NASA ocean color processing and data analysis support for SGLI

Bryan Franz

Ocean Biology Processing Group
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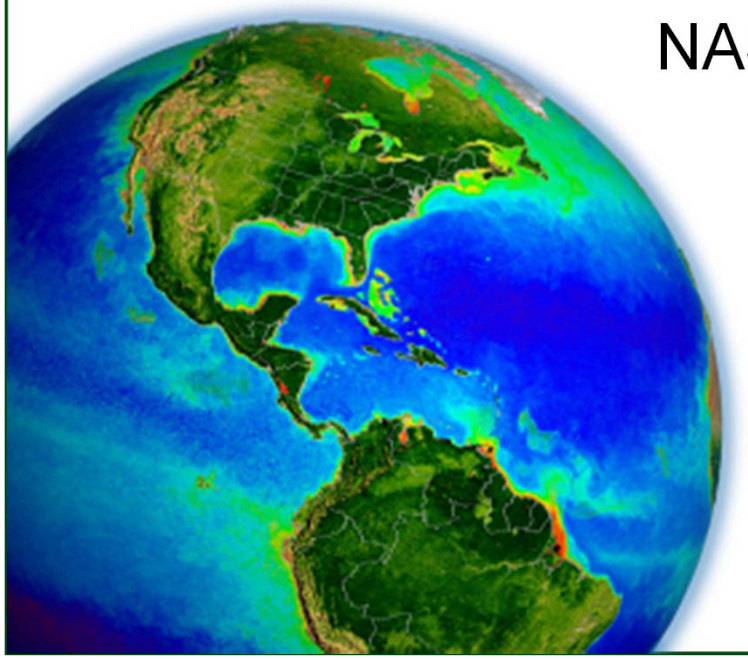


JAXA GCOM-C PI Workshop. January 2014

Collaborators

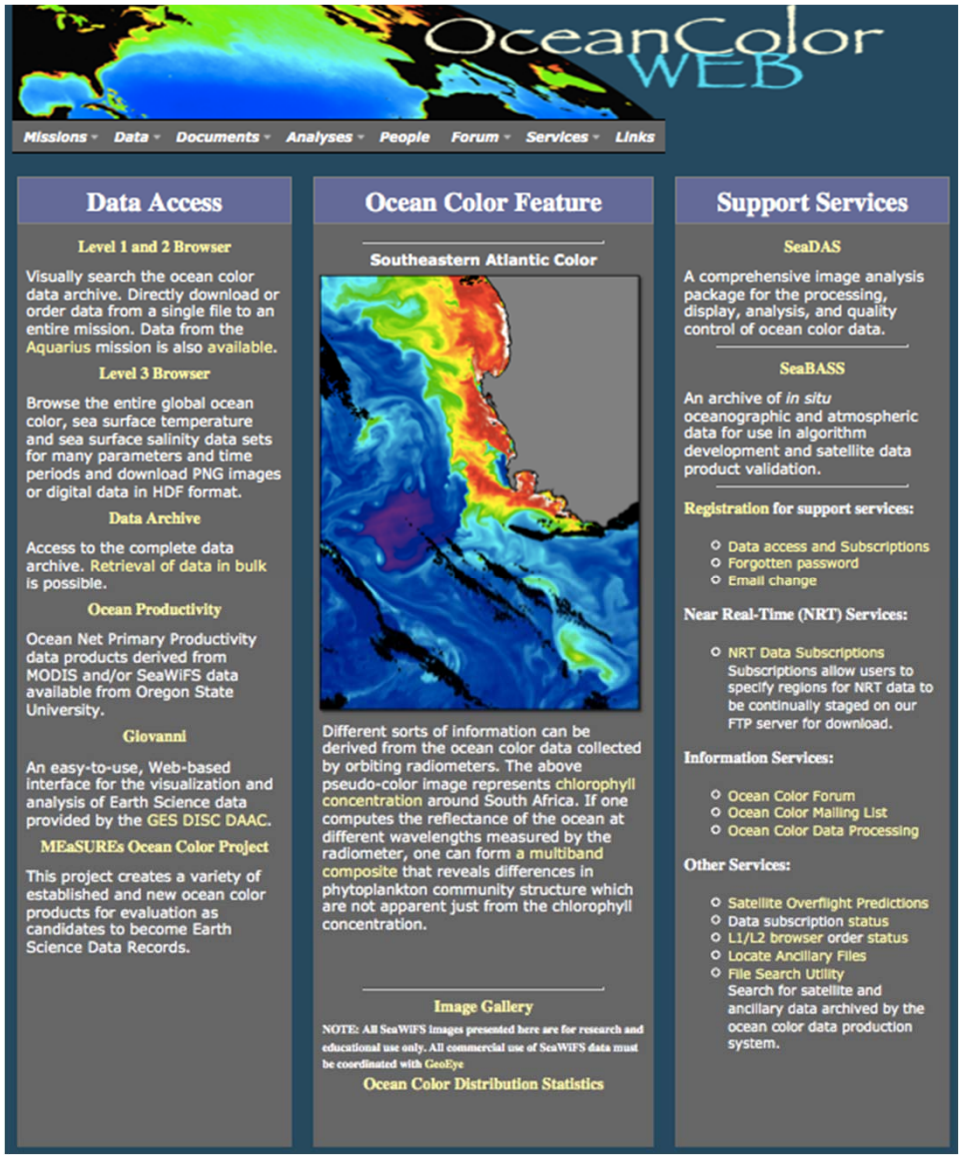
Ziauddin Ahmad	*radiative transfer, aerosol models*
Sean W. Bailey	*software development, SeaDAS*
Gerhard Meister	*instrument calibration*
Jeremy Werdell	*bio-optical algorithms, SeaBASS*

and the NASA Ocean Biology Processing Group

We have no progress to report!

NASA Ocean Biology Processing Group

calibration, validation, algorithm development, processing, and distribution



http://oceancolor.gsfc.nasa.gov/

Global Processing & Distribution

- VIIRS/NPP
- MODIS/Aqua
- MODIS/Terra (USA)
- SeaWiFS
- CZCS

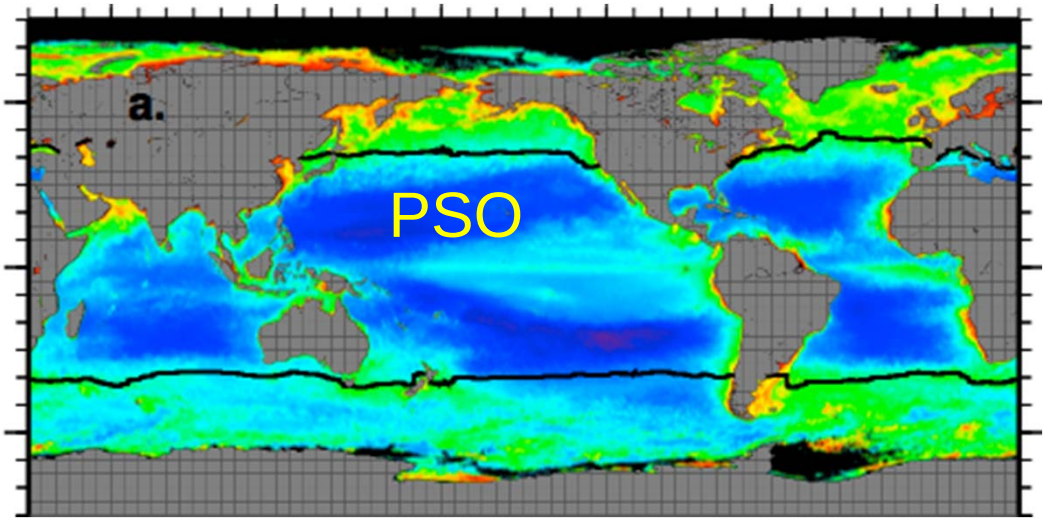
- MERIS (Europe)
- OCTS (Japan)

Regional Missions Supported

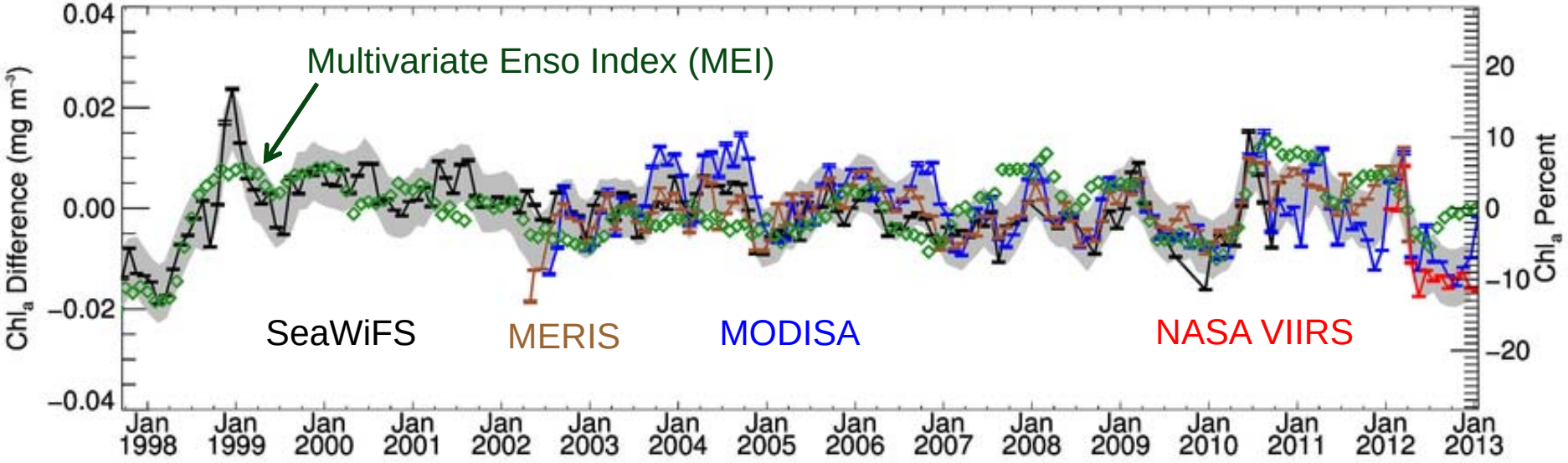
- GOCI (Korea)
- HICO (USA)
- OCM-1/2 (India)
- MOS (Germany)

we want to produce high quality data records of sufficient length, **consistency**, and continuity to support climate and ecosystem research

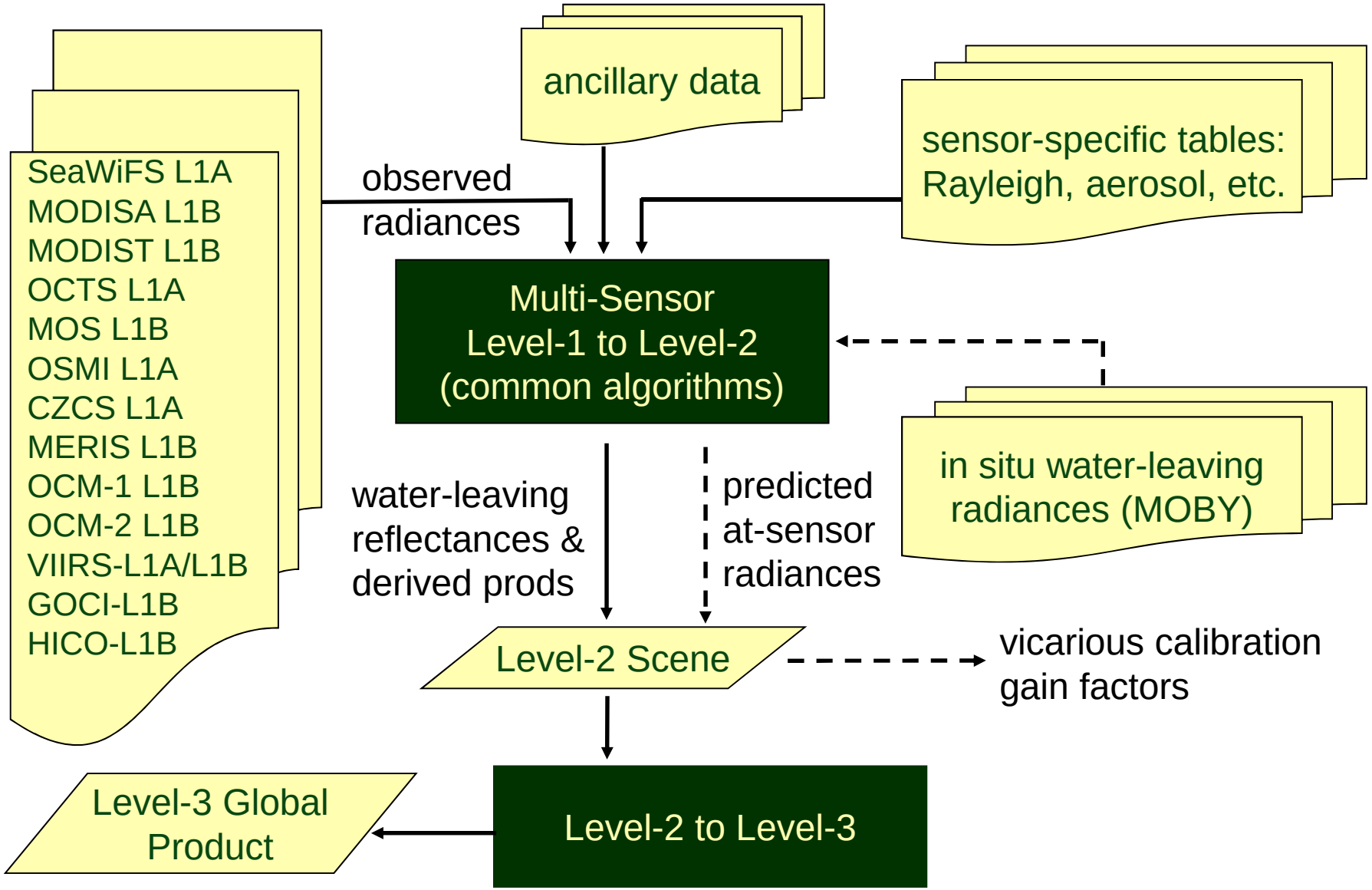
Following
Berenfeld et al. 2006
Mean SST > 15C



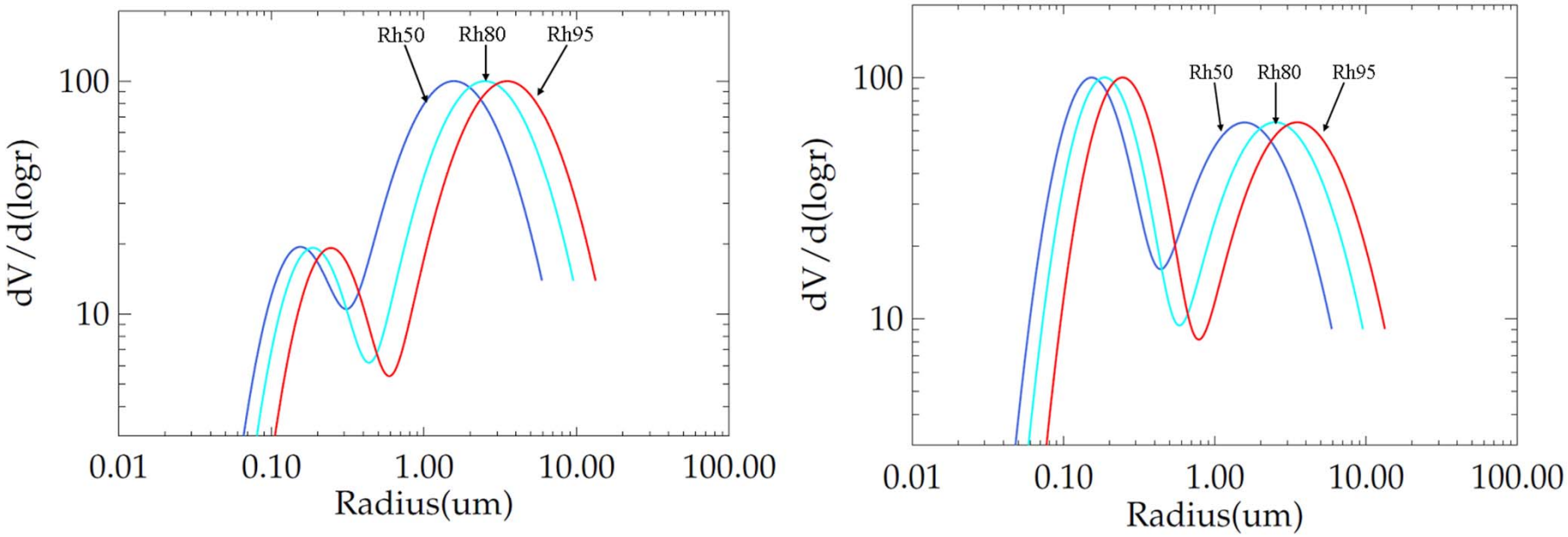
PSO Anomaly



Common Processing Approach



Generate SGLI-specific Aerosol & Rayleigh Tables



- NASA using 80 weakly absorbing aerosol models based on bi-modal size distributions that vary by modal fraction and relative humidity
- look-up tables (aerosol and Rayleigh) will be generated for SGLI band-passes using Ahmad-Fraser vector radiative transfer code
- need SGLI spectral response functions

Ahmad, Z., B.A. Franz, C.R. McClain, E.J. Kwiatkowska, J. Werdell, E.P. Shettle, and B.N. Holben (2010). New aerosol models for the retrieval of aerosol optical thickness and normalized water-leaving radiances from the SeaWiFS and MODIS sensors over coastal regions and Open Oceans, Appl. Opt., 49(29).

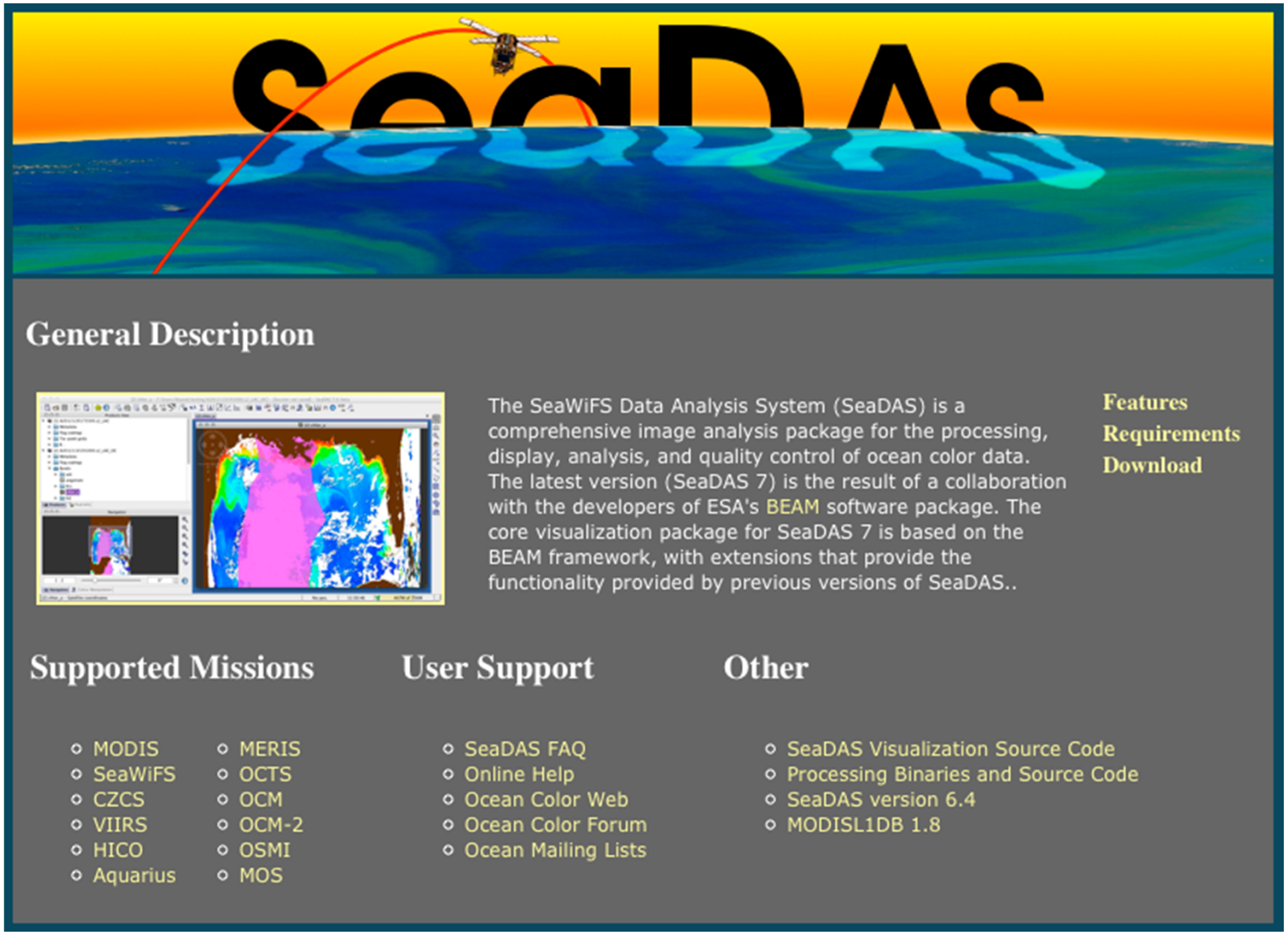
Research & Development Plan

1. implement L1 to L3 processing support for SGLI in our multi-sensor ocean color processing software

Current NASA OC Products Relevant to SGLI

Level-2 OC Product	Algorithm Reference
1. $R_{rs}(\lambda)$	
2. Ångstrom	*Ahmad et al. 2010, Gordon and Wang 1994.*
3. AOT	
4. Chlorophyll *a*	*O'Reilly et al. 1998 (OC3) updated by Werdell*
5. $K_d(490)$	*Werdell (KD2) algorithm (similar to OC3)*
6. POC	*Stramski et al. 2008*
7. PIC	*Balch et al. 2005, Gordon et al. 2001*
8. PAR	*Frouin et al. 2003*
9. IOPs (GIOP)	*Werdell et al. 2013.*
10. IOPs (QAA)	*Lee et al. 2002*
11. IOPs (GSM)	*Maritorena et al. 2002*
	and many more

SeaDAS: free open-source multi-sensor processing, image display, and analysis tool



http://seadas.gsfc.nasa.gov/

SeaDAS Product Generation

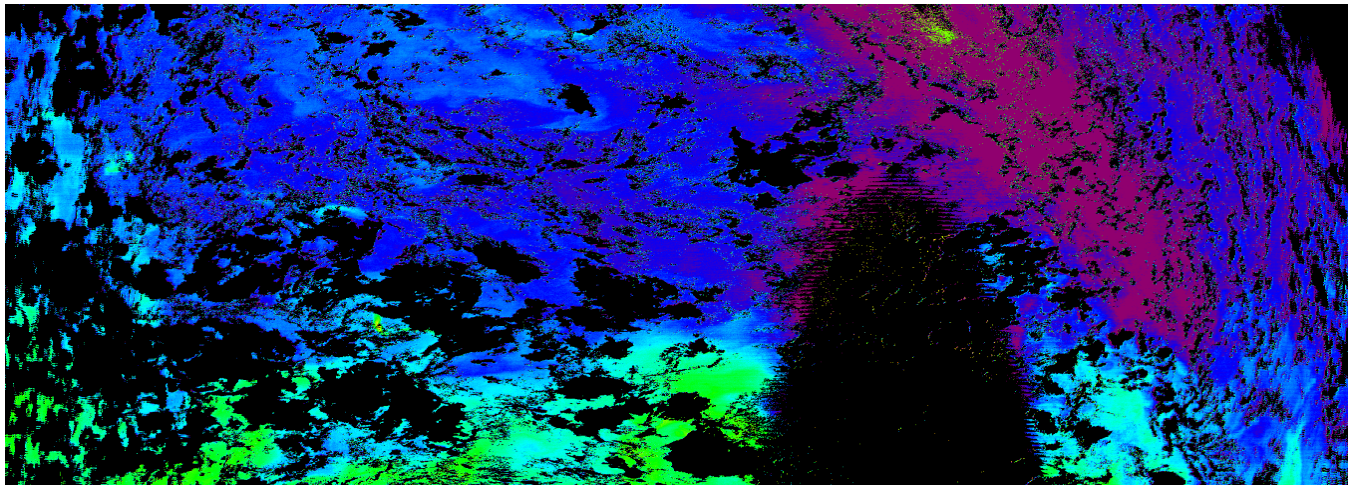
many additional products + alternate correction algorithms

- Atmospheric Correction Options
  - alternate band pairs
  - aerosol model suites
  - model selection methods
  - turbid-water corrections
  - absorbing gases (e.g., NO2)
  - ancillary data sources
  - flag & mask thresholds
- Intermediate Products
  - aerosol and Rayleigh radiances
  - derived transmittances
  - polarization state
  - glint and whitecap radiances
  - co-located ancillary inputs
  - etc.
- Additional Derived Products
  - alternate C_a algorithms
  - regionally-tuned coefficients
  - Zeu, KPAR, spectral Kd
  - water classification
  - inherent optical properties
    - a, bb, adg, aph, bbp
    - full suite of published models
    - generic IOP model
  - etc.
- Community Algorithm Development
  - full source distribution with build environment and user support

Alternative Chlorophyll Algorithm OCI

more robust in glint retrieval in presence of Sun glint

Chl_{OC3}
Flags off



Chl_{OCI}
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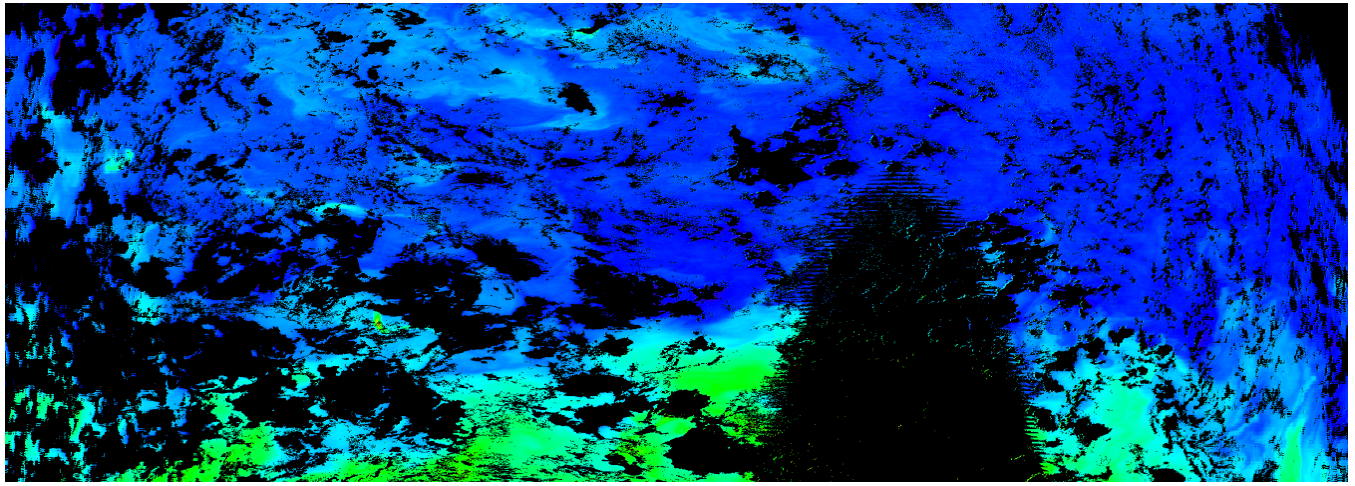
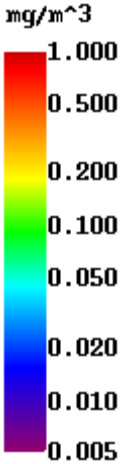




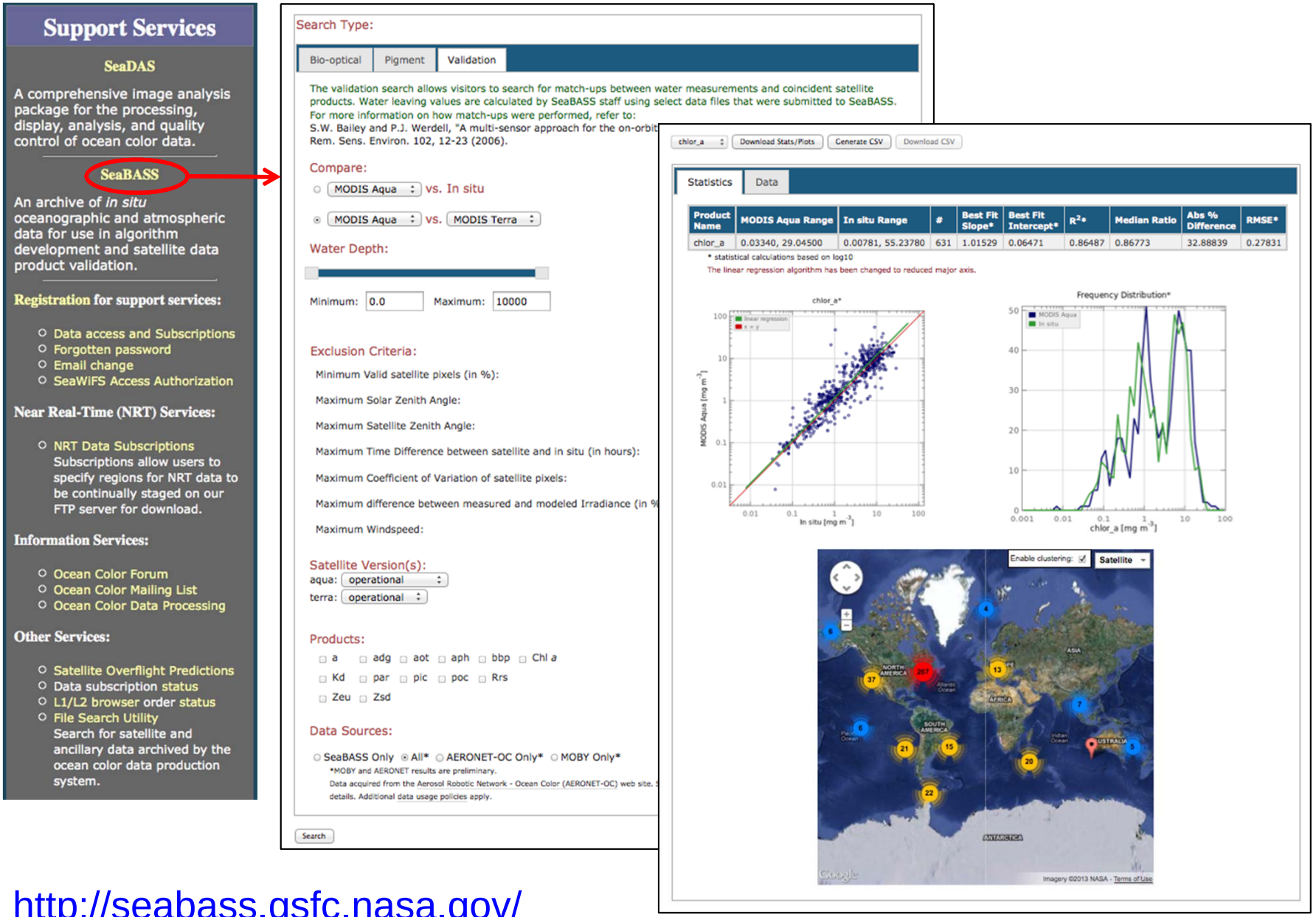
Hu, C., Z. Lee, and B. Franz (2012), Chlorophyll a algorithms for oligotrophic oceans: A novel approach based on three-band reflectance difference, J. Geophys. Res., 117.

Research & Development Plan

1. implement L1 to L3 processing support for SGLI in our multi-sensor ocean color processing software

2. implement processing, display, and analysis support for SGLI in SeaDAS

SeaBASS In Situ Validation Tool



http://seabass.gsfc.nasa.gov/

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3. implement support for SGLI into our automated in situ validation system for ocean color (SeaBASS & AeroNET-OC)

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1. implement L1 to L3 processing support for SGLI in our multi-sensor ocean color processing software

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4. develop tools for timeseries comparison of SGLI standard products and SGLI products processed with NASA standard algorithms, and coincident products from MODIS and/or VIIRS and/or OLCI

Radiometric Consistency of MODISA & SeaWiFS

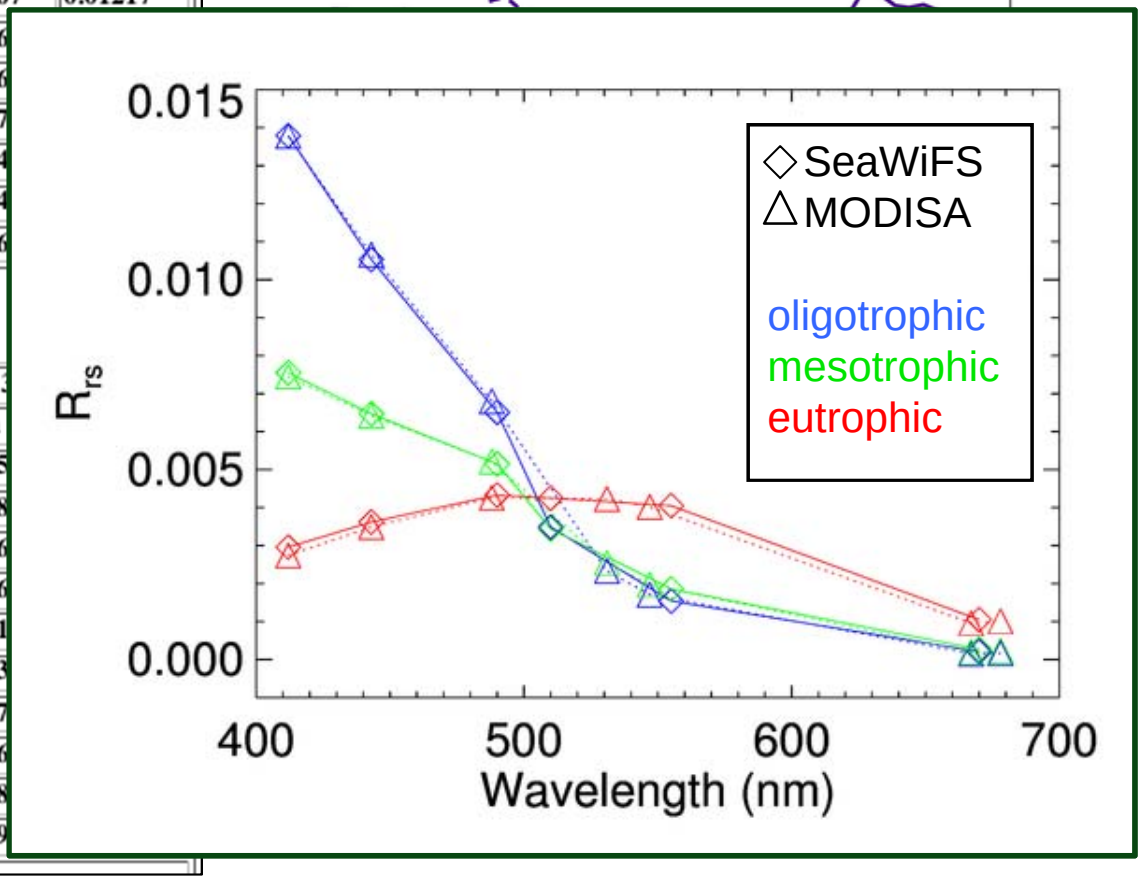
Deep-Water

Deep-Water

	sr2010.0m		ar2013.0m		ar2013.0m/sr2010.0m	
Prod	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
chlor_a	0.17947	0.00910	0.17367	0.01064	0.96779	0.03539
Rrs_412	0.00987	0.00029	0.00981	0.00034	0.99417	0.03190
Rrs_443	0.00797	0.00019	0.00799	0.00021	1.00225	0.01852
Rrs_490,Rrs_488	0.00564	0.00013	0.00578	0.00015	1.02507	0.01217
Rrs_510,Rrs_531	0.00345	0.00008	0.00245	0.00006	0.7106	
Rrs_555,Rrs_547	0.00173	0.00005	0.00186	0.00005	1.0756	
Rrs_670,Rrs_667	0.00025	0.00001	0.00019	0.00001	0.7367	
Rrs_670,Rrs_678	0.00025	0.00001	0.00021	0.00001	0.8224	
aot_865,aot_869	0.07316	0.00303	0.08322	0.00303	1.1384	
angstrom	0.83233	0.08118	0.83383	0.05318	1.0096	

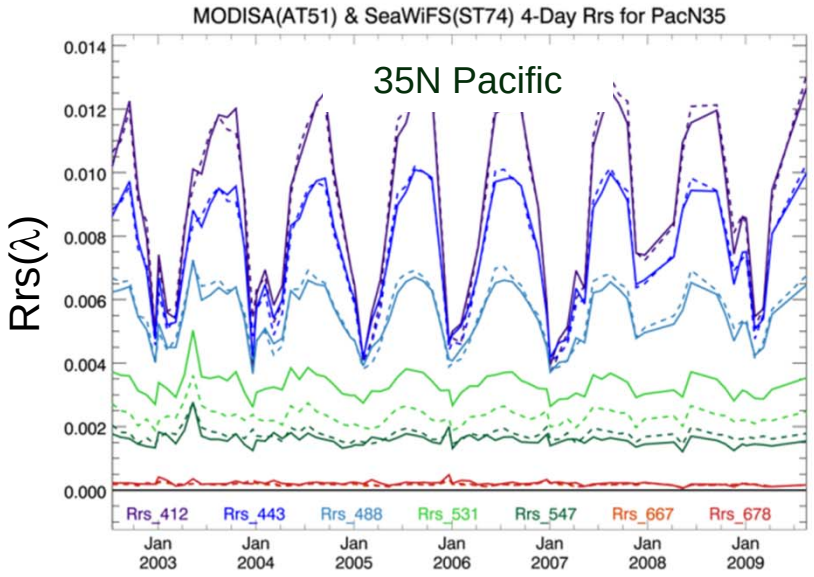
Oligotrophic

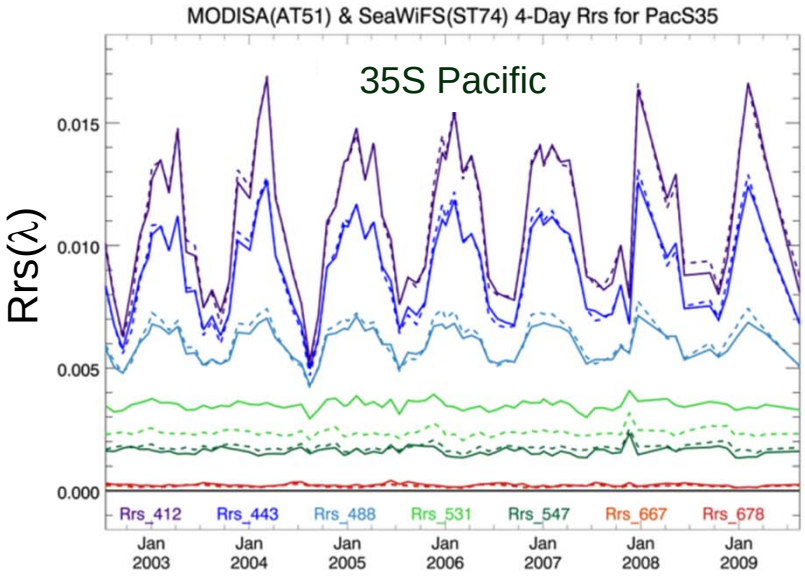
	sr2010.0m		ar2013.0m		ar201
Prod	Mean	Std Dev	Mean	Std Dev	Mean
chlor_a	0.06091	0.00637	0.05776	0.00532	0.9505
Rrs_412	0.01379	0.00060	0.01378	0.00065	0.9998
Rrs_443	0.01053	0.00037	0.01066	0.00042	1.0126
Rrs_490,Rrs_488	0.00651	0.00012	0.00680	0.00017	1.0446
Rrs_510,Rrs_531	0.00349	0.00005	0.00233	0.00004	0.6681
Rrs_555,Rrs_547	0.00154	0.00004	0.00171	0.00003	1.1083
Rrs_670,Rrs_667	0.00021	0.00001	0.00016	0.00001	0.7567
Rrs_670,Rrs_678	0.00021	0.00001	0.00017	0.00001	0.7866
aot_865,aot_869	0.06858	0.00397	0.07764	0.00408	1.1338
angstrom	0.79744	0.09358	0.80293	0.07993	1.0169



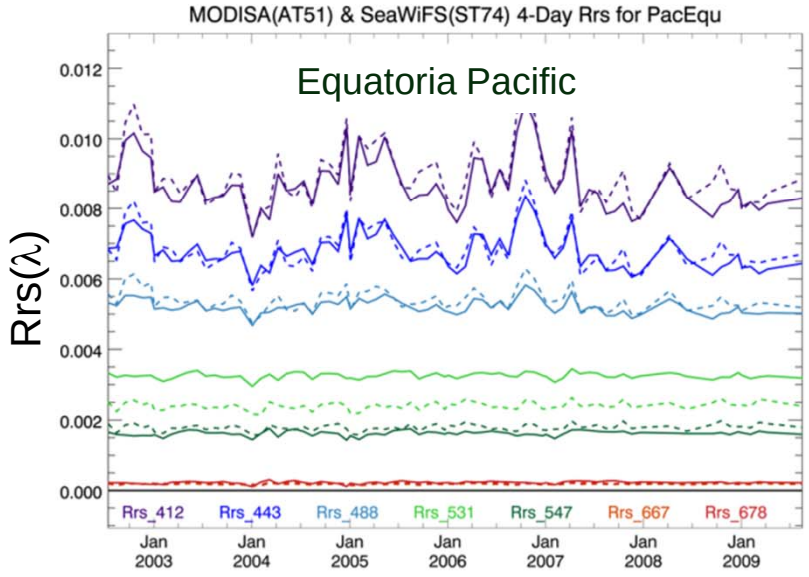
MODISA & SeaWiFS Water-Leaving Reflectance

zonal analysis over duration of mission overlap

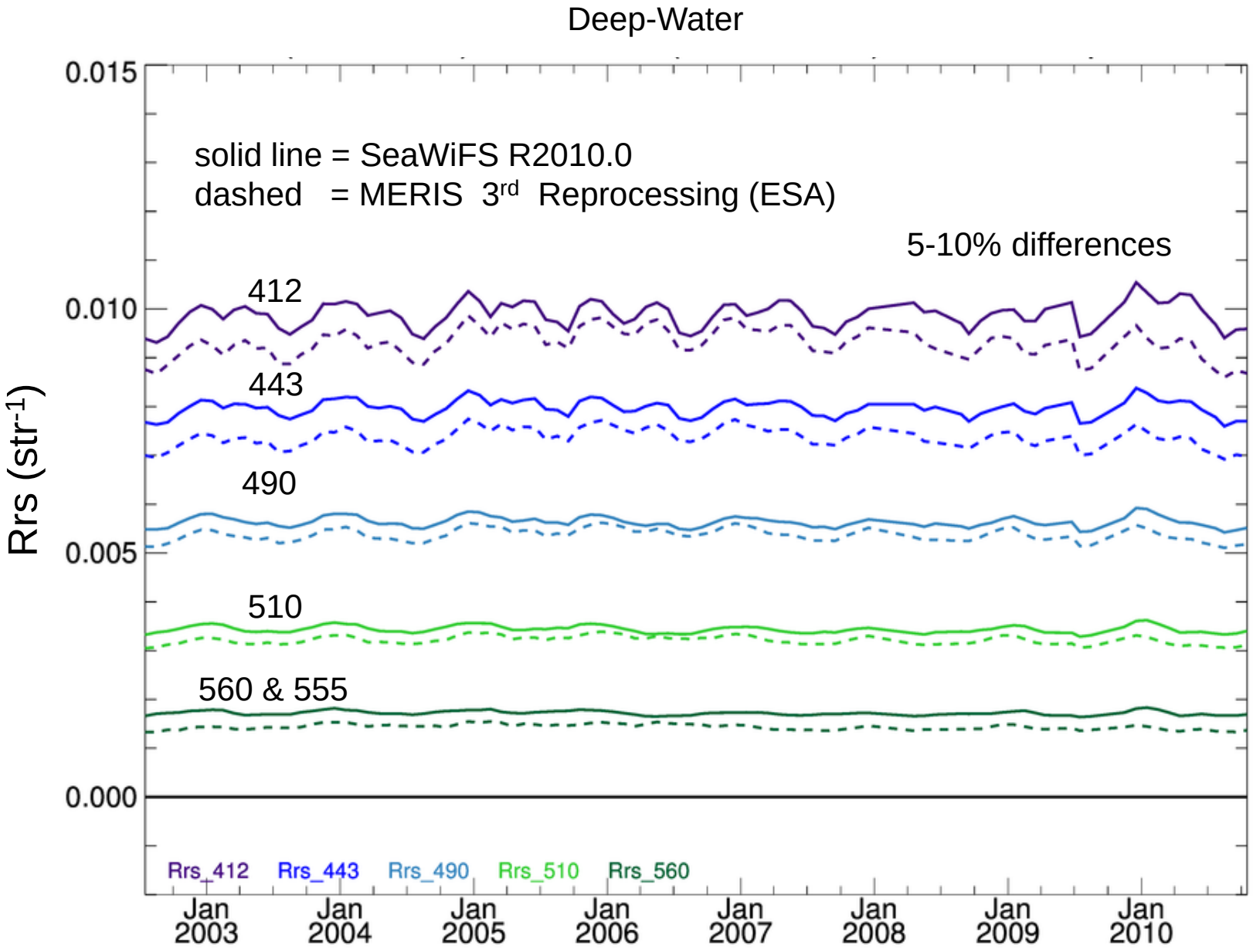




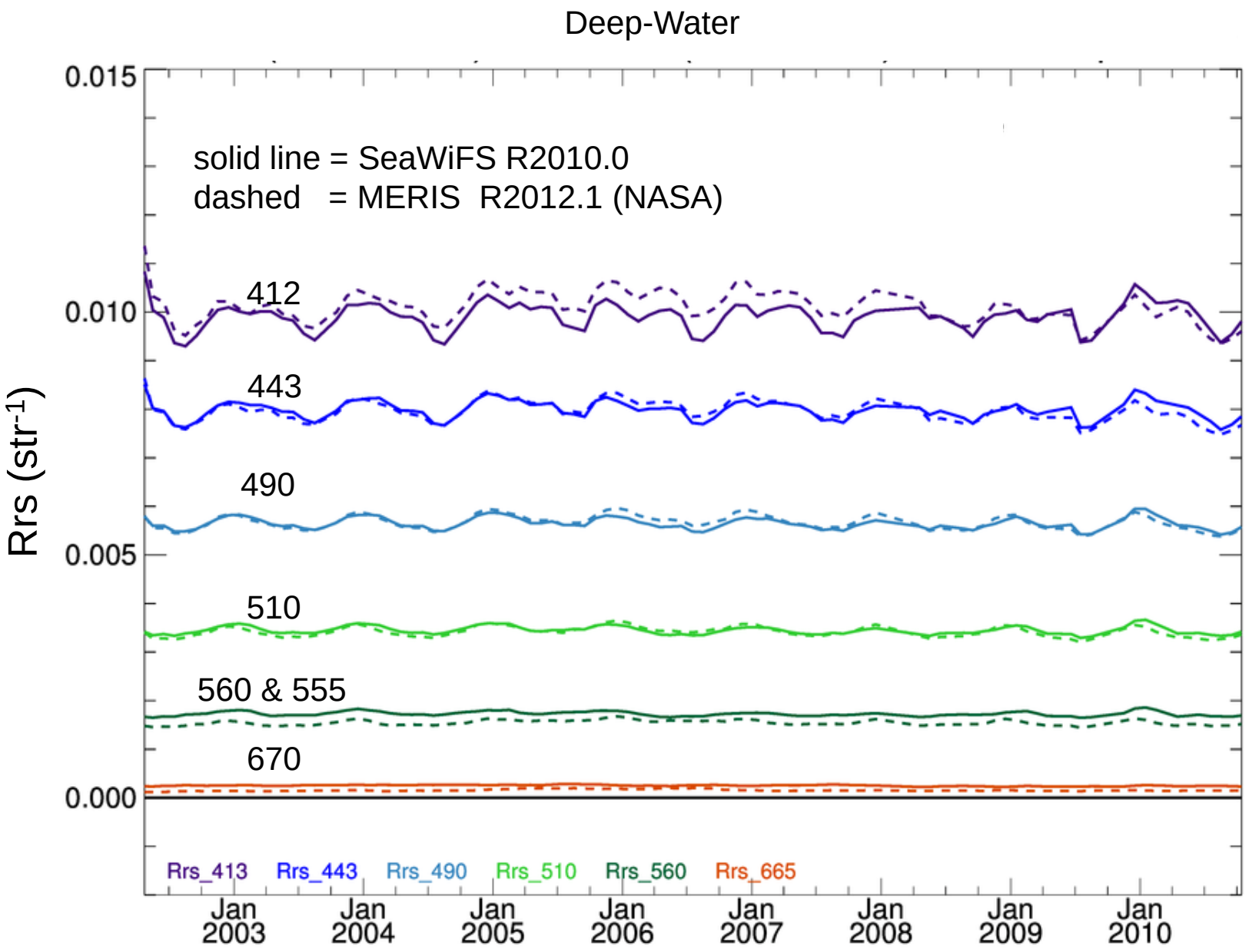
Challenges atmospheric models and polarization corrections.



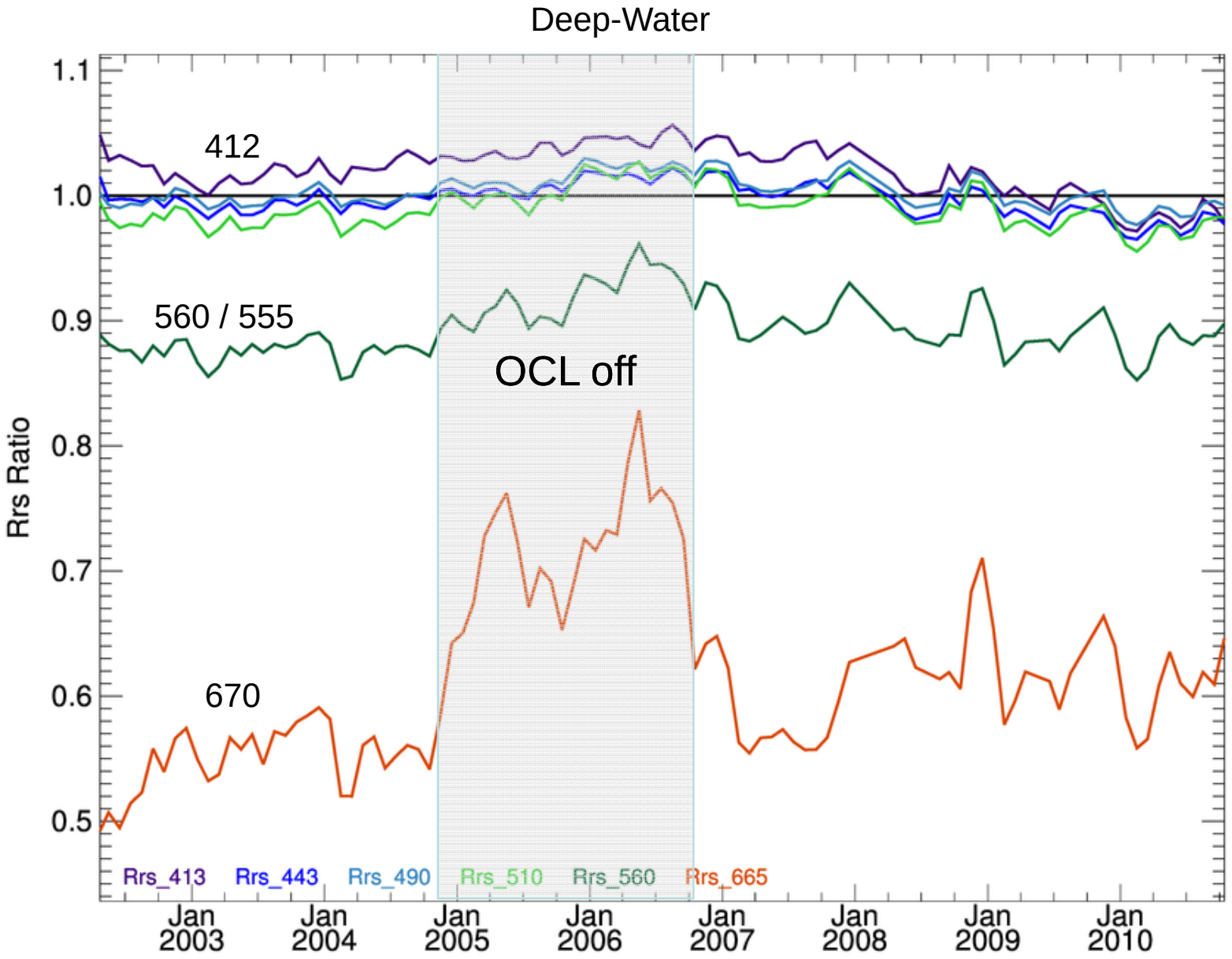
Radiometric (in)Consistency of MERIS & SeaWiFS



Radiometric Consistency of MERIS & SeaWiFS



MERIS/SeaWiFS Rrs Ratios



SGLI Data Requirements

- Prelaunch
  - relative spectral response functions
  - sample Level-1 data
  - sample Level-2 data
  - sample Level-3 data

- Postlaunch
  - global, full mission Level-1(A?) at 1-km resolution
  - global, full mission Level-3

Anticipated Benefits

- SeaDAS support will provide the international science community with a familiar tool to readily access and exploit the capabilities of SGLI for earth system science and applications

- freely-distributed open-source processing software will facilitate community-based application development to maximize the value & impact of SGLI

- comparative analyses of SGLI time-series relative to other sensors using common algorithms can identify instrument calibration issues

- comparative performance assessment of SGLI processed with different algorithms helps to advance the state of the art

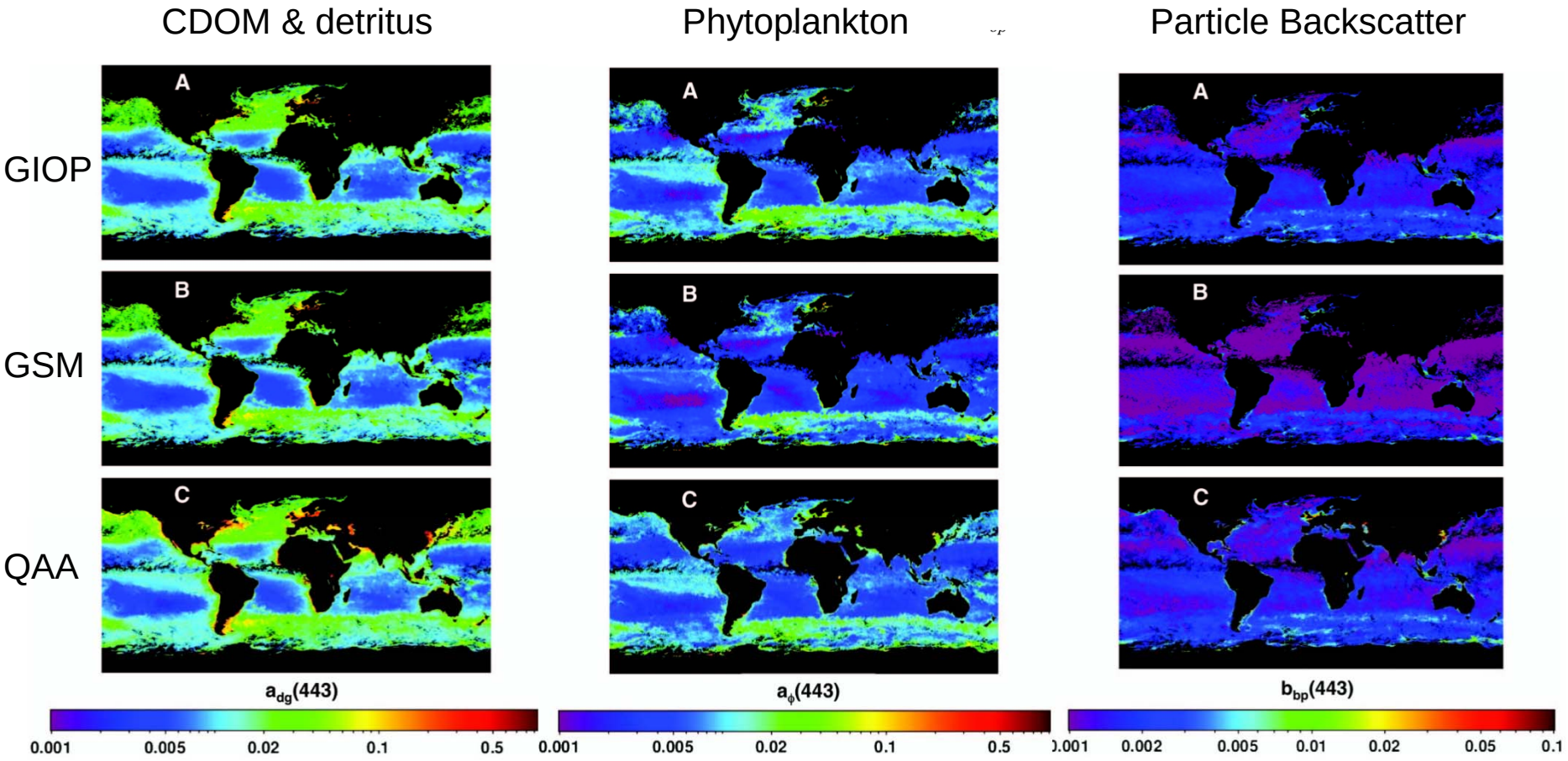
Final Thought

Fundamentally, we wish to

share lessons learned from NASA ocean color experience
to contribute to the value and success of the SGLI mission.


Thank You

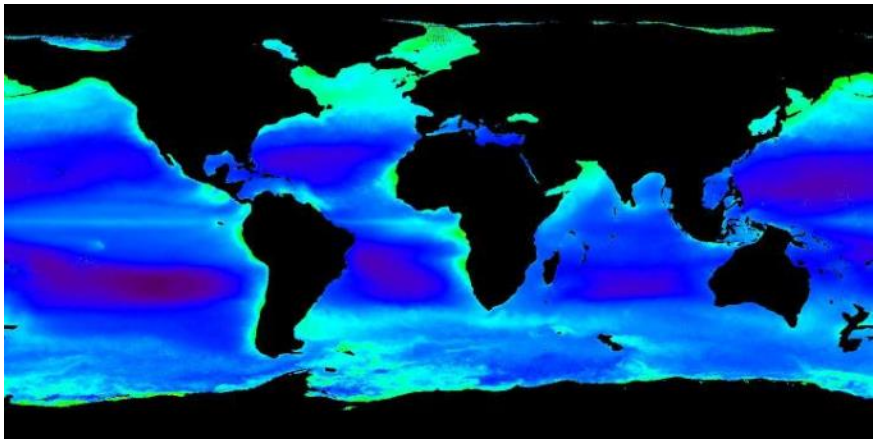
Inherent Optical Properties



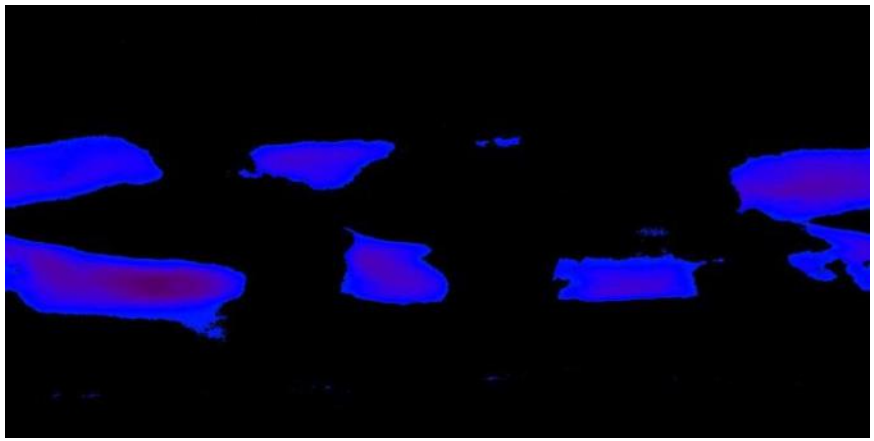
Werdell, P.J., B.A. Franz, S.W. Bailey, G.C. Feldman and 15 co-authors (2013). Generalized ocean color inversion model for retrieving marine inherent optical properties, Applied Optics 52, 2019-2037.

Global Trophic Subsets

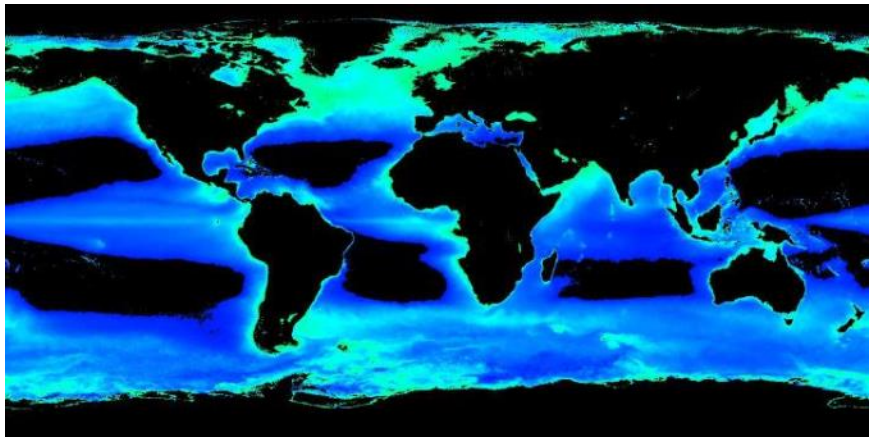
Deep-Water (Depth > 1000m)



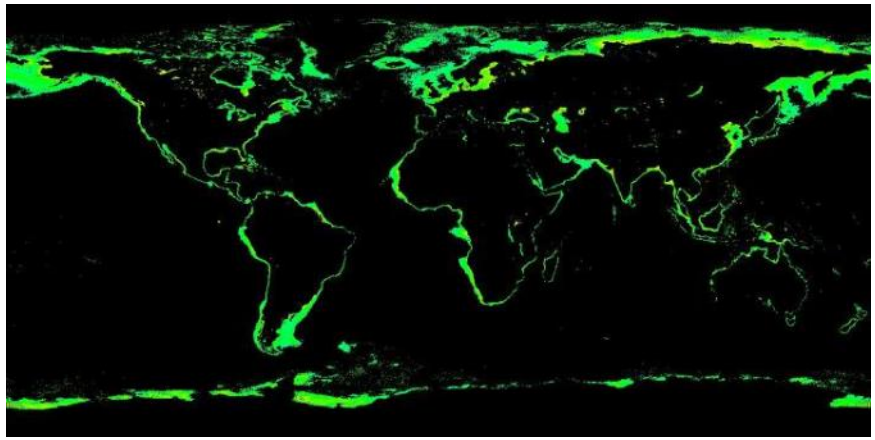
Oligotrophic (Chlorophyll < 0.1)



Mesotrophic (0.1 < Chlorophyll < 1)

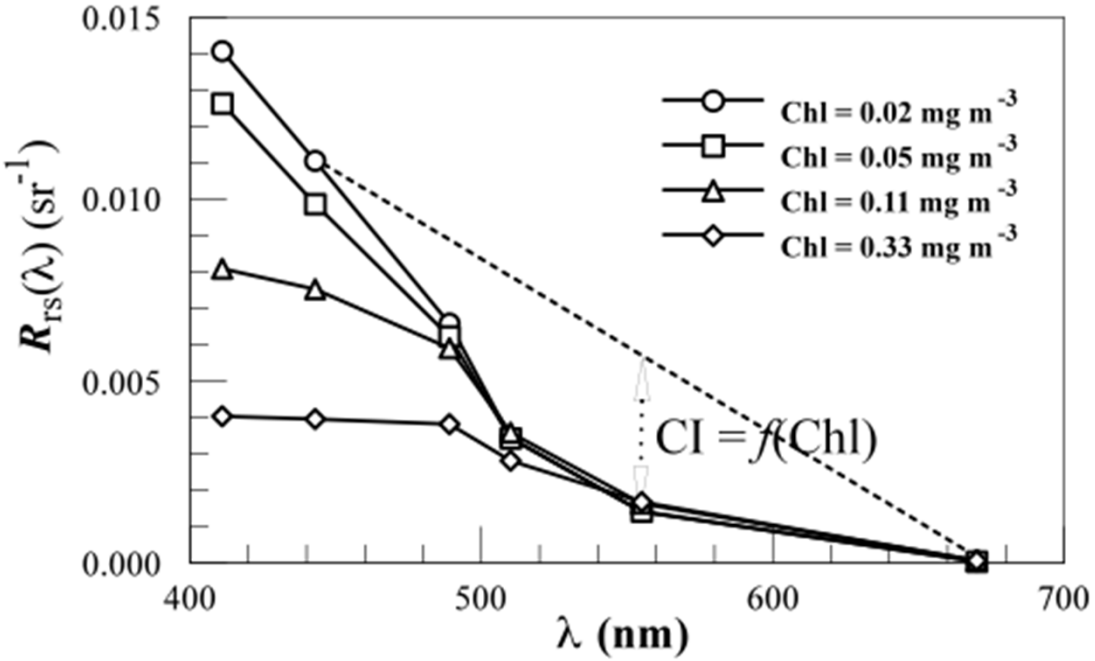


Eutrophic (1 < Chlorophyll < 10)



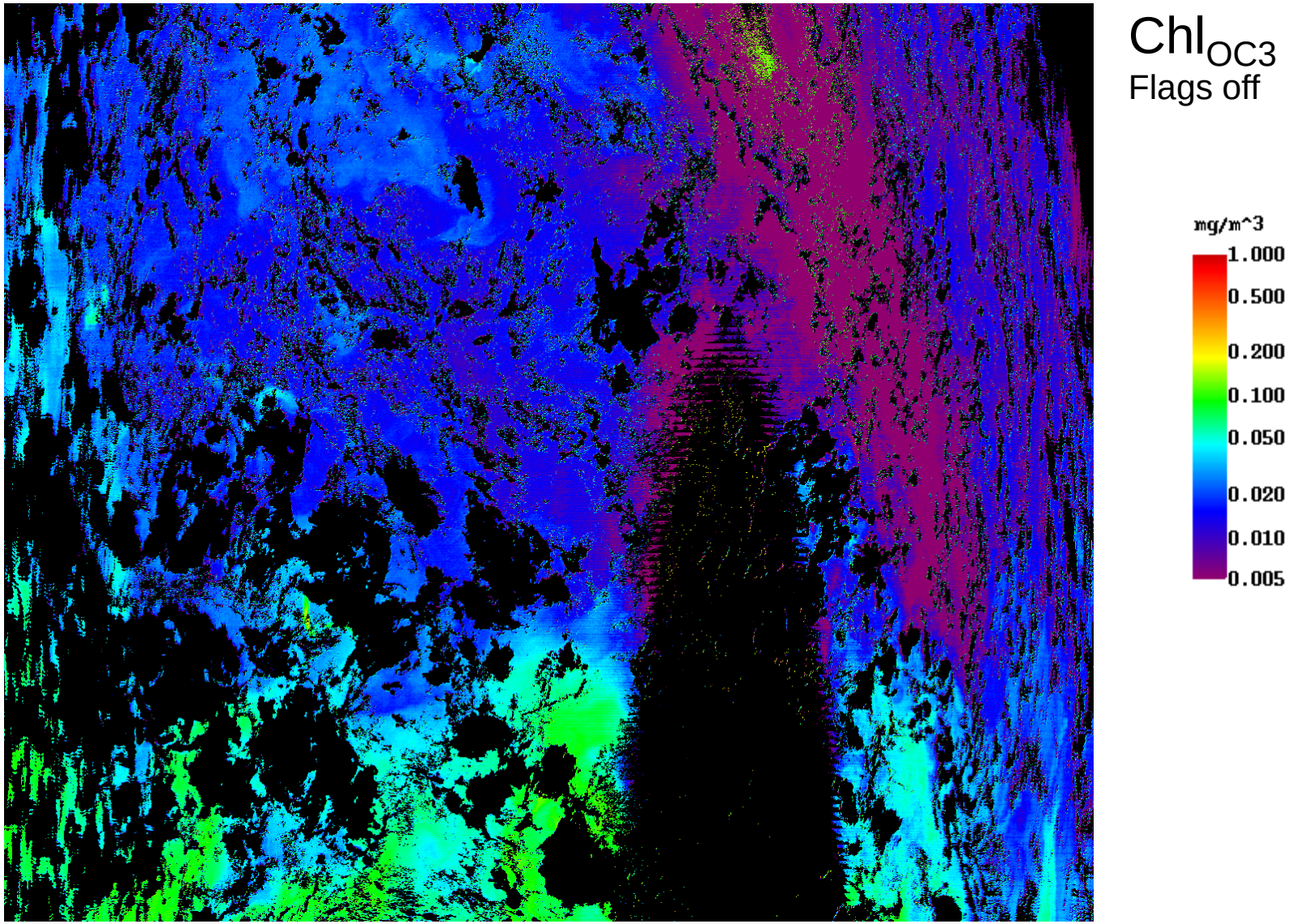
OCI Chlorophyll Algorithm

Line height algorithm for chlorophyll < 0.25 mg m^{-3}, merged with OC3/OC4 max band ratio algorithm for chlorophyll > 0.3 mg m^{-3}.



Hu, C., Z. Lee, and B. Franz (2012), Chlorophyll a algorithms for oligotrophic oceans: A novel approach based on three-band reflectance difference, J. Geophys. Res., 117, C01011, doi:10.1029/2011JC007395.

MODIS/Aqua, March4, 2003, 21:10 GMT



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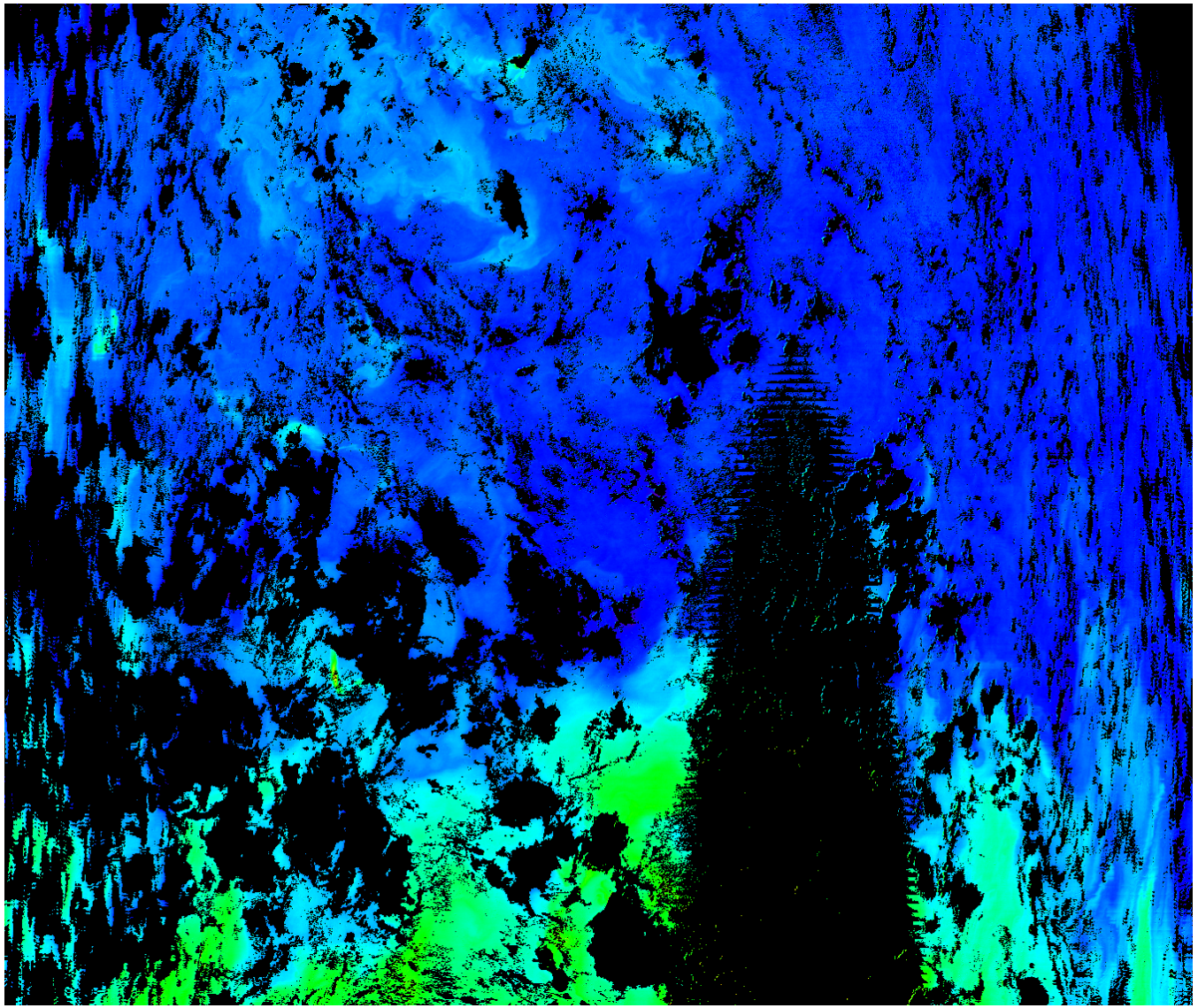

Chl_{CI}
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mg/m^3
1.000
0.500
0.200
0.100
0.050
0.020
0.010
0.005