MODIS Ocean Color Processing

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Processing Approach Calibration/Validation

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Data Processing & Distribution

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* 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

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

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

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

**Reconfigurable & Scalable**

**OCDP Management & Staff**

**Community Agreed Standards and Protocols**

**In Situ Data**

**MCST**
- NASA HQ Program Management
- NASA Flight Projects
- Science Community

**Data Users**

**GSFC**
- DAAC

**L1 DATA**
- L1-L3 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

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<th>Previous OC Parameter Set</th>
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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)

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

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

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

SeaWiFS-MODIS Regional & Global Comparisons (OCDP Group)

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

Time-dependent gain factors.

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

In Situ Data Collection (MODIS Ocean Team)
SeaWiFS Stability

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
MOBY Vicarous Calibration

![Image of scuba divers underwater with equipment]

![Graph showing data with 412nm wavelength]

![Diagram of MOBY Vicarous system with labels for various depths and components like Es Collector, Solar Panels, MOBY Surface Float, TT7 control Unit, Cellular Transceiver, Mooring Tether, Ed Top, Lu Top, Ed Mid, Lu Mid, Ed Bot, Lu Bot, Instrument Bay, MOS System, Power Junction, Batteries]

- Accepted (N=9)
- Rejected (N=16)
- Mean Gain 0.97093
MODIS(Aqua)/SeaWiFS Lwn 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
  - 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)

412 nm atmospheric correction problem at high solar zenith angles?
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/m^3

SeaWiFS

MODIS
(Correct polarization phase & amplitude)
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

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