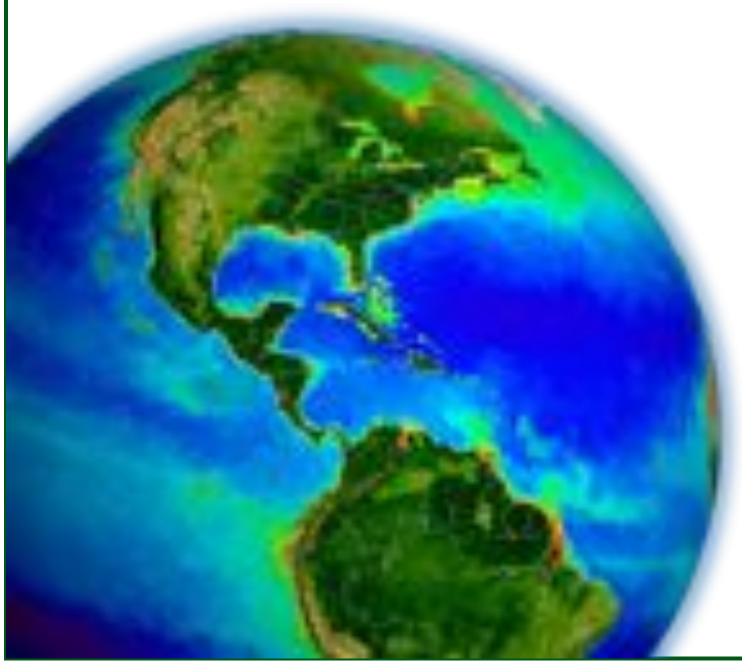
Summary of Ocean Break-out

Bryan Franz

and the

MODIS Ocean Science Team

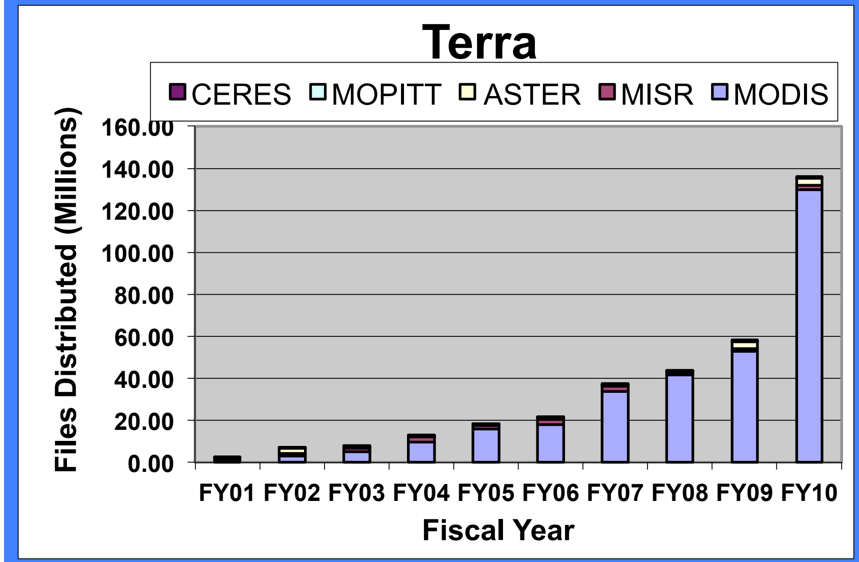


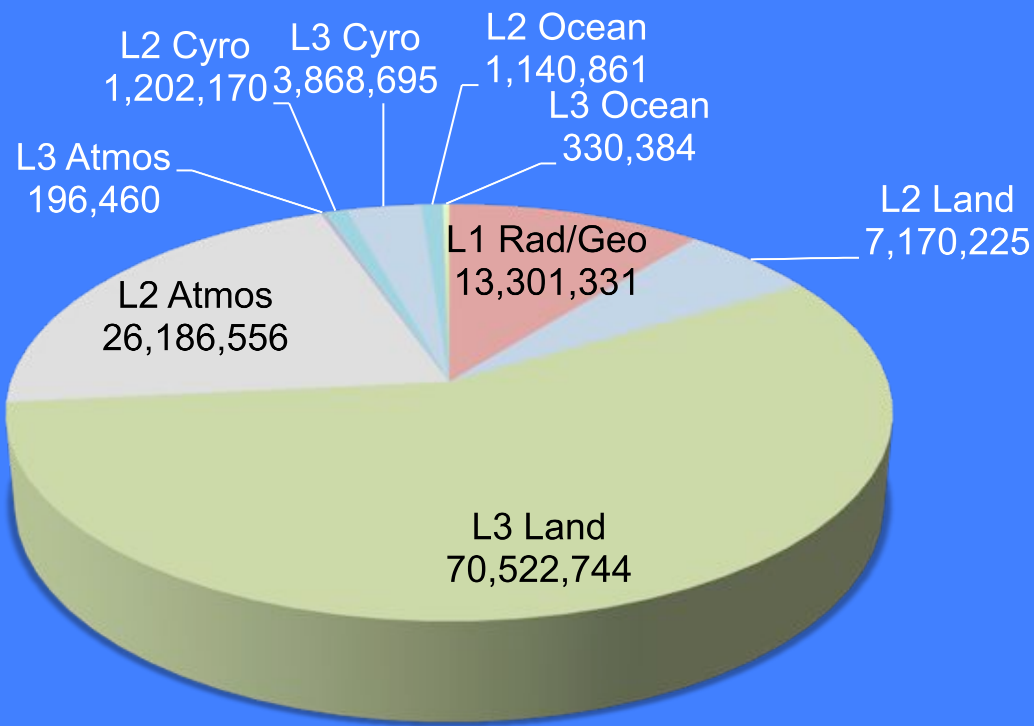
MODIS Science Team Meeting

20 May 2011, College Park, MD

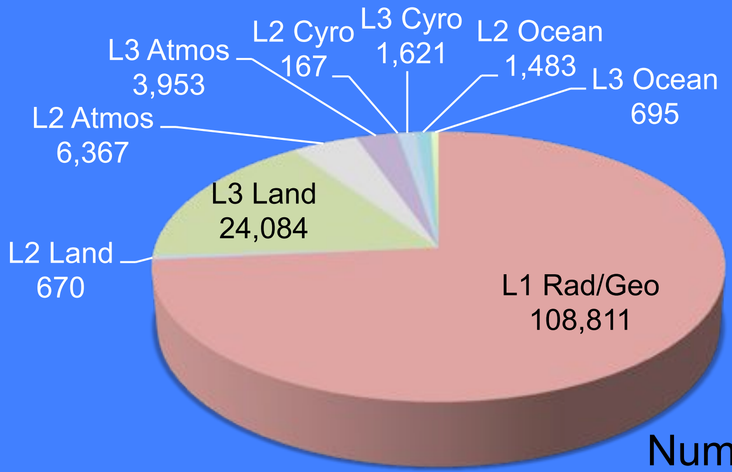
Senior Review Panel Question 6 for Terra:

"Provide statistics/data on product use: What is the use of each product (quantitative comparison) and what is the use of products from each instrument?"





Number of MODIS data granules distributed in 2010 by product type

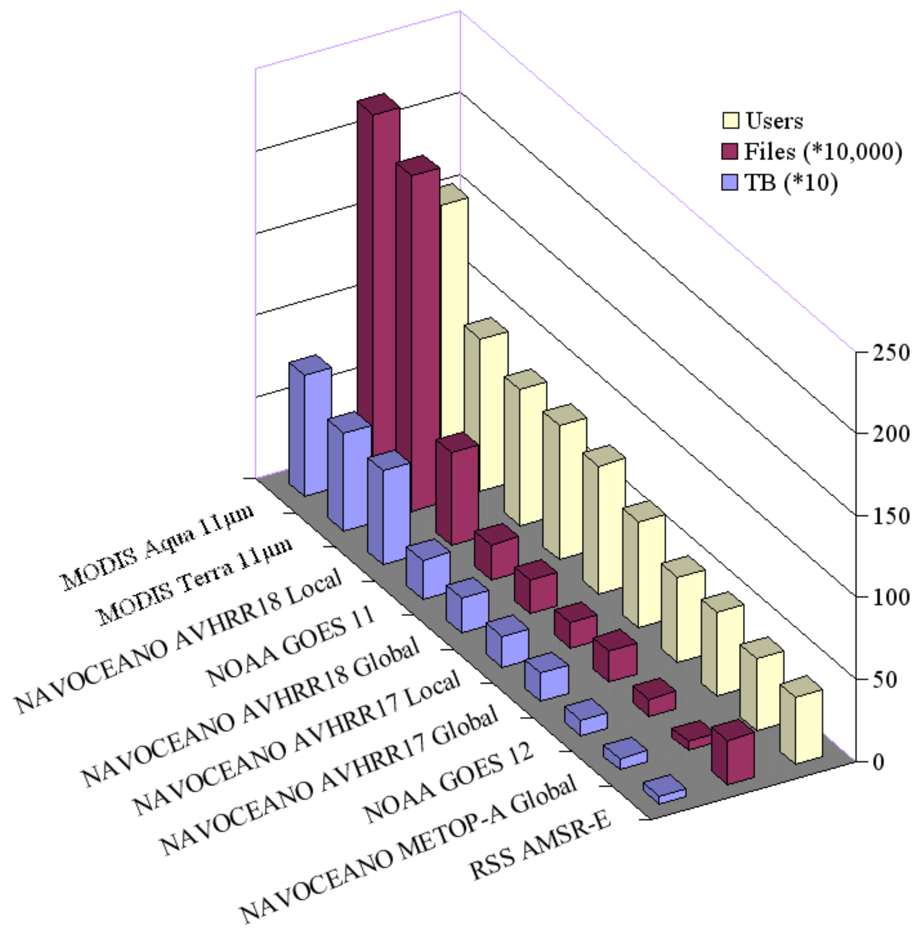


Number of MODIS data users in 2010 for each product type

L2P SSTs from the JPL PO-DAAC

MODIS SSTs are the most requested L2P SST data sets at the NASA JPL PO-DAAC.

Data from Ed Armstrong



Ocean Science Team Members

MODIS

1. Barney Balch
2. Peter Cornillon
3. Heidi Sosik (Hui Feng)
4. Bryan Franz*
5. Watson Gregg
6. Antonio Mannino
7. Stephane Maritorena
8. Galen McKinley (Colleen Mouw)
9. Peter Minnett
10. Norm Nelson
11. Crystal Thomas
12. Toby Westberry

NPP/VIIRS

1. Barney Balch
2. Watson Gregg
3. Peter Minnett
4. Dave Siegel
5. Kevin Turpie*
6. Menghua Wang

Additional Speakers

1. Chuck McClain
2. Sam Ahmed
3. Fred Patt
4. Zia Ahmad

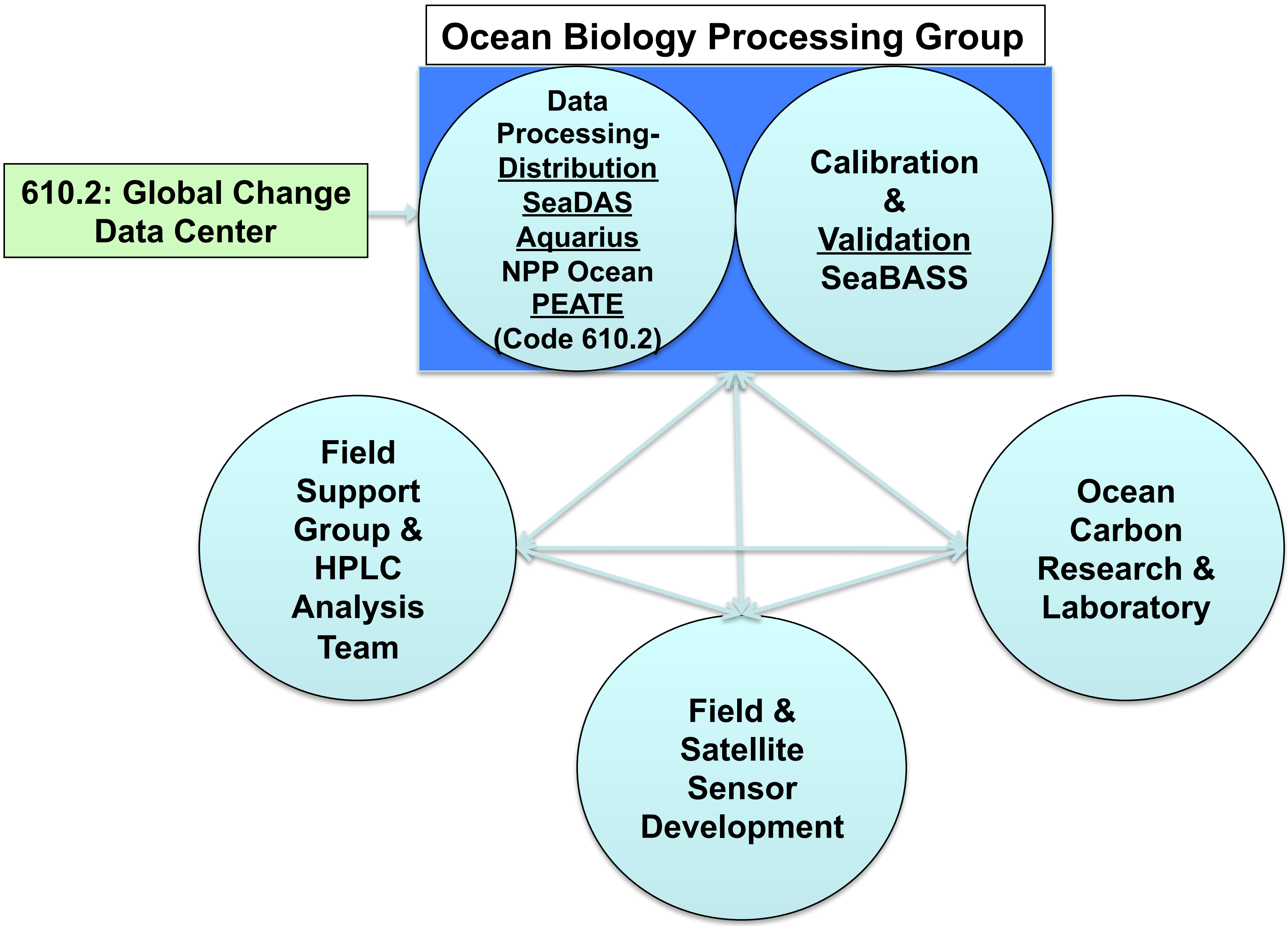
* Discipline Leads

Ocean Break-out Agenda

May 18

2:00	Bryan Franz	*Welcome*
2:15	Chuck McClain	*GSFC Ocean Ecology Branch and Field Program Support Office*
2:30	Crystal Thomas	*Improved Pigment Detection and Quantitation for Quality-Assured HPLC Production Analyses*
2:45	Gerhard Meister	*MODIS calibration status*
3:10	Zia Ahmad	*Atmospheric correction and aerosol models*
3:30	Break	
3:45	Menghua Wang	*Remote sensing of water properties using the SWIR-based atmospheric correction algorithm*
4:00	Sam Ahmed	*Uncertainties assessment and MODIS validation from multi- and hyperspectral measurements in coastal waters at Long Island Sound Coastal Observatory (LISCO)*
4:20	Fred Patt	*NPP/VIIRS Ocean PEATE activities*
4:40	Kevin Turpie	*NPP/VIIRS Science Team activities*
5:00	Discussion	

Ocean Ecology Branch Organization



NASA NPP SDS Level 1 Requirements

- 2.1.2.1 The SDS shall be designed with the assumption that the operational IPO IDPS generated NPP EDRs **do not require reprocessing or re-computation in order to support climate research needs**. Consequently, the SDS **will not be designed to routinely generate climate data products** which require long-term archival in the ADS.

- 2.1.2.3 In developing the SDS, the Project **shall assume that EDRs produced by the IDPS are climate quality** and put in place the capability to test that hypothesis in order to contribute to improving the quality of future EDRs. The SDS shall provide suggested algorithm improvements to the IDPS.

  The SDS is NOT tasked to produce data products for distribution.

Fred Patt

NASA VIIRS Ocean Science Team

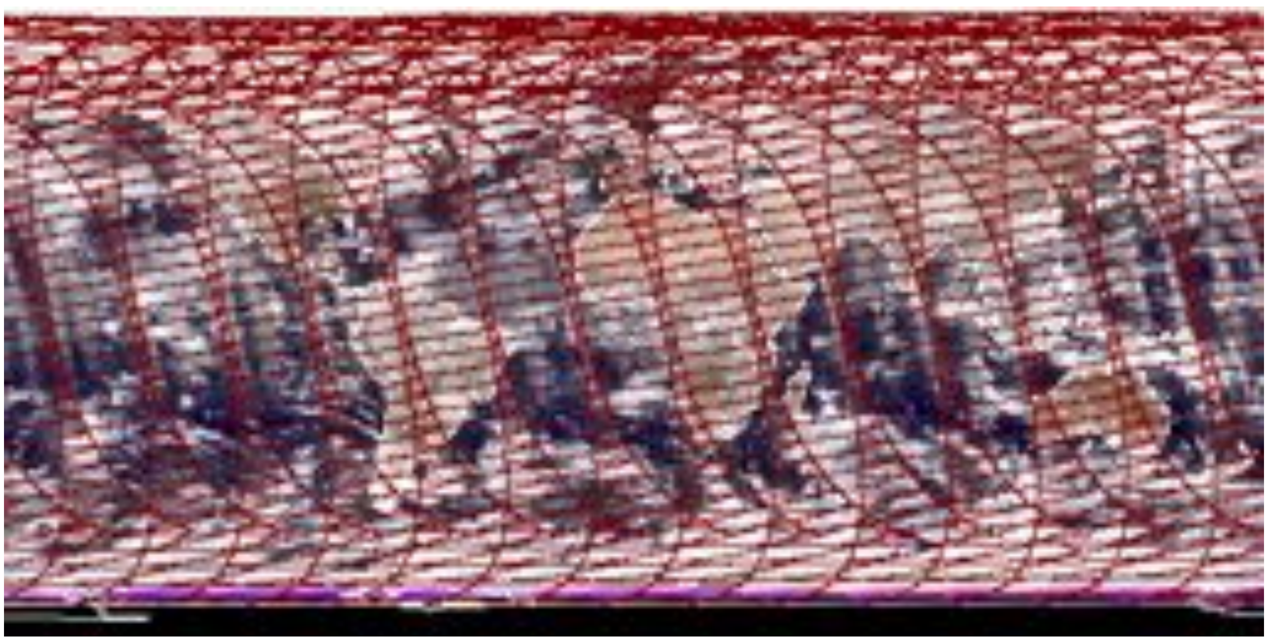
- Evaluate sensor artifacts (e.g, crosstalk) and potential corrections based on
  - Prelaunch: Characterization data and simulated data.
  - Postlaunch: Flight data and *in situ* data, if available.
- Evaluate VIIRS RSB Rad Cal (solar, lunar, & vicarious).
- Process VIIRS flight data with NASA algorithms to compare against operational products.
- Sensor-to-sensor and self-consistency checks; will include *in situ* data, if available.
- Expect to produce a postlaunch quality report after one year.

RSB - Reflective Solar Bands
Rad Cal - Radiometric Calibration

Kevin Turpie

VIIRS DATA SIMULATOR

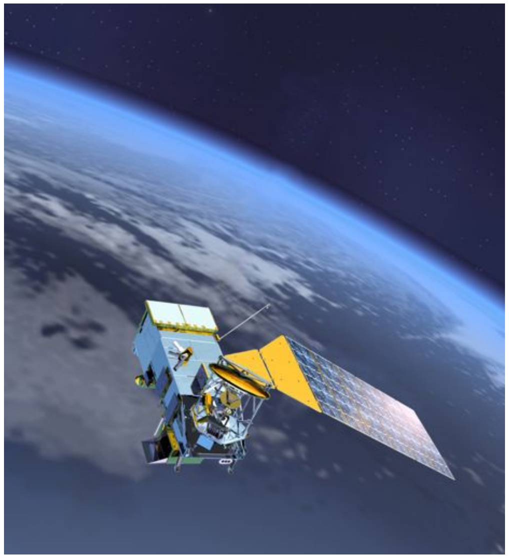
- The VIIRS Data Simulator was designed to provide the ocean team with a better fidelity product for evaluating instrument effects to EDR quality. Key features:
  - Can generate global time series.
  - Ability to include sensor response and artifacts.
  - Helps to prepare team and infrastructure for postlaunch evaluation.



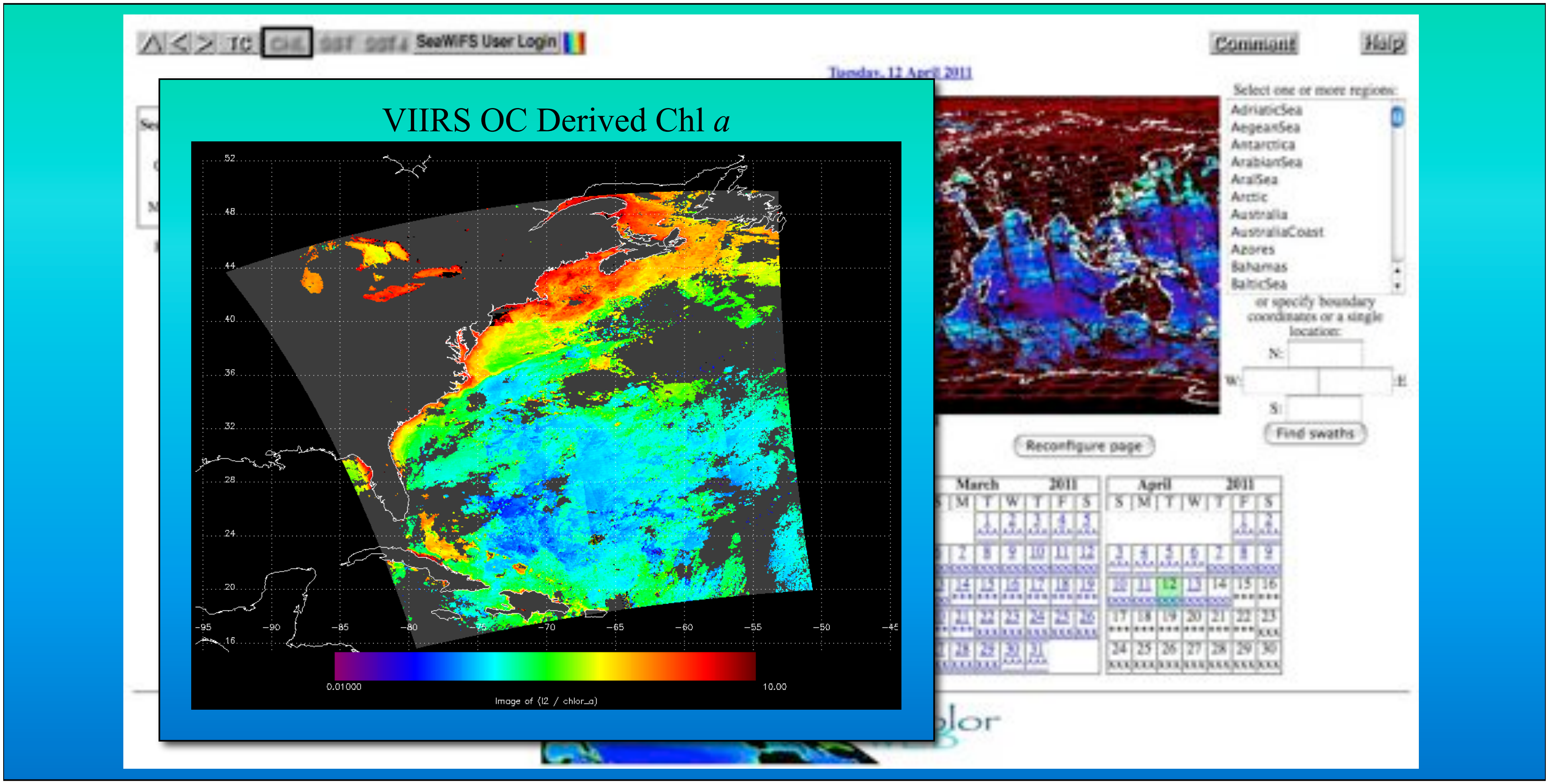
Quasi-true color browse image showing global production by the VIIRS Data Sim-ulator for one day.

VIIRS DATA SIMULATOR

- Based on MODIS Aqua L3:
  - L3 provides global surface fields.
  - VIIRS viewing geometry, w/ aggregation and bow-tie deletion.
  - l2gen atmospheric RT modeling provides TOA radiances.
  - VIIRS response and artifacts applied (see below).
  - Includes clouds and land radiances as well as ocean.
  - NASA algorithms used to produce “L2” VIIRS products.
- Sensor artifacts currently included:
  - Spectral effects of optical crosstalk.
  - Spectral/spatial effects of electronic crosstalk.
  - VIIRS RSR, w/ OOB.
  - VIIRS polarization response.
  - VIIRS RVS.
- Artifacts to be included shortly:
  - Noise (VIIRS SNR)
  - Stray light (NFR)



VIIRS DATA SIMULATOR

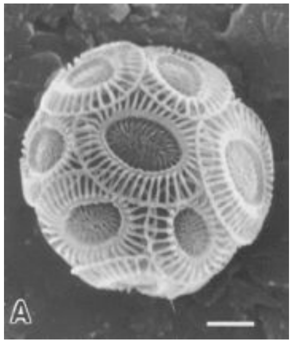


- L1, L2, & L3 simulated data will be available to science team members via <u>restricted</u> access to the oceancolor website. (L3 pending testing)
- Not operational yet, pending discussion with NPP Science Team members.

Ocean Break-out Agenda

May 19

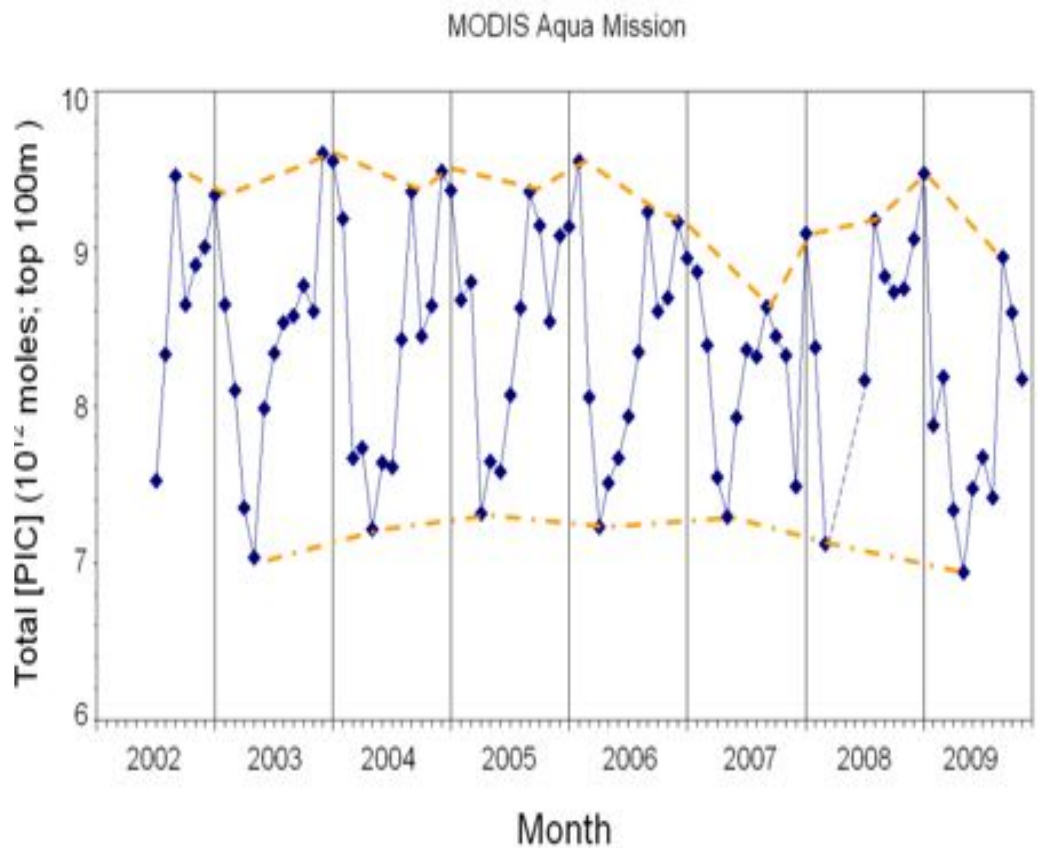
2:00	Norm Nelson	*Bermuda Bio-Optics Project: Enhancement of Measurements for New Ocean Color Applications*
2:15	Hui Feng	*Seasonal to Interannual Variability in Phytoplankton Biomass and Diversity on the New England Shelf: In Situ Time Series for Validation and Exploration of Remote Sensing Algorithms*
2:30	Barney Balch	*Science Data Analysis for the MODIS Ocean Product for Particulate Inorganic Carbon (PIC)*
2:45	Antonio Mannino	*Development of MODIS Global Ocean Algorithms for CDOM and DOC*
3:00	Toby Westberry	*Development Of A Globally Consistent Aqua MODIS Fluorescence Line Height (FLH) Record And Its Science Applications*
3:15	Stephane Maritorena	*From UV to fluorescence, a semi-analytical ocean color model for MODIS and beyond*
3:30	Break	
3:45	Colleen Mouw	*Phytoplankton cell size from ocean color imagery: connection to variability in the ocean carbon sink*
4:00	Watson Gregg	*Radiative coupling in the oceans*
4:15	Peter Cornillon	*Topographic Control of Ocean Dynamics in the Subtropics*
4:30	Peter Minnett	*MODIS Sea Surface Temperature Algorithm Refinement And Validation Through Ship-Based Infrared Spectroradiometry*
4:45	Bob Evans	*Ongoing Calibration and Extension of SST 4 and 11 μm Waveband Algorithms for AQUA and TERRA MODIS Using the in situ Buoy, Radiometer Matchup Database*
5:00	Discussion	



Merged 2-band/3-band algorithm for Particulate Inorganic Carbon (suspended calcium carbonate)

The NASA PIC algorithm has broadened our *temporal* view of global PIC

- e.g. Global patterns of PIC standing stock
- e.g. Will be important for evaluating global impacts of ocean acidification



global ocean

Barney Balch

Expanded MODIS Product Suite

OLD

- nLw(λ)
- Chlorophyll *a*
- $K_d(490)$
- Ångstrom
- AOT
- Epsilon

NEW

- $R_{rs}(\lambda)$
- Chlorophyll *a*
- $K_d(490)$
- Ångstrom
- AOT
- POC
- PIC
- CDOM_index
- PAR
- iPAR
- FLH

$R_{rs}(412)$
$R_{rs}(443)$
$R_{rs}(469)$
$R_{rs}(488)$
$R_{rs}(531)$
$R_{rs}(547)$
$R_{rs}(555)$
$R_{rs}(645)$
$R_{rs}(667)$
$R_{rs}(678)$

land bands

revised band center

$$\boxed{R_{rs}(\lambda) = \frac{nL_w(\lambda)}{F_0(\lambda)}}$$

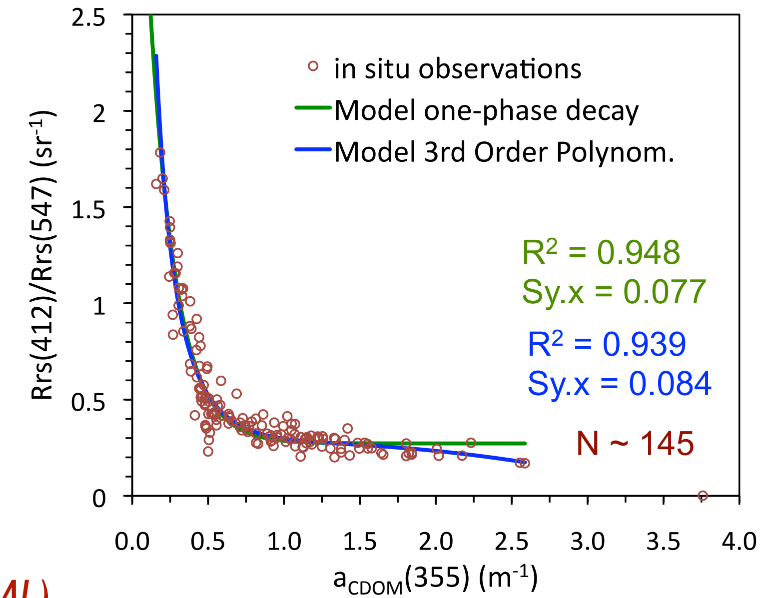
MODIS Global Ocean Algorithms for CDOM and DOC

Antonio Mannino (NASA/GSFC) & David Lary (UT Dallas)

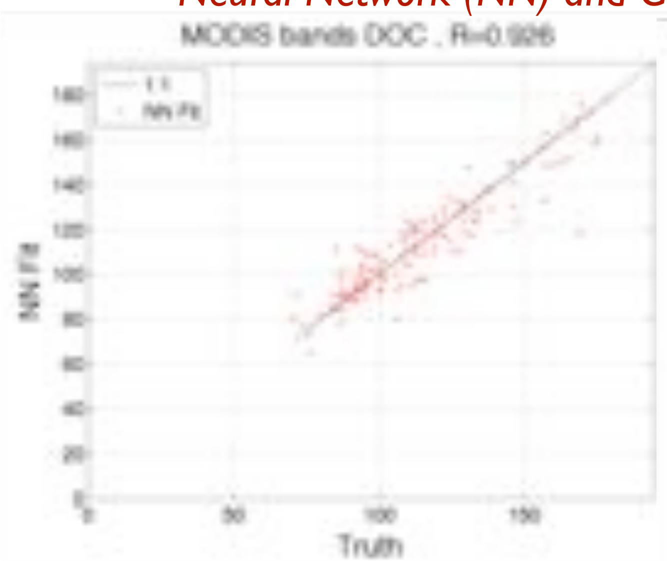
Research Objectives

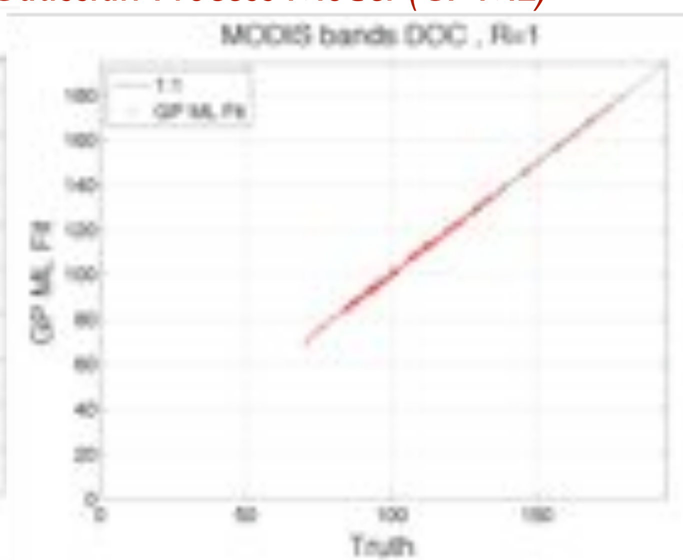
1. Develop and validate global ocean satellite algorithms for Colored Dissolved Organic Matter (CDOM) absorption coefficient (a_{CDOM}), CDOM spectral slope (S_{CDOM}) and Dissolved Organic Carbon (DOC) that will yield new MODIS ATBDs.
    a. Extend and validate existing coastal ocean empirical band-ratio algorithms for a_{CDOM} to the global ocean.
    b. Develop and validate multivariate machine learning algorithms including neural network and Gaussian Process models to retrieve DOC, a_{CDOM} and S_{CDOM}.
2. Examine the seasonal, inter-annual and decadal-scale variability of global ocean surface layer DOC, a_{CDOM} & S_{CDOM}.

Coastal ocean a_{CDOM} band-ratio algorithms



Coastal ocean machine learning DOC algorithms:
Neural Network (NN) and Gaussian Process Model (GP ML)



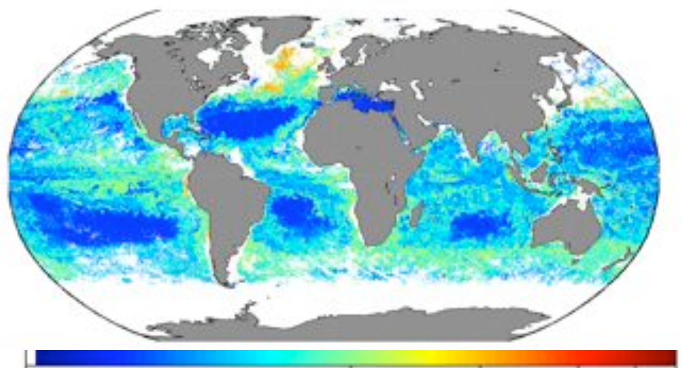


Antonio Mannino

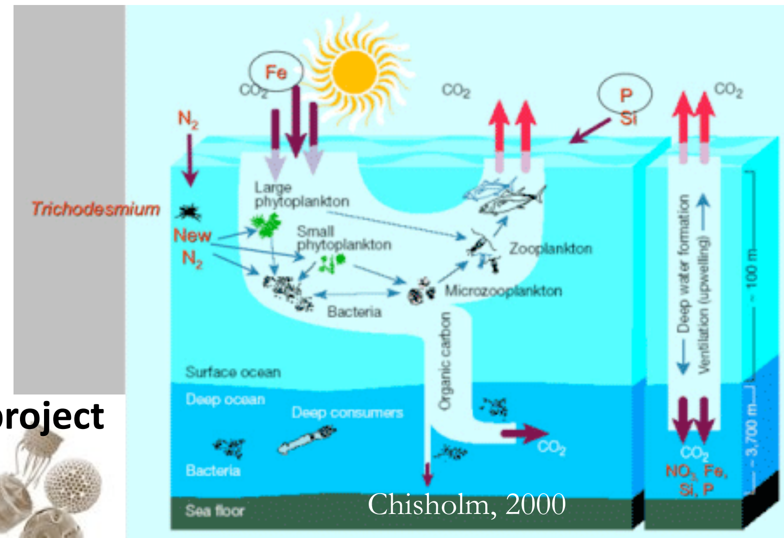
Phytoplankton cell size from ocean color imagery: connection to variability in the ocean carbon sink

Colleen Mouw
Galen McKinley
WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

Satellite Percent Microplankton (large cells)

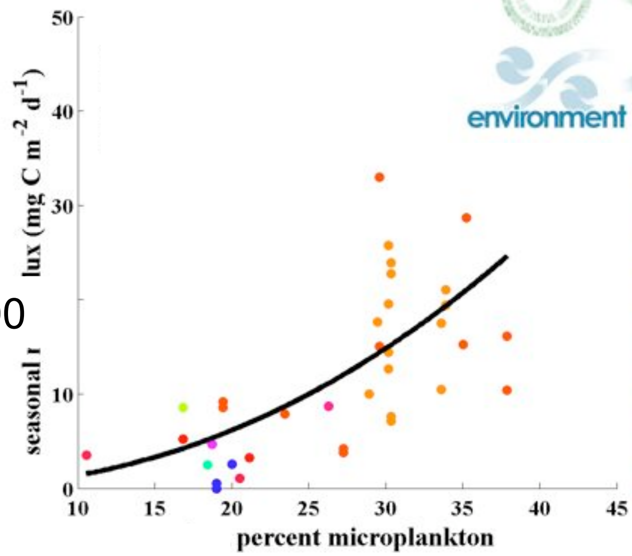


Mouw & Yoder, 2010



Chisholm, 2000

The darwin project



2000

- Use newly available satellite retrievals of phytoplankton community size structure to refine algorithms for sinking biogenic particles and their remineralization at depth.
  - Integrate into the Darwin model to improve export parameterization.
    - Use the improved Darwin model to understand connections to ocean carbon uptake and storage.

Phytoplankton Biomass and Diversity on the New England Shelf:

In Situ Time Series for Validation and Exploration of Remote Sensing Algorithms

PI: **Heidi M. Sosik**, Woods Hole Oceanographic Institution

Co-I: Hui Feng, University of New Hampshire

Goal: Use unique time series to evaluate algorithms that extend MODIS ocean color data beyond chlorophyll to functional group or size-class-dependent phytoplankton retrievals

Approach: End-to-end time series observations, with step by step algorithm evaluation and error analysis

single cells → phytoplankton community → bulk water optical properties → sea surface optical properties (air and water) → MODIS optical properties

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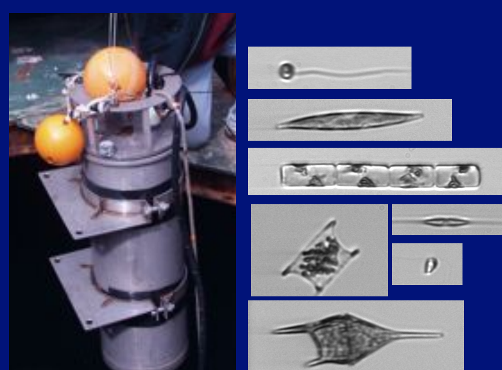
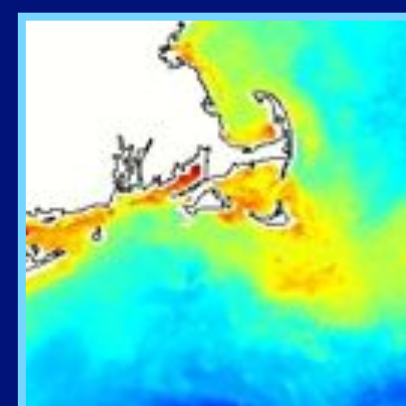
Martha's Vineyard Coastal Observatory

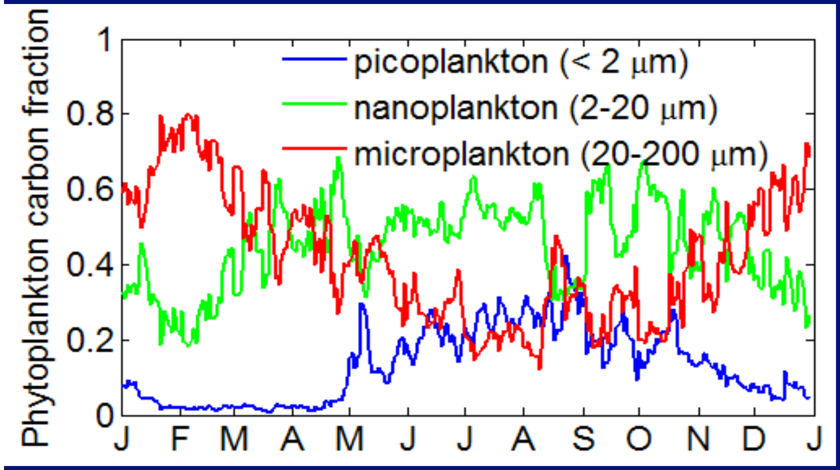


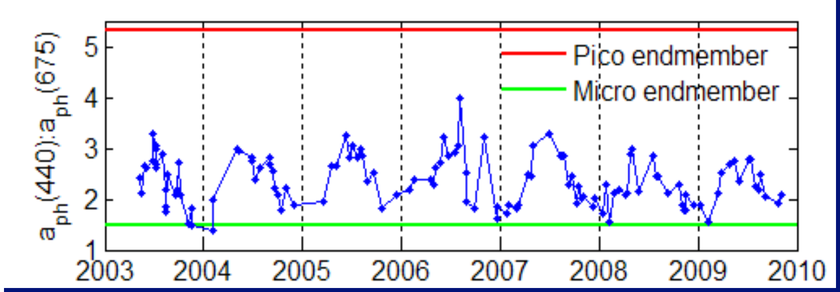
Submersible Imaging Flow Cytometry

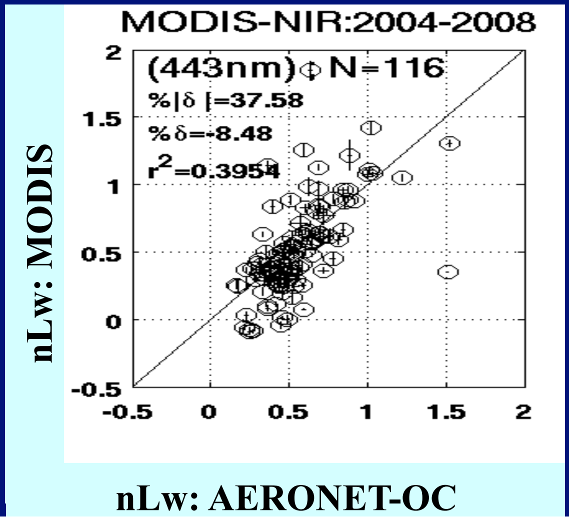
Tower mounted AERONET-OC



MODIS products







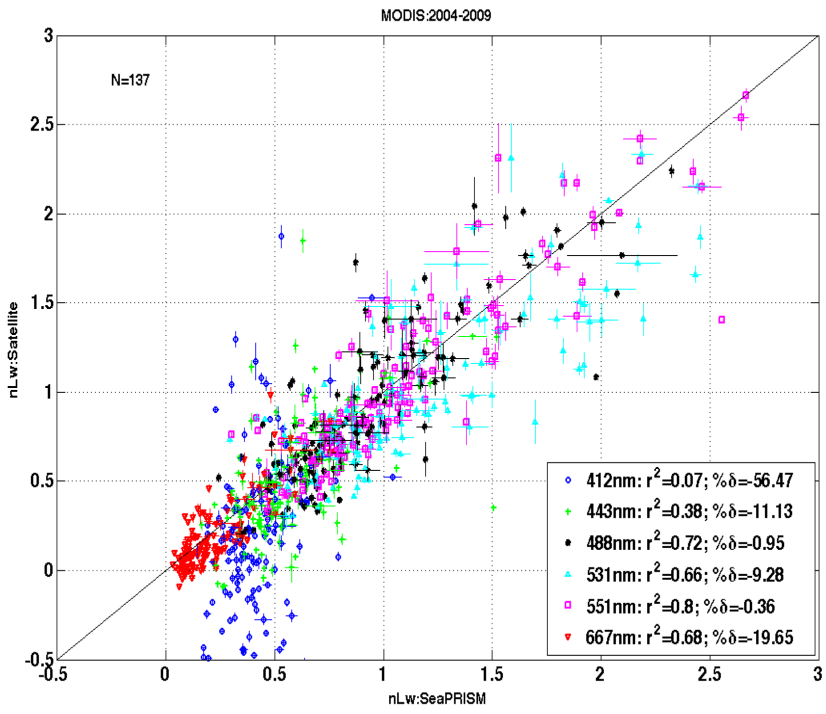
The study site presents important Opportunities and Challenges

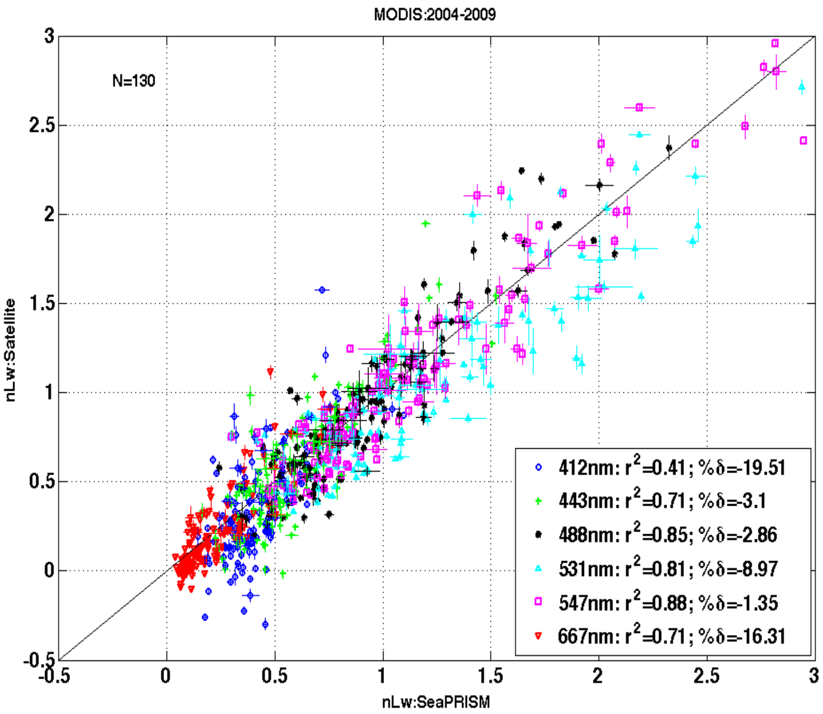
- Predictable seasonal switch in phytoplankton dominance
  - large diatoms in winter
  - small cells in summer
- Phytoplankton community changes impact bulk optical properties ((discrete samples)
  - Seasonality strong
  - Interannual variability also evident
- MODIS products influenced by atmospheric correction and other potential issues
  - Well-known for northeast US waters
  - Unique dataset to evaluate new approaches

Scatterplot of Matchups in nLw spectra

MODIS-Aqua Version 5

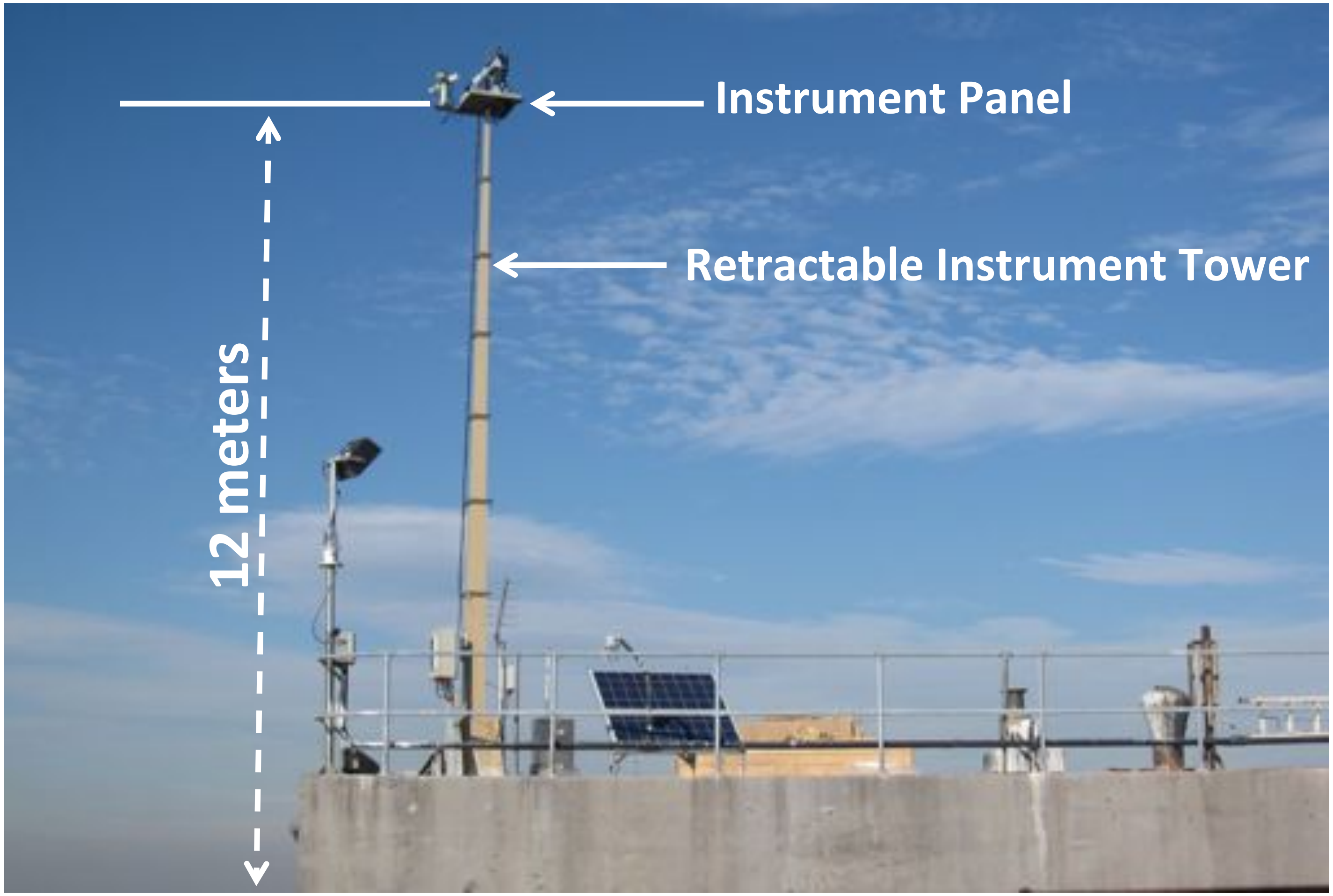
MODIS-Aqua Version 6
(Reprocessing 2009)



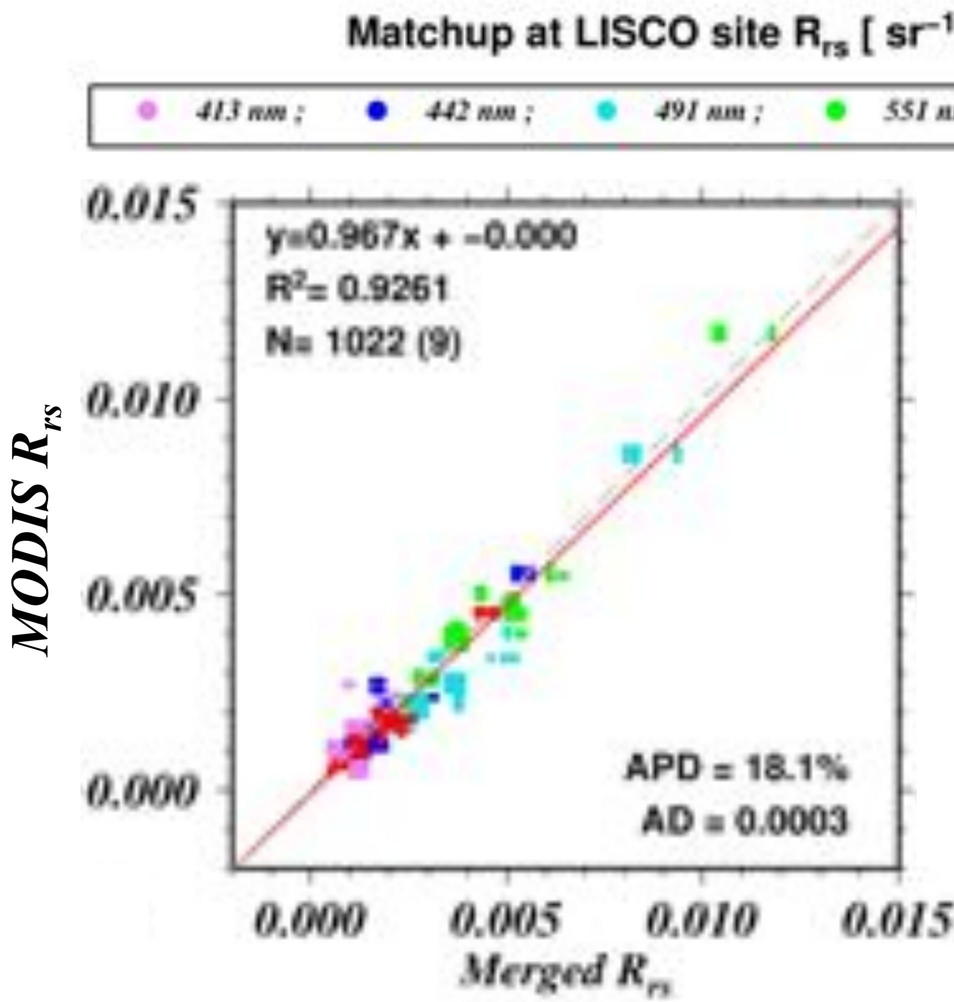


LISCO site Characteristics

Platform: Collocated multispectral **SeaPRISM** and hyperspectral **HyperSAS** instrumentations since October 2009



Satellite Validation



Use of merged in situ data:
1. Improve correlation and regression
2. Reduce dispersion

in comparison to the two datasets taken separately

HyperSAS APD=23.6%

SeaPRISM=23.7%

Merged APD =18.1%

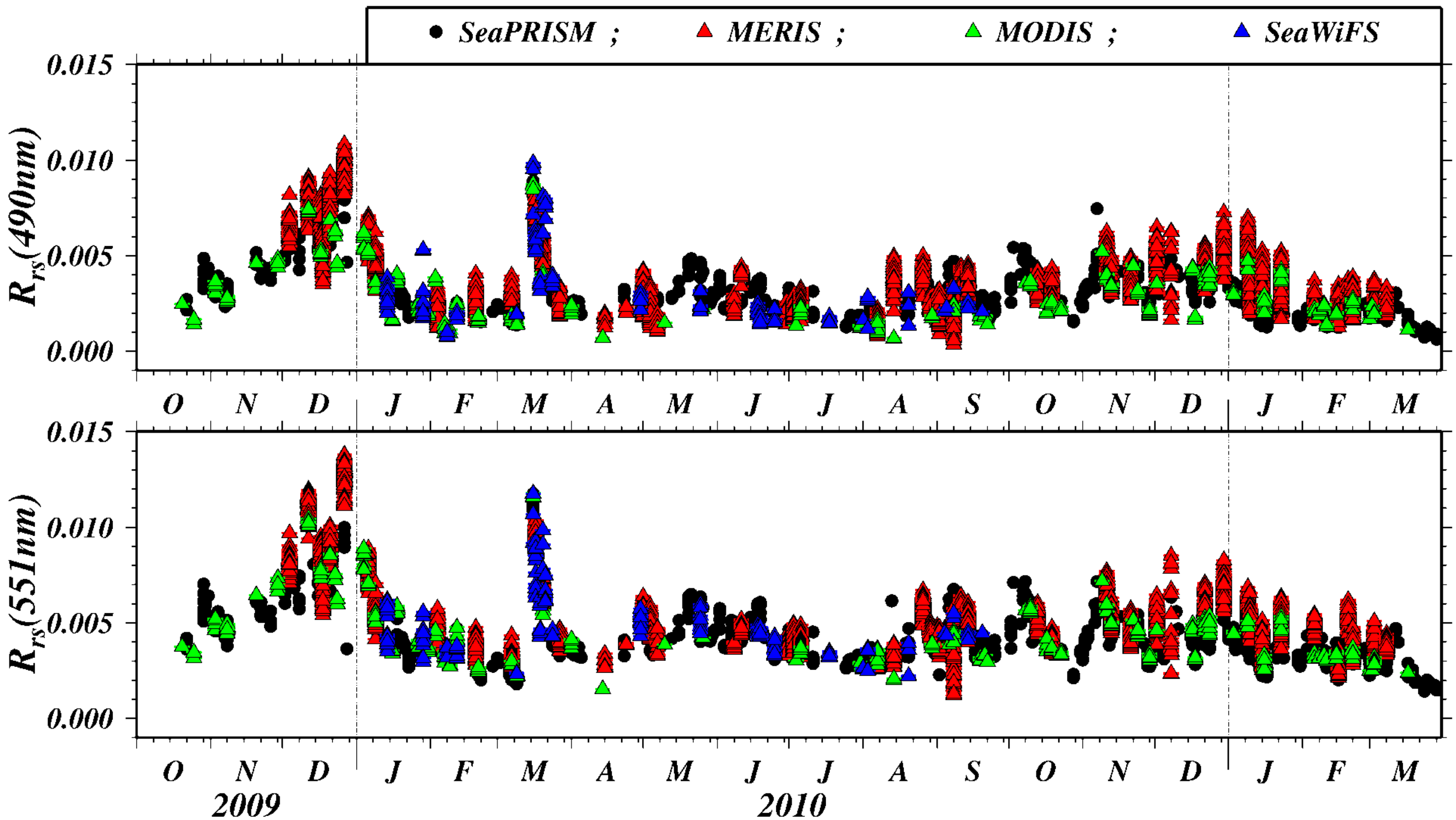
(APD is driven by very low values, but the Absolute Diff. stays very low in respect to the radiometric resolution of the satellite)

→Collocated instruments permit data quality assurance

→ Very high-quality data for calibration purposes

Satellite Validation

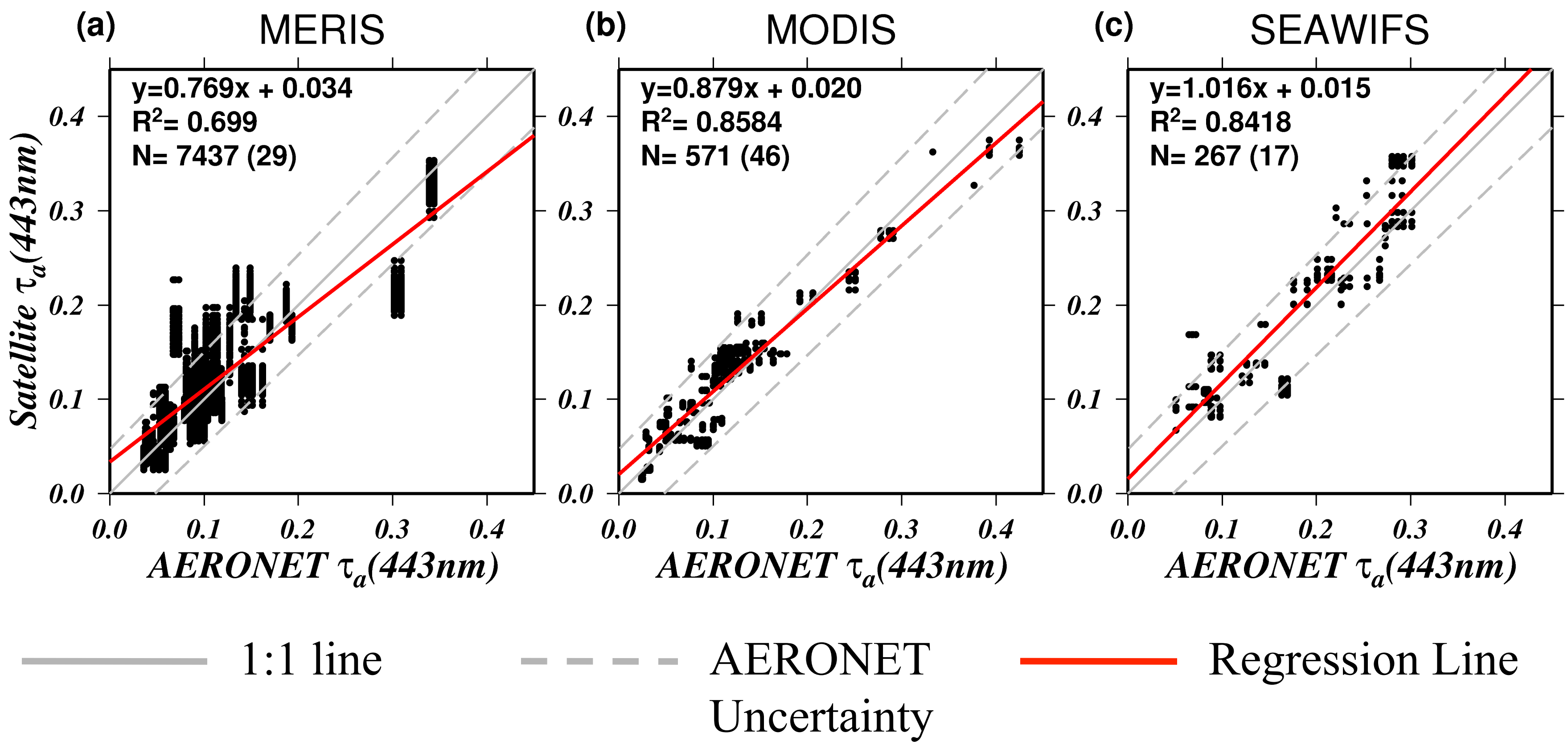
Time Series of Water Remote Sensing Reflectance (R_{rs}) [sr^{-1}]



→ Consistency in seasonal variations observed from the platform and from space

Satellite Validation

Aerosol Optical Thickness Validation



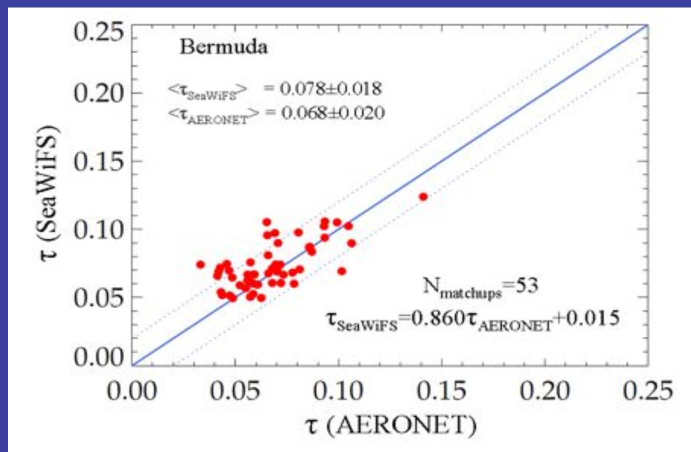
Strong Correlation and most of the matchup points are within the AERONET uncertainty for all satellite (best performance for MODIS-AQUA)

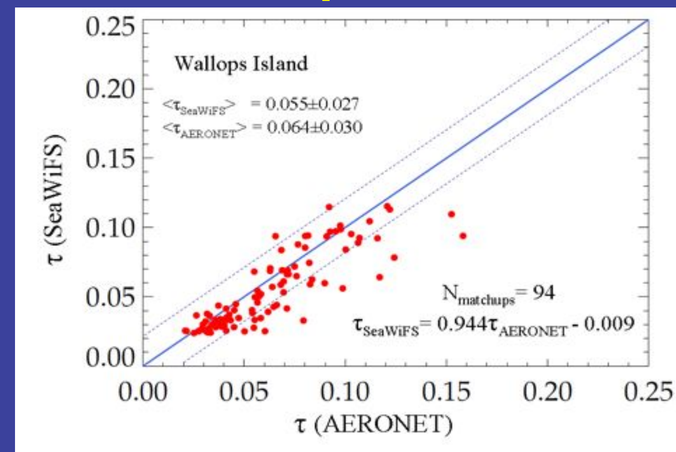
→ Representativeness of LISCO site - suitable for aerosol retrieval

Comparison of τ (SeaWiFS vs. AERONET)

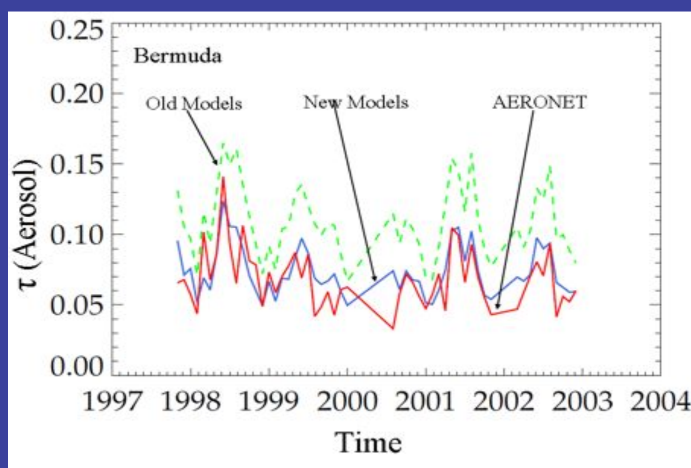
Bermuda | **Wallops Island**

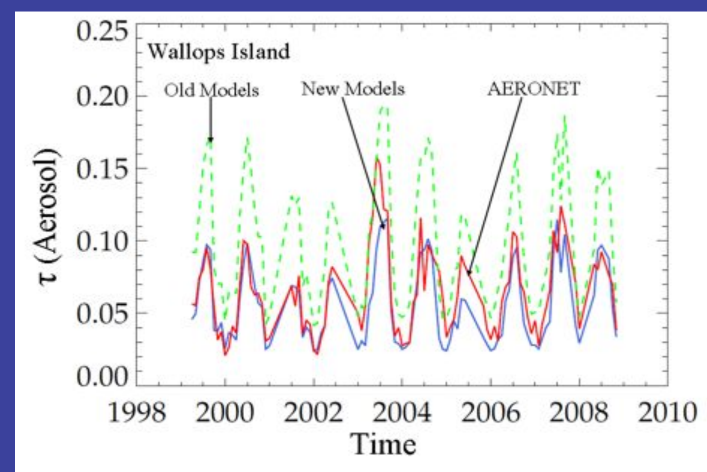
Scatter Plot





Time Series

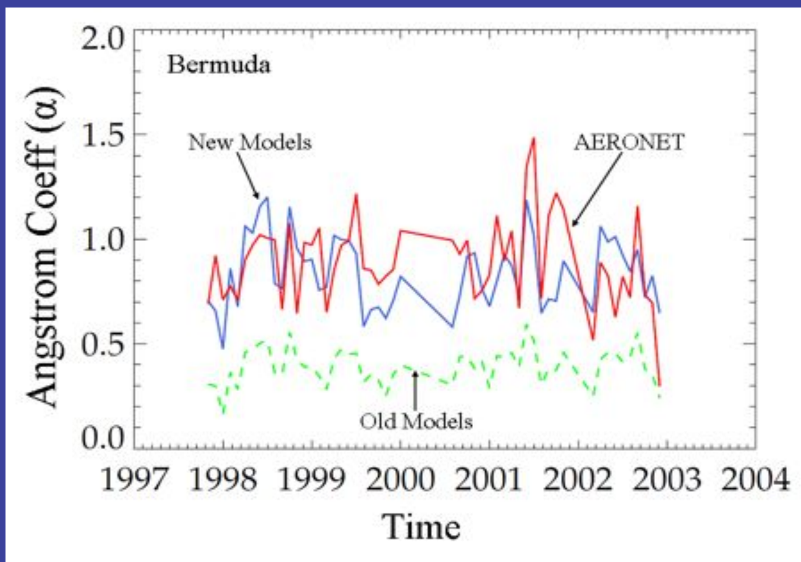




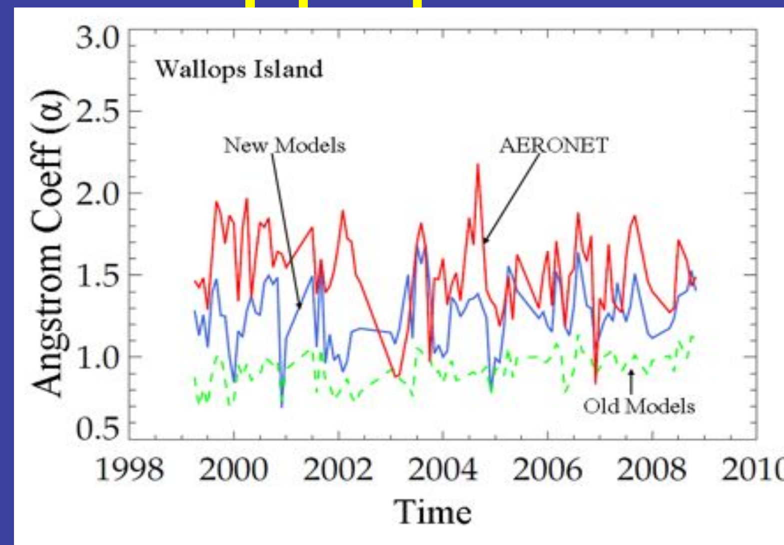
- 81% of the retrieval at Bermuda and 78% of the retrievals at Wallops Island fall within an uncertainty of ±0.02 in τ

Comparison of α (SeaWiFS vs. AERONET)

Bermuda



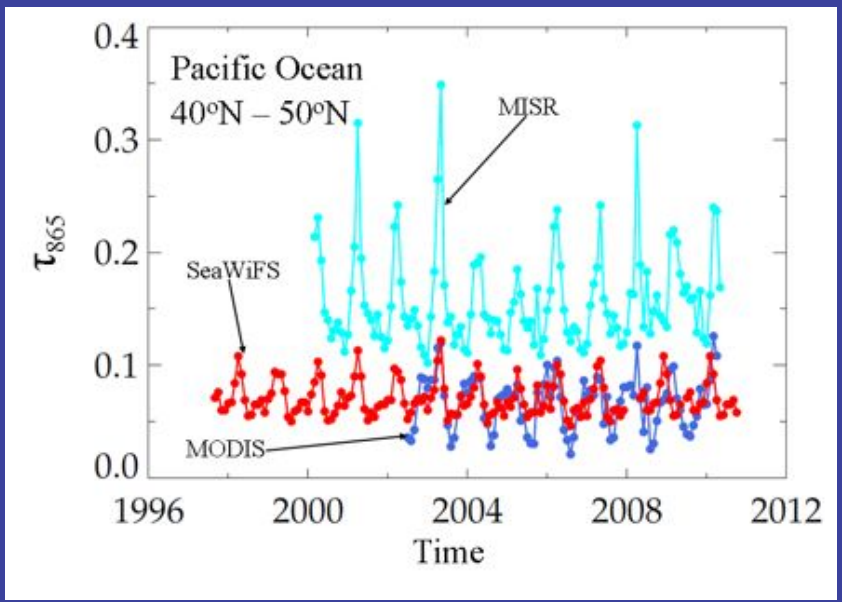
Wallops

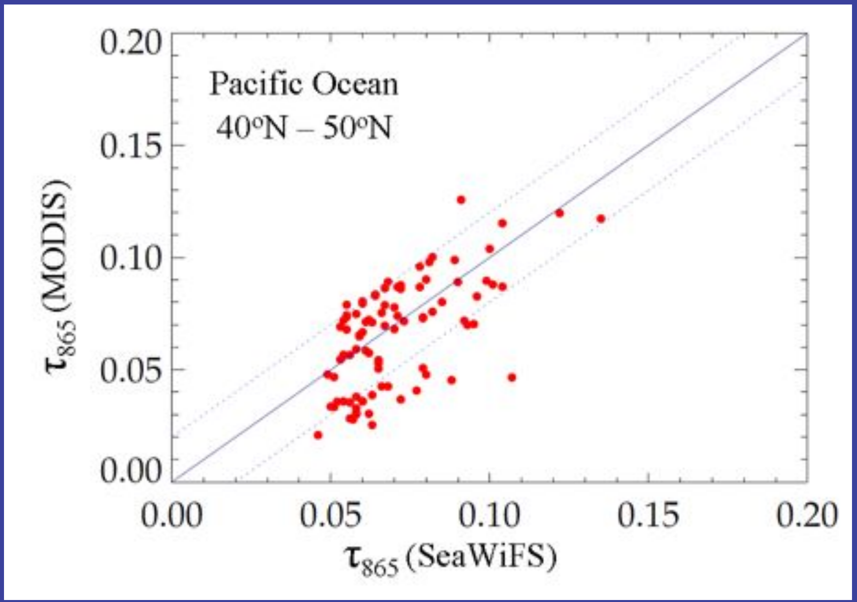


- For new models, the Angstrom coeff. (α) shows better agreement over Bermuda than over Wallops Island
- For old models, the α values are almost one-half of AERONET Values

Comparison of τ_{865}
SeaWiFS vs. MODIS(atm) vs. MISR

Pacific Ocean (40°N – 50°N)





- τ_{865} from the SeaWiFS and MODIS sensors are very close (~ ±0.02)

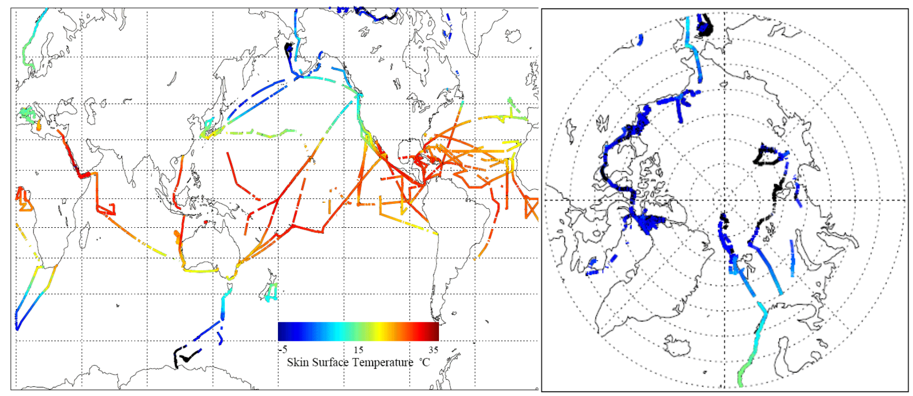
- The minimum values of τ_{865} from the MISR sensor are higher than SeaWiFS & MODIS values by ~ 0.05

Minnett – Sea Surface Temperature algorithm refinement and validation though ship-based infrared spectroradiometry

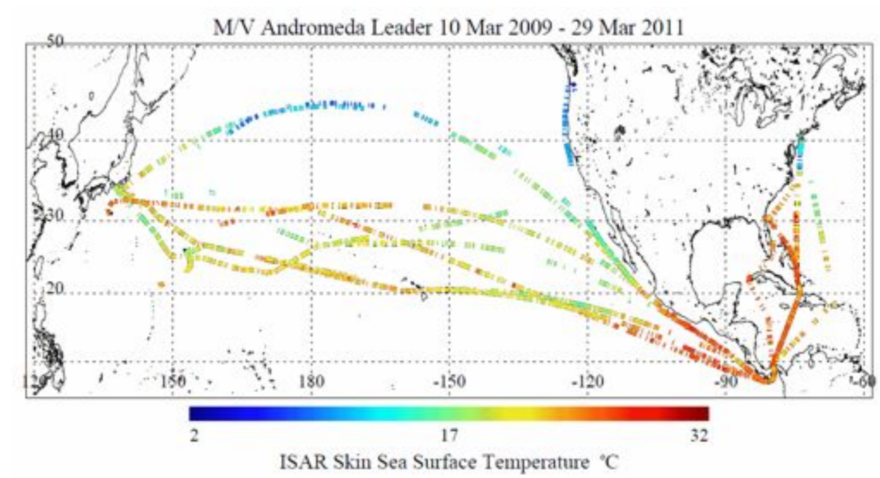
Objective: **Ensure that MODIS SSTs are part of the Climate Data Record**

Approach:

- Use shipboard FTIR spectroradiometers (M-AERI), and filter radiometers (ISAR) for independent validation of MODIS SST retrievals.
- Ensure traceability of validation data to NIST reference standards.
- Continue studies into improved atmospheric correction algorithms.
- Continue studies of thermal skin layer of the ocean.
- Continue studies of diurnal heating and cooling in the upper ocean.
- Related activities:
  - GHRSST Science Team
  - NPP (VIIRS) Science Team
  - SST Science Team
  - AATSR Science Advisory Group
  - HyspIRI Science Study Group
  - EUMETSAT Mission Expert Team



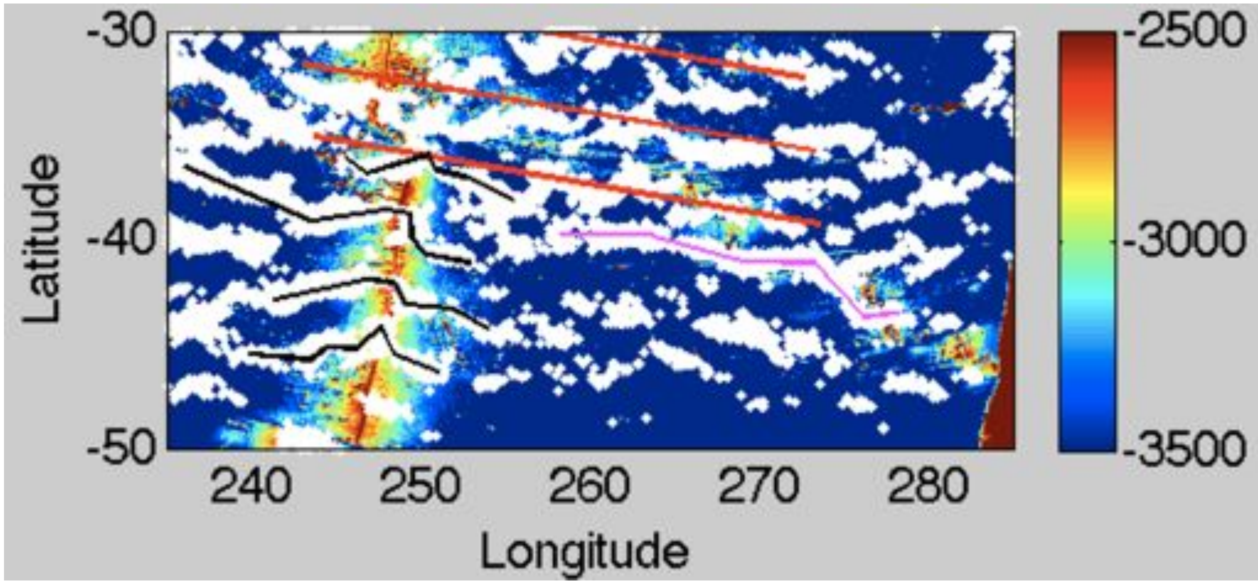
M-AERI cruises



Topographic Control of Ocean Dynamics in the Subtropics

(Peter Cornillon and Lew Rothstein)

Objective: To better understand the topographic control of phenomena associated with the quasi-zonal structures observed in fields of mean dynamic ocean topography (Maximenko et al. (2008) and of sea surface temperature front probability (Obenour et al. (2010).

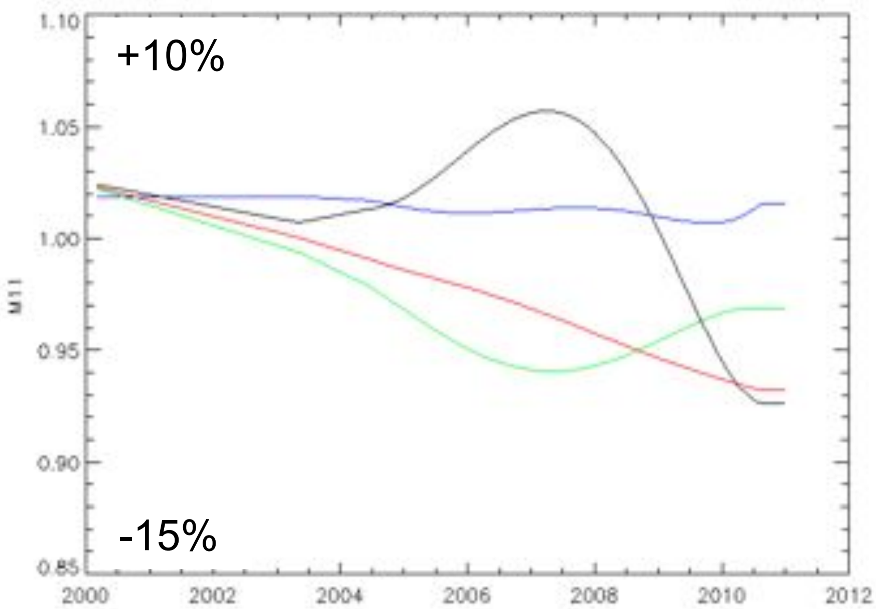


Colored background is bathymetry in meters. White dots are locations where SST front probability exceeds 18% in 2004-2005. Purple and black lines are digitized bands of front probability to aid the eye and red lines are the approximate location of structures seen in fields of filtered mean dynamic topography.

More Calibration Stuff

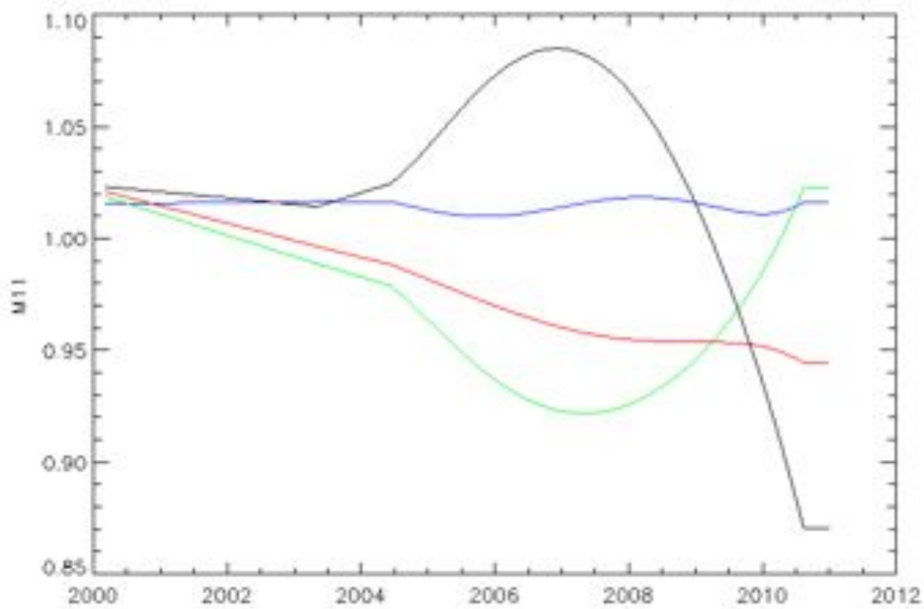
MODIS/Terra gain corrections as a function of time at different view angles, based on SeaWIFS nLw

412 nm, Mirror 1



2000 2012

412 nm, Mirror 2



Color coding: Frame/pixel 22 (beginning of scan, lunar), 675 (nadir), 989 (solar diffuser), 1250 (end of scan)

Gerhard Meister

Deep-Blue Aerosol Collaboration

Jeong, M-J., N.C. Hsu, E.J. Kwiatkowska, B.A. Franz, G. Meister, C.E. Salustro (2011). Impacts of Cross-platform Vicarious Calibration on the Deep Blue Aerosol Retrievals for Moderate Resolution Imaging Spectroradiometer aboard Terra, T. Geo. Rem. Sens., accepted.


Thank You