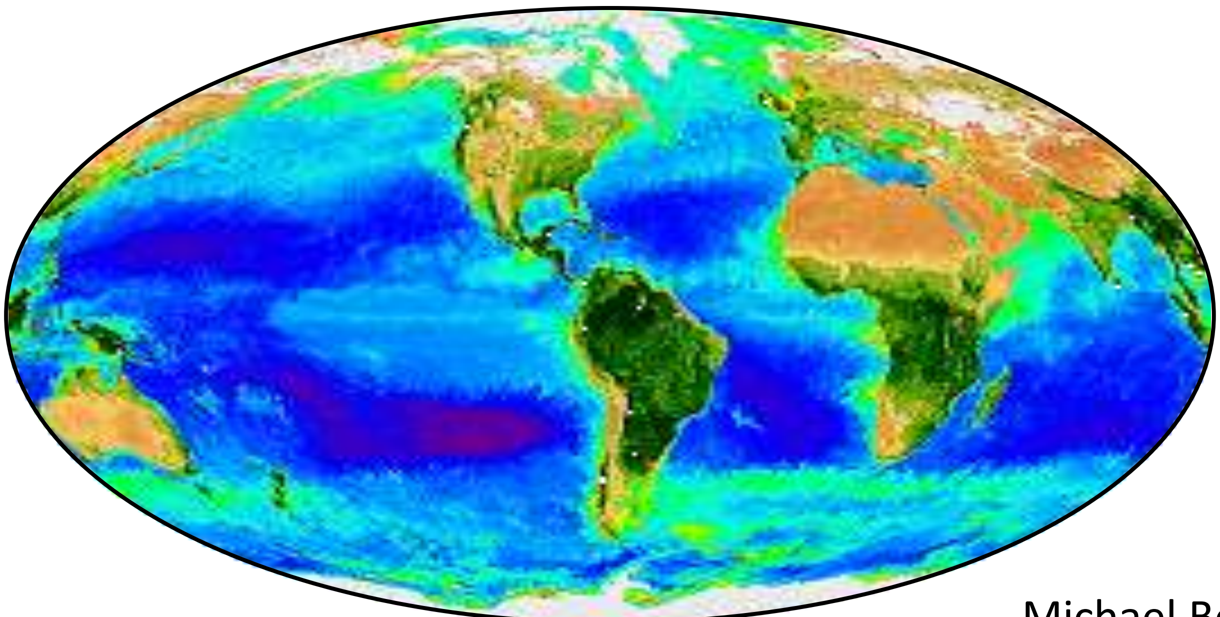
Hyperspectral Hallucinations



Michael Behrenfeld

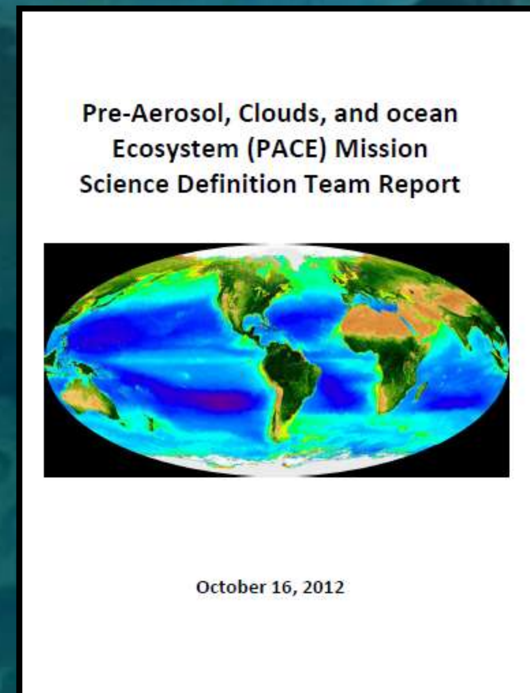
Research supported by:
NASA Ocean Biology and
Biogeochemistry Program

PACE

Pre-Aerosol , Cloud, and Ecosystem Mission

"Threshold Requirement: 5 nm spectral resolution from 350 to 800 nm, in addition to spectral bands identified in section 3.2.7 for atmospheric corrections. Downlink of the complete 5 nm resolution (or finer) data from the spacecraft to ground and archival of all data."

"Goal: Spectral subsampling at ~1-2 nm resolution from 655 to 710 nm for refined characterization of the chlorophyll fluorescence spectrum."

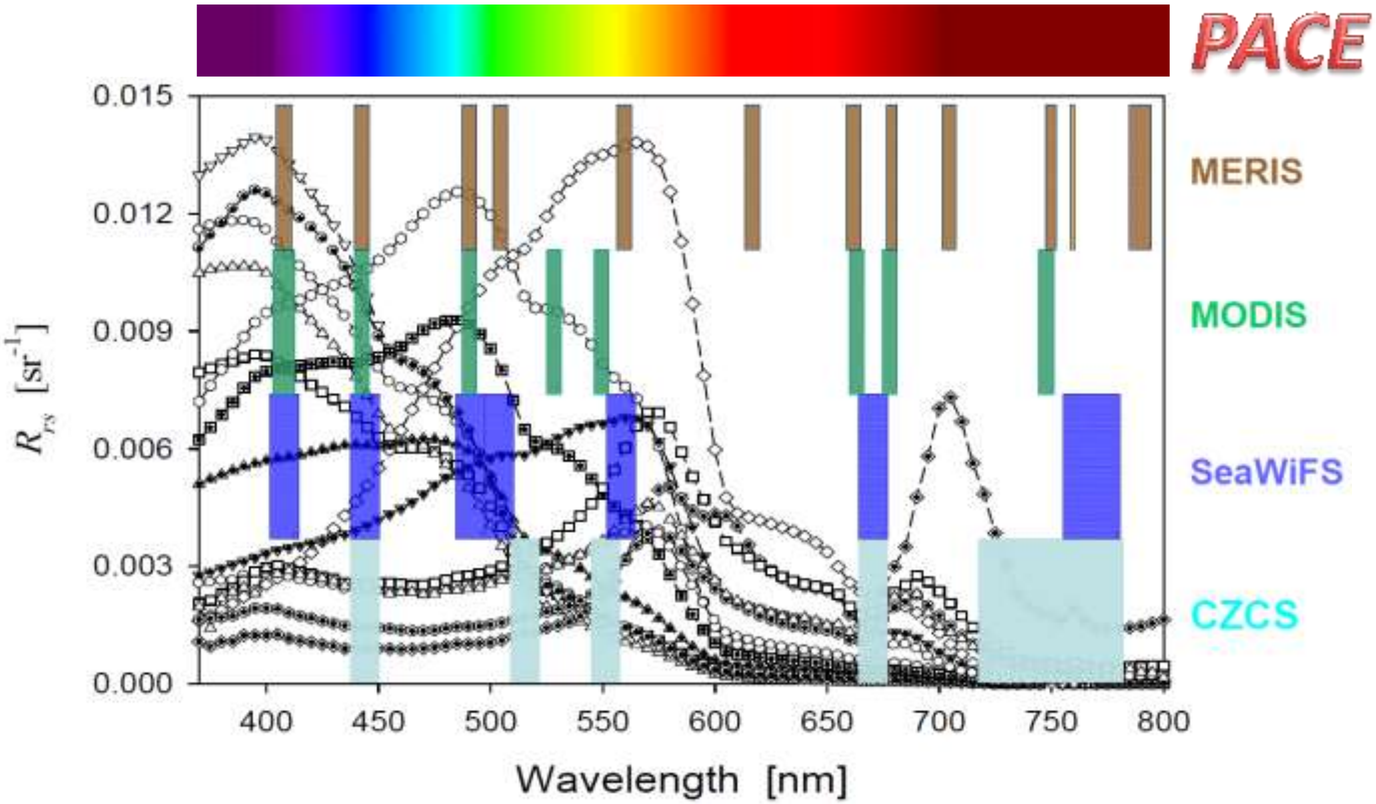


Pre-Aerosol, Clouds, and ocean Ecosystem (PACE) Mission Science Definition Team Report

October 16, 2012

274 glorious pages

Hyperspectral Hallucinations



Examples of measured spectral remote-sensing reflectance (R_{rs}) used in this study. Overlaid are spectral bands (location and width) of CZCS, SeaWiFS, MODIS, and MERIS.

Determination of Primary Spectral Bands for Remote Sensing of Aquatic Environments

ZhongPing Lee [1], Kendall Carder Robert Arnone [1] and MingXia He [3]

Sensors **2007**, *7*, 3428-3441

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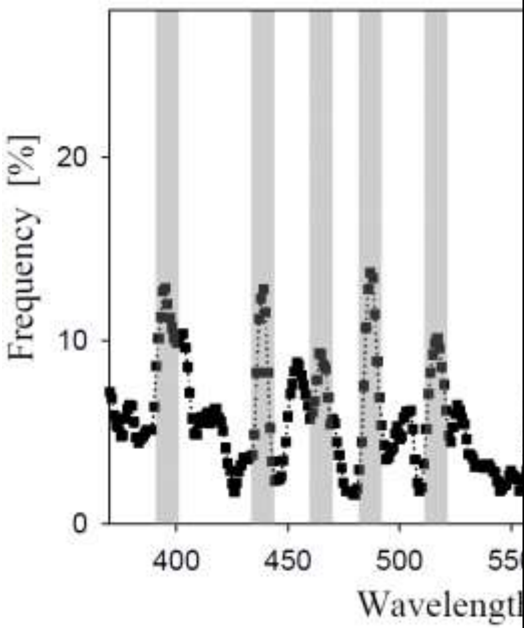

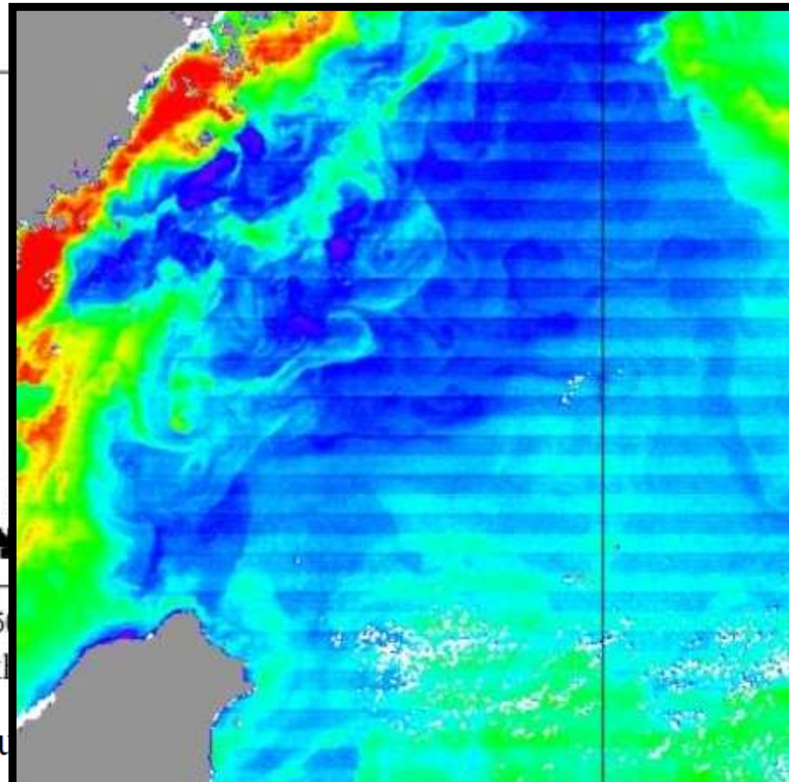

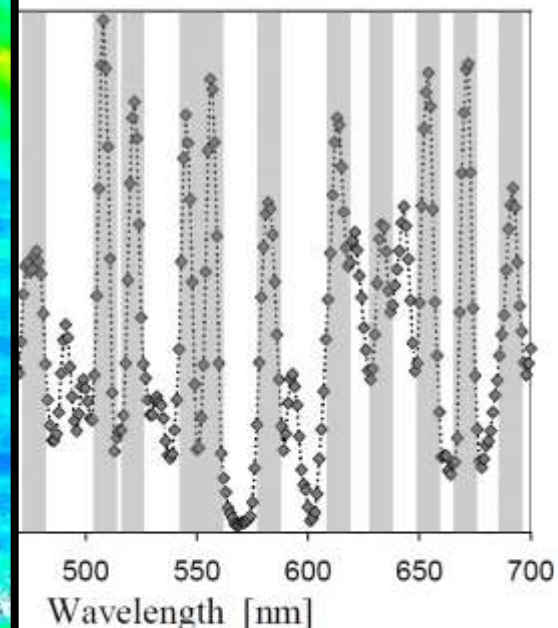

(left) Spectral distribu… rivative of $R_{rs}(\lambda)$ equals 0.

(right) Spectral distribution of the frequency where the second-order derivative of $R_{rs}(\lambda)$ equals 0.

Determination of Primary Spectral Bands for Remote Sensing of Aquatic Environments

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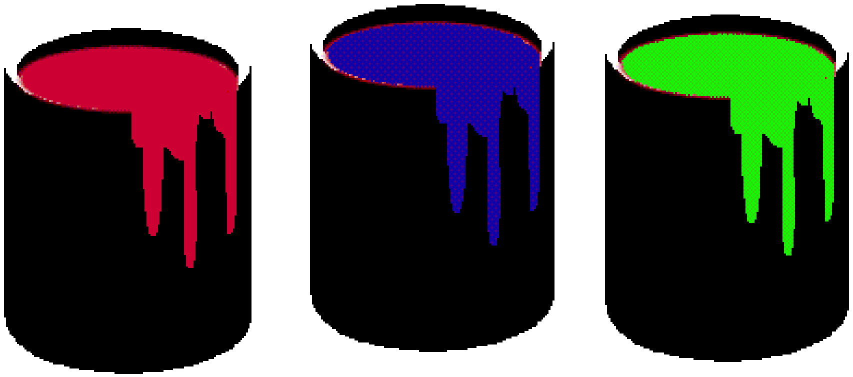
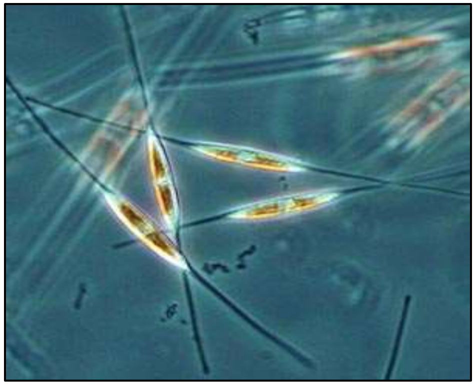
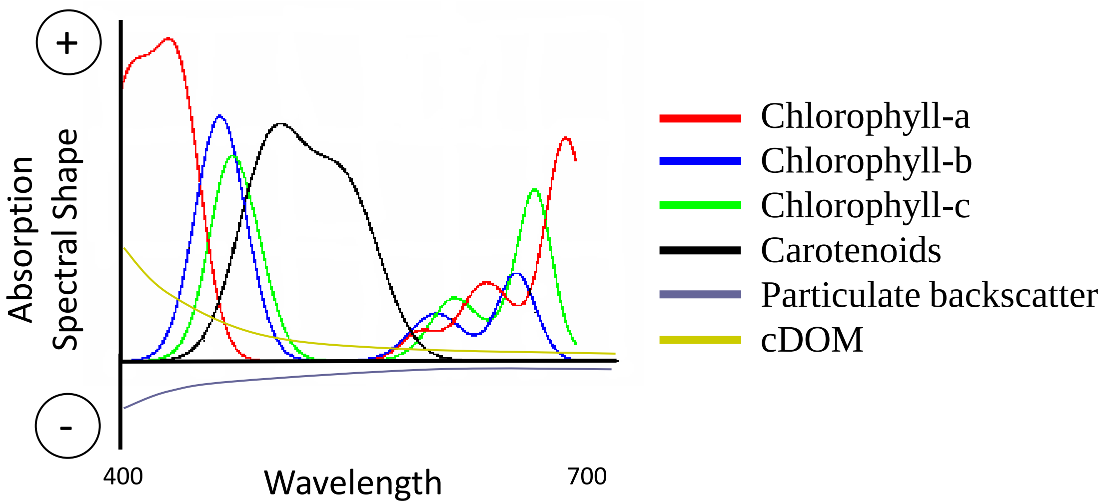
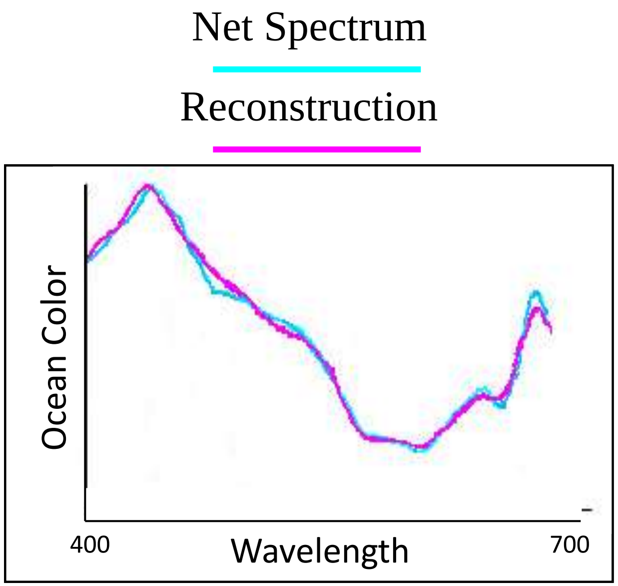


“Making Paint Approach”

Hyperspectral Hallucinations







Hyperspectral Hallucinations

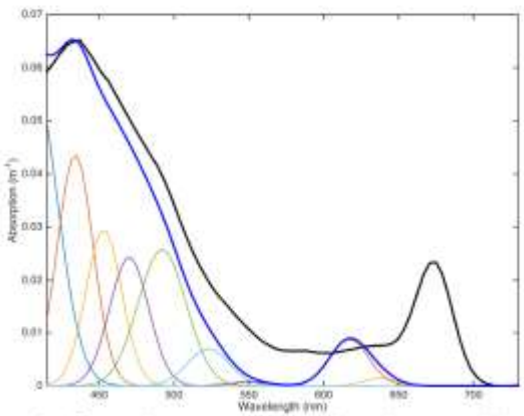


Figure 4. Example Gaussian component functions and their sum (thick blue line); black line shows particulate absorption measured independently with an in situ spectrophotometer (AC-S instrument).

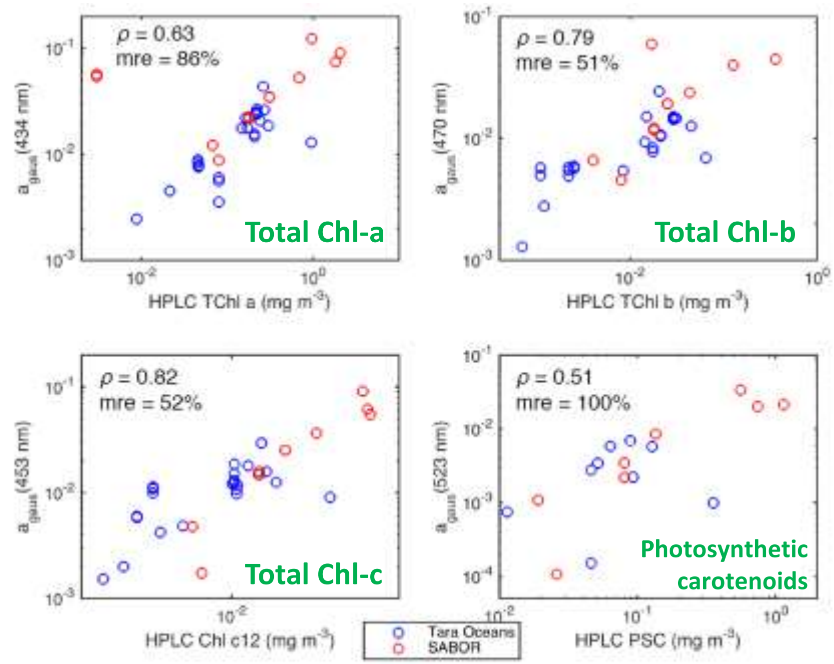


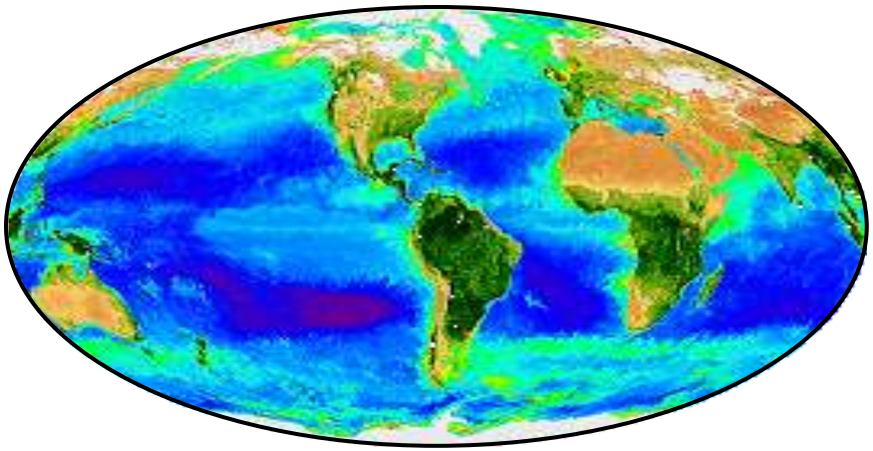
Figure 5. Magnitude of component Gaussian functions ($a_{gaus}(\lambda)$, y-axes) compared to pigment concentrations from HPLC analysis (x-axes).

Decomposition of in situ particulate absorption spectra

Alison Chase[a,*], Emmanuel Boss[a], Ronald Zaneveld[b], Annick Bricaud[c], Herve Claustre[c], Josephine Ras[c], Giorgio Dall'Olmo[d], Toby K. Westberry[e]

Methods in Oceanography 7 (2013) 110–124

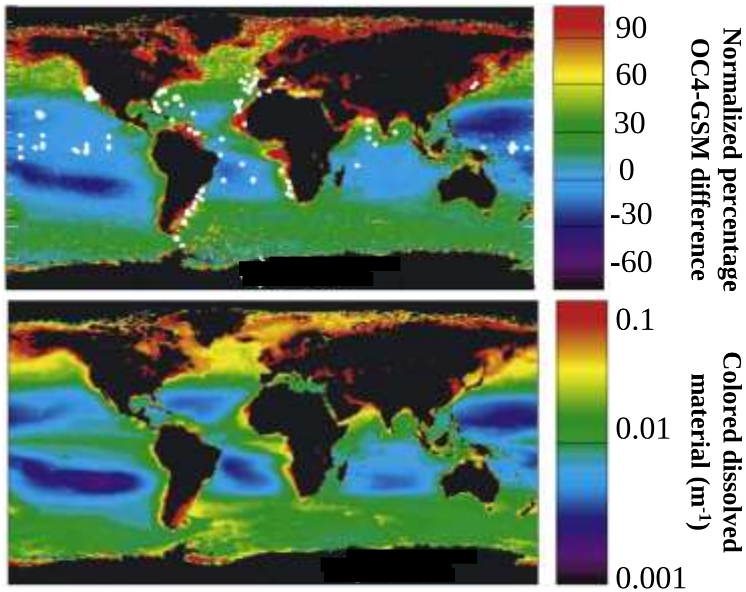
… now, if I had a MOVIE of these 'colors', what could I do?...

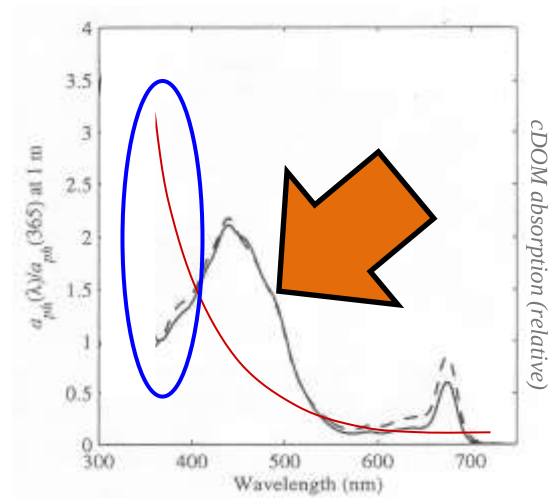


- How are temporal variations in 'color' distribution partitioned into 'advective' and 'lagrangian' drivers?
- What is the sequence of 'color' changes and how does this succession vary spatially?
- How is 'color' succession partitioned into 'physical' and 'ecological' drivers?
- Is 'color' related to predator-prey disequilibria? (….explain…)
- What do trends in 'color' distributions tell us that bulk signals do not?

… of course, we might also try to relate 'color' to specific phytoplankton groups and infer implications on carbon fluxes…

Hyperspectral Hallucinations





Colored dissolved organic matter and its influence on the satellite-based characterization of the ocean biosphere

Siegel et al.,

GEOPHYSICAL RESEARCH LETTERS

VOL. 32, L20605, doi:10.1029/2005GL024310, 2005

Hyperspectral Hallucinations

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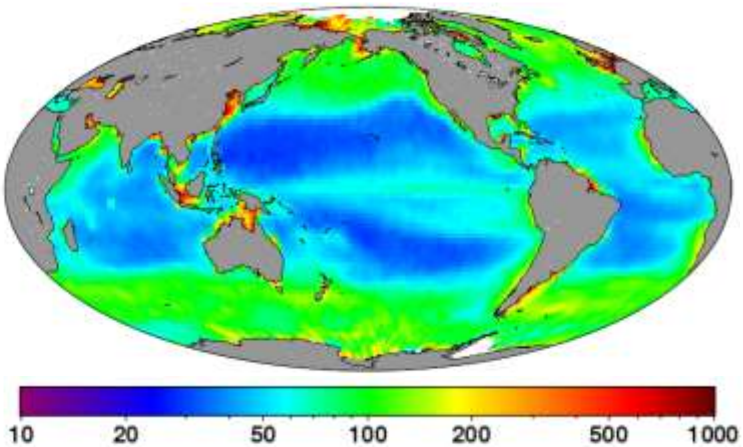
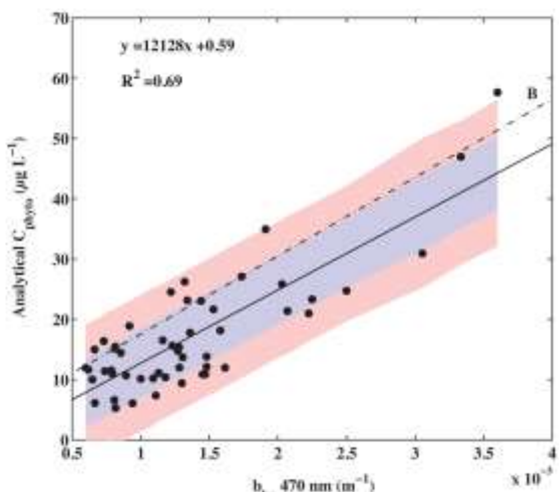


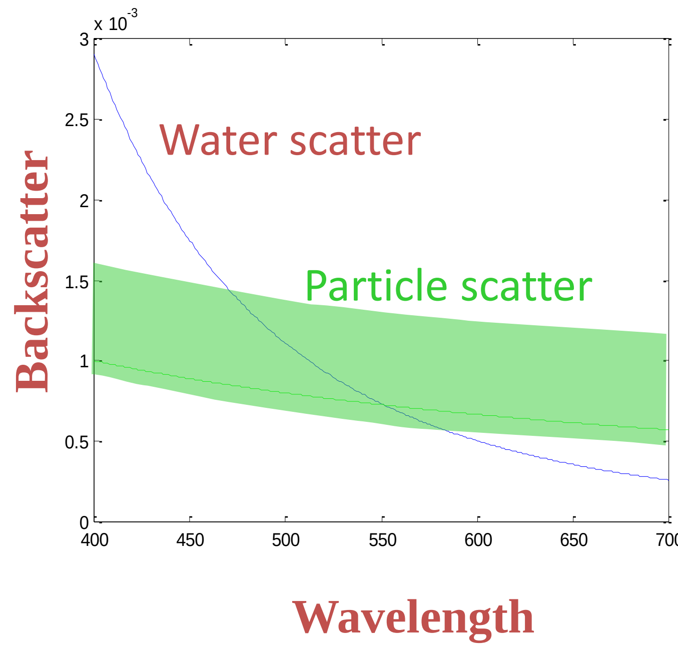
CALIOP Retrieved Plankton biomass (mg C m^{-3})



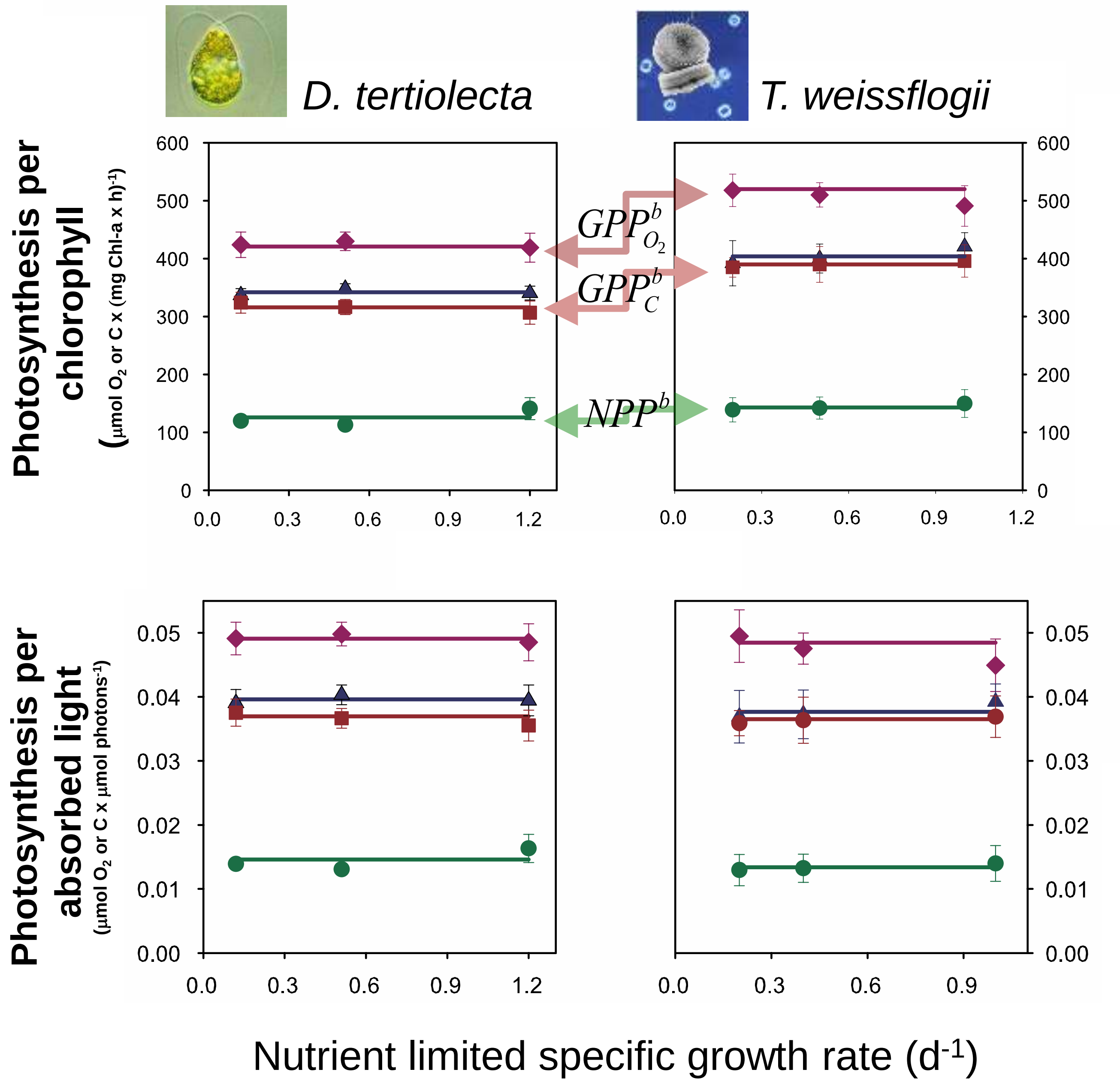
Analytical phytoplankton carbon measurements spanning diverse ecosystems.
Graff, J.R., *et al*.
Deep Sea Res. I 102:16-25 (2015).

Do this as questions -

Slope of particle size spectrum
Other on photoacclimation
Maa's
New study showing photoacc is most of c



Loisel et al. [2007] *JGR-Oceans*
Kostadinov et al. [2009] *JGR-Oceans*
Kostadinov et al. [2010] *Biogeosciences*



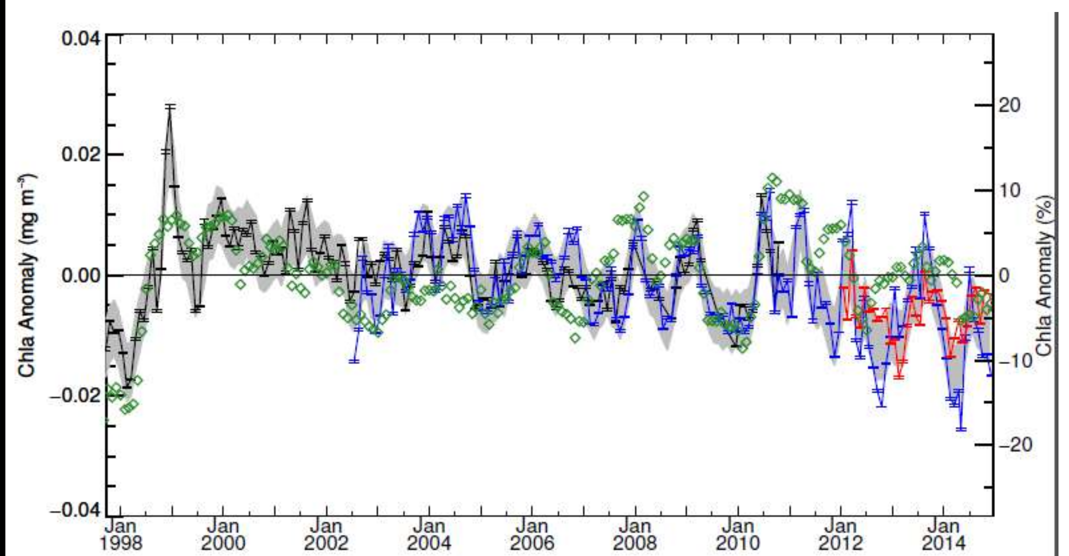
A common partitioning strategy for photosynthetic products in evolutionarily distinct phytoplankton species

Halsey et al.,
New Phytologist (2013)
doi: 10.1111/nph.12209

What else might we do…?

PACE

Pre-Aerosol , Cloud, and Ecosystem Mission



Black = SeaWiFS; Blue = MODIS Aqua; Red = VIIRS;
Green = Inverted ENSO Index

Satellite data live longer than satellites

Historically, we have designed sensors according to the state of the science during mission concept development. It would be preferable in the future to design for the future.

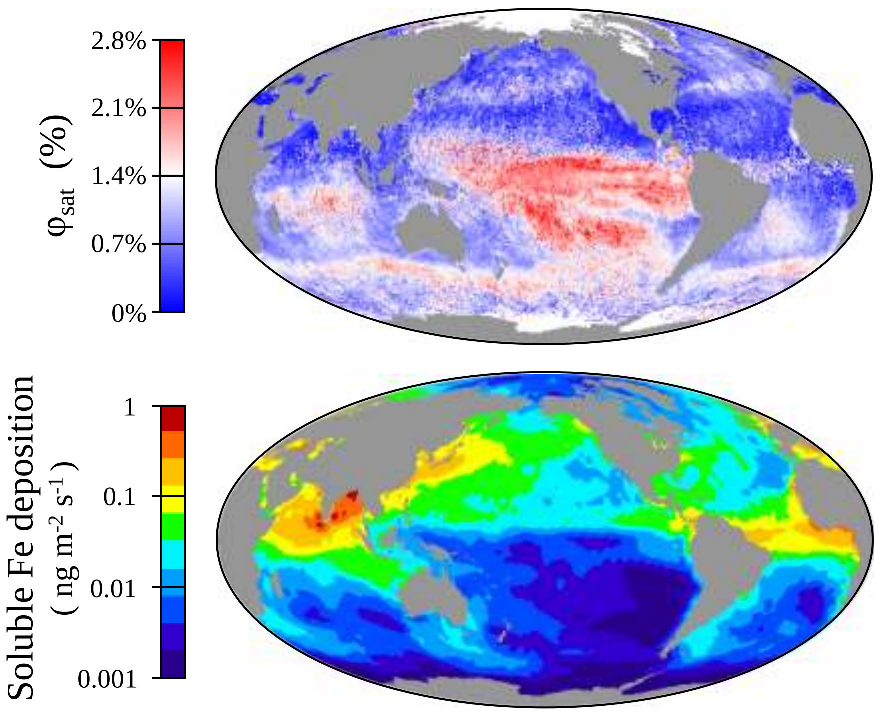
Hyperspectral Hallucinations

Massive cyanobacterial bloom in the **Baltic Sea** (July 2002) as seen by the Advanced Land Imager. Cyanobacteria have high concentrations of phycocyanin which gives an absorption peak near **625 nm** that can be used as a bloom marker.

10 km

Kutser et al 2004
Simis et al. 2005

Hyperspectral Hallucinations



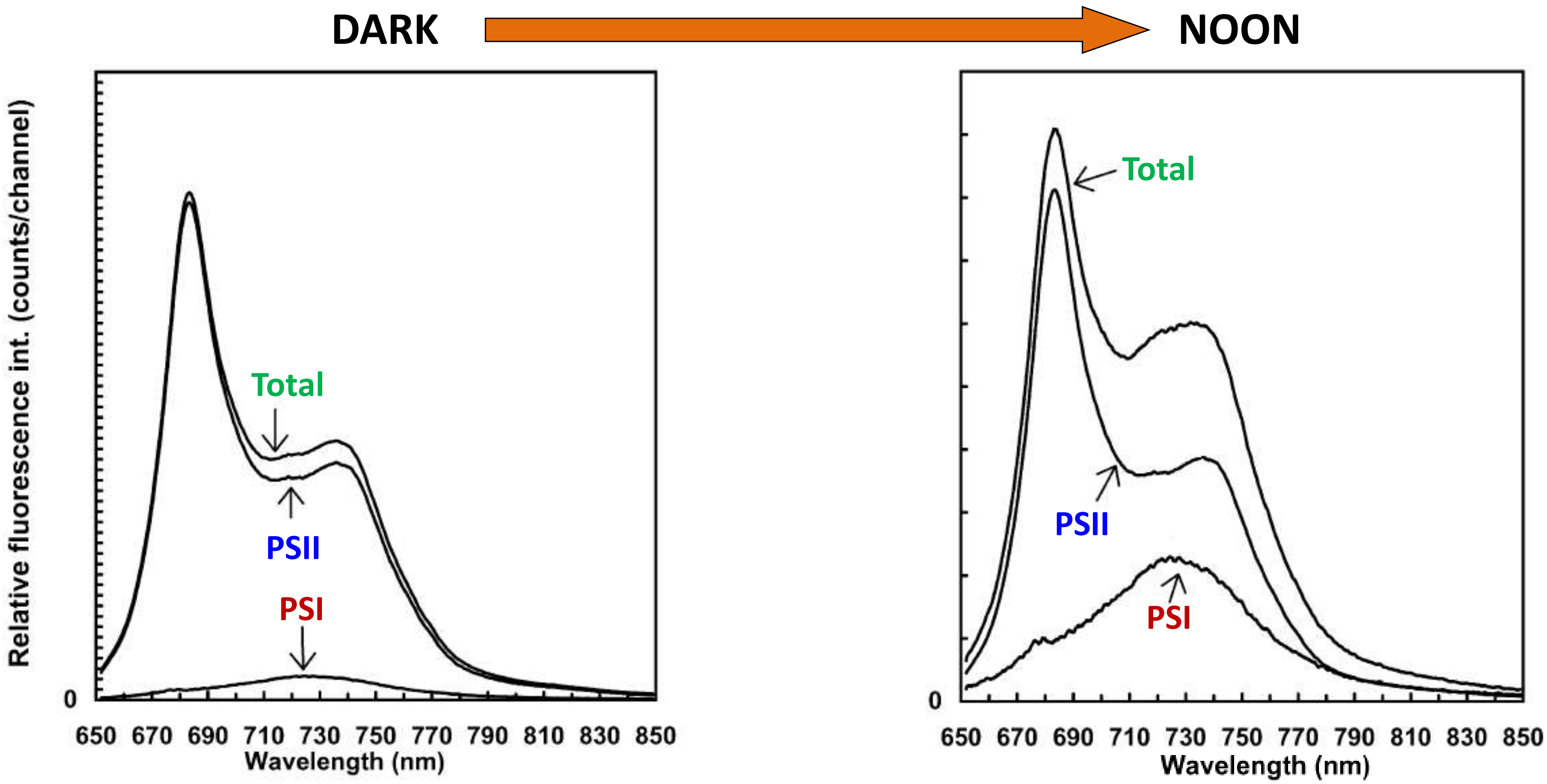
Detecting Iron Stress with Fluorescence

- Detached chlorophyll complexes
- Altered ratio of PSI:PSII

Photophysiological expressions of iron stress in phytoplankton.
Behrenfeld & Milligan
Ann. Rev. Mar. Sci. 5: 217-246 (2013)

Surplus Photosynthetic Antennae Complexes Underlie Diagnostics of Iron Limitation in a Cyanobacterium.
Schrader et al. , PLoS ONE 6(4): e18753 (2011).
doi:10.1371/journal.pone.0018753

Hyperspectral Hallucinations



Resolution of the Photosystem I and Photosystem II contributions to chlorophyll fluorescence of intact leaves at room temperature
Franck et al.
Biochem. et Biophys. 1556: 239-246 (2002)

Fluorescence and nonphotochemical quenching responses to simulated vertical mixing in the marine diatom *Thalassiosira weissflogii*.
Milligan, et al.
Mar. Ecol. Prog. Ser., 448, 67-78 (2012)

Hyperspectral Hallucinations: What could we do?