Identifying the in situ data stream for NPOESS Ocean EDR

1) Define a VIIRS Proxy Data Stream

2) Define the required in situ data stream for Cal/Val

3) Tuning of algorithms and LUTS (Vicarious calibration and SDR feedback)

4) Ocean Algorithm, stability evaluation and uncertainty

5) Product validation and product long-term stability

6) Satellite inter-comparisons, robustness, seasonal and product stability

Presenter/Affiliation: *Giulietta S. Fargion, San Diego State University*

Performers: *Giulietta S. Fargion*

Trust area: "*2-Define the Required in-situ Data Stream for Cal/Val*"

Award date: From 8/3/2009 to 3/31/2010 (**Yr-1**)

Total Man-Months Effort:

FY09	FY10	FY11
2.6 months------	*5 months*	-------

Identifying the in situ data stream for NPOESS Ocean EDR

Project Objectives

Yr 1 (8/09 to 3/10):
• Define the required in-situ data stream for Cal/Val (element #2, see milestones below)

Yr 2 (*3/10-2/11*):
• Matchup with AERONET-OC and ocean products
• AERONET-OC protocols: coordinate update
• Update ship data collection
• Provide managerial support on the Cal/Val plan ✓
• Team working group coordination and Q Reports ✓

Milestones / Deliverables

		FY 09 1 2 3 4	FY10 1 2 3 4	FY11 1 2 3 4
1.	**Identify potential in situ data streams for cal/val, both national and international**	-----	D-C	
2.	**Describe existing in situ data tools**	------	D-C	
3.	**Team Working Group, Q-reports; managerial support**	------	---	

D= document; C= complete

Major Yr 1 on Challenges/Issues

- Recommended HPLC analyses for the upcoming Cal/Val cruises; needs funding allocation (HPL $67 each sample)
- NOAA and NAVY Cal/Val cruises at VIIRS launch: need a sliding time window with PI team commitment
- Ship-of-opportunity data collection from the ocean VIIRS Team: requires yearly update; new sources of in situ data for Cal/Val need to be monitored (upcoming NASA NRA's and international data);
- Alternative database and QA/QC should be identified (NASA approval still pending)

Major Progress Points

1) The delivery document is completed and addresses the following items: a) define existing methods/protocols and coordinate in situ data for Cal/Val (task 9); and b) identify potential in situ data streams for Cal/Val national and international efforts (tasks 6, 7, 10);
2) Initial SeaPRISM working group & workshop with Team SeaPRISM done (2/22/10);
3) NASA SeaBASS archive for in situ collection: pending formal approval by NASA HQ;

The field data collected by the Cal/Val team leverage on-going efforts

Collaboration and Coordination with Inside and Outside Activities

1) *"In situ Data Management" Working Group*: G. Fargion, Lead. Members: Stumpf, Ondrusek (NOAA); Davis, R. Letelier (Universities); NAVY: Arnone, Trees (NATO); NASA: Turpie; J. Feeley (NPOESS).

Initiated and follow up discussion with NASA on:

- *SeaBASS*: Werdell, Bailey (GSFC), Bontempi (HQ);
- AERONET-OC & MAN: Holben, Smirnov

2) "*AERONET SeaPRISM Data: Set up, Data Management & Maintenance*" Working Group: Fargion and Davis Co-Lead. Members: Gibson, Gilerson, Ahmed, Jones (US Universities); NAVY: Arnone, Weidemann; Johnson, Parr (NIST); Zibordi, D'Alimonte (JRC); Brando, Dekker (CSIRO, Australia).

Transition Partners

In situ data collection plan & protocols will be shared with the larger ocean color community, NPP (IPO), NOAA (NESDIS), NASA (SeaBASS), NAVY

Leveraged RDT&E Projects

1. NASA in situ archive (SeaBASS): established with documented QA/QC protocols, standardized data format.
2. The Maritime Aerosol Network (MAN) component of AERONET provides ship-borne aerosol optical depth (AOT) measurements from the MicroTops sun photometers. Established and documented expertise in calibrating pre-post cruise of MicroTops instrument and standardized AOT data processing;
3. AERONET-OC standardized measurements performed at different sites with a single measurement system and protocol; SeaPRISM calibrated with an identical reference source and method, and processed with the same code.
4. NASA-SIMBIOS Ocean Protocols (Mueller & Fargion, 2004)

International Partnerships

- Giuseppe Zibordi and David D'Almonte, Global Environment Monitoring Unit, Institute for Environment and Sustainability, Joint Research Center, Ispra, Italy
- Vittorio Brando (CSIRO), Australia

Identifying the in situ data stream for NPOESS Ocean EDR

Yr 1 - MILESTONES Completed In Progress

- **Define the required in-situ data stream for Cal/Val**

Through conference calls and email the "In situ Data Management" working group discussed and addressed the following tasks:

a) What is planned for the cruises of opportunity FY09-10-11 by PI (dates/location/# stations). What are we sampling (parameter: surface/vertical) and how (instruments/protocols/calibration scheme/processing software version)?

b) Need one data management center and standard formats and protocols. Need to develop policy for database delivery times for in situ data. Involvement with NASA SeaBASS (QA/QC & archive).

- **Both tasks were addressed and completed**. Spreadsheet of planned cruises of opportunity was compiled (including SST) and delivered;
- **Delivered the document** that addresses the following items: a) define existing methods/protocols and coordinate in situ data for Cal/Val (task 9); and b) identify potential in situ data streams for national and international Cal/Val efforts (tasks 6, 7, 10);

The field data collected by the Cal/Val team **leverage on-going efforts**, satisfy the required measurements for validation match-ups, and follow collection protocols

PI	Region		Funded	Parameters/instruments
Gould/ Arnone (NRL)	Gulf of Mexico	Station profiles, discrete water, samples, underway	Yes (2011)	temp, sal, HPLC, a(λ), c(λ), b(λ), bb(λ), filter pad ,abs (phyto, detrital, CDOM),TSS/PIM/POM, VSF, particle, size, above-water Rrs, POC, DOC, chl fluorescence ac9, ac-s, CTD, LISST, MVSM, ASD fieldspec, ECO, VSF3, WETstar, Hydroscat Note: HPLC will be done at HPL
	Australia	Mooring, gliders, underway	Yes (2011)	temp, sal, c(650), bb(3λ), chl/CDOM/phycoerythrin fluorescence, Ed(7λ), CTD, 7 channel OCR, ECO, fluorescence, triplet puck
D. May (NRL)	TBD	Ship Time (2 weeks)	Pending 2011	Cal/Val team activity
C. Trees (NURC)	Gulf of Cadiz & Alboran Sea	Station profiles, discrete water, samples, underway, gliders	Yes (2011)	HyperPRO profiles-hyperspectral; MiniPRO profiles-9 wavelength; MiniPRO profiles-9 wavelength; ac-9; acs; Scattering meter-HydroScatt; Towed vehicle with CTD and bb/fluor-ScanFish Particulate abs-filter pad; CDOM and particulate abs from integrating sphere TSM, HPLC pigments; Slocum gliders with 4-channel irradiance and chl and CDOM fluor. Note: HPLC will be done at HPL
Weidemann	East Sound, WA	Station profiles, underway	Yes (2011)	temp, sal, a(λ), c(λ), b(λ), bb(3λ), chl/CDOM/phycoerythrin fluorescence, Ed(7λ), VSF, particle size. ac9, ac-s, CTD, LISST, MVSM, ASD fieldspec, ECO, VSF3, fluorescence, triplet puck, 7 channel, OCR, MVSM, LISST
R. Stumpf (NOAA)	Lake Erie, Puerto Rico, Virgin Island, possible other locations	Ship of opportunity	Yes On-going	Rrs 9Hyperspectral, 400-800nm), ac-9 (occasionally) TRiOS Ramses SAM_8188, ASD FieldSpec HH_1399, WetLabs ac-9, Wetlabs bb2F

Identifying the in situ data stream for NPOESS Ocean EDR

Eight Working Groups in total among Ocean Team

Topic	Tasks	Lead	Team Members	Status
4. In-situ data collection/management	Identify field activities, sites, protocols, data QA/QC, data management	**Fargion**	Davis, Stumpf, Ondrusek, Trees, Arnone, Turpie	***Completed***
2. AERONET SeaPRISM	Establish US sites, and International Coordination; Protocols, data QA/QC	**Fargion** & Davis	Gibson, Gilerson, Ahmed, Jones, Arnone, Weidemann; Johnson, Parr; Zibordi, D'Alimonte; Brando, Dekker	*On going, No issues to report*
5. Automated matchup / uncertainty of in-situ data with satellite data	AERONET match up software; MOBY matchup procedures; validation data matchup procedures; develop common tools	Arnone	Turpie, Davis, Stumpf, Ondrusek, **Fargion**, Wang, Lawson	*Will start in Spring 2010*
6. Vicarious calibration methods	Using MOBY, central gyres, coastal/open ocean, etc.	Wang	Davis, Stumpf, Ondrusek, **Fargion**, Gould.	*Will start in Spring 2010*

Identifying the in situ data stream for NPOESS Ocean EDR

Yr 2 MILESTONES **Completed** **In Progress**

- **AERONET-OC**

Through conference calls, email and workshop the "AERONET SeaPRISM Data: Set up, Data Management & Maintenance" working group discussed and covered the following topics:

SeaPRISM system; Measuring protocol;
Requirements for deployment sites;
System installation; System operation and maintenance;
System calibration;
Data access; Processing, Quality assurance,
Strengths and weaknesses of the system;
Applications; Data processing, Strengths and weaknesses

Target goal: The estimate of the overall uncertainty budget in AERONET-OC L_{wn} has shown values typically below 5% at the blue and green center wavelengths (D'Alimonte et al. 2008; Zibordi et al. 2009)

Identifying the in situ data stream for NPOESS Ocean EDR

Yr 2 Milestones (Started 3/1/10)	Delivery plans
• Matchup with AERONET-OC and ocean products	AERONET-OC statistical AOT & L_{wn} site characterization and match-ups with satellite ocean products (effort with staff at NRL/Stennis).
• AERONET-OC protocols *(update)*	Document (could be joint with NIST/JRC)
• Update VIIRS Team ship data collection and new US and international opportunities	Table
• Leading and participating in the Team working groups	Documents, presentations, etc.
• Provide managerial support on the Cal/Val plan execution and coordination, including Quarterly Reports	Documents, presentations 1st Quarterly Report (done)

Identifying the in situ data stream for NPOESS Ocean EDR

Status and Issues (Yr-1):

1. Deliverable: *Define existing methods/protocols and coordinate in situ data for cal/val (task 9)*
    1. Dates achieved: March 31, 2010
    2. Development status: 98% (percent complete at time of review)
    3. Major technical issues and their impacts: *None*
2. Deliverable: *Identify potential in situ data streams for Cal/Val national and international efforts (tasks 6, 7, 10)*
    1. Dates achieved: March 31, 2010
    2. Development status: 98% (percent complete at time of review)
    3. Major technical issues and their impacts: *None*

Identifying the in situ data stream for NPOESS Ocean EDR

Status and Issues (Yr-2):

- Deliverables:

1. *Provide managerial support on the Cal/Val plan* ✓
2. *Team working group coordination and Q Reports* ✓
    1. Start Date: October 2009 (before scheduled start date- 3/10)
    2. Development status: 30% (percent complete at time of review)
    3. Major technical issues and their impacts: *None*

- Deliverables *(expected delivery End Yr-2)*:

3. *Matchup with AERONET-OC and ocean products*

    Work done in collaboration with NRL staff; first visit on 4/12/10

4. *AERONET-OC updated protocols (maybe jointly with NIST/JRC);*
5. *Update ship data team collection (ocean color);*

Identifying the in situ data stream for NPOESS Ocean EDR

Impact of Deliverables on Program

Prepare for Ocean Cal/Val Campaigns
(*critical following launch FY11*)

Require major Cal/Val cruises following launch
Agree to protocols for in-situ data collection and processing (QA/QC)
Pre-post instrument calibration, centralized database (SeaBASS)
Agree on parameters for situ data (bio-optical, atmospheric and SST)
Wide range of water types, atmospheric conditions and seasons
Coordinate with Climate Data Records

IMPACT: **Preparation for Cal/Val procedures**

establish required ship program data sets
define required measurement protocols and uncertainties
define the tools, data management structure

Note: In situ data collected for calibration and validation uses the same measurements and the same methodologies, but calibration requires lower measurement uncertainties. This means that the sampling site must have minimal natural variability (oceanic and atmospheric), in order to reduce total uncertainty

Identifying the in situ data stream for NPOESS Ocean EDR

Preparation steps for cal/val procedures (*guidelines*):

- *Data collected in a stable environment (spatially & temporally homogeneous; and known atmospheric conditions) and sufficiently far from land (>5km);*
- *Sample all measurements necessary to produce good water leaving radiance data. Measurements should have well defined uncertainties quantified, collected with appropriate methodology (approved protocols), with calibrated instruments (pre/post-cruise calibrations that are traceable). Cal/Val team should define set of parameters to be measured to have cross-site consistency;*
- *Sample as close to satellite overpass as possible, preferably in a time-series. Continuous data will have higher match-up retrievals and will allow for assessment of products for successive missions.*
- *Globally distributed in situ data to fully represent the wide range of geophysical conditions that remote sensing is expected to observe.*
- *Consistent data processing with a clear QA/QC process*

IMPACT: in situ data sets are critical for producing consistent ocean products

Impact of Deliverables on Program

National and International Coordination
Exchange of data and validation procedures

IMPACT: Exchange of data sets for improved global Cal/Val procedures

AERONET-OC match-ups
(critical following launch FY11)

IMPACT: online data for automated validation procedures; VIIRS Remote Sensing reflectance and chlorophyll and other data products.

NIST investigation on SeaPRISM system components (e.g., filter characteristics, field of view); system performance (e.g., thermal response, signal to noise ratio); and field performance.

Schedule with Major Deliverables

Red background indicates delays and green indicates on or ahead of schedule (as compared to FY09 DD1498)

Title: Identifying the in situ data stream for NPOESS Ocean EDR																				
Tasks	FY08				**FY09**				**FY10**				**FY11**				**FY12**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
YR-1: Define the required in-situ data stream for Cal/Val (Document)							S		C D											
YR-2: *1. Matchup with AERONET-OC and ocean products* *2. AERONET-OC protocols;* *3. Update ship data collection;* *4. Provide managerial support on the Cal/Val plan;* *5. Team working group coordination and Q Reports*									S				C							
									S				C							
									S				C							
							S						C							
							S						C							
5.1 Team working group # 2 (AERONET-OC)							S		W											
5.2 Team working group # 4 (in situ data collection)							S		C											

Note: Timeliness of deliverables science and transition (i.e., documents/demo/software, etc). Indicate changes from FY09 1498 by highlighting original planned time in red. Table legend: S – Start, C – Complete, W – Workshop, I-Issues, M - Manual/Documentation, R – Final Report, T- Transition

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Thanks

Questions ?

In Situ Observations for Cal/Val

	Required	Highly Desired	Specialized Measurement	Derived
Radiometric Quantities				
Downwelled Irradiance $E_d(z,\lambda)$	✓			
Upwelled Radiance $L_u(z,\lambda) = L(z,\lambda,0,0)$	✓			
Upwelled Irradiance $E_u(z,\lambda)$			✓	
Radiance Distribution in water $L(z,\lambda,\theta',\phi')$			✓	
Water Surface Radiance in air $L_{air}(\lambda,\theta,\phi)$		✓		
Incident Irradiance in air $E_s(\lambda) = E_d(0^+,\lambda)$	✓			
Normal Solar Irradiance $E_{sol}(\lambda,\theta_\circ,\phi_\circ)$	✓			
Sky Radiance $L_{sky}(\lambda,\theta,\phi)$		✓		
Diffuse Sky Irradiance $E_{sky}(\lambda)$		✓		
Direct Sun Irradiance $E_{sun}(\lambda) = E_s(\lambda) - E_{sky}(\lambda)$				✓
Water-Leaving Radiance $L_w(\lambda,\theta,\phi,\theta_\circ,\phi_\circ)$				✓
Remote Sensing Reflectance $R_{RS}(\lambda,\theta,\phi,\theta_\circ,\phi_\circ)$				✓
Attenuation Coefficient $K(z,\lambda)$ for $E_d(z,\lambda)$ and $L_u(z,\lambda)$				✓
Ocean Bidirectional Reflectance Distribution Function BRDF			✓	✓
Aerosol Optical Depth $\tau_a(\lambda)$	✓			
Aerosol Phase Function $P_a(\lambda,\Psi)$				✓
Inherent Optical Properties				
Beam Attenuation Coefficient $c(z,\lambda)$	✓			
Absorption Coefficient $a(z,\lambda)$	✓			
Backscattering Coefficient $b_b(z,\lambda)$	✓			
Scattering Coefficient $b(z,\lambda) = c(z,\lambda) - a(z,\lambda)$				✓
Volume Scattering Function $\beta(z,\lambda,\Psi)$			✓	
Particle Absorption Coefficient $a_p(z,\lambda)$		✓		
Dissolved Material (CDOM) Absorption Coefficient $a_g(z,\lambda)$	✓			
Non-Pigmented Particle Absorption Coefficient $a_d(z,\lambda)$		✓		
Phytoplankton Absorption Coefficient $a_\phi(z,\lambda)$		✓		
Biogeochemical and Bio-Optical Quantities				
Phytoplankton Pigment Composition (HPLC method)	✓			
Chlorophyll *a* and Phaeopigments Conc. (Fluorometric method)		✓		
Phycobiliprotein Concentrations			✓	
Coccolith Concentrations			✓	
Total Suspended Particulate Material (SPM)			✓	
Fluorescence Intensity, *in situ* profile $F(z)$	✓			
Dissolved Organic Carbon (DOC)			✓	
Particulate Organic Carbon (POC)			✓	
Particulate Inorganic Carbon (PIC)			✓	
Particle Size Distribution (PSD)			✓	
Dissolved Inorganic Carbon (DIC) and Alkalinity			✓	
Particle Functional Types (PFTs)			✓	
Oxygen		✓		
Primary Production (PP)			✓	

Principal *in situ* observations for satellite ocean color system validation, and algorithm development and validation. The right-hand columns identify and classify measurements, from left to right, as: (a) required for minimal validation match-up; (b) highly desired and important for general algorithm development and validation; (c) specialized measurements of important, but restricted, applicability to algorithm development and validation; and (d) calculated or derived quantities.

The field data collected by the Cal/Val team leverage on-going efforts, satisfy the required measurements for validation match-ups, and follow collection protocols approved by the community and used in current NASA cal/val activities.