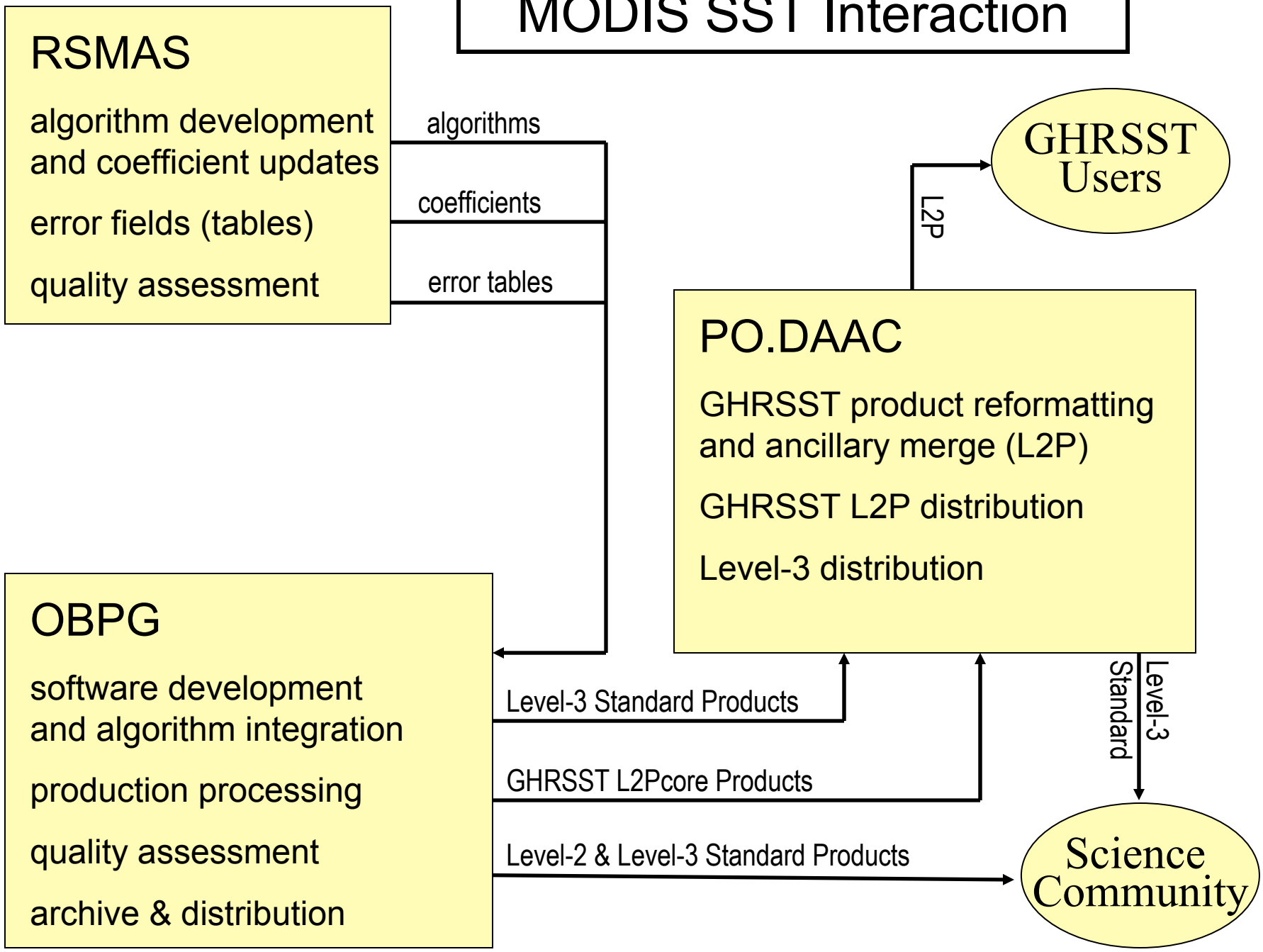
Development of GHRSST L2Pcore for MODIS

Bryan Franz
NASA Ocean Biology Processing Group
Goddard Space Flight Center

MODIS SST Interaction



MODIS SST Activities at OBPG

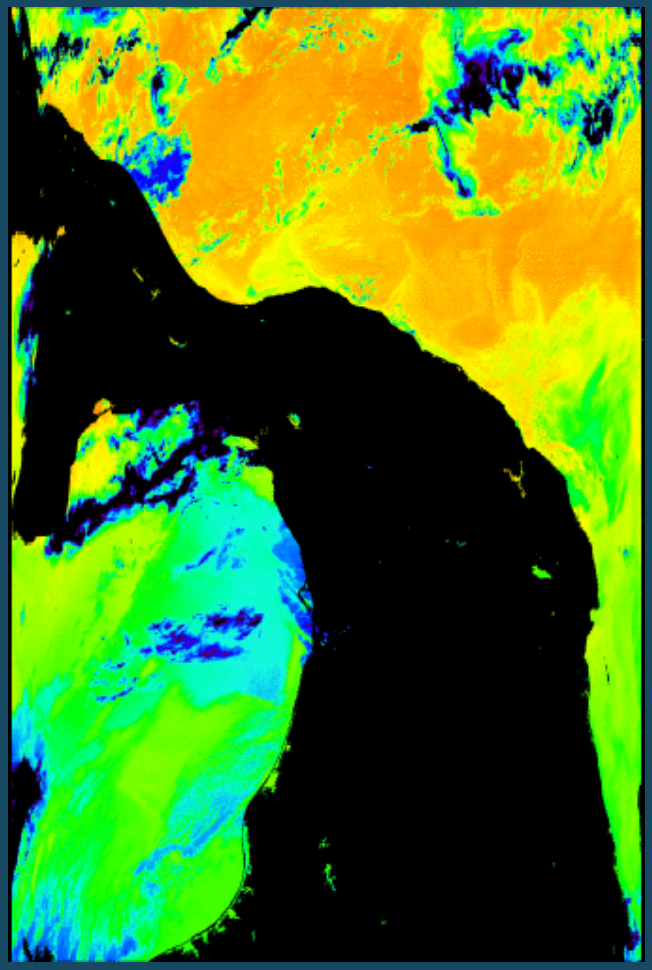
- Standard Global Production (transitioning from MODAPS/DAAC)
  - Level-0 through Level-3
  - Terra & Aqua, Day and Night, 11-12um and 4um SST products
  - Online archive and distribution (L1A, L2, L3)

- GHRSST L2Pcore Production
  - Parallel production effort, at no additional cost
  - Level-0 through L2Pcore is operational
  - Terra & Aqua, Day and Night, 11-12um and 4um SST products
  - Distribution to PO.DAAC for L2P conversion

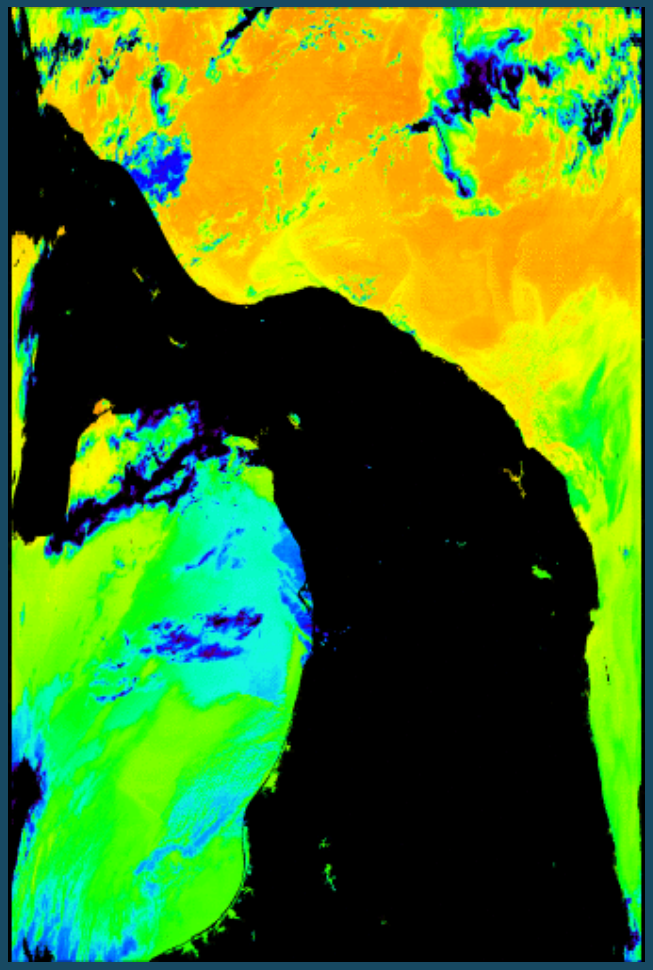
- User Support
  - SeaDAS: distributed processing software, display and analysis
  - OCForum: online user support forum, monitored by project staff

Nighttime 11-12um SST

RSMAS (modsst)

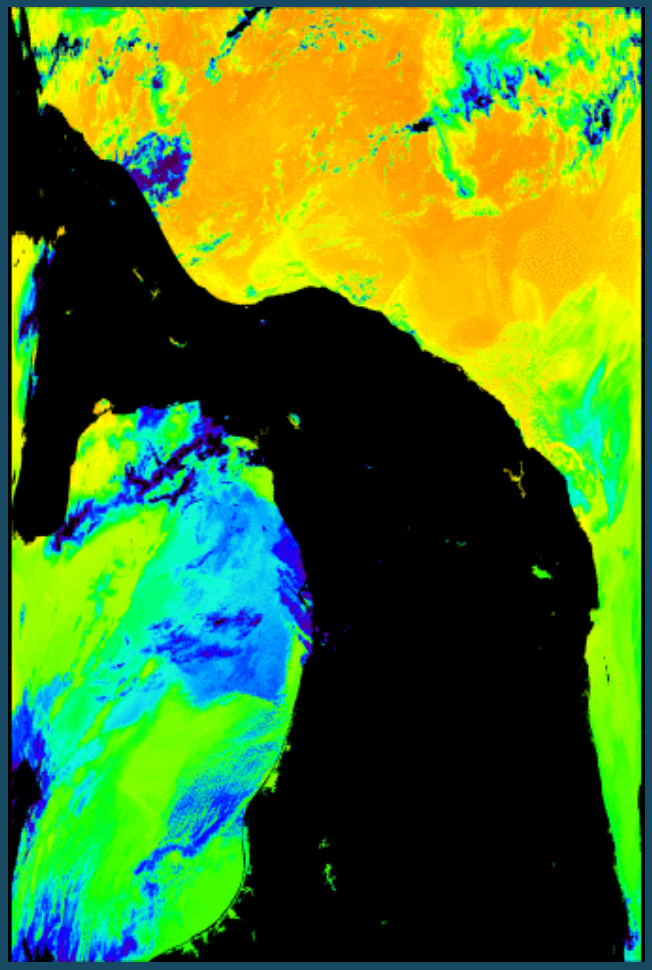


OBPG (msl12)

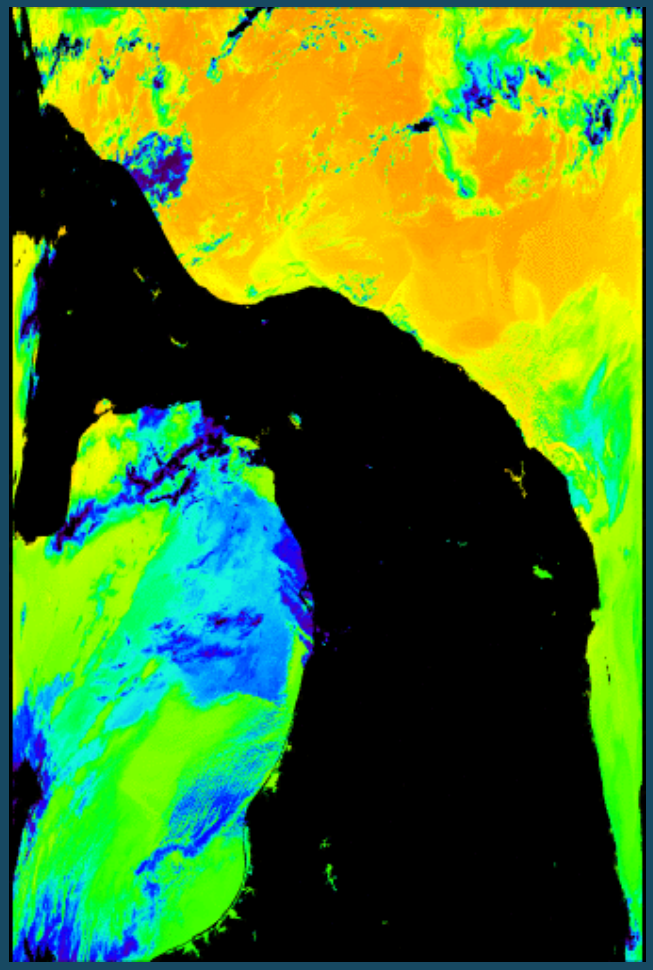


Nighttime 4um SST

RSMAS (modsst)

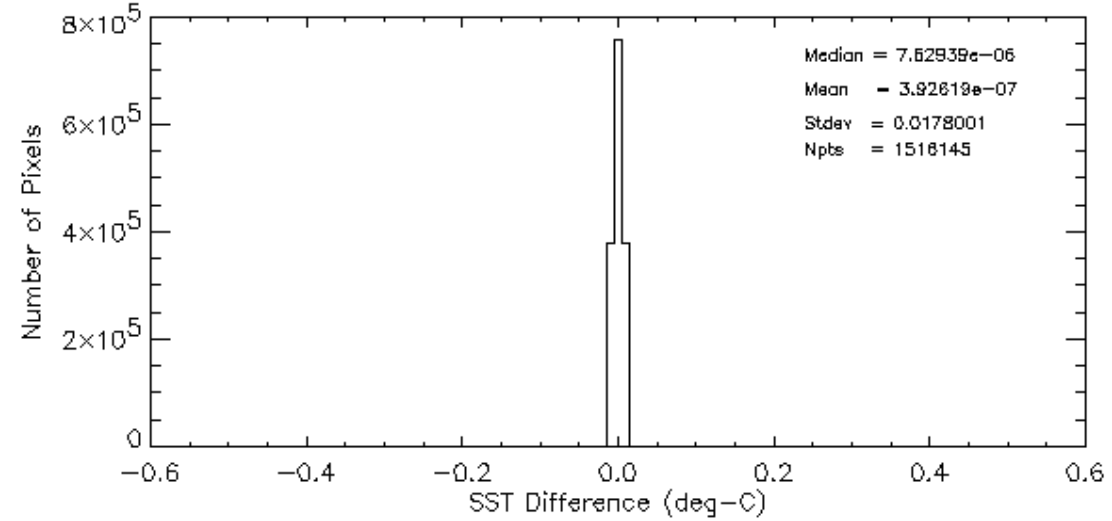


OBPG (msl12)

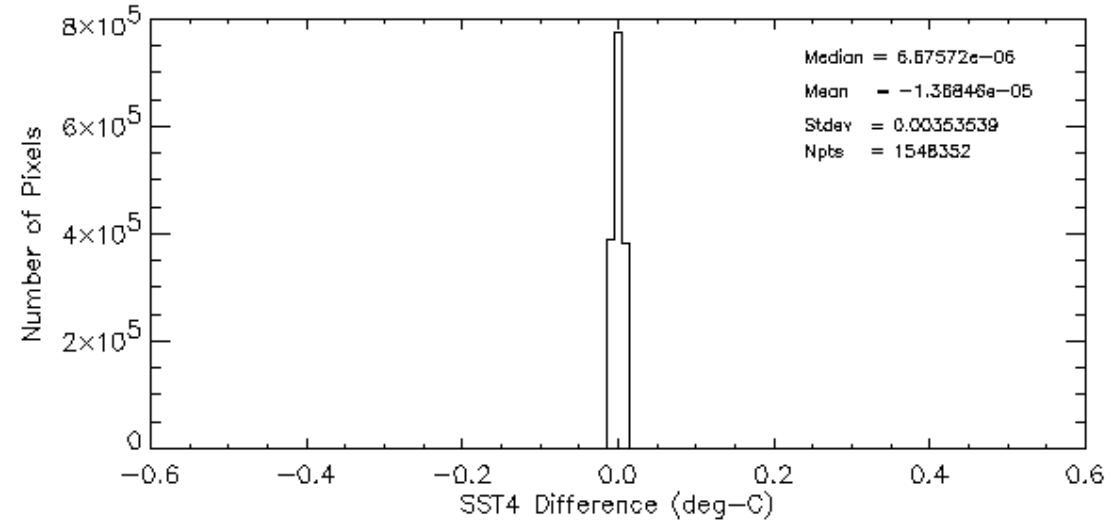


Verification of Algorithm Implementation
OBPG - RSMAS

11-12um SST Differences



4um SST Differences

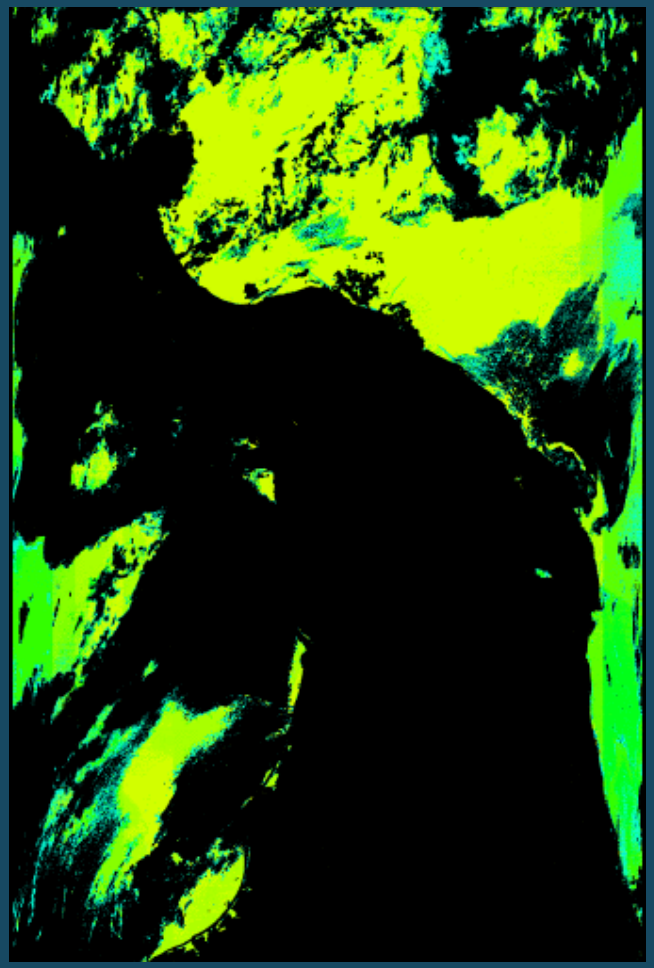


Status of MODIS GHRSST Production

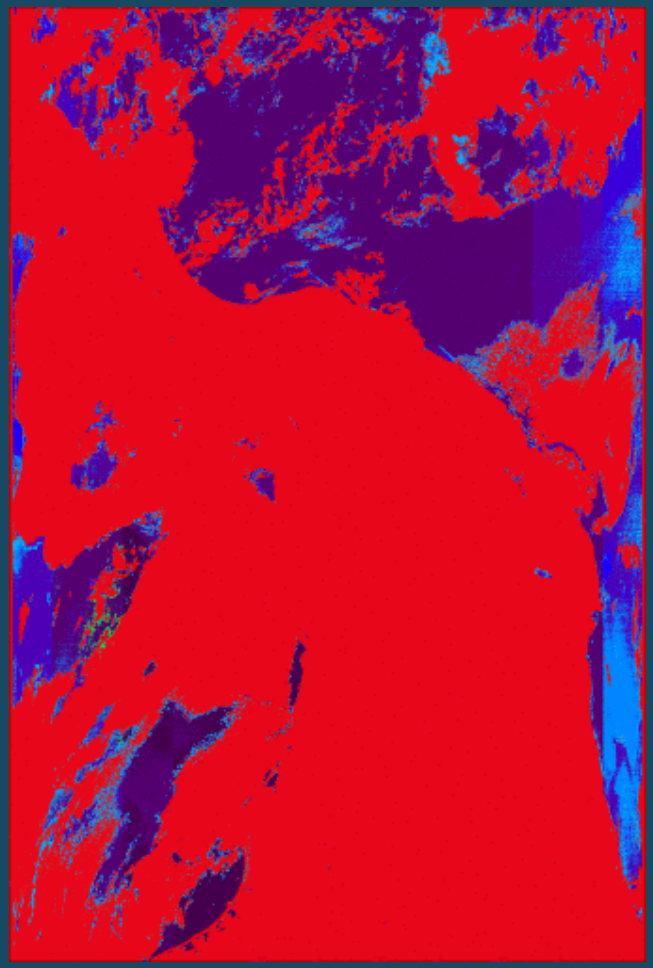
- L2Pcore files have been available to PO.DAAC via rolling ftp archive since October 2005.
- File content evolving: recent updates incorporate SSES.

11-12um SSES Error Fields

SSES Bias



SSES Std Dev



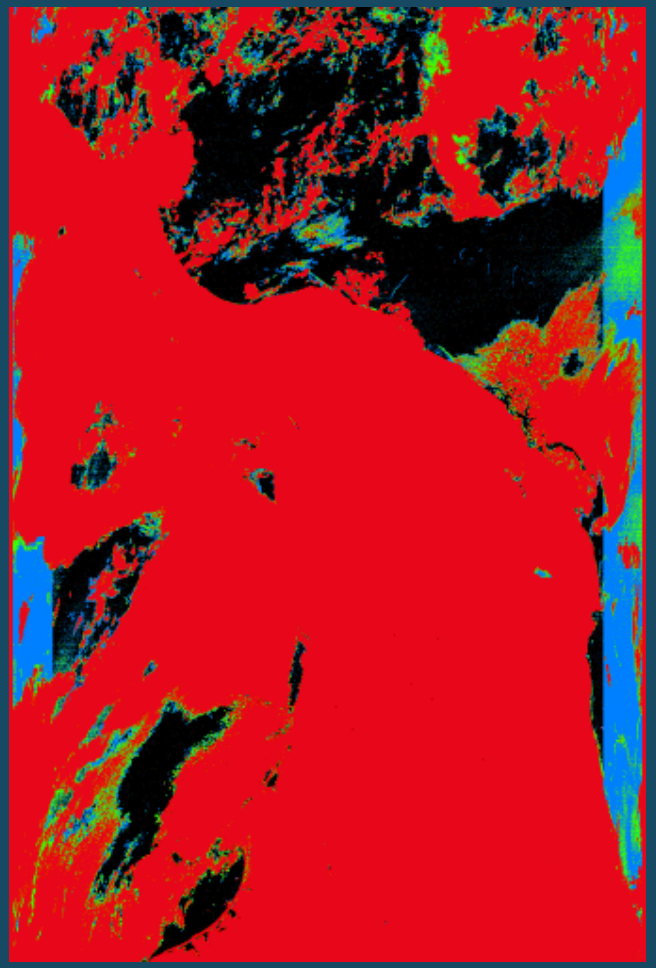
Status of MODIS GHRSST Production

- L2Pcore files have been available to PO.DAAC via rolling ftp archive since October 2005.

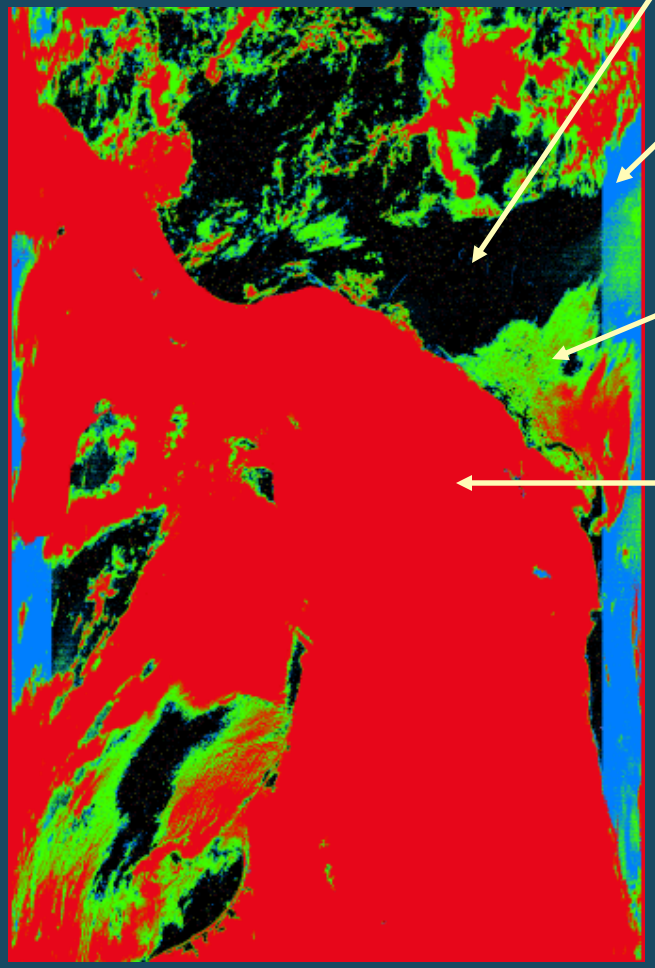
- File content evolving: recent updates incorporate SSES
  - static tables developed by RSMAS
  - function of
    - SST
    - day or night
    - season
    - view zenith
    - BT difference
    - latitude
    - quality level

Quality Levels

11-12um Night



4um Night



QL=0

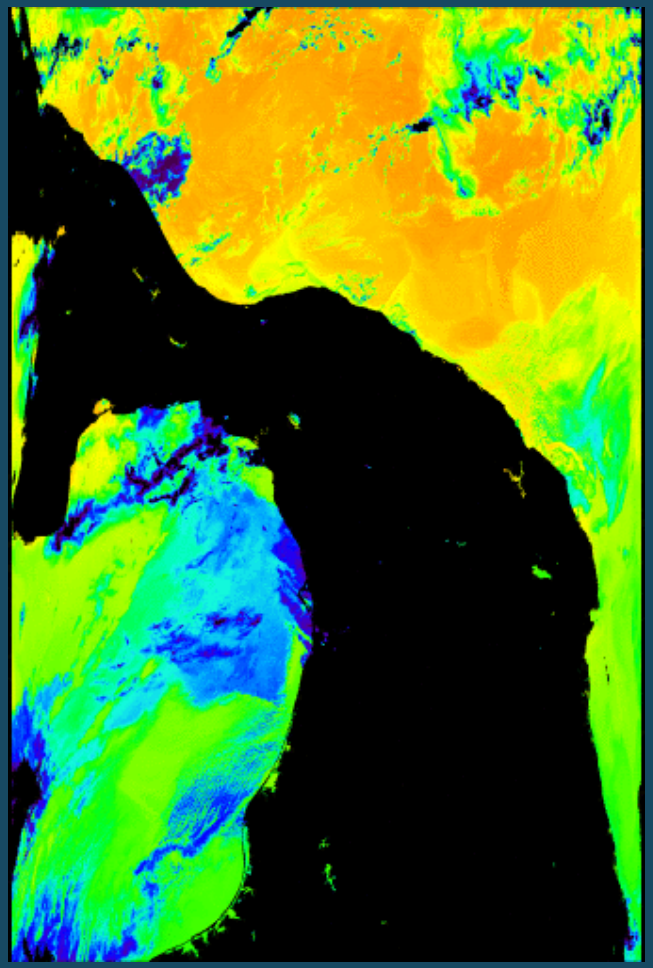
QL=1

QL=2

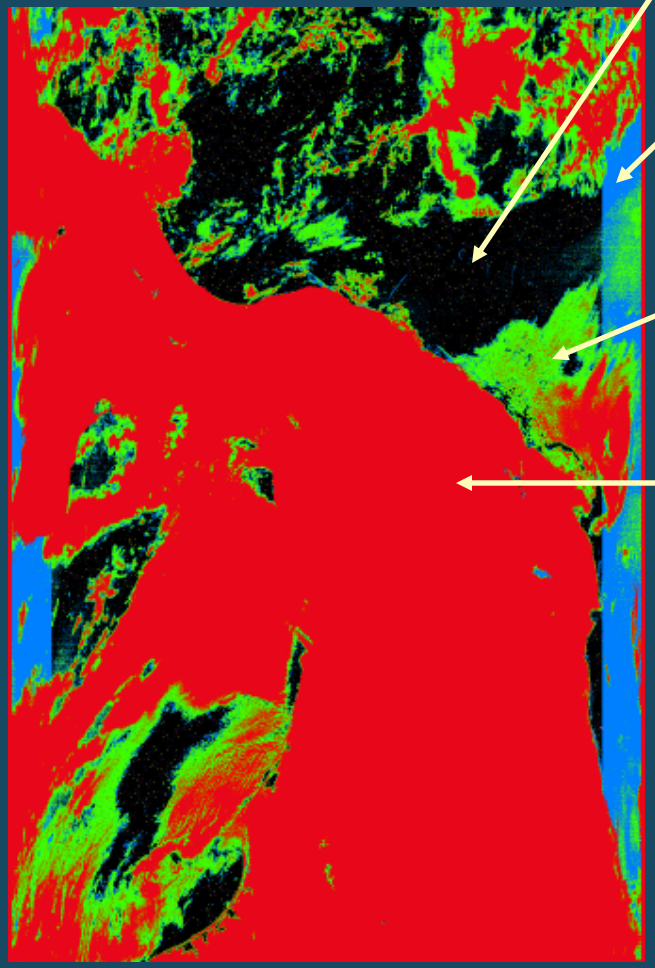
QL=3

Quality Levels

4um Night SST



4um Night QL



11-12um Night Quality 3

- Land
- Radiance bad (saturated, masked at Level-1)
- BT out of range (-4 to 33 deg-C)
- SST out of range (-2 to 45 deg-C)
- 4um BT difference too different from reference
- SST too different from reference (5 deg-C absolute)

11-12um Night Quality 2

- BT spatial non-uniformity (3x3 max-min > 1.2 deg-C)
- SST too different from 4um SST (1 deg-C absolute)

Additional information is available here
http://oceancolor.gsfc.nasa.gov/DOCS/modis_sst/

L2Pcore File Content

Data Set	Description
year, day, msec	scan time
longitude	pixel longitude
latitude	pixel latitude
sst	11-12um SST
bias_sst	11-12um SST SSES bias
stdv_sst	11-12um SST SSES std. dev.
qual_sst	11-12um quality levels
sst4	4um SST
bias_sst4	4um SST SSES bias
stdv_sst4	4um SST SSES std. dev.
qual_sst4	4um SST quality levels
sstref	Reynolds SST (co-located)
l2_flags	e.g., land, day/night per pixel

~65MB per 5-min MODIS granule, uncompressed

~20GB (288 granules) per day per sensor

“Potential” Options for L2Pcore File Size Reduction

“Potential” Options for L2Pcore File Size Reduction

1) Deal with it ! The “H” stands for high-resolution.
   a) our only intended customer is Ed
   b) is this an L2Pcore or L2P issue ?
2) Sub-sample L2Pcore lon/lat along-scan by 8 (28% reduction)
3) 4um SST
   a) eliminate from L2Pcore (19% reduction)
   b) produce separate L2Pcore for 4um (night) and 11-12um
   c) eliminate from daytime L2Pcore (mixed day/night?)
4) Quality Levels
   a) zero-out lower quality pixels to improve compression
   b) reformat from swath to time-ordered vectors and only include best quality pixels.
5) Reduction of Resolution
   a) sub-sample to every 4th pixel & line (4km at nadir, 84% reduction)
   b) average to 4km at nadir (raises many problems/concerns)

“Potential” Options for L2Pcore Expansion

- sensor zenith angle
- brightness temps
- chlorophyll concentration
  - daytime, cloud & glint-free
- aerosol optical thickness
  - daytime, cloud & glint-free

MODIS GHRSST L2Pcore
Distribution and Latency

- Files distributed to JPL PO.DAAC via rolling ftp archive
  - Operational since 14 October 2005
  - Recent updates to incorporate SSES fields
  - Aqua (ftp://oceans.gsfc.nasa.gov/MODISA/GHRSST/)
  - Terra (ftp://oceans.gsfc.nasa.gov/MODIST/GHRSST/)

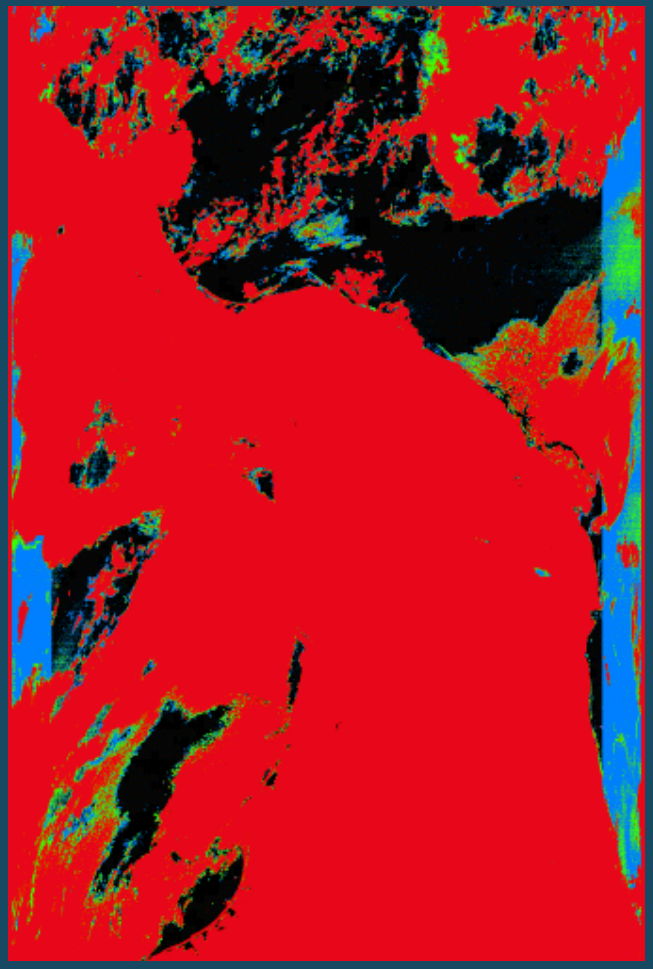
- Quicklook Products
  - best available ancillary, predicted attitude/ephmerides
  - available ~5 hours from time of observation

- Refined Products
  - preferred ancillary, definitive attitude/ephmerides
  - available 2-8 days later

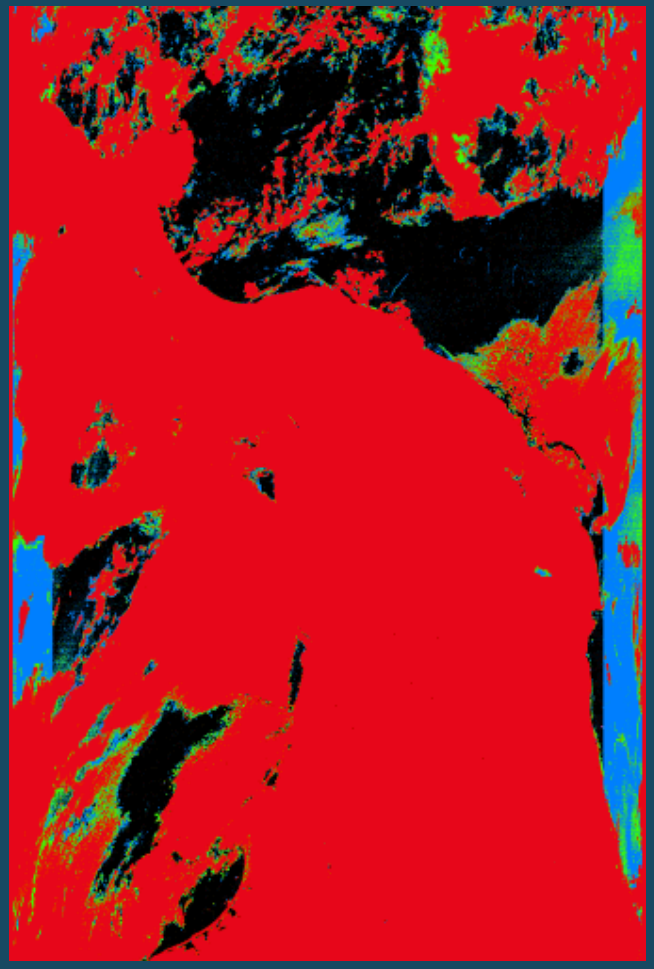
END

Nighttime 11-12um SST Quality

RSMAS (modsst)

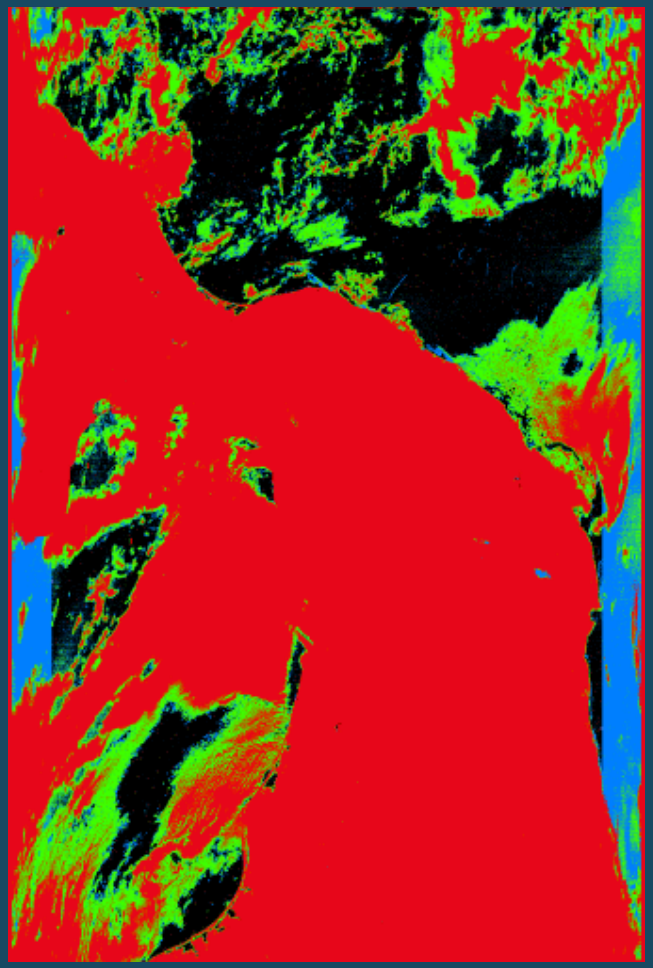


OBPG (msl12)

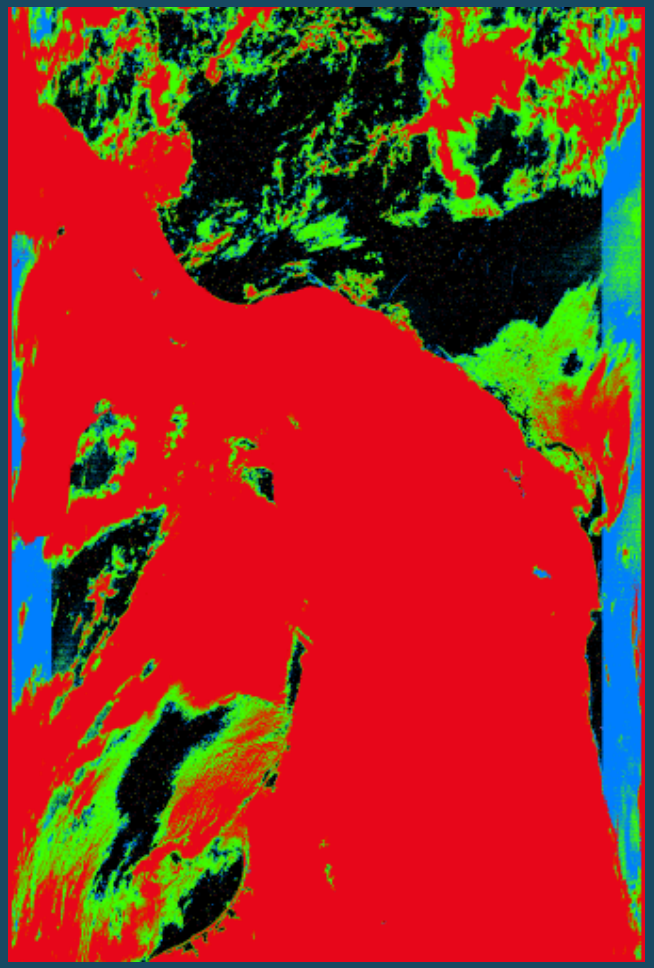


Nighttime 4um SST Quality

RSMAS (modsst)



OBPG (msl12)



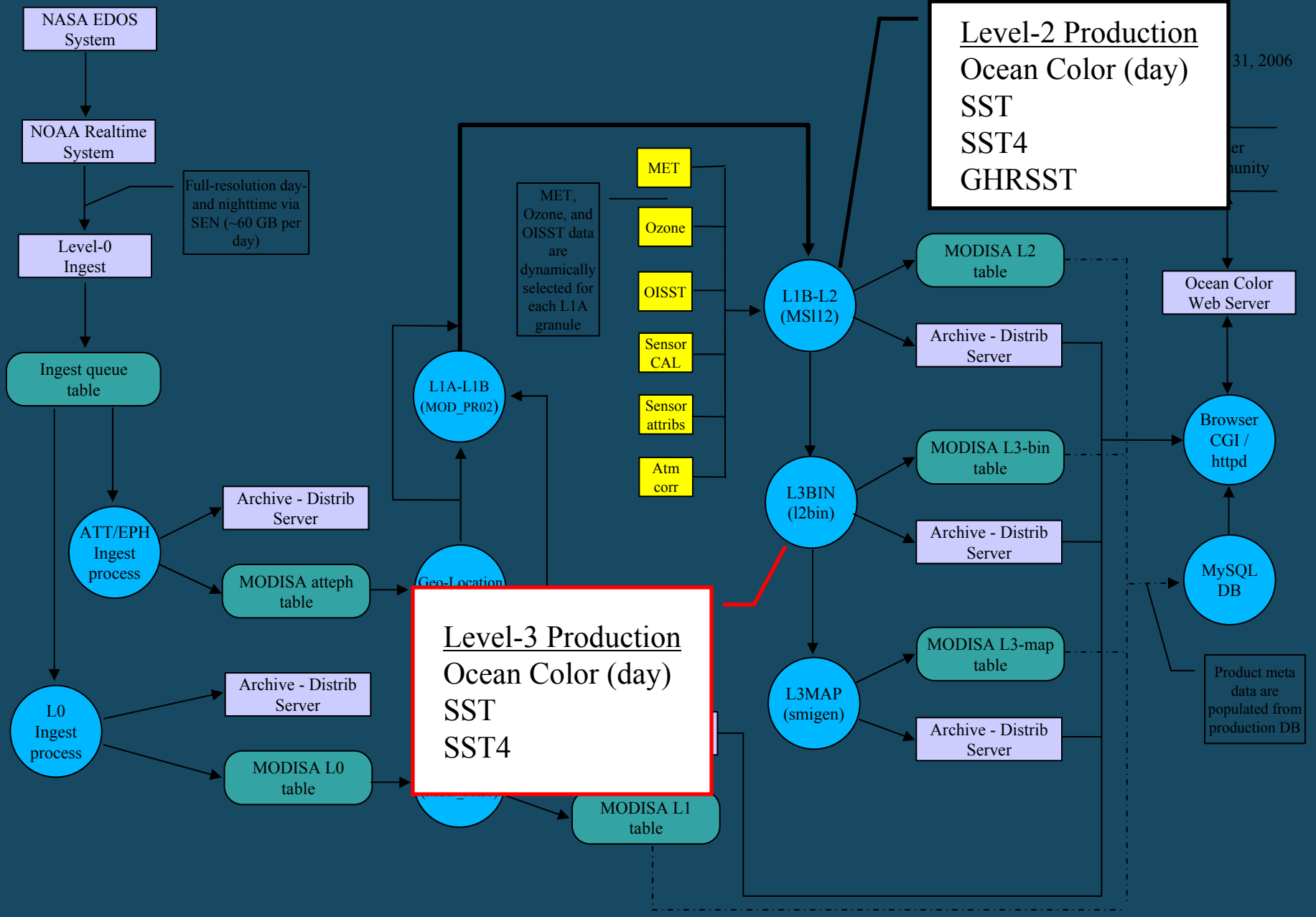
Implementation of SST Processing within the OBPG

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 impementation 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 implemention within msl12 are provided, and comparisons between the msl12 and modsst processing results are shown.

Operational MODIS-Aqua Data Flow



OBPG Responsibilities for MODIS SST & GHRSST

- ✓ 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.
- ✓ 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 GHRSST-specific, L2 processing code. To include both 11 µm (SST) and 4 µm (SST4) through implementation of SST and quality assessment algorithms developed at RSMAS.
- ✓ OBPG will work with JPL to ensure the delivery of GHRSST 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 & GHRSST
(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.

SST Quality Flags

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

SST Quality Levels

Nighttime Long-Wave SST

Quality Bit	Minimum Quality Level
ISMASKED	3
BTBAD	3
BTRANGE	3
SSTRANGE	3
BT4REFDIFF	3
SSTREFDIFF	3
BTVNONUNIF	2
VHISENZ	2
SST4DIFF	2
BTNONUNIF	1
SST4VDIFF	1
HISENZ	1