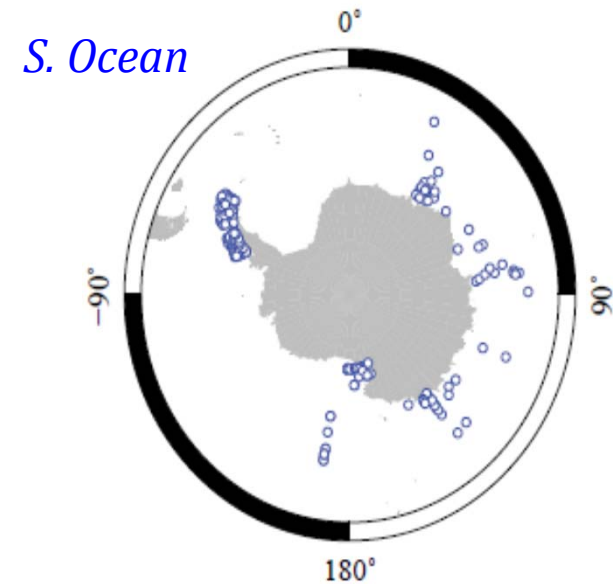
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# Polar regions often sparse in global databases

- ❑ NASA NOMAD database
  - 4,127 total stations
  - S. Ocean ~ 29%
  - Arctic ~ 3%
- ❑ Supplemented with recent work
- ❑ Regional bias



	Experiment	General location	<i>N</i>
<i>Arctic</i>	Oceania	N. Polar Atlantic	90
	ORCA	Canadian Arctic, Labrador Sea	24
	CASES	E. Beaufort Sea	58
	ICESCAPE	Chukchi and W. Beaufort Seas	51
	KH09-4	Bering and Chukchi Seas	12
	MALINA	E. Beaufort Sea	37
	MR	Bering and Chukchi Seas	64
	OS	Bering and Chukchi Seas	56
	SBI	Bering and Chukchi Seas	43
	<i>S. Ocean</i>	AMLR	Antarctic Peninsula
BWZ		Antarctic Peninsula	21
I8SI9N		Indian S. Ocean	6
Palmer LTER		Antarctic Peninsula	1005
ROAVERRS97		Ross Sea	8
SO JGOFS		Ross Sea, Pacific S. Ocean	40
UM		Indian S. Ocean	63

# Empirical Chla algorithms

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## □ Southern Ocean

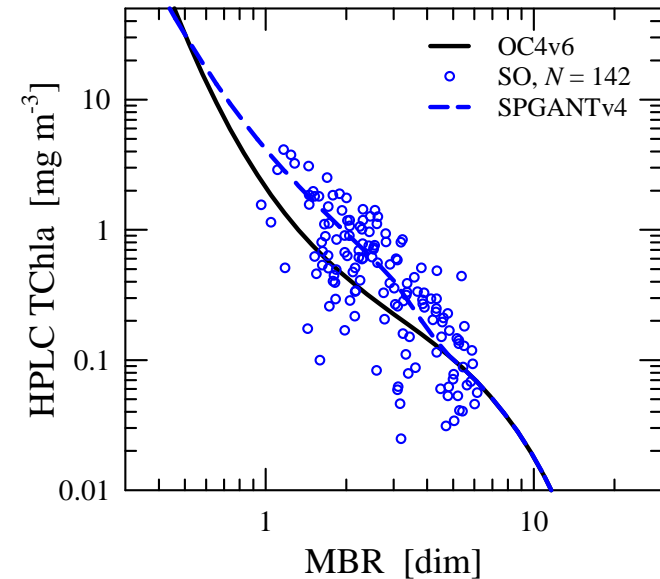
- ~2-fold underestimation of Chla by OC4 for Chla > 0.1 mg m<sup>-3</sup>

## □ Arctic

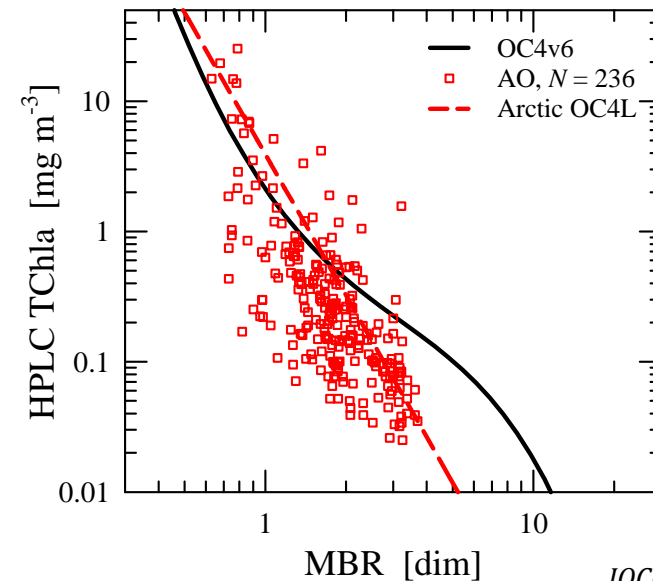
- ~2.5-fold average overestimation of Chla by OC4 over most of the range

- Regionally-tuned algorithms reduce bias, but only slightly improve predictive accuracy

*S. Ocean*



*Arctic*



# Partitioning of nonwater absorption

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□ Large differences between the two polar regions

□ Southern Ocean

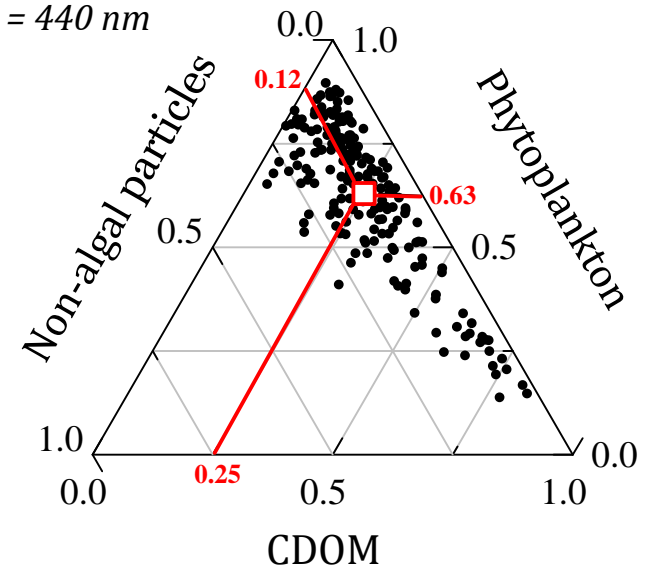
- Phytoplankton predominant (63%)
- CDOM relatively low

□ Arctic

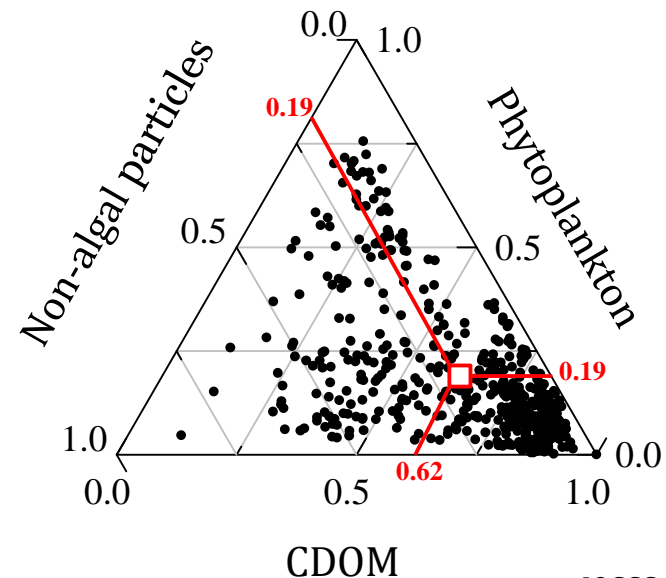
- CDOM predominant (62%)
- Phytoplankton generally small contributor (19%)

Wavelength = 440 nm

*S. Ocean*



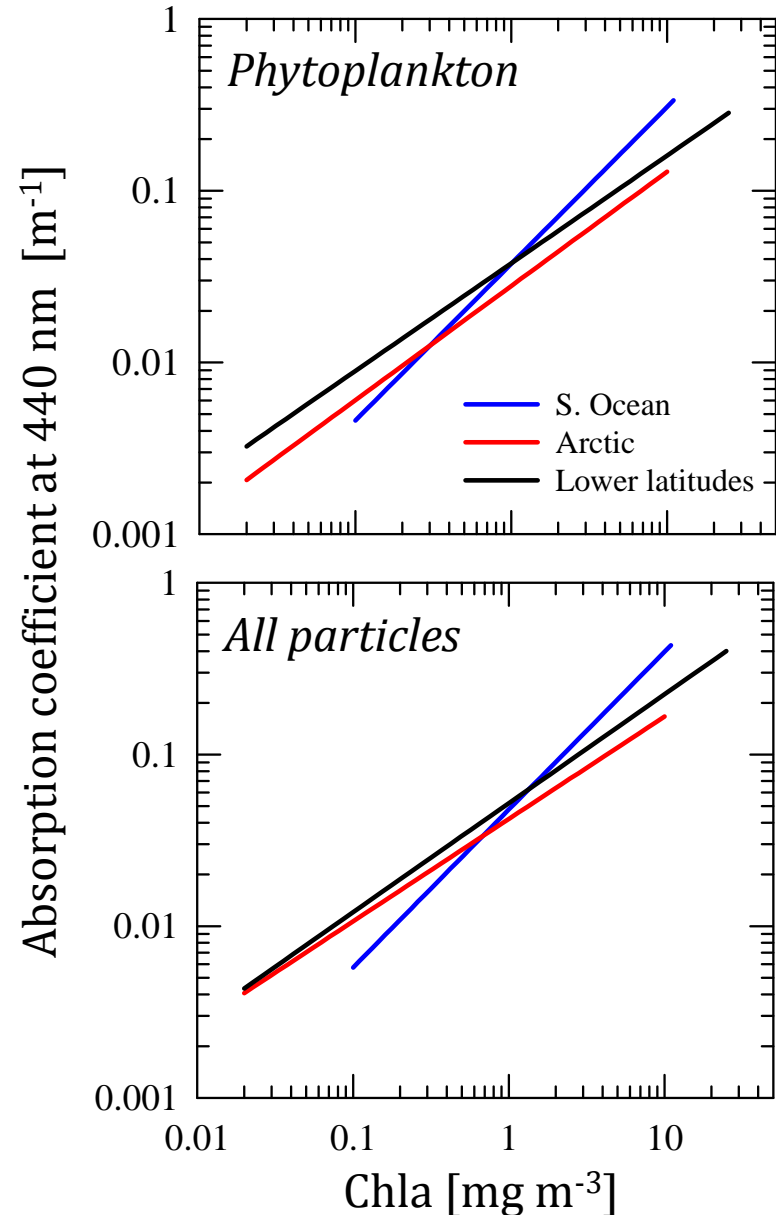
*Arctic*



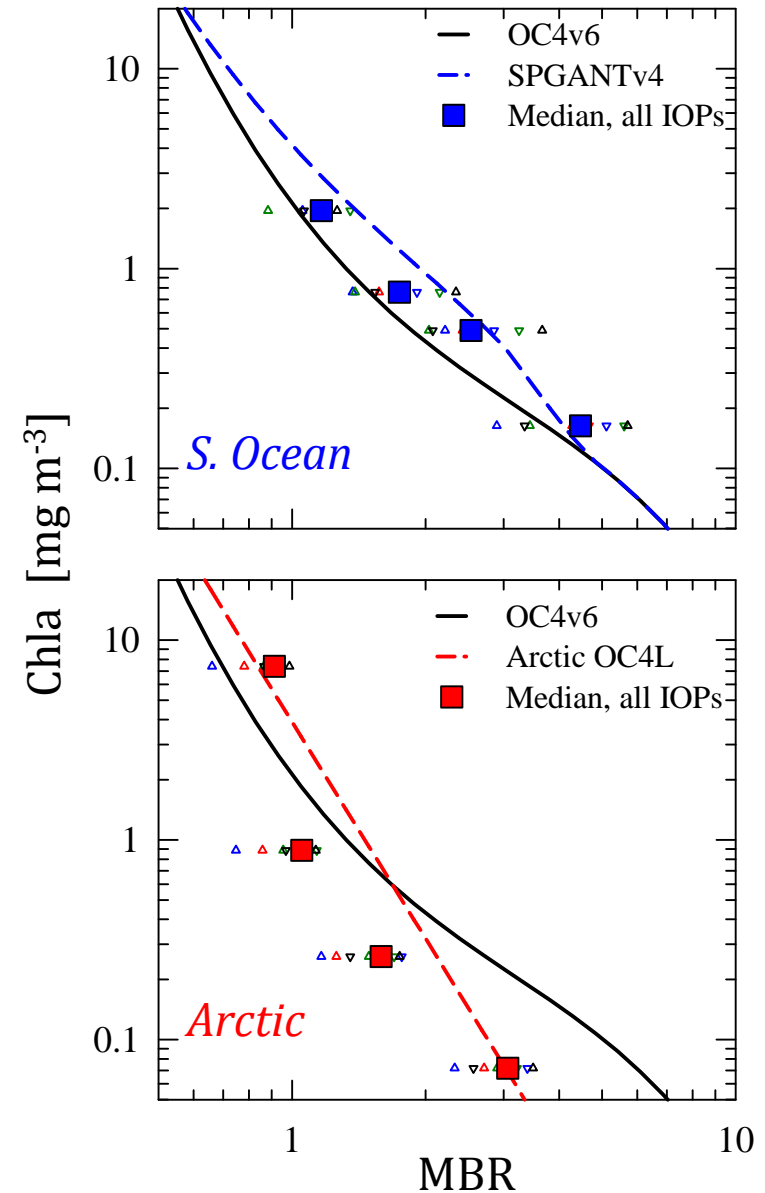
# Chla-specific particle absorption

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- Phytoplankton absorption
  - Generally lower per unit Chla in polar regions compared to lower latitudes
  
- Particle absorption
  - S. Ocean similar pattern as phytoplankton absorption
  - Arctic similar to lower latitudes for low Chl (increased non-algal particle absorption)



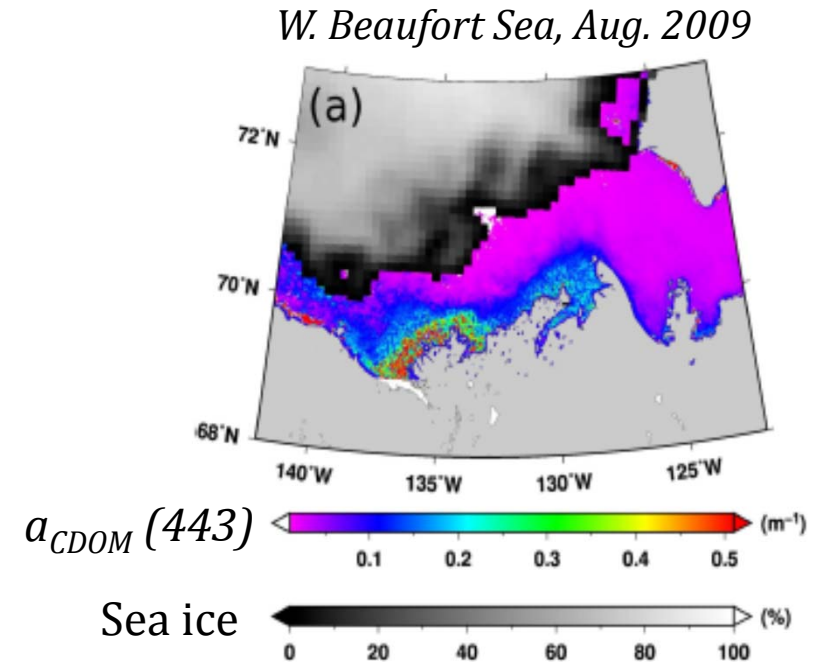
- Differentiation in Chla algorithms consistent with trends observed in IOP measurements
- S. Ocean
  - Phytoplankton absorption dominant source of variability
- Arctic
  - CDOM dominant, phytoplankton small impact



□ Limited number of studies suggest SA models can retrieve  $a(\lambda)$  and  $b_b(\lambda)$  reasonably well in both polar regions

□ Additional work needed

- full evaluation
- partitioning of total  $a(\lambda)$  and  $b_b(\lambda)$
- relationships between optical constituents and biogeochemical parameters of interest



*Matsuoka et al. 2013*

- ❑ Analysis of historical and recent data confirms that polar regions differ from lower latitudes, and from each other, in bio-optical relationships underlying empirical ocean color algorithms
- ❑ Regional variability within polar regions also significant
- ❑ Semi-analytical approaches coupled with IOP-constituent relationships offer the best path forward for improving estimates of biogeochemical parameters of interest
- ❑ This will require
  - Comprehensive data sets (physical, optical, biological)
  - Higher spectral range and resolution for improved discrimination of individual constituents



## □ IOCCG Working Group on Remote Sensing of Polar Seas

- A. Matsuoka, T. Hirawake, S. Bélanger, B. G. Mitchell, M. Babin, K. Arrigo, M. Benoit-Gagné, J. Comiso, M-H. Forget, C. Goyens, R. Frouin, V. Hill, D. Perovich, K. Stamnes, M. Wang, V. Stuart

## □ Agencies

- NASA Ocean Biology and Biogeochemistry
- NASA Cryospheric Sciences
- NSF Polar Programs