

MODIS Ocean Color Processing

Chuck McClain*

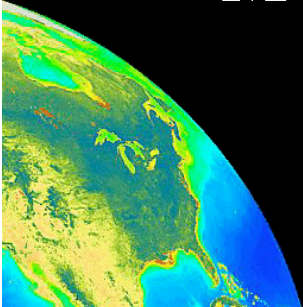
Processing Approach Calibration/Validation

Gene Feldman*

Data Processing & Distribution

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

* NASA/GSFC

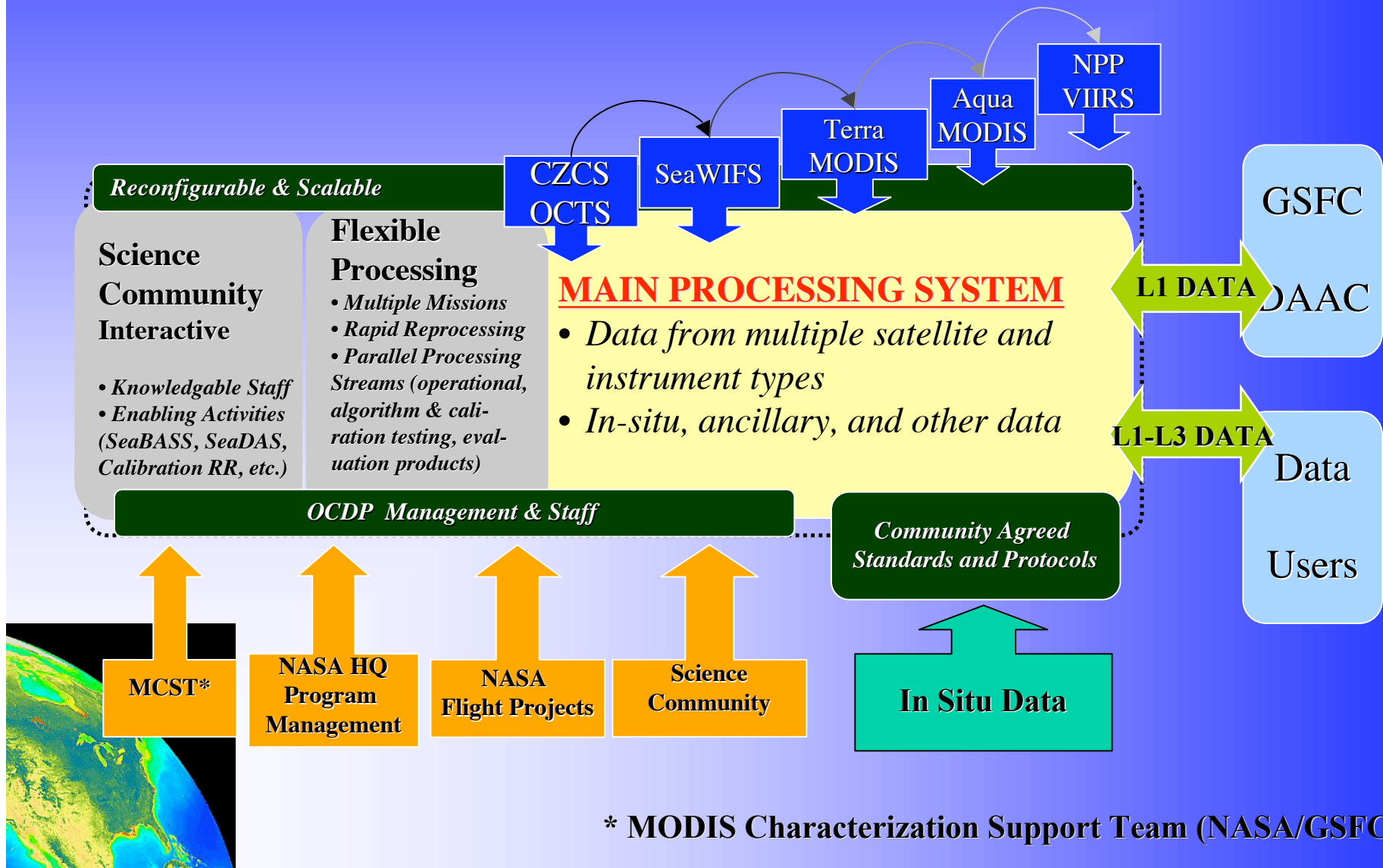


MODIS Ocean Processing Reorganization

- 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



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**

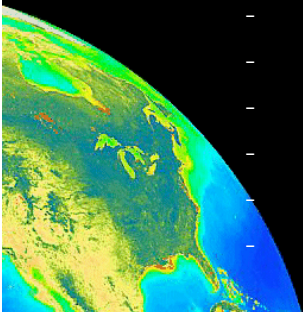
- Normalized water-leaving radiances (7)
- Aerosol optical thickness (865 nm)
- Atmospheric correction epsilon
- Aerosol model numbers (2)
- Clear water aerosol correction epsilon
- CZCS pigment concentration
- Chlorophyll-a concentration (3)
- Total pigment concentration
- Chlorophyll fluorescence line height
- Chlorophyll fluorescence baseline
- Chlorophyll fluorescence efficiency
- Total suspended matter
- Coccolithophore pigment concentration
- Detached coccolithophore concentration
- Calcite concentration
- Diffuse attenuation at 490 nm
- Phycoerythrobilin 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.

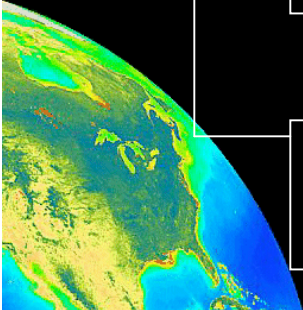
MOBY-based Vicarious Calibration Adjustment
(D. Clark and OCDP Group)

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

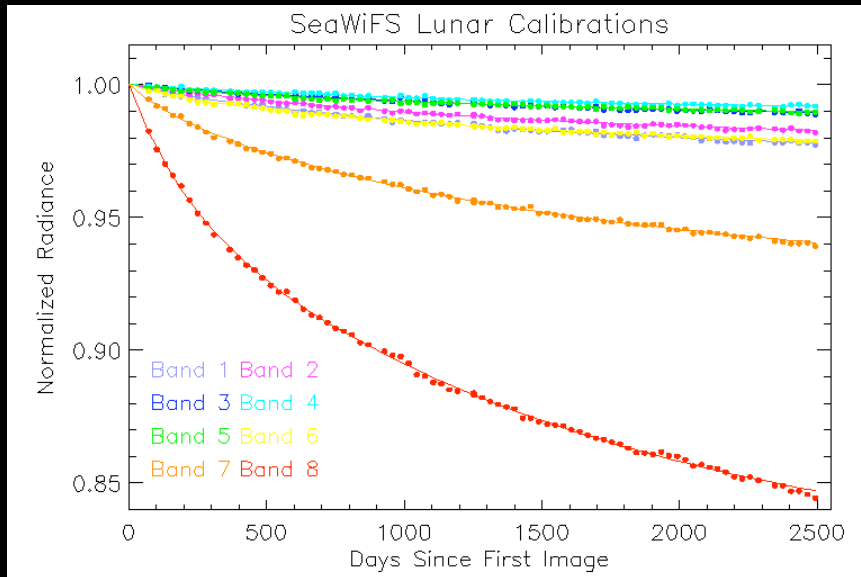
In-situ/Satellite Match-up Comparisons
(OCDP Group)

In Situ Data Collection
(MODIS Ocean Team)

SeaWiFS-MODIS Regional & Global Comparisons
(OCDP Group)

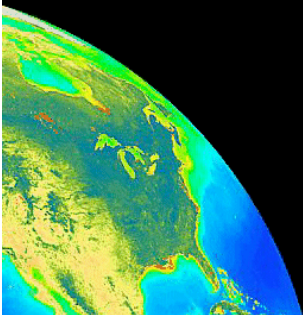
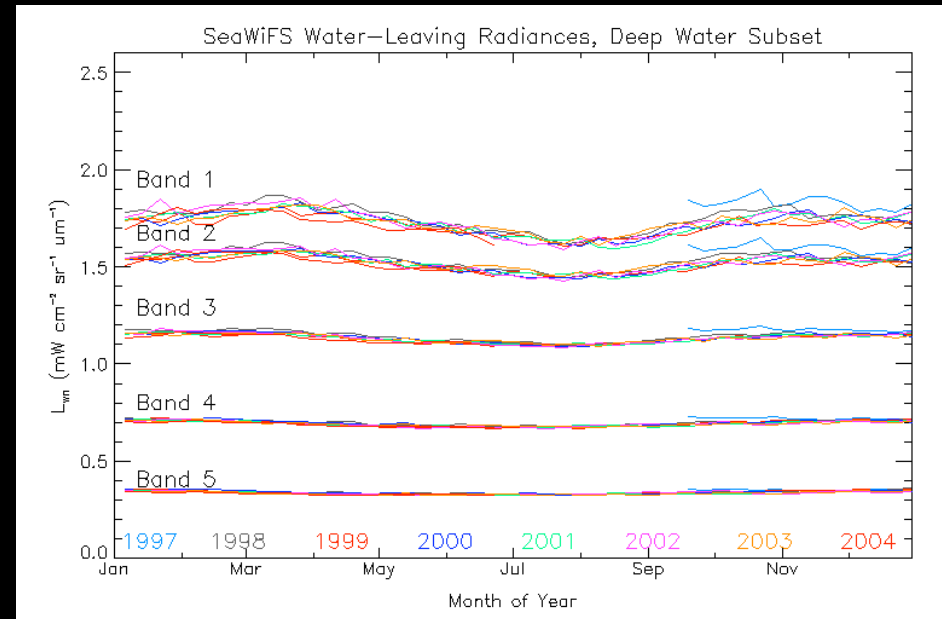


SeaWiFS Stability

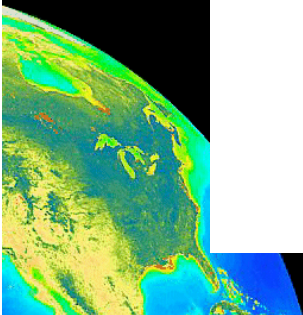
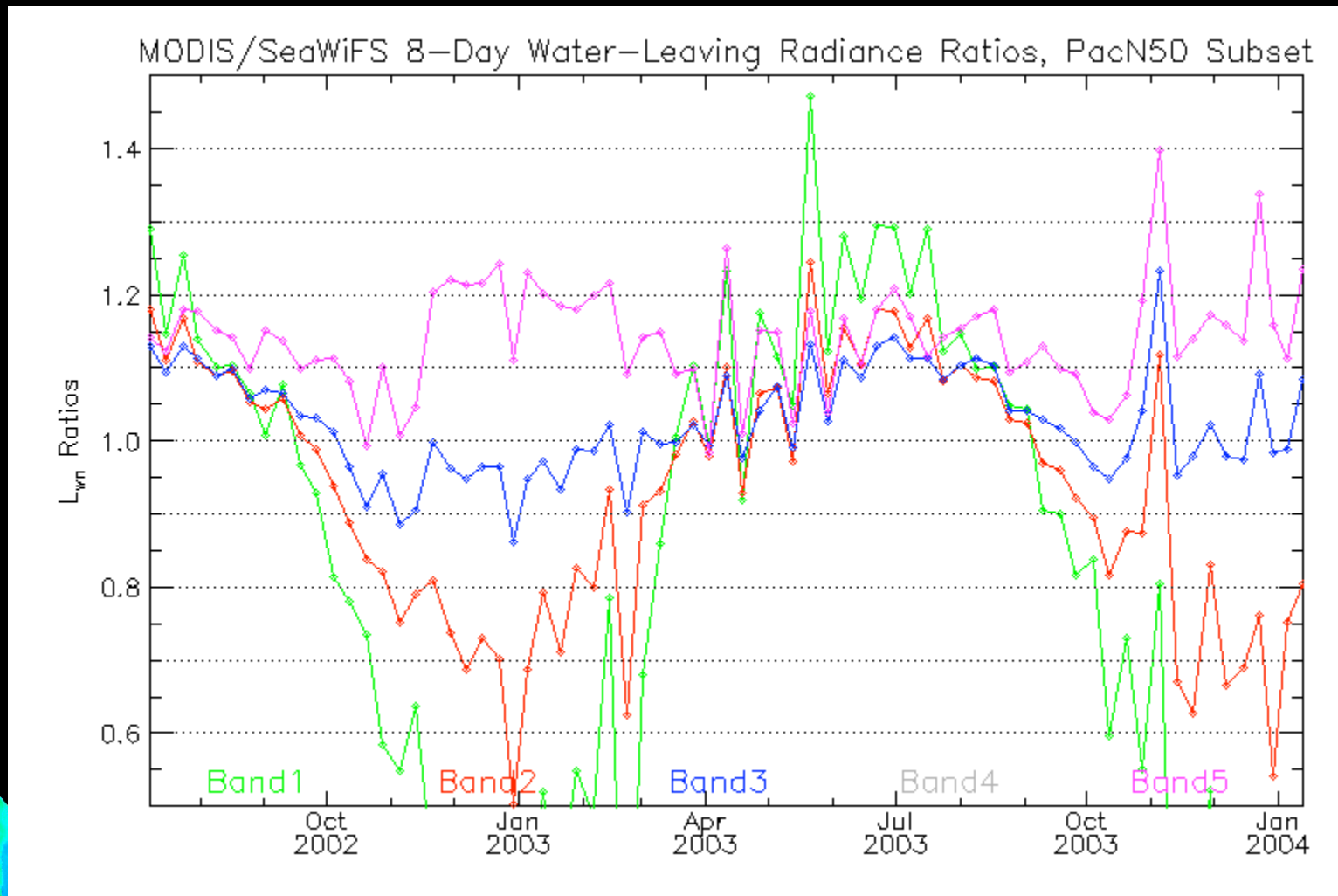


Monthly views of the moon at $\sim 7^\circ$ phase angle. Gradual monotonic degradation primarily in NIR bands.

Global mean deep water L_{wn} 's with no trends, i.e., repeating annual cycles



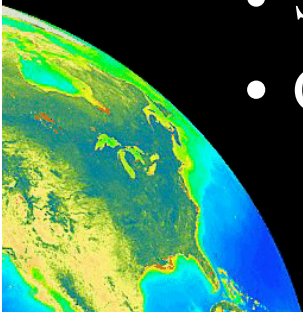
MODIS(Aqua)/SeaWiFS L_wn Ratios (N. Pacific): Initial comparison



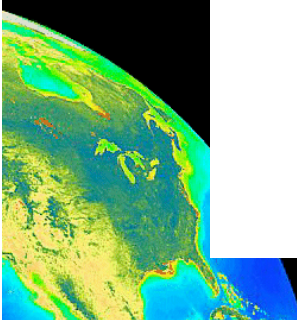
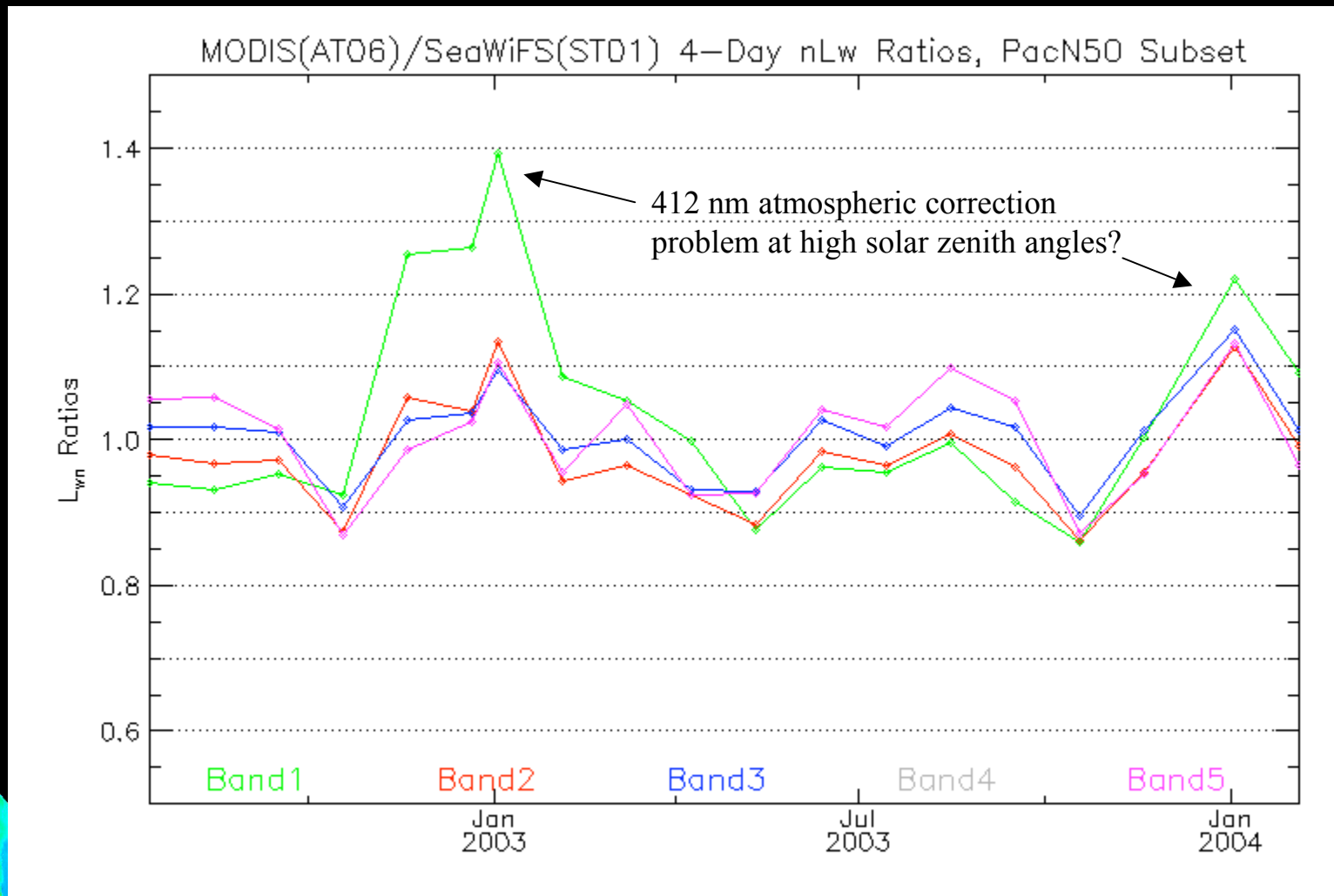
MODIS/SeaWiFS Comparisons

- 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
 - Sunlint 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)

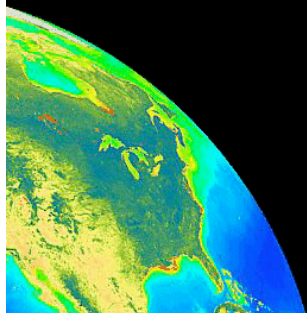
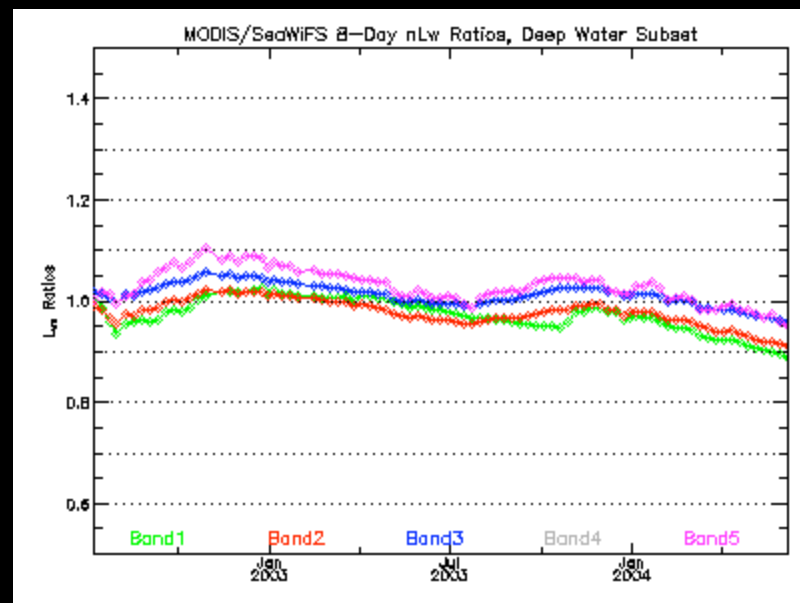


MODIS/Aqua Reprocessing

Completed in May '04 (~ 1_ 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.



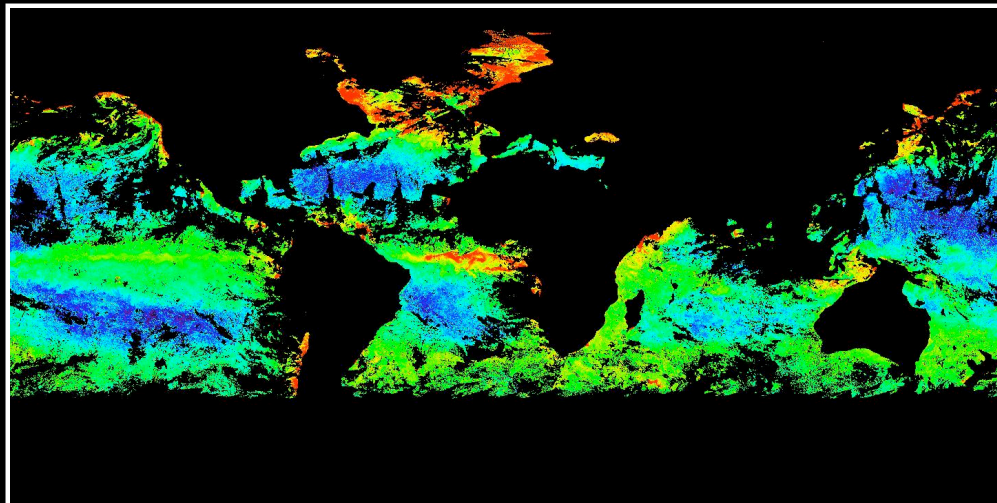
SeaWiFS & MODIS 4-Day Deep-Water Chlorophyll Images

4 day composites, Summer 2002



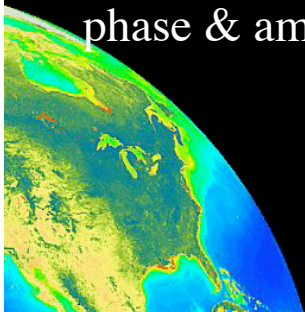
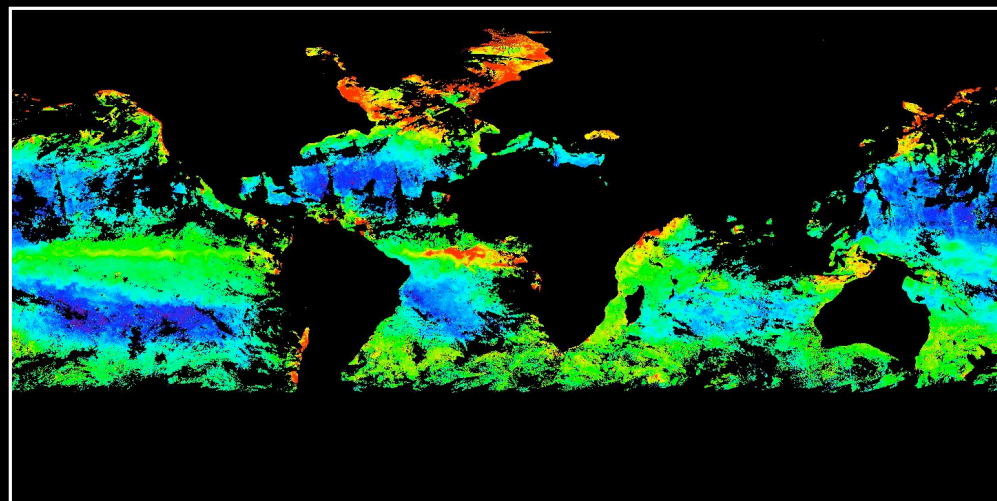
0.01-1 mg/m³

SeaWiFS



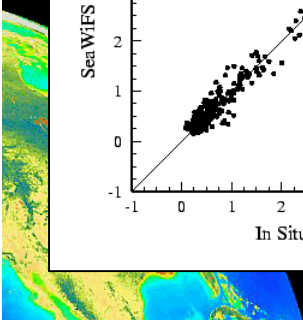
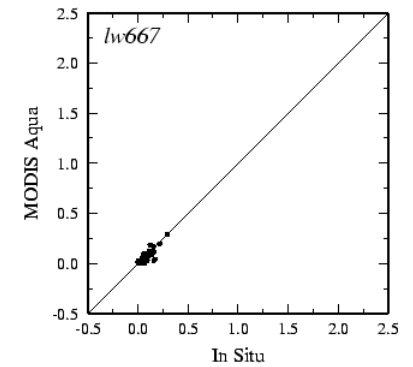
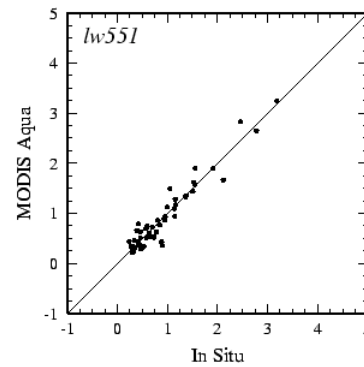
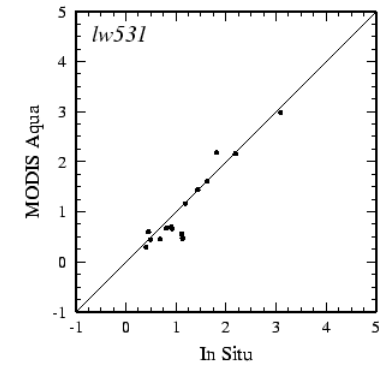
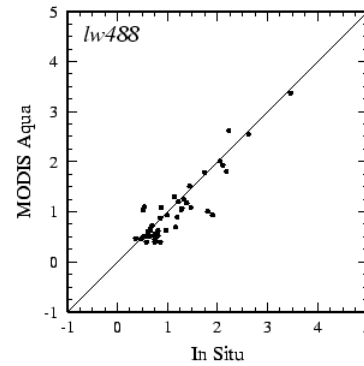
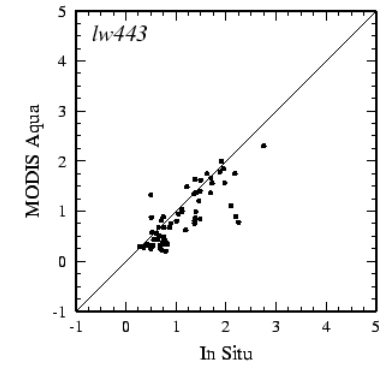
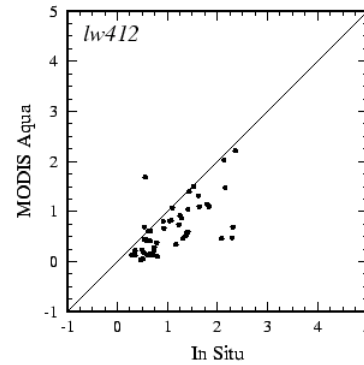
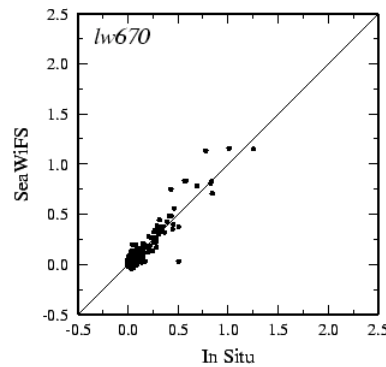
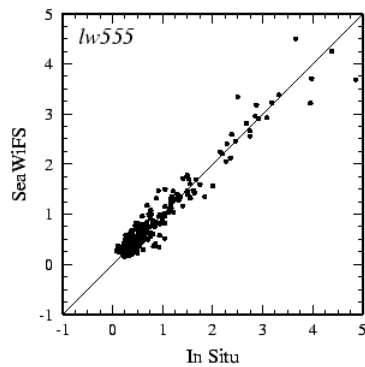
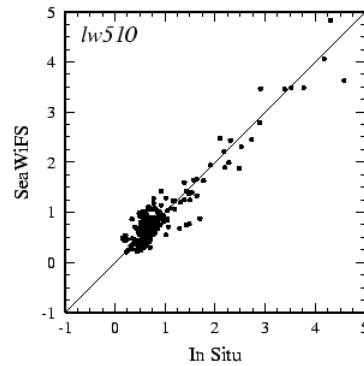
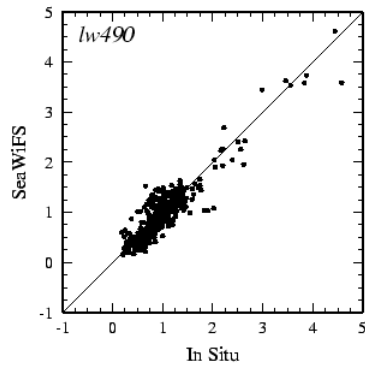
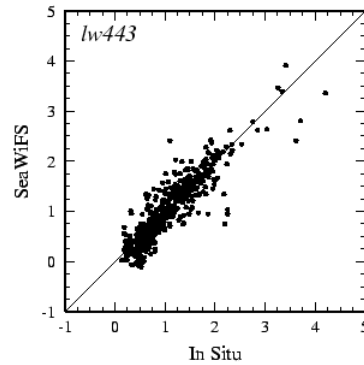
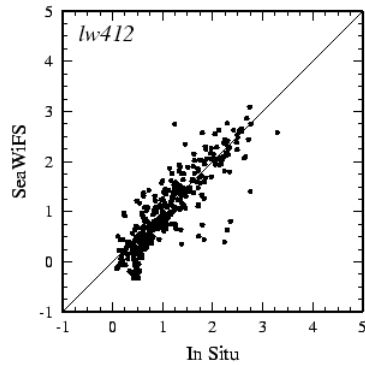
MODIS

(Correct polarization phase & amplitude)



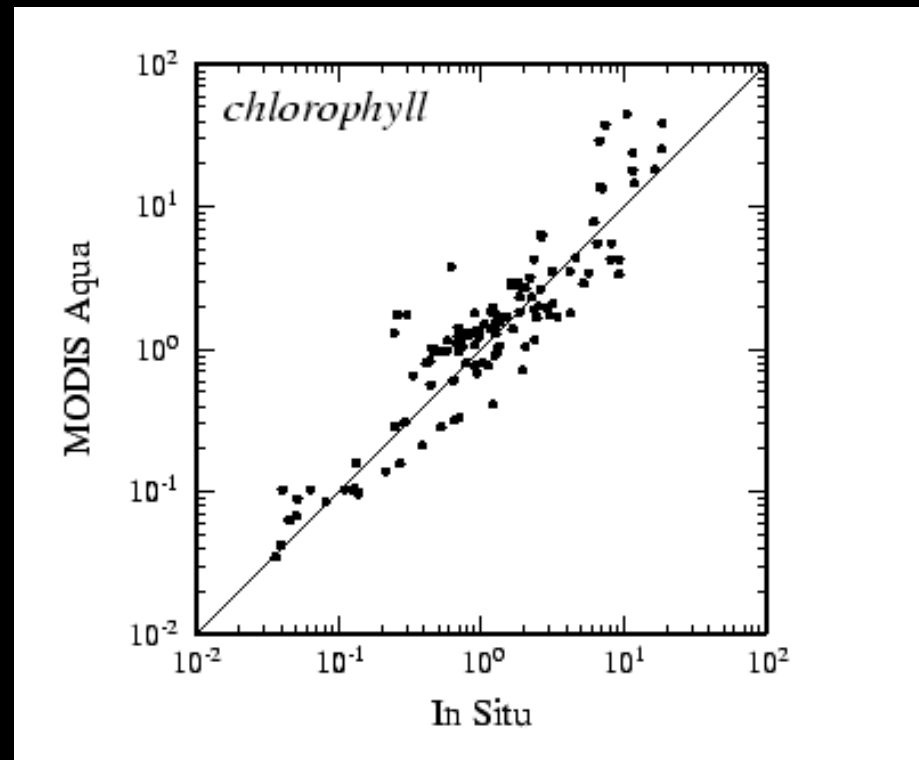
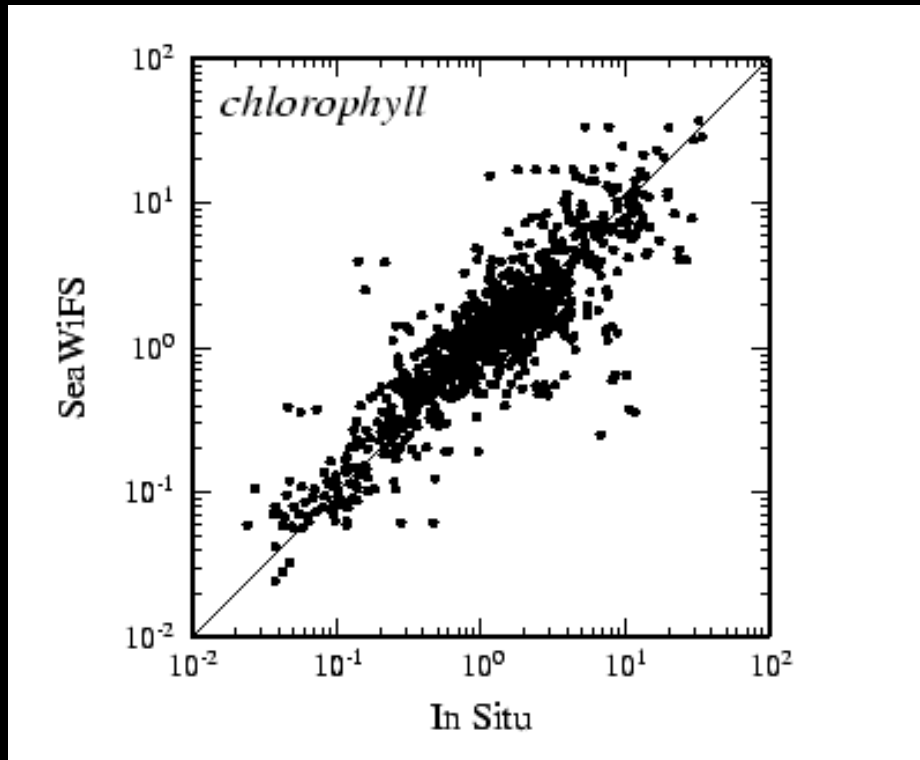
SeaWiFS Lw OCDPS Repro4

MODIS/Aqua Lw OCDPS Repro



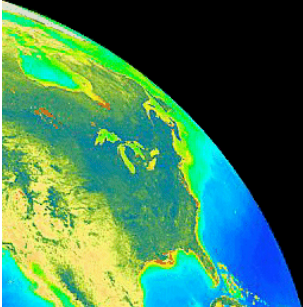
**OCDPS Repro4
OC4 Chlorophyll**

**OCDPS Repro
OC3 Chlorophyll**



SeaWiFS

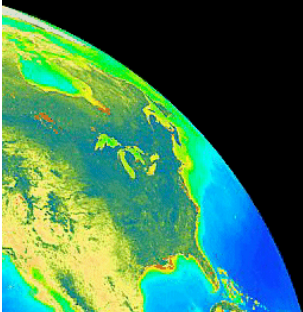
MODIS/Aqua



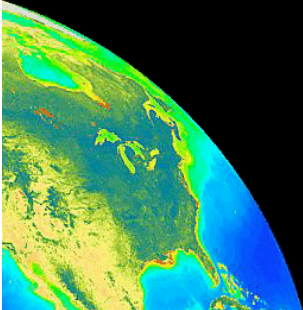
Additional Sensor Calibration Issues

- 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.



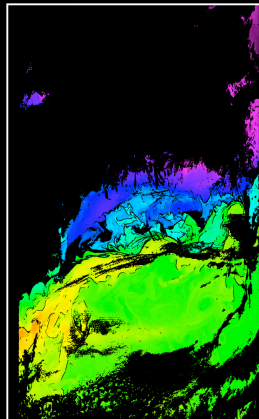
Back Up Slides



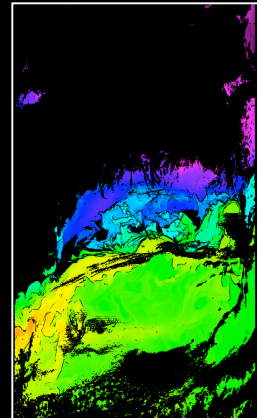
OCDP SST

- 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

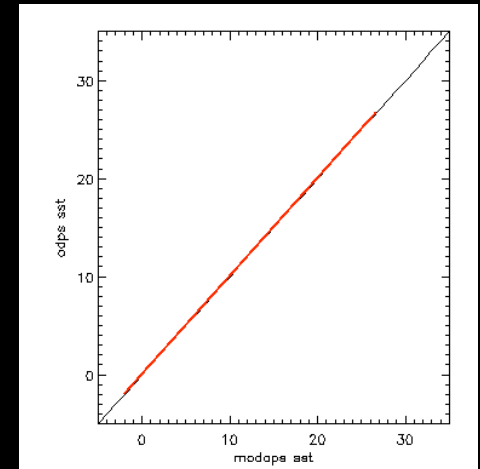


ODPS



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>