# MODIS Ocean Color Processing

## Chuck McClain*

### Processing Approach Calibration/Validation

## Gene Feldman*

### Data Processing & Distribution

MODIS Team Meeting/ July 13-15, 2004/Baltimore, MD

* NASA/GSFC

# MODIS Ocean Processing Reorganization

- MODIS Ocean Color processing reorganized by NASA HQ to coincide with new MODIS Ocean Science Team selection.

  - Ocean color to lead the NASA Earth Science Enterprise transition to "discipline processing", i.e., move from "missions to measurements" processing.

- Operational ocean color data processing transferred from MODAPS to the Ocean Color Discipline Processing Group on February 1.

  - SST processing remains at MODAPS until HQ defines an alternative processing structure.

# Ocean Color Discipline Processing System



**Reconfigurable & Scalable**

**Science Community Interactive**

- *Knowledgable Staff*
- *Enabling Activities (SeaBASS, SeaDAS, Calibration RR, etc.)*

**Flexible Processing**
- *Multiple Missions*
- *Rapid Reprocessing*
- *Parallel Processing Streams (operational, algorithm & calibration testing, evaluation products)*

CZCS OCTS

SeaWIFS

Terra MODIS

Aqua MODIS

NPP VIIRS

## MAIN PROCESSING SYSTEM
- *Data from multiple satellite and instrument types*
- *In-situ, ancillary, and other data*

**L1 DATA**

**L1-L3 DATA**

GSFC

DAAC

Data Users

*OCDP Management & Staff*

*Community Agreed Standards and Protocols*

MCST*

NASA HQ Program Management

NASA Flight Projects

Science Community

**In Situ Data**

**\* MODIS Characterization Support Team (NASA/GSFC)**

# MODIS OC Processing Strategy

- **Initial focus on MODIS/Aqua**
  - MODIS/Aqua more stable than MODIS/Terra
  - MODIS/Aqua overlap with NPP/VIIRS
- **Initial emphasis on calibration & Lwn's**
  - Large seasonal/regional differences between MODIS/(Terra & Aqua) & SeaWiFS Lwn's
- **Reduced product set until radiometry verified**
  - Simplify processing for radiometry evaluations
  - Maintain a baseline consistent with SeaWiFS product suite. Expand product suite later.

# MODIS Ocean Color Parameters

- **Previous OC Parameter Set**
  - Normalized water-leaving radiances (7)
  - Aerosol optical thickness (865 nm)
  - Atmospheric correction epsilon
  - Aerosol model numbers (2)
  - Clear water aerosol correction epsilon
  - CZCS pigment concentration
  - Chlorophyll-a concentration (3)
  - Total pigment concentration
  - Chlorophyll fluorescence line height
  - Chlorophyll fluorescence baseline
  - Chlorophyll fluorescence efficiency
  - Total suspended matter
  - Coccolithophore pigment concentration
  - Detached coccolithophore concentration
  - Calcite concentration
  - Diffuse attenuation at 490 nm
  - Phycoerythobilin concentration
  - Phycourobilin concentration
  - Instantaneous PAR
  - Instantaneous absorbed radiation for fluorescence
  - Gelbstoff absorption coefficient at 400 nm
  - Phytoplankton absorption coefficient at 675 nm
  - Total absorption coefficients (5)
  - Primary production (2 at Level-4)

- **Current OC "Baseline" Parameter Set**
  - Normalized water-leaving radiances (6)
  - Aerosol optical thickness
  - Atmospheric correction epsilon
  - Ångström exponent
  - Chlorophyll-a (1)
  - Diffuse attenuation coefficient at 490 nm
  - SST (near real-time daytime skin temp.)
    - Same masks & flags as OC products

Previous OC Parameter Set     38
(does not include archived ancillary data & quality control fields)

Current OC Parameter Suite     12
(does not include archived ancillary data)
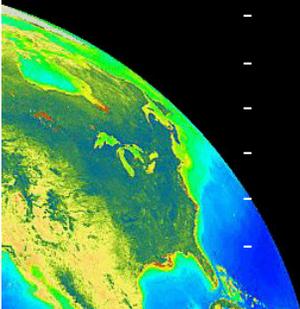
# Calibration/Validation Approach

- **Apply same cal/val approach as for SeaWiFS**
- **Common processing codes**
- **Work sensor calibration issues with MCST**
  - Solar and lunar calibration analysis and products, e.g., calibration tables, response-vs-scan (RVS), sensor polarization.
- **Systematically test algorithms using both SeaWiFS & MODIS for comparison**
  - Polarization, BRDF, glint, cloud masking, etc.
  - Global time series with regional analyses (clear-water, deep-water, coastal, basin-latitude zones)

# MODIS OC Calibration

Prelaunch Calibration & Characterization:
(Santa Barbara Research Center)

Prelaunch data reviewed by
MCST, OCDP, & MODIS
Ocean Team members

On-Orbit Solar & Lunar Calibration
(MODIS Characterization Support Team)

Time-dependent gain factors.

MOBY-based Vicarious Calibration Adjustment
(D. Clark and OCDP Group)

One set of vicarious gains
for entire MODIS/Aqua data
record.

In-situ/Satellite Match-up Comparisons
(OCDP Group)

In Situ Data Collection
(MODIS Ocean Team)

SeaWiFS-MODIS Regional & Global Comparisons
(OCDP Group)

# SeaWiFS Stability



SeaWiFS Lunar Calibrations
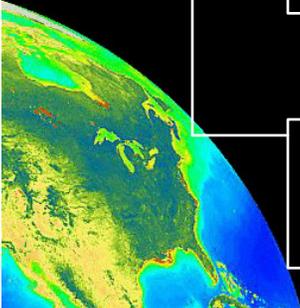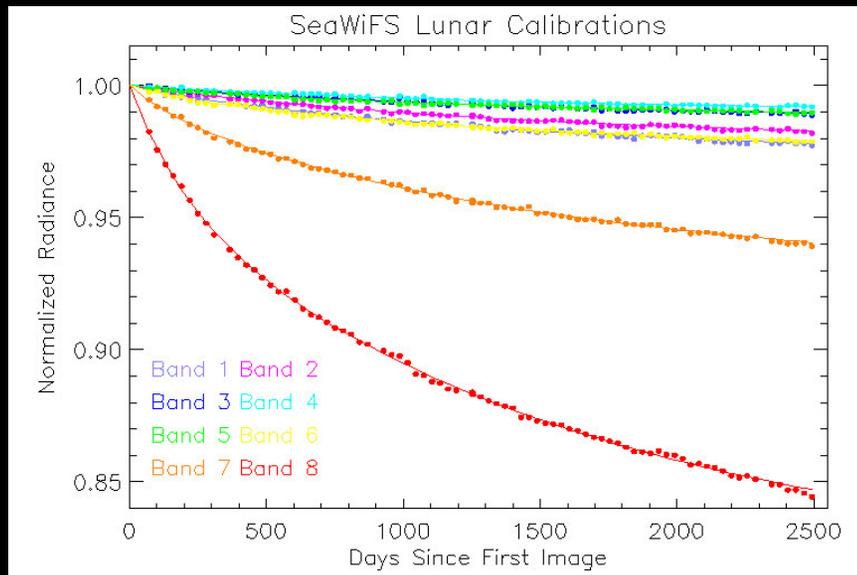
Monthly views of the moon at ~ 7° phase angle. Gradual monotonic degradation primarily in NIR bands.

Global mean deep water Lwn's with no trends, i.e., repeating annual cycles



SeaWiFS Water-Leaving Radiances, Deep Water Subset

# MOBY Vicarous Calibration
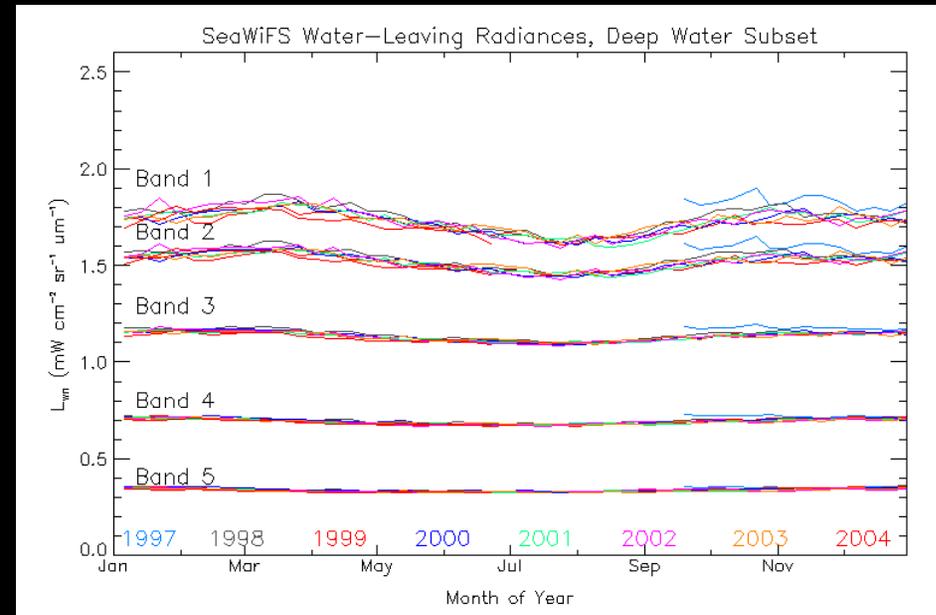
# MODIS(Aqua)/SeaWiFS Lwn Ratios (N. Pacific): Initial comparison



MODIS/SeaWiFS 8-Day Water-Leaving Radiance Ratios, PacN50 Subset
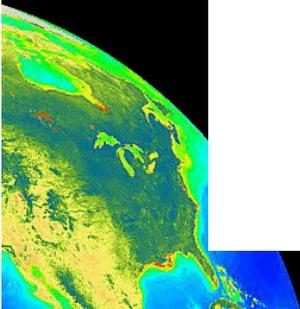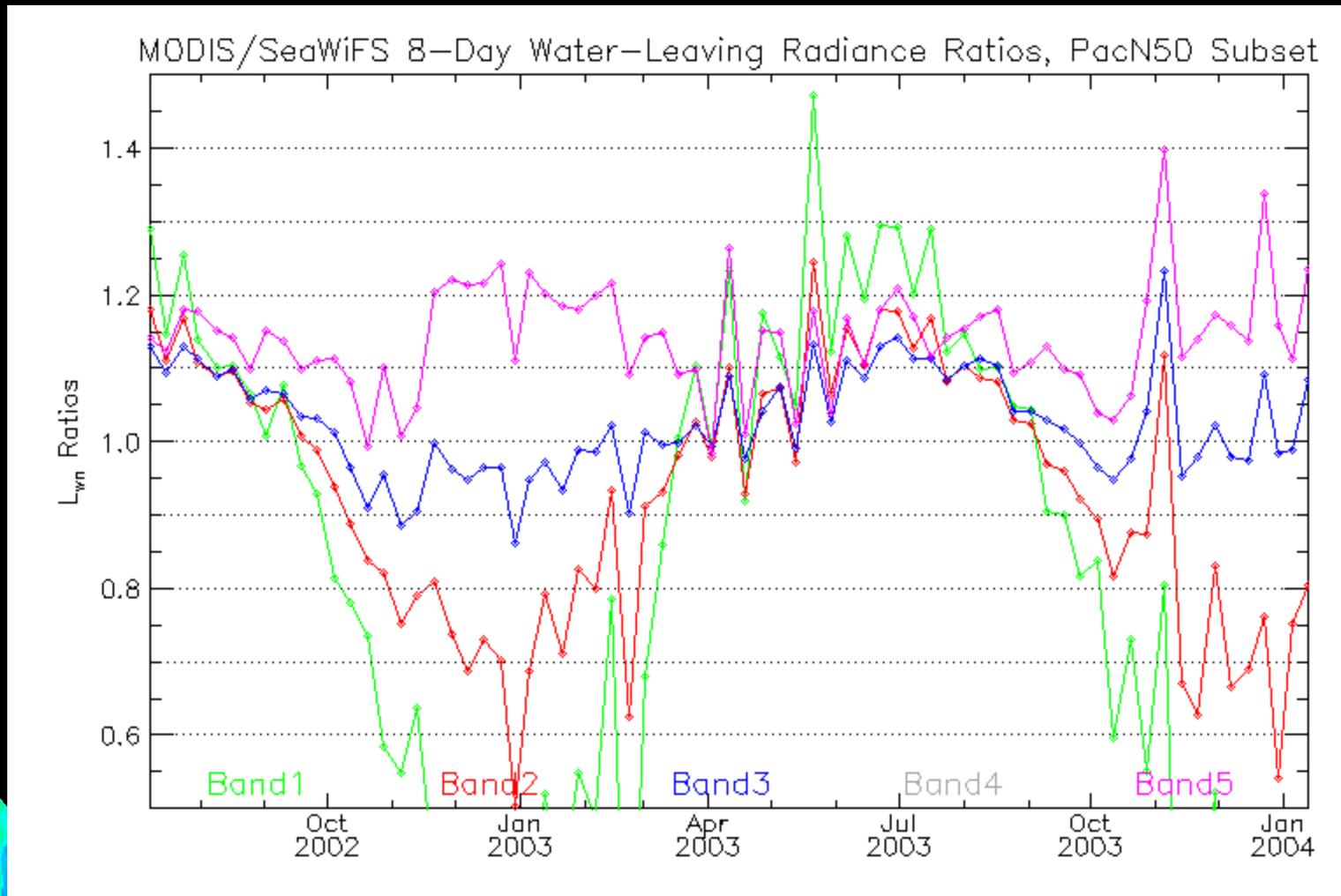
# MODIS/SeaWiFS Comparisons

- MODIS polarization correction*
    - Polarization tables found to be phase-shifted with approximately half the correct amplitude
- BRDF correction (based on Morel et al., 2002)
    - Developed for Case 1 waters (mostly open ocean)
        - Not accurate in turbid waters
    - Error in algorithm found recently
    - Testing to continue
- Quality mask & flag thresholds
    - Sunglint radiance threshold
    - Cloud mask threshold

- MODIS polarization tables based on prelaunch characterization table.
- SeaWiFS essentially polarization insensitive.

# MODIS(Aqua)/SeaWiFS Lwn Ratios (N. Pacific): Correct polarization (corrected phase & magnitude)



MODIS(AT06)/SeaWiFS(ST01) 4-Day nLw Ratios, PacN50 Subset

412 nm atmospheric correction problem at high solar zenith angles?
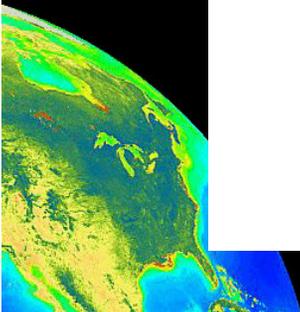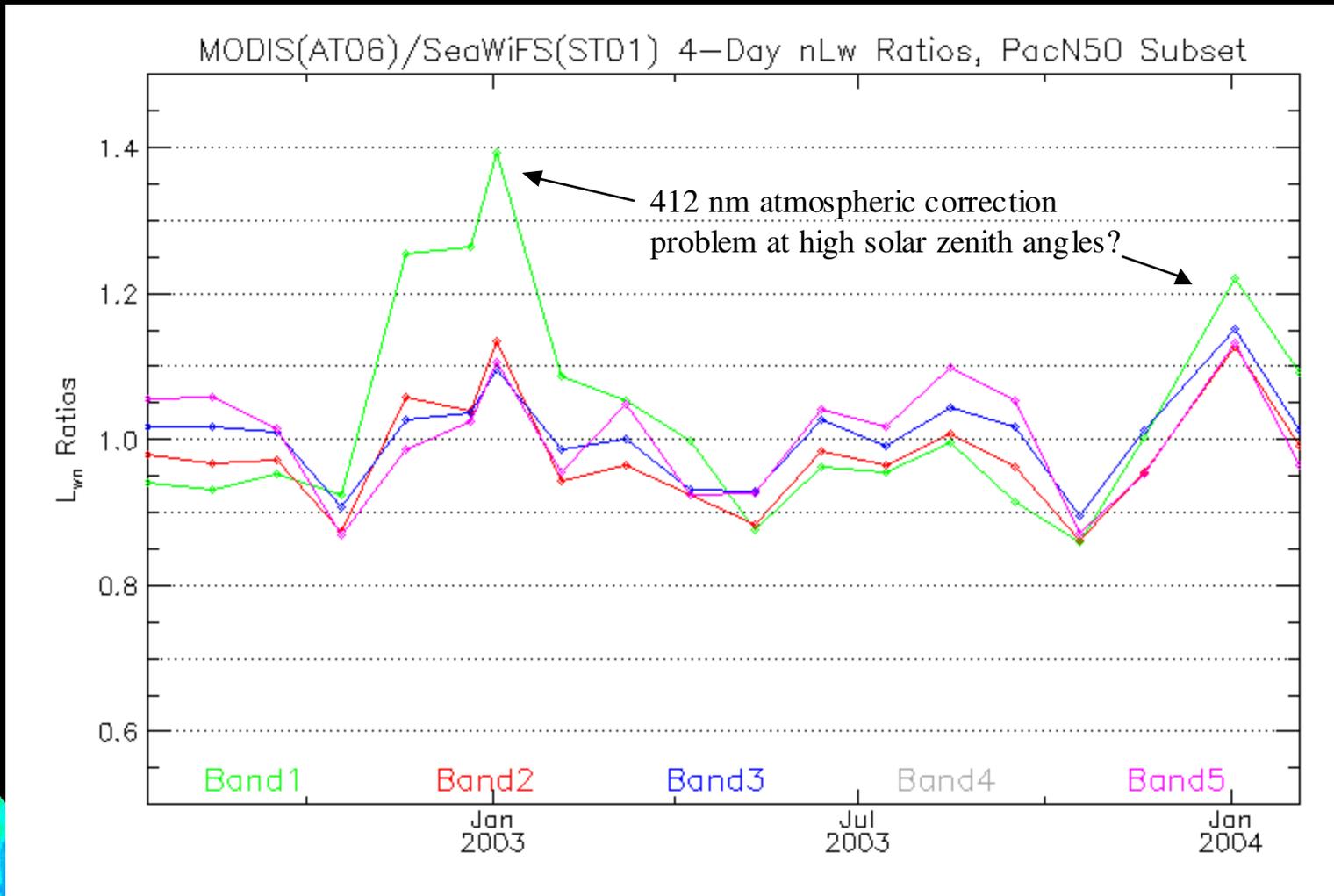
# MODIS/Aqua Reprocessing
## Completed in May '04 (~ 1½ weeks)

- MCST temporally smoothed calibration tables

- Phase & magnitude corrected polarization tables

- Simple BRDF correction

- OC3 chlorophyll-a algorithm
  - Similar to SeaWiFS OC4v4 algorithm

OCDP Group continues work
with MCST to refine on-board
lunar & solar calibration analyses.
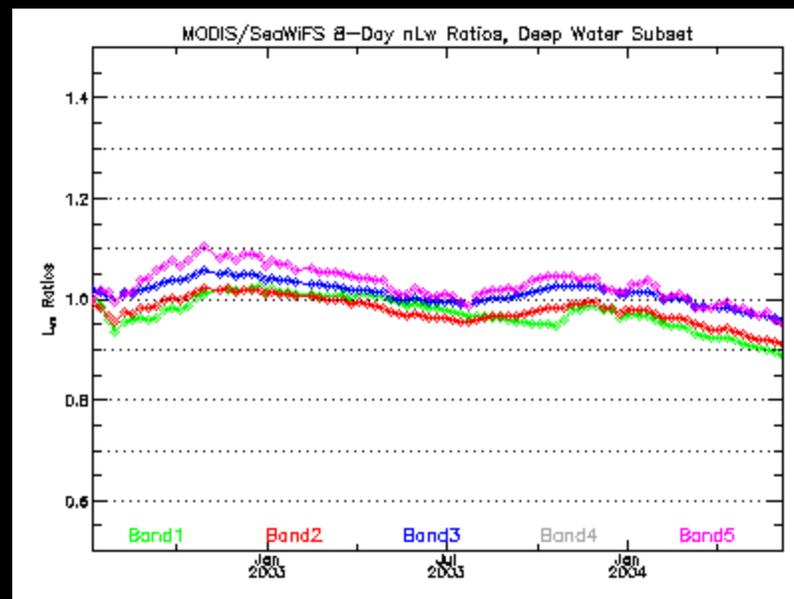
# SeaWiFS & MODIS 4-Day Deep-Water Chlorophyll Images
## 4 day composites, Summer 2002

**0.01-1 mg/m^3**

SeaWiFS
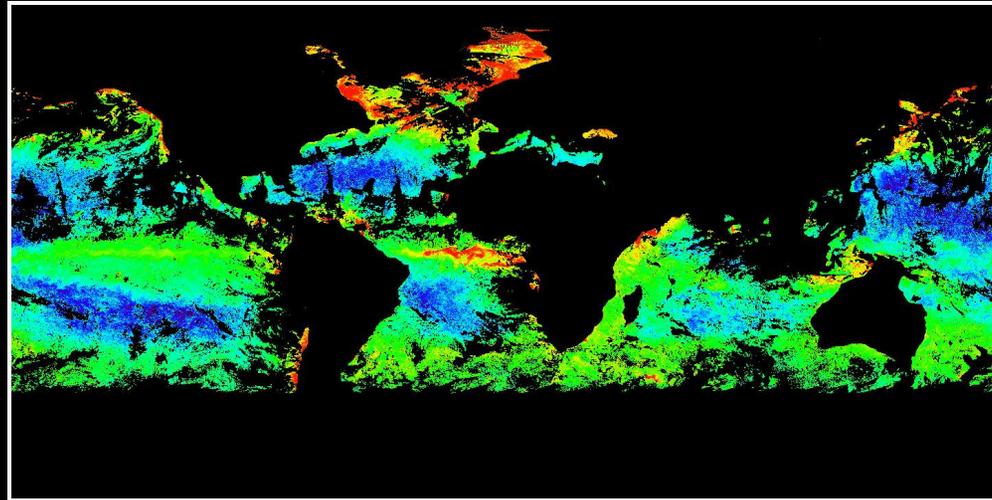
MODIS
(Correct polarization
phase & amplitude)
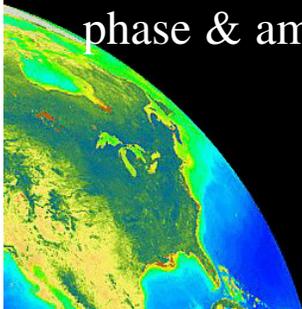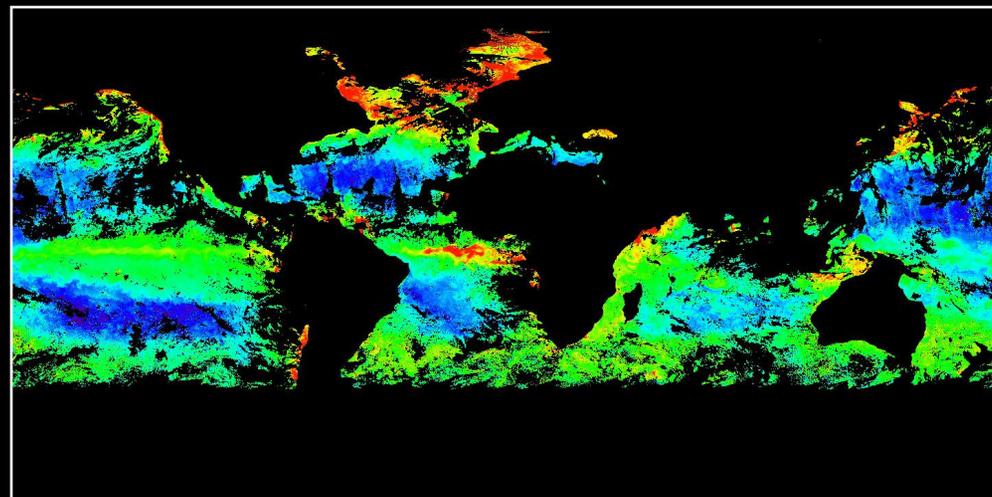
SeaWiFS Lw
OCDPS Repro4

MODIS/Aqua Lw
OCDPS Repro
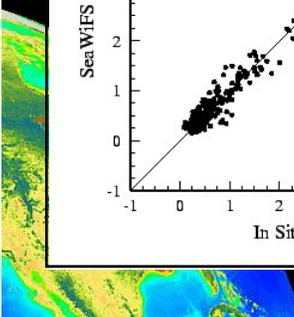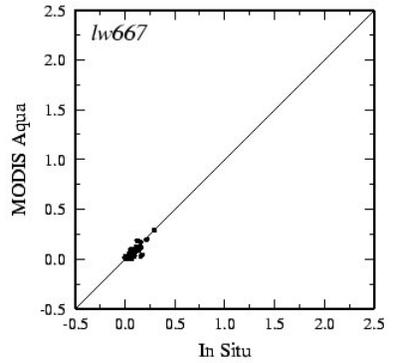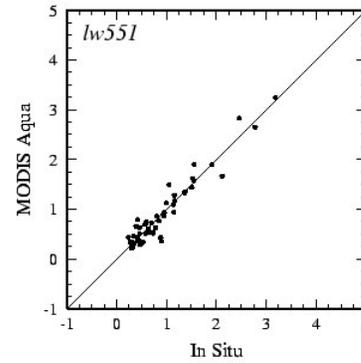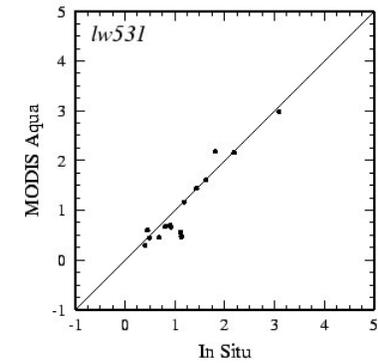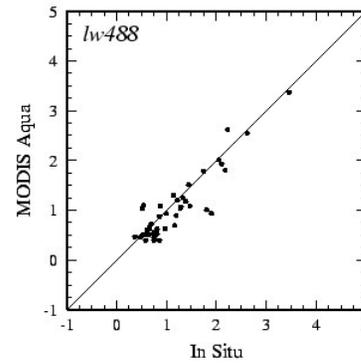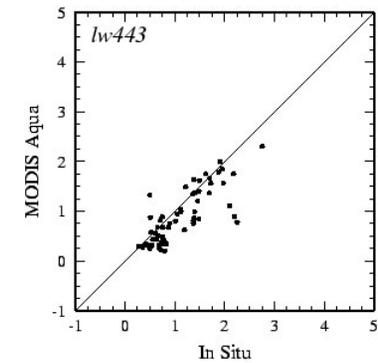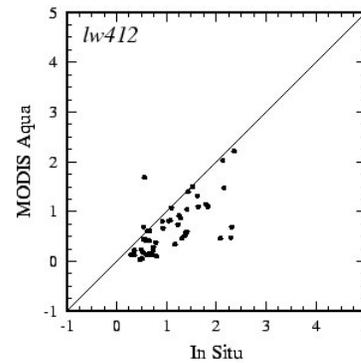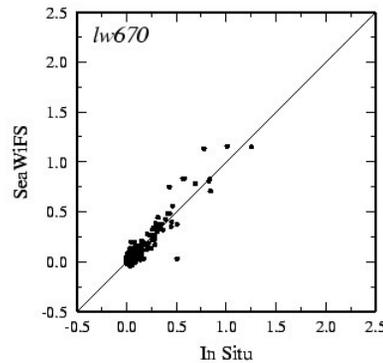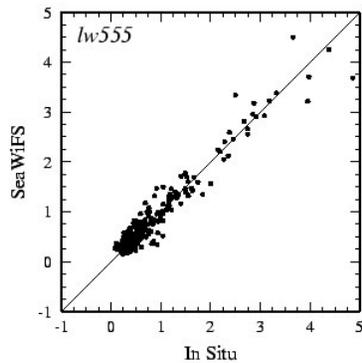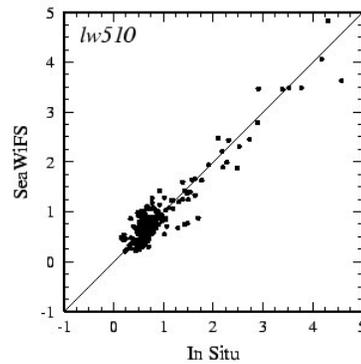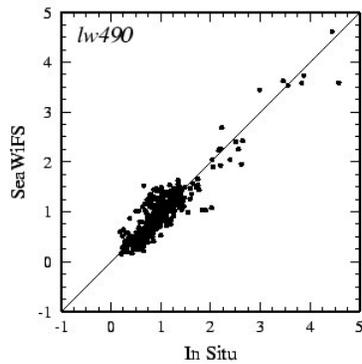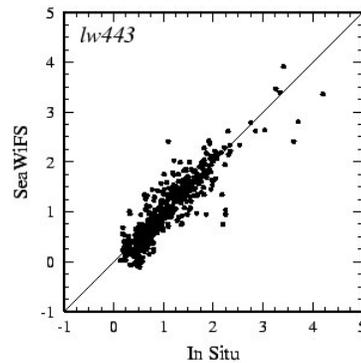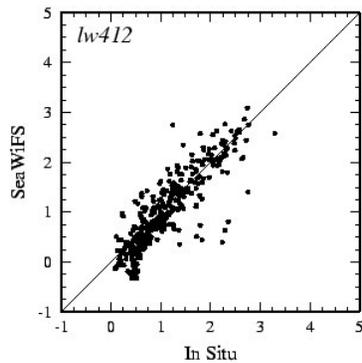
# OCDPS Repro4
## OC4 Chlorophyll

# OCDPS Repro
## OC3 Chlorophyll
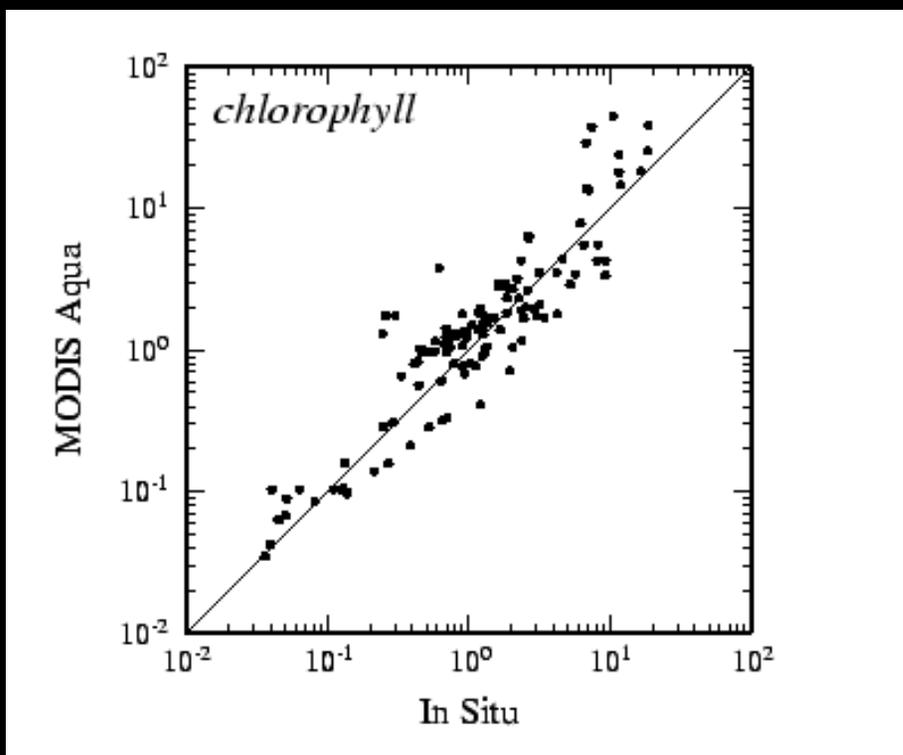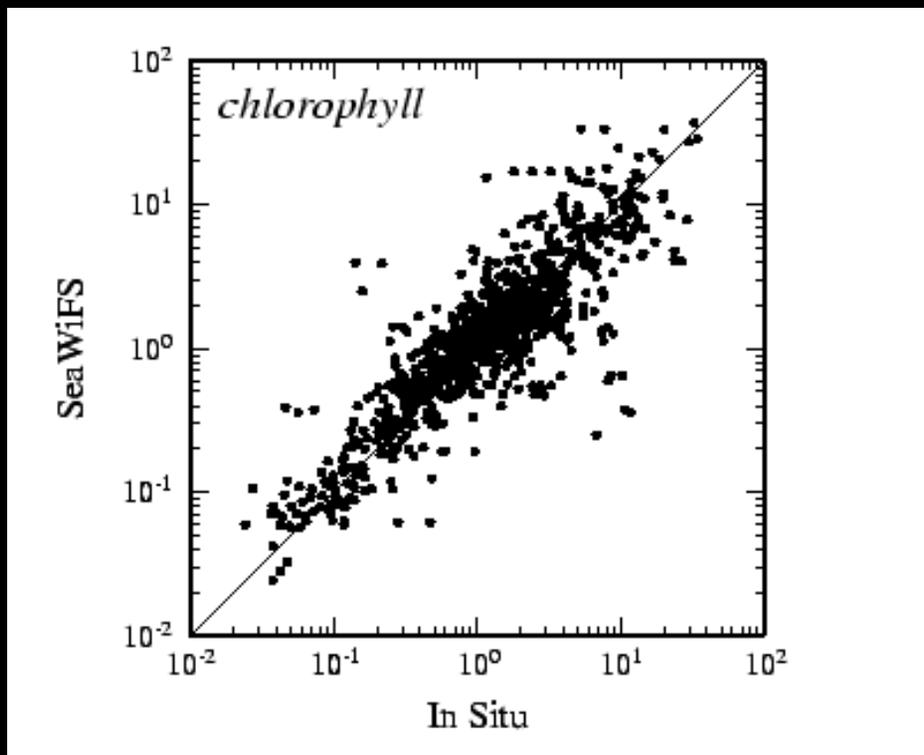


**SeaWiFS**

**MODIS/Aqua**
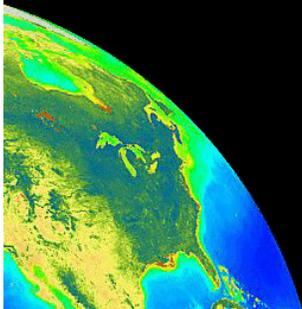
# Additional Sensor Calibration Issues

- Temporal stability: long-term and seasonal
- Refine "Response vs. Scan" (RVS) or scan modulation functions
- Minimize mirror-side calibration differences (image banding)
- Detector to detector calibration (striping)

Analyses to be conducted in collaboration with MCST and science community.

# Back Up Slides

# OCDP SST

- SST
  - enhanced to allow use of Reynolds OI SST as input
  - detailed intercomparison with MODAPS products performed
  - **exact match** demonstrated at Level-2 (given same input SST)
    - required correction of MODAPS code for OISST interpolation error
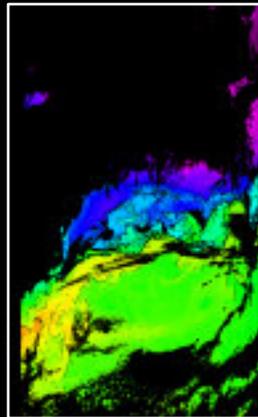
MODAPS          ODPS
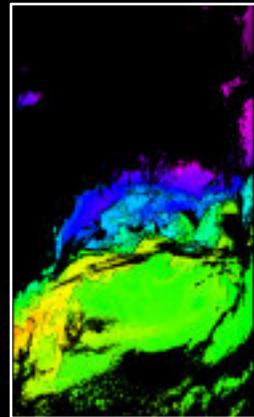
Only remaining issue is Level-3 quality masking
  • MODAPS approach has been analyzed in detail
  • implementation plans TBD

http://seabass.gsfc.nasa.gov/eval/fq.cgi