MODIS SST Processing and Support for GHRSSST at OBPG

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OBPG SST Activities

• **MODIS/Aqua**
  – global daytime SST production operational since early 2004
  – day/night production and distribution, transitioning from MODAPS/DAAC
  – intermediate Level-2 production for GHRSSST
  – community processing and display support through SeaDAS

• **MODIS/Terra**
  – global production and distribution, transitioning from MODAPS/DAAC
  – intermediate Level-2 production for GHRSSST
  – community processing and display support through SeaDAS

• **VIIRS/NPP**
  – oceans PEATE (Product Evaluation and Test Element)
  – community processing and display support through SeaDAS
Operational MODIS-Aqua Data Flow

- NASA EDOS System
- NOAA Realtime System
- Level-0 Ingest
  - Ingest queue table
  - ATT/EPH Ingest process
    - MODISA ateph table
    - Geo-Location (MOD_PR03)
    - L0 Ingest process
      - MODISA L0 table
      - L0-L1A (MOD_PR01)
      - Archive - Distrib Server
    - Archive - Distrib Server
  - MODISA L1B (MOD_PR02)
    - Full-resolution day- and nighttime via SEN (~60 GB per day)
    - MET, Ozone, and OISST data are dynamically selected for each L1A granule
    - MET
    - Ozone
    - OISST
    - Sensor CAL
    - Sensor attrs
    - Atm corr
  - L1B-L2 (MSI12)
    - Archive - Distrib Server
    - MODISA L2 table
  - L3BIN (L2bin)
    - Archive - Distrib Server
    - MODISA L3-bin table
  - L3MAP (smigen)
    - Archive - Distrib Server
    - MODISA L3-map table
    - Archive - Distrib Server
    - MODISA L1 table
    - Archive - Distrib Server

Software process
Hardware system
Database table
Ancillary input data

User Community:
- Ocean Color Web Server
  - Browser CGI / httpd
  - MySQL DB
  - Product meta data are populated from production DB

December 13, 2005
Operational MODIS-Aqua Data Flow

Level-2 Production
Ocean Color (day)
SST
SST4
GHRSSST

Level-3 Production
Ocean Color (day)
SST
SST4

L0 Ingest process
MODISA L0 table
Archive - Distrib Server
ATT/EPH Ingest process
MODISA ateph table
Geo-Location
L1A-L1B (MOD_PR02)
L1B-L2 (MSI12)
L3BIN (l2bin)
L3MAP (smigen)
MODISA L1 table
MODISA L2 table
MODISA L3-bin table
MODISA L3-map table
MET
Ozone
OISST
Sensor CAL
Sensor attribs
Atm corr

Ocean Color Web Server
Browser CGI / httpd
MySQL DB
Product meta data are populated from production DB

Level-0 Ingest
Ingest queue
Full-resolution day- and nighttime via SEN (~60 GB per day)

NASA EDOS System
NOAA Realtime System
MODIS SST Interaction

RSMAS
- algorithm development and coefficient updates
- error fields (tables)
- quality assessment

MODIS SST Interaction

GHRSSST Users

PO.DAAC
- GHRSSST product reformatting and ancillary merge (L2P)
- GHRSSST L2P distribution
- Level-3 distribution

OBPG
- software development and algorithm integration
- production processing
- quality assessment
- archive & distribution

Science Community

Level-3 Standard Products
Level-2 GHRSSST Products
Level-2 & Level-3 Standard Products
Evaluation & Recommendation
Processing & Display Software

Level-2P

evaluation & recommendation
Transition of MODIS/Aqua SST Processing from MODAPS to OBPG

- expansion of Level-1A archive to include night granules (completed)

- incorporation of RSMAS-provided algorithm coefficients and quality tests into MSL12 (completed)

- enhancements to MSL12 for night granule processing and 4um SST capability (completed)

- verification of implementation
Daytime 11-12um SST

MODAPS (modsst)  
OBPG (msl12)
Daytime 11-12um SST (OBPG - MODAPS)

SST Differences

Brightness Temperature Differences
Daytime 4um SST

MODAPS (modsst)  OBPG (msl12)
Daytime 4um SST (OBPG - MODAPS)

SST Differences

Brightness Temperature Differences
Nighttime 4um SST

MODAPS (modsst)  OBPG (msl12)
Nighttime 4um SST (OBPG - MODAPS)

SST Differences

Brightness Temperature Differences
Nighttime 11-12um SST

MODAPS (modsst)  OBPG (msl12)
Nighttime 11-12um SST (OBPG - MODAPS)

SST Differences

Brightness Temperature Differences
Nighttime 11-12um SST

MODAPS (modsst)

Quality Levels
### SST Quality Flags

<table>
<thead>
<tr>
<th>Bit</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>ISMASKED</td>
<td>Pixel was already masked</td>
</tr>
<tr>
<td>01</td>
<td>BTBAD</td>
<td>Brightness temperatures are bad</td>
</tr>
<tr>
<td>02</td>
<td>BTRANGE</td>
<td>Brightness temperatures are out-of-range</td>
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<tr>
<td>03</td>
<td>BTDIFF</td>
<td>Brightness temperatures are too different</td>
</tr>
<tr>
<td>04</td>
<td>SSTRANGE</td>
<td>SST outside valid range</td>
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<tr>
<td>05</td>
<td>SSTREFDIFF</td>
<td>SST is too different from reference</td>
</tr>
<tr>
<td>06</td>
<td>SST4DIFF</td>
<td>Longwave SST is different from shortwave SST</td>
</tr>
<tr>
<td>07</td>
<td>SST4VDIFF</td>
<td>Longwave SST is very different from shortwave SST</td>
</tr>
<tr>
<td>08</td>
<td>BTNONUNIF</td>
<td>Brightness temperatures are spatially non-uniform</td>
</tr>
<tr>
<td>09</td>
<td>BTVNONUNIF</td>
<td>Brightness temperatures are very spatially non-uniform</td>
</tr>
<tr>
<td>10</td>
<td>BT4REFDIFF</td>
<td>Brightness temperatures differ from reference</td>
</tr>
<tr>
<td>11</td>
<td>REDNONUNIF</td>
<td>Red-band spatial non-uniformity or saturation</td>
</tr>
<tr>
<td>12</td>
<td>HISENZ</td>
<td>Sensor zenith angle high</td>
</tr>
<tr>
<td>13</td>
<td>VHISENZ</td>
<td>Sensor zenith angle very high</td>
</tr>
<tr>
<td>14</td>
<td>Spare</td>
<td>Spare</td>
</tr>
<tr>
<td>15</td>
<td>Spare</td>
<td>Spare</td>
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### SST Quality Levels

<table>
<thead>
<tr>
<th>Nighttime Long-Wave SST</th>
<th>Quality Bit</th>
<th>Minimum Quality Level</th>
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<tr>
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<td>BTBAD</td>
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<tr>
<td></td>
<td>BTRANGE</td>
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</tr>
<tr>
<td></td>
<td>SSTRANGE</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>SSTREFDIFF</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>BT4REFDIFF</td>
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</tr>
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<td>BTNONUNIF</td>
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<tr>
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<td>VHISENZ</td>
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<tr>
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<td>SST4DIFF</td>
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<tr>
<td></td>
<td>BTNONUNIF</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>SST4VDIFF</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>HISENZ</td>
<td>1</td>
</tr>
</tbody>
</table>
Nighttime 11-12um SST Quality

MODAPS (modsst)  OBPG (msl12)
Nighttime 11-12um SST Quality
“Collection 5” Changes

Collection 4

Collection 5
Implementation of SST Processing within the OBPG

Bryan Franz
NASA Ocean Biology Processing Group
7 September 2005

Introduction

Generation of the Sea Surface Temperature (SST) products from the MODIS sensors is currently performed using software developed by the Rosenstiel School of Marine and Atmospheric Science (RSMAS) at the University of Miami. The RSMAS software is known formally as PGE10, and informally as modsst. In the future, processing and distribution of the MODIS SST products will be performed by the Ocean Biology Processing Group (OBPG). The OBPG will generate the Level-2 SST products using the Multi-Sensor Level-1 to Level-2 software (msl12), which is the same software used to generate the MODIS ocean color products. The use of common software simplifies integration of SST processing into the OBPG processing system, and also minimizes software maintenance costs. The immediate goal is to transfer all current SST processing logic from modsst into msl12. To this end, the latest available version of modsst and several past versions were examined, and the required algorithms were implemented into msl12. The implementation was then verified through comparison with standard archive products from the most recently available MODIS/Aqua reprocessing (MODAPS/DAAC Collection 4). A description of the algorithms as determined from analysis of the RSMAS code is provided in this document. Recent modifications are specifically identified, as these are not reflected in the current archive products used for verification. Details of the implementation within msl12 are provided, and comparisons between the msl12 and modsst processing results are shown.
Status of MODIS SST Standard Production

- MODAPS nearing completion of Collection 5 reprocessing.

- OBPG is now generating Level-3 SST & SST4, Day and Night products for Terra and Aqua in forward stream, with quality similar to Collection 5 MODAPS.

- Need to develop a global quality assessment strategy with RSMAS.

- OBPG would like to finalize initial processing plans for MODIS/Aqua SST, to present at MODIS Science Team meeting of Jan 3-6, with possible completion of full mission reprocessing by end of February.
Level-2 Processing for GHRSSST

- Level-2 products are currently being generated
- Aqua and Terra, day and night
- operational since 14 October
- content is preliminary
Intermediate Level-2 GHRSS SST File Content

<table>
<thead>
<tr>
<th>Scientific Data Set</th>
<th>Description</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>_year, day, msec</td>
<td>scan time</td>
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</tr>
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<td>longitude</td>
<td>pixel longitude</td>
<td>10.5 MB</td>
</tr>
<tr>
<td>latitude</td>
<td>pixel latitude</td>
<td>10.5 MB</td>
</tr>
<tr>
<td>sst</td>
<td>11-12um SST</td>
<td>5.2 MB</td>
</tr>
<tr>
<td>sst4</td>
<td>4um SST</td>
<td>5.2 MB</td>
</tr>
<tr>
<td>sstref</td>
<td>Reynolds SST (co-located)</td>
<td>5.2 MB</td>
</tr>
<tr>
<td>flags_sst</td>
<td>flags for 11-12um SST</td>
<td>5.2 MB</td>
</tr>
<tr>
<td>flags_sst4</td>
<td>flags for 4um SST</td>
<td>5.2 MB</td>
</tr>
<tr>
<td>qual_sst</td>
<td>quality levels for 11-12um SST</td>
<td>2.6 MB</td>
</tr>
<tr>
<td>qual_sst4</td>
<td>quality levels for 4um SST</td>
<td>2.6 MB</td>
</tr>
<tr>
<td>windspeed</td>
<td>wind speed (co-located NCEP)</td>
<td>10.5 MB</td>
</tr>
<tr>
<td>l2_flags</td>
<td>standard ocean flags (land, etc)</td>
<td>10.5 MB</td>
</tr>
</tbody>
</table>

Possible additions:

- AOT: what wavelength, what source?
- SSI: need an algorithm or preferred global source.
- **Proximity to cloud**: no reliable method to detect cloud.
- **Proximity to ice**: need preferred source for ice.
- **Error Fields**: method to be provided by RSMAS.
MODIS GHRSSST Level-2 Files
Distribution and Latency

- Files distributed to JPL via rolling ftp archive
  - Quicklook (best available ancillary)
  - Refined (best ancillary, e.g. Reynolds)
  - Operational since 14 October

  - Quicklook, average latency 4 hours, 52 minutes
  - Refined, available within 2-8 days

  - Quicklook, average latency 4 hours, 38 minutes
  - Refined, available within 2-8 days
OBPG Responsibilities for MODIS SST & GHRSSST

- Processing will build on the Aqua MODIS data stream already implemented at OBPG (11\(\mu\)m, daytime). This will be extended to night-time 11\(\mu\)m SST retrievals.
- The 4\(\mu\)m SST fields will be added to the data stream, including the option to produce daytime data.
- The RSMAS cloud masking methodology will be implemented for both day-time and night-time data streams.
- OBPG will work with RSMAS in the testing of the integrity of the SST fields (i.e. there should be no significant difference in the products that are generated at MODAPS and those at OBPG when the same algorithms are implemented).
- OBPG will work with RSMAS to implement the GHRSSST-specific, L2 processing code. To include both 11 \(\mu\)m (SST) and 4 \(\mu\)m (SST4) through implementation of SST and quality assessment algorithms developed at RSMAS.
- OBPG will work with JPL to ensure the delivery of GHRSSST MODIS granules to JPL PO.DAAC via network with the least possible delay (generally within 4-6 hours of satellite observation time as dictated by the availability of the Level-0 MODIS data from the NOAA realtime system.)
- The Terra MODIS data stream will be added as soon as the Aqua SST stream is successfully implemented and when directed to do so by NASA Headquarters.
OBPG Responsibilities for MODIS SST & GHRSSST

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OBPG Responsibilities for MODIS SST & GHRSSST

✔ Processing will build on the Aqua MODIS data stream already implemented at OBPG (11μm, daytime). This will be extended to night-time 11μm SST retrievals.

✔ The 4μm SST fields will be added to the data stream, including the option to produce daytime data.

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OBPG Responsibilities for MODIS SST & GHRSSST

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✓ The 4µm SST fields will be added to the data stream, including the option to produce daytime data.

✓ The RSMAS cloud masking methodology will be implemented for both day-time and night-time data streams.

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• The Terra MODIS data stream will be added as soon as the Aqua SST stream is successfully implemented and when directed to do so by NASA Headquarters.
OBPG Responsibilities for MODIS SST & GHRSSST
(on-going activities)

- OBPG will work together with RSMAS to ensure the continuing accuracy of the SST fields, and implement upgrades to the processing algorithms and methodology when necessary.
- OBPG will work together with RSMAS to improve the efficacy of the cloud screening algorithms.
- OBPG will work with RSMAS on the periodic updating of algorithms and retrieval coefficients as required (anticipated to be no more than twice per year), and reprocess the past data to a consistent data set as necessary.
- OBPG will implement improved instrument models as recommended by MCST.
- OBPG will assemble L3 SST products (4km resolution with mutually agreed upon quality criteria) for timely distribution to the SST community through the OBPG and JPL PO.DAAC.
- OBPG will provide archiving of the MODIS SST
- OBPG will support the web-based MODIS quality assurance utility (functions similar to MQABI)
- OBPG will implement MODIS SST algorithms in the SEADAS software suite using easily supported coding standards and methods.