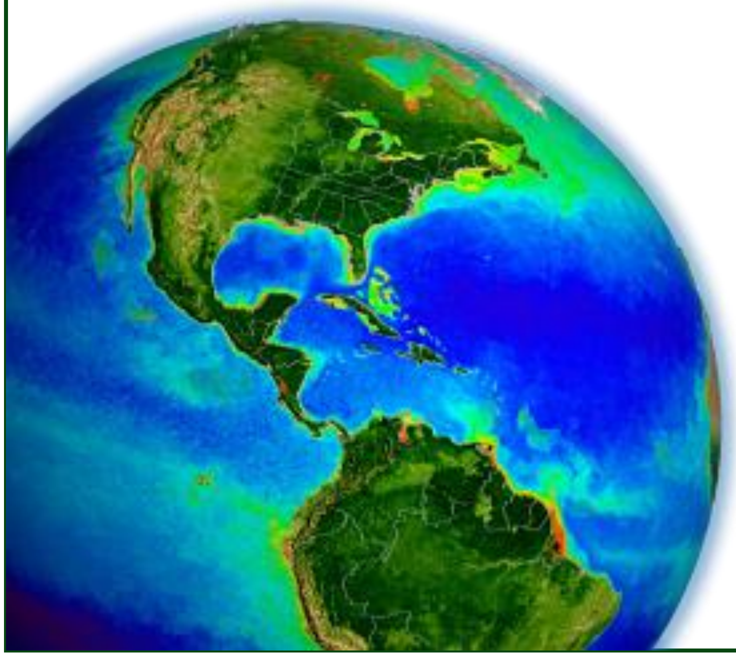
OBPG Status

Bryan Franz

and the
Ocean Biology
Processing Group



OCRT Meeting

May 2014

Content

- Expanding mission support

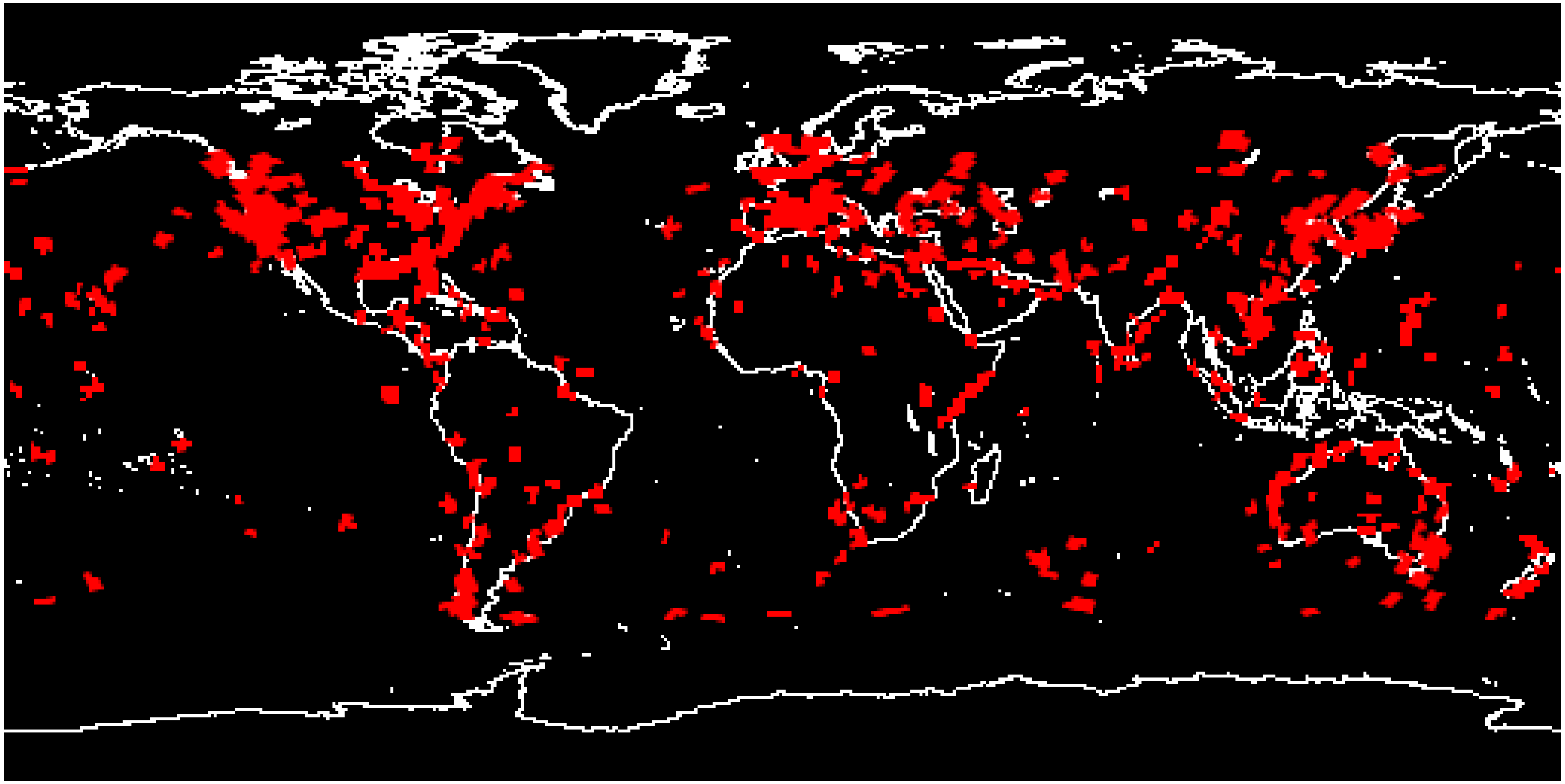
- Reprocessing history and current product quality

- Sensor calibration issues (VIIRS & SeaWiFS)

- Changes for next reprocessing (R2014.0, starting now)

Hyperspectral Imager for Coastal Oceans (HICO)

Data Available from OBPG



More than 8000 HICO scenes currently archived and available that were acquired since 15 October 2009. New files received generally within 3 days of acquisition.

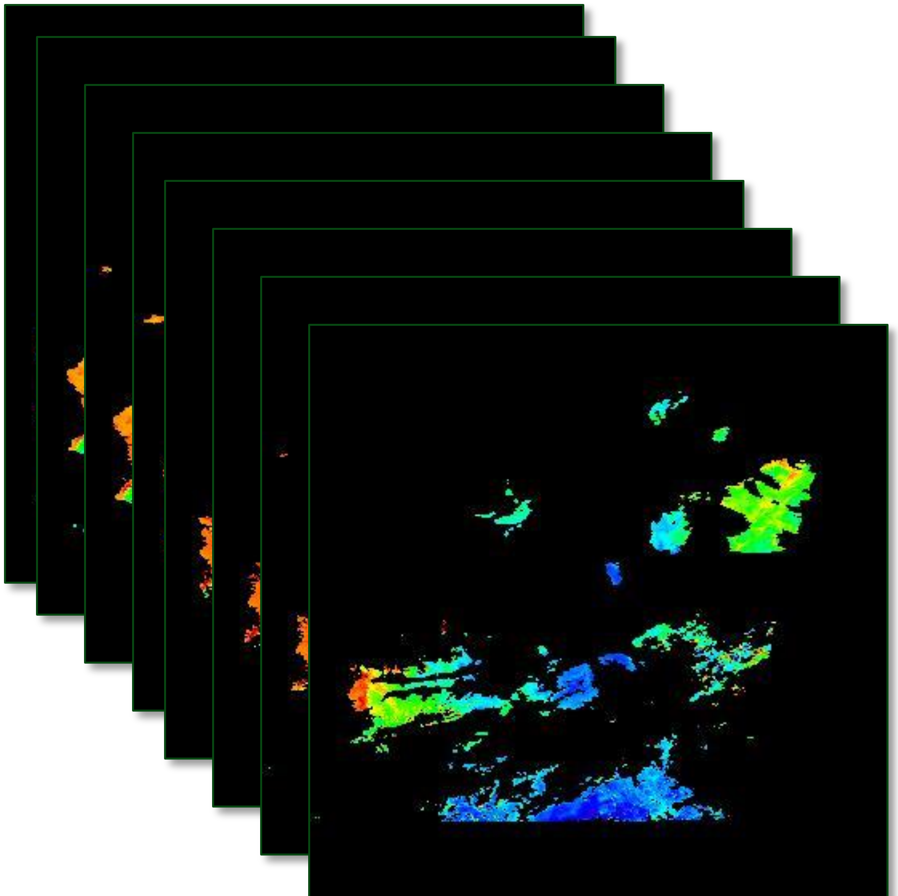
HICO Support by OBPG

- Request and scheduling of data collection handled by OSU/NRL/ISS.
- Raw data acquired by NRL-DC via MSFC and transferred to OBPG within days of acquisition.
- HICO L1B products produced using standard software and calibrations supplied by NRL-DC.
- SeaDAS has been enhanced with HICO processing and display capabilities.
- Initial NASA Level-2 processing capability treats HICO as a 15-band MERIS-like instrument.
- Full hyperspectral processing capability is to be developed.
- Vicarious calibration to be developed.

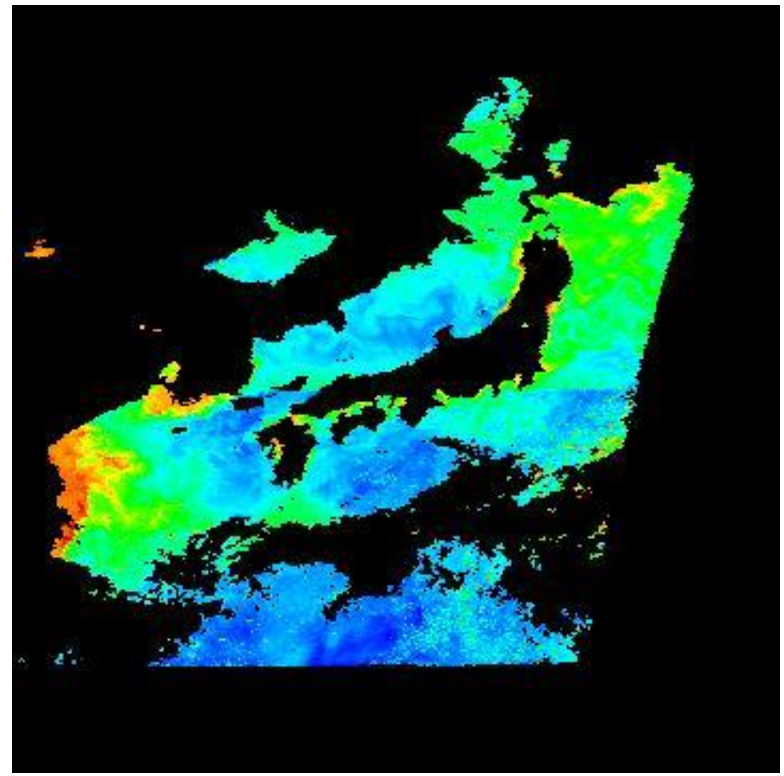
- All past and future data collected by HICO is now openly available to anyone for research purposes, regardless of who requested it.

Korean Geostationary Ocean Color Imager (GOCI)

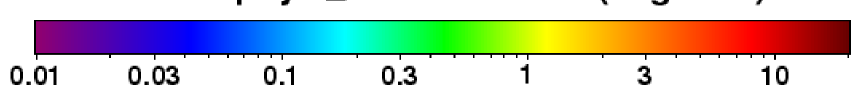
NASA Level-2 and Level-3 Processing Support



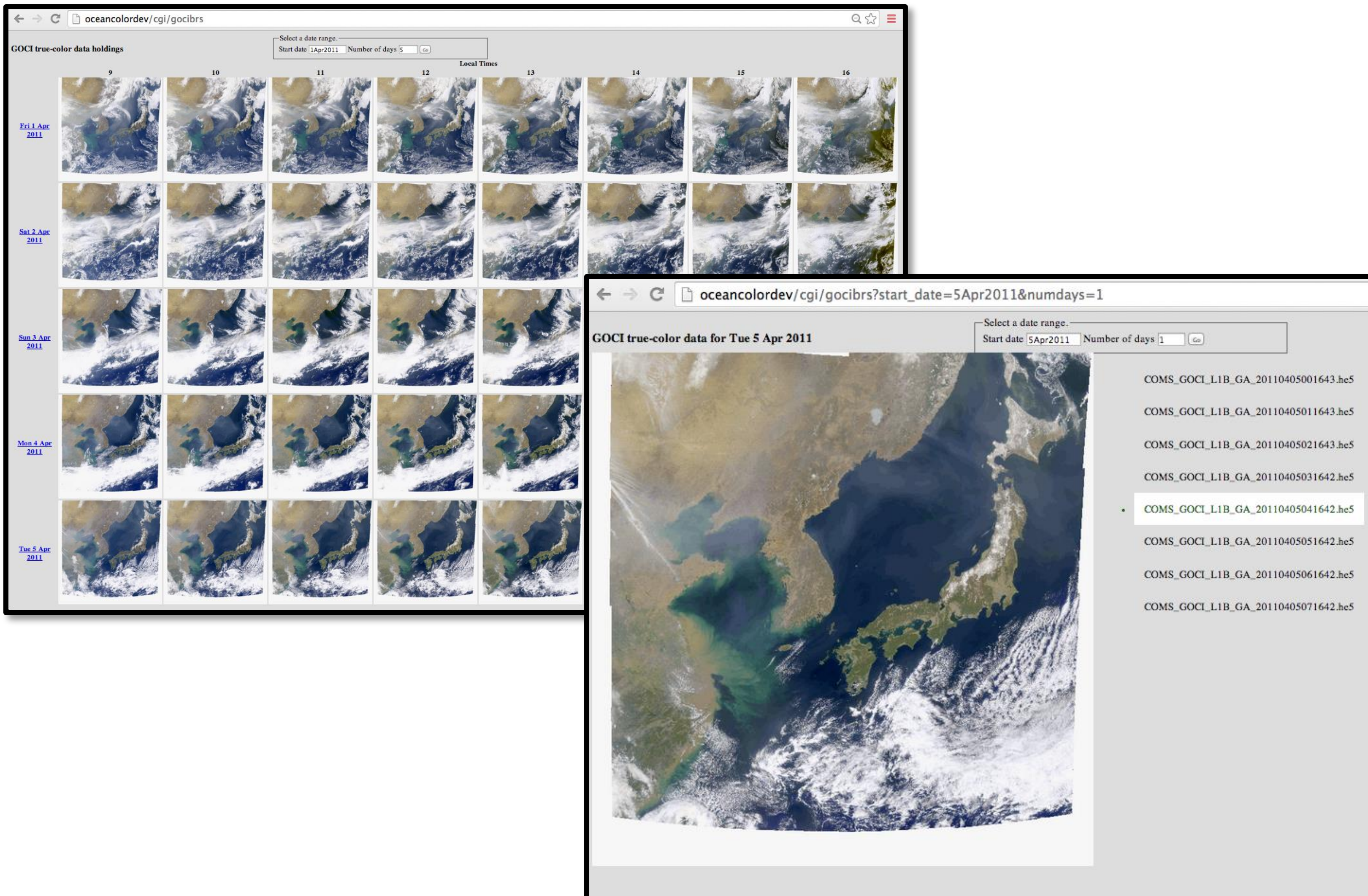
Daily Mean Chlorophyll



Chlorophyll a concentration (mg / m^3)



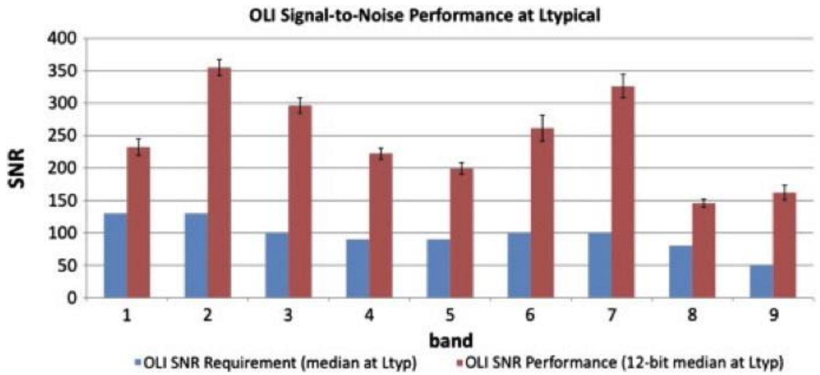
Geostationary Ocean Color Imager (GOCI) Mirror Site Development

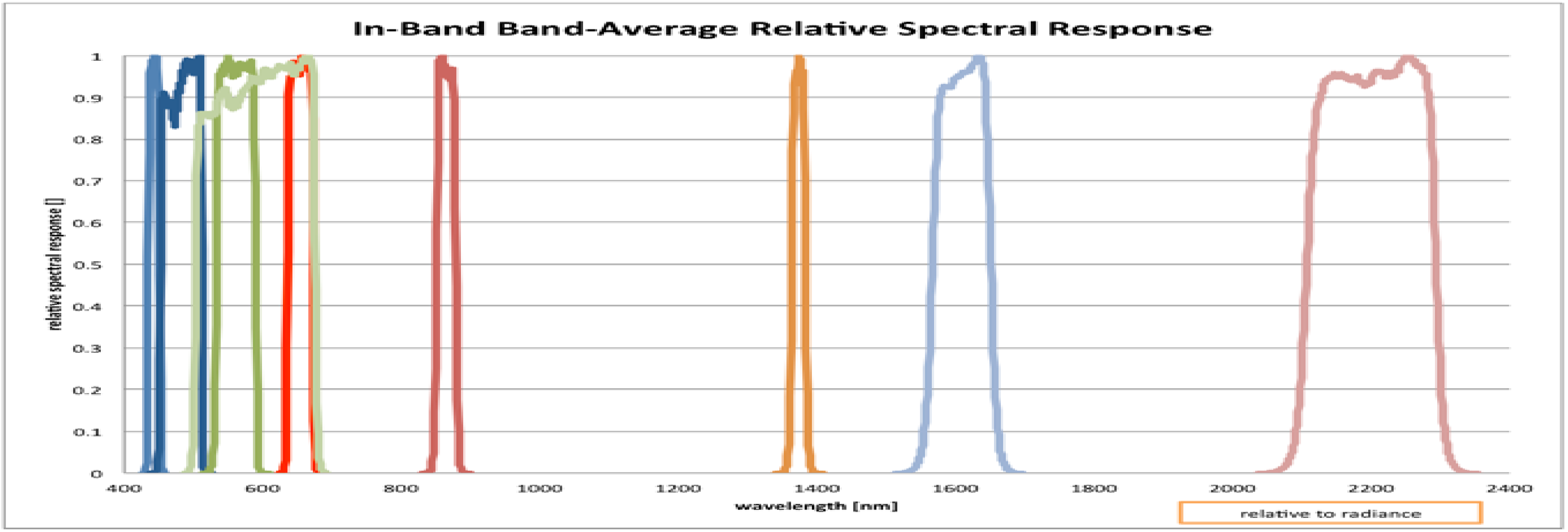


Landsat-8 Ocean Land Imager (OLI)

Spectral Band	Wavelength	Resolution
Band 1 - Coastal / Aerosol	0.433 - 0.453 μm	30 m
Band 2 - Blue	0.450 - 0.515 μm	30 m
Band 3 - Green	0.525 - 0.600 μm	30 m
Band 4 - Red	0.630 - 0.680 μm	30 m
Band 5 - Near Infrared	0.845 - 0.885 μm	30 m
Band 6 - Short Wavelength Infrared	1.560 - 1.660 μm	30 m
Band 7 - Short Wavelength Infrared	2.100 - 2.300 μm	30 m
Band 8 - Panchromatic	0.500 - 0.680 μm	15 m
Band 9 - Cirrus	1.360 - 1.390 μm	30 m

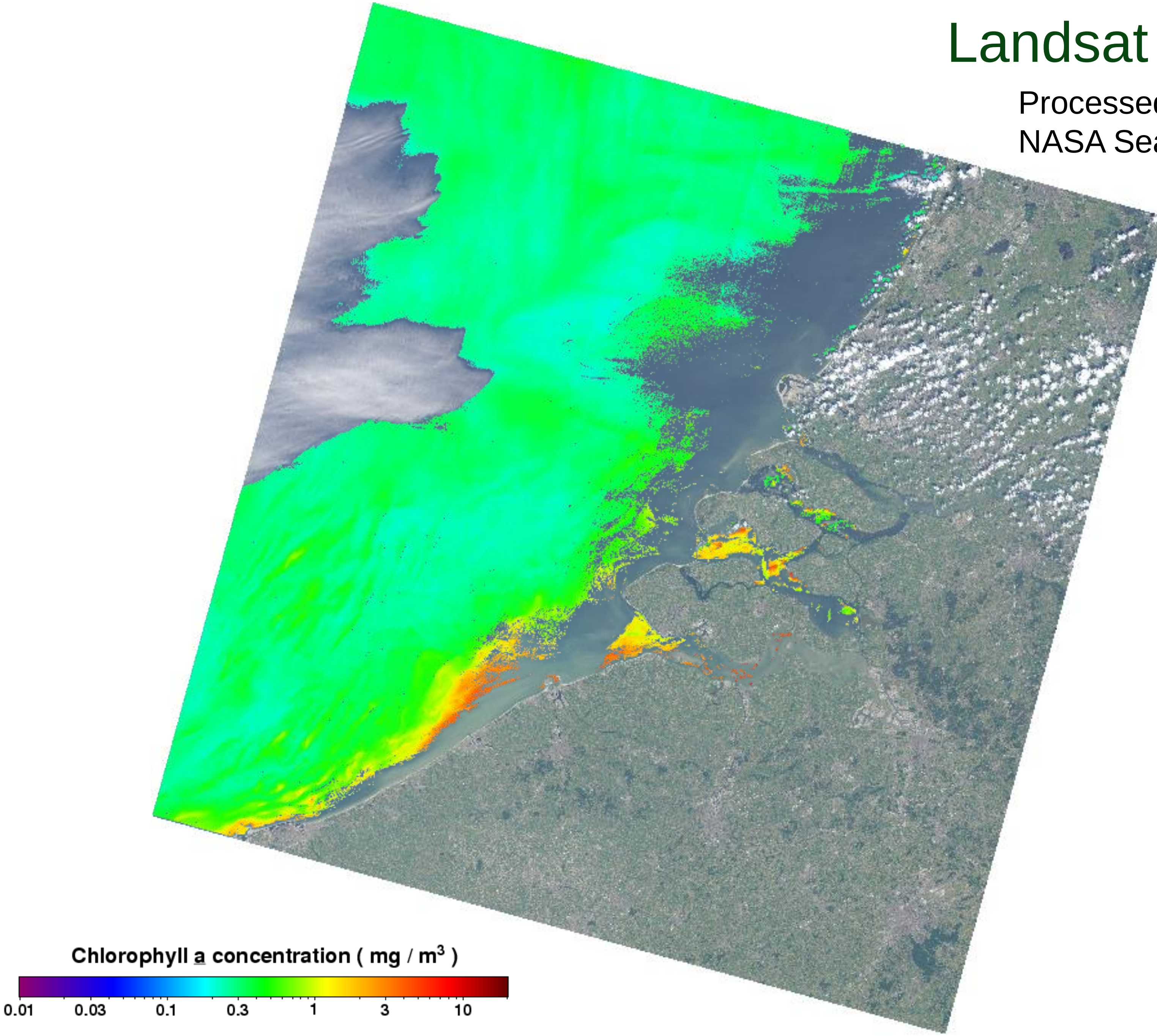
- Launch February 2013
- Operational April 2013





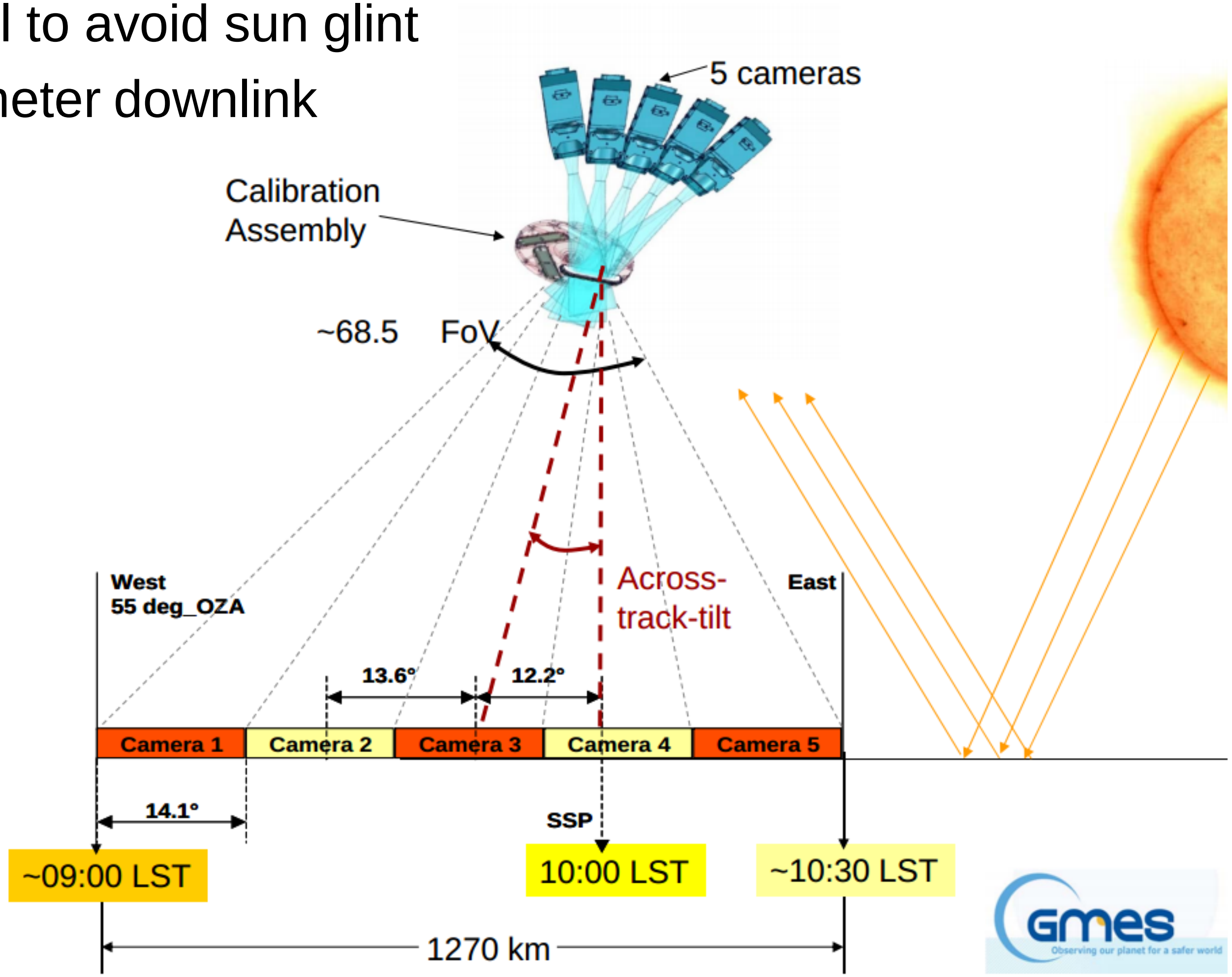
Landsat 8 OLI

Processed with
NASA SeaDAS



Ocean and Land Color Instrument (OLCI)

- ESA MERIS follow-on to fly on Sentinel-3, launch date June 2015
- Some additional bands relative to MERIS (e.g.: 400nm, 673.5nm)
- Westward roll to avoid sun glint
- Global 300-meter downlink



OLCI Support by OBPG

- OBPG staff (Gerhard Meister, Bryan Franz, Jeremy Werdell, Sean Bailey) participating in S3 validation team

- Agency-level data sharing effort, NASA/NOAA - ESA/EUMETSAT, to enable redistribution of Sentinel-1,-2,-3 data

- Tentative plan for OBPG to acquire full L0 (or L1B) and distribute L1B and NASA-derived L2 and L3 products (300-m or 1.2-km)

Reprocessing history and current data quality

Ocean Color Reprocessing History

calibration updates

2010-2011

R2010.0: multi-mission reprocessing using common algorithms.

MODISA, MODIST, SeaWiFS, OCTS, CZCS

2012 May

R2012.0: MODISA full-mission reprocessing to incorporate final MCST C6 calibration and OBPG RVS refinements. + MERIS

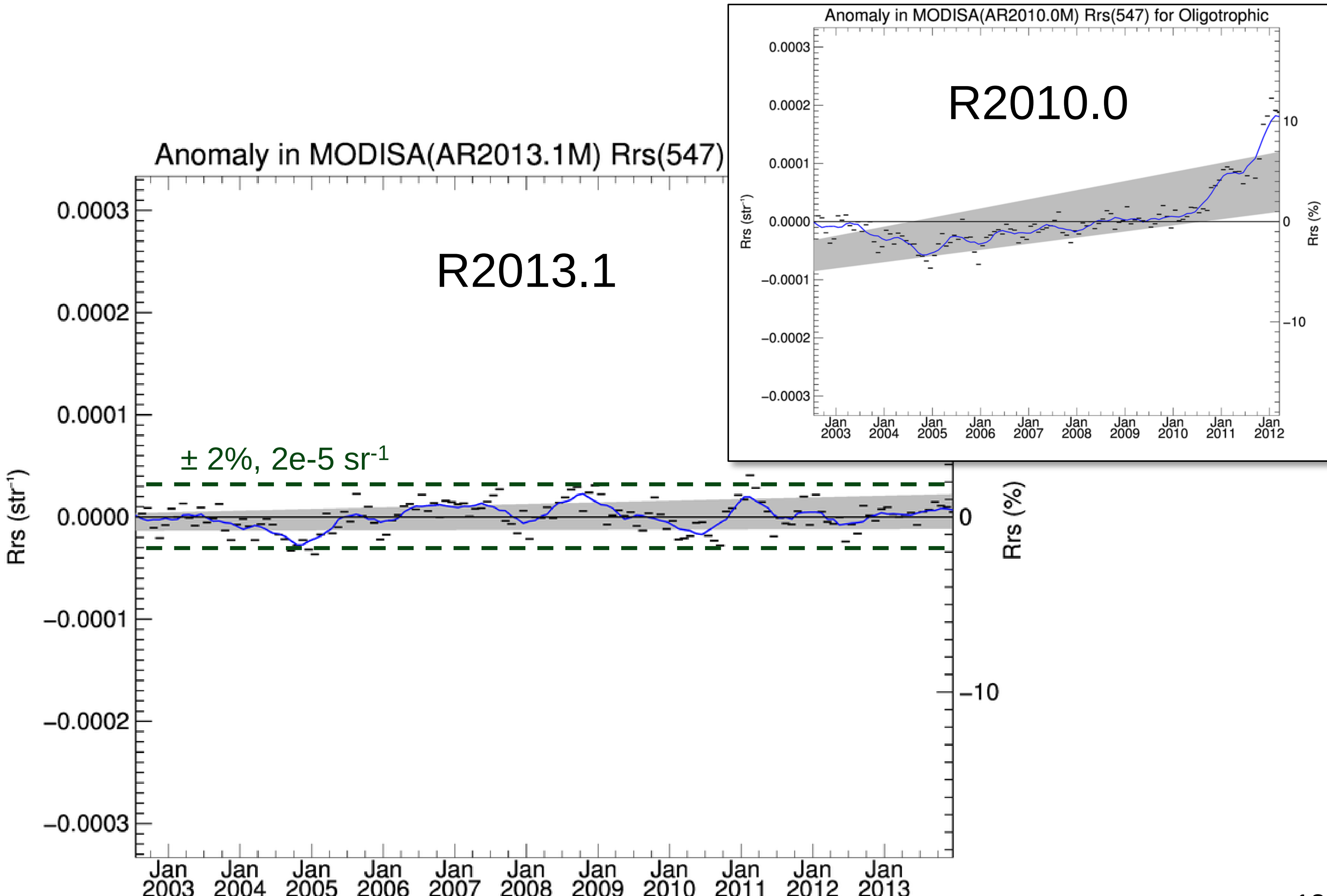
2013 February

R2013.0: MODISA partial-mission reprocessing (period 2011-2013) to incorporate refined MCST C6 calibration. + MODIST

2013 September & November

R2013.1, R2013.1.1: MODISA minor calib. updates (period 2013)

Clear-Water Rrs(547) Anomaly Trend



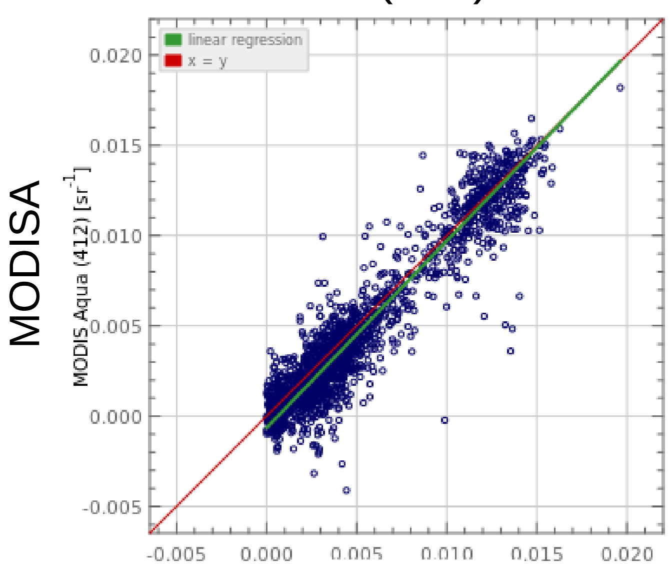
Meister & Franz 2013, IEEE Trans. Geo. Rem. Sens.

SeaBASS + AERONET-OC

MODISA (R2013.1) Rrs vs Field Measurements

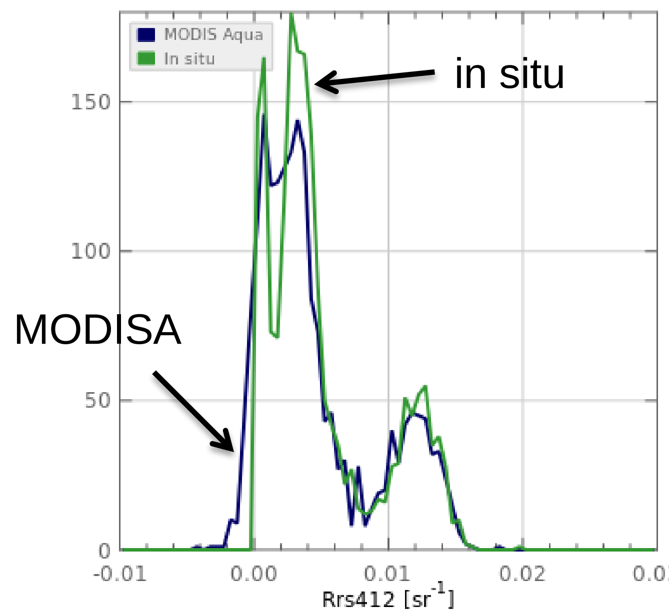
Product Name	MODIS Aqua Range	In situ Range	#	Best Fit Slope	Best Fit Intercept	R^2	Median Ratio	Abs % Difference	RMSE
Rrs412	-0.00411, 0.01820	0.00000, 0.01964	1945	1.03539	-0.00065	0.90481	0.90307	22.21457	0.00147
Rrs443	-0.00065, 0.01950	0.00005, 0.01783	1774	1.04628	-0.00026	0.88967	1.00894	12.06771	0.00109
Rrs488	0.00033, 0.02513	0.00039, 0.02289	2127	0.94853	-0.00021	0.89894	0.91509	12.00520	0.00106
Rrs531	0.00092, 0.01682	0.00130, 0.02110	639	0.87525	0.00017	0.91346	0.97562	11.98040	0.00096
Rrs547	0.00088, 0.01590	0.00091, 0.01984	469	0.91611	0.00018	0.92442	1.04480	13.38668	0.00072
Rrs667	-0.00016, 0.01186	0.00002, 0.01100	709	0.98687	-0.00002	0.91982	0.94565	37.48856	0.00017
Rrs678	-0.00015, 0.00283	0.00004, 0.00295	373	0.94854	-0.00000	0.89380	1.00161	32.16394	0.00008

Rrs(412)



in situ

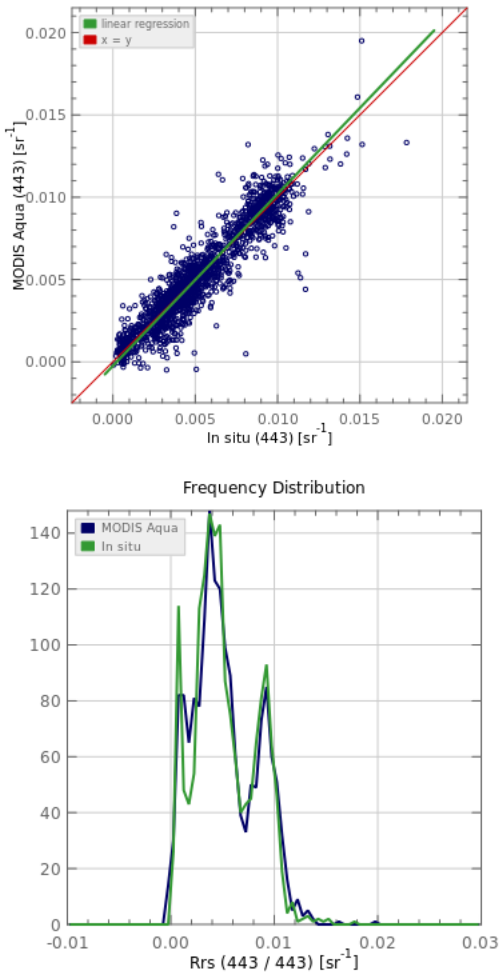
Frequency Distribution



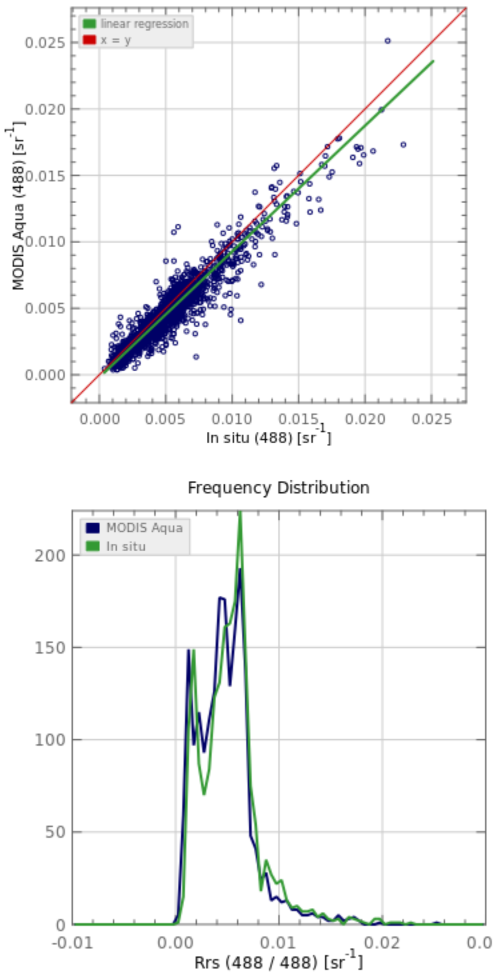
http://seabass.gsfc.nasa.gov/

MODISA (R2013.1) Rrs vs Field Measurements

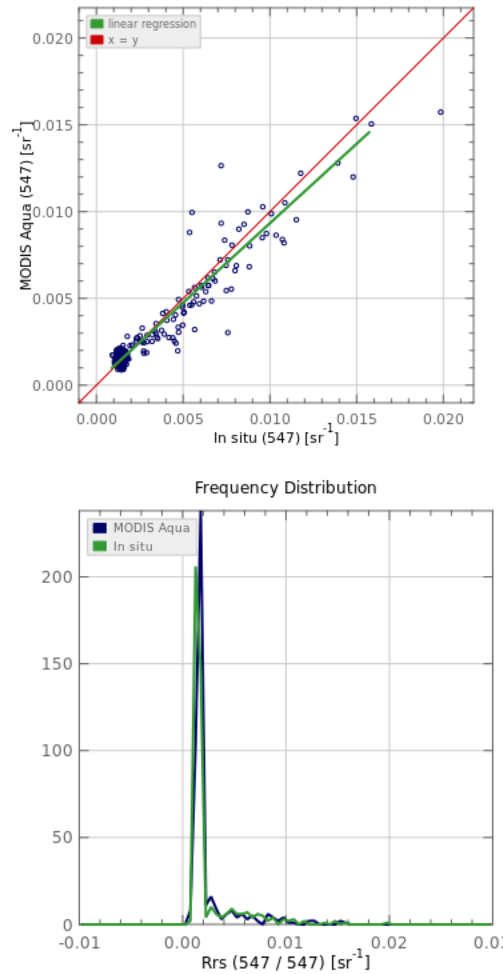
Rrs(443)



Rrs(488)



Rrs(547)

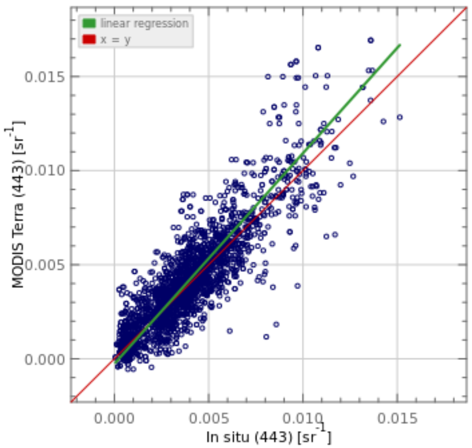


Mean APD 12-13%, Mean Bias < 10%, R^2 > 0.9

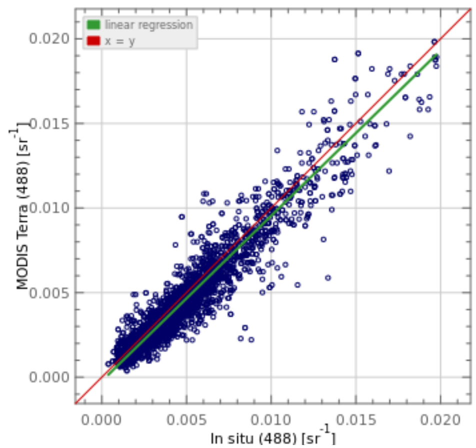
SeaBASS + AERONET-OC

MODIST (R2013.0) Rrs vs Field Measurements

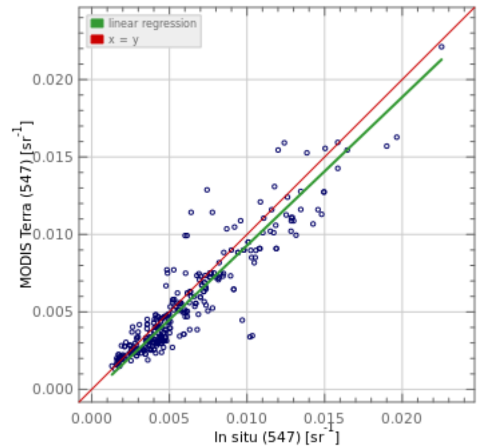
Rrs(443)

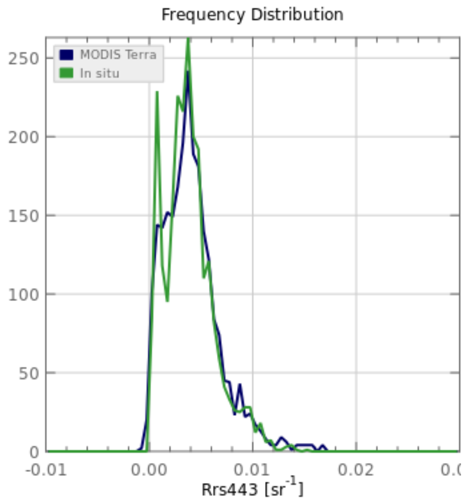


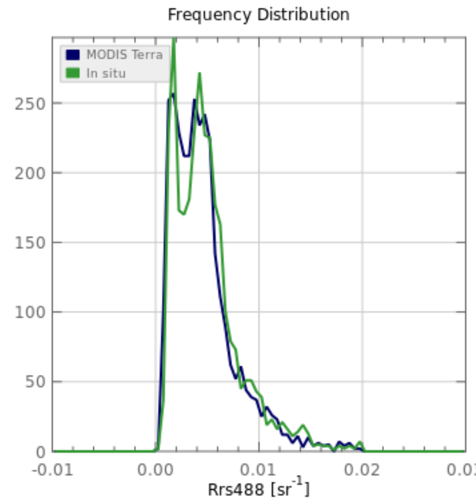
Rrs(488)

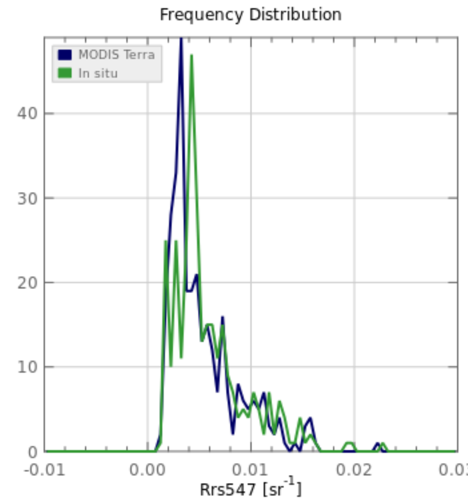


Rrs(547)





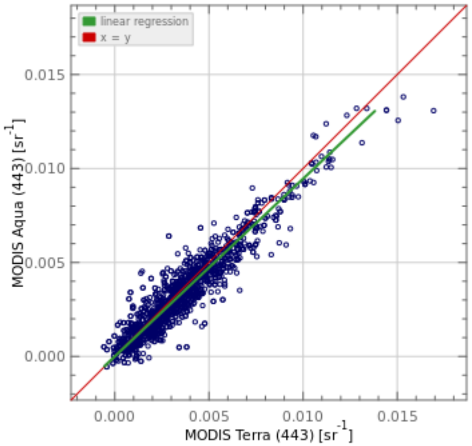


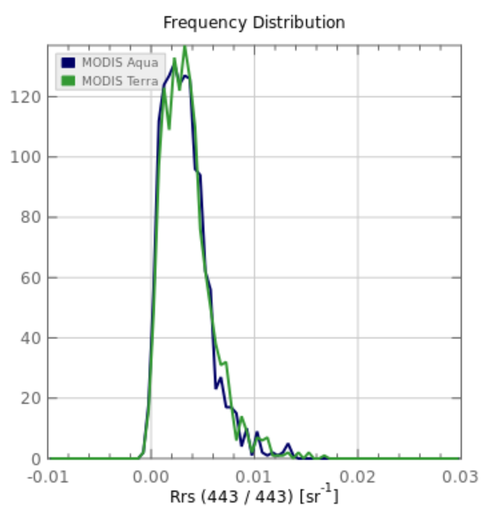


Mean APD 13-20%, Mean Bias < 10%, R^2 0.8-0.9

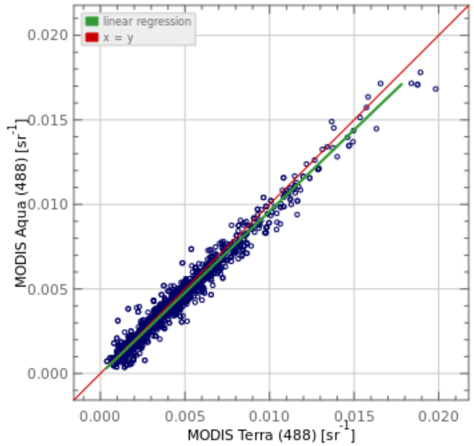
MODIST (R2013.0) vs MODISA (R2013.1)

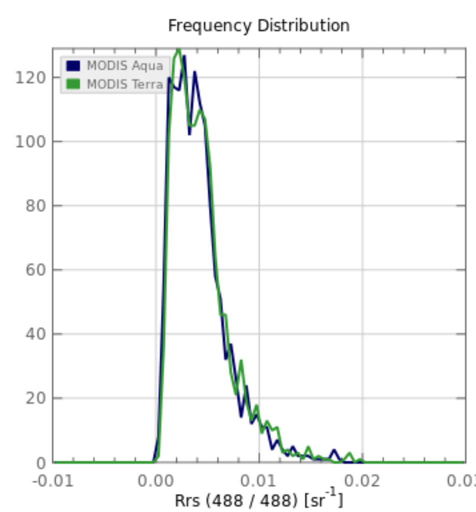
Rrs(443)



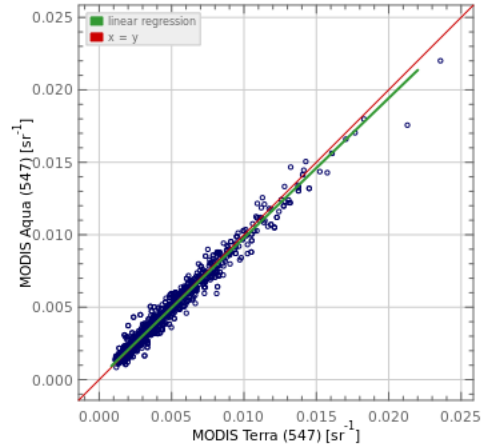


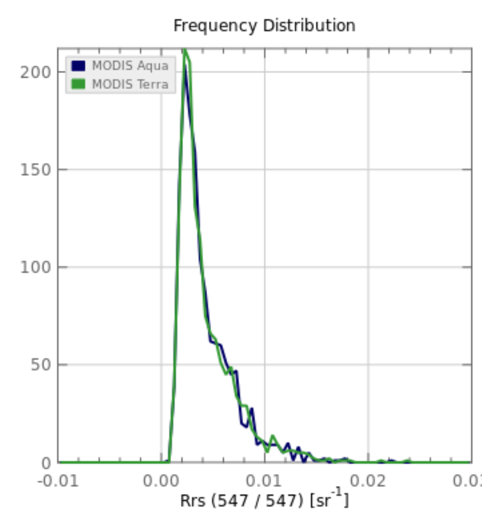
Rrs(488)





Rrs(547)





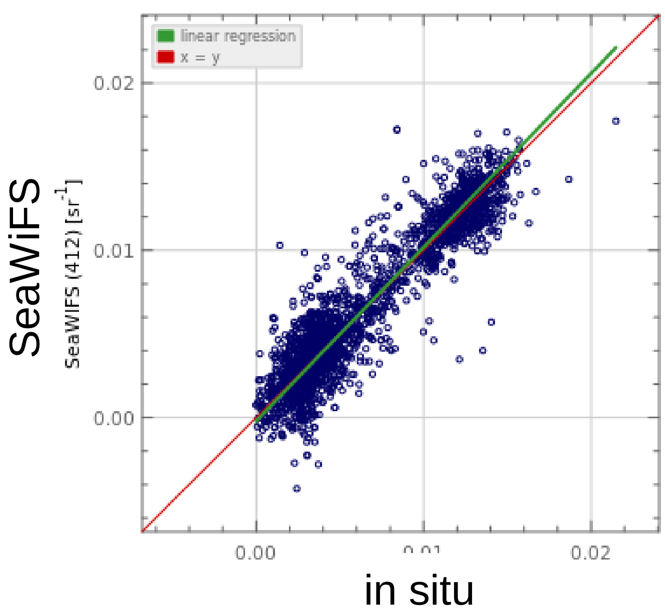
MODIS to MODIS scatter 1/2 the MODIS to in situ scatter!

SeaBASS + AERONET-OC

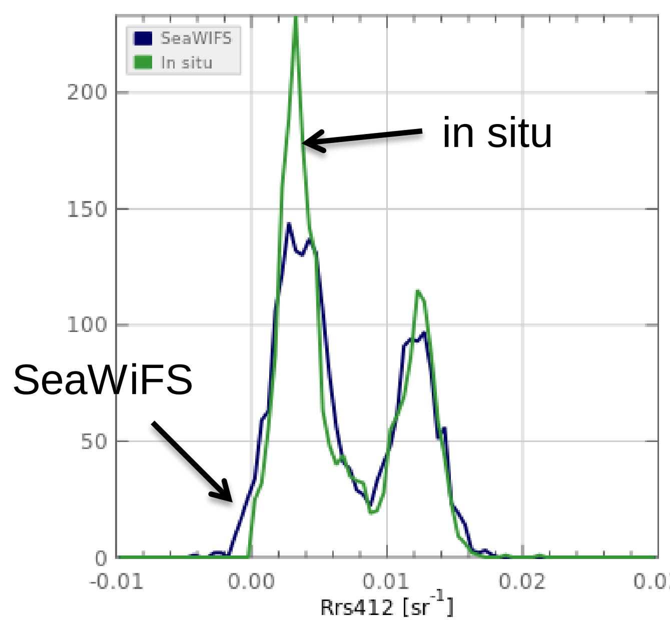
SeaWiFS (R2010.0) Rrs vs Field Measurements

Product Name	SeaWIFS Range	In situ Range	#	Best Fit Slope	Best Fit Intercept	R^2	Median Ratio	Abs % Difference	RMSE
Rrs412	-0.00425, 0.01773	0.00000, 0.02150	2323	1.03928	-0.00021	0.88622	1.00507	15.66889	0.00160
Rrs443	-0.00070, 0.02021	0.00022, 0.02227	2380	1.06826	-0.00019	0.84026	1.02870	12.62121	0.00132
Rrs490	0.00042, 0.02644	0.00074, 0.03020	2575	0.99072	-0.00024	0.82200	0.94335	10.86846	0.00115
Rrs510	0.00097, 0.02753	0.00065, 0.03023	1449	0.95042	0.00011	0.83939	0.98680	10.65210	0.00080
Rrs555	0.00088, 0.02600	0.00029, 0.03052	2261	0.94860	0.00002	0.88035	0.97217	13.33206	0.00115
Rrs670	-0.00037, 0.01223	0.00002, 0.01161	1203	0.88307	0.00002	0.86020	1.05347	41.03380	0.00039

Rrs(412)



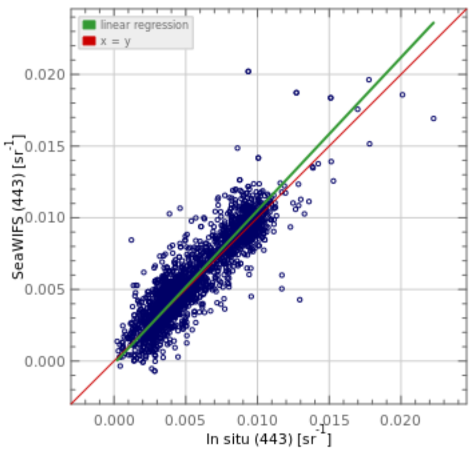
Frequency Distribution



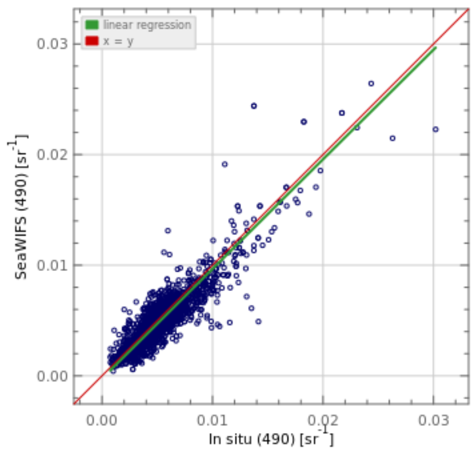
http://seabass.gsfc.nasa.gov/

SeaWiFS (R2010.0) Rrs vs Field Measurements

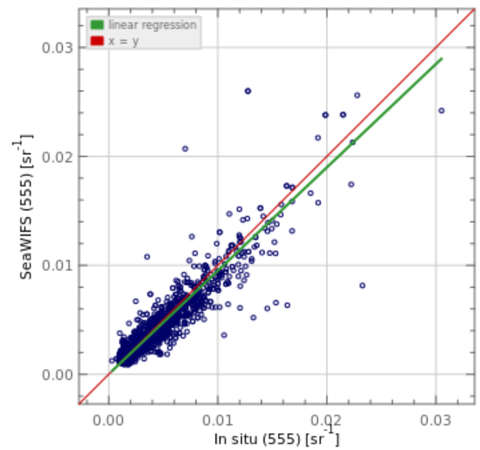
Rrs(443)

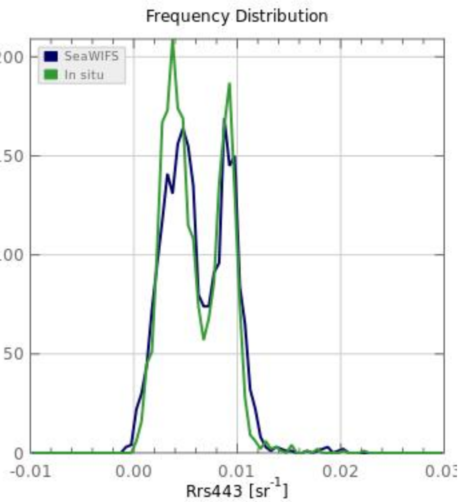


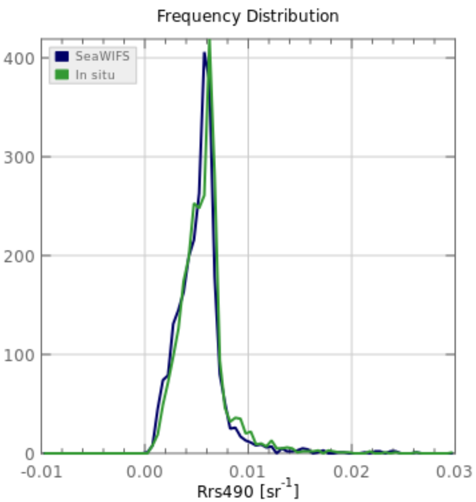
Rrs(490)

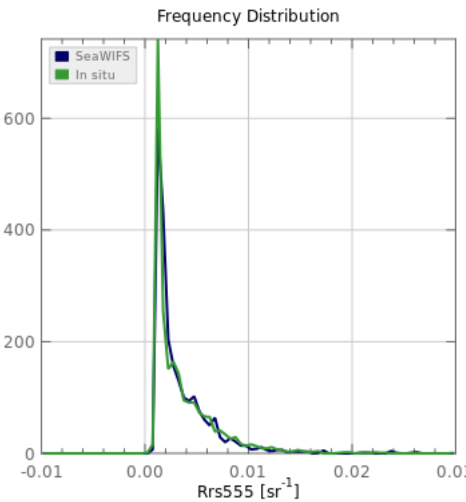


Rrs(555)









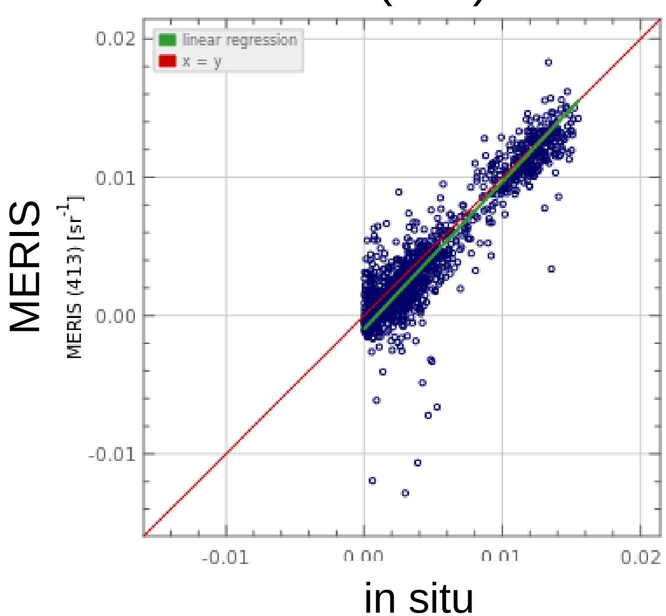
Mean APD < 13%, Mean Bias < 5%, R^2 0.8-0.9

SeaBASS + AERONET-OC

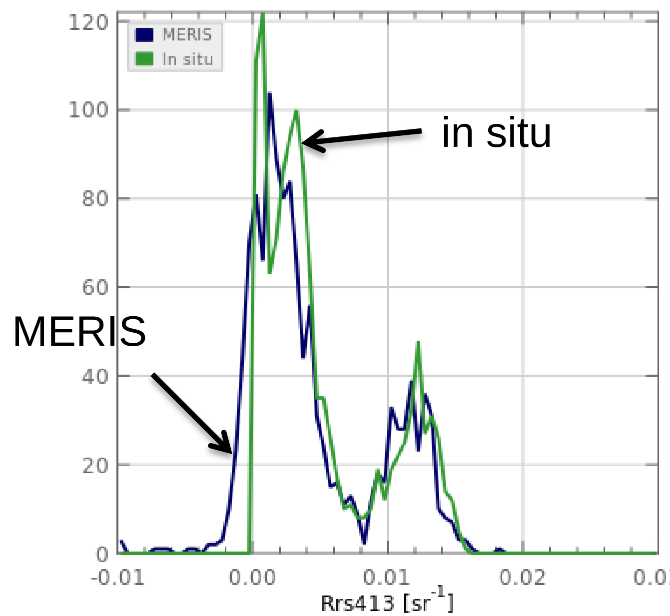
MERIS (R2012.0) Rrs vs Field Measurements

Product Name	MERIS Range	In situ Range	#	Best Fit Slope	Best Fit Intercept	R^2	Median Ratio	Abs % Difference	RMSE
Rrs413	-0.01283, 0.01832	0.00001, 0.01550	1250	1.06363	-0.00097	0.87358	0.84771	28.28140	0.00186
Rrs443	-0.00084, 0.01761	0.00014, 0.01557	1158	1.06040	-0.00067	0.87490	0.91770	16.55719	0.00127
Rrs490	0.00032, 0.02499	0.00054, 0.02442	1366	0.96946	-0.00042	0.86451	0.87365	14.98263	0.00125
Rrs510	0.00106, 0.02567	0.00131, 0.02538	582	1.08277	-0.00045	0.82955	0.94721	11.04571	0.00083
Rrs560	0.00087, 0.02889	0.00085, 0.02862	481	1.03390	-0.00017	0.91258	0.94987	13.62841	0.00076
Rrs665	-0.00071, 0.01217	0.00003, 0.01078	510	1.08306	-0.00007	0.92559	0.70893	47.51158	0.00029
Rrs681	-0.00022, 0.00235	0.00006, 0.00199	282	1.04185	-0.00004	0.83938	0.69642	42.98729	0.00009

Rrs(413)



Frequency Distribution

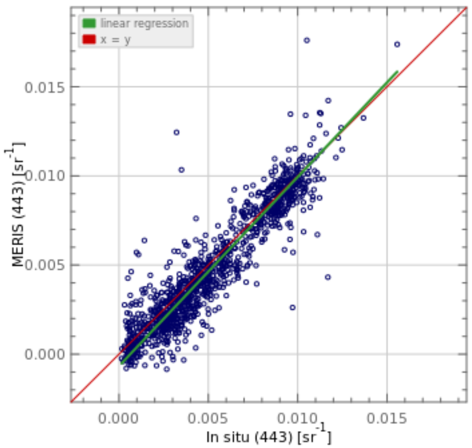


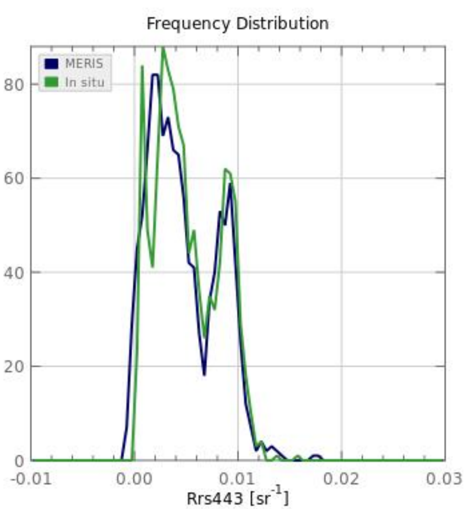
http://seabass.gsfc.nasa.gov/

SeaBASS + AERONET-OC

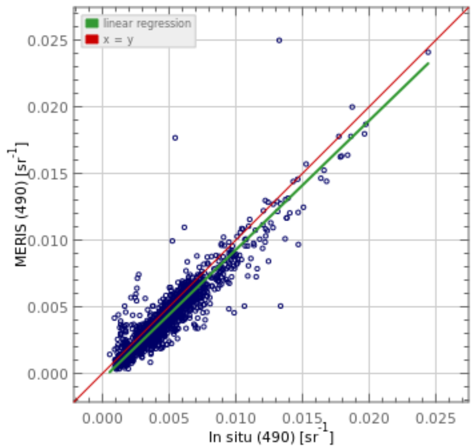
MERIS (R2012.0) Rrs vs Field Measurements

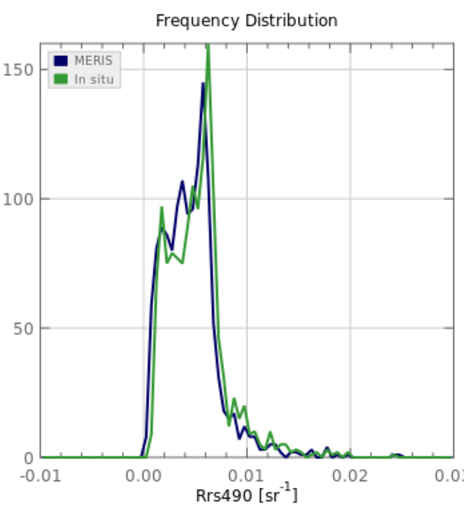
Rrs(443)



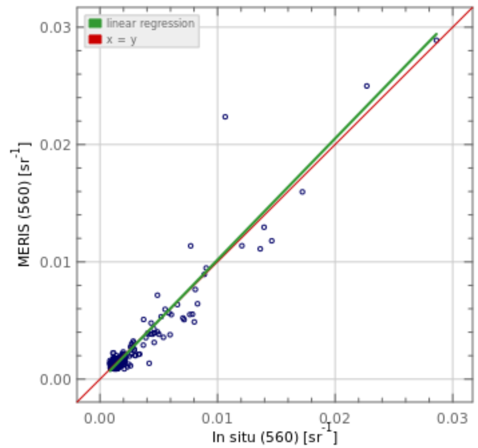


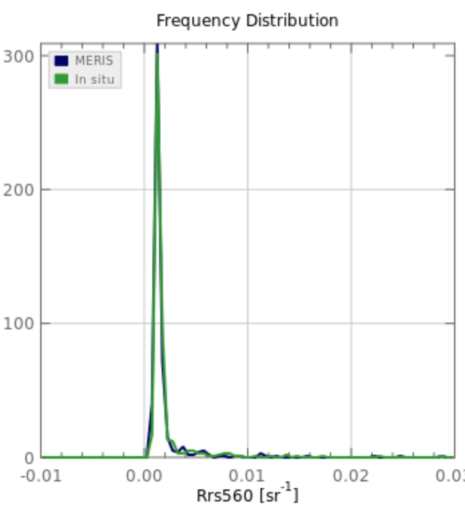
Rrs(490)





Rrs(560)

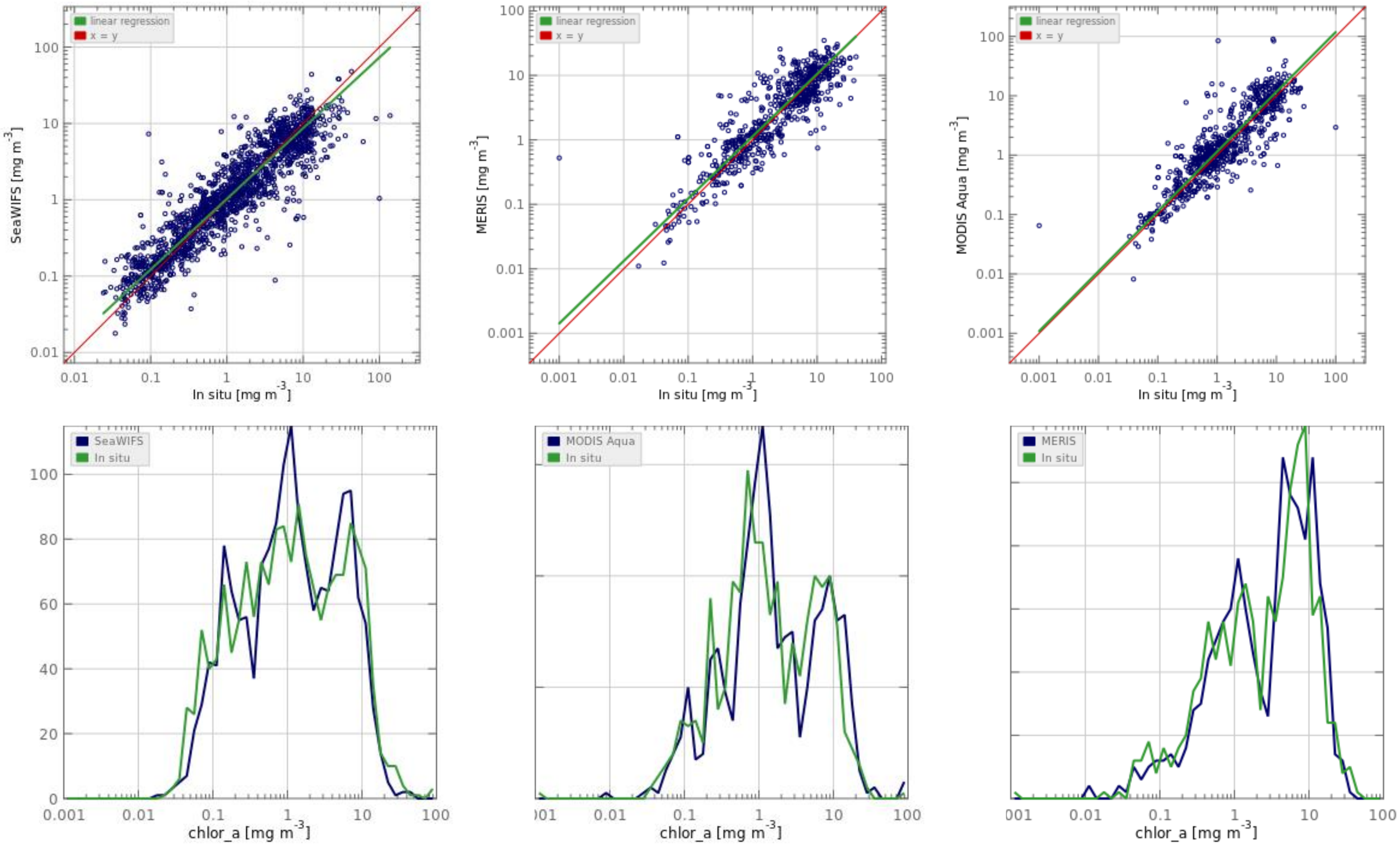




Mean APD 11-17%, Mean Bias < 13%, R^2 0.9

Chlorophyll vs Field Measurements

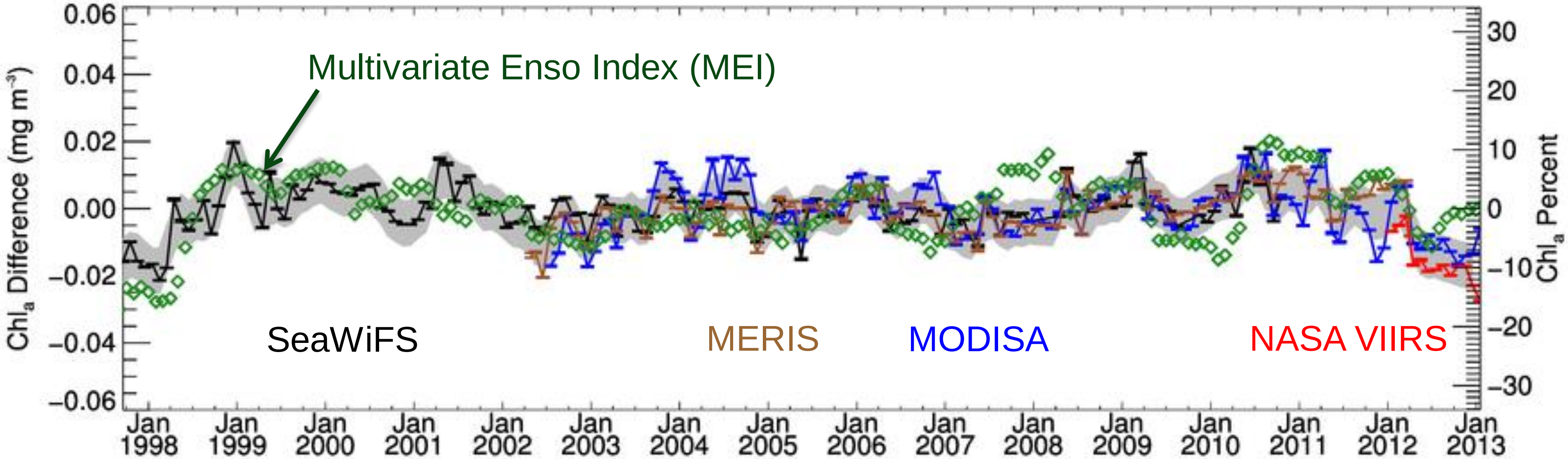
SeaWiFS | MERIS | MODISA



APD	36%	39%	38%
Bias	+4%	+7%	+12%
R^2	0.85	0.81	0.80

Multi-Mission Chlorophyll Time-Series

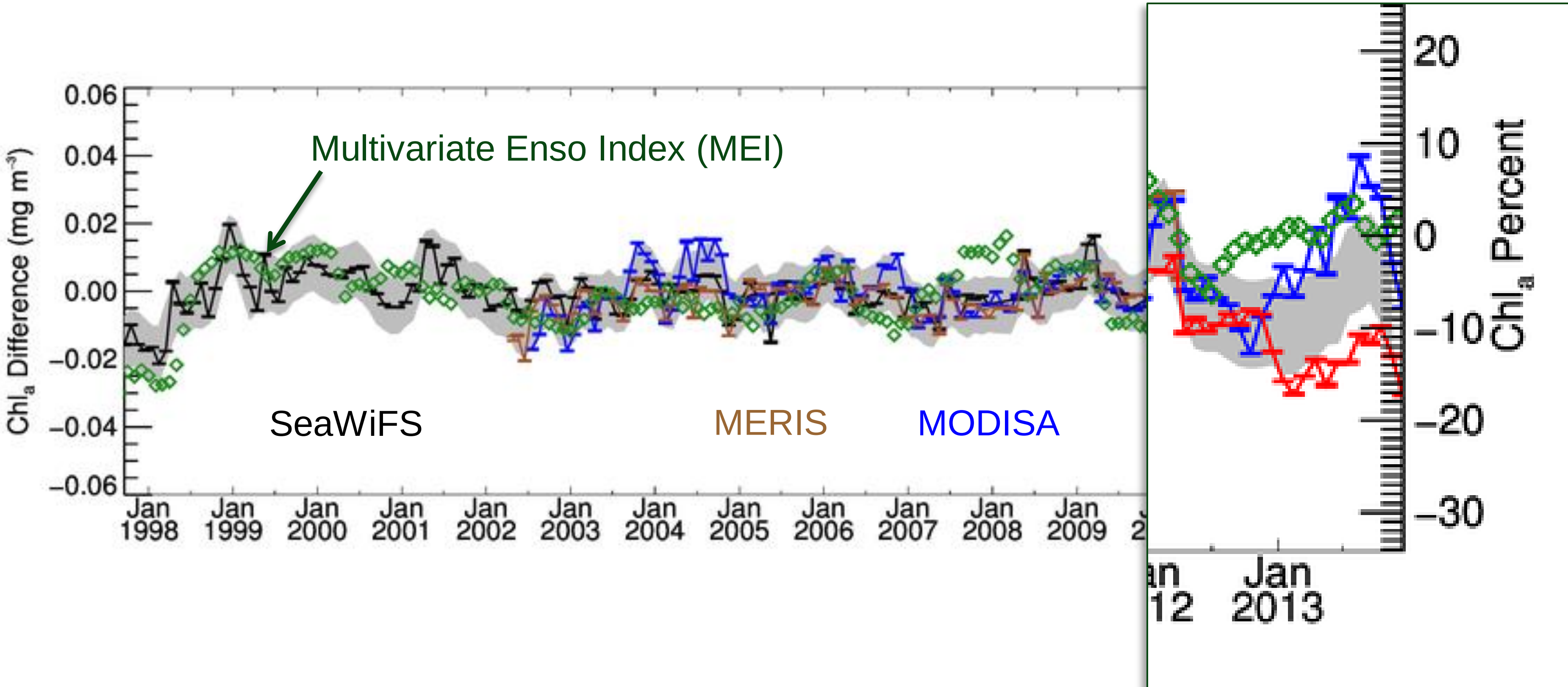
Deep-Water Chlorophyll Anomaly



~5% month-to-month temporal precision

Multi-Mission Chlorophyll Time-Series

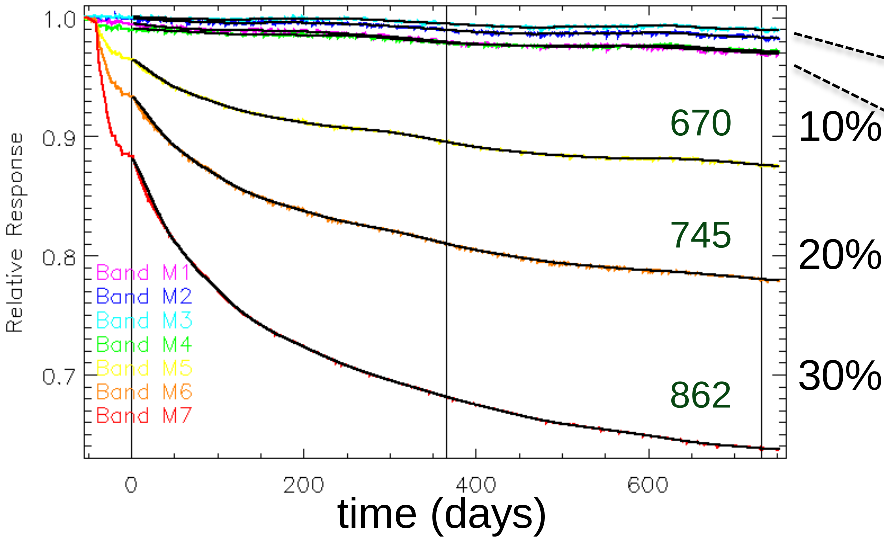
Deep-Water Chlorophyll Anomaly



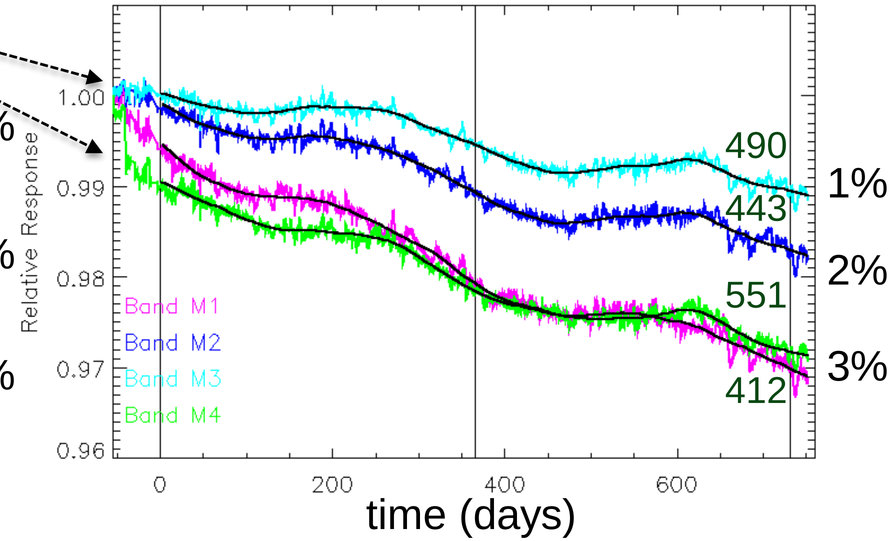
there is a problem with VIIRS calibration after 2012

VIIRS Temporal Calibration

VIIRS Solar Calibration Trend



VIIRS Solar Calibration Trend



large degradation in NIR due to tungsten oxide contamination (but stabilizing!)

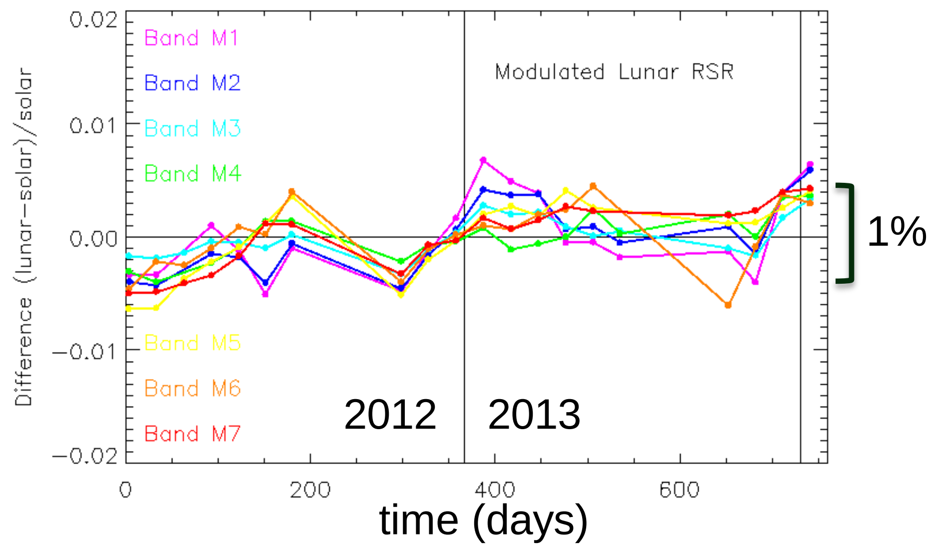
- impact to system spectral response

residual seasonal variability in solar time-series, likely due to error in solar vector

- likely source of blue calibration error

inconsistency in lunar and solar calibration time-series, due to above (and insufficient lunar samples, yet, to resolve and correct for residual lunar libration effects).

Lunar – Solar Trend Difference



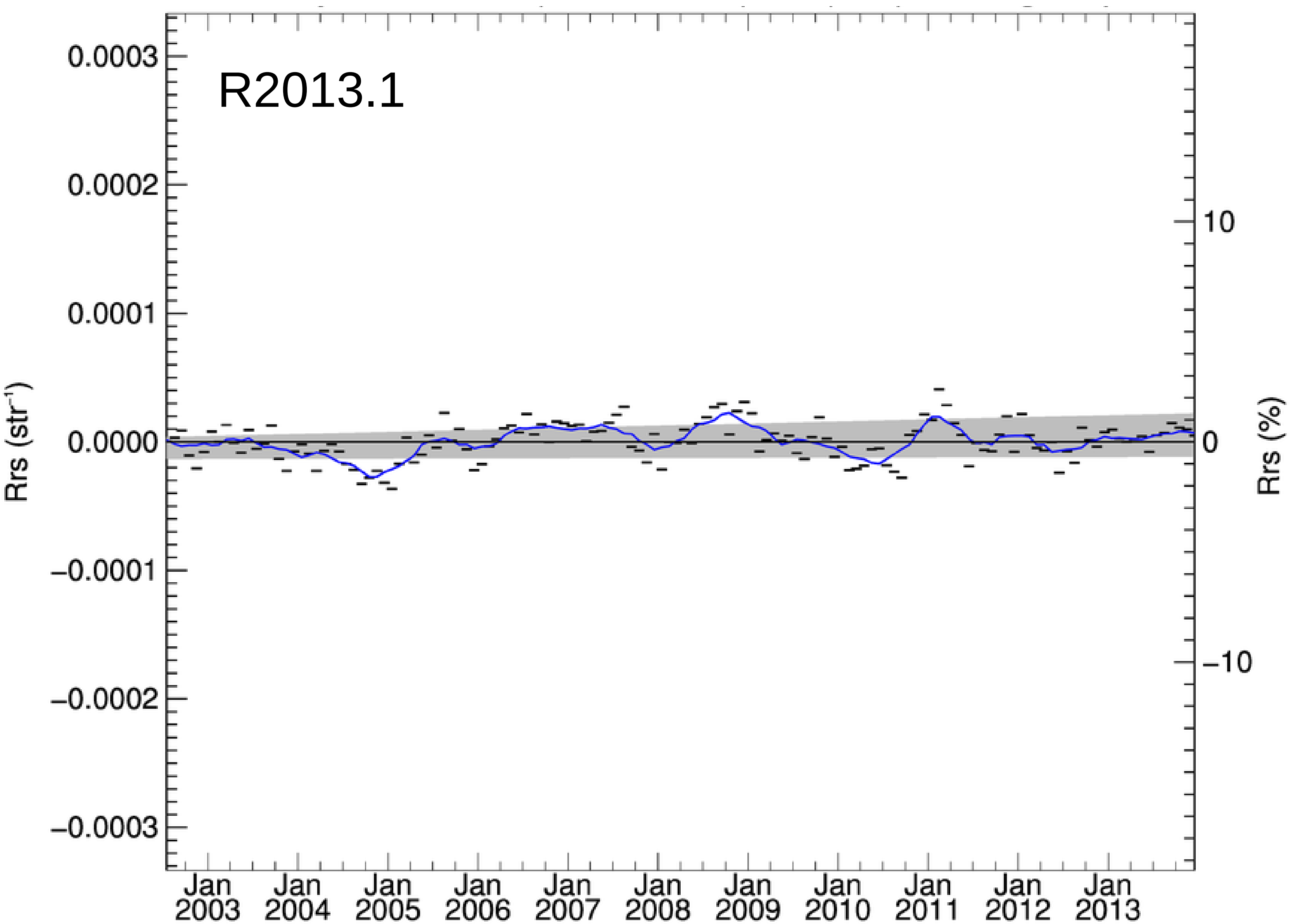
VIIRS Status

- Substantial radiometric degradation in NIR (> 35%) due to contamination of optical surfaces with tungsten oxides
  - a function of UV exposure, but impact is stabilizing
- Temporal calibration error starting in 2013
  - likely cause: solar vector error (reference frame inconsistency) in NOAA's IDPS software, impact assessment in progress
- Significant detector striping artifacts
  - statistical solutions exist, but waiting on above before pursuing further
- OBPG is currently operating as the NPP Ocean PEATE, proposed to continue supporting VIIRS as the Ocean SIPS
- NASA redevelopment of Level-0 to Level-1B process and formats in progress (led by OBPG, w/ land, atmosphere PEATES and VCST).

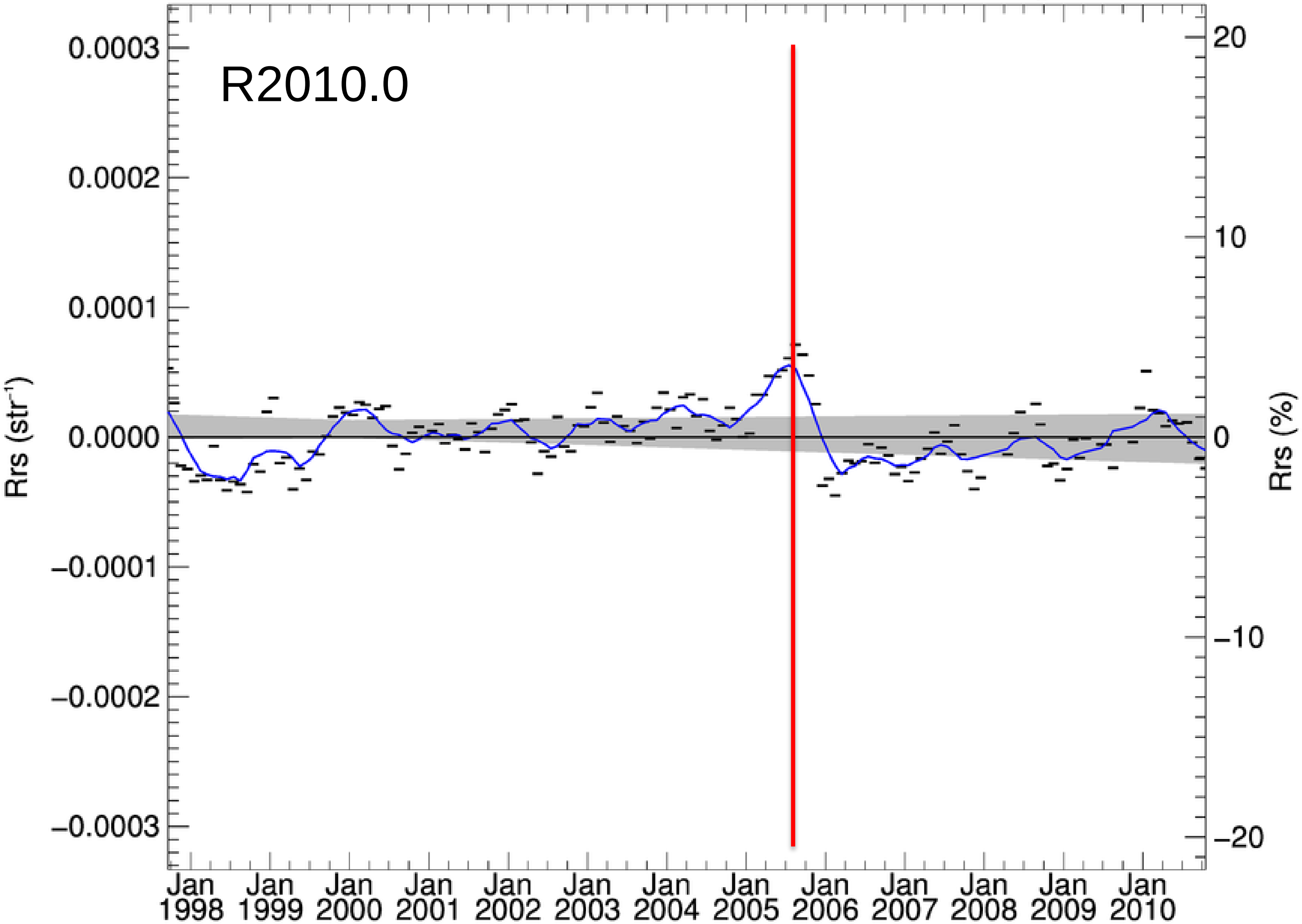
Advancement in SeaWiFS Calibration

a story of less than one digital count

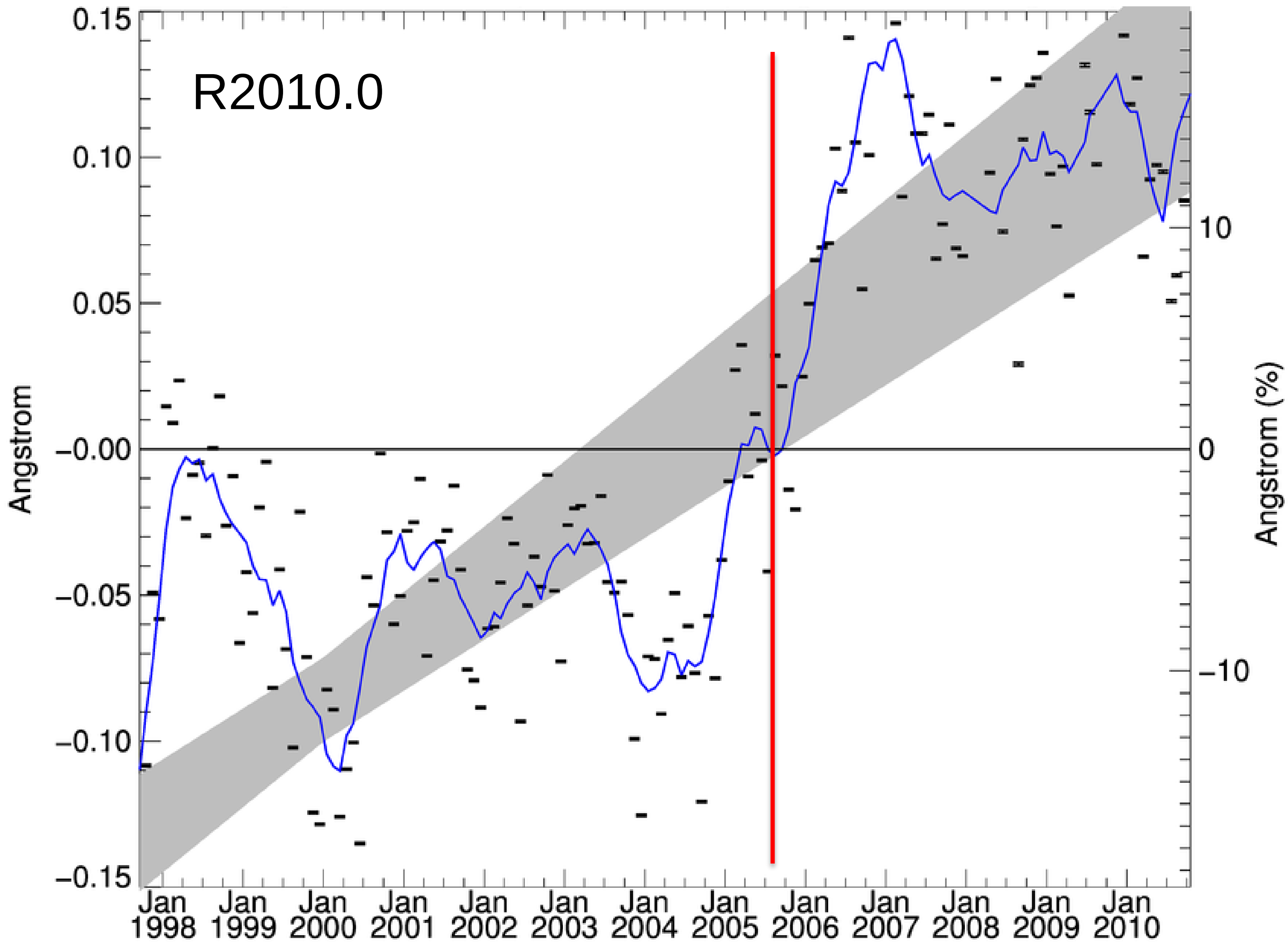
MODISA Clear-Water Rrs(547) Anomaly Trend



SeaWiFS Clear-Water Rrs(555) Anomaly Trend

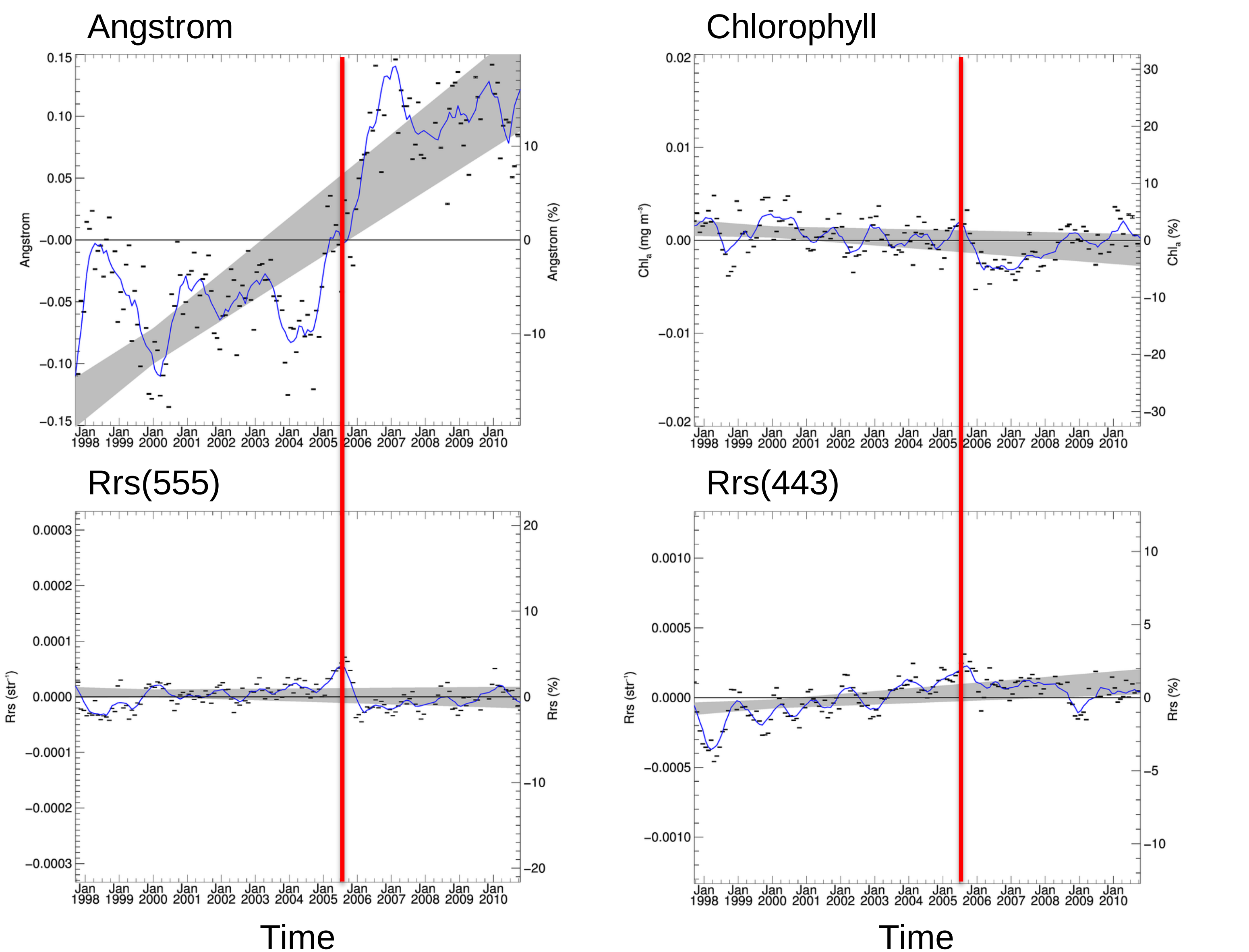


SeaWiFS Aerosol Angstrom Anomaly Trend



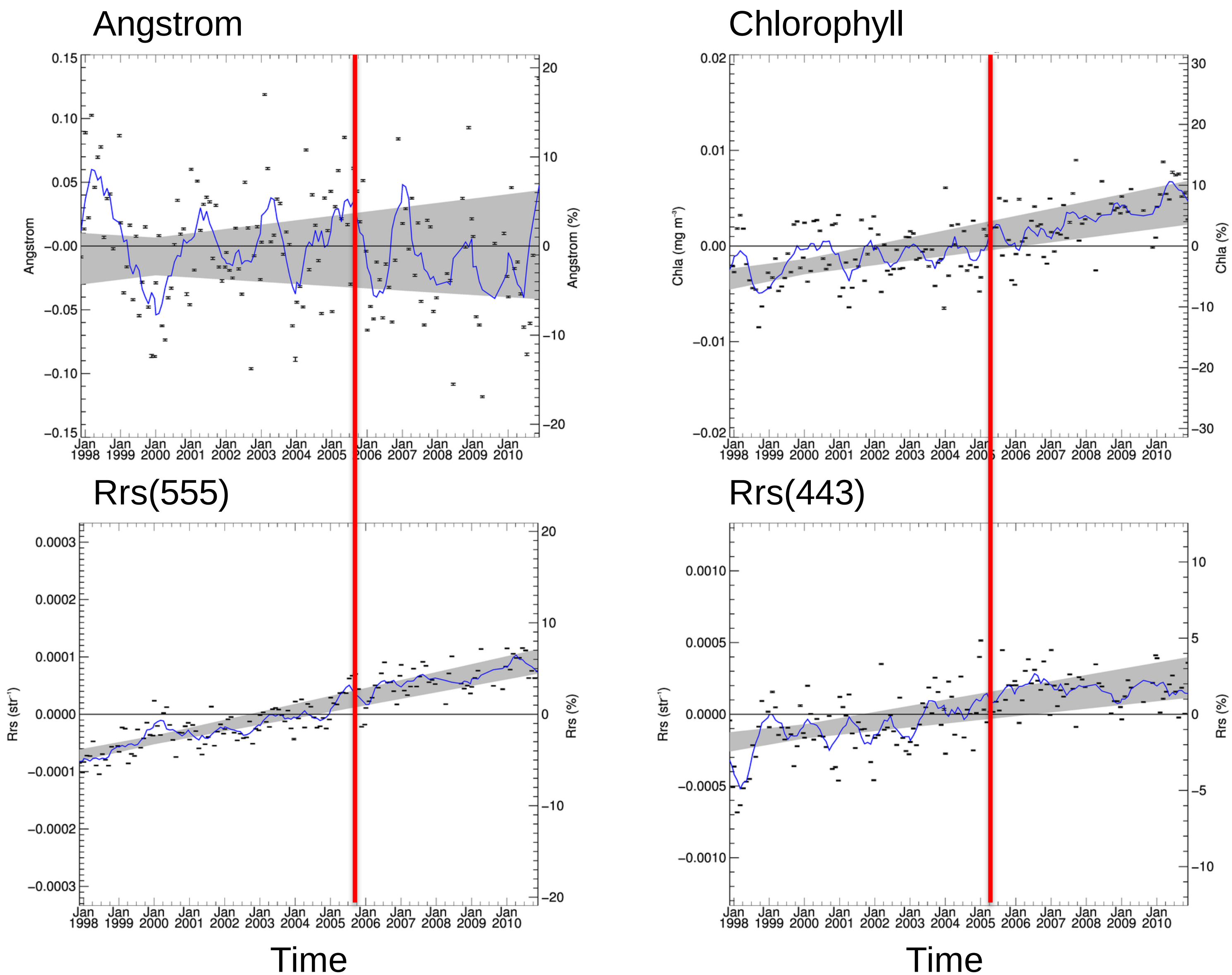
SeaWiFS Radiometric Instability Issue

due to a 1-count shift in dark offset

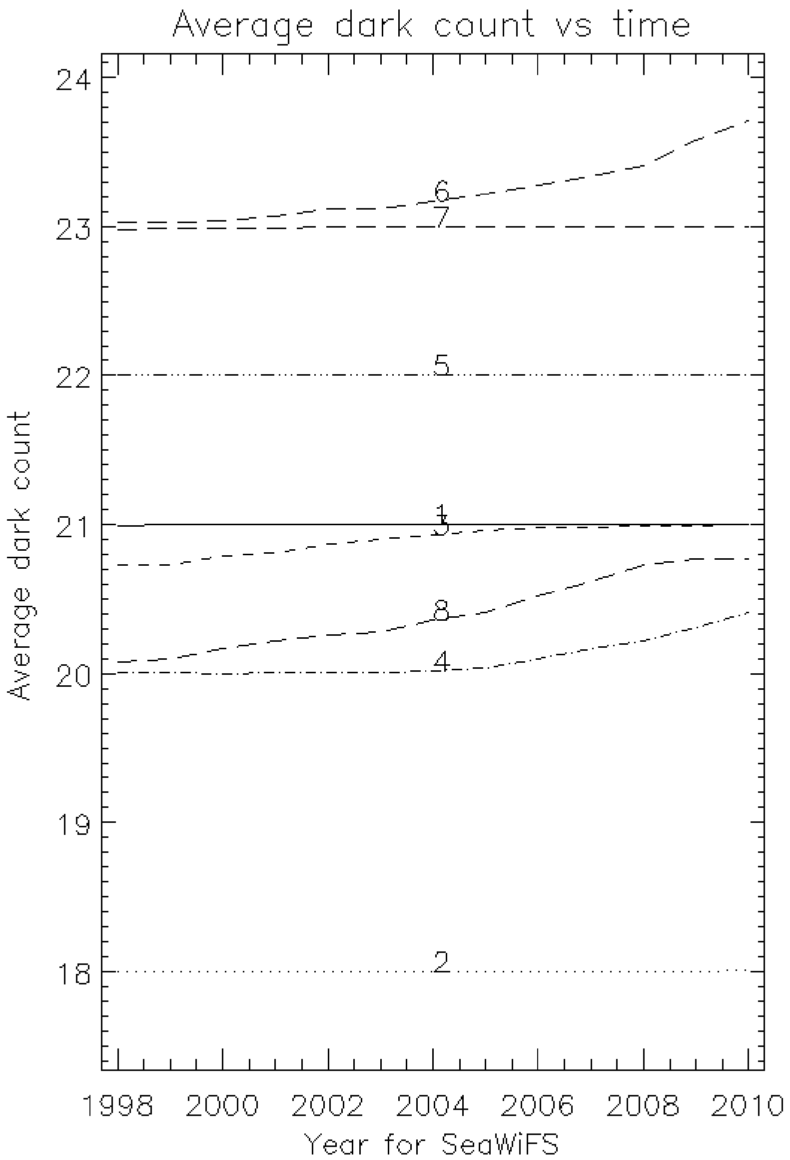


SeaWiFS Radiometric Instability Issue

constant dark offset



SeaWiFS Status



- dark offsets **are changing**, by less than one digital count over 12 yrs.

  ... and it matters

- effort now to determine best way to estimate or model a continuous drift in the dark offsets

- also impacts lunar calibration measurements, which may have different offset behavior

- complicating factor is 1-2 count drift in lunar calibration gain relative to earth view gain

Changes for next reprocessing (R2014.0)

2014.0 Multi-Mission Reprocessing

Scope

- OC from CZCS, OCTS, SeaWiFS, MERIS, MODIS(A/T), and VIIRS
- SST from MODIS (and maybe VIIRS)

Motivation

1. incorporate knowledge gained in instrument-specific radiometric calibration and updates to vicarious calibration
2. incorporate algorithm updates and advances from community and last MODIS Science Team developed since 2010 (last reprocessing).
3. improve interoperability and sustainability of the product suite by adopting modern data formats, standards, and conventions

Data Format Change

Level-2 and Level-3 products moving from HDF4 to netCDF4 with

- Climate and Forecast (CF) meta-data conventions
- ISO19115 standards for geographic information
- Unidata's Attribute Convention for Data Discovery (ACDD)

Why change?

- HDF4 is no longer being developed, and the current implementation is limiting for new missions (and current missions) – file size issues
- current OBPG format pre-dates development of international standards and is not recognized in many third-party software packages

Why netCDF?

- framework on which many international data standards are developed
- common use in physical oceanography (e.g., GHRSST), and adopted by our international partners (e.g., ESA Sentinel missions)
- widely supported by 3rd-party tools and applications
- netCDF4 is built on HDF5 – active support and development, backward compatibility

http://oceancolor.gsfc.nasa.gov/DOCS/FormatChange.html

Current OC Standard Product Suite

Level-2 OC Product	Algorithm Reference
1. $R_{rs}(\lambda)$	
2. Ångstrom	*Gordon and Wang 1994, Ahmad et al 2010, etc.*
3. AOT	
4. Chlorophyll *a*	*O'Reilly et al. 1998 (OC3) updated by Werdell*
5. $K_d(490)$	*Mueller et al. 2000 (KD2) updated by Werdell*
6. POC	*Stramski et al. 2008*
7. PIC	*Balch et al. 2005, Gordon et al. 2001*
8. CDOM_index	*Morel and Gentili 2009*
9. PAR	*Frouin, Franz, & Werdell 2003*
10. iPAR	
11. nFLH	*Behrenfeld et al. 2009*

Proposed Changes to Standard Product Suite

Level-2 OC Product	Algorithm Changes
1. $R_{rs}(\lambda)$	*calibration updates, ancillary data updates, improved land/water masking, terrain height, other minor fixes*
2. Ångstrom	
3. AOT	
4. Chlorophyll *a*	*merge OCx with Hu et al. 2012 CI*
5. $K_d(490)$	*no change*
6. POC	*no change*
7. PIC	*updated b_b* and two-band LUT (Balch)*
8. CDOM_index	*remove product*
9. PAR	*consolidated algorithm, minor fixes*
10. iPAR	*no change*
11. nFLH	*flagging changes (allow negatives)*

Chlorophyll Algorithm Refinement

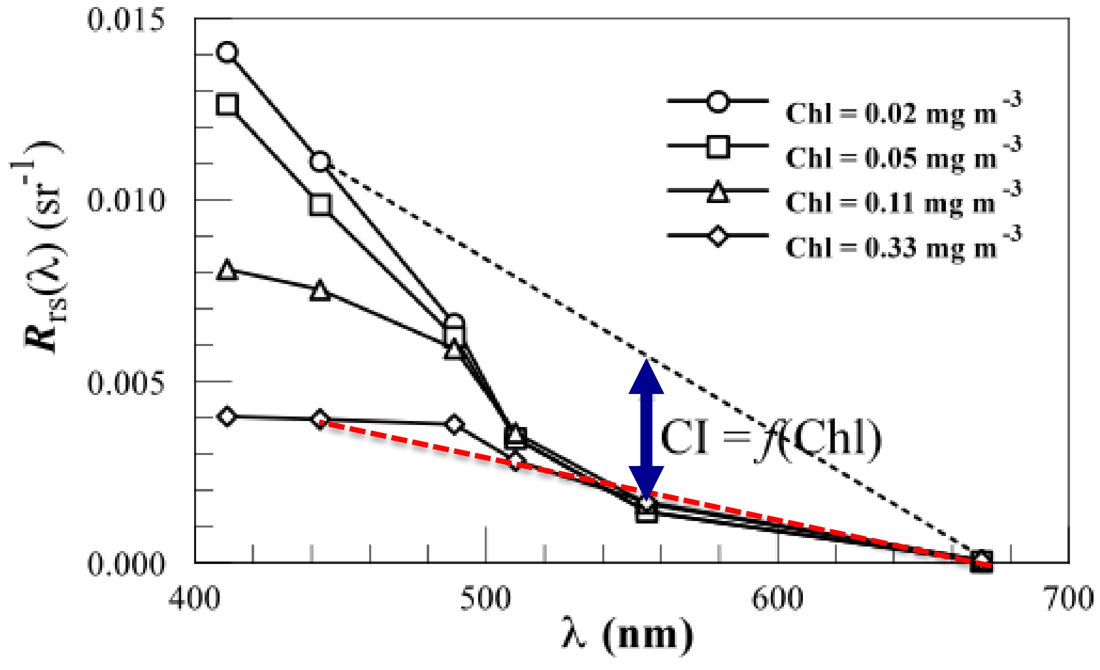
line-height approach

Chlorophyll *a* algorithms for oligotrophic oceans: A novel approach based on three-band reflectance difference

Chuanmin Hu,[1] Zhongping Lee,[2] and Bryan Franz[3]

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 117, C01011, doi:10.1029/2011JC007395, 2012

diminishing sensitivity



Chlorophyll Algorithm Refinement

a hybrid approach

New CI Line Height Algorithm

better at low chlorophyll

$$CI = R_{rs}(555) - [R_{rs}(443) + (555-443)/(670-443) * (R_{rs}(670) - R_{rs}(443))]$$

which is equivalent to $CI \approx R_{rs}(555) - 0.5(R_{rs}(443) + R_{rs}(670))$

Standard OCx Band Ratio Algorithm

better at mid to high chlorophyll

$$\mathrm{Chl}_{\mathrm{OC4}} = 10^{y}$$

$$y = a_0 + a_1\chi + a_2\chi^2 + a_3\chi^3 + a_4\chi^4$$

$$\chi = \log_{10}(R) \text{ and } R = \max(R_{rs}(443, 490, 510))/R_{rs}(555)$$

Chl ≤ 0.25 mg m^{-3}

Chl > 0.3 mg m^{-3}

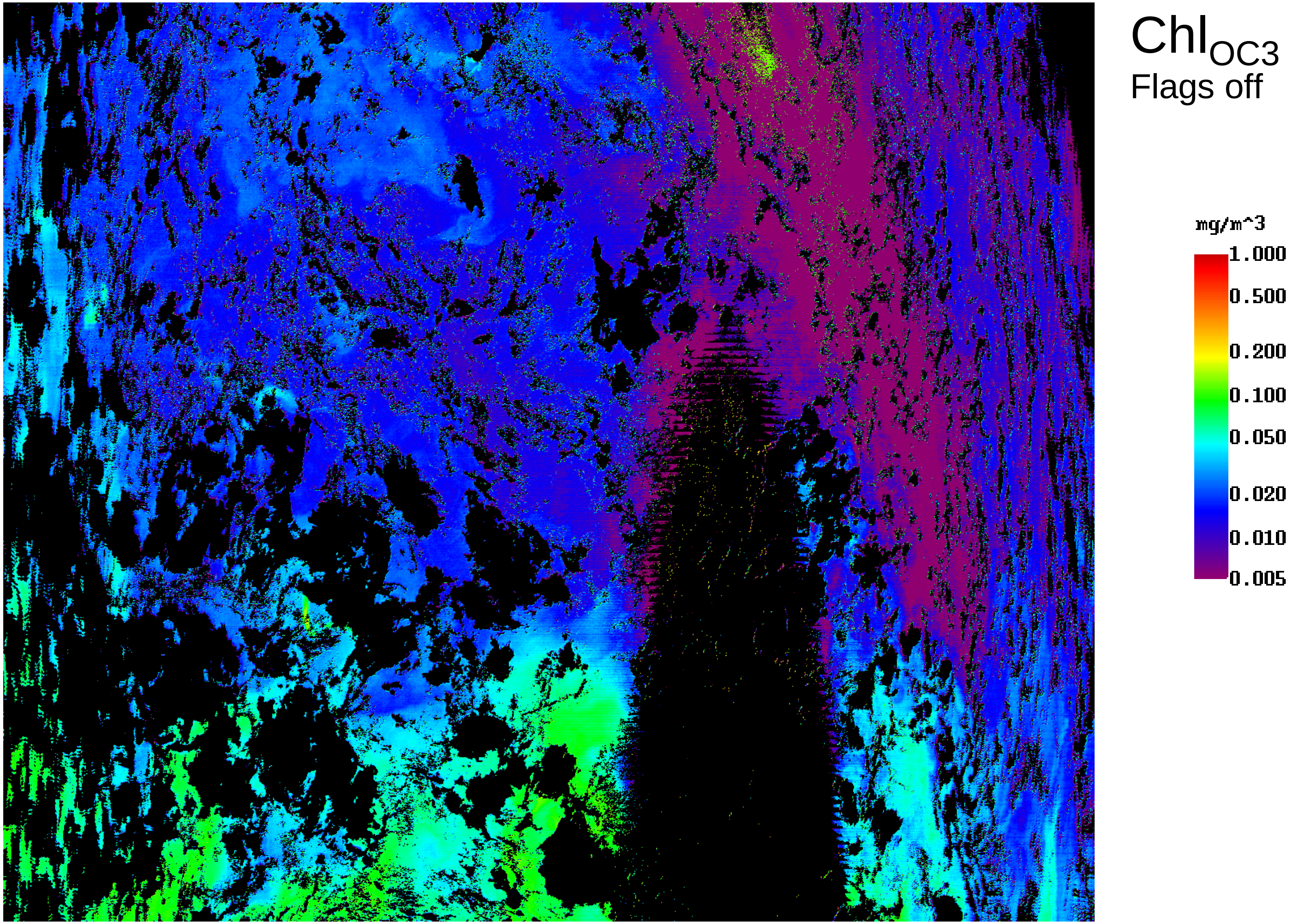
Proposed OCxI Algorithm

$$\mathrm{Chl}_{\mathrm{OCI}} = \mathrm{Chl}_{\mathrm{CI}}\left[\text{for } \mathrm{Chl}_{\mathrm{CI}} \leq 0.25 \text{ mg m}^{-3}\right]$$

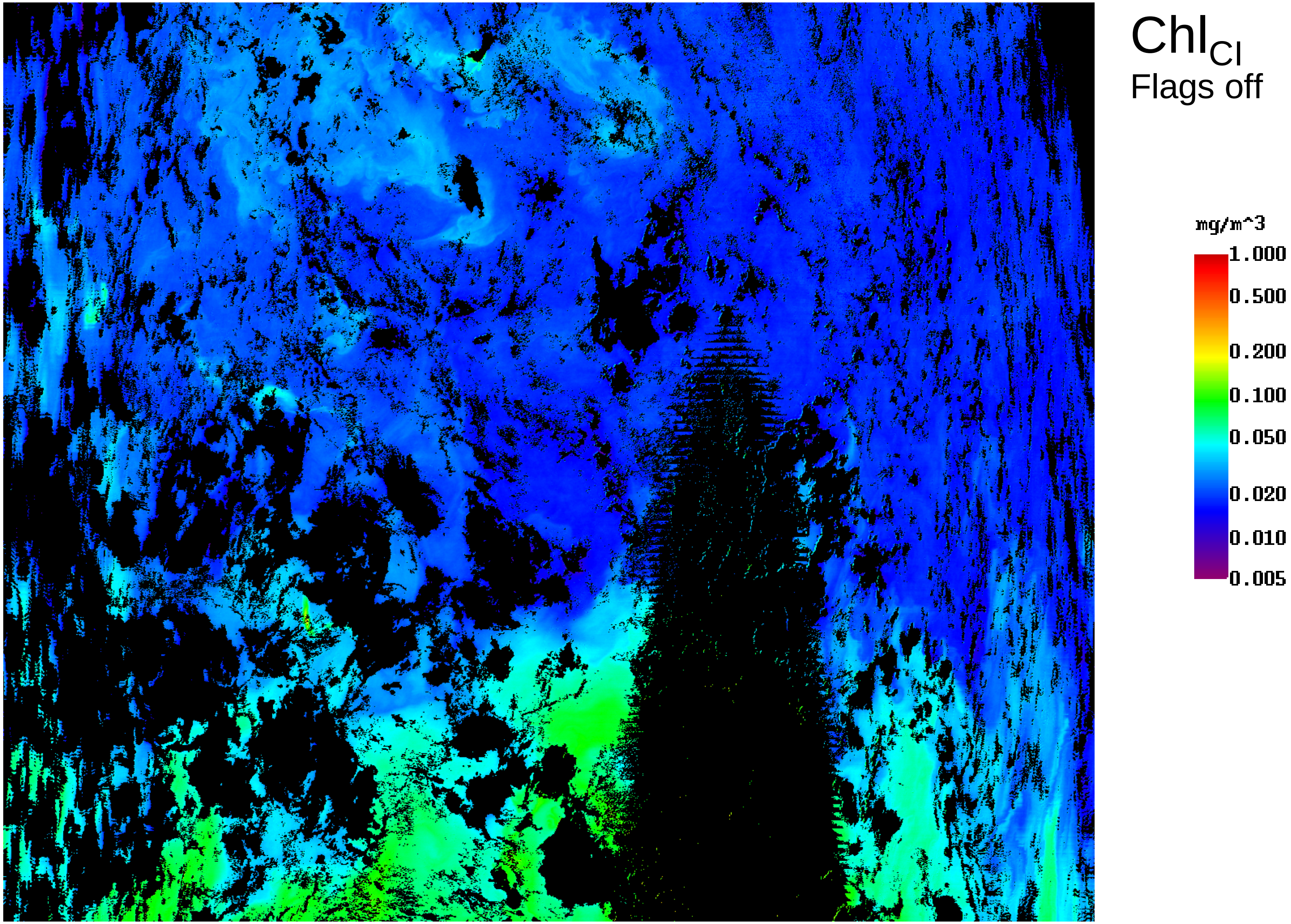
$$\mathrm{Chl}_{\mathrm{OC4}}\left[\text{for } \mathrm{Chl}_{\mathrm{CI}} > 0.3 \text{ mg m}^{-3}\right]$$

$$\alpha \times \mathrm{Chl}_{\mathrm{OC4}} + \beta \times \mathrm{Chl}_{\mathrm{CI}}\left[\text{for } 0.25 < \mathrm{Chl}_{\mathrm{CI}} \leq 0.3 \text{ mg m}^{-3}\right]$$

MODISA Standard OC3 Chlorophyll

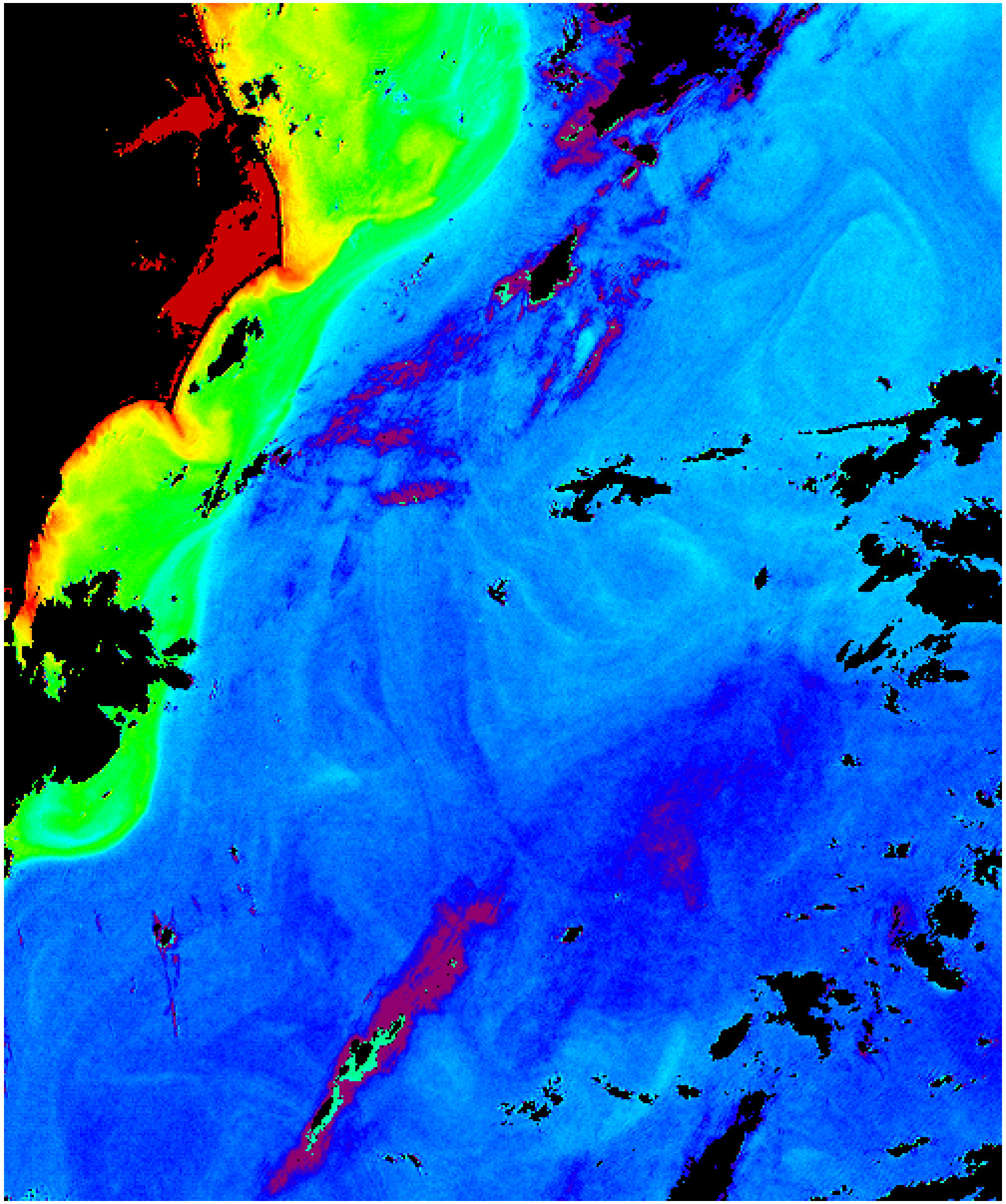


MODISA Evaluation OCI Chlorophyll

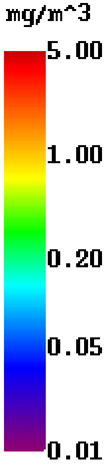


Chl_{CI}
Flags off

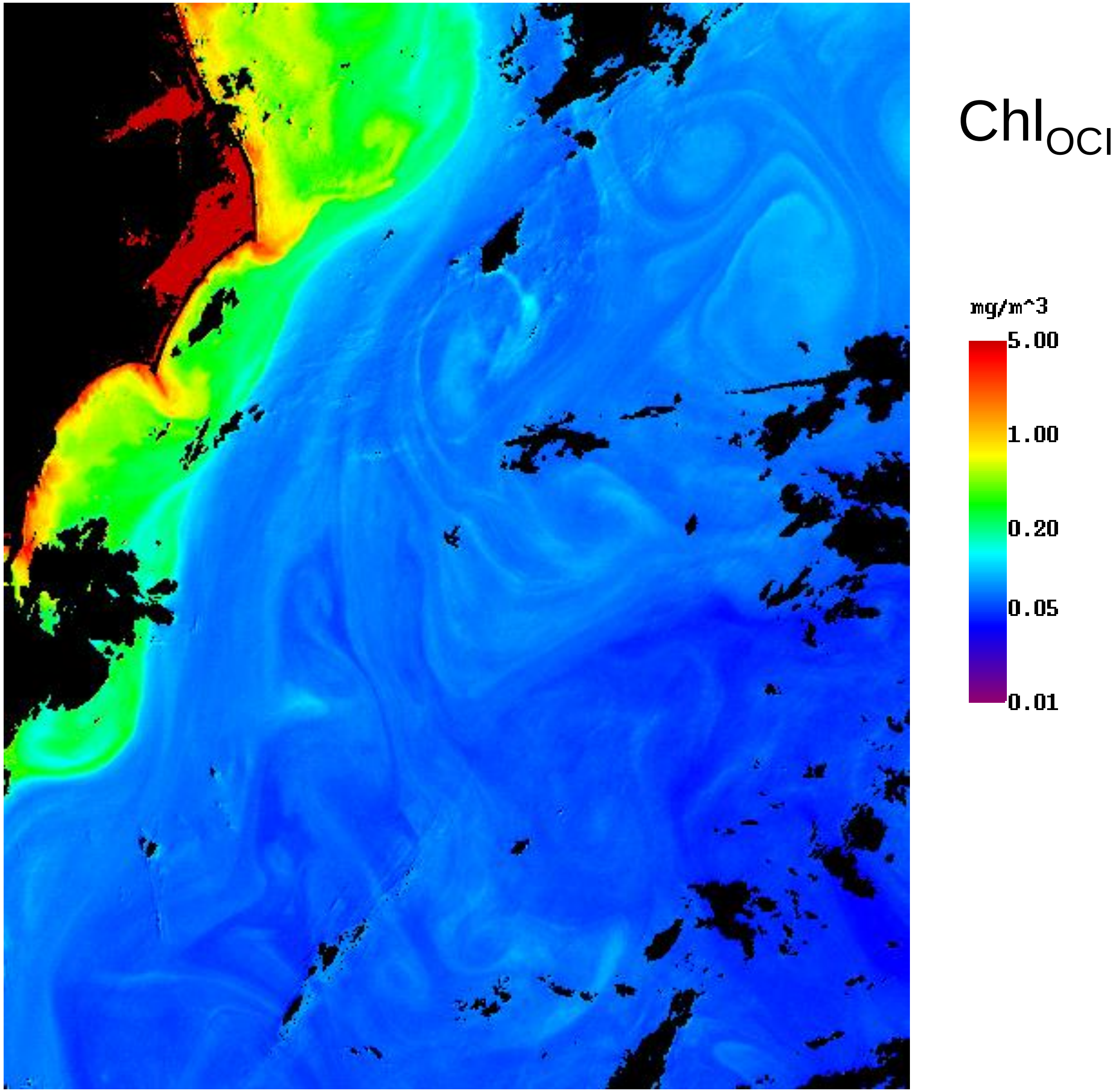
SeaWiFS Standard OC4 Chlorophyll



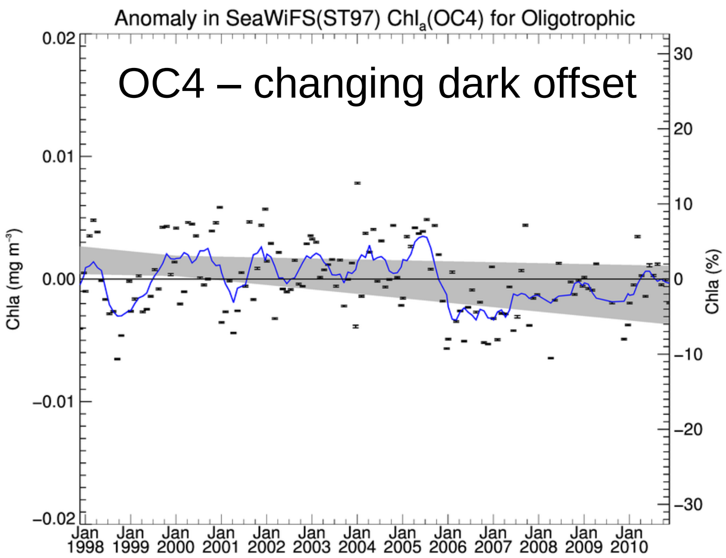
Chl_{OC4}

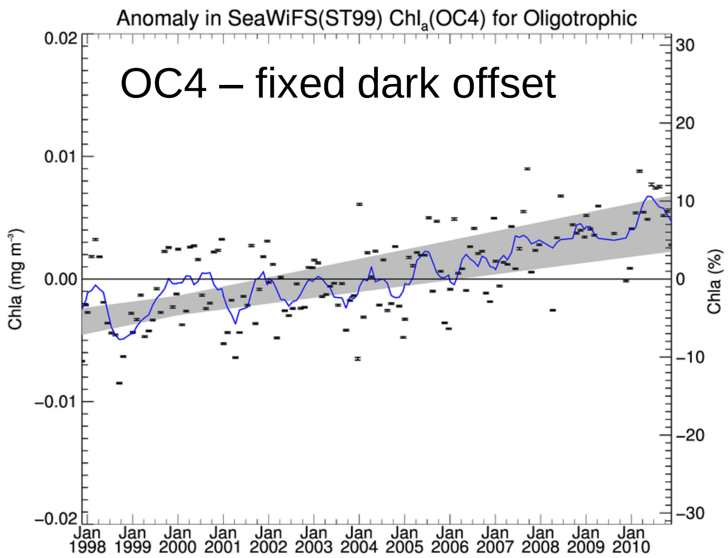


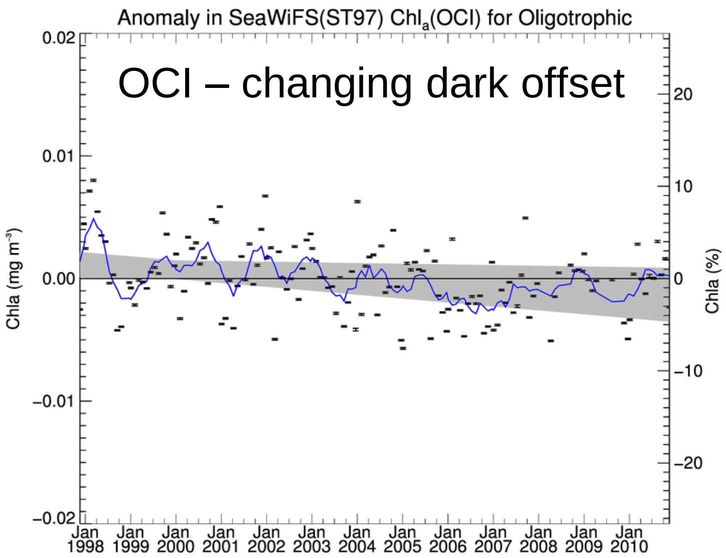
SeaWiFS Evaluation OCI Chlorophyll

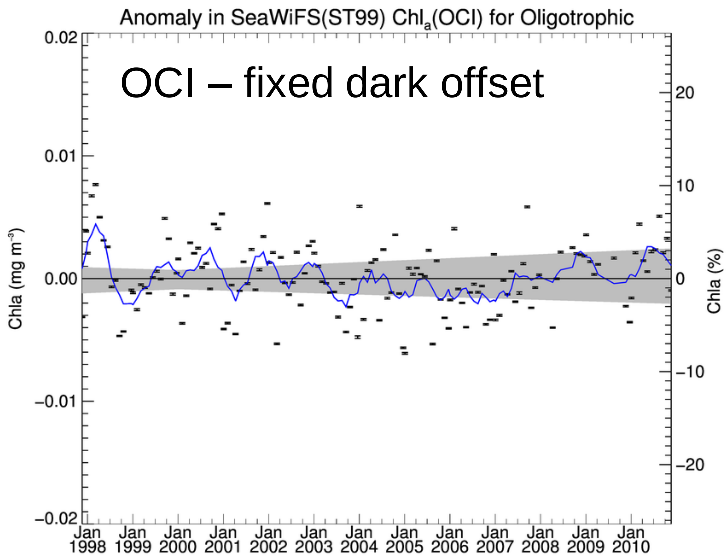


OCI Resistance to SeaWiFS Offset Issue









Improved Agreement in Chl Distribution

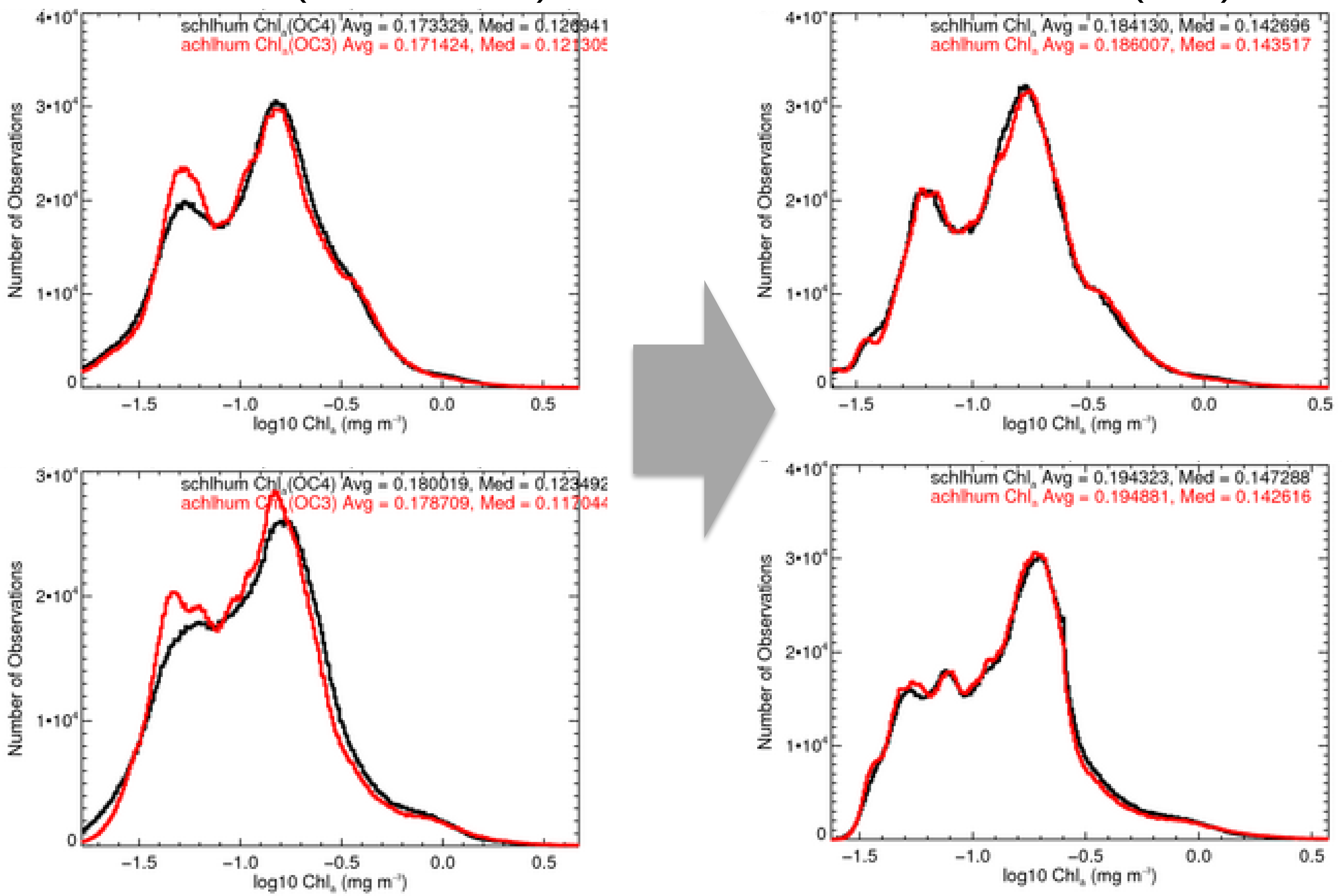
Deep-Water Monthly Mean, MODISA (red) & SeaWiFS (black)

Standard (OC3 & OC4)

Evaluation (OCI)

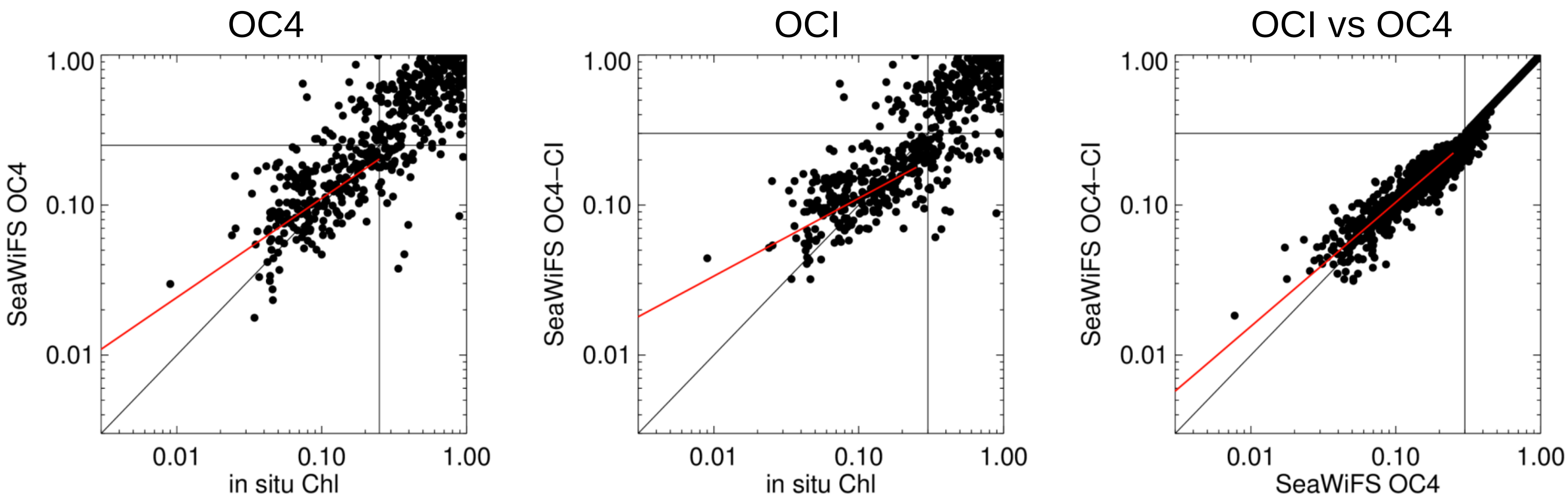
Fall 2002

Fall 2010



SeaWiFS match-ups for OCI chl < 0.25 mg m^{-3}

red line is best fit (Type II, RMA)
r^2, slope, and RMSE log-transformed statistics
sample size is 314

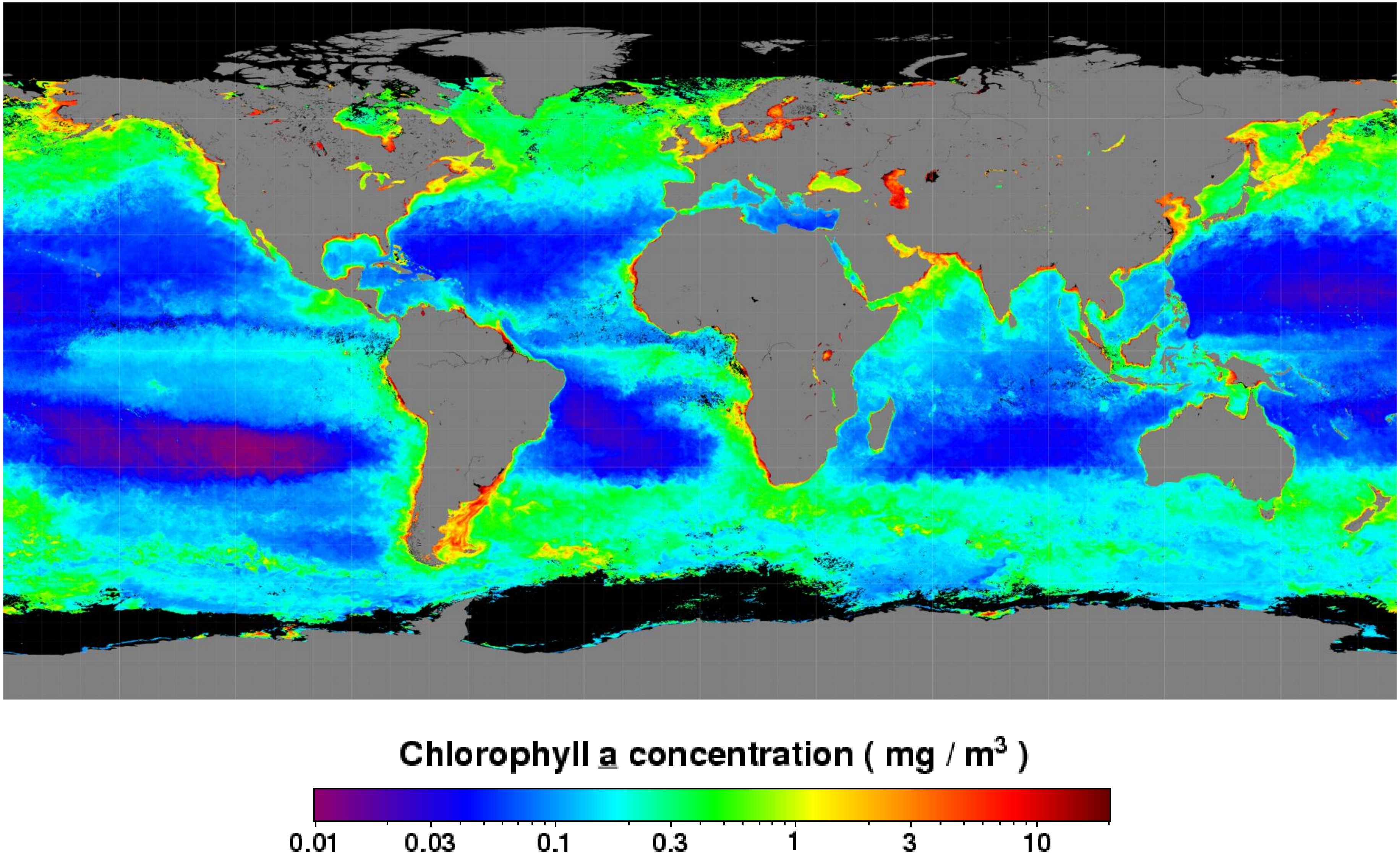


	OC4	OCI	OCI vs OC4
r^2	0.35	0.32	0.85
Slope	0.66	0.52	0.83
RMSE	0.104	0.085	0.074
Ratio	1.02	0.99	0.96
MPD	36.4	36.3	11.4

results are inconclusive

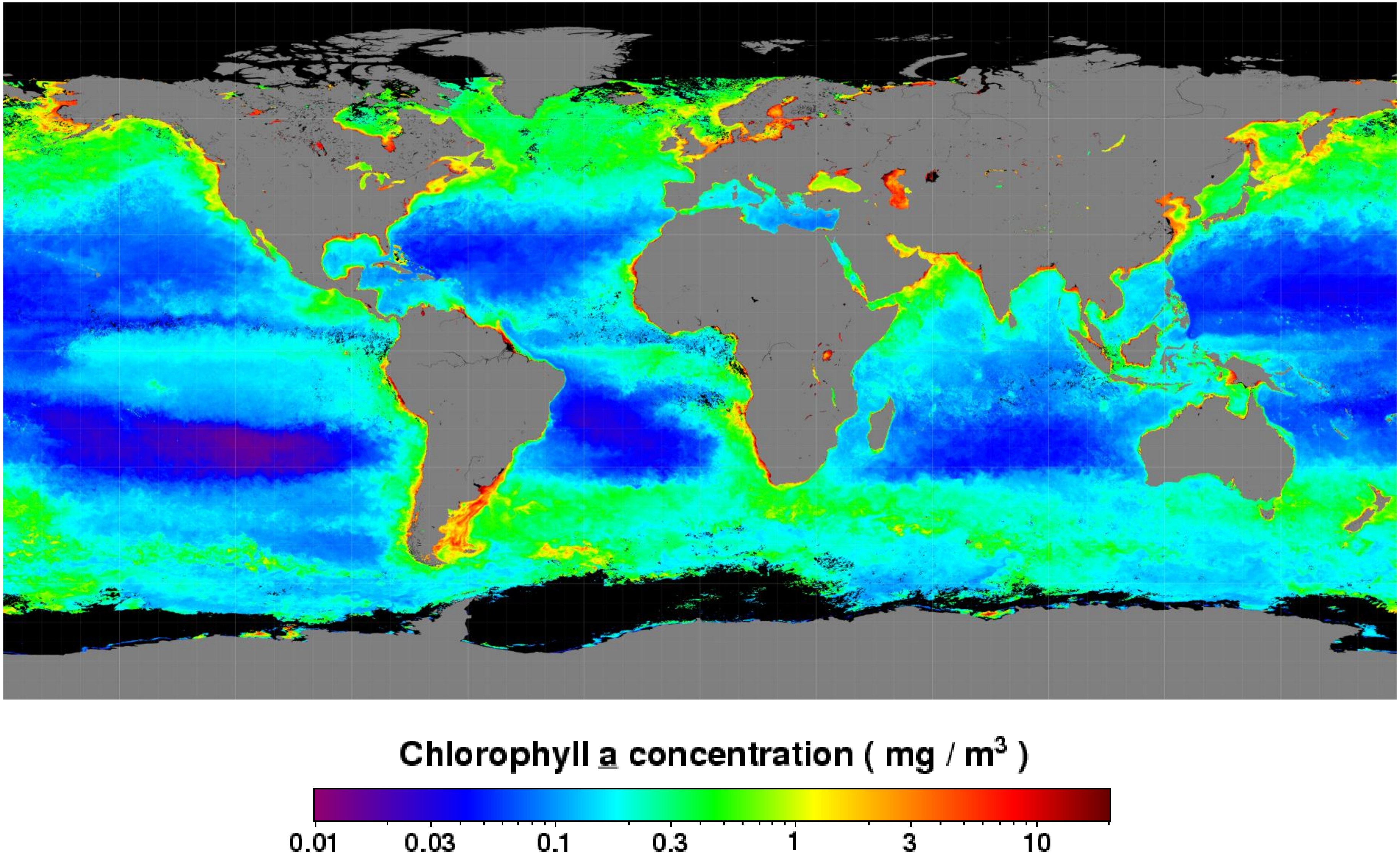
MODISA Standard OC3 Chlorophyll

Fall 2002



MODISA Evaluation OCI Chlorophyll

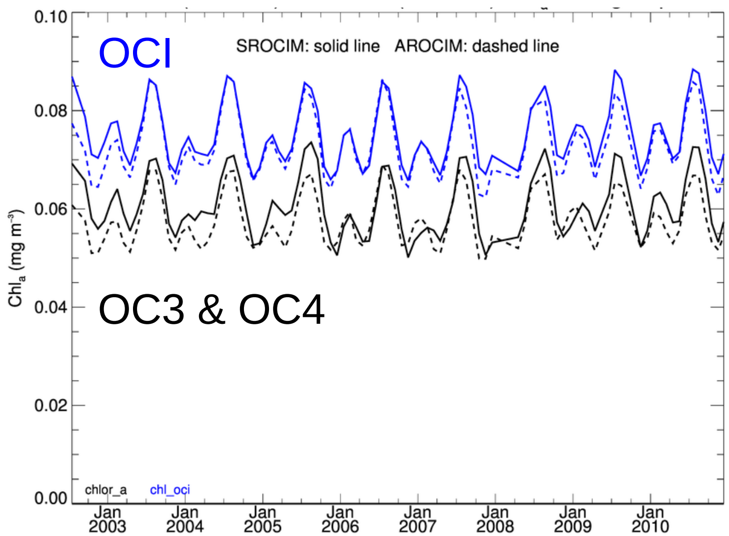
Fall 2002



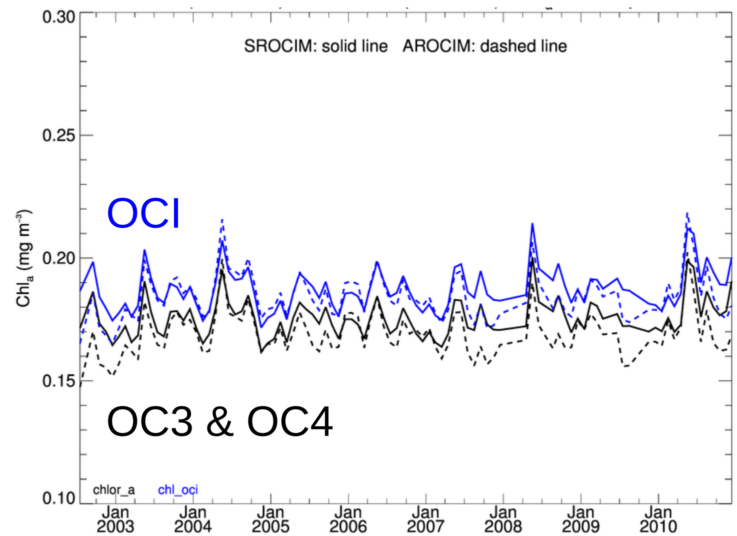
MODISA & SeaWiFS Chlorophyll Trends

Impact of OCI Algorithm – Elevated Chlorophyll

Global Mean Clear-Water Trend



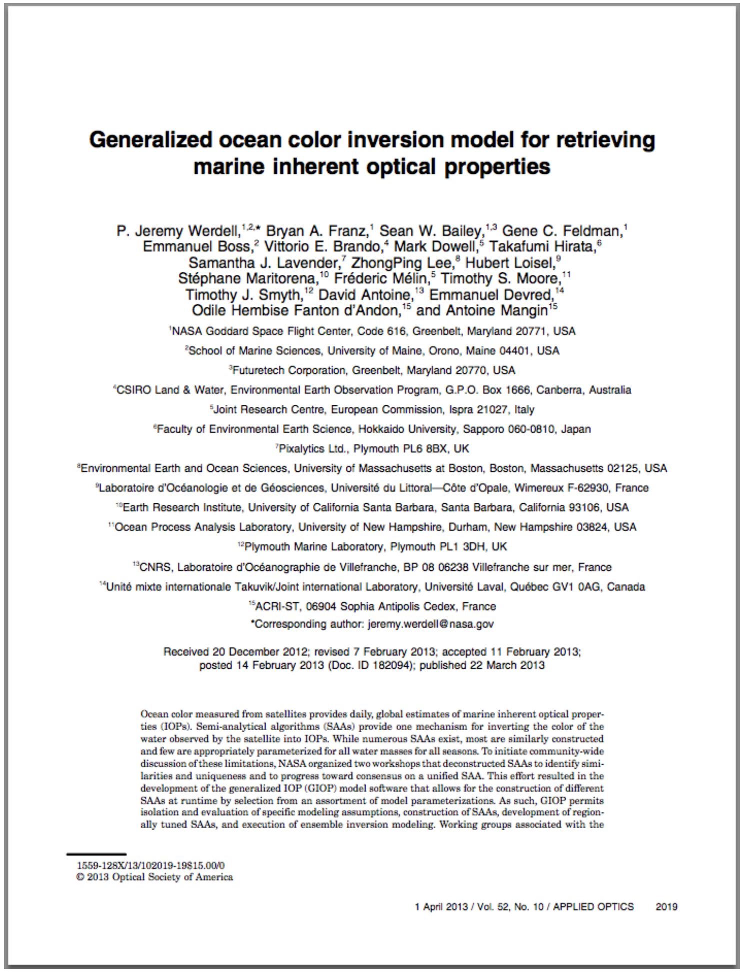
Global Mean Deep-Water Trend



	Clear Water			Deep Water		
mg m^{-3}	SeaWiFS	MODIS	Ratio	SeaWiFS	MODIS	Ratio
OCx	0.061	0.058	0.95	0.175	0.169	0.96
OCI	0.075	0.073	0.97	0.187	0.184	0.98
OCI - OCx	**0.014**	**0.015**		**0.012**	**0.015**	

proceed with OCI?

Expanded Product Suite - IOPs



Generalized ocean color inversion model for retrieving marine inherent optical properties

P. Jeremy Werdell,[1,2,*] Bryan A. Franz,[1] Sean W. Bailey,[1,3] Gene C. Feldman,[1] Emmanuel Boss,[2] Vittorio E. Brando,[4] Mark Dowell,[5] Takafumi Hirata,[6] Samantha J. Lavender,[7] ZhongPing Lee,[8] Hubert Loisel,[9] Stéphane Maritorena,[10] Fréderic Mélin,[5] Timothy S. Moore,[11] Timothy J. Smyth,[12] David Antoine,[13] Emmanuel Devred,[14] Odile Hembise Fanton d'Andon,[15] and Antoine Mangin[15]

[1]NASA Goddard Space Flight Center, Code 616, Greenbelt, Maryland 20771, USA
[2]School of Marine Sciences, University of Maine, Orono, Maine 04401, USA
[3]Futuretech Corporation, Greenbelt, Maryland 20770, USA
[4]CSIRO Land & Water, Environmental Earth Observation Program, G.P.O. Box 1666, Canberra, Australia
[5]Joint Research Centre, European Commission, Ispra 21027, Italy
[6]Faculty of Environmental Earth Science, Hokkaido University, Sapporo 060-0810, Japan
[7]Pixalytics Ltd., Plymouth PL6 8BX, UK
[8]Environmental Earth and Ocean Sciences, University of Massachusetts at Boston, Boston, Massachusetts 02125, USA
[9]Laboratoire d'Océanologie et de Géosciences, Université du Littoral—Côte d'Opale, Wimereux F-62930, France
[10]Earth Research Institute, University of California Santa Barbara, Santa Barbara, California 93106, USA
[11]Ocean Process Analysis Laboratory, University of New Hampshire, Durham, New Hampshire 03824, USA
[12]Plymouth Marine Laboratory, Plymouth PL1 3DH, UK
[13]CNRS, Laboratoire d'Océanographie de Villefranche, BP 08 06238 Villefranche sur mer, France
[14]Unité mixte internationale Takuvik/Joint international Laboratory, Université Laval, Québec GV1 0AG, Canada
[15]ACRI-ST, 06904 Sophia Antipolis Cedex, France
*Corresponding author: jeremy.werdell@nasa.gov

Received 20 December 2012; revised 7 February 2013; accepted 11 February 2013; posted 14 February 2013 (Doc. ID 182094); published 22 March 2013

Ocean color measured from satellites provides daily, global estimates of marine inherent optical properties (IOPs). Semi-analytical algorithms (SAAs) provide one mechanism for inverting the color of the water observed by the satellite into IOPs. While numerous SAAs exist, most are similarly constructed and few are appropriately parameterized for all water masses for all seasons. To initiate community-wide discussion of these limitations, NASA organized two workshops that deconstructed SAAs to identify similarities and uniqueness and to progress toward consensus on a unified SAA. This effort resulted in the development of the generalized IOP (GIOP) model software that allows for the construction of different SAAs at runtime by selection from an assortment of model parameterizations. As such, GIOP permits isolation and evaluation of specific modeling assumptions, construction of SAAs, development of regionally tuned SAAs, and execution of ensemble inversion modeling. Working groups associated with the

1559-128X/13/102019-19$15.00/0

ARTICLE IN PRESS
RSE-08816; No of Pages 24
Remote Sensing of Environment xxx (2013) xxx–xxx
Contents lists available at ScienceDirect
Remote Sensing of Environment
journal homepage: www.elsevier.com/locate/rse

The Ocean Colour Climate Change Initiative: III. A round-robin comparison on in-water bio-optical algorithms

Robert J.W. Brewin[a,b,*], Shubha Sathyendranath[a,b], Dagmar Müller[c], Carsten Brockmann[d], Pierre-Yves Deschamps[e], Emmanuel Devred[f], Roland Doerffer[c], Norman Fomferra[d], Bryan Franz[g], Mike Grant[a], Steve Groom[a], Andrew Horseman[a], Chuanmin Hu[h], Hajo Krasemann[c], ZhongPing Lee[i], Stéphane Maritorena[j], Frédéric Mélin[k], Marco Peters[d], Trevor Platt[a], Peter Regner[l], Tim Smyth[a], Francois Steinmetz[e], John Swinton[m], Jeremy Werdell[g], George N. White III[n]

[a] Plymouth Marine Laboratory (PML), Prospect Place, The Hoe, Plymouth PL1 3DH, UK
[b] National Centre for Earth Observation, PML, Plymouth PL1 3DH, UK
[c] Helmholtz-Zentrum Geesthacht, Max-Planck-Straße 1, 21502 Geesthacht, Germany
[d] Brockmann Consult, Max-Planck-Straße 2, D-21502 Geesthacht, Germany
[e] HYGEOS, 165 Avenue de Bretagne, 59000 Lille, France
[f] Université Laval, 2325, rue de l'Université, Québec G1V 0A6, Canada
[g] NASA Goddard Space Flight Center, Greenbelt, MD, USA
[h] College of Marine Science, University of South Florida, St. Petersburg, FL 33701, USA
[i] College of Science and Mathematics, University of Massachusetts Boston, Boston, MA 02125-3393, USA
[j] Earth Research Institute, University of California Santa Barbara, Santa Barbara, CA 93106-3060, USA
[k] European Commission, Joint Research Centre, Institute for Environment and Sustainability, Ispra 21027, Italy
[l] European Space Agency, ESRIN, Via Galileo Galilei, Casella Postale 64, 00044 Frascati, Italy
[m] Telespazio VEGA UK Ltd., 350 Capability Green, Luton, Bedfordshire LU1 3LU, UK
[n] Ocean Science Division, Bedford Institute of Oceanography, Box 1006, Dartmouth, Nova Scotia B2Y 4A2, Canada

ARTICLE INFO

Article history:
Received 9 November 2012
Received in revised form 8 August 2013
Accepted 15 September 2013
Available online xxxx

Keywords:
Phytoplankton
Ocean colour
Inherent Optical Properties
Remote sensing
Chlorophyll-a

ABSTRACT

Satellite-derived remote-sensing reflectance can be used for mapping biogeochemically relevant variables, such as the chlorophyll concentration and the Inherent Optical Properties (IOPs) of the water, at global scales for use in climate-change studies. Prior to generating such products, suitable algorithms have to be selected that are appropriate for the purpose. Algorithm selection needs to account for both qualitative and quantitative requirements. In this paper we develop an objective methodology designed to rank the quantitative performance of a suite of bio-optical models. The objective classification is applied using the NASA bio-Optical Marine Algorithm Dataset (NOMAD). Using in situ R_{rs} as input to the models, the performance of eleven semi-analytical models, as well as five empirical chlorophyll algorithms and an empirical diffuse attenuation coefficient algorithm, is ranked for spectrally-resolved IOPs, chlorophyll concentration and the diffuse attenuation coefficient at 489 nm. The sensitivity of the objective classification and the uncertainty in the ranking are tested using a Monte-Carlo approach (bootstrapping). Results indicate that the performance of the semi-analytical models varies depending on the product and wavelength of interest. For chlorophyll retrieval, empirical algorithms perform better than semi-analytical models, in general. The performance of these empirical models reflects either their immunity to scale errors or instrument noise in R_{rs} data, or simply that the data used for model parameterisation were not independent of NOMAD. Nonetheless, uncertainty in the classification suggests that the performance of some semi-analytical algorithms at retrieving chlorophyll is comparable with the empirical algorithms. For phytoplankton absorption at 443 nm, some semi-analytical models also perform with similar accuracy to an empirical model. We discuss the potential biases, limitations and uncertainty in the approach, as well as additional qualitative considerations for algorithm selection for climate-change studies. Our classification has the potential to be routinely implemented, such that the performance of emerging algorithms can be compared with existing algorithms as they become available. In the long-term, such an approach will further aid algorithm development for ocean-colour studies.

* Corresponding author at: Plymouth Marine Laboratory (PML), Prospect Place, The Hoe, Plymouth PL1 3DH, UK.
E-mail address: robr@pml.ac.uk (R.J.W. Brewin).

0034-4257/$ – see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.rse.2013.09.016

Please cite this article as: Brewin, R.J.W., et al., The Ocean Colour Climate Change Initiative: III. A round-robin comparison on in-water bio-optical algorithms, *Remote Sensing of Environment* (2013), http://dx.doi.org/10.1016/j.rse.2013.09.016

use "consensus" GIOP model in default configuration (Werdell et al. 2013, Appl. Opt.) with addition of temperature and salinity dependence on bbw (Werdell et al. 2013 Opt. Exp., Zhang et al. 2009).

Expanded Product Suite - IOPs

proposed IOP product suite

- aph(λ) *all visible wavelengths*
- adg(443) + Sdg *exponential spectral slope*
- bbp(443) + Sbp *power-law spectral slope*
- uncertainties *only at 443nm*

other potential products

- bbw(443) + Sbw *power-law spectral slope; Zhang et al. 2009*
- chlorophyll

proposed distribution

- aph(443), adg(443), bbp(443) included in standard OC Level-2
- full product suite included in new standard IOP Level-3

what best serves the community?

Next multi-mission OC reprocessing (R2014.0) in progress

OCTS ➡ SeaWiFS ➡ CZCS ➡ MERIS ➡ MODISA ➡ MODIST ➡ VIIRS

May 2014 June 2014

Includes instrument and vicarious calibration updates

Incorporates algorithm refinements since 2010

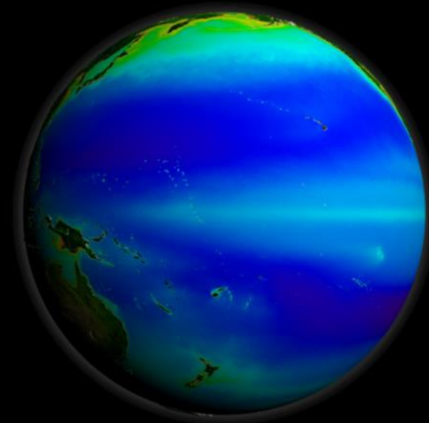
Expands standard product suite

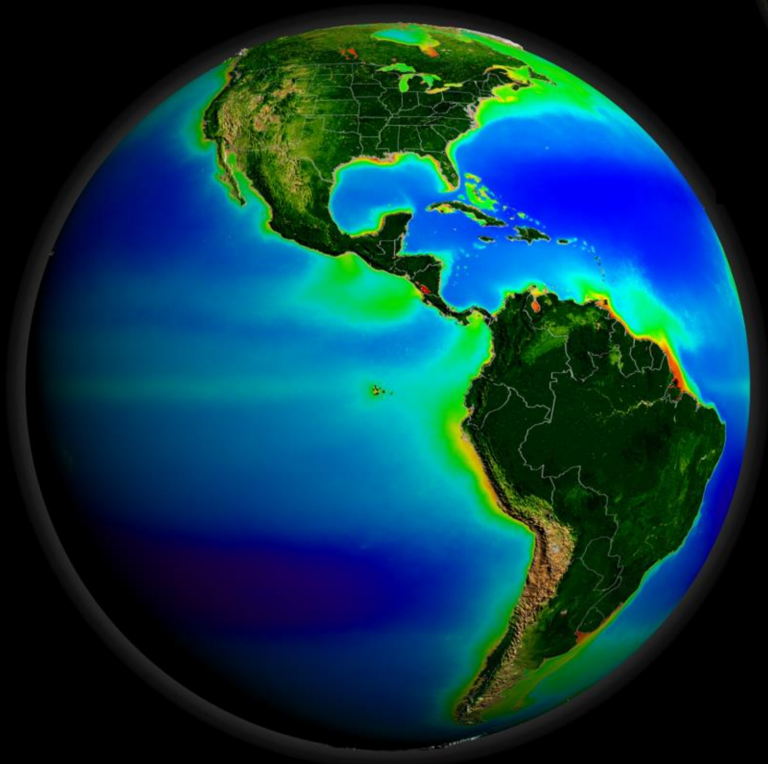
Changes data formats

Looking for feedback on:

OCI chlorophyll algorithm refinement

IOP model and products to be included



questions?

Second-generation GLobal Imager (SGLI)

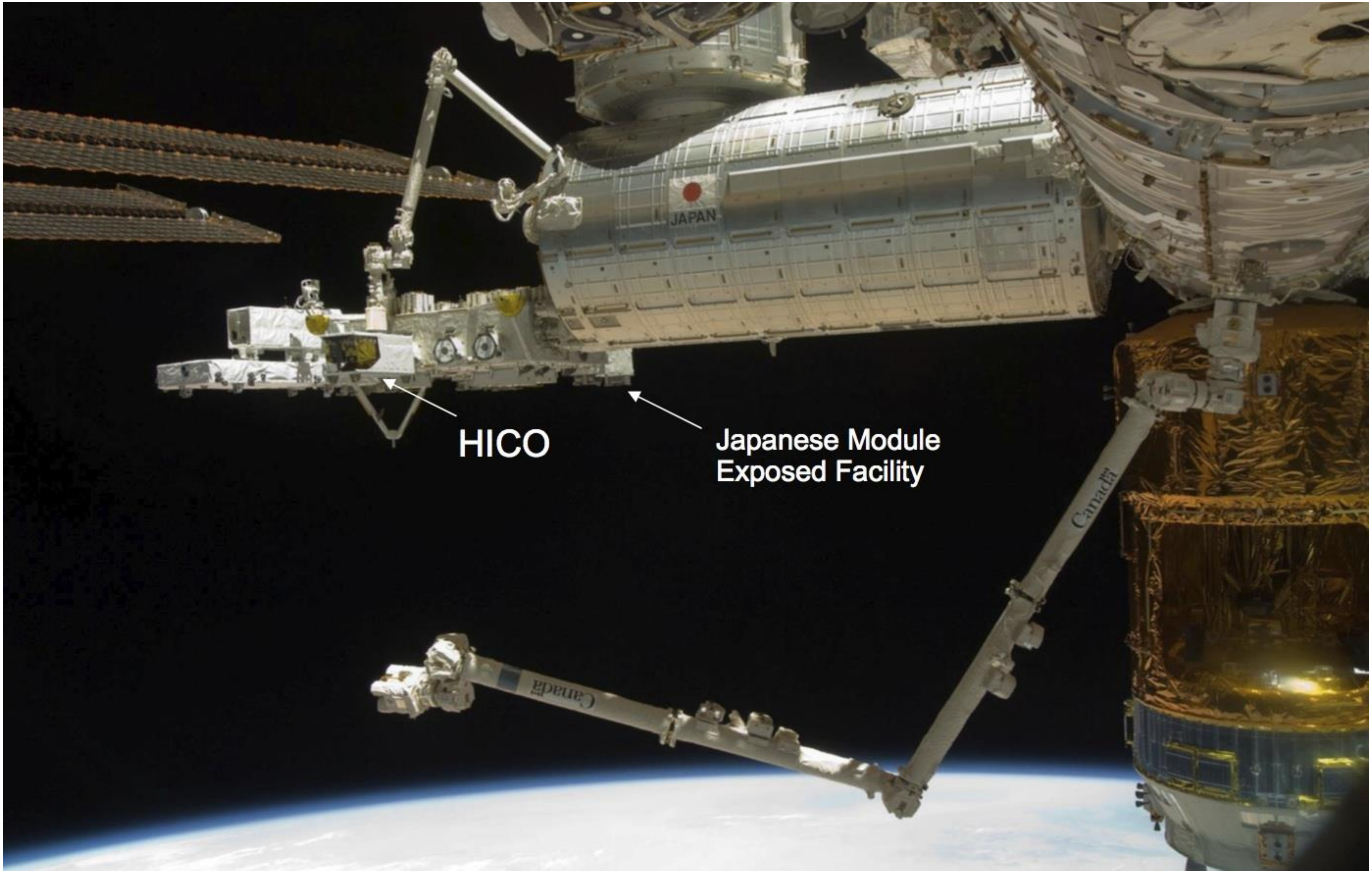
- JAXA SGLI follow-on to fly on GCOM-C1, launch date Dec 2015
- multi-spectral push-broom (380nm to 870nm) with multi-angle polarimeter in the red-NIR, married to a SWIR-IR scanner
- global 1-km with 250-m coastal
- no sun glint avoidance

GCOM-C SGLI characteristics (Current baseline)	
Orbit	Sun-synchronous (descending local time: 10:30), Altitude: 798km, Inclination: 98.6deg
Launch Date	**JFY 2016 (TBD)**
Mission Life	5 years (3 satellites; total 13 years)
Scan	Push-broom electric scan (VNR: VN & P) Wisk-broom mechanical scan (IRS: SW & T)
Scan width	1150km cross track (VNR: VN & P) 1400km cross track (IRS: SW & T)
Digitalization	12bit
Polarization	3 polarization angles for POL
Along track tilt	Nadir for VN, SW and TIR, & +/-45 deg for P
On-board calibration	VN: Solar diffuser, Internal lamp (LED, halogen), Lunar by pitch maneuvers (~once/month), and dark current by masked pixels and nighttime obs. SW: Solar diffuser, Internal lamp, Lunar, and dark current by deep space window TIR: Black body and dark current by deep space window All: Electric calibration

Characteristics of SGLI spectral bands

CH	λ	$\Delta\lambda$	L_{std}	L_{max}	SNR@L_{std}	IFOV	Tilt
	nm		$W/m^2/sr/\mu m$ K: Kelvin		- K: NEΔT	m	deg
VN1	380	10	60	210	250	**250** /1000	0
VN2	412	10	75	250	400	**250** /1000	0
VN3	443	10	64	400	300	**250** /1000	0
VN4	490	10	53	120	400	**250** /1000	0
VN5	530	20	41	350	250	**250** /1000	0
VN6	565	20	33	90	400	**250** /1000	0
VN7	673.5	20	23	62	400	**250** /1000	0
VN8	673.5	20	25	210	250	**250** /1000	0
VN9	763	12	40	350	1200*	250 /**1000***	0
VN10	868.5	20	8	30	400	**250** /1000	0
VN11	868.5	20	30	300	200	**250** /1000	0
POL1	673.5	20	25	250	250	**1000**	±45
POL2	868.5	20	30	300	250	**1000**	±45
SW1	1050	20	57	248	500	**1000**	0
SW2	1380	20	8	103	150	**1000**	0
SW3	1630	200	3	50	57	**250** /1000	0
SW4	2210	50	1.9	20	211	**1000**	0
TIR1	10800	0.7	300K	340K	0.2K	250 /**500** /1000	0
TIR2	12000	0.7	300K	340K	0.2K	250 /**500** /1000	0

Hyperspectral Imager for Coastal Oceans (HICO)



GOCI Analysis and Display in SeaDAS 7.1