The International Network for Sensor InTercomparison and Uncertainty assessment for Ocean Colour Radiometry (INSITU – OCR)

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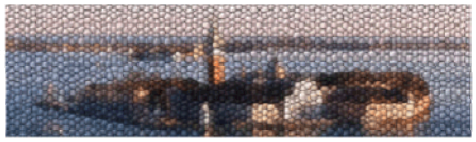
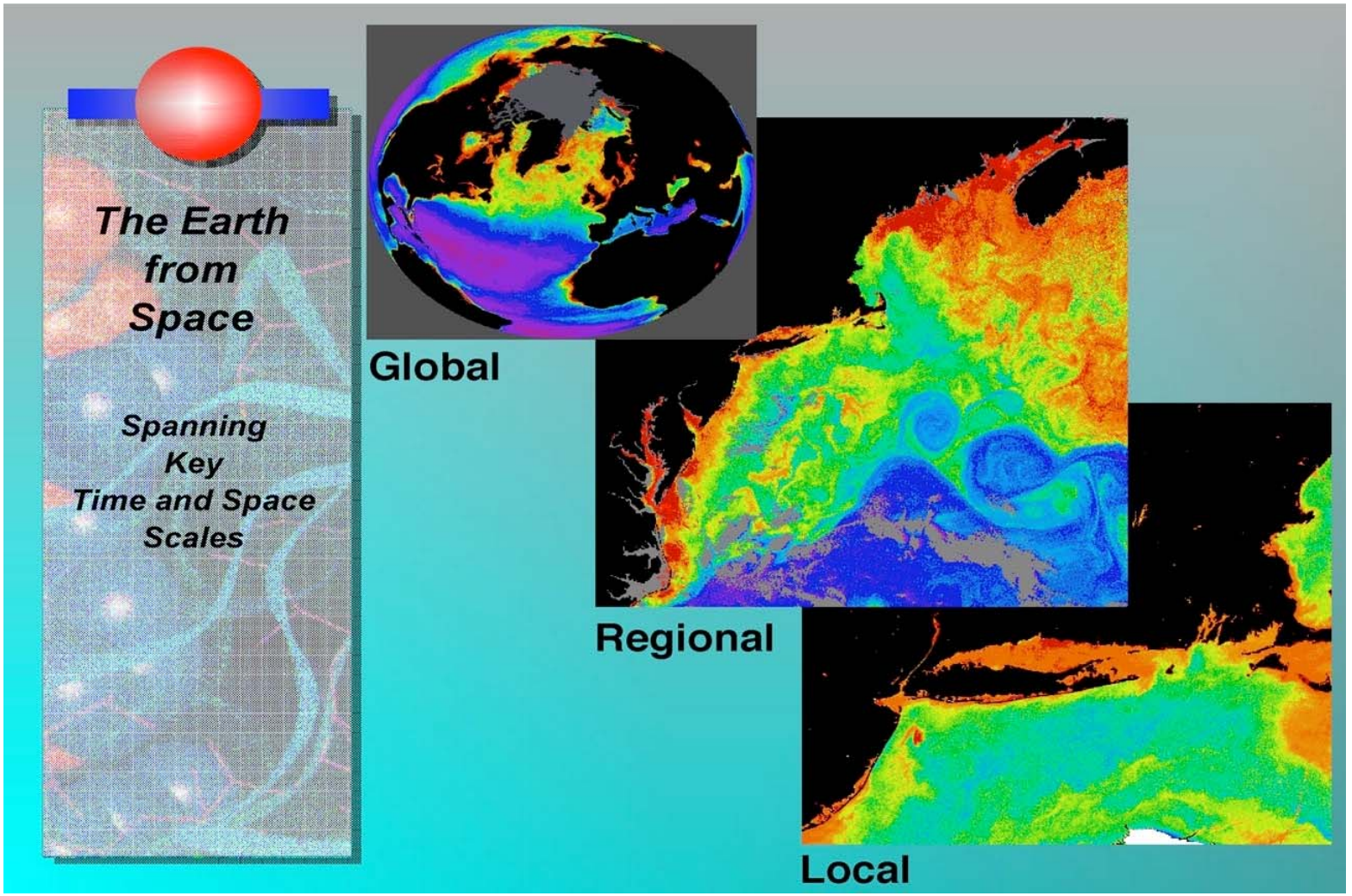
Contributions from IOCCG (V. Stuart & D. Antoine - Chair)



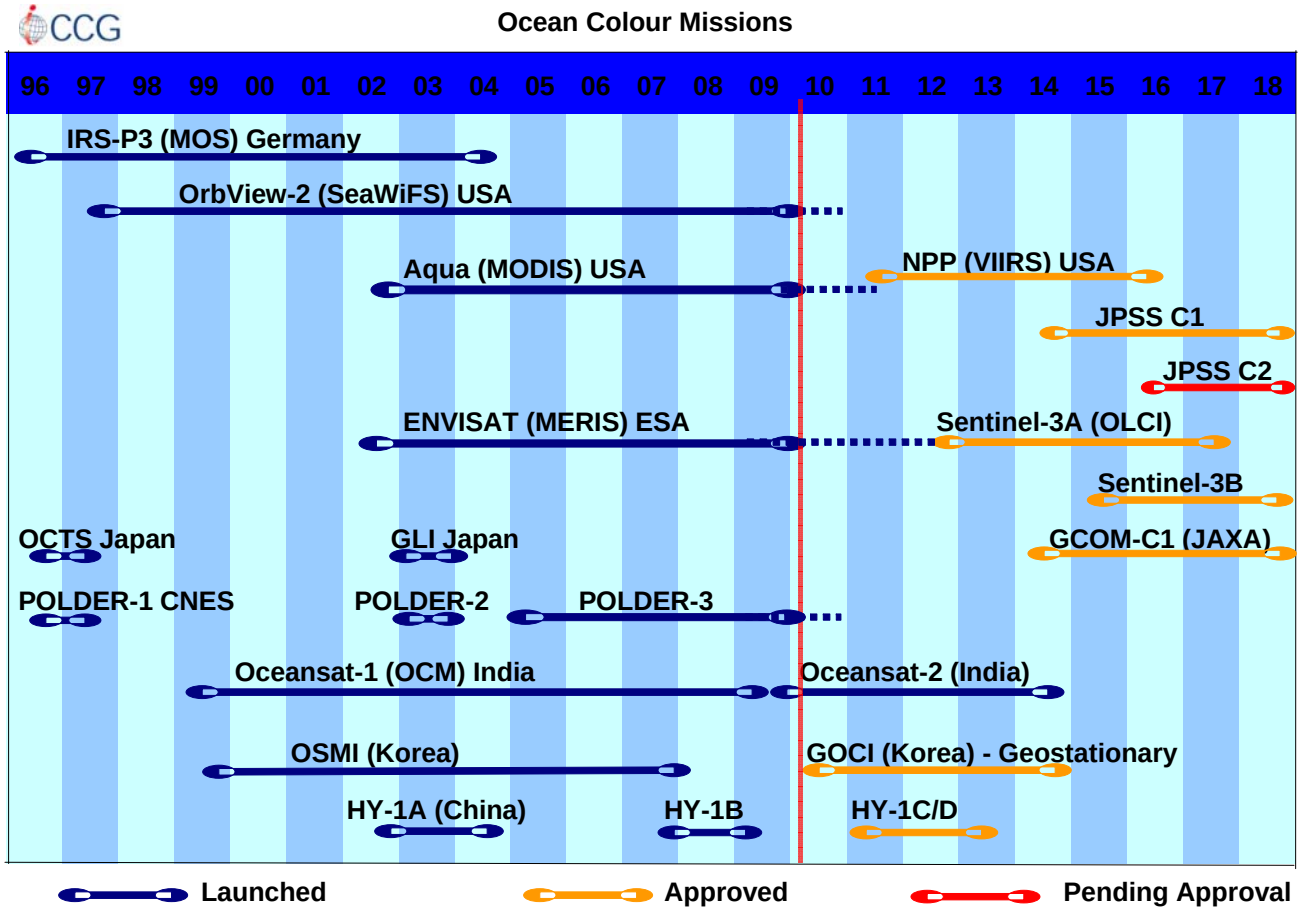
Oceans from Space, Venice 2010
Scuola Grande di San Giovanni Evangelista, Venezia (Italia)
26-30 April 2010

CZCS: Global to Local Biosphere



G. Feldman (NASA GSFC), 2008

2009-2010 Progress of OCR-VC



- *Improve VIIRS on C1 (NASA, NOAA)*
- *Sentinel-3B approved (ESA)*
- *GCOM-C1 approved (JAXA)*
- *OCM-2 launched on Sep. 23, 2009 (ISRO)*
- *GOCI preparation (KORDI, KARI)*

- *A new IOCCG WG of "ASSESSING LEVEL 1 REQUIREMENTS FOR OCEAN COLOR REMOTE SENSING" is underway, led by C. McClain, P. Bontempi, and G. Meister, NASA.*

OCR-VC Priorities Identified

1. Inter-agency OCR Essential Climate Variable (ECV) implementation strategy and subsequent execution of this strategy
2. **Concerted inter-agency effort on activities relating to sensor inter-comparison and uncertainty assessment of datasets required for ECV generation**
   - **International Network for Sensor InTercomparison and Uncertainty assessment for Ocean Colour Radiometry (INSITU-OCR)**

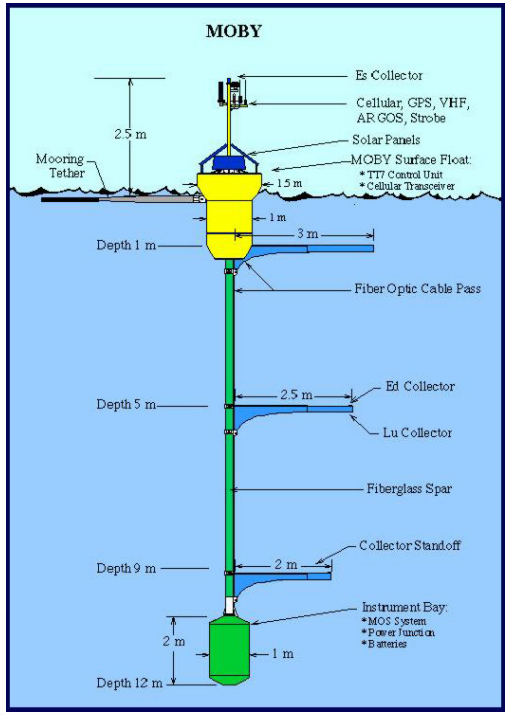
What is the Goal of the INSITU-OCR ?

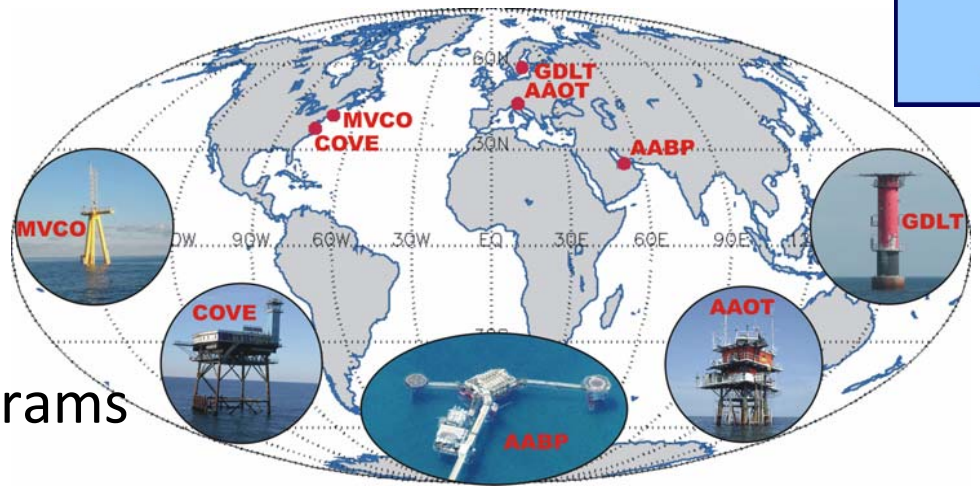
- The OCR-VC will provide **long time series of calibrated ocean color radiance (OCR)** at key wavelength bands from measurements obtained from **multiple satellites**.
- INSITU-OCR activities will include calibration, validation, merging of satellite and *in situ* data, product generation, as well as development and demonstrations of new and improved applications.
  - IOCCG Working Groups addressing many aspects including atmospheric correction, vicarious calibration, Level 1 requirements, etc.

INSITU-OCR

International Network for Sensor InTercomparison and Uncertainty assessment for Ocean Colour Radiometry

- sensor inter-comparison
- product validation
- Investigate vicarious calibration approaches
- algorithm parameterization
- instrument inter-calibration
- Building from previous investments/ prototype programs





SIMBIOS Lessons Learned and Addition of INSITU-OCR to OCR-VC

Sensor Intercomparison & Merger for Biological & Interdisciplinary Ocean Studies

- Ensure development of internally consistent research products and time series from multiple satellite ocean color data sources
- Develop methodologies for cross-calibration of satellite ocean color sensors
- Develop methodologies for merging data from multiple ocean color missions
- Promote cooperation between ocean color projects

■ Conceived in 1994 by NASA HQ as an alternative to the EOS Color mission. SIMBIOS Program ended in December 2003

- What are lessons learned, and would there be any advantages to having a follow on program that could be part of the OCR-VC?

SIMBIOS Functional structure

- **SIMBIOS Science Team:** 1997 - Nov. 2003
  - NRA-96 (1997-2000): 21 US & 5 international investigations
  - NRA-99 (2001-2003): 21 US & 14 international investigations
  - MODIS Oceans Team ~US$3.2 M/year
- **SIMBIOS Project Office:** 1996 - Nov. 2003
  - Co-located with SeaWiFS, technical & program management (budgets, staff, tasks, etc.), science team coordination, contract negotiations and revisions, and NASA Research Announcement coordination with NASA HQ
  - Technical interface and MOUs with international space agencies (e.g., NASDA, CNES, ESA, KARI), other organizations (e.g., NIST, IOCCG, JRC, DLR), and programs (e.g., EOS, AERONET)
  - Specific research activities ~US$1.3 M/year

"We worked in the meso to large scale and tried to developed long-term, high quality data for climate research"

SIMBIOS Project Activities/Staff

- **SeaBASS Database**
- **Support Services**
  - **Overflight Predictions**
  - **Near Real Time Imagery**
  - **Scheduling on-Board Recording**
- **SIMBIOS SunPhotometers & Calibration**
  - Instrument pool, measurement of atm and ocean data together
- **Calibration Round Robin**
  - Manufacturers participated, as did NIST
- **Data Product Validation (matchups)**
  - **Bio-optical & Atmospheric**
- **Satellite Characterization Ocean Color Sensors**
- **Cal/Val Activities**
- **Satellite Data Processing**
- **Cross-Calibration & Data Merging**

SIMBIOS Program Requirements/Activities

- Global bio-optical & atmospheric *in situ* data collection (NRA's)
- Bio-optical & atmospheric database development (SeaBASS)
- Field measurement & data processing protocol definition & development
- Traceability of laboratory calibration sources to standards (R/R)
- R&D of new instruments & instrument pool (SeaPRISM, SIMBAD(A))
- Prelaunch sensor calibration & characterization protocols
- On-orbit calibration evaluation & methodology development
- Instrumented calibration sites (MOBY)
- Bio-optical & atmospheric correction algorithm development (NRA's & staff)
- Product accuracy evaluation & methodology development
- Data merger algorithm development & data processing
- High volume data processing capabilities
- Multi satellite data processing software (SeaDAS)
- Systematic documentation (NASA TMs and publications)
- International collaborations and Science Team

Project office lead
SeaWiFS lead
SeaWiFS-SIMBIOS

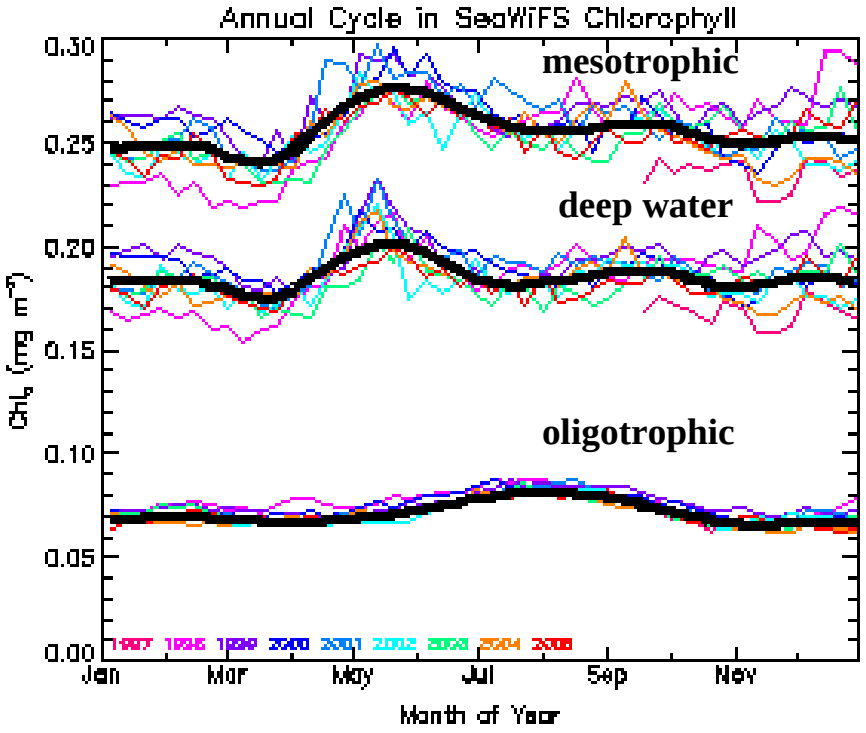
Lessons learned by working with foreign missions

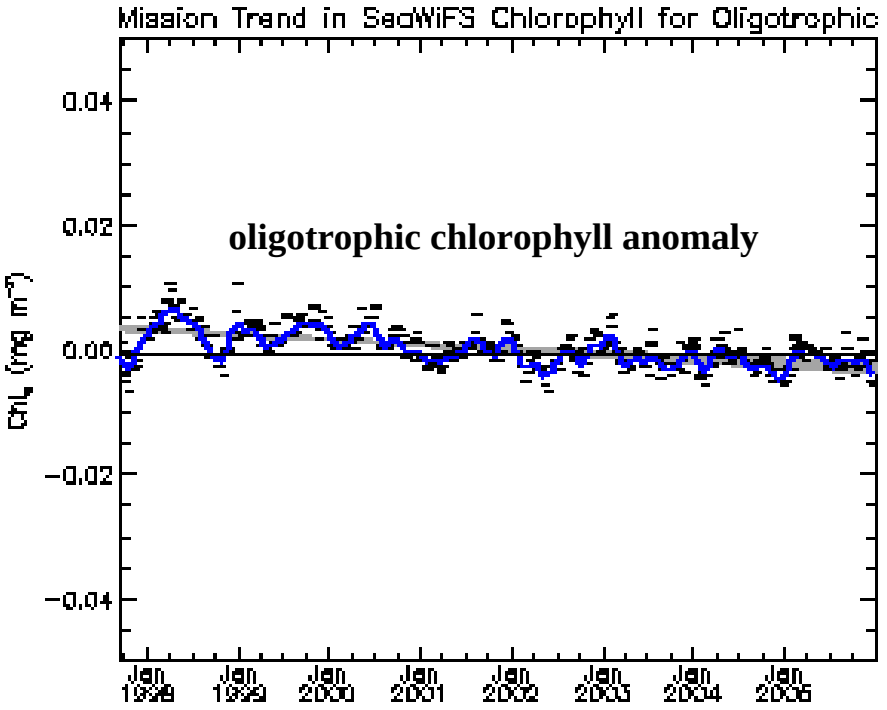
- Documentation was in native language and generally of poor quality. Collaboration was essential to have access to personnel with full technical understanding of mission.
- Sensor characterization was not always done. Pre-post launch on–board sensor calibration and characterization are essential for the long-term stability of the sensor. Most of the time, missing the involvement of an agency similar to NIST.
- Vicarious calibration using MOBY was done by SIMBIOS. Additional open ocean stable sites were clearly needed. No site available for coastal waters.

Sensor Cross-Comparisons Lessons Learned

- Important to identify user applications on how the merged data can meet their requirements better than any-single sensor datasets. (interest in “coastal” zones)
- SIMBIOS goal was to create high quality, long-term, multi-sensor ocean color data sets (mesoscale to large scale):
  - Bring all multi-sensor data to a common, consistently calibrated and jointly validated ocean color baseline.
  - Accomplish it through sensor intercomparisons, validations, cross-calibrations, and “intelligent” data merger.
  - Integrate data on the level of chlorophyll, nLw, and radiances at the top-of-the-atmosphere.
- Small erroneous trends in sensor calibration can be misinterpreted as real signal from interannual oscillation.

Geophysical vs. Instrument
SeaWiFS Temporal Trends: Chl Anomaly





Can we believe relatively small trends seen on decadal scales (relative to seasonal and short-term variabilities) without highly calibrated data?

Overall SIMBIOS Lessons Learned:

- The calibration and validation programs for individual missions (both domestic and international) had a wide range of approaches and methodologies, making international cooperation imperative to ensure high **quality climate data**.
- The SIMBIOS Project, including the Science Team, is a success story on how to tackle these issues while engaging the ocean color community. The achievements were certainly due to the operational configuration & activities undertaken by the Project with the community.
- Long-term, high quality measurements are needed for climate research.
- Data stability should be addressed in terms of :
  - sensor characterization, calibration, traceability to standards and data product validation;
  - Requirements for and approaches to data continuity (accurate characterization of the time series), and
  - data systems (long-term archiving, data reprocessing capability, careful metadata and documentation, algorithm development in a open, peer-review process, etc.)
- Long-Term, consistent data sets should be addressed in terms of:
  - overlapping observations
  - cross-calibration
  - evolution, reprocessing, and multiple version of data sets

SIMBIOS Lessons Learned and Addition of Possible Follow-on to OCR-VC

Sensor Intercomparison & Merger for Biological & Interdisciplinary Ocean Studies

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INSITU-OCR components:

- Research Announcements could be drafted and released together
- Agencies could target specific scientific problems of interest, supporting what is most relevant
- Centralized database like SeaBASS, QA/QC and data submission requirements (e.g., 3 months for data submission), protocol development, exchange of personnel possible, connectivity to Round Robins

Satellite Data from Calibrated Sensors (2010)

Mission Feedback

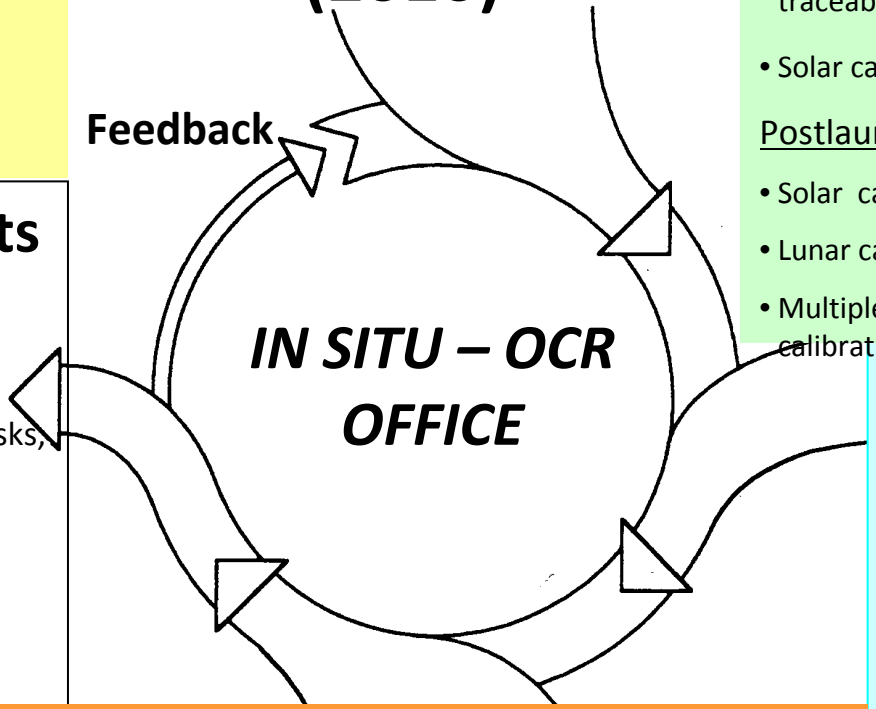
- Science community input
- Comparison with other appropriate products
- New Mission
- Protocol development

Improved Products & Algorithms

- Reprocessing due to improvements in calibration, masks, binning schemes, product compatibilities, etc.
- New products from bio-geochemical fields, atmospheric fields, etc.
- Data distribution interface

SeaDAS, BEAM….

- Satellite data processing software (ACE, OCM-2, MERIS, OLCI, SGLI, GOCI, …..)



Product & Algorithm Validation

- Atmospheric & bio-optical algorithm validation and development (INSITU-OCR PIs and project staff)
- Match-up analysis via Aeronet-OC sites, satellite QC, time series evaluation, Bio-Argo , ChloroGIN, etc.
- **Earth System/Climate Model data assimilation**

Calibration Strategy

Prelaunch

- Lab. characterization & calibration (SI-traceable)
- Solar calibration (transfer-to-orbit)

Postlaunch (operational adjustments)

- Solar calibration (daily)
- Lunar calibration (monthly)
- Multiple sites L_{wn} time series for vicarious calibration – ISRO, MOBY-C

In Situ Data

- Collection of required bio-optical and atmospheric measurements (INSITU-OCR PIs)
- *in situ* instrument calibration (Project round robin SI-traceable, IOPs, AOPs)
- Data collection following NASA Ocean Optics protocols
- Archive of calibrated QC *in situ* data (SeaBASS)
- Calibrated instrument pool
- Development of new instrumentation