Annul Program Review Meeting
Ocean Color Team
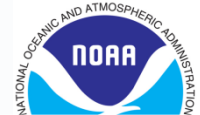
Menghua Wang, Bob Arnone
and *VIIRS Ocean Color Team*

September 21, 2012

Team Members' Roles & Responsibilities
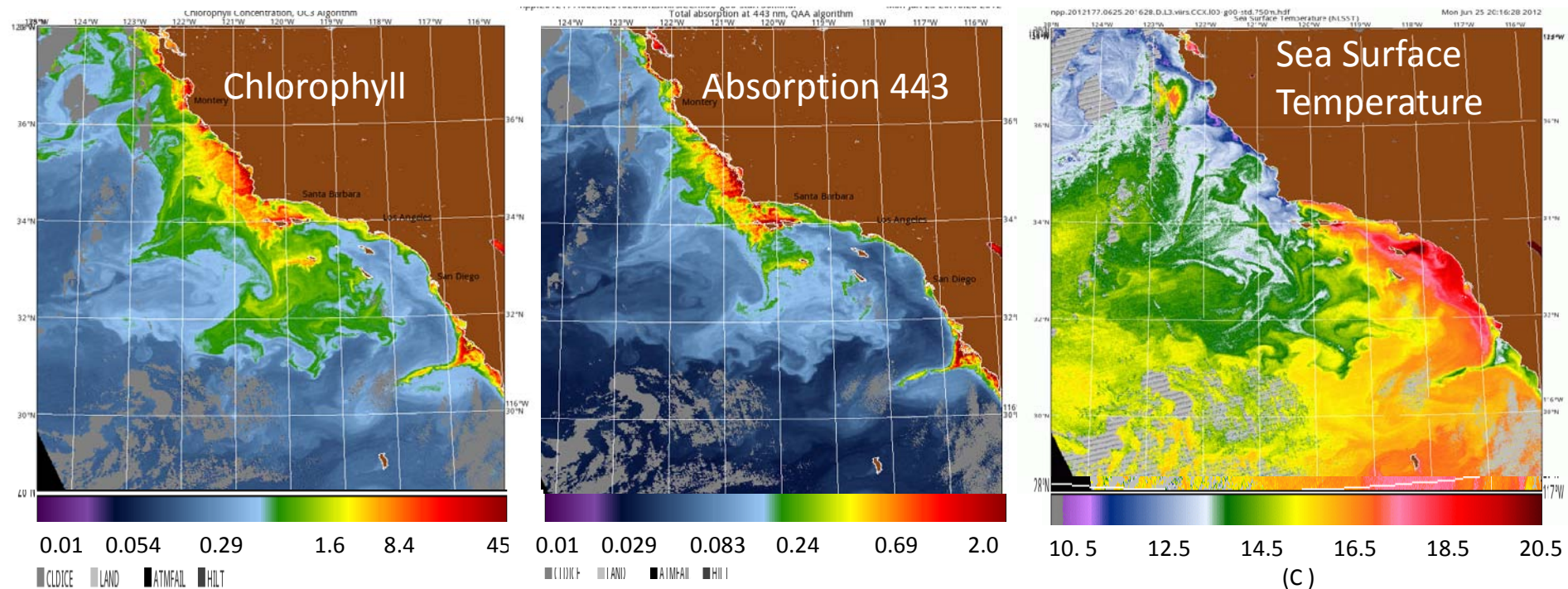
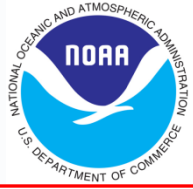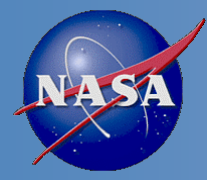| EDR	Name	Organization	Funding Agency	Task
Lead	**Menghua Wang (EDR Lead), L. Jiang, X. Liu, W. Shi, S. Son, L. Tan, M. Ondrusek**	NOAA/NESDIS/ STAR	JPSS	Leads – Ocean Color EDR Team OC products, algorithms, SDR, EDR, Cal/Val, vicarious cal., refinements, data processing DR- Software updates
Ocean Color	**Robert Arnone** **Sherwin Ladner , Adam Lawson,** **Paul Martinolich, Jen Bowers,** **Giulietta Fargion** **Bill Gibson**	U. Southern MS NRL QinetiQ Corp. SDSU LSU	JPSS	Leads – coordination Look Up Tables – SDR-EDR impacts, Satellite matchup tool (SAVANT) – Golden Regions DR – Evaluation and updates, vicarious calibration adjustment, cruise participation and matchup. WAVE_CIS (AERONET site)
	Carol Johnson	NIST	JPSS	AERONET Uncertainty
	Curt Davis, Nicholas Tufillaro	OSU	JPSS	Cruise data matchup West Coast
	Burt Jones	OSC	JPSS	Eureka (AERONET Site)
	Sam Ahmed, Alex Gilerson	CUNY	JPSS	LISCO (AERONET site) Cruise data and matchup
	Charles Trees, Giuliana Pennucci, Alberto Alvarez	NURC	JPSS	Uncertainty index
	ZhongPing Lee , Nima Pahlevan	U MB	JPSS	VIIRS IOPs evaluations, matchup ocean gyres stability Inland lakes matchup
	Patty Pratt, S. Jackson	NGAS	JPSS	Matchup and DR and IDPS updates

Working with: SDR team, MOBY team (PI, Ken Voss), DPA/DPE (e.g., Neal Baker), Raytheon (e.g., Marine Hollingshead), NASA OC Working Group (K. Turpie, C. McClain, B. Franz , J . Werdell), NOAA OC Working Group, NOAA OCPOP
Collaborators: B. Holben (NASA-GSFC); G. Zibordi (JRC-Italy); V. Brando (Australia)

Overview of Data Products & Status

VIIRS Ocean Color Products

1. Normalized Water-leaving Radiance (nLw(λ)) (M1 to M5) - basis for all products
2. Chlorophyll-a (OC3) algorithm, using nLw at 443, 486, 551 nm (M2, M3, M4)
3. Inherent Optical Property (IOP), absorption and backscattering coefficients (at M1-M5)
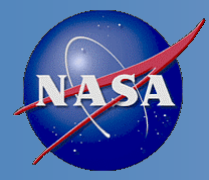   → May need to change to QAA algorithm

Southern California

Chlorophyll

Absorption 443

Sea Surface Temperature

| 0.01 | 0.054 | 0.29 | 1.6 | 8.4 | 45 |

| 0.01 | 0.029 | 0.083 | 0.24 | 0.69 | 2.0 |

| 10.5 | 12.5 | 14.5 | 16.5 | 18.5 | 20.5 |
(C)

Examples of VIIRS Ocean Color Global Images (Level-3 Products)

Produced routinely in STAR EDR Team for **Daily**, **8-Day**, and **Monthly**
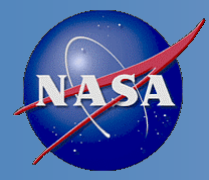
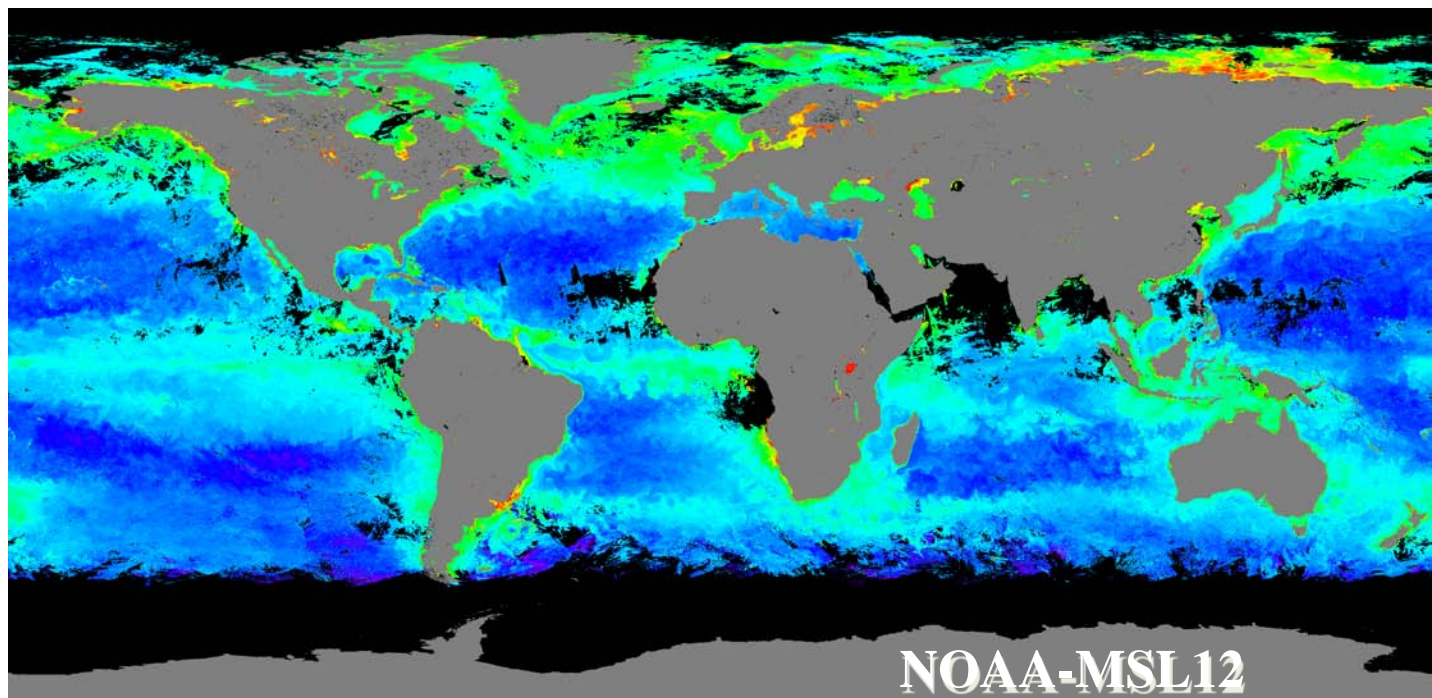**VIIRS Global Daily Chl-a Image**

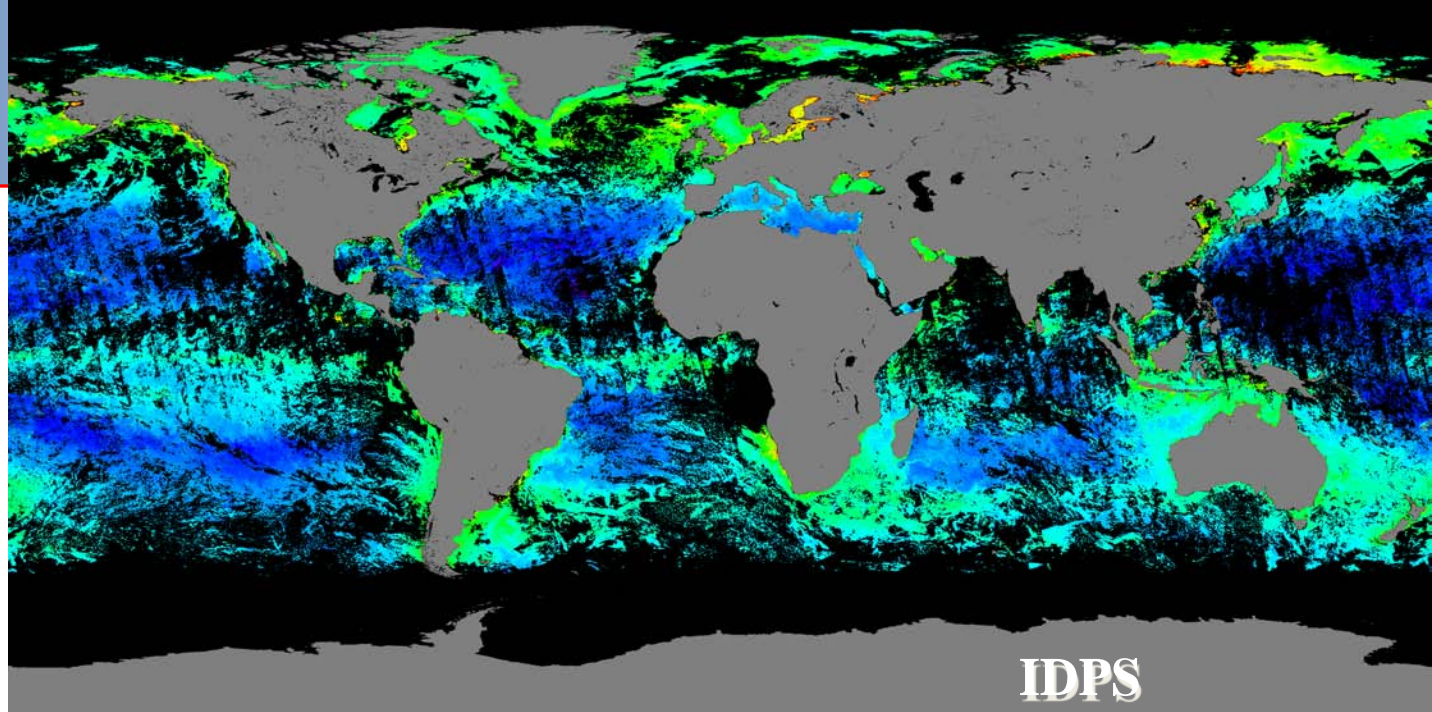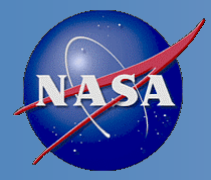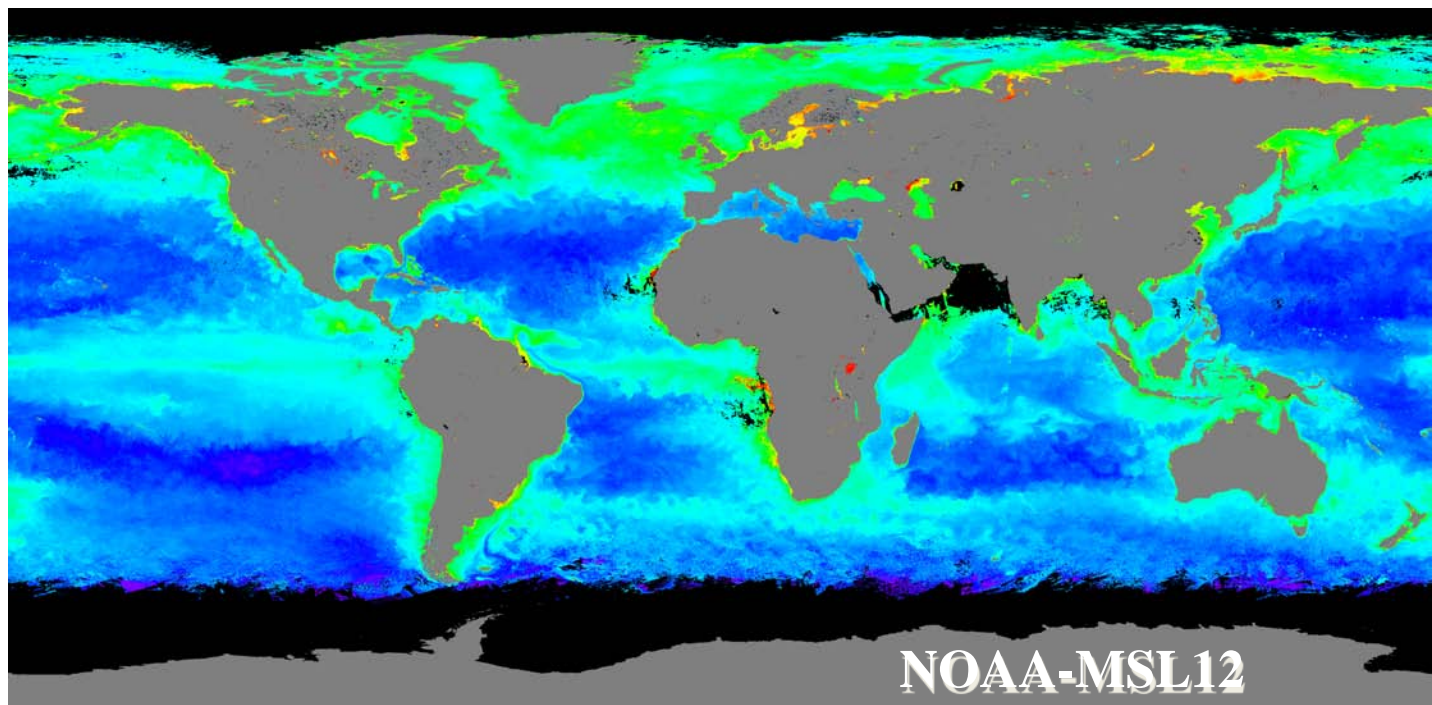(Aug. 12, 2012)

Log scale: 0.01 to 64 mg/m3

IDPS
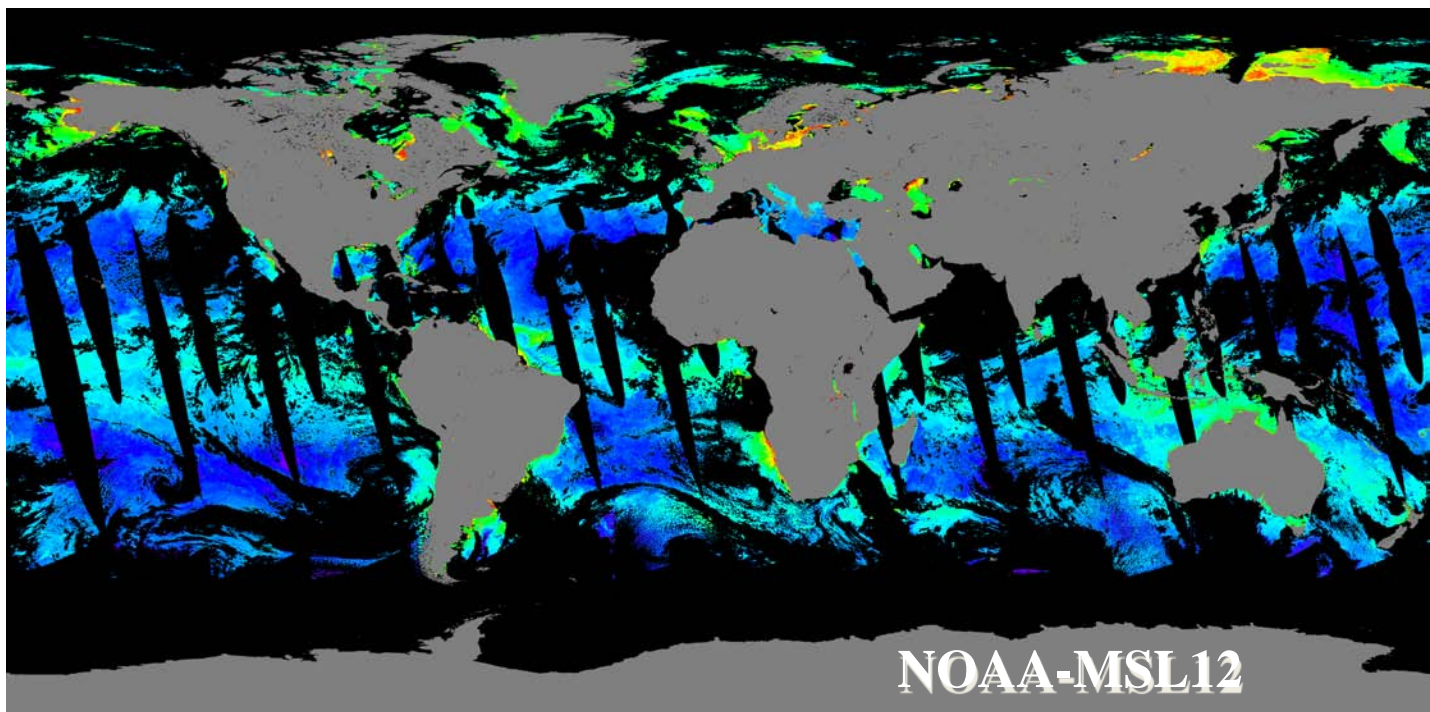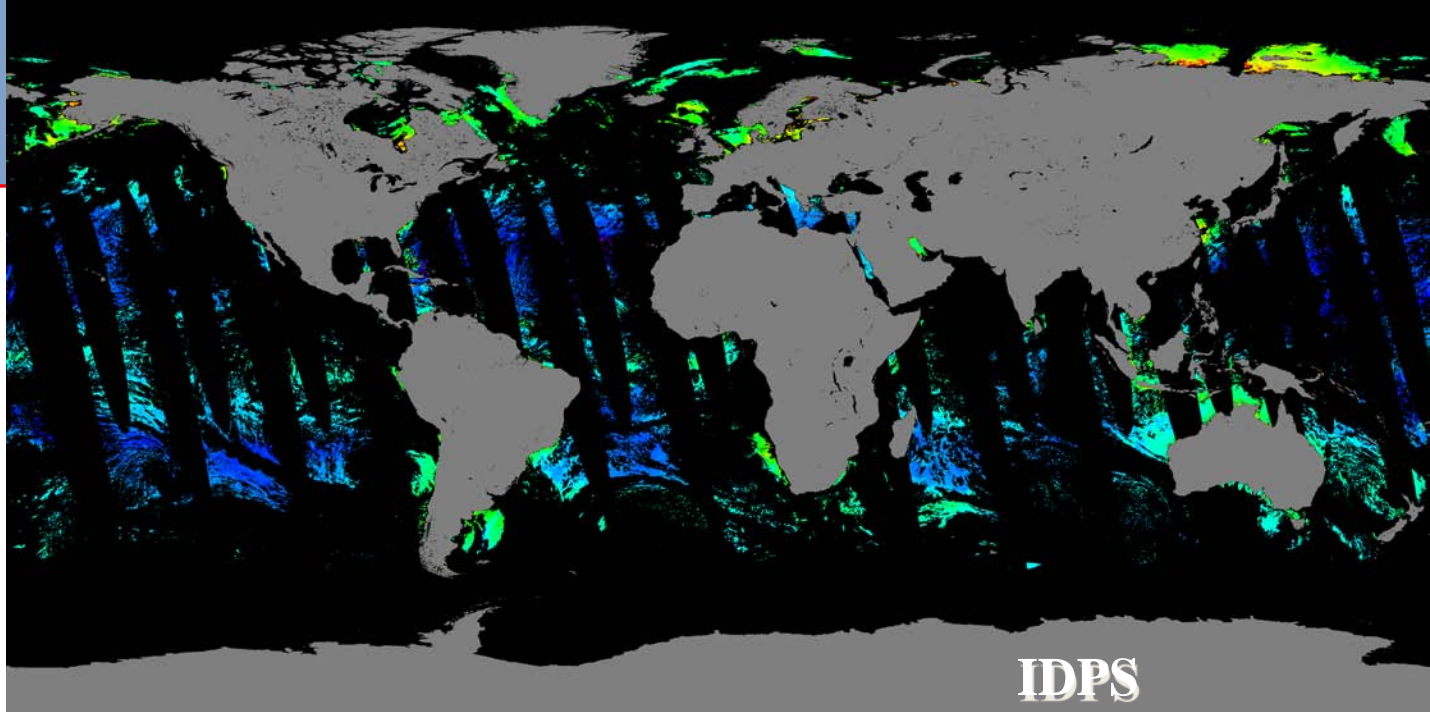
NOAA-MSL12

VIIRS Global 8-Day Chl-a Image

(Aug. 12-19, 2012)
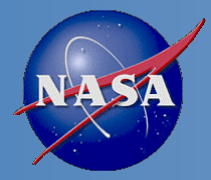
Log scale: 0.01 to 64 mg/m3

IDPS

NOAA-MSL12

VIIRS Global Monthly Chl-a Image

(Aug., 2012)
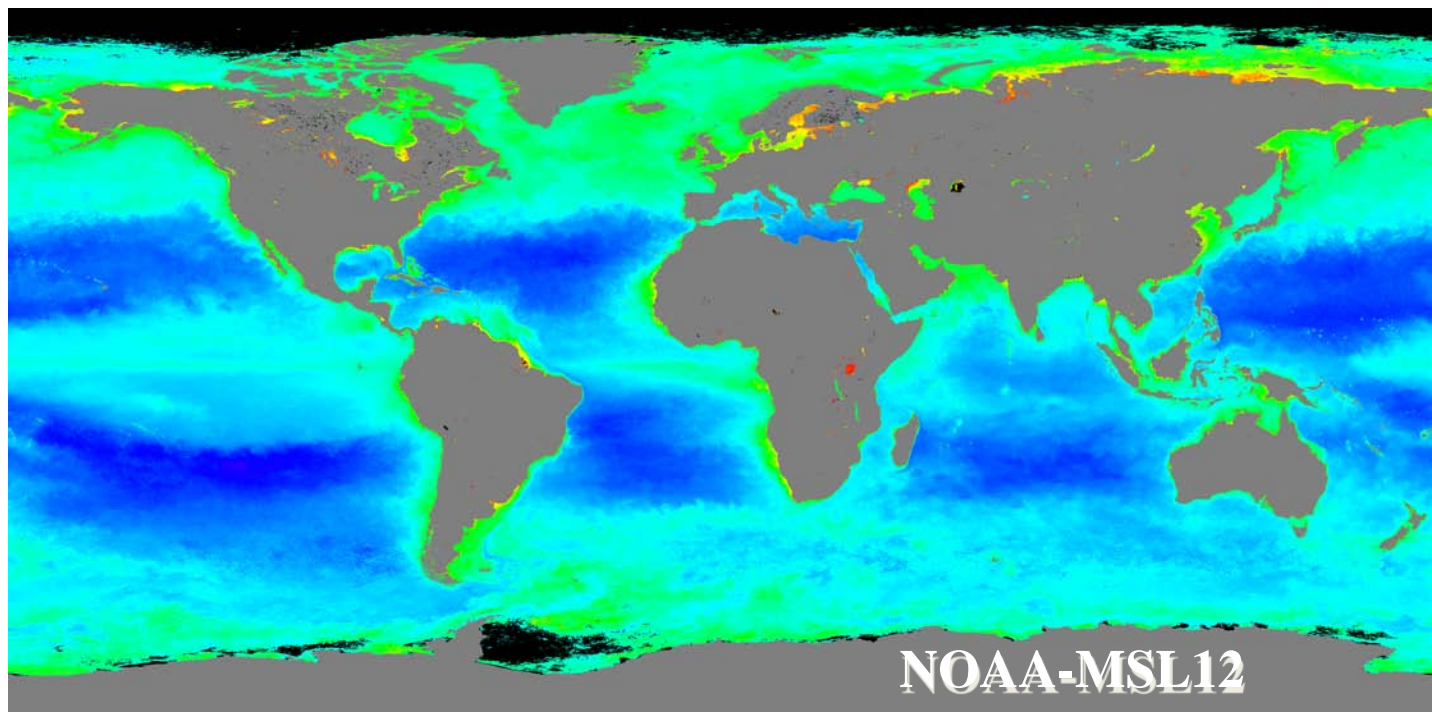
Log scale:
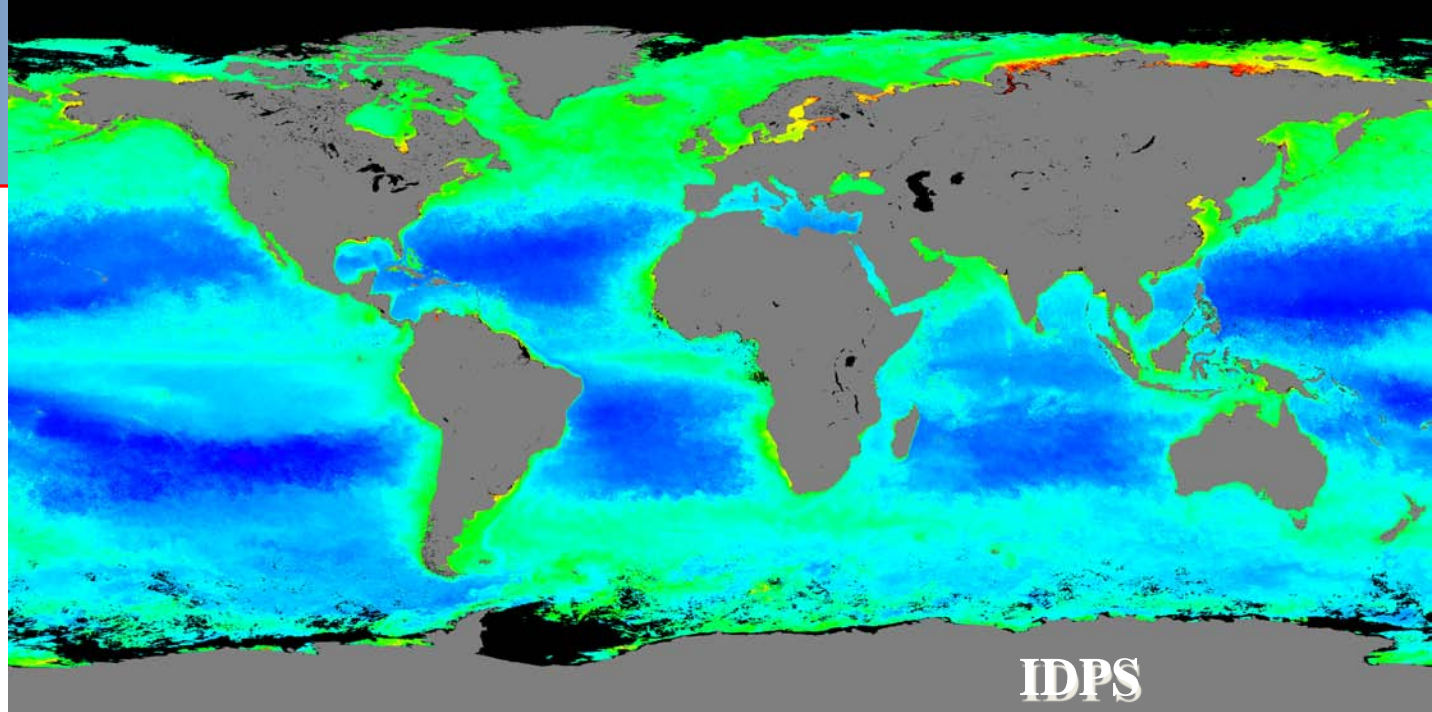0.01 to 64 mg/m3

IDPS
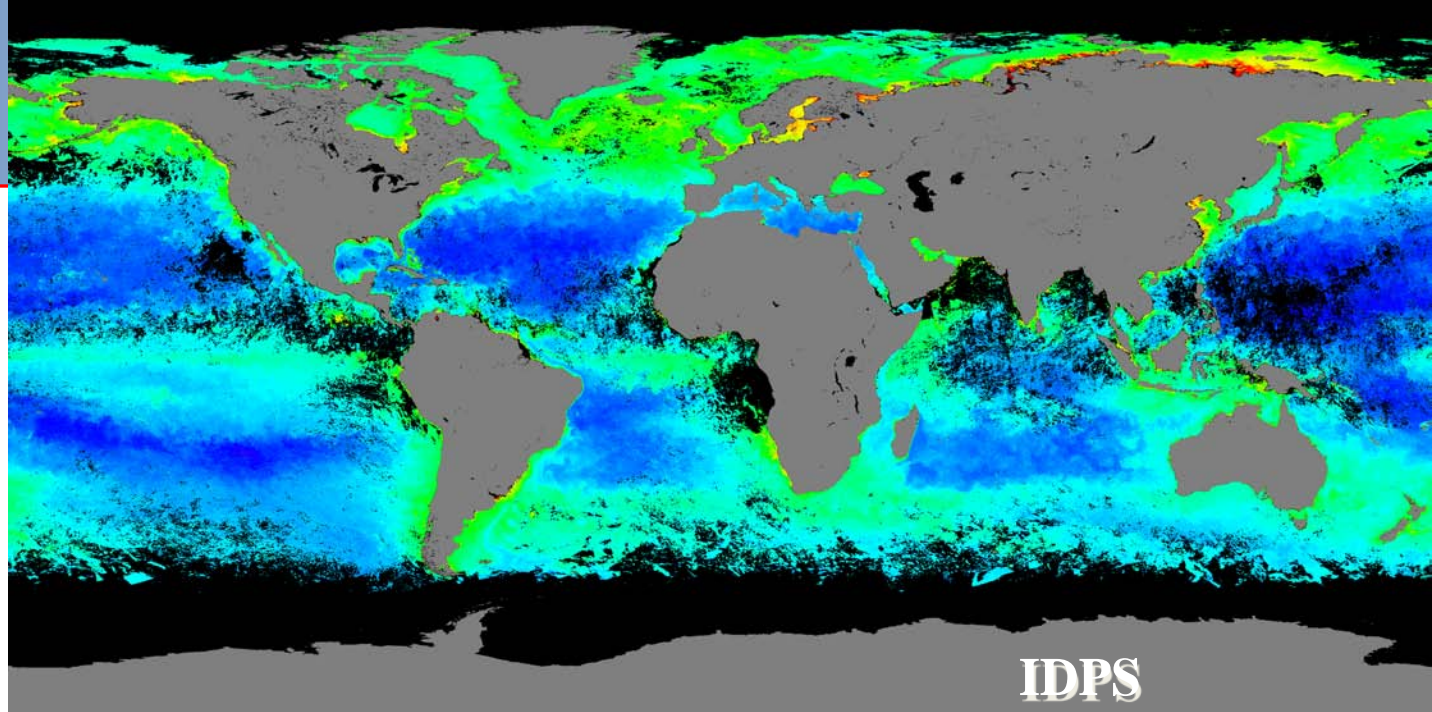
NOAA-MSL12

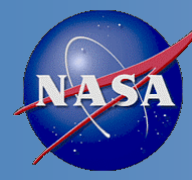**VIIRS Global Climatology Chl-a Image**

(Feb.6-Sep.14, 2012)
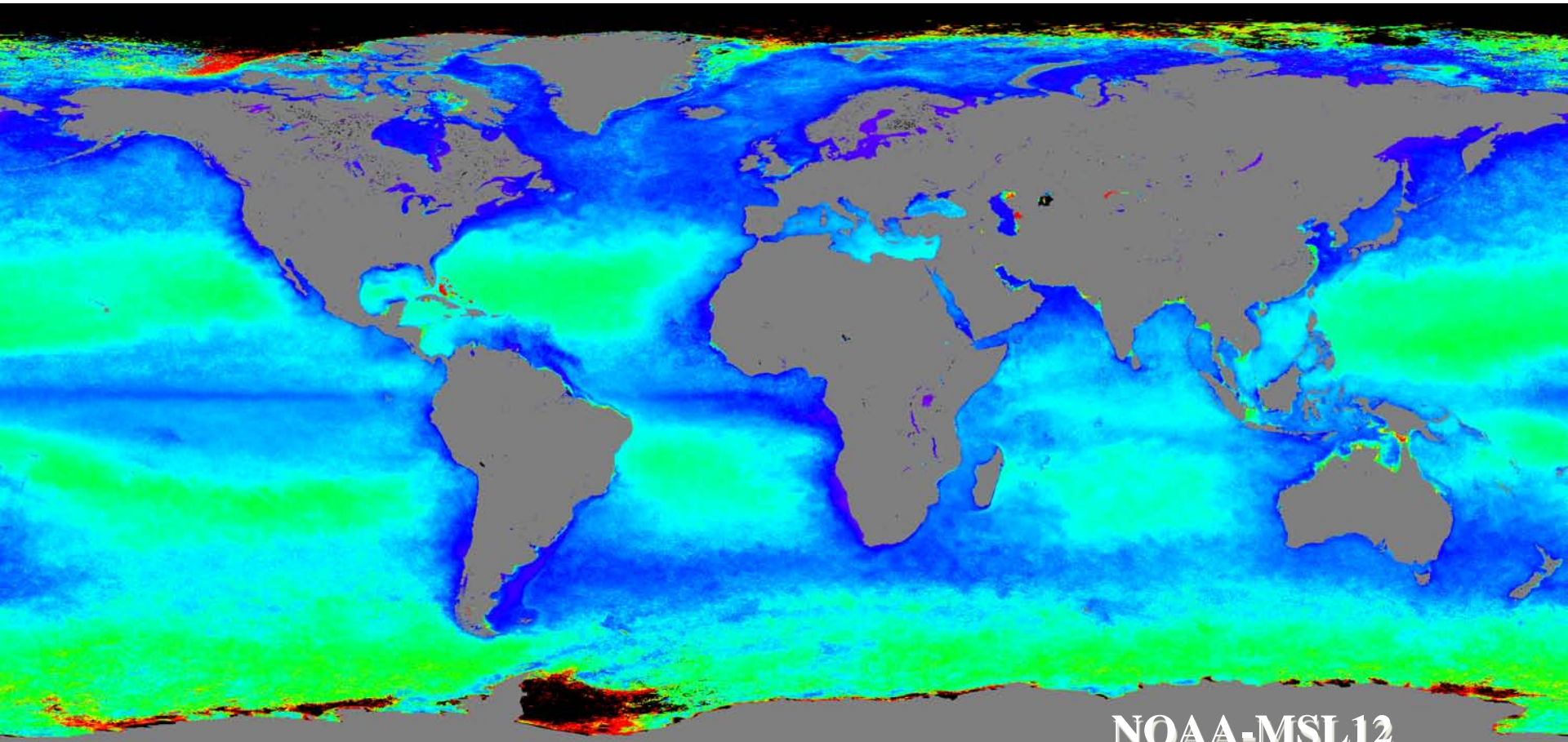
Log scale:
0.01 to 64 mg/m3

IDPS

NOAA-MSL12

VIIRS Global **Climatology** *nLw*(443) Image
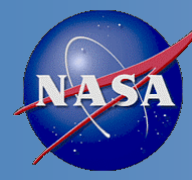
(Feb. 6-Sep. 14, 2012)

NOAA-MSL12

Scale: 0.0 to 5 mW cm-2 μm-1 sr-1

VIIRS Global Climatology *nLw*(486) Image
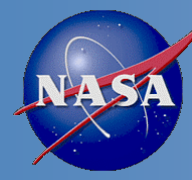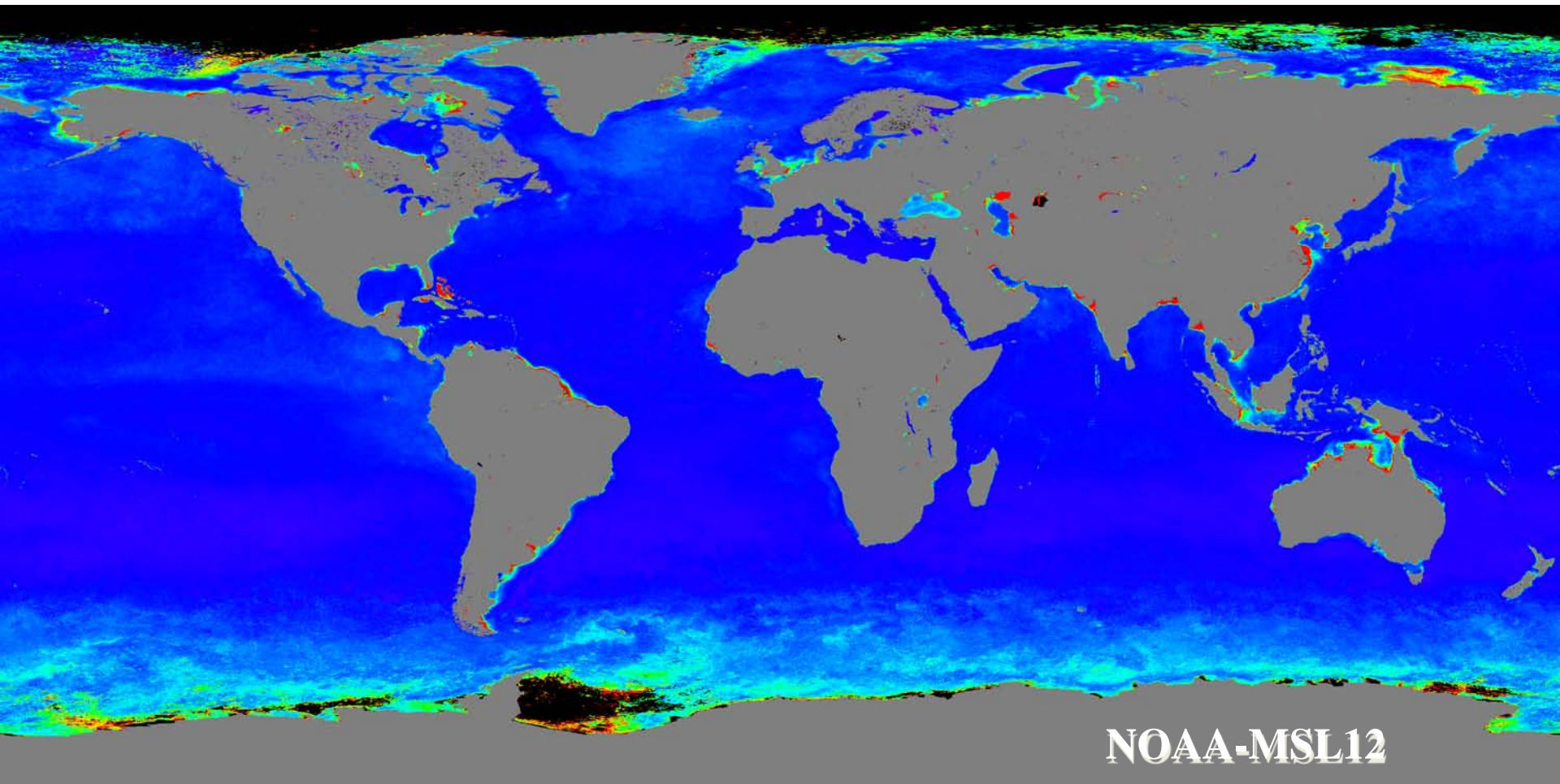
(Feb. 6-Sep. 14, 2012)
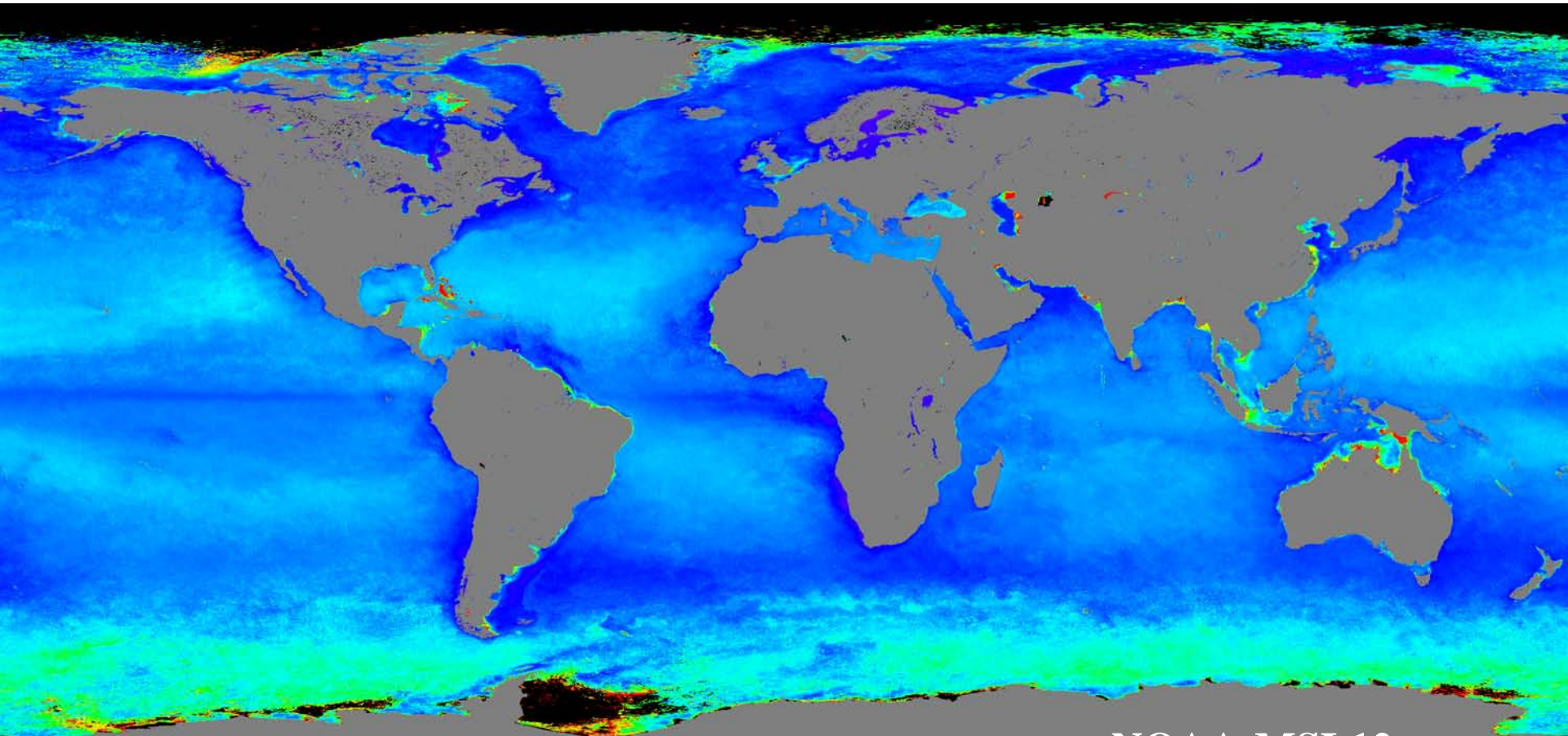
NOAA-MSL12

Scale: 0.0 to 5 mW cm-2 μm-1 sr-1

VIIRS Global **Climatology** *nLw*(551) Image

(Feb. 6-Sep. 14, 2012)

NOAA-MSL12

Scale: 0.0 to 3 mW cm-2 μm-1 sr-1

Some Quantitative Evaluations with MOBY Measurements

Routine data monitoring and evaluation in STAR and by various Team Members

VIIRS vs. MOBY In Situ

- VIIRS OC data compared with the **MOBY in situ data**, showing that SDR data since **2/6/2012** are good and reasonable, before that SDR date were **poor/not reliable**.

- Vicarious calibration is needed and will further improve ocean color products.

- Data **reprocessing** is required for SDR and EDR.

- **MOBY** data played a critical role for evaluation of VIIRS SDR and EDR data.

MOBY PI: Ken Voss
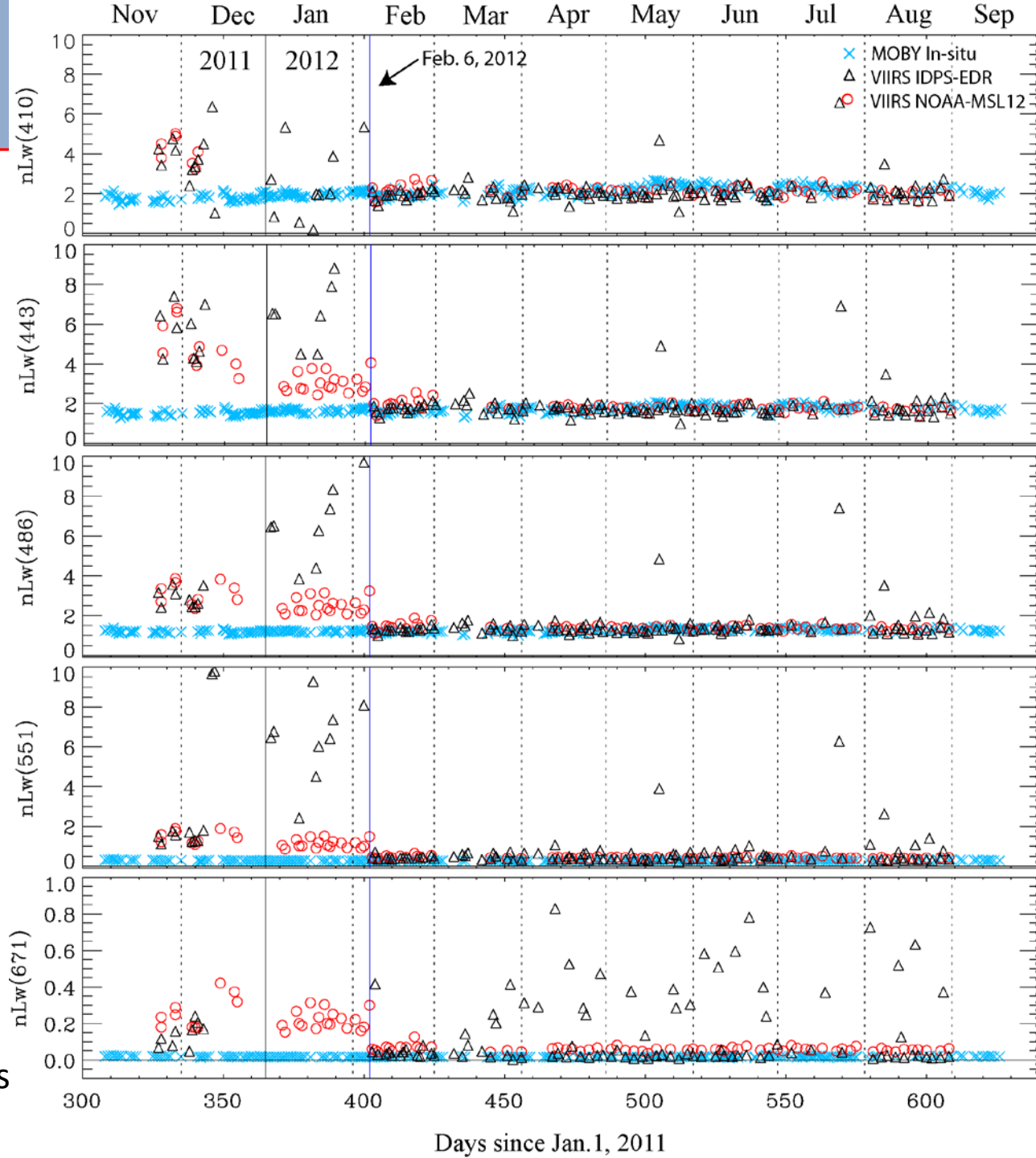
Comparison of VIIRS Ocean Color Products at MOBY Site
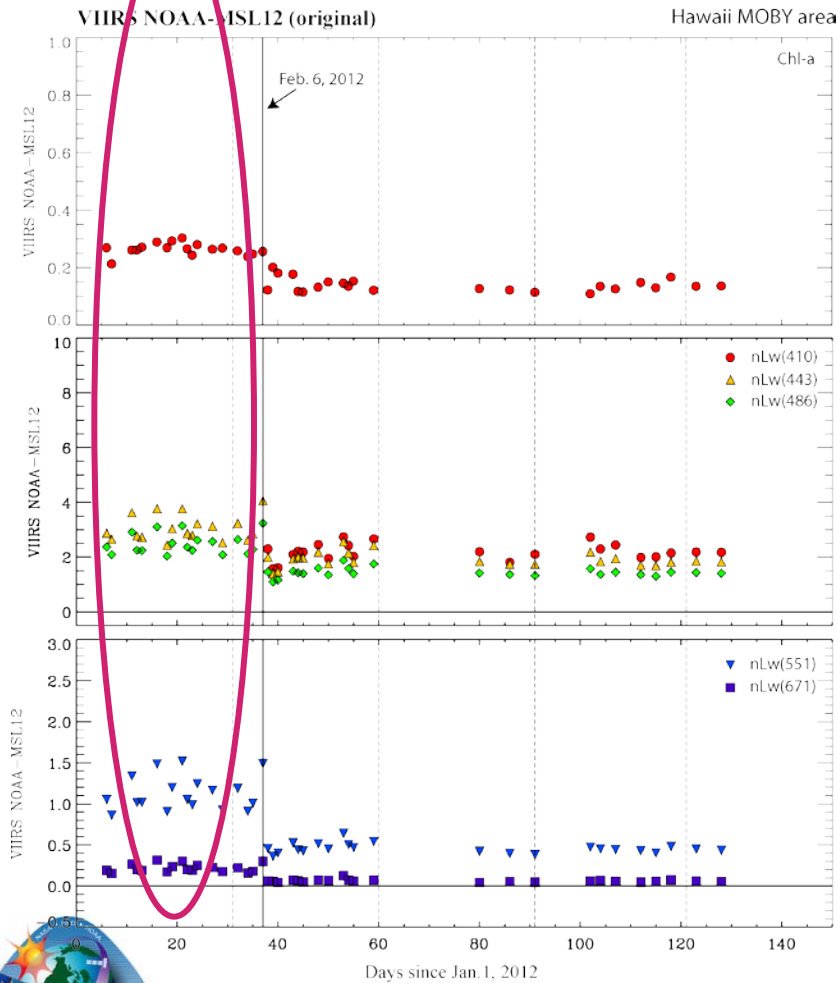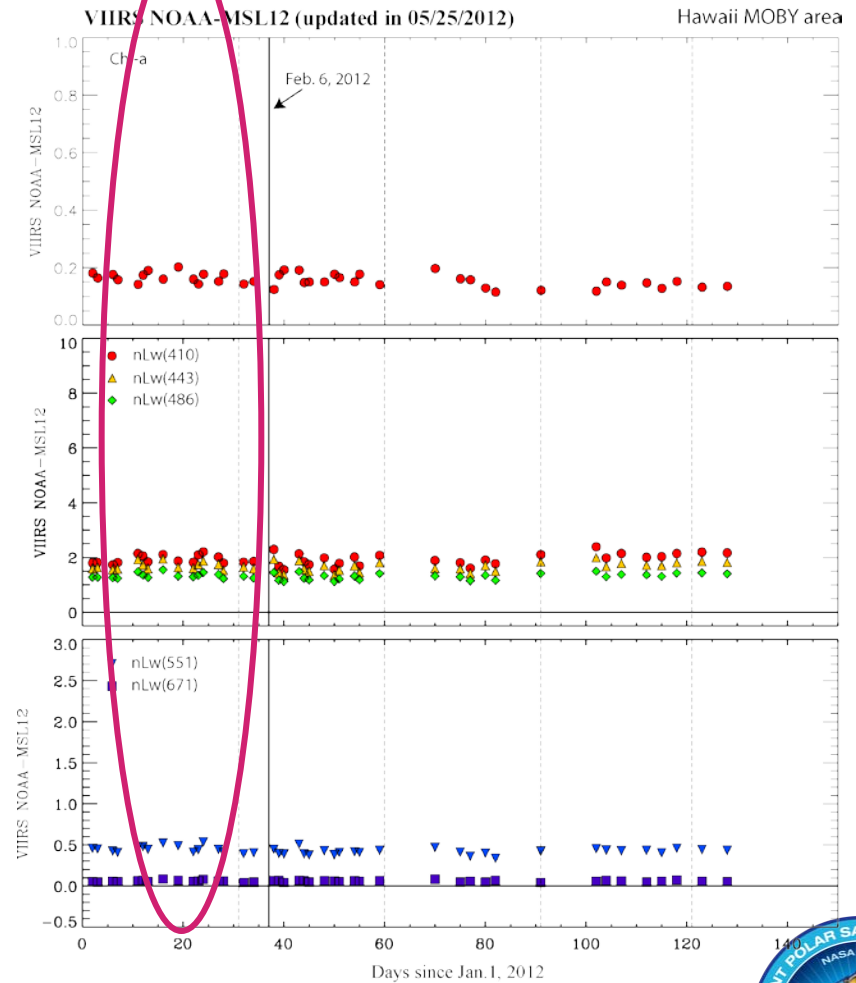
Daily (or better) F-LUTs for SDR data are required!
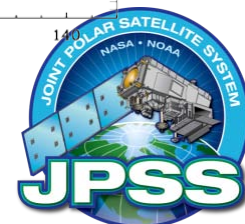
Anomaly Timeseries of nLw in the Hawaii MOBY area
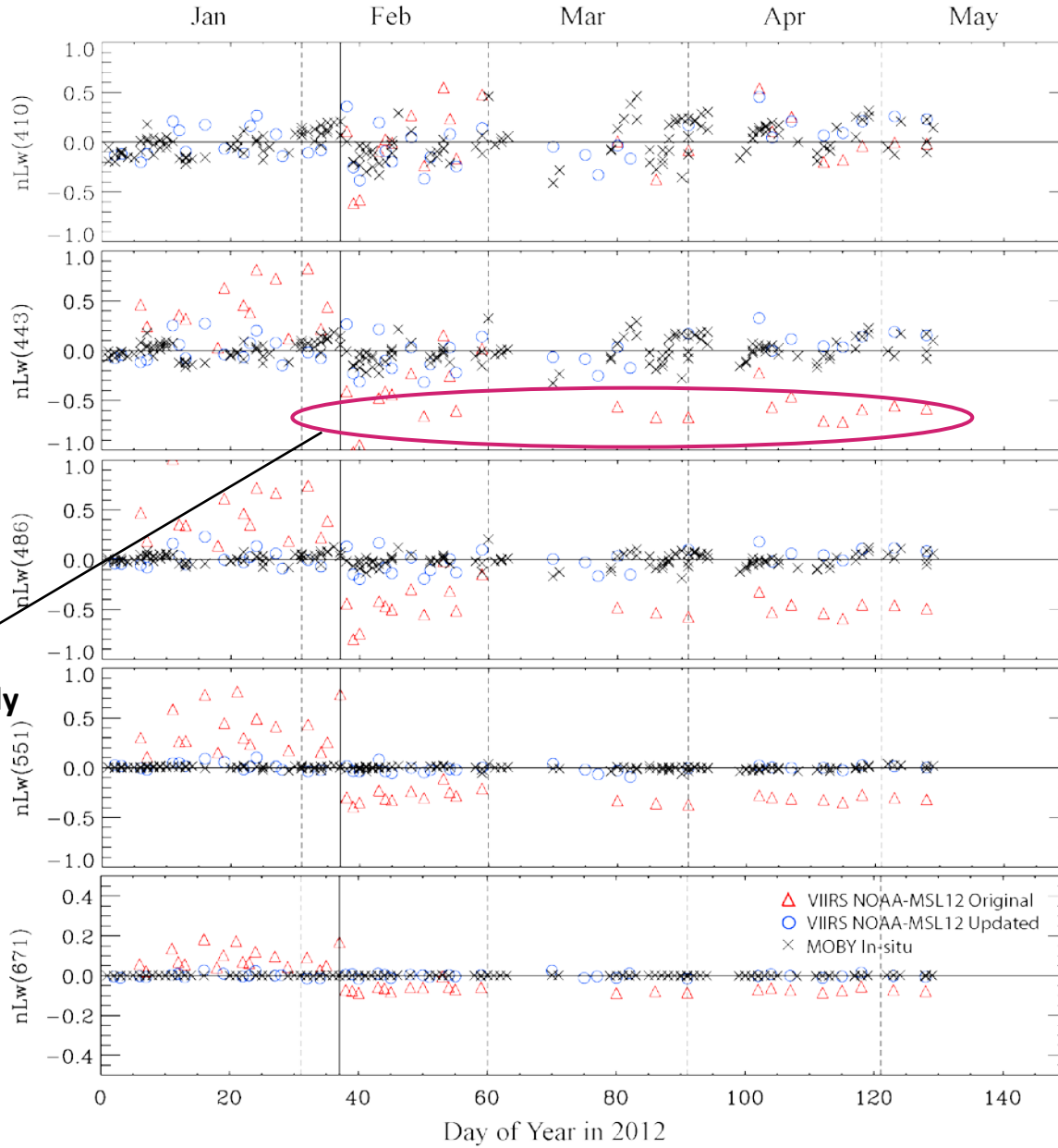
Daily F-LUTs for SDR data are required!

Derived from Weekly F-LUTs SDR
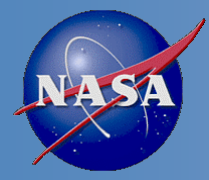
Principle investigator - Sam Ahmed (CCNY) - Coastal Site Data Uncertainties and In situ Validation-LISCO

Time series of normalized water leaving radiance, nLw(λ), retrieved from SeaPRISM (green dots), MODIS (yellow diamonds), VIIRS (red triangles) and MERIS (blue triangles` at the SeaPRISM spectral bands (NASA processing).

Matchups between SeaPRISM and VIIRS, MODIS nLw

Data were also compared from NASA, CLASS (NOAA) and NRL processing

VIIRS Ocean Color EDR Team (STAR) has provided near-real-time VIIRS daily Chl-a image during the period of March 29 to June 30, 2012 to Mitchell Roffer's team (ship *Gordon Gunther* in Golf of Mexico) in support of the NOAA/NMFS SEAMAP survey (**PI**: John Lamkin).

The project is to find bluefin tuna and other highly migratory species larvae.

March 27, 2012
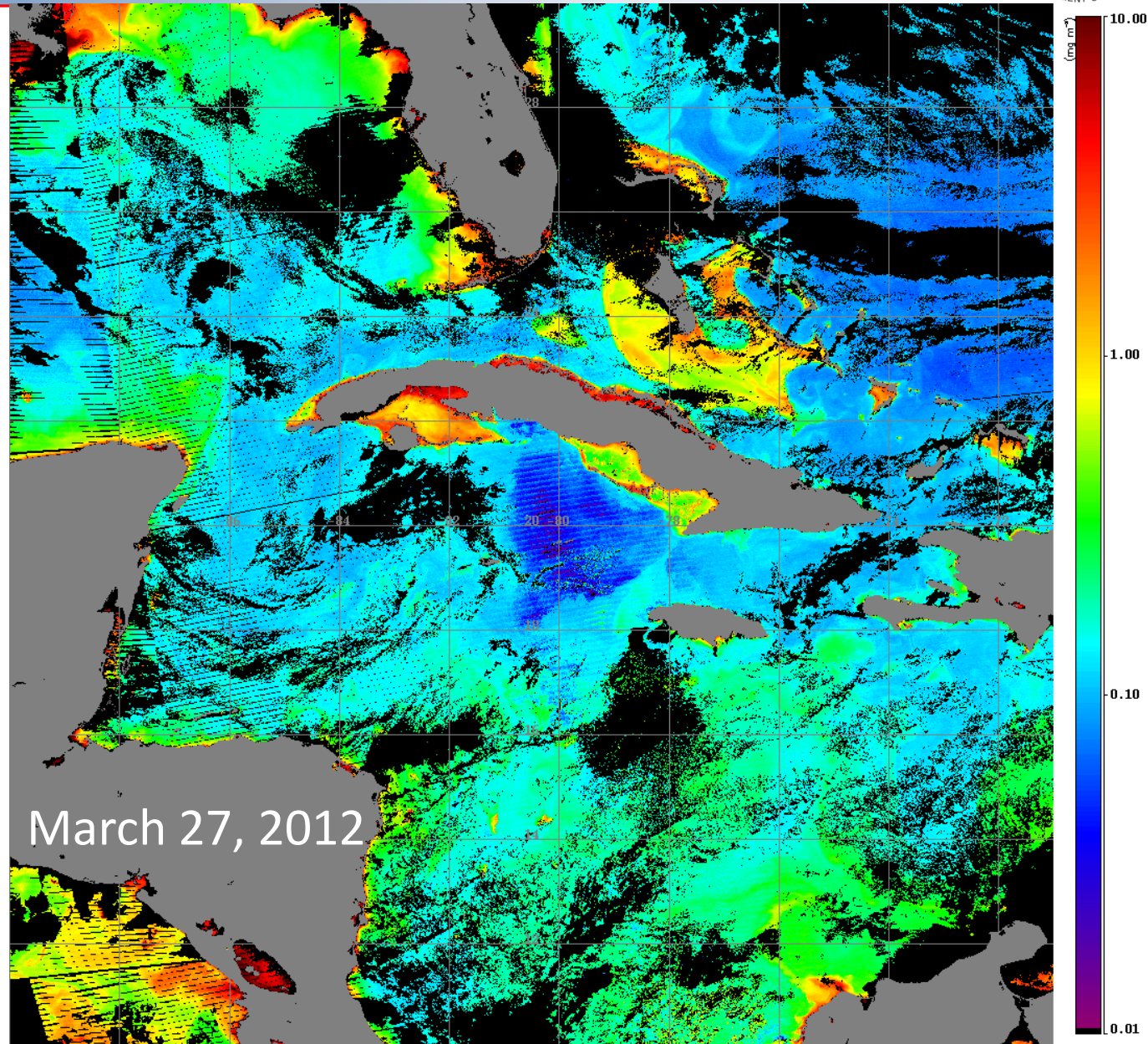
FY-12 Accomplishments - Highlights

- VIIRS near-real-time Chl-a data have supported a NOAA fishery field operations (3 months), contributed significantly to the success of the project.
- Global Level-3 ocean color EDR data productions.
- VIIRS end-to-end data processing capability in the EDR team.
- Global monitoring and evaluations of VIIRS ocean color EDR products
- 3 new AERONET-OC sites operational (Level-2 data) for VIIRS data validation
- EDR team has actively participated all SDR activities and provide some important feedbacks (through various ocean color EDR evaluation).
- Worked with SDR team for evaluations of various LUTs for improving SDR data.
- Real-time operational VIIRS global data stream and processing
  - Monitoring EDR products globally
  - SAVANT- matchup tool for "Golden Regions"
- Vicarious calibration/adjustment to ocean color products
- Field work support (VIIRS images); cruise data collection; and in situ data matchup performed (AERONET-OC and field data)
- Evaluation to the IDPS and "government algorithms"
  - Evaluation of Cloud mask, negative Radiances
  - Glint flags
  - Activities for various DRs
- Presentations at science meetings (TOS-ASLO, SPIE, IGARSS, AGU)

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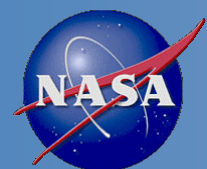
Ocean Color In Situ Cal-Val
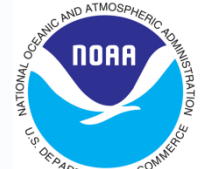
Ocean Color Cruises and In Situ Data

PI	Region	Timing
C. Davis/R. Letelier (OSU)	Hawai Time Series , Oregon Coast	Quarterly,
Michelle Woods, NOAA	South Florida Keys, MOCHA (HABS) Ocean Carbon cruise	Bi –Monthly, Quarterly , Aug 2012
ZhongPing Lee (UMB)	Lake Michigan and Green Bay	Sept 2012
Alex Gilerson, Sam Ahmed (CUNY)	LISCO-Long Island NY	2011-on
M. Ondrusek (NOAA)	Chesapeake Bay, Hawaii	monthly , Summer 2012 , Spring 2012
C. Trees (NURC	Ligurian Sea	Nov
R. Arnone, S. Ladner (USM, NRL)	N. Gulf of Mexico	Fall 2012 , Spring 2013
Jones, Burt (UCS)	West Coast Southern Cal.	2011-on
AERONET -Seaprism -		
Bob Arnone/Gibson	GulF of Mexico	Deployed. Data at AERONET-OC
Jones, Burt	UCS, West Coast	Deployed. Data at AERONET-OC
Ahmed, S	Long Island Sound	Deployed. Data at AERONET-OC
G. Zibordi	Adriatic Sea (Venice), Abu_Al_Bukhoosh; Gustav_Dalen_Tower; Helsinki_Lighthouse', Gloria	Data at AERONET-OC
Jae-Seol Shim	Gageocho Ocean Research Station	Data at AERONET-OC
AERONET_OC	COVE_SEAPRISM	Data at AERONET-OC
Vandemark, Douglas (UHN)	MVCO	Data at AERONET-OC
Kratzer, Susanne	Palgrunden	Data at AERONET-OC
Vittorio Brando	LJCO, Great Barrier Reef, Australia	Data at AERONET-OC and at IMOS website (from mid 2010)

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Following Slides:

Highlights of each team member

Accomplishments and tasking FY13

(*Some details from team members are in backup slides*)
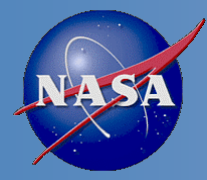
FY-12 Accomplishments
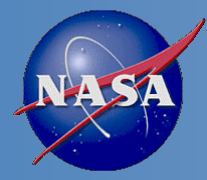
- The capability for the VIIRS data processing from RDR to SDR, SDR to EDR, and EDR to global Level-3 ocean color products. Automatically, download and process these data.
- Built the capability for routine VIIRS ocean color data performance.
- Supported a NOAA fishery field operation (3 months) with VIIRS Chl-a data.
- Actively participated all SDR activities and provide some important feedbacks (through ocean color EDR evaluation):
  - Weekly and daily F-LUTs evaluations: Daily F-LUTs are required
  - Worked with Aerospace group and other SDR members in evaluating LUTs generating schemes.
  - Identified VIIRS SDR gain state miss-match anomalies
  - Identified high sensor-zenith angle anomalies
  - Reported RDR bite-swapping error in ADL code
  - Data striping issue
  - Participate weekly telecons
- Derived vicarious gains for VIIRS ocean color data processing using MOBY in-situ data.
- VIIRS SDR and ocean color EDR analyses and evaluation, software changes, DR activities.

FY-13 Tasks:

1. Support of IDPS-OCC algorithm testing and evaluation, participate SDR activities (will closed work
2. OCC algorithm evaluation, calibration/validation, and refinement and improvements.
3. Participate SDR-related activities, will work closely with various SDR team members.
4. Support of algorithm implementation and maintenance.
5. Support of VIIRS data processing, various product generations.

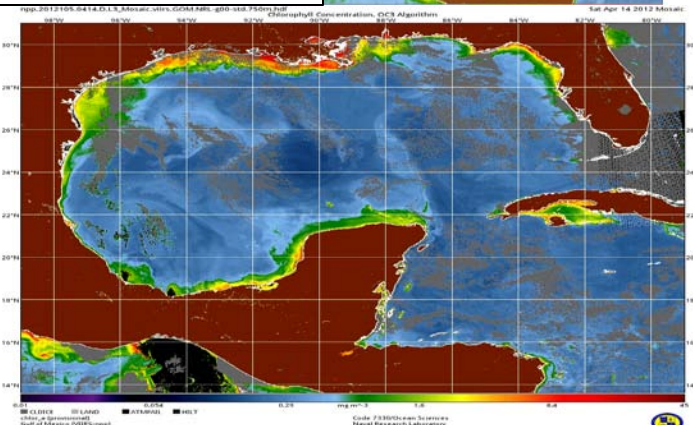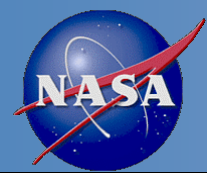**Arnone -PI, Ladner, Martinolich, Fargion, Bower & Lawson**

SAVANT

Progress in FY12

1. **Golden Regions monitoring is operational.** (offshore, gyres, coastal) and products validation;

2. **Collection of field data & WAVE-CIS (AERONET);**

3. **Provided VIIRS in real time to support cruises;**

4. **Performed 1st Vicarious Calibration on MOBY.** Results are very good;

5. **South Florida Cruise and Matchup VIIRS, MODIS** results very good →

6. **Matchup in Gulf of Mexico Cruise, very good** *Noted* IDPS masking problems → new DRAT Updated DRAT for IDPS;

7. Performed Inter Satellite Product Comparison VIIRS, MODIS, MERIS & EDRS. Results are good;

8. Demonstrated continuity of operational real-time → ocean color products

9. Updates to the LUTS coordination with SDR team

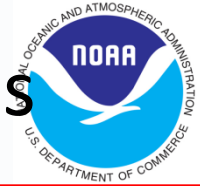10. Evaluation to the IDPS & "government algorithms": cloud mask, negative radiance & glint flags; DR- updates
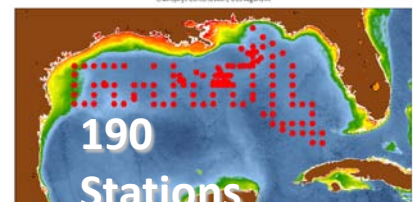
South Florida Cruise

190 Stations

NRL n2gen
~55% more retrievals
than IDPS (masking)

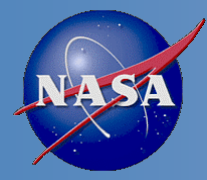**USM-NRL-SDSU   Arnone -PI, Ladner, Martinolich, Fargion, Bower & Lawson**

12 -   Evaluated and updated the IDPS DRAT changes EDR -- Continual upgrades in FY13
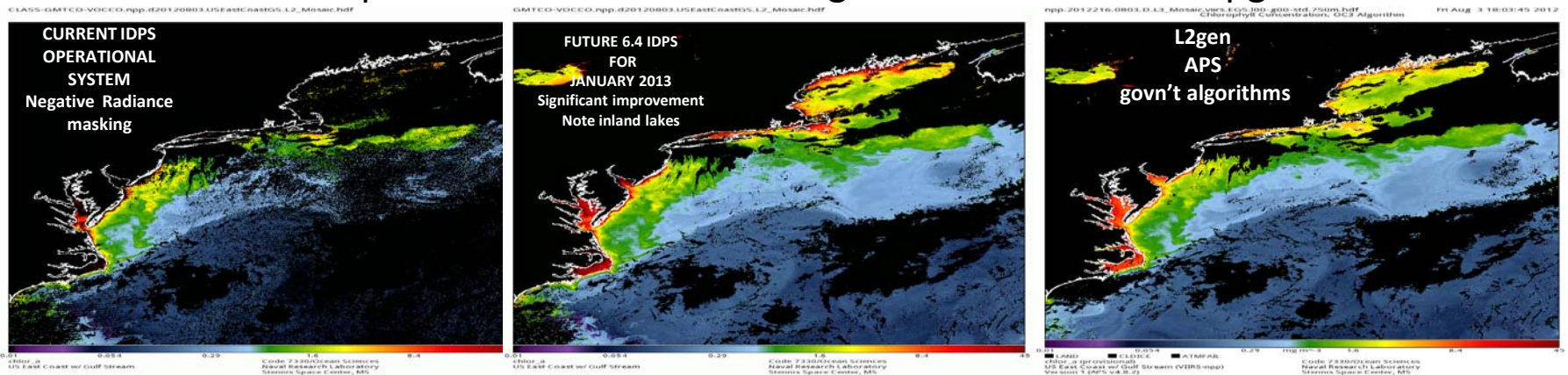
FY13 – Tasks and Milestones
1) Maintain the operational Global matchup "SAVANT" – insitu and satellite data -- 27 regions
2) Monitor vicarious adjustments at regions sites and the "gains"
3) Support products and software to team members (gyres, cruises, AERONET-OC, Uncertainty)
4) Determine product stability for SDR and EDR and impact of changing LUTS
5) Cruise and insitu data collection processing and matchup – with team members
6) Compare the IDPS and govn't products for DRAT updates and provide evaluation in
7) Evaluate Glint mask, Cloud mask, coastal and inland products on IDPS
8) Coordinate the Ocean EDR products
   - a) Develop reports and presentations of the activities in the cal/val program with Gravite and JPSS and NASA
   - b) Arrange and participate in meetings, conference calls and provide summaries to the team members
   - c) Prepare team for rehearsals with Gravite and DPD
   - d) Provide schedules and activities on cruise and data exchanges with team members
   - e) Participate in updates on DR with JPPS and provide feedback to STAR, NGAS and JPSS
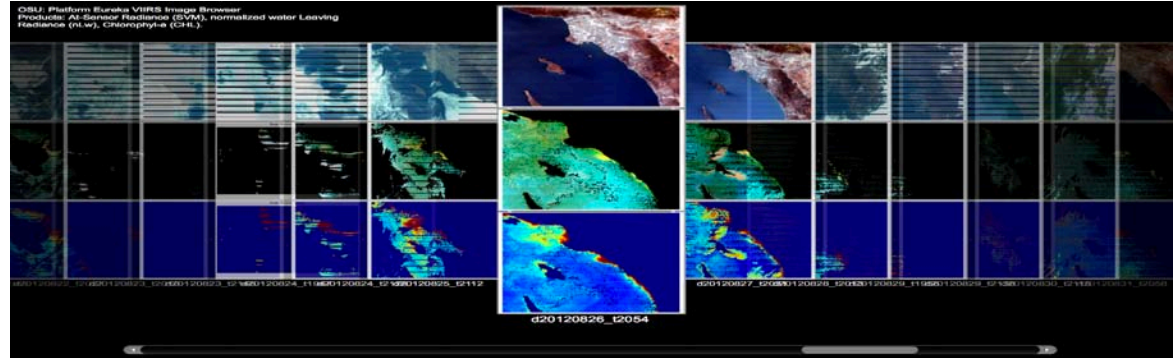
West Coast VIIRS Cal/Val

FY-12 Accomplishments and FY 13 Plan
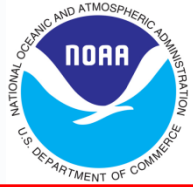
Curt Davis and Nick Tufillaro, OSU

Platform Eureka Golden Region cover-flow data browser
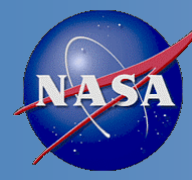

❖ **FY-12 Progress**

1. Receiving and evaluating VIIRS data and products from IDPS (CLASS), APS and NASA processing for West Coast Golden Areas.
2. Developed automated archiving and browsing system.
3. Operating West Coast ground station receiving VIIRS data

❖ **FY13 Milestones**

1. Oregon Coast and HOT in situ data for VIIRS validation
2. Validation of VIIRS data with Platform Eureka SeaPRISM data.
3. Validation of VIIRS products for West Coast Golden Regions
   - Assess flags and other issues with IDPS processing
   - Comparing IDPS, APS and NASA VIIRS L_{wn} and chlorophyll products
4. Continue real-time capture of VIIRS data and produce ocean products with NASA IPOPP software and compare to IDPS products.

Burt Jones and Matthew Ragan, USC

- **FY-12 Accomplishment**
➢Work with Curt Davis(OSU), and AERONET team to get Platform Eureka SeaPRISM working
➢First comparisons of PE SeaPRISM and IDPS VIIRS data
  – Days with 0 values for VIIRS Chl-a are lost due to flags

- **FY 13 Plans**
  ➢Continue operation of Platform Eureka SeaPRISM
  ➢Field validation SeaPRISM data with cruises and gliders
  ➢Continue work with Curt Davis on validation of VIIRS products with this data.

Chl-a matches June-Aug 2012
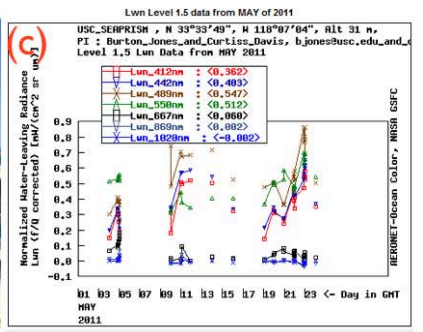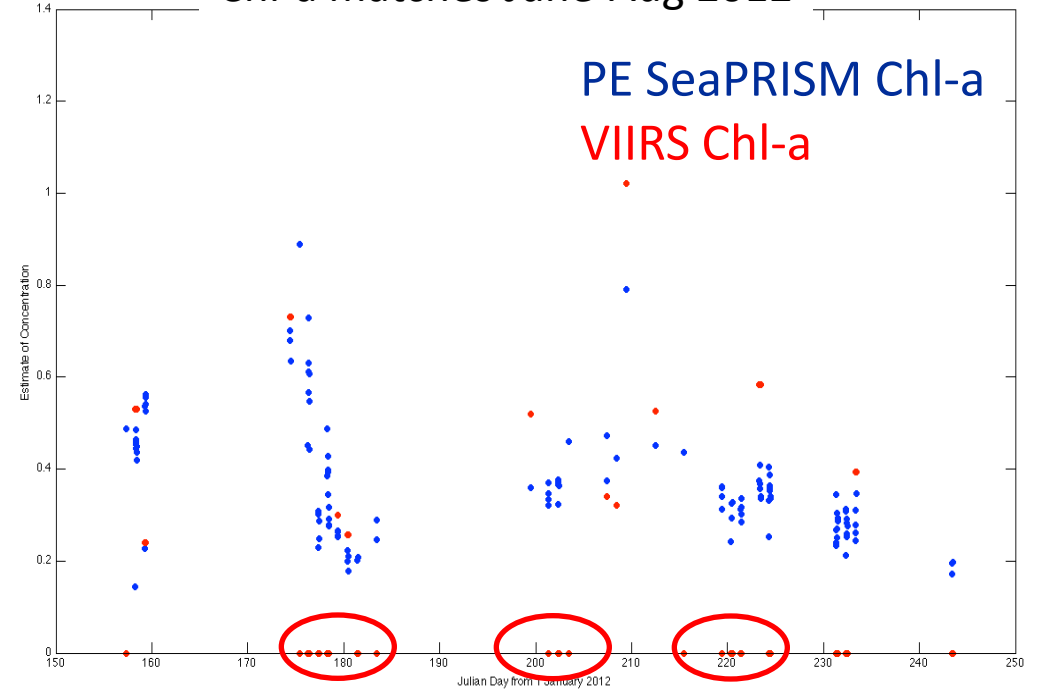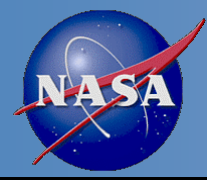
25
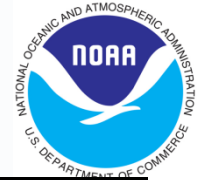
CMRE - Centre for Maritime Research and Experimentation. C. Trees, A. Alvarez and G. Pennucci

Past Year progress

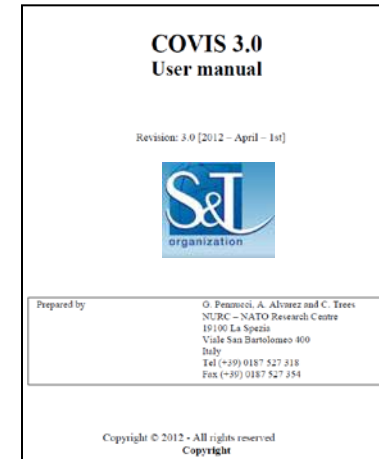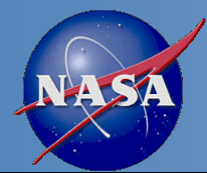1. A new software tool (COVIS) to ingest and process ocean color satellite images (including also the VIIRS NPP data format) was developed and delivered with user manual.

2. The methodology to investigate suitable *in situ* sampling locations to calibrate & validate remote sensing was applied on VIIRS data.

3. The uncertainty analysis of the MVCO, LISCO and Eureka golden regions Is under processing.

FY13 – Milestones

1. Characterize the uncertainty of *in situ* data and apply to satellite matchups;

2. Deliver a Seasonal Uncertainty Index-UI for the regional golden regions (MOBY, Ocean Gyres, AAOT, etc.);

3. Deliver a tool for regional analyses of *in situ* data;

4. Collect and process ship observations based on the *in situ* UI.

COVIS 3.0
User manual

Revision: 3.0 [2012 – April – 1st]

S&T
organization

Prepared by | G. Pennucci, A. Alvarez and C. Trees
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Copyright

Ocean cal val
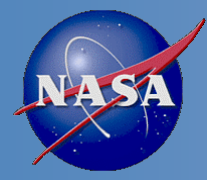# Schedule and Milestones

PI - Sam Ahmed (CCNY)- Coastal Site Data Uncertainties
and In situ Validation-LISCO Coastal Site Data

Past year progress

- **Provided continuous flow of SeaPRISM data to NASA from the LISCO site since July 2011 (after instrument calibration at NASA) with proper site maintenance**
- **Conducted 3 field tests (2 in the LISCO area, 1 in NY Bight) with full set of instruments to measure reflectances and water IOPs.**
- **Demonstrated VIIRS – products with the SeaPrism radiance is good .**
- **Developed BRDF model for coastal waters and validated for the LISCO site**
- **3 papers in Applied Optics, presentations at AGU Oceans, Feb 12, SPIE Security and Defense, Apr 12**

FY13 – Milestones

1. **Maintenance LISCO site to ensure proper data quality and data transmission to the NASA AERONET**
2. **Matchups between satellite data (MODIS, VIIRS) and SeaPRISM and HyperSAS data. Comparison of data from CLASS, NASA and NRL Stennis.**
3. **Evaluation of data errors and uncertainties of the AERONET /SeaPrism data stream (nLw and atmospheric parameters).**
4. **Field measurements in the area of the platform and other areas of opportunity, and matchup with SeaPRISM and HyperSAS data.**
5. **Analysis of impact of light polarization on the removal of the reflected sky component**

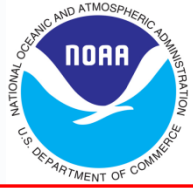Principal Investigator: Patty Pratt NGAS

- Past year progress
  - Completed and delivered OMT and PVT
  - Integrated OMT as PGE
  - Developed a process to capture and analyze daily high quality pixels
  - Developed PVT Analysis & Trending Tool - ongoing
    - Sensor-centric approach to viewing data over stable ocean cal target (South Pacific Gyre) for Polarization Verification and characterization

- FY13 – Milestones
  1. Develop standard outputs
  2. Optimize PVT trending tools
  3. Perform Polarization Verification Analysis

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Principle investigator: Michael Ondrusek

Progress FY12 –

In situ/satellite matchup efforts to support NPP VIIRS Calibration and validation.

- **Organized Hyperpro collection and processing protocols for Cal/Val team**
- **Conducted 3 crusies Chesapeake Bay and provide matchup data to Cal/Val Team.**
- **Participated in South Florida Program Cruise (WS1118) on board the R/V *Walton Smith***
- **Participate in MOBY shadowing experiment off Honolulu, HI**
- **Purchased ASD instrument.**

FY13 – Milestones

1. **Analyze validation collection protocols and ensure in situ data reliability between groups and over time.**
2. **Data collection Chesapeake Bay and other regions**
3. **Provide VIIRS matchup data to Cal/Val Team.**
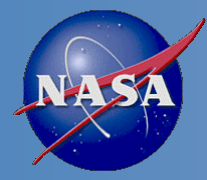4. **Submit and support ship time request to NOAA NMAO for FY14.**
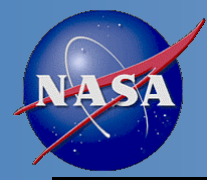
Carol Johnson, NIST

Progress FY12

- Analyses of the Long Island workshop for above water radiometry

- Three test reflectance standards were measured

- Determined behavior of (AERONET) CIMEL on SIRCUS – impacts
    measurements of low radiance sources (e.g. water)
    BRDF measurements of Long Island samples completed

FY13 – Milestones

1. Address the out of band and nonlinearity in one SeaPRISM
    radiometer (AERONET-OC instrument);
2. "SeaPRISM Characterization" document to JPSS; and
3. "Long Island Sound Experiment" document to JPSS.

Principle investigator : ZhongPing Lee/UMB

- ## Past year progress
  - Analyzed comparison between VIIRS and MODIS TOA radiance and several test sites
  - Determined Stable gains using the ocean gyres.
  - Completed cruise in Matchup Lake Michigan and evaluated VIIRS – nLw and optical properties with VIIRS data -- Good Agreement

- ## FY13 – Milestones
  1. Monitor stability of VIIRS gain using Ocean Gyre waters using SAVANT and EDR
  2. Finalize VIIRS data product validation in the lakes
  3. Validate VIIRS data product in the coastal zones (e.g. Massachusetts Bay)
      Cruise planned with data matchup with VIIRS

Principle investigator : ZhongPing Lee/UMB

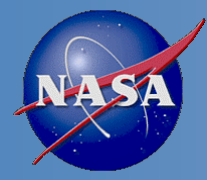- Rrs and IOP comparison over lake waters (June 25-27, 2012)
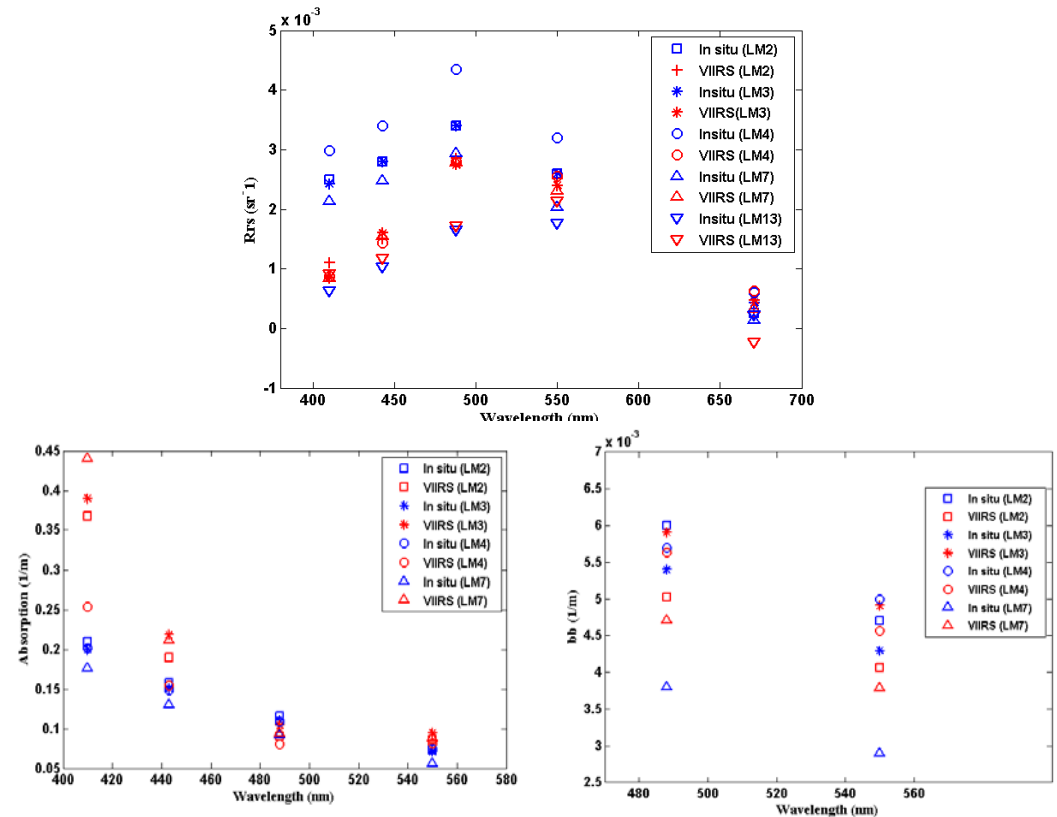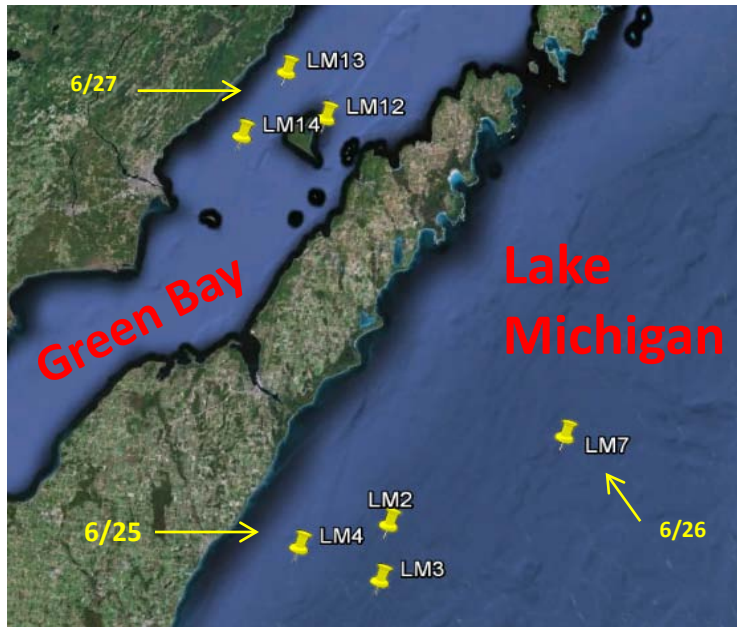
VIIRS Rrs is lower in the blue bands, possibly a result of inadequate aerosol properties in the processing algorithm; consequently higher VIIRS absorption coefficients in the blue bands.
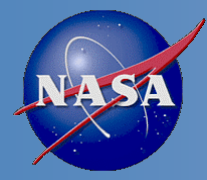
FY12 Accomplishments: DRs

DR number	Short Description
	Negative radiance - masking lifted
	Inland water masking lifted
	Quality flags – modified
	Chl-a retrieval condition changed
	High sensor-zenith angle flag -- need to increase to 60 (Deg.)
	Solar irradiance update

- Sensor significant degradation at the NIR and SWIR bands -- continued evaluation of impact on ocean color EDR.
- Both VIIRS SDR and EDR data re-processing are required for improving data quality.
- Daily or better F-LUTs are required for ocean color EDR.
- VIIRS data flow is now more stable (GRAVITE is quite stable), but data missing still happens (now much improved).
- However, from Nov. 21, 2011 to May, 2012, there are still a lot of missing data. Download daytime only data from CLASS is not easy.
- SDR and EDR teams interaction, e.g., how to get SDR update information efficiently.
- How to effectively evaluate the applied vicarious gains within the IDPS software. ADL code is not efficient, and is not possible for routine global data processing.
- Further improve code change efficiency (DR process, etc.). It has been improved.
- FY13 funding is critical to support the mission.

- Significant support for VIIRS OCC algorithm refinement and improvement, Cal/Val, addressing various issues related to sensor performances is required.

- Reduction with in situ match ups (field work).

- Leverage on other opportunity for in situ data (e.g., free ship).

- May leverage other programs from other agencies in US
  - NASA, NAVY, NOAA

- Coordinate data collection with JPSS architecture

- Coordinate with other foreign agencies, e.g., ESA – cal/val program (Sentinel-3)

- May leverage with other resources, e.g., link with coastal and inland waters programs/resources.

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Summary Ocean Cal/Val Team

- Cal/ Val team working closely together and on schedule.
- SDR evaluated using ocean color EDR data with in situ measurements (e.g., from MOBY data).
- Monitored and evaluated various SDR LUTs and their impact on ocean color EDR data.
- Performed vicarious gains using the MOBY data -- results are very good.
- Inter-satellite, ship and in situ data matchup for evaluation of VIIRS ocean color products showing good results.
- Identified some important issues with IDPS data processing, and these issues are being resolved (code changes in addressing these issues are proposed) -- will lead to improved ocean color products.
- Our results show that, although there are still some issues, e.g., sensor significant degradation at the NIR and SWIR bands, VIIRS can potentially provide high-quality global ocean color products in support of science researches and various operational applications -- continued support/funding is needed.

VIIRS Global Climatology *Chl-a* Image

(Feb. 6-Sep. 14, 2012)

NOAA-MSL12

(mg m⁻³)

0.01   0.1   1.0   10.0   64.0
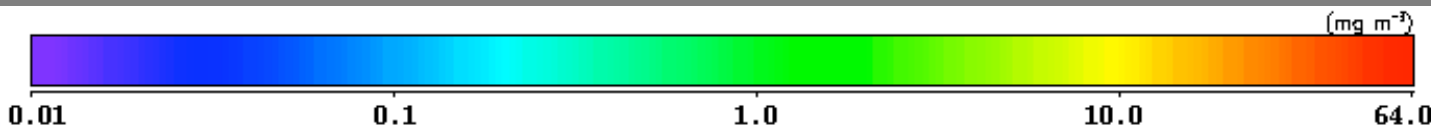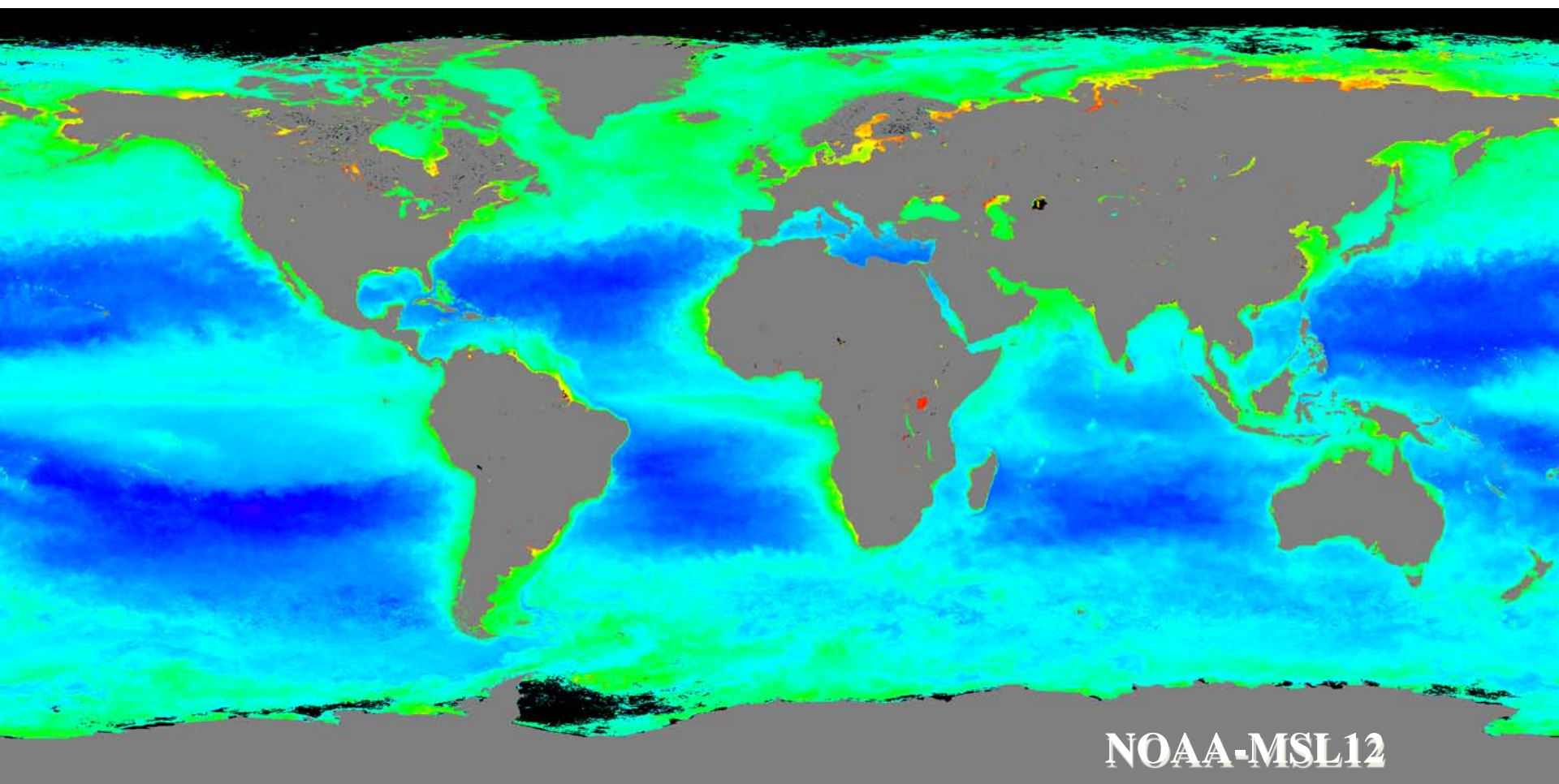
Thank You!

**Some Details of
Accomplishments & FY13 Plans
from Team Members**

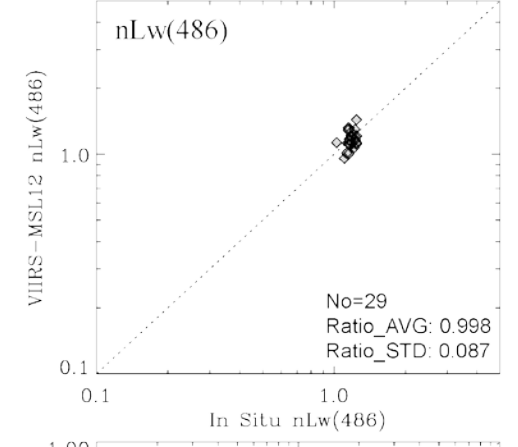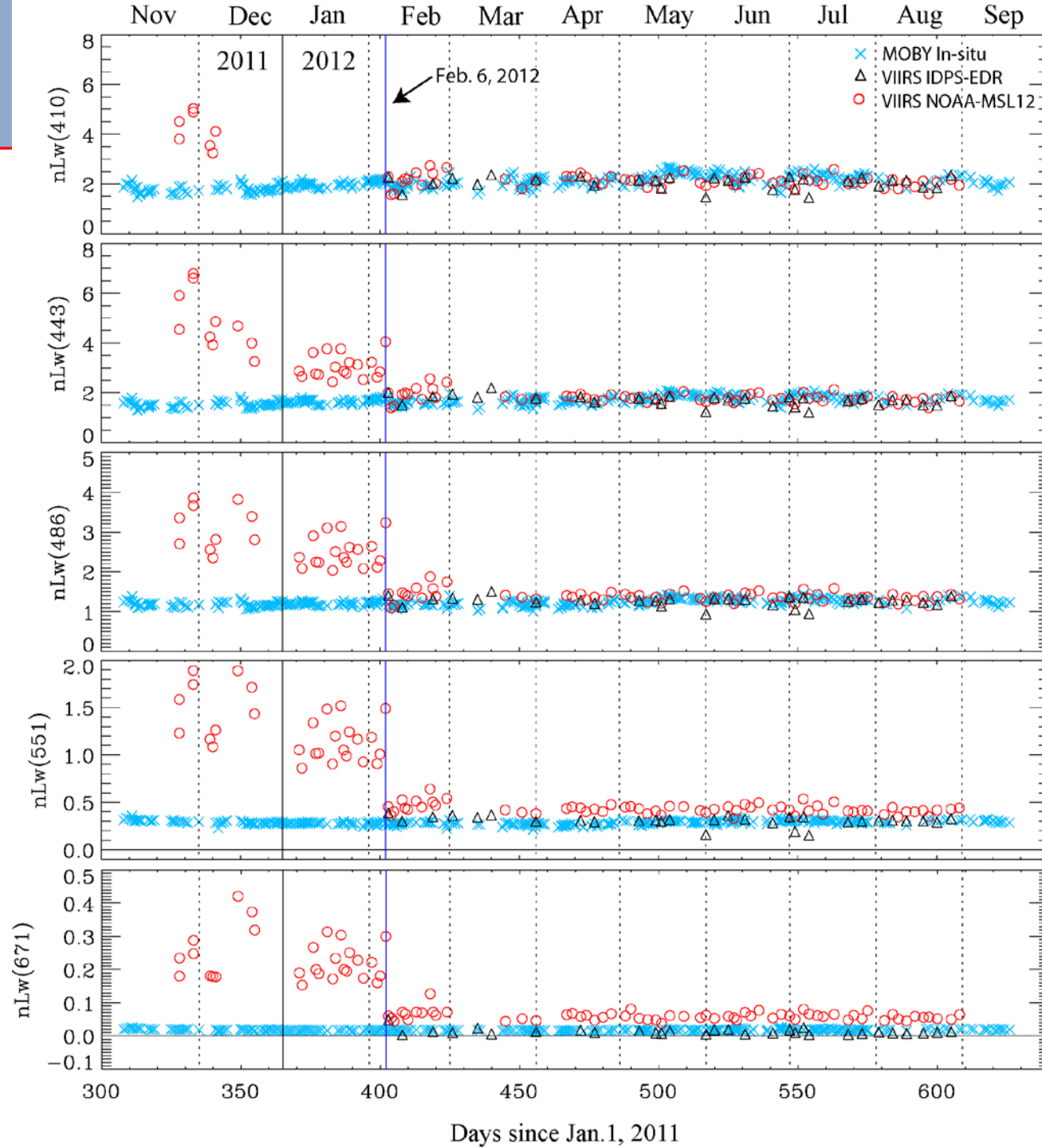## Evaluation Results (STAR)
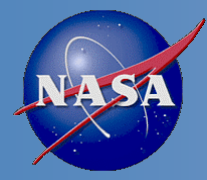

Daily F_LUT and **New V.C. gain** applied.
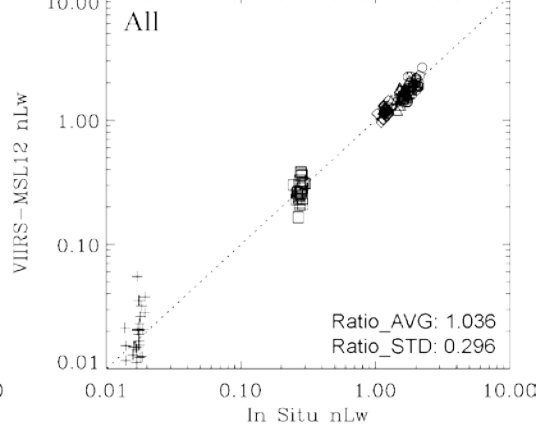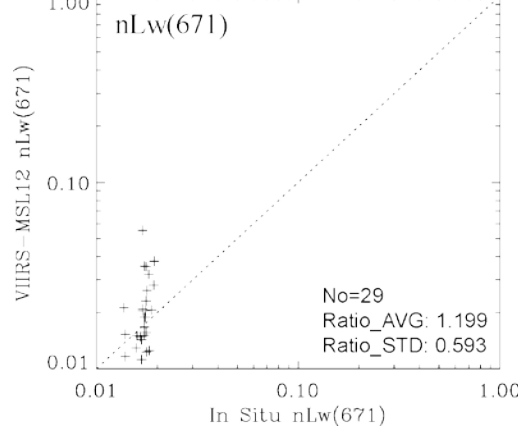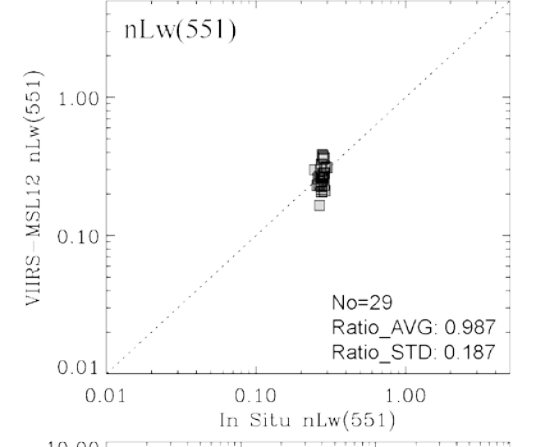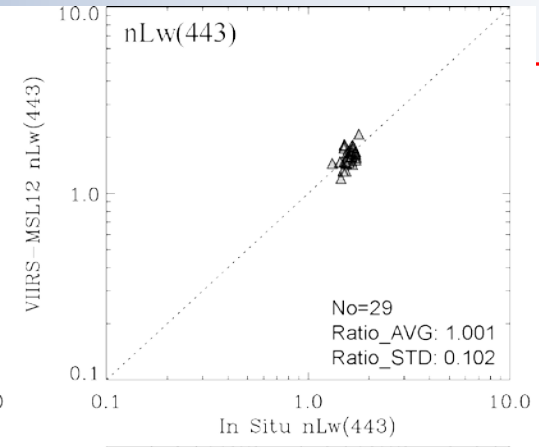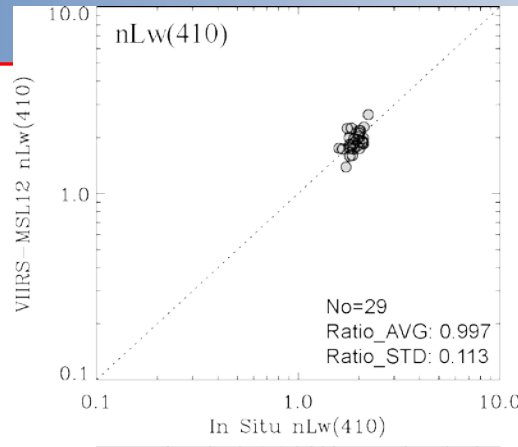
VIIRS vs. MOBY In Situ

• All IDPS flags were applied to IDPS ocean color products---leading to good quality data but with significantly less amount of data.
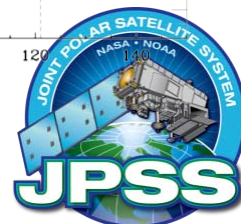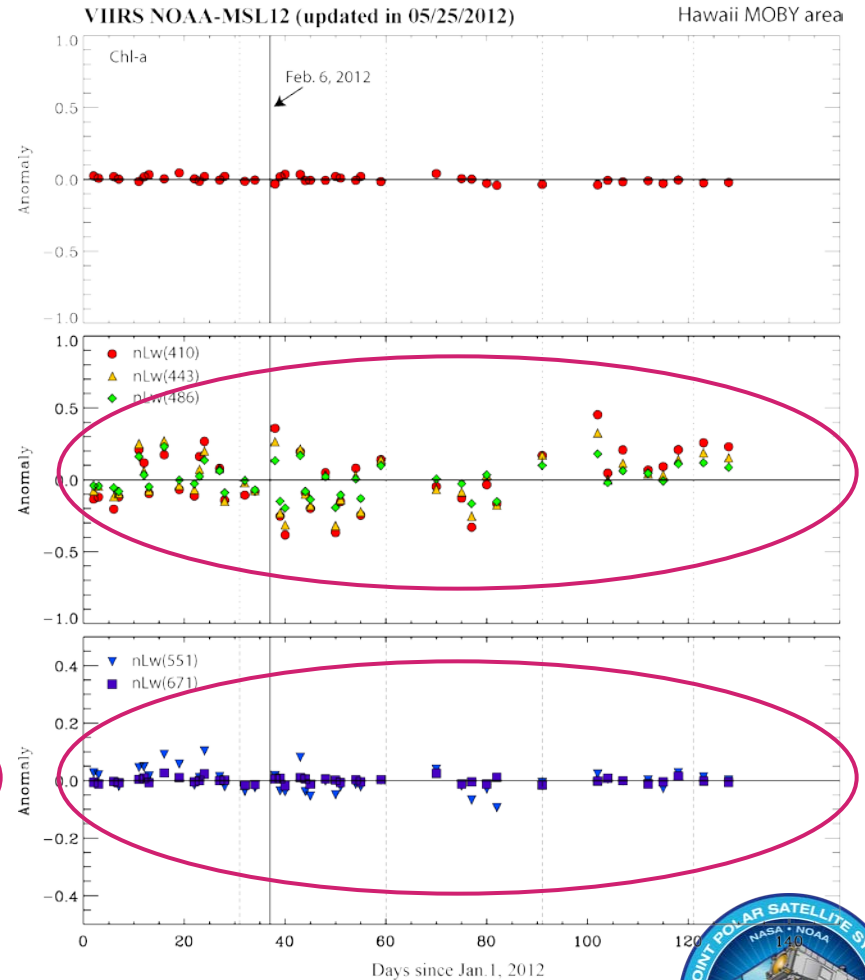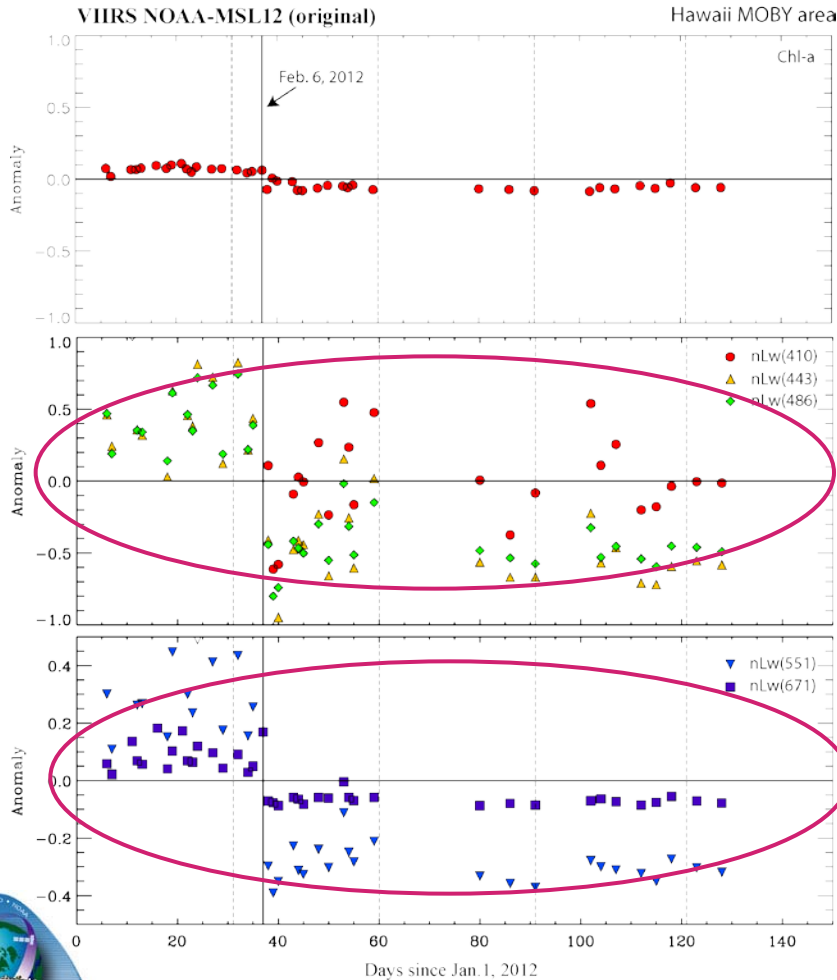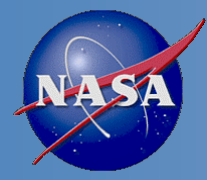
MOBY PI: Ken Voss

Comparison of VIIRS Ocean Color Product Anomalies at MOBY Site

From SDR using weekly updated F-LUT

From SDR using daily updated F-LUT

FY-12 Accomplishments
## USM-NRL-SDSU   (9 Major Accomplishments)

Arnone -PI, Ladner, Martinolich, Fargion, Bower. Lawson

SAVANT

1. **Golden Regions monitoring is "Operational!"**
Monitoring of global regions (offshore, gyres, coastal)
- Product evaluation & Vicarious adjustment
- Matchups: AERONET, MOBY, Ship data

2. **Collection of field data** & WAVE-CIS (AERONET)
Provided VIIRS in real time to support cruises
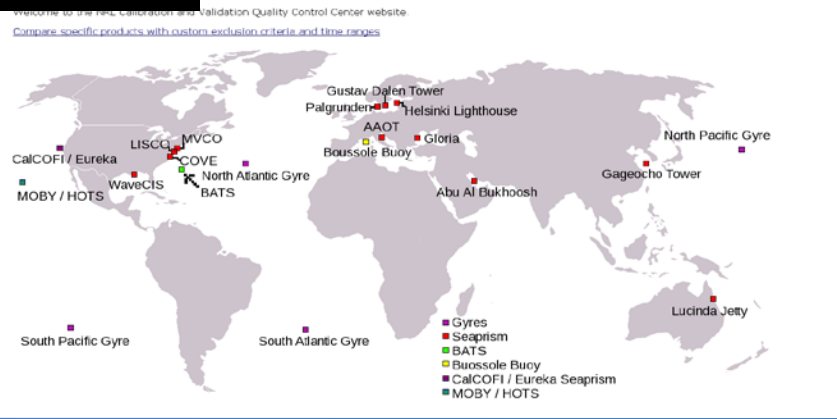
**3.** **Performed 1st Vicarious Calibration on MOBY**

Averaged Vicarious Gains:

M1 412	M2 442	M3 490	M4 555	M5 668
0.987092	0.986498	0.989244	0.979387	0.984837
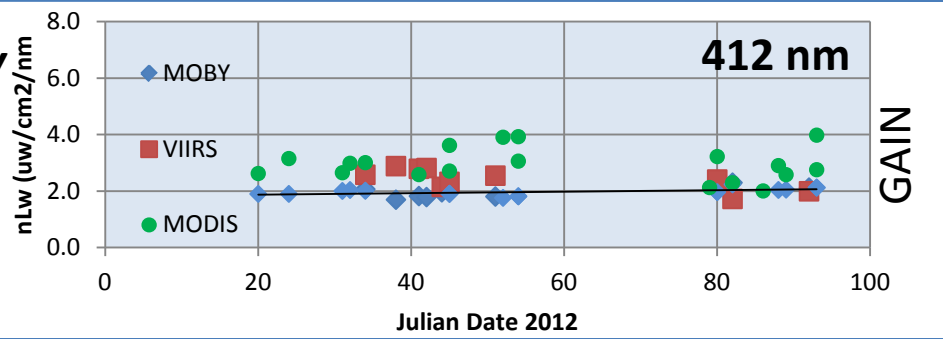
Currently is minimal, i.e. SDR LUT are "GOOD"

412 nm

- MOBY
- VIIRS
- MODIS

GAIN

nLw (uw/cm2/nm) vs Julian Date 2012

4. **Inter Satellite Product Comparison**
VIIRS , MODIS , MERIS
- EDRS Good Agreement
- Software
- IDPS and govn't code
- Update DRAT

NPP- IDPS - VOCCO

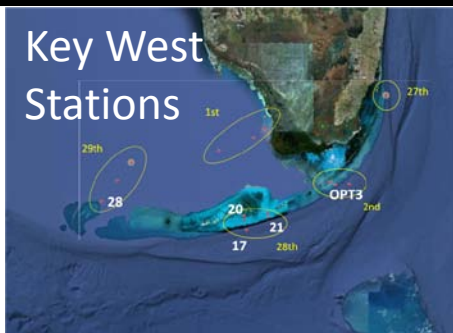MODIS-Aqua

NPP-L2Gen - NRL
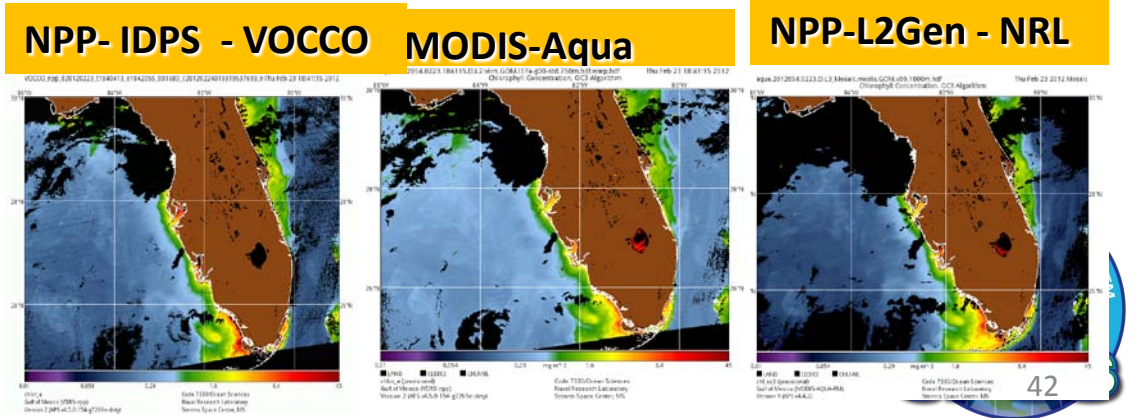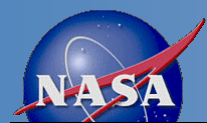
FY-12 Accomplishments

Arnone -PI, Ladner, Martinolich, Fargion, Bower. Lawson

In situ Key West matchup – EDR

Key West Stations

5. **Correlation :**
Excellent Agreement
with the nLw

M	VIIRS IDPS		VIIRS – Gov software	
lamda	r2	PerDiff	r2	PerDiff
410	0.836424	17.66	0.929217	17.1
443	0.976641	9.99	0.978796	8.74
486	0.991231	7.51	0.990916	5.35
551	0.975921	14.9	0.987854	16.64
671	0.961313	53.76	0.944684	49.86

6. **Gulf of Mexico Cruise**
- Chlorophyll matchup
  - Good matchup
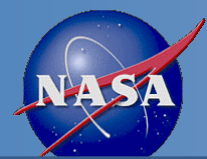- Identified IDPS, no retrievals
- mask ODPS problems
- update to DR

190 Stations

NRL n2gen
~55% more retrievals
than IDPS (masking)

Legend:
- NRL Viirs w/Gains (n=
- NRL Viirs (n=71)
- IDPS Viirs (n=22)
- Insitu (n=190)

(Chlorophyll vs Station #)
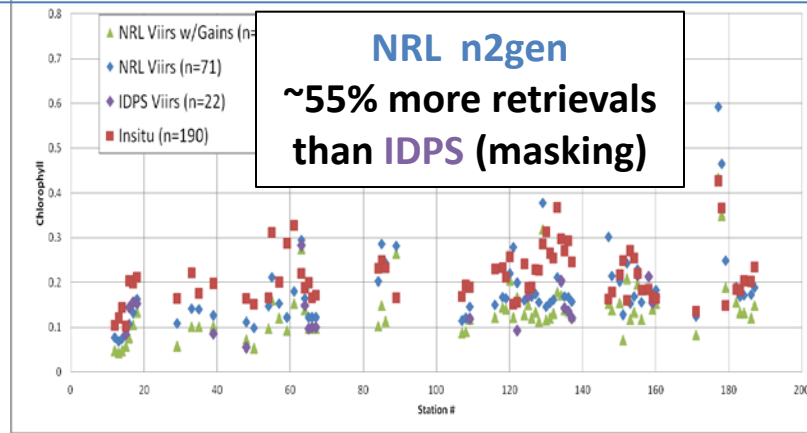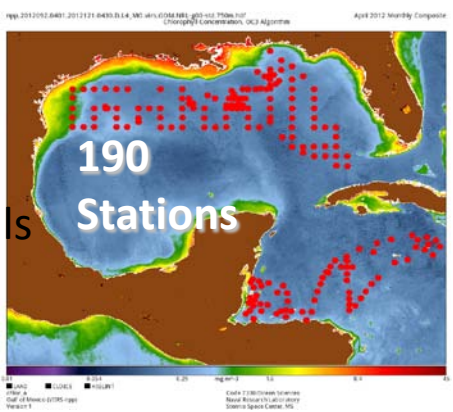
7.
- **Updates to the LUTS coordination with SDR team**
- **Cruise data: In situ data matchup performed & validation of products**
- **Evaluation to the IDPS and "government algorithms"**
  - Evaluation of cloud mask, negative radiances and glint flags,
  - DR – updates
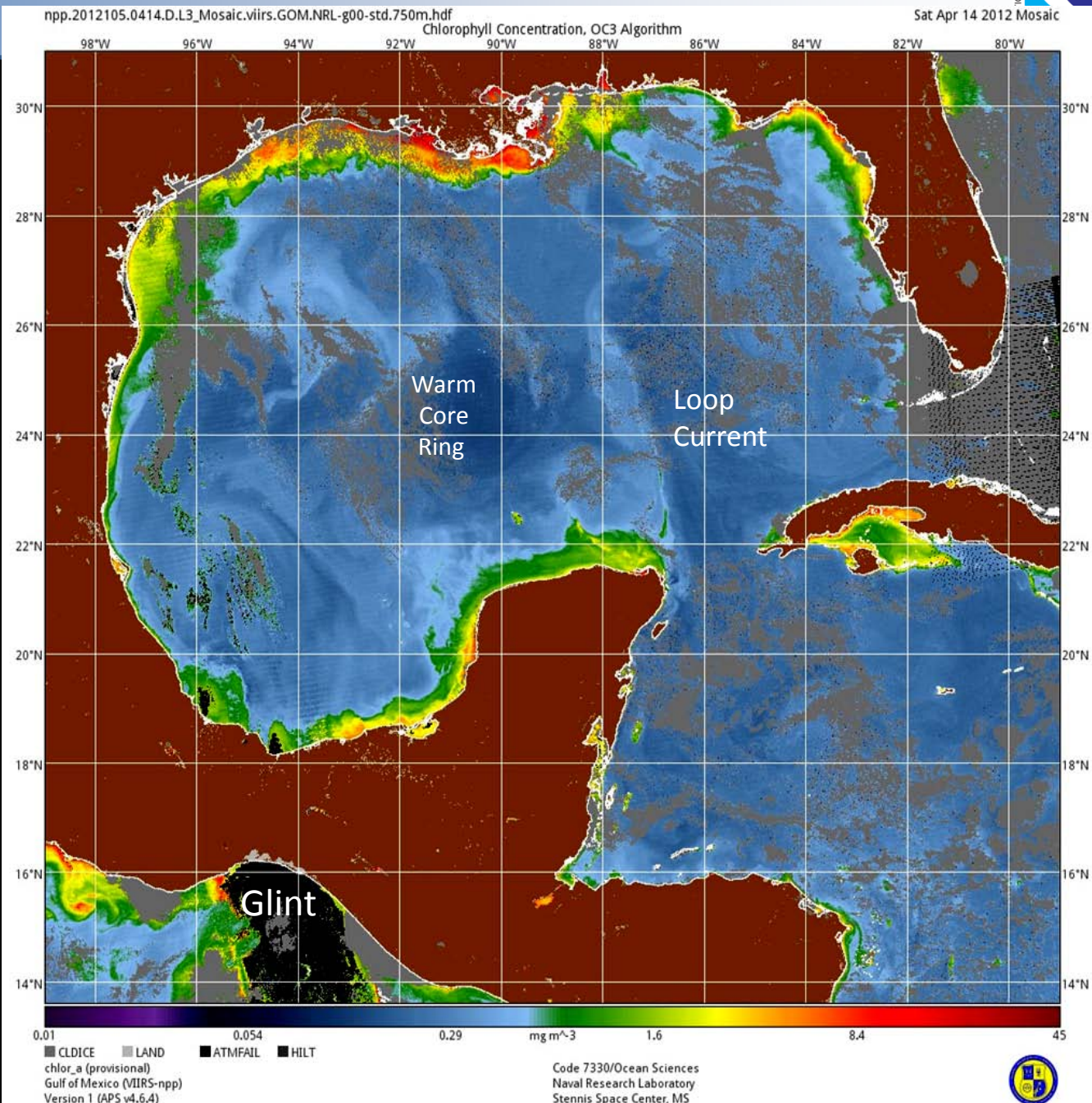- **Several presentations at science meetings**

USM and NRL

8.

Demonstrated continuity of operational real-time products

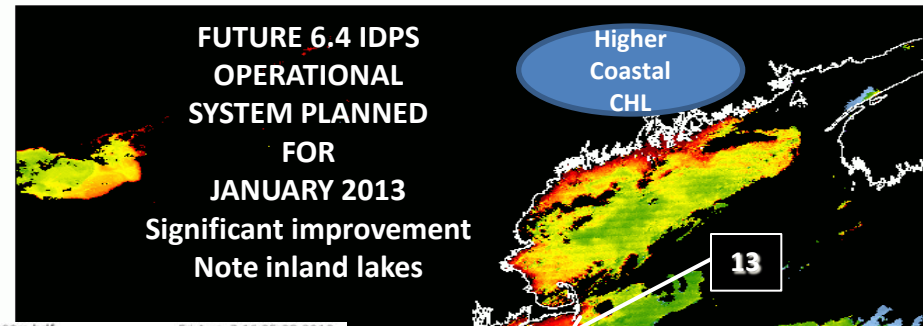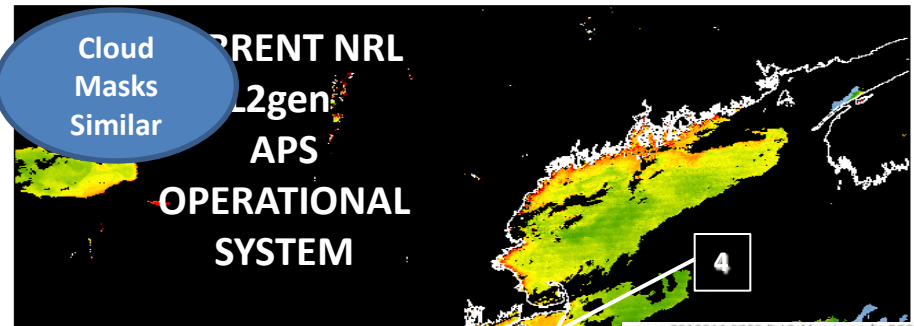**Animation of VIIRS chlorophyll April 2012**

Note: glint mask not applied

Warm Core Ring

Loop Current

Glint

npp.2012105.0414.D.L3_Mosaic.viirs.GOM.NRL-g00-std.750m.hdf

Chlorophyll Concentration, OC3 Algorithm

Sat Apr 14 2012 Mosaic

chlor_a (provisional)
Gulf of Mexico (VIIRS-npp)
Version 1 (APS v4.6.4)

Code 7330/Ocean Sciences
Naval Research Laboratory
Stennis Space Center, MS

44

9. Evaluated and updated the IDPS EDR -- Continual upgrades planned for FY 13 tasking

npp.2012216.0803.D.L3_Mosaic.viirs.EGS.l00-g00-std.750m.hdf   Fri Aug 3 18:03:45 2012
Chlorophyll Concentration, OC3 Algorithm

Cloud Masks Similar

CURRENT NRL L2gen APS OPERATIONAL SYSTEM

GMTCO-VOCCO.npp.d20120803.USEastCoastGS.L2_Mosaic.hdf

FUTURE 6.4 IDPS OPERATIONAL SYSTEM PLANNED FOR JANUARY 2013 Significant improvement Note inland lakes

Higher Coastal CHL

aqua.2012216.0803.D.L3_Mosaic.modis.EGS.v10.1000m.hdf   Fri Aug 3 16:35:28 2012
Chlorophyll Concentration, OC3 Algorithm
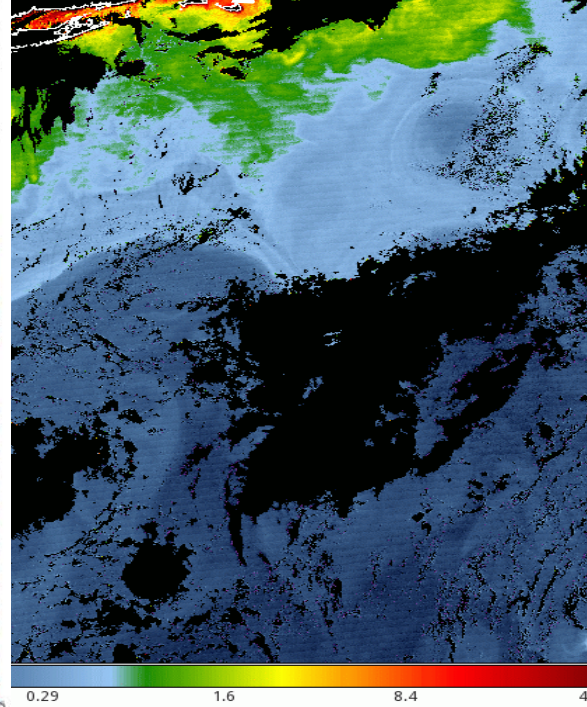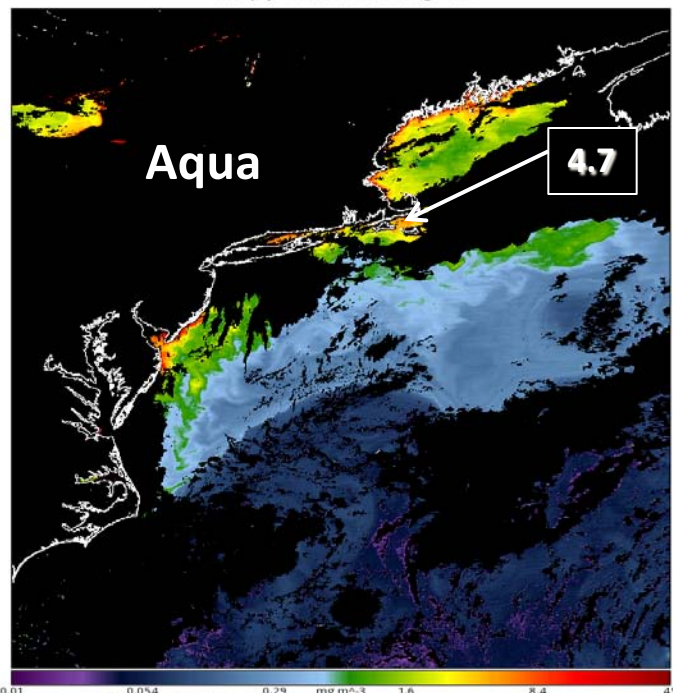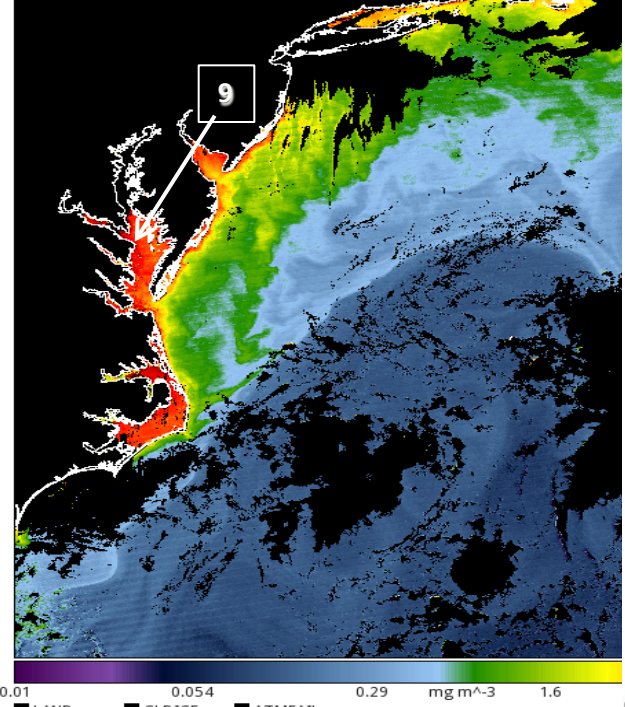
Aqua

0.01   0.054   0.29   mg m^-3   1.6
■ LAND   ■ CLDICE   ■ ATMFAIL
chlor_a (provisional)
US East Coast w/ Gulf Stream (VIIRS-npp)
Version 1 (APS v4.8.3)

0.01   0.054   0.29   mg m^-3   1.6
■ LAND   ■ CLDICE   ■ ATMFAIL
chl_oc3 (provisional)
US East Coast w/ Gulf Stream (MODIS-AQUA-PM)
Version 10 (APS v4.8.1)

Code 7330/Ocean Sciences
Naval Research Laboratory
Stennis Space Center, MS

0.29   1.6   8.4   45
Code 7330/Ocean Sciences
Naval Research Laboratory
Stennis Space Center, MS

Ocean Cal/Val Schedule and Milestones

USM- NRL-SDSU

Past year progress

1) **Evaluated the VIIRS Ocean EDR products for ocean color**
   a) Assembled VIIRS RDR and SDR and EDR from Gravite, CLASS, AFWA for the global "Golden Regions"
   b) Generate statistics of VIIR performance using EDR and in situ data (AERONET– OC, MOBY, BOUSSOLE and cruise data) using the Satellite Validation Navy Tool (SAVANT)
   c) Upgraded government software for VIIRS and provided feedback to IDPS algorithms for DR.
   d) Determined the stability of the VIIRS ocean products using the matchup tool at 27 golden regions.
   e) Tracked and evaluated the LUT changes on the EDR products provide feedback to the SDR team (report)
   f) Participated in and coordinated team field work (AERONET – Seaprism and in situ data collection).
   h) Delivered an evaluation of the cloud mask of ocean color products (report).

2) **Coordinated the ocean EDR products**

FY13 – Tasks and Milestones

1) **VIIRS ocean color EDR product evaluation and algorithm stability**
   a) Assemble and maintain the collection of VIIRS RDR, SDR and EDR from Gravite, CLASS, AFWA for global Golden Regions
   b) Assemble and maintain the collection of in situ data from AERONET-OC, MOBY, BOUSSOLE and cruise data
   c) Monitor global EDR's using statistics of satellite with AERONET, MOBY, and cruise data at 27 Gold Regions with SAVANT tool
   d) Determine the stability of the VIIRS ocean products: 1. Track the vicarious adjustment using global regions; 2. Determine VIIRS products using ocean gyres; 3. Determine VIIRS EDR products at the AERONET coastal sites (AAOT, WaveCIS, etc.)
   f) Evaluate the IDPS ocean products and compare with L2 gen product and in situ data
   h) Collect and process ship, AERONET–WaveCIS and in situ data collection
   i) Provide EDR and SAVANT VIIRS data sets to the other team members

2) **Coordinate the Ocean EDR products**
   a) Develop reports and presentations of the activities in the cal/val program with Gravite and JPSS and NASA
   b) Arrange and participate in meetings, conference calls and provide summaries to the team members
   c) Prepare team for rehearsals with Gravite and DPD
   d) Provide schedules and activities on cruise and data exchanges with team members
   e) Participate in updates on DR with JPPS and provide feedback to STAR, NGAS and JPSS
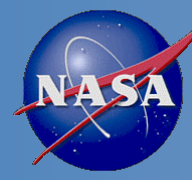
46
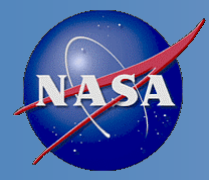
Curt Davis and Nick Tufillaro, OSU
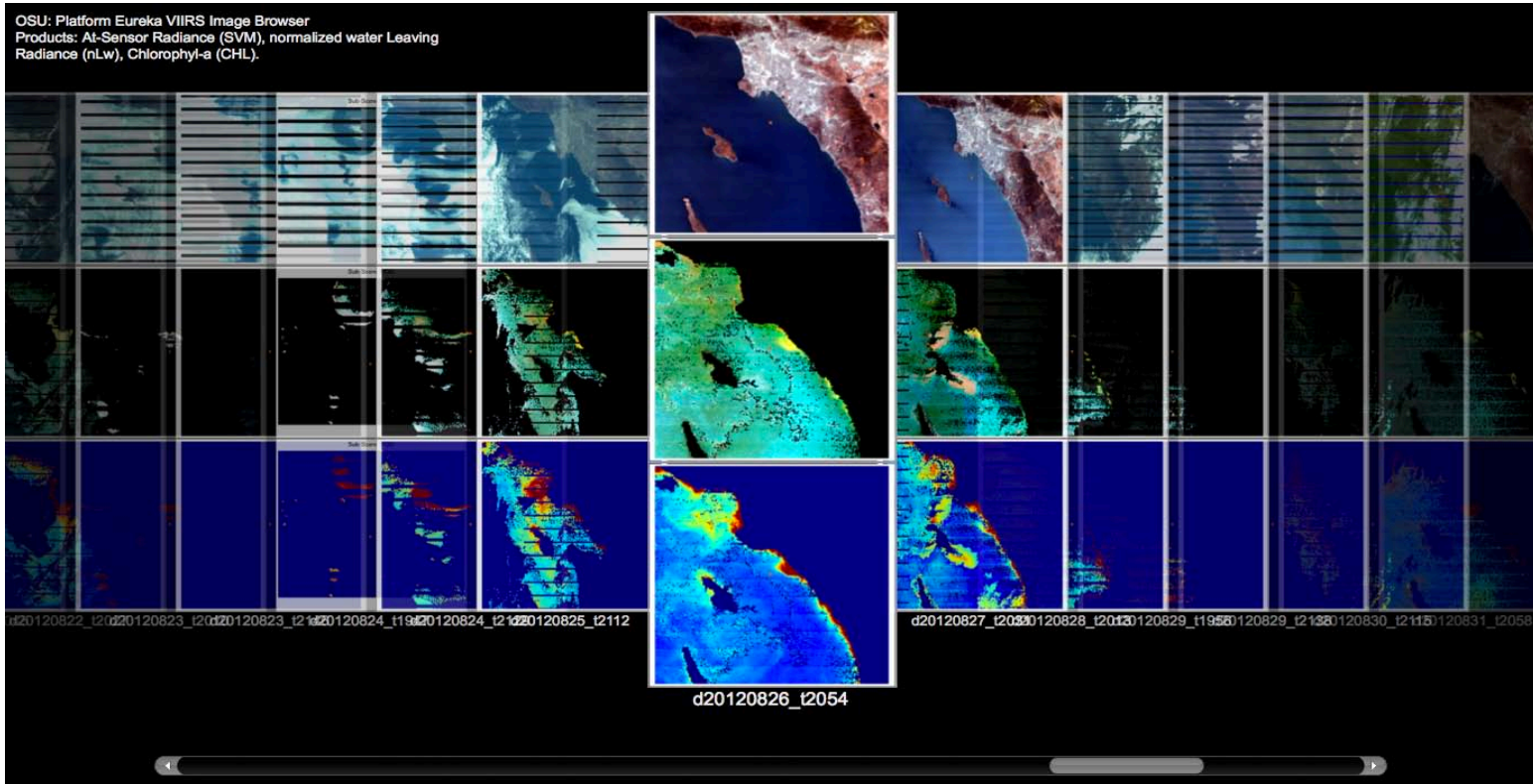
- Automatically extracting standard scenes for West Coast Golden Regions from MODIS data and VIIRS data processed by IDPS, APS and NASA
- Allows rapid scan through entire data set
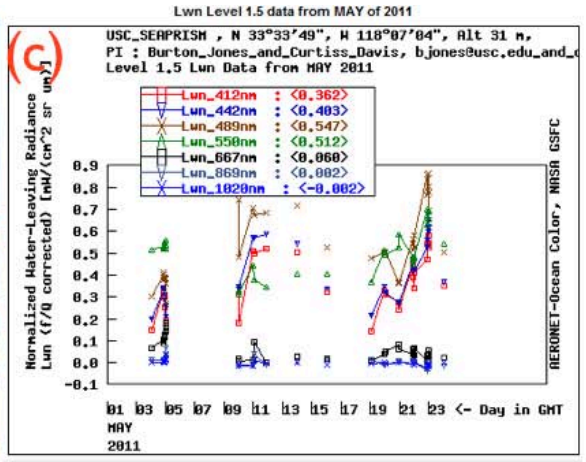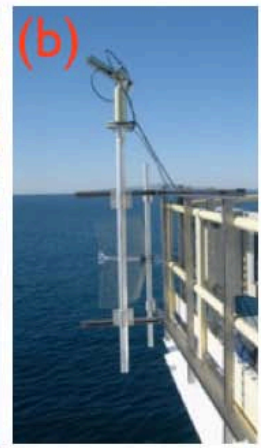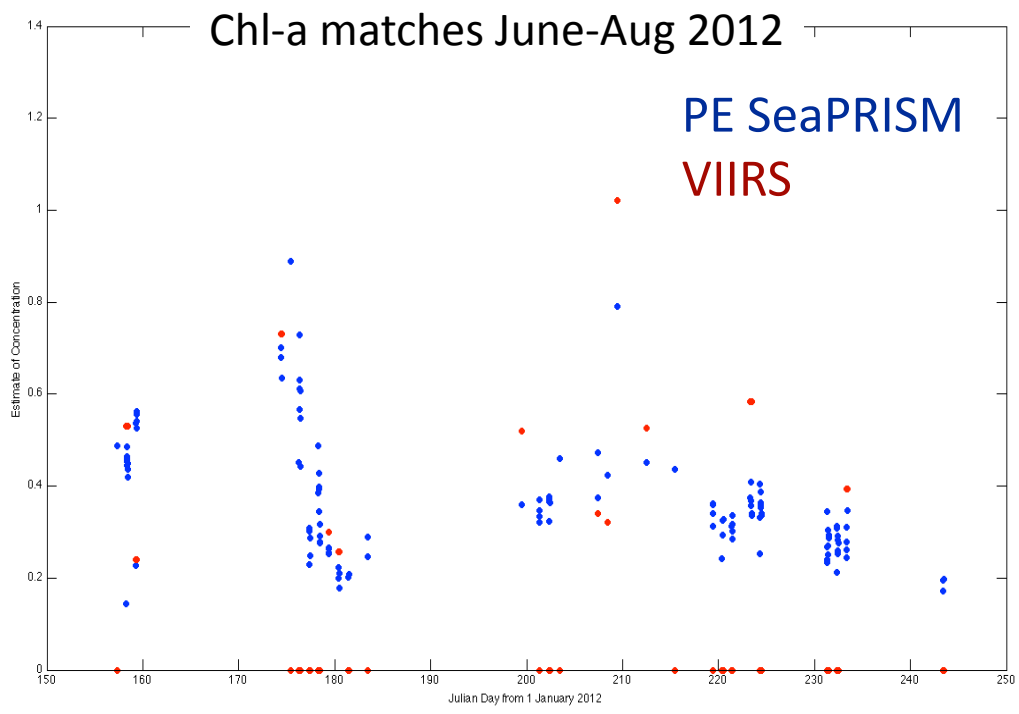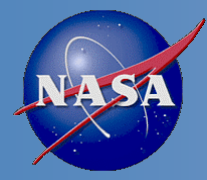- Developing tools for automated statistical comparisons of selected scenes
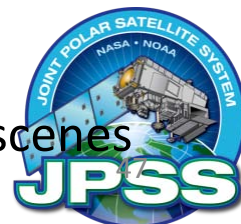
Curt Davis and Nick Tufillaro, OSU

- Work with Burt Jones (USC), and AERONET team to get Platform Eureka SeaPRISM working
- First comparisons of PE SeaPRISM data and VIIRS products
- Days with 0 chl-a values for VIIRS are lost due to flags

Chl-a matches June-Aug 2012

PE SeaPRISM
VIIRS

Ocean cal val
Schedule and Milestones

Curt Davis and Nick Tufillaro, OSU

- ## Past year Progress
  1. Receiving and evaluating VIIRS data and products from IDPS (CLASS), APS and NASA processing for West Coast Golden Areas.
  2. Developed automated archiving and browsing system.
  3. Operating West Coast ground station receiving VIIRS data on a routine basis
     - IPOPP processing producing land and atmosphere products, ocean products to come.

- ## FY13 – Milestones
  1. Processing and archiving Oregon Coast and HOT in situ data for VIIRS validation
  2. Validation of VIIRS water leaving radiances with Platform Eureka SeaPRISM data.
  3. Validation of VIIRS products for West Coast Golden Regions
     - Assess flags and other issues with IDPS processing
     - Comparing IDPS, APS and NASA VIIRS L_{wn} and chlorophyll products
  4. Evaluate new LUTs and vicarious calibrations (MOBY) as they become available.
  5. Continue real-time capture of VIIRS data and produce ocean products with NASA IPOPP software and compare to IDPS products.

Ocean Cal Val
FY-12 Accomplishments

CMRE - Centre for Maritime Research and Experimentation. C. Trees, A. Alvarez and G. Pennucci

1. Evaluation of the Uncertainty of the other Golden region using MODIS time series-acquisitions

In 2011, before the VIIRS launch, the Uncertainty analysis of MOBY and AERONET sites have been performed using MODIS time-series. Because the actual historical data set of VIIRS is not enough to perform a proper statistical analysis, the other Golden regions (MVCO,LISCO and Eureka) will be characterized downloading MODIS time series from NASA (intensive time demanding due to user supervision).
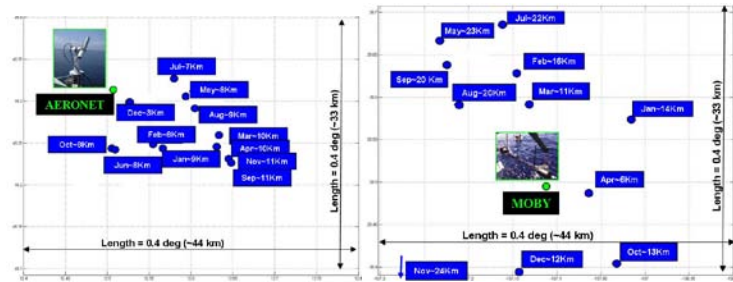
2. VIIRS imagery processing (in the GUI)

The available VIIRS satellite acquisition are processed as we did for MODIS, AVHRR and MERIS images, in particular:
- We include the VIIRS file format (hdf4 and hdf5) as input of our Matlab GUI (in order to automatically read VIIRS outputs from the GUI);
- The VIIRS gridded-data are registered to a map using the Lambert Projection;
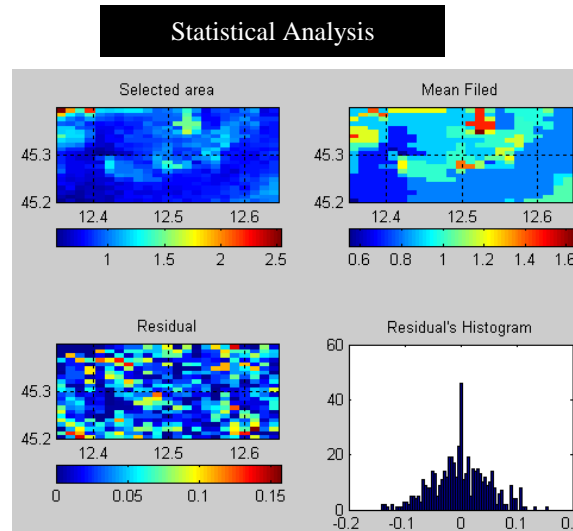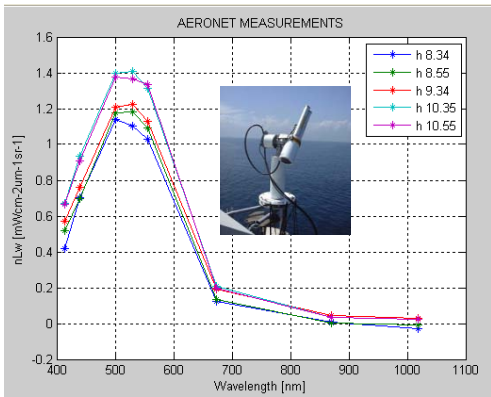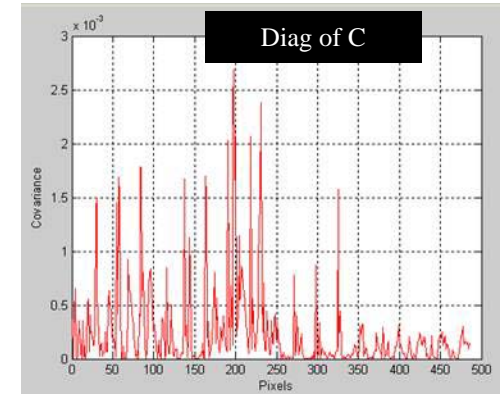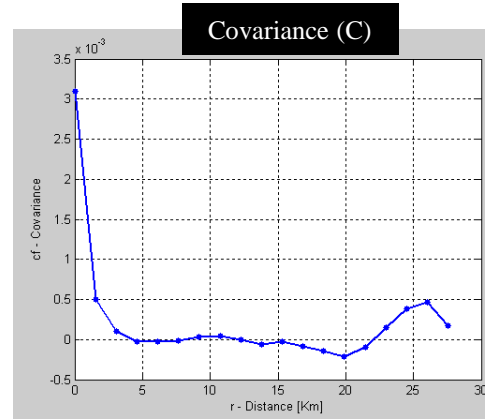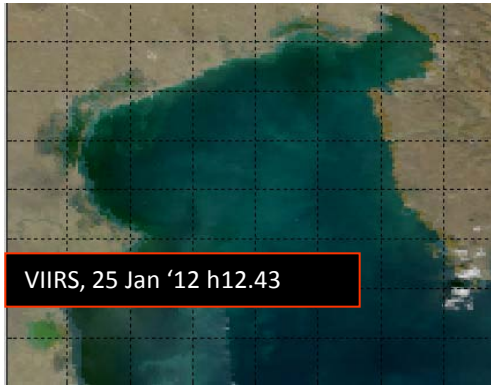- A database of the covariances of the available images will be created.
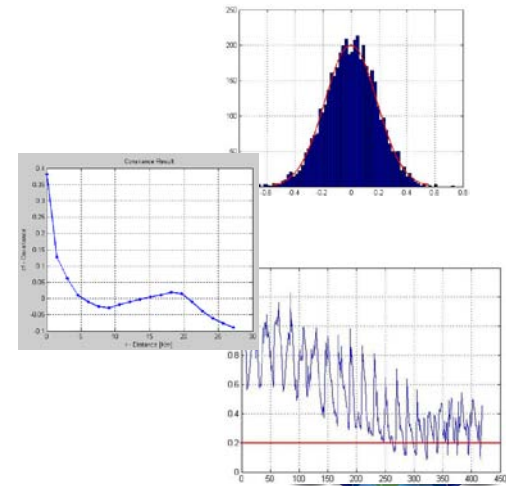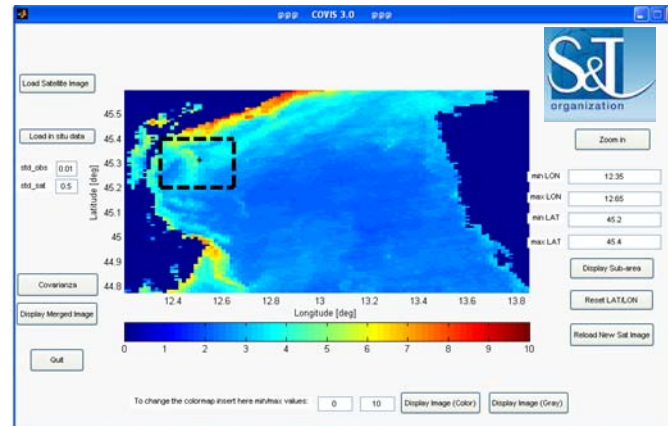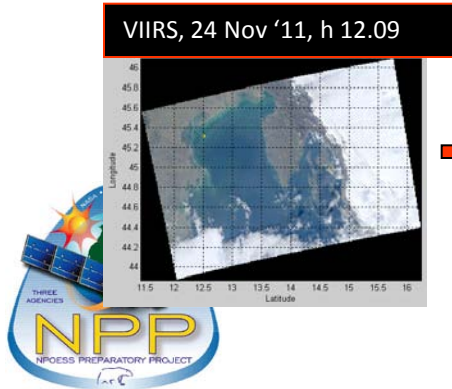
VIIRS, 24 Nov '11, h 12.09

Ocean Cal Val
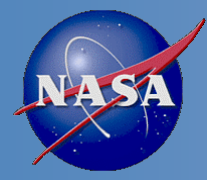# FY-12 Accomplishments

CMRE - Centre for Maritime Research and Experimentation. C. Trees, A. Alvarez and G. Pennucci

3. Analyses of NPP VIIRS satellite to merge with *in situ*

Once the VIIRS spatial analysis has been evaluated, we focus the attention on the Golden Regions areas and the VIIRS satellites images (with a cloud cover lesser than 10%-15%) are merged with the available *in situ* measurements (match-up).
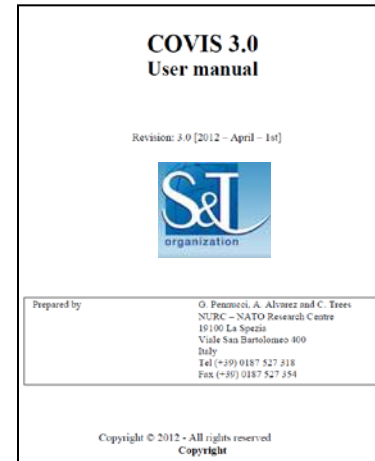

VIIRS, 25 Jan '12 h12.43

AERONET MEASUREMENTS

COVIS

Covariance (C)

Diag of C

Statistical Analysis

Selected area

Mean Filed

Residual

Residual's Histogram

Merged image
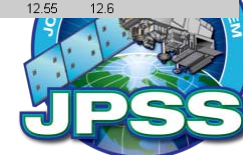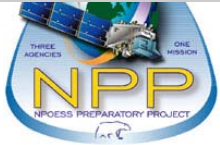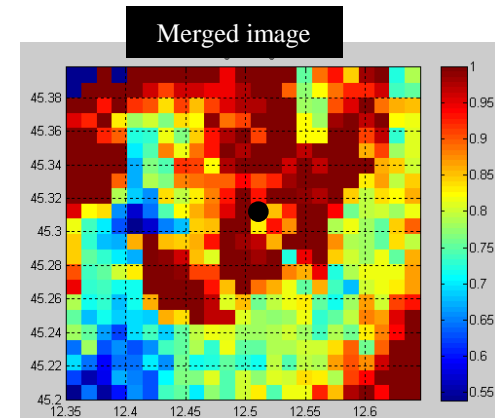
Ocean Cal Val
Schedule and Milestones

CMRE - Centre for Maritime Research and Experimentation. C. Trees, A. Alvarez and G. Pennucci
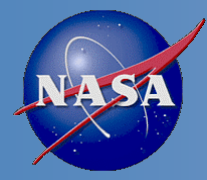
- ## FY12.

 1. A new software tool (COVIS) to ingest and process ocean color satellite images (including also the VIIRS NPP data format) was developed and delivered with user manual.

2. The methodology to investigate suitable *in situ* sampling locations to calibrate & validate remote sensing was applied on VIIRS data.

3. The uncertainty analysis of the MVCO, LISCO and Eureka golden regions is under processing.

- ## FY13 – Milestones

   1. Characterize the uncertainty of *in situ* data and apply to satellite matchups;

   2. Deliver a Seasonal Uncertainty Index-UI for the regional golden regions (MOBY, Ocean Gyres, AAOT, etc…);

   3. Deliver a tool for regional analyses of *in situ* data;

   4. Collect and process ship observations based on the *in situ* UI.

COVIS 3.0
User manual

Revision: 3.0 [2012 – April – 1st]

Prepared by

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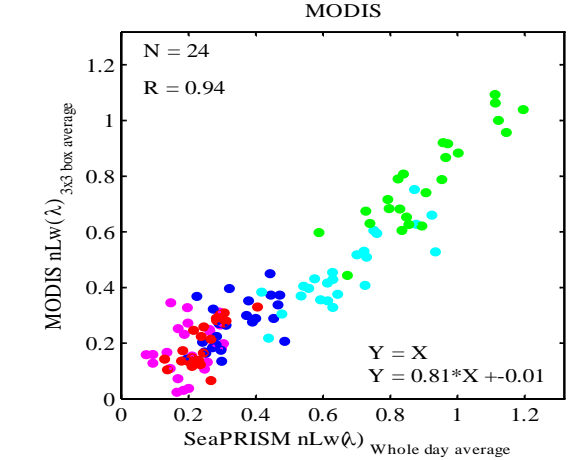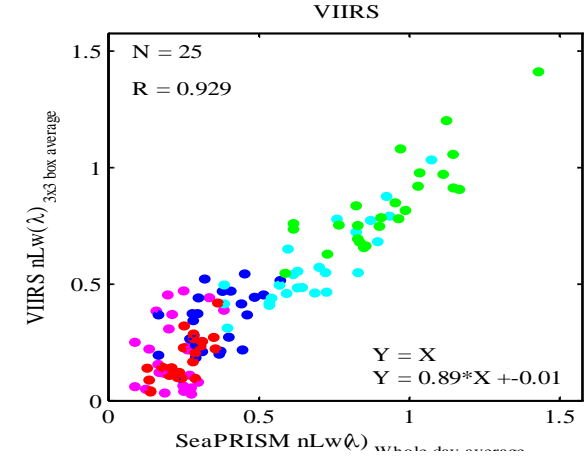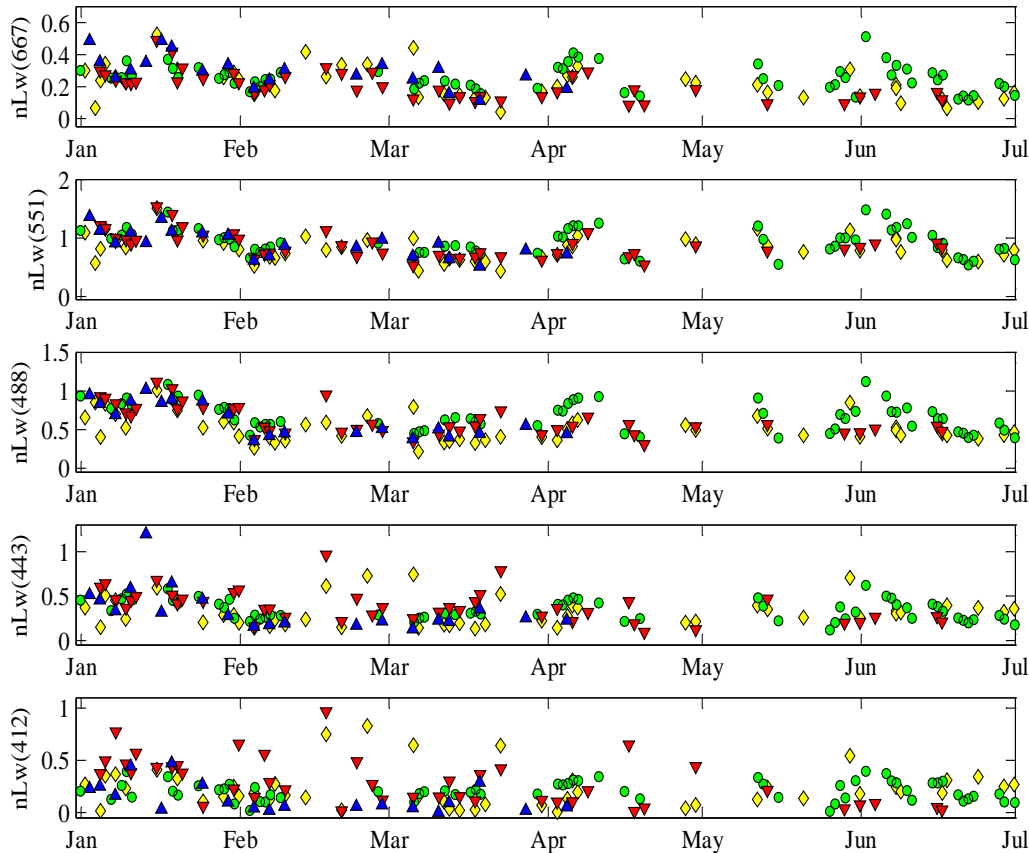Copyright © 2012 - All rights reserved
Copyright

Ocean Cal Val FY-12 Accomplishments

Principle investigator - Sam Ahmed (CCNY) - Coastal Site Data Uncertainties
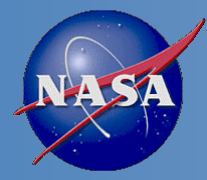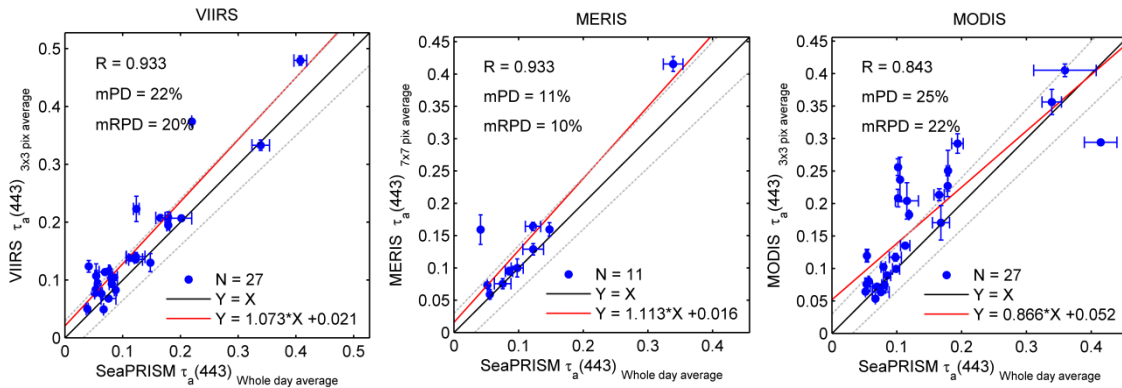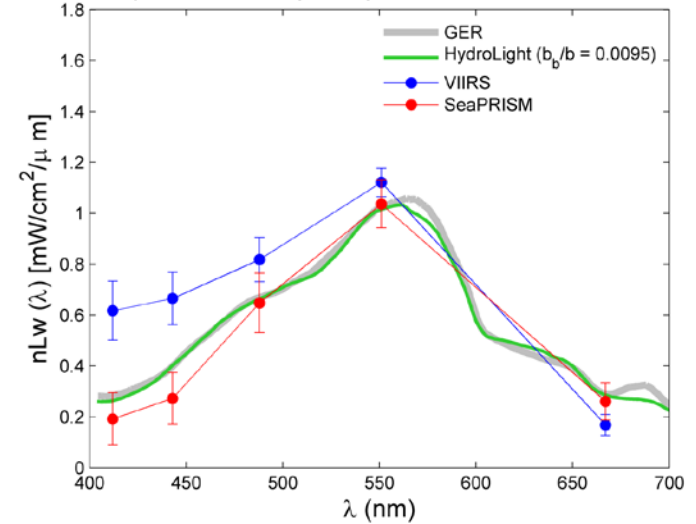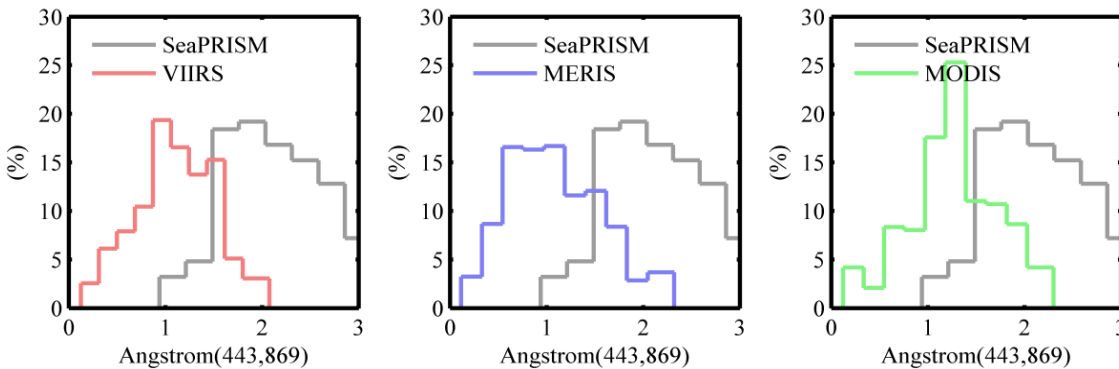and In situ Validation-LISCO

Time series of normalized water leaving radiance, nLw(λ), retrieved from SeaPRISM (green dots), MODIS (yellow diamonds), VIIRS (red triangles) and MERIS (blue triangles) at the SeaPRISM spectral bands (NASA processing).

Matchups between SeaPRISM and VIIRS, MODIS nLw

Data were also compared from NASA, CLASS (NOAA) and NRL processing

Principle investigator - Sam Ahmed (CCNY)- Coastal Site Data Uncertainties and In situ Validation-LISCO

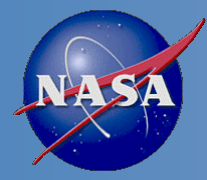Three field trips were conducted in the LISCO area and NY Bight

Matchup comparisons of aerosol optical thickness derived from satellite and SeaPRISM measurements (NASA processing) at LISCO site from January to June 2012.

Histograms of the % distribution of the Angstrom exponent for SeaPRISM and for VIIRS, MERIS and MODIS.
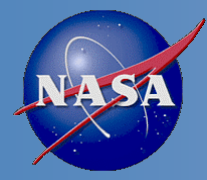

Comparison of nLw at the LISCO site from VIIRS, SeaPRISM, just below water (GER) and simulated based on the measured IOPs (Hydrolight)

Ocean cal val
Schedule and Milestones

Principle investigator - Sam Ahmed (CCNY)- Coastal Site Data Uncertainties
and In situ Validation-LISCO

- **Past year progress**
- Provided continuous flow of SeaPRISM data to NASA from the LISCO site since July 2011 (after instrument calibration at NASA) with proper site maintenance
- Conducted 3 field tests (2 in the LISCO area, 1 in NY Bight) with full set of instruments to measure reflectances and water IOPs.
- Analyzed data from the SeaPRISM and satellites: MODIS, MERIS and VIIRS (data processed by NOAA-CLASS, NRL Stennis, NASA) including water leaving radiances and atmospheric characteristics
- Modified webtool to incorporate VIIRS data
- Developed BRDF model for coastal waters and validated for the LISCO site
- 3 papers in Applied Optics, presentations at AGU Oceans, Feb 12, SPIE Security and Defense, Apr 12

- **FY13 – Milestones**
1. Maintenance of the instruments on the LISCO site to ensure proper data quality and data transmission to the NASA AERONET group (SeaPRISM) and to the CCNY server (HyperSAS), instrument calibration at NASA (SeaPRISM) and and Satlantic (HyperSAS).
2. Matchups between satellite data (MODIS, VIIRS) for the area of the platform and SeaPRISM and HyperSAS data. Comparison of data from CLASS, NASA and NRL Stennis. Evaluation of data errors and uncertainties of the AERONET /SeaPrism data stream (nLw and atmospheric parameters).
3. Comparison of satellite – SeaPRISM, satellite – HyperSAS and satellite –satellite data on the webtool, webtool modification and improvement.
4. Field measurements in the area of the platform and other areas of opportunity, and matchup with SeaPRISM and HyperSAS data.
5. Analysis of impact of light polarization on the removal of the reflected sky component

# Ocean Cal Val
FY-12 Accomplishments

Principal Investigator: Patty Pratt NGAS

- OMT selects granules in ROI for in-situ/cruise matchups or validation

- 32 standard outputs
  - Includes detector, scan position & HAM side data

- Automated PGE for 6 ROI's

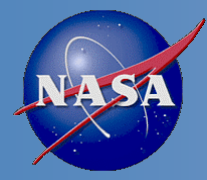Granule ID/start times d20120227 Florida Keys Cruise
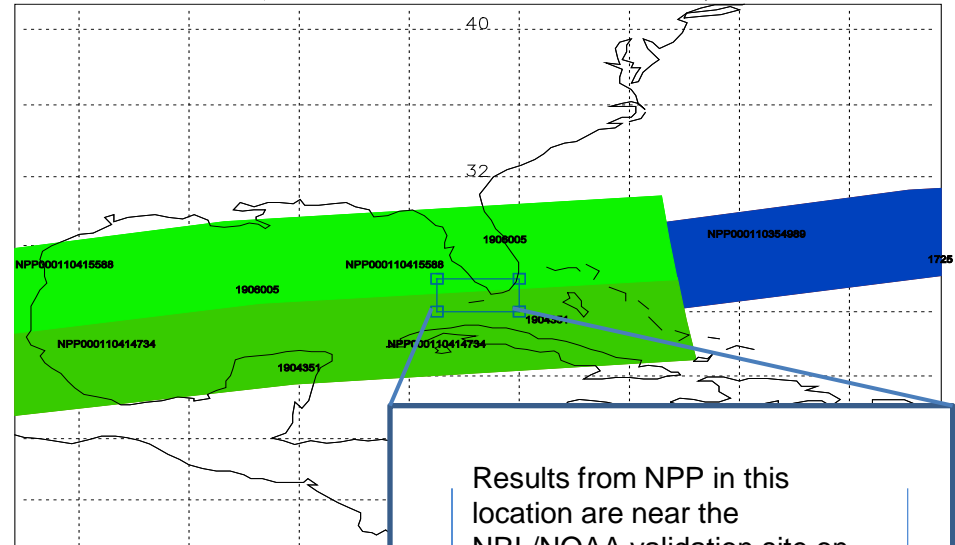
Results from NPP in this location are near the NRL/NOAA validation site on 02-27-2012
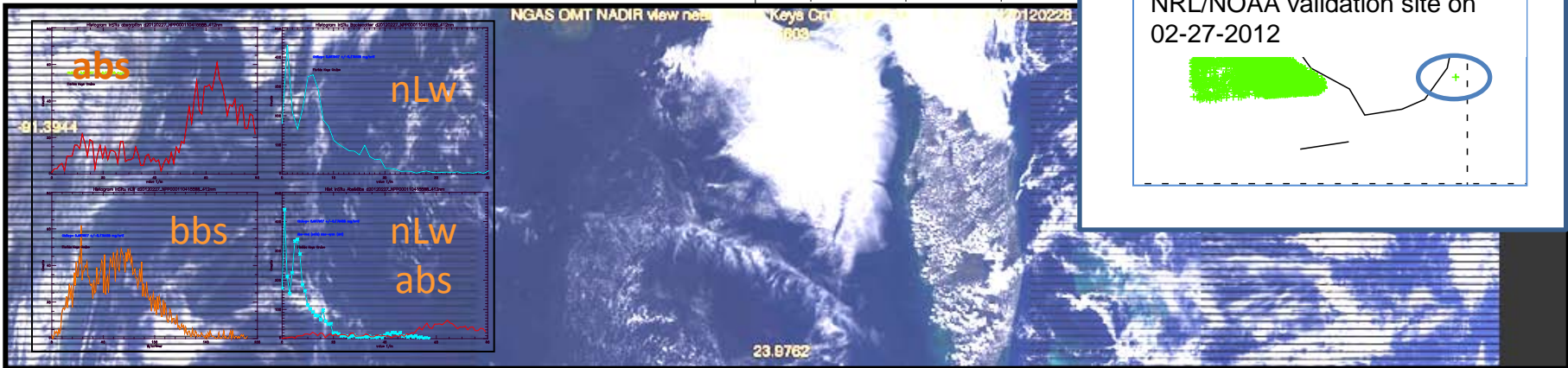
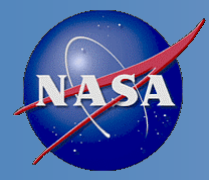| Granule Index	Longitude	Latitude	detector	scan	HAMside	pixel	SCpositionX	SCpositionY	SCpositionZ	Sensor Azimuth	Sensor Zenith	Solar Azimuth	Solar Zenith
427019	-80.121	25.701	11	2100	1	556	6.40E+04	-6.56E+06	2.98E+06	-9.59E+01	5.49E+01	-1.43E+02	4.08E+01
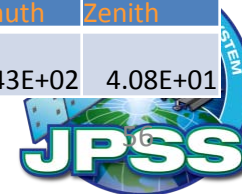
Ocean Cal Val
FY-12 Accomplishments

Principal Investigator: Patty Pratt NGAS

- PVT uses daily SPG OMT output
  - for sensor-centric on characterization
- Samples of data shown below for detector, scan position & HAM side dependence
  - Provides data for Polarization Verification Analysis
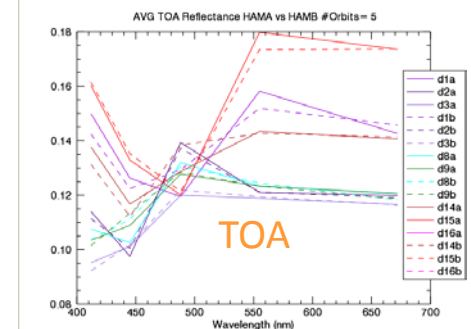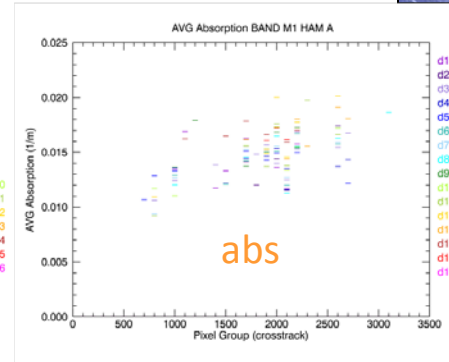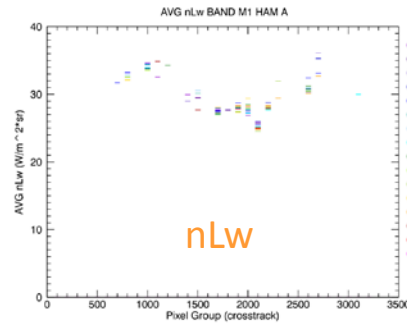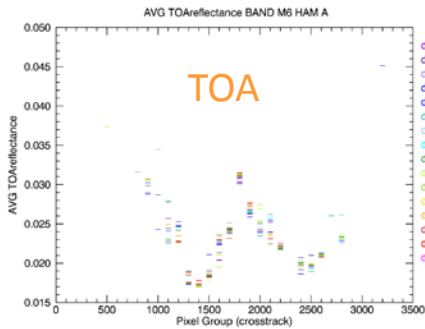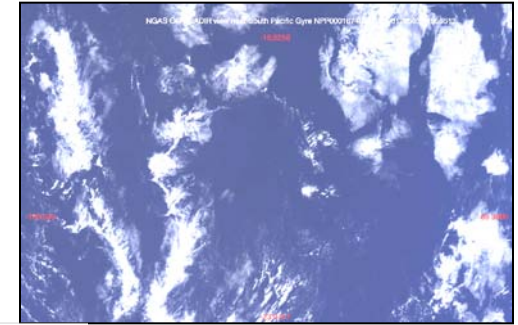
PVT Analysis & Trending Tool shows scan and detector dependencies over time
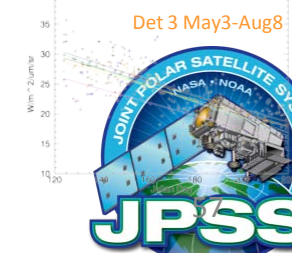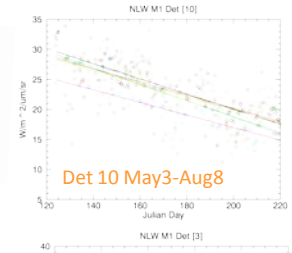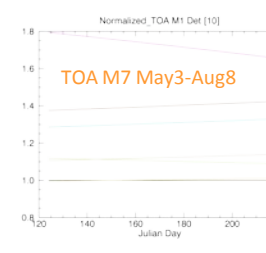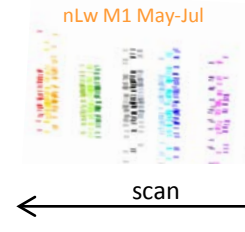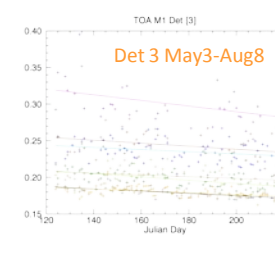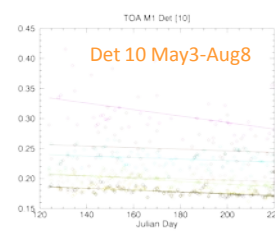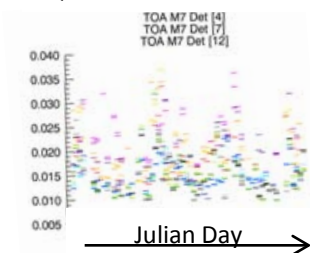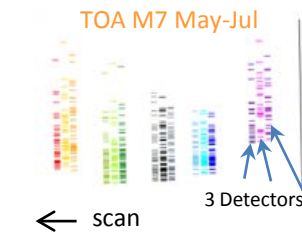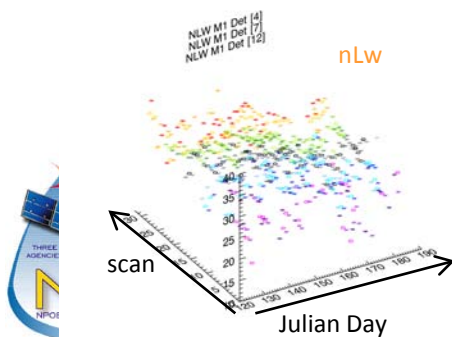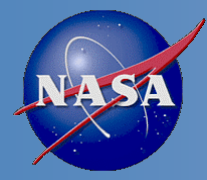
Principal Investigator: Patty Pratt NGAS

- Past year progress
  - Completed and delivered OMT and PVT
  - Integrated OMT as PGE
  - Developed a process to capture and analyze daily high quality pixels
  - Developed PVT Analysis &Trending Tool -ongoing
    - Sensor-centric approach to viewing data over stable ocean cal target (South Pacific Gyre) for Polarization Verification and characterization

- FY13 – Milestones
  1. Develop standard outputs
  2. Optimize PVT trending tools
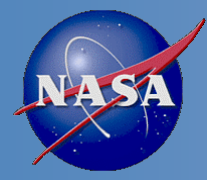 3. Perform Polarization Verification Analysis

Principle investigator : Michael Ondrusek

FY12 - In situ/satellite matchup efforts to support NPP VIIRS Calibration and validation.

- Organized Hyperpro collection and processing protocols for Cal/Val team – Included investigators from NOAA, NASA, NRL, and Academia as well as Satlantic engineers to define processing criteria. Documented and provided protocols and processing software to Cal/Val Team.

- Conducted in-water Hyperpro and above-water validation measurements in the Chesapeake Bay and provide matchup data to Cal/Val Team. Conducted first clear sky Hyperpro ocean color validation measurements on the Chesapeake Bay on 12/1/11. Conducted other measurements in the Chesapeake Bay on 2/3/12, 3/27/12, 5/11/12, and 7/3/12 In process of matching up with VIIRS data. Share data with VIIRS Cal/Val Working Group.
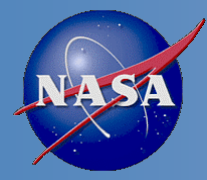
Principle investigator Michael Ondrusek

- Participated in South Florida Program Cruise (WS1118) on board the R/V *Walton Smith* to conduct validation and inter-comparison measurements and demonstrating NOAA Hyperpro protocols to NRL and FSU. Processed data and share with VIIRS Cal/Val Working Group.

- Participate in MOBY shadowing experiment off Honolulu, HI. Conducted Hyperpro, ASD and other in situ measurements in support of MOBY optics characterization and VIIRS cal/val activities.

- Purchased ASD Hand-Held 2 above-water radiometer for in situ validation measurements. These measurements compliment the Hyperpro in-water measurements increasing the reliability of the validation measurement, especially in coastal waters.
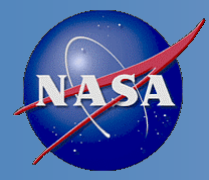
Principle investigator Michael Ondrusek

FY13 – Milestones

1. Continue working with VIIRS Cal/Val in situ team and other investigators to analyze validation collection protocols and ensure in situ data reliability between groups and over time. This data is essential for consistent validation of the VIIRS ocean color sensor

2. Continue in situ/satellite matchup efforts in the Chesapeake Bay and other areas to support VIIRS cal/val. Provide VIIRS matchup data to Cal/Val Team.

3. Participate in NPP VIIRS initialization and validation data collection in the Chesapeake Bay and other regions with Cal/Val team members. Provide VIIRS matchup data to Cal/Val Team.
   - VIIRS products to be validated include:
   - Normalized water-leaving radiances.
   - Chlorophyll a
   - Backscatter coefficients
   - Absorption coefficients
   - CDOM
   - TSM

4. Submit and support shiptime request to NOAA NMAO for FY14 dedicated VIIRS Cal/Val Team validation cruise off the continental US.
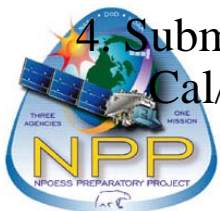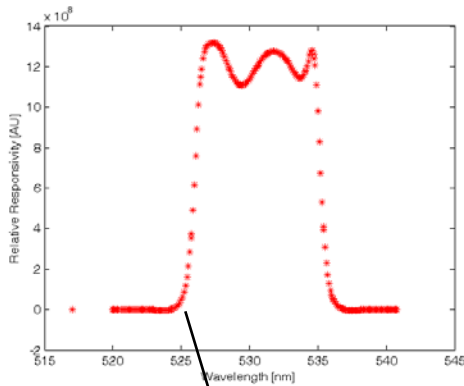
Carol Johnson, NIST

EDR Ocean Color Traceability for the JPSS VIIRS Sensor SeaPRISM Characterization on SIRCUS
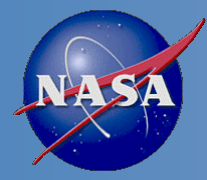

The relative shape of the spectral response agreed with GSFC's filter transmittance values, but **negative values in the <u>out of band</u> and <u>apparent nonlinearity</u> in one channel measured raises several questions** (that need to be addressed in FY13).

Negative values

Apparent nonlinearity
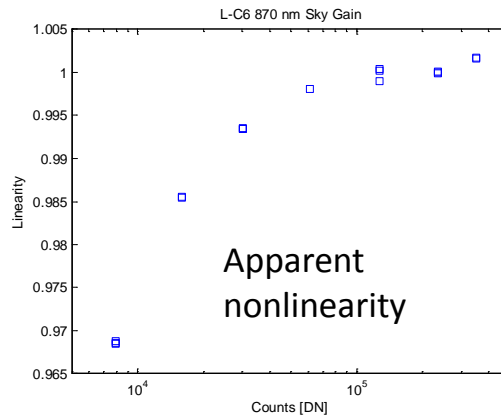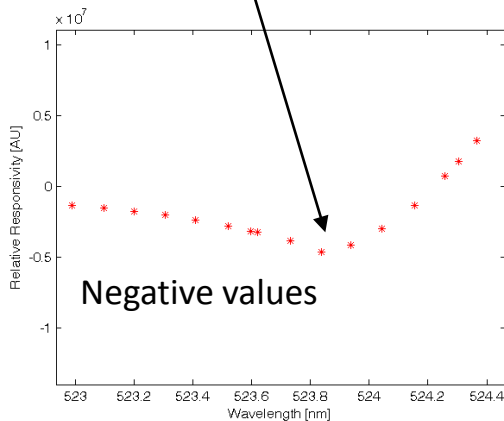
FY-12 Accomplishments:
•Hypothesis developed: The CIMEL internally subtracts background, and if the value is negative, reports a positive value.
•SIRCUS used an external shutter for backgrounds. The effect is amplified for low flux levels.

Carol Johnson, NIST

EDR Ocean Color Traceability for the JPSS VIIRS Sensor
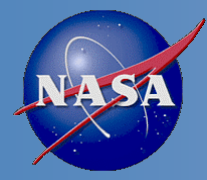
Long Island Sound Workshop

- Long Island Sound Experiment (2010)
- Data collected by Ondrusek (STAR), Arnone (UMS-NRL), Lee (UMB), and Ahmed (CUNY)
- Goals: instrument protocol and data inter-calibration
- Three test reflectance standards were measured by the participants as controls

  If we can't get the correct (and same) reflectance for standards, how can we get the correct Remote Sensing Reflectance?

FY-12 Accomplishments:
- The 0/45 BRDF of the three samples was measured at NIST.
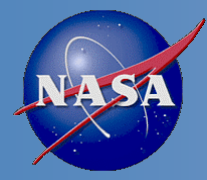- The participant's results for the samples will be presented at the 2012 Fall AGU meeting.

Carol Johnson, NIST

FY-12 Accomplishments:

- Hypothesis developed for behavior of SeaPRISM on SIRCUS – impacts measurements of low radiance sources (e.g. water ⟶ matchups ⟶ VIIRS validation)

- BRDF measurements of Long Island samples completed

- FY13 – Milestones

  1. Address the out of band and nonlinearity in one SeaPRISM radiometer (AERONET-OC instrument);

  2. "SeaPRISM Characterization" document to JPSS; and
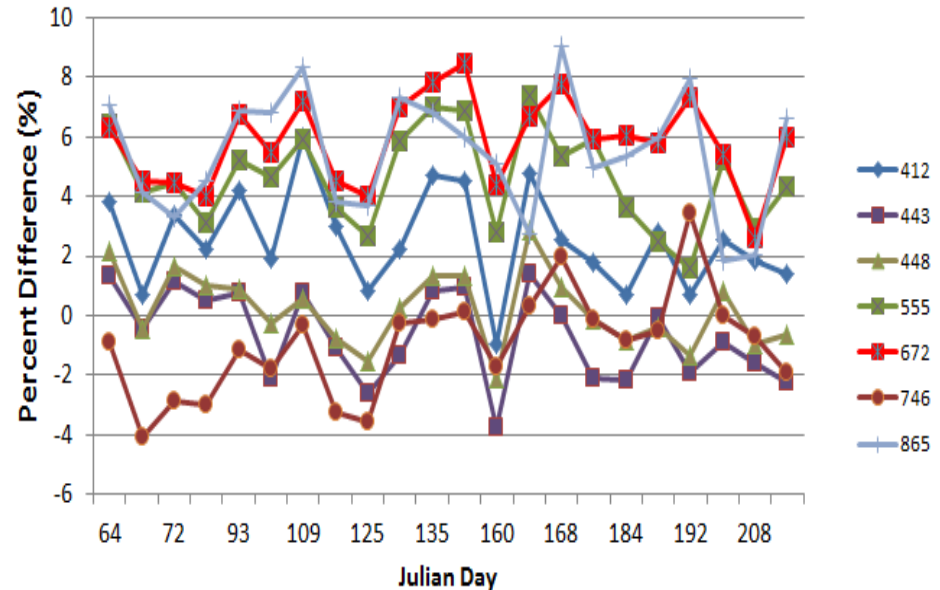
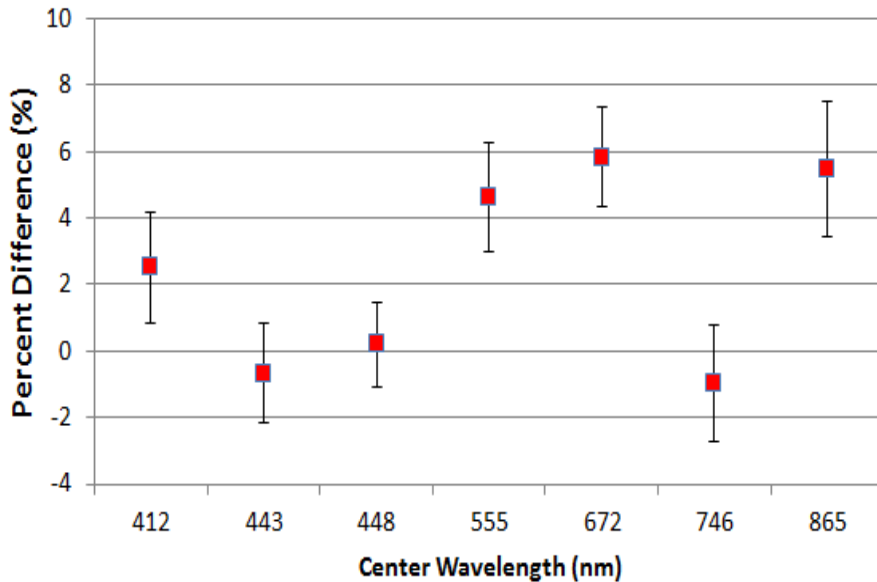 3. "Long Island Sound Experiment" document to JPSS.

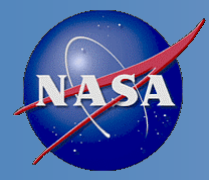**Principle investigator** : ZhongPing Lee/UMB

- ## VIIRS-MODIS TOA cross-comparison

- **Percent differences (left, %) represent (VIIRS-MODIS)/MODIS and are averaged for 24 scene pairs. Error bars are associated with one standard deviation calculated for all the scenes (n=24).**
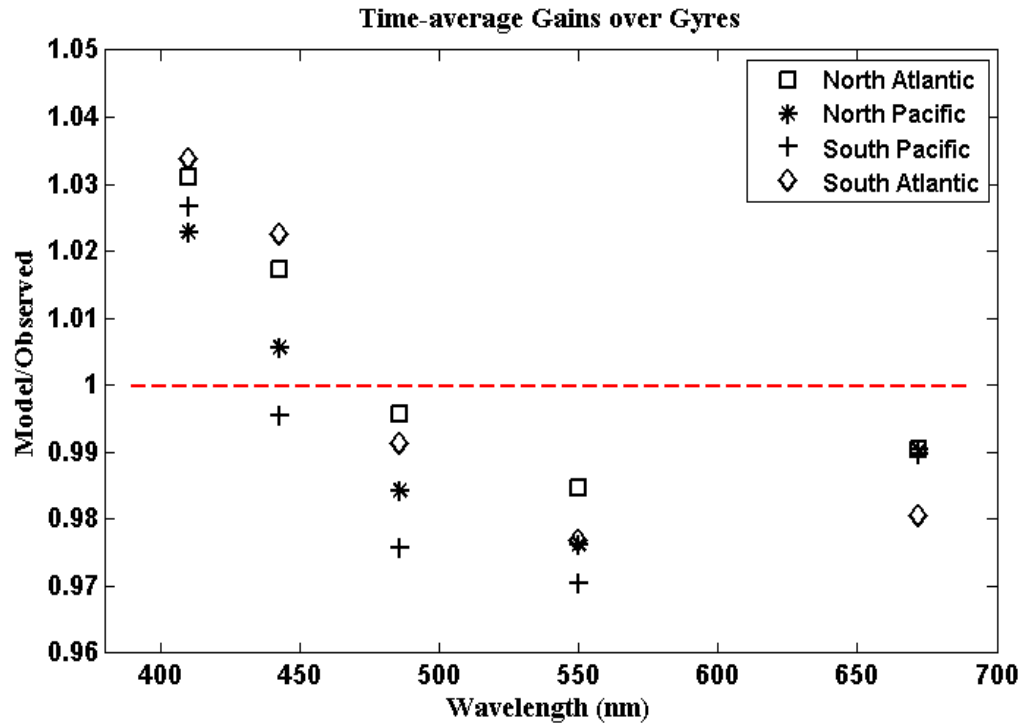- **Time series (right) indicates relatively stable differences for all the bands.**

Ocean Cal Val
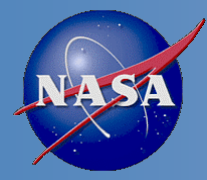# FY-12 Accomplishments

Principle investigator : ZhongPing Lee/UMB

- ## VIIRS gains derived from gyre waters

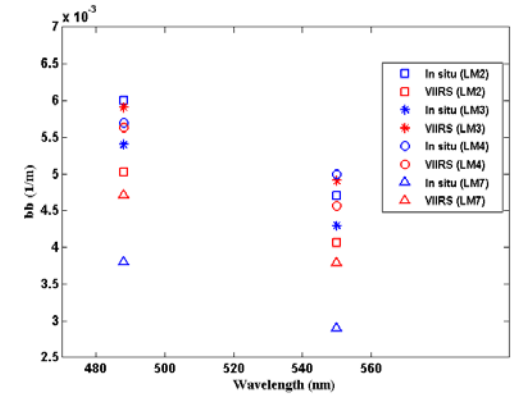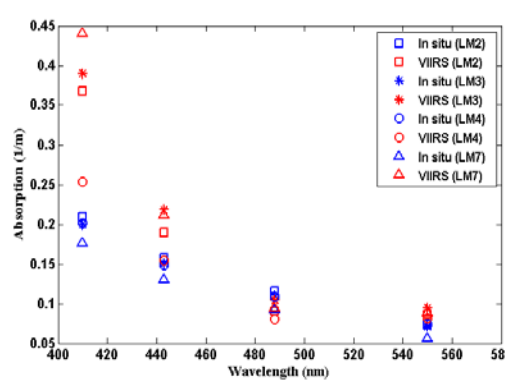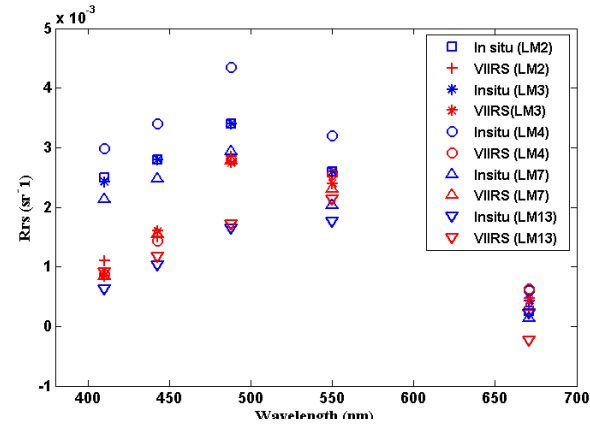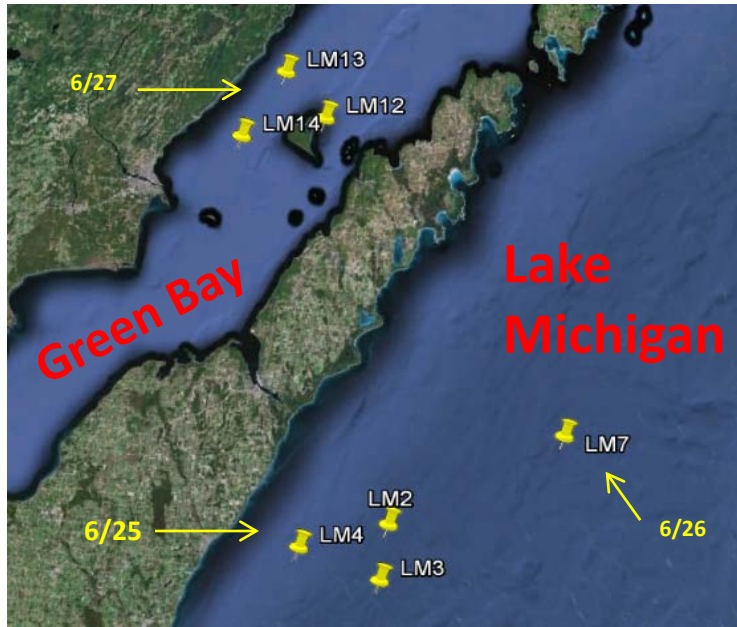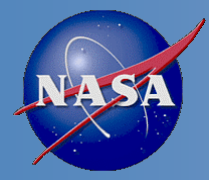**Gains derived from gyre waters are found quite stable/consistent.**

Principle investigator : ZhongPing Lee/UMB

- Rrs and IOP comparison over lake waters (June 25-27, 2012)

VIIRS Rrs is lower in the blue bands, possibly a result of inadequate aerosol properties in the processing algorithm; consequently higher VIIRS absorption coefficients in the blue bands.

Ocean cal val
Schedule and Milestones

Principle investigator : ZhongPing Lee/UMB

- ## Past year progress
  - Systematic comparison between VIIRS and MODIS TOA radiance
  - Found stable gains using gyre waters as reference
  - Finished preliminary comparison of VIIRS products in inland lakes

- ## FY13 – Milestones
  1. Continue monitoring VIIRS gain using gyre waters as reference
  2. Finalize VIIRS data product validation in the lakes
  3. Validate VIIRS data product in the coastal zones (e.g. Massachusetts Bay)