MODIS SST Processing and Support for GHRSST at OBPG

Bryan Franz
NASA Ocean Biology Processing Group
Goddard Space Flight Center

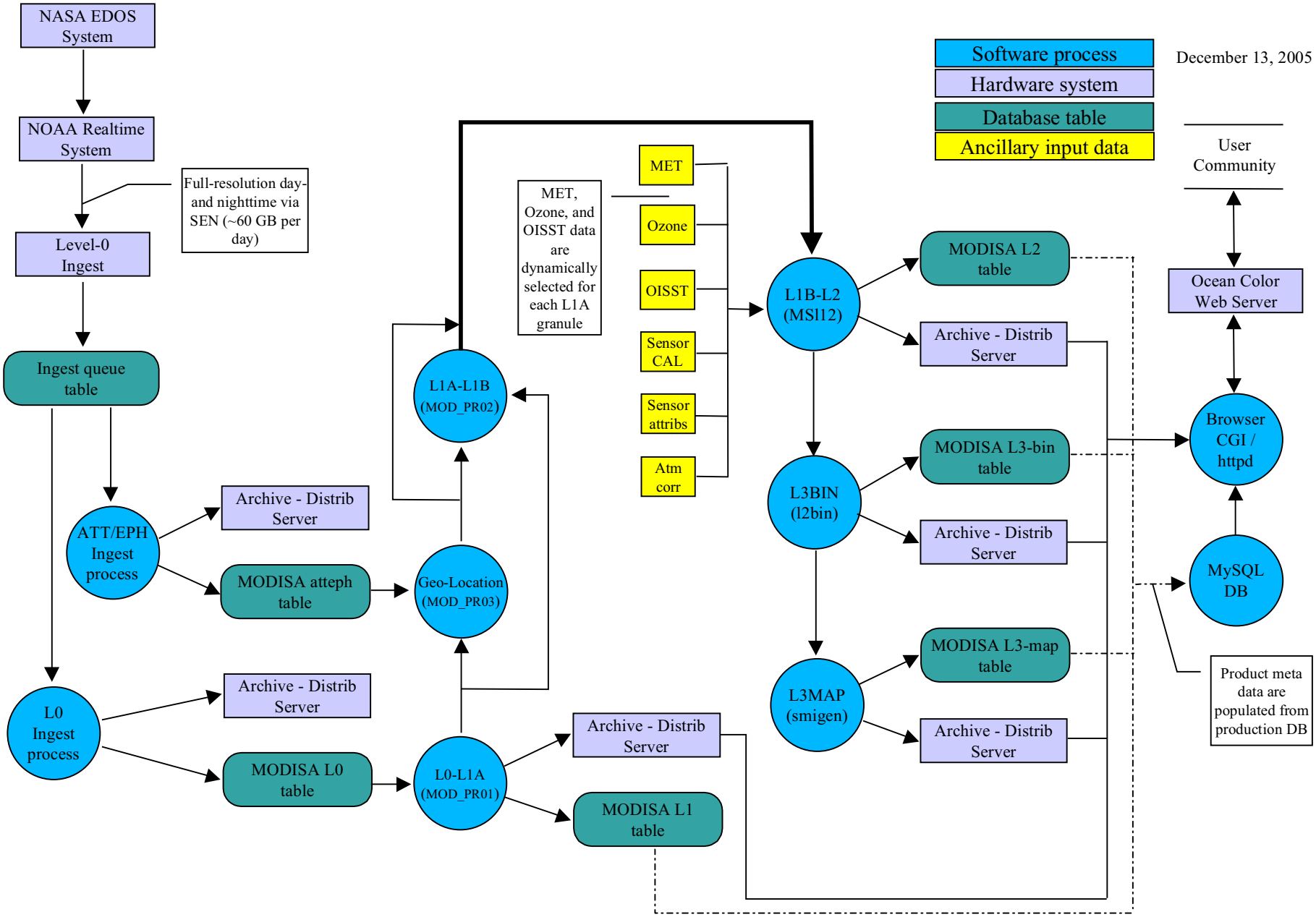
OBPG SST Activities

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

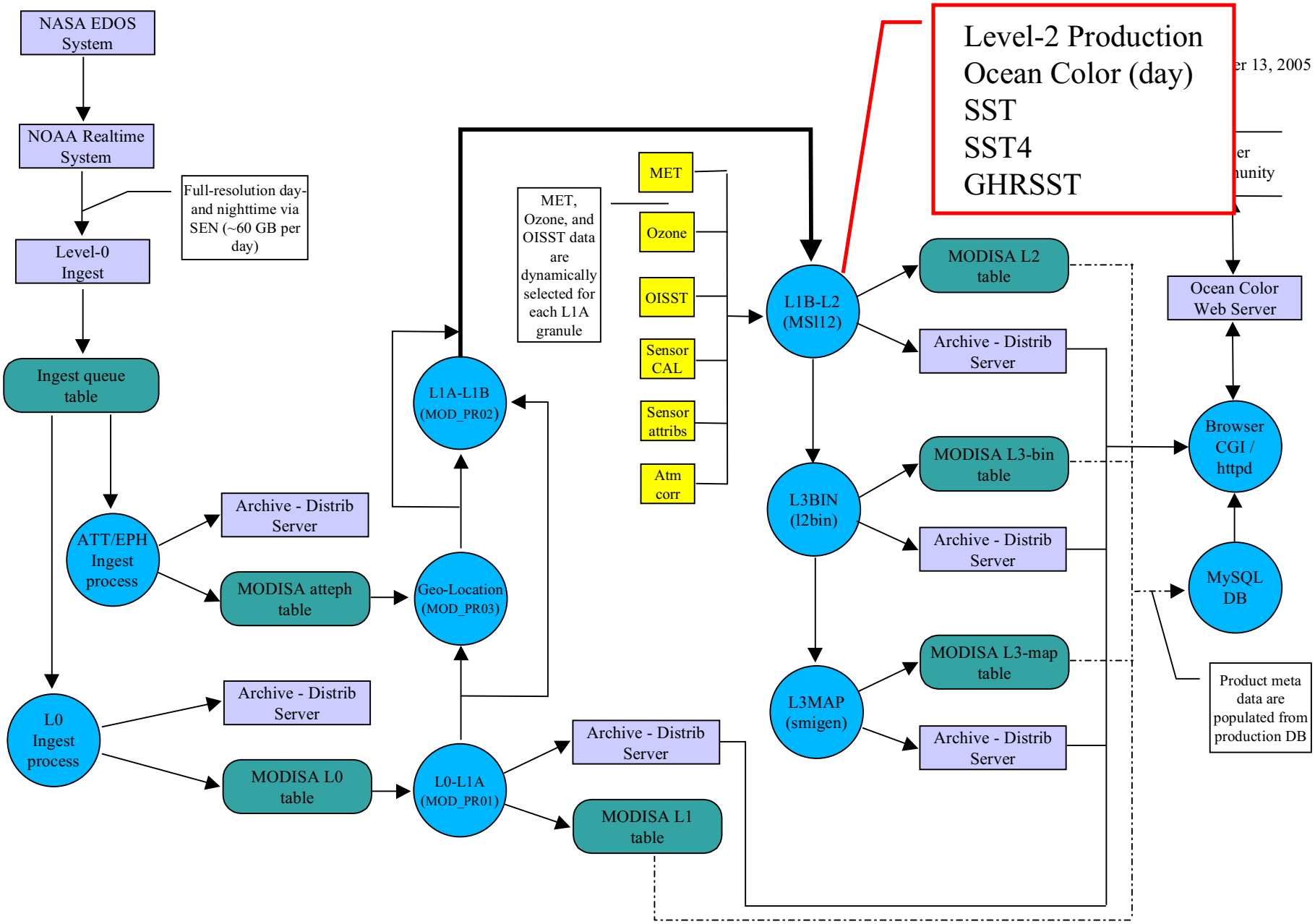
- **MODIS/Terra**
  - global production and distribution, transitioning from MODAPS/DAAC
  - intermediate Level-2 production for GHRSST
  - community processing and display support through SeaDAS

- **VIIRS/NPP**
  - oceans PEATE (Product Evaluation and Test Element)
  - community processing and display support through SeaDAS

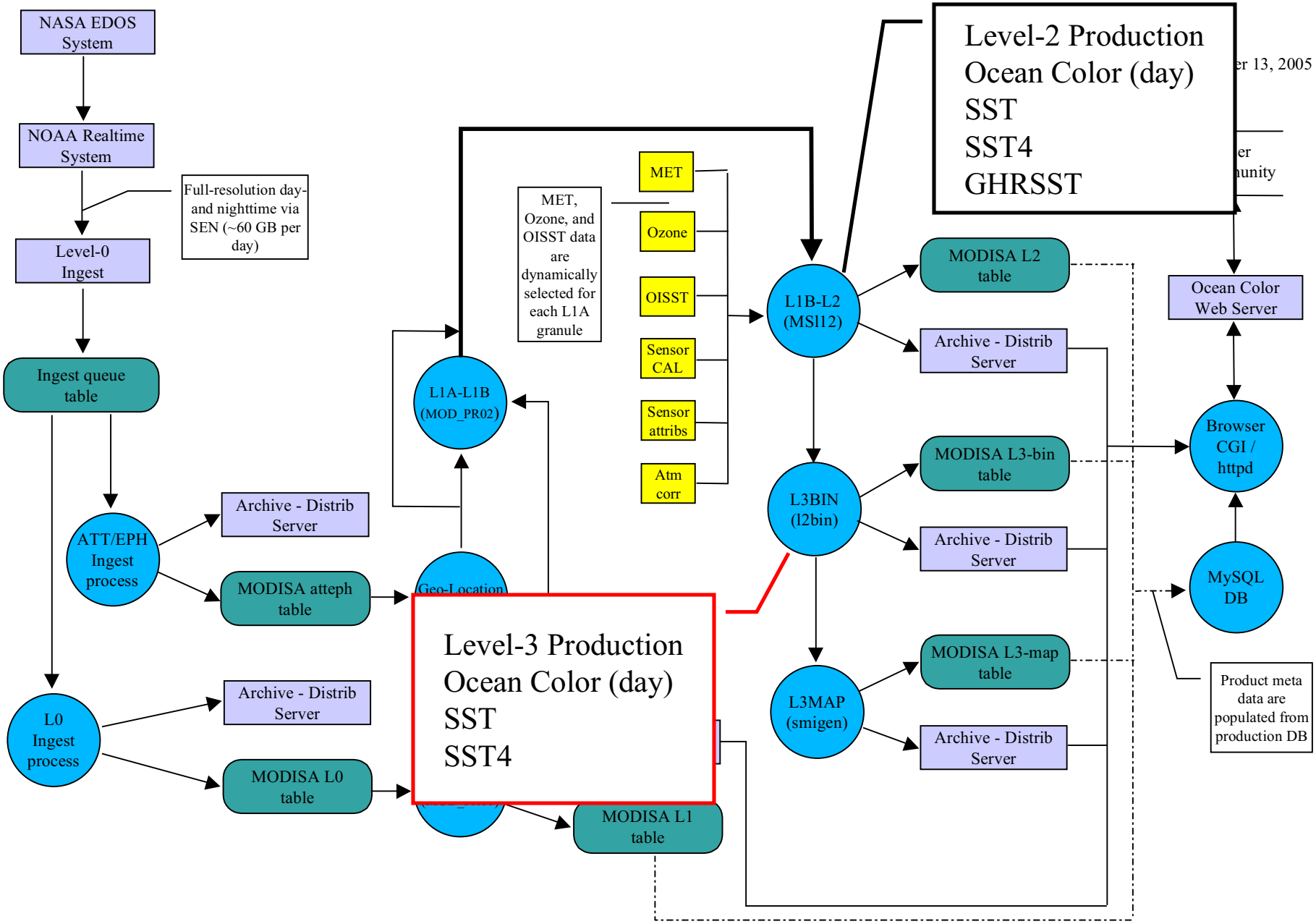
Operational MODIS-Aqua Data Flow

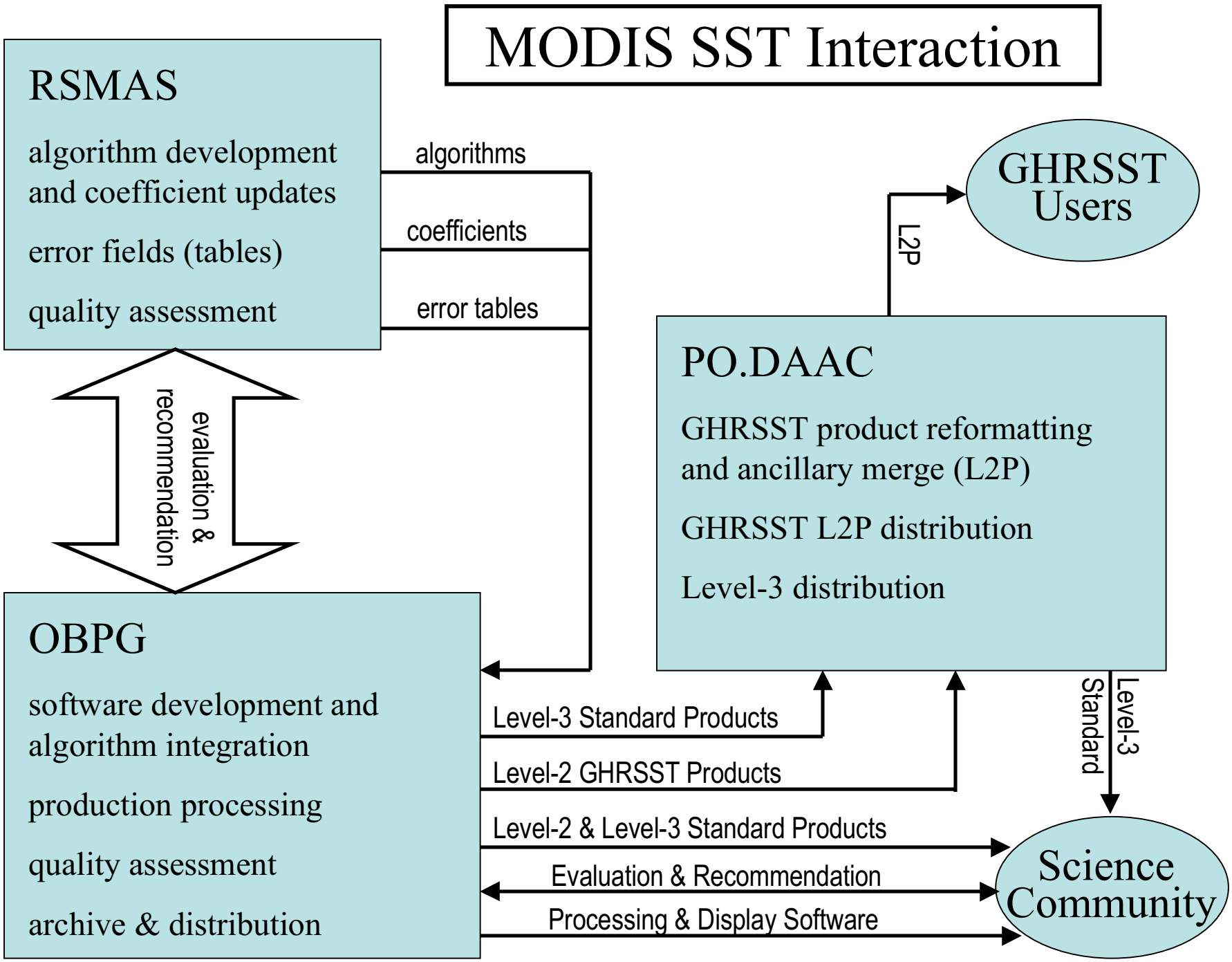


Operational MODIS-Aqua Data Flow



Operational MODIS-Aqua Data Flow



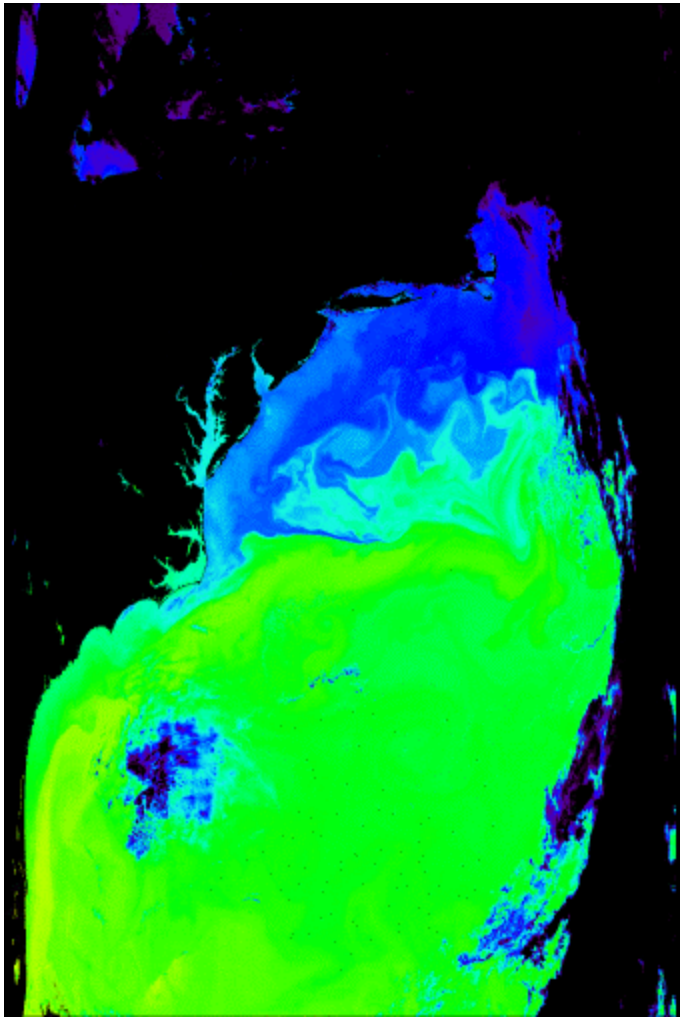

MODIS SST Interaction
RSMAS
algorithm development and coefficient updates
error fields (tables)
quality assessment
algorithms
coefficients
error tables
evaluation & recommendation
OBPG
software development and algorithm integration
production processing
quality assessment
archive & distribution
GHRSST Users
L2P
PO.DAAC
GHRSST product reformatting and ancillary merge (L2P)
GHRSST L2P distribution
Level-3 distribution
Level-3 Standard Products
Level-2 GHRSST Products
Level-3 Standard
Level-2 & Level-3 Standard Products
Evaluation & Recommendation
Processing & Display Software
Science Community

Transition of MODIS/Aqua SST Processing from MODAPS to OBPG

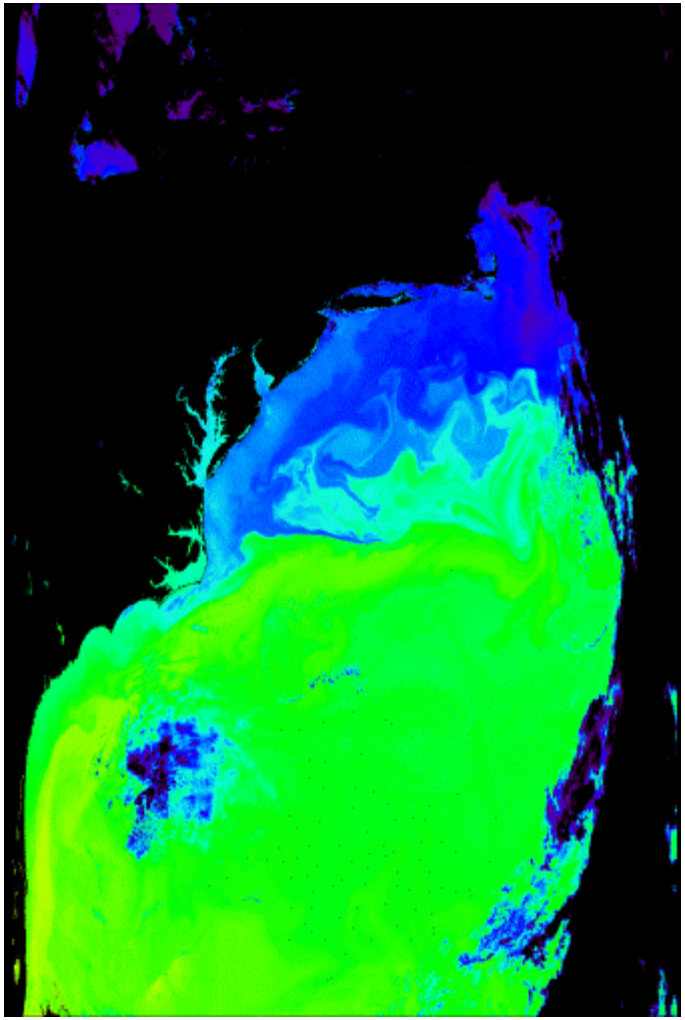
- expansion of Level-1A archive to include night granules (completed)
- incorporation of RSMAS-provided algorithm coefficients and quality tests into MSL12 (completed)
- enhancements to MSL12 for night granule processing and 4um SST capability (completed)
- verification of implementation

Daytime 11-12um SST

MODAPS (modsst)

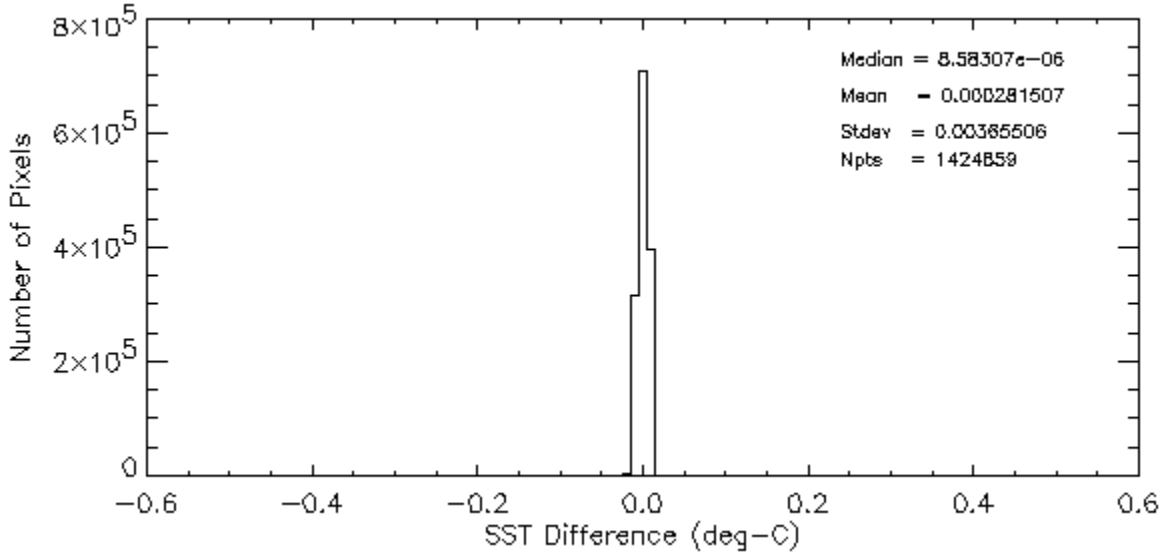


OBPG (msl12)

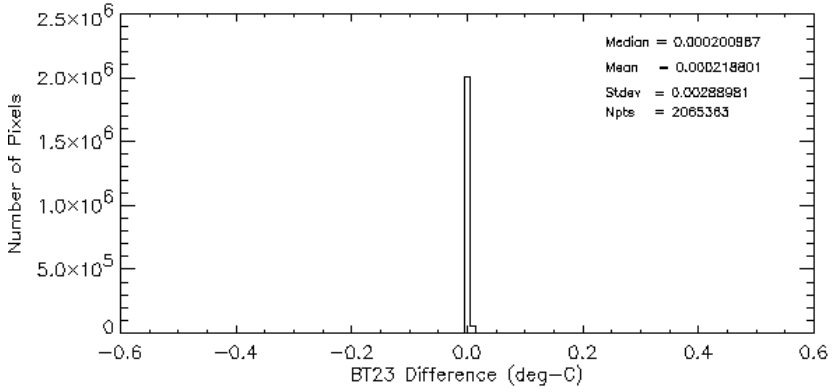


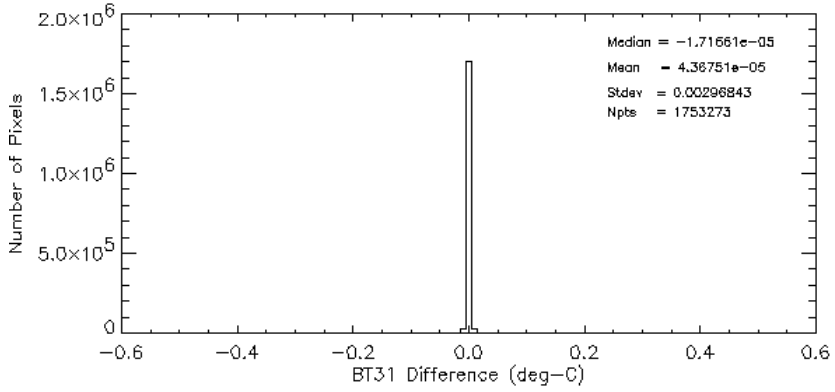
Daytime 11-12um SST (OBPG - MODAPS)

SST Differences



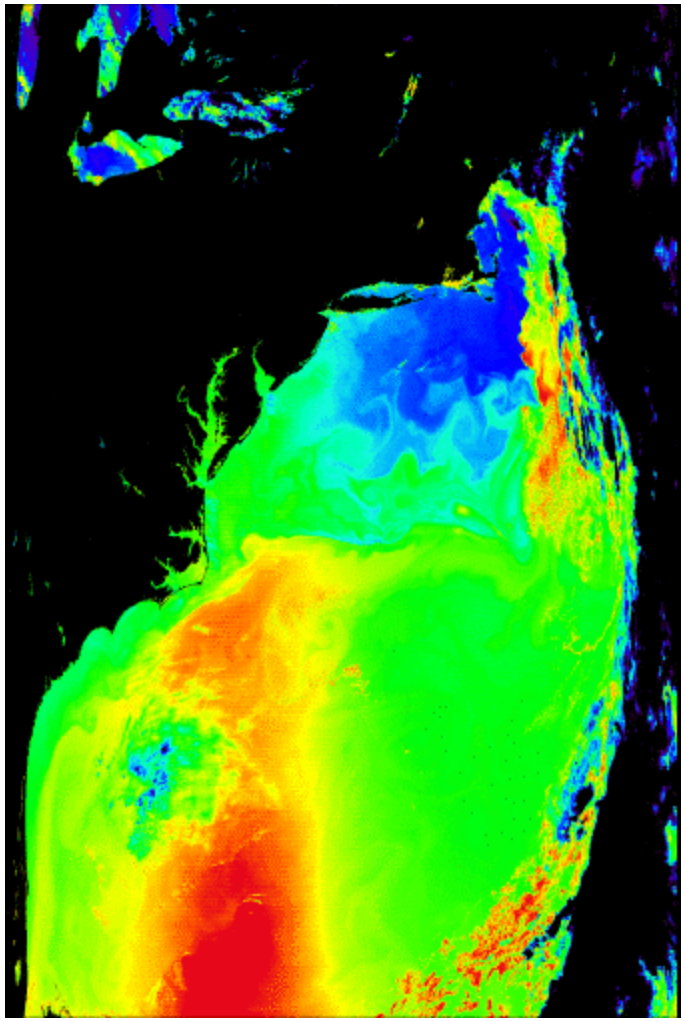
Brightness Temperature Differences



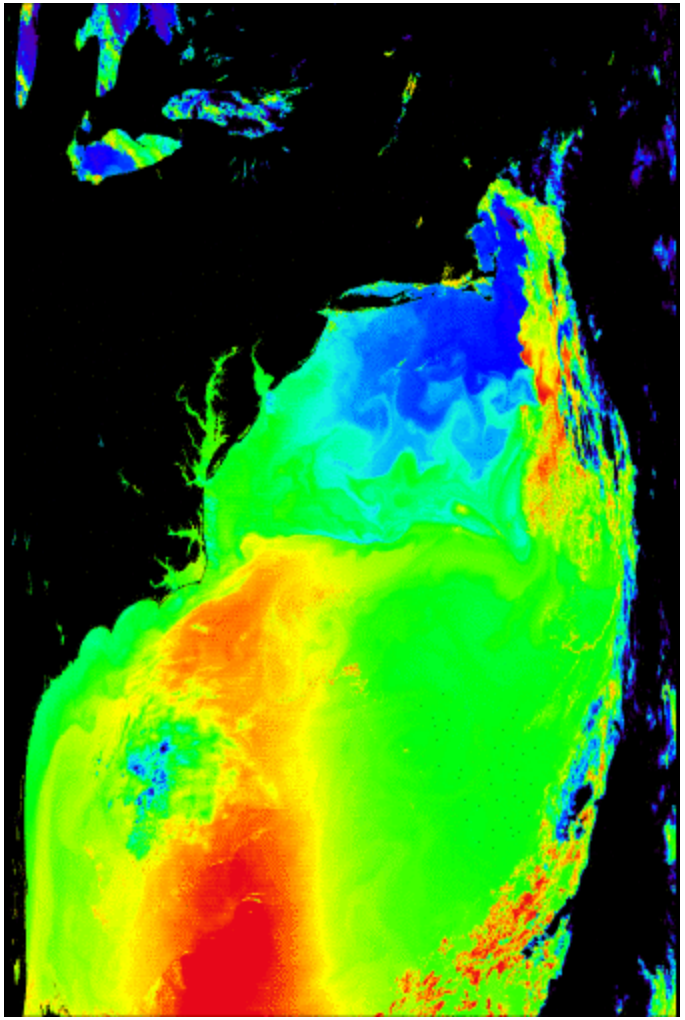


Daytime 4um SST

MODAPS (modsst)

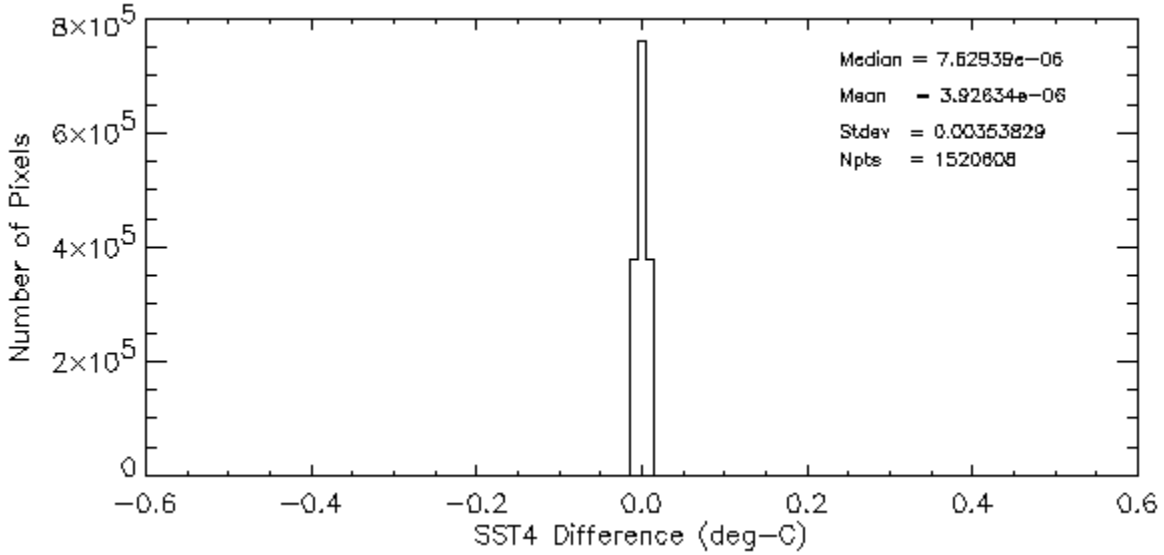


OBPG (msl12)

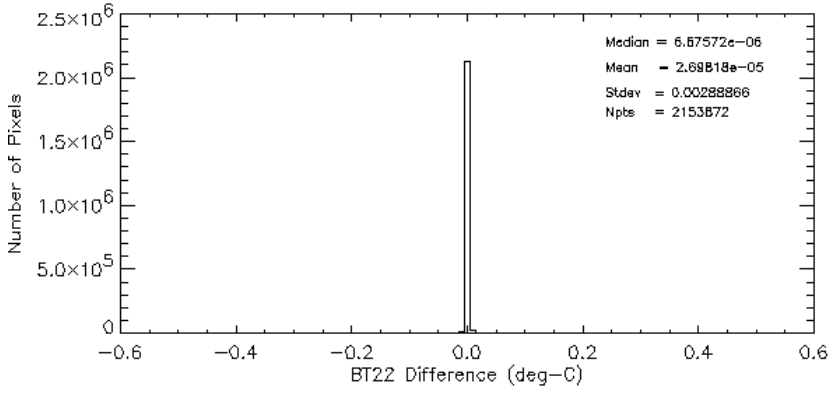


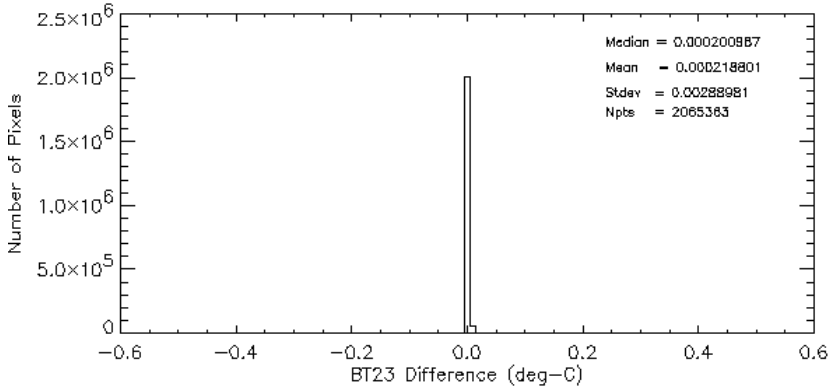
Daytime 4um SST (OBPG - MODAPS)

SST Differences



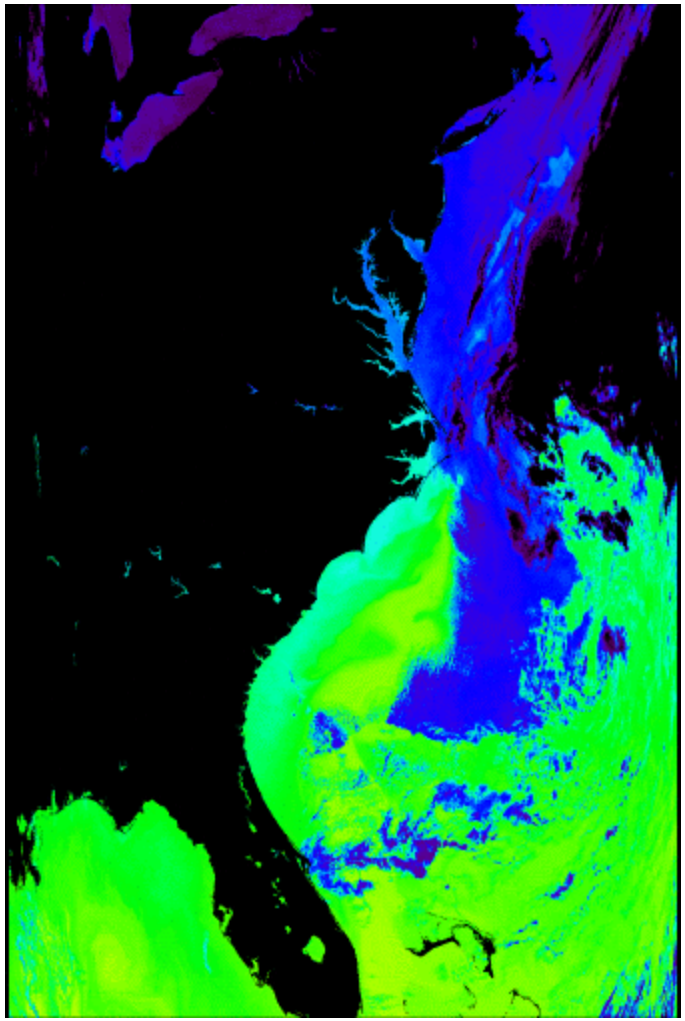
Brightness Temperature Differences



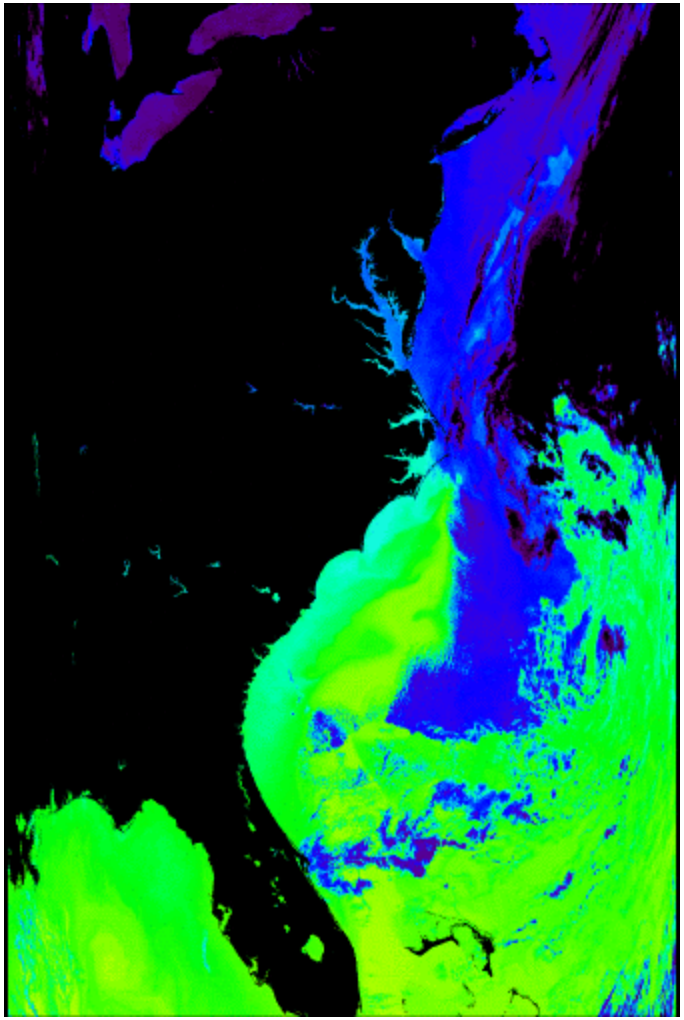


Nighttime 4um SST

MODAPS (modsst)

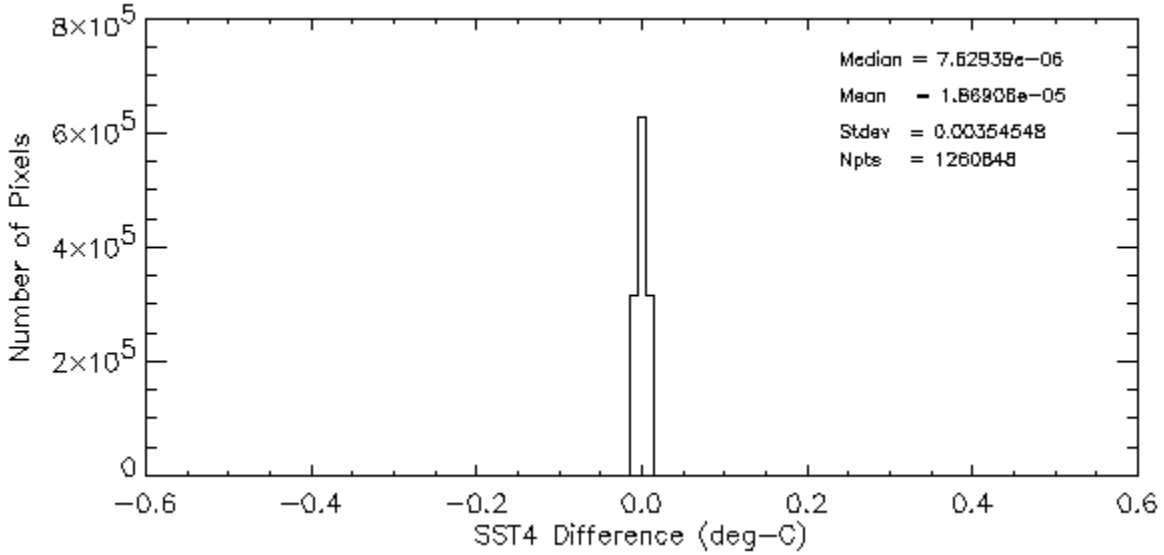


OBPG (msl12)

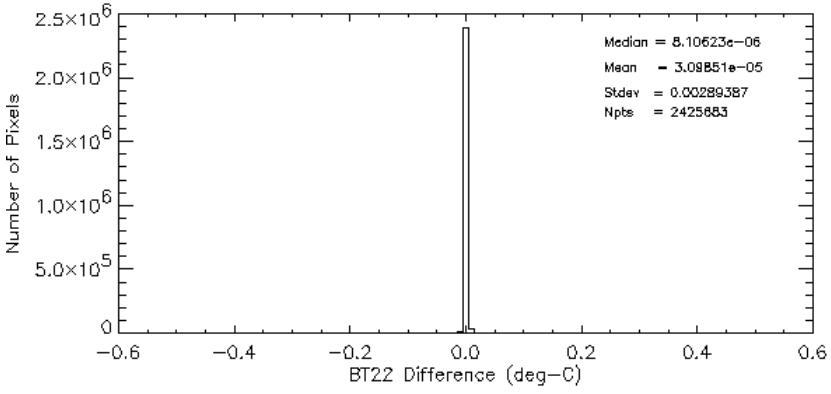


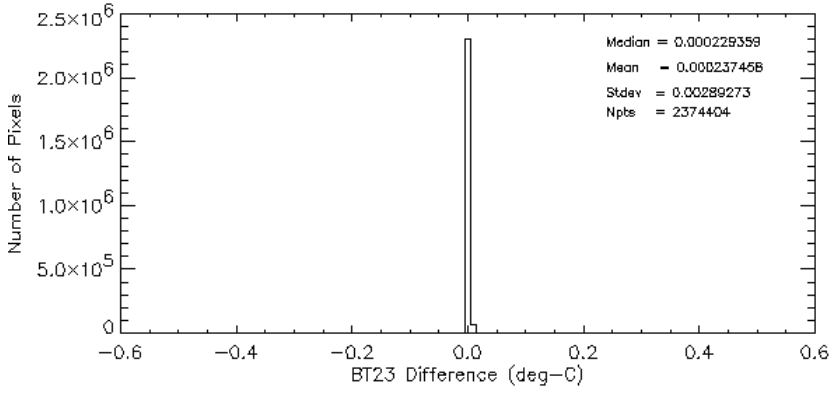
Nighttime 4um SST (OBPG - MODAPS)

SST Differences



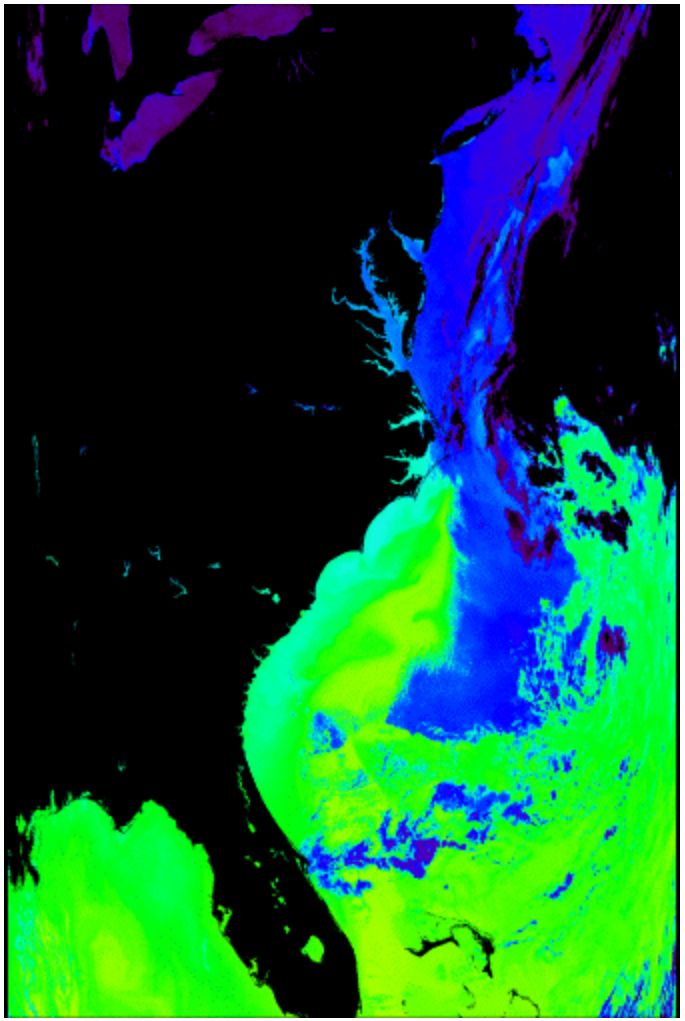
Brightness Temperature Differences



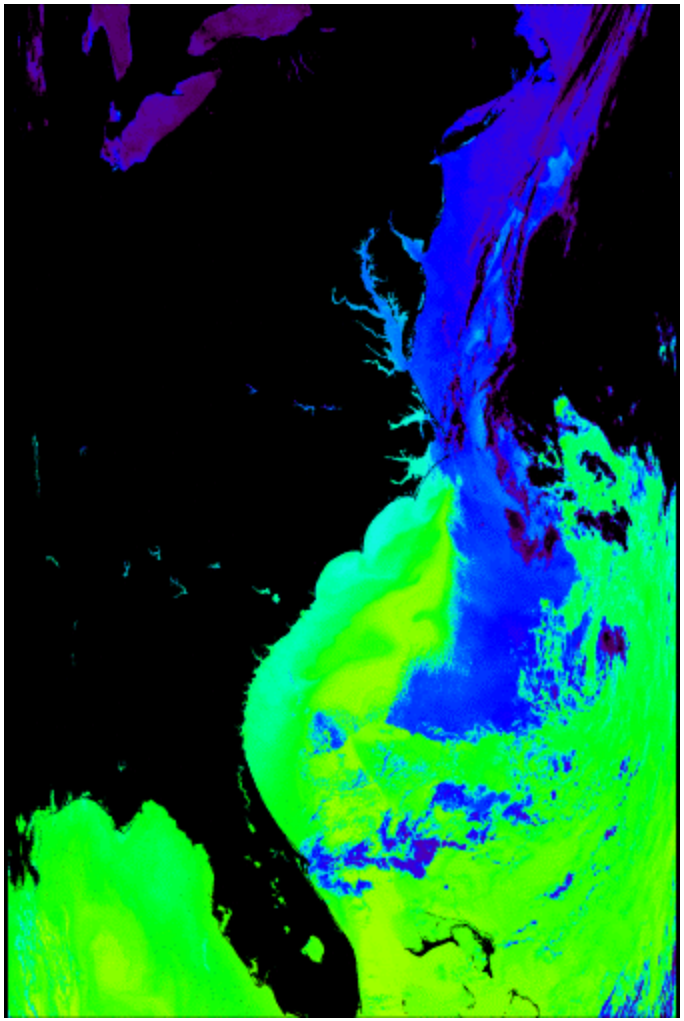


Nighttime 11-12um SST

MODAPS (modsst)

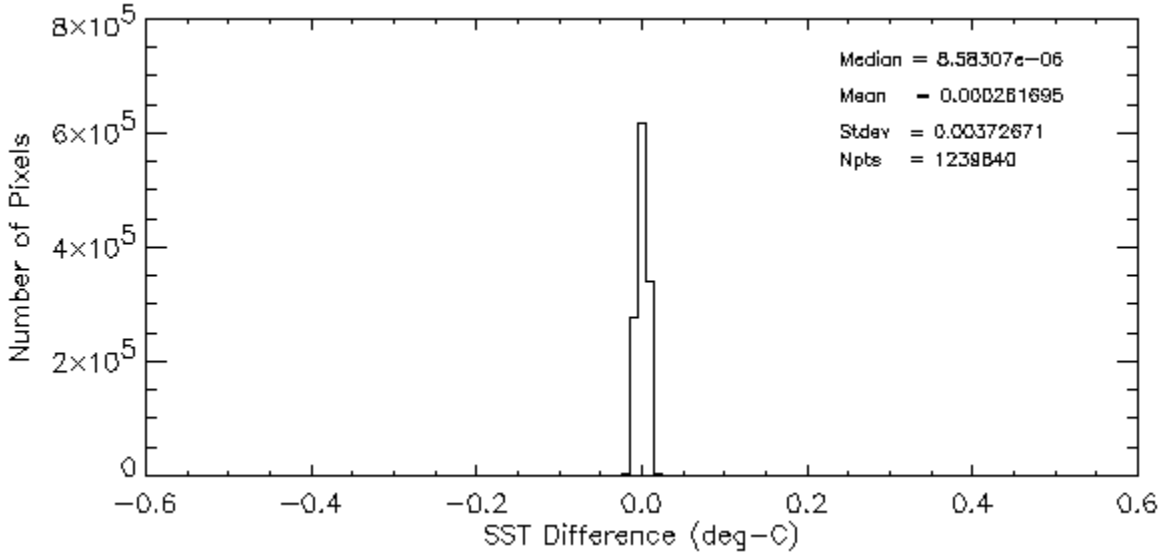


OBPG (msl12)

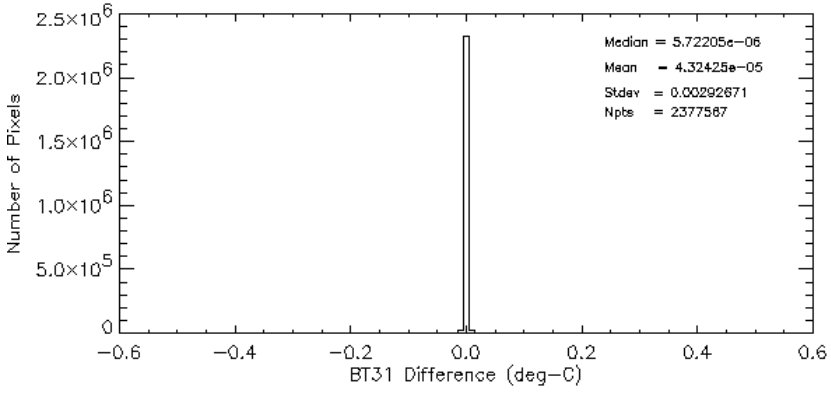


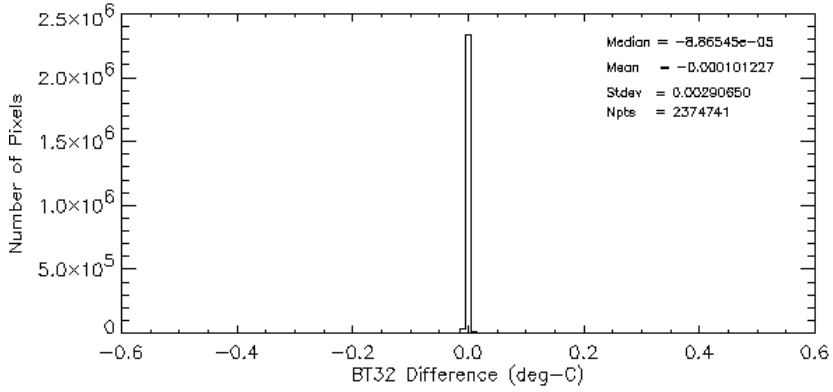
Nighttime 11-12um SST (OBPG - MODAPS)

SST Differences



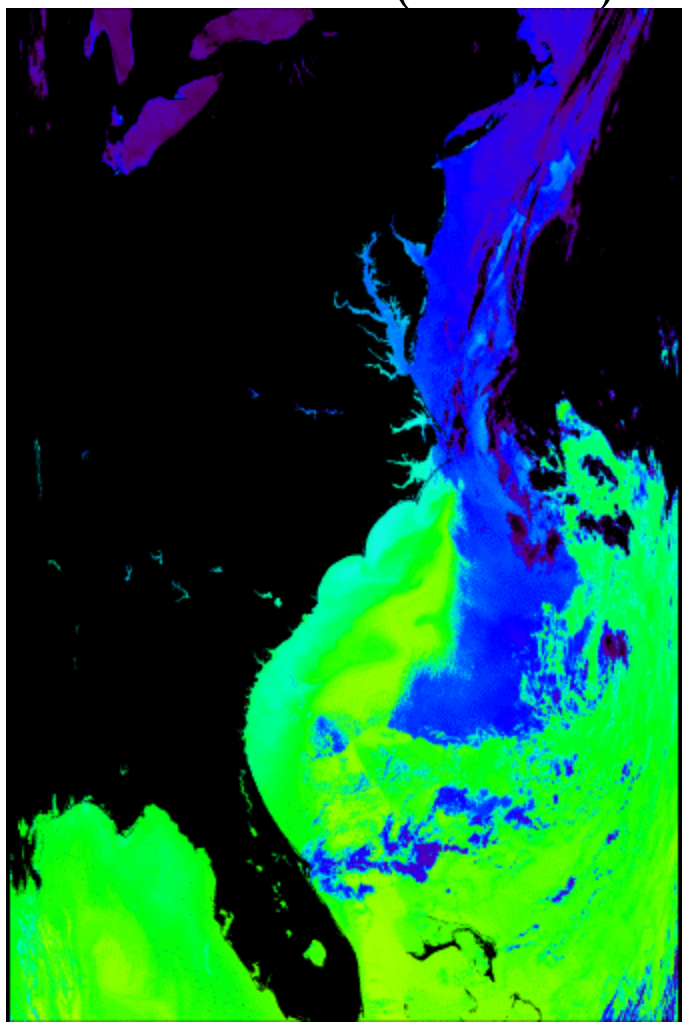
Brightness Temperature Differences



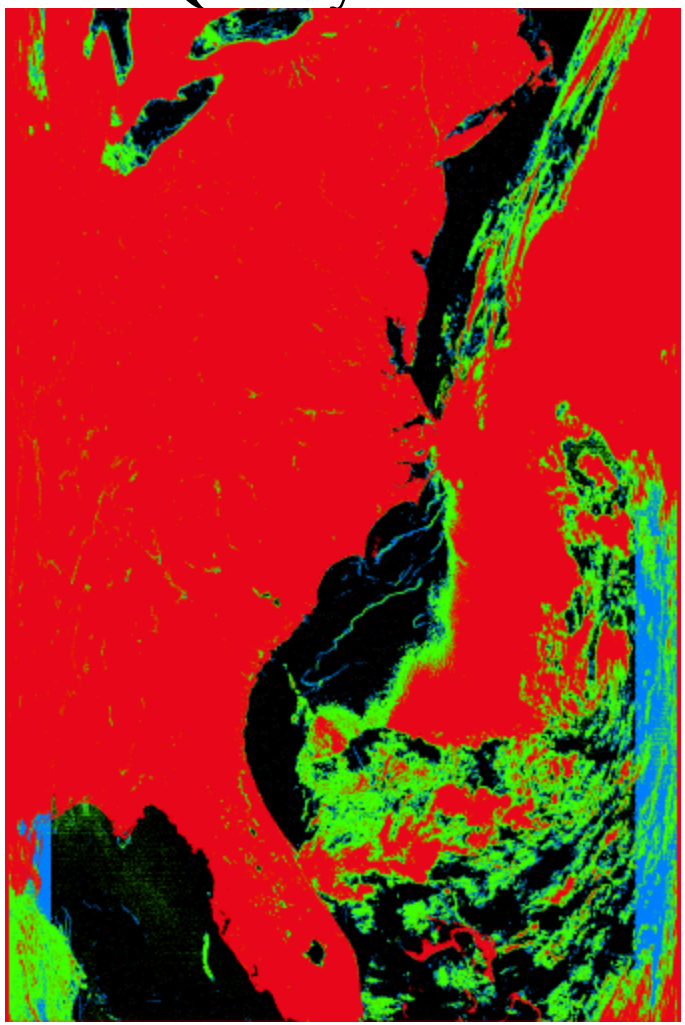


Nighttime 11-12um SST

MODAPS (modsst)



Quality Levels



SST Quality Flags

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

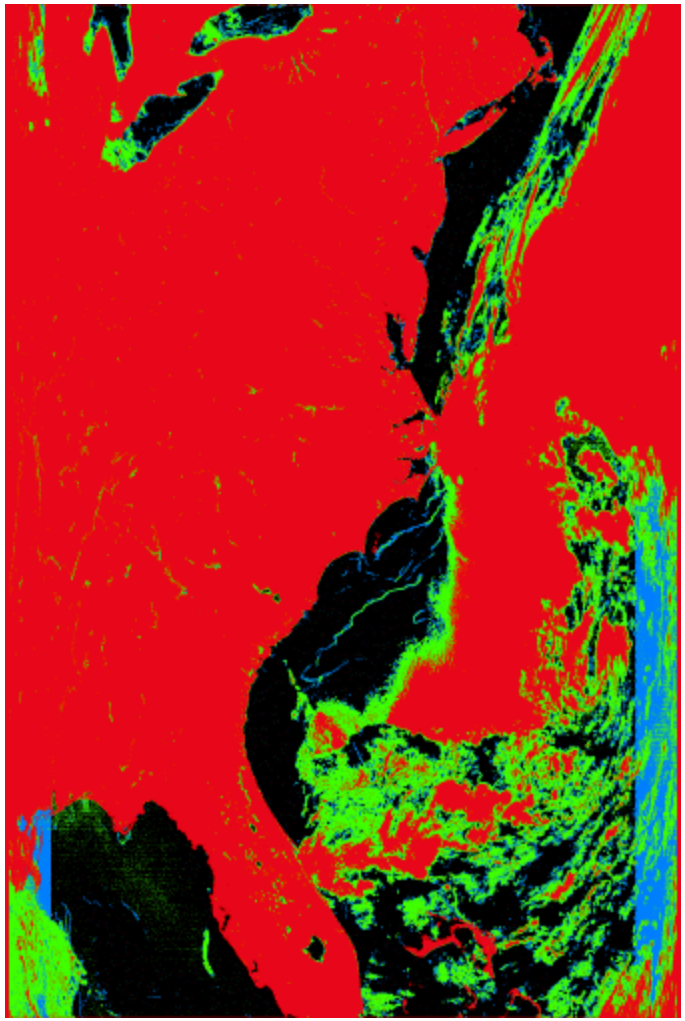
SST Quality Levels

Nighttime Long-Wave SST

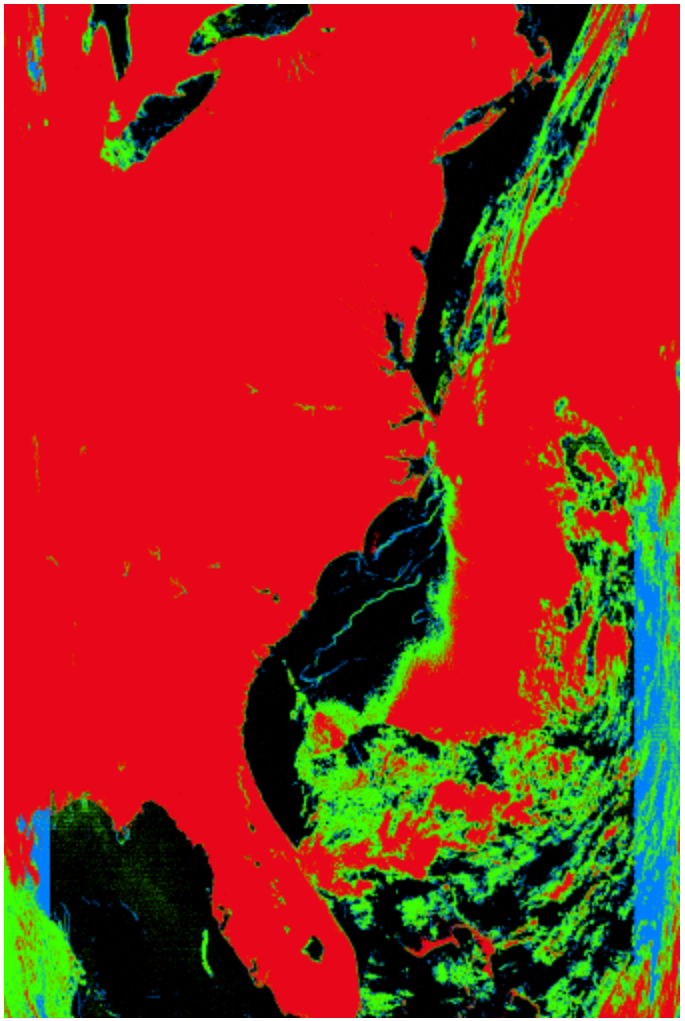
Quality Bit	Minimum Quality Level
ISMASKED	3
BTBAD	3
BTRANGE	3
SSTRANGE	3
BT4REFDIFF	3
SSTREFDIFF	3
BTVNONUNIF	2
VHISENZ	2
SST4DIFF	2
BTNONUNIF	1
SST4VDIFF	1
HISENZ	1

Nighttime 11-12um SST Quality

MODAPS (modsst)

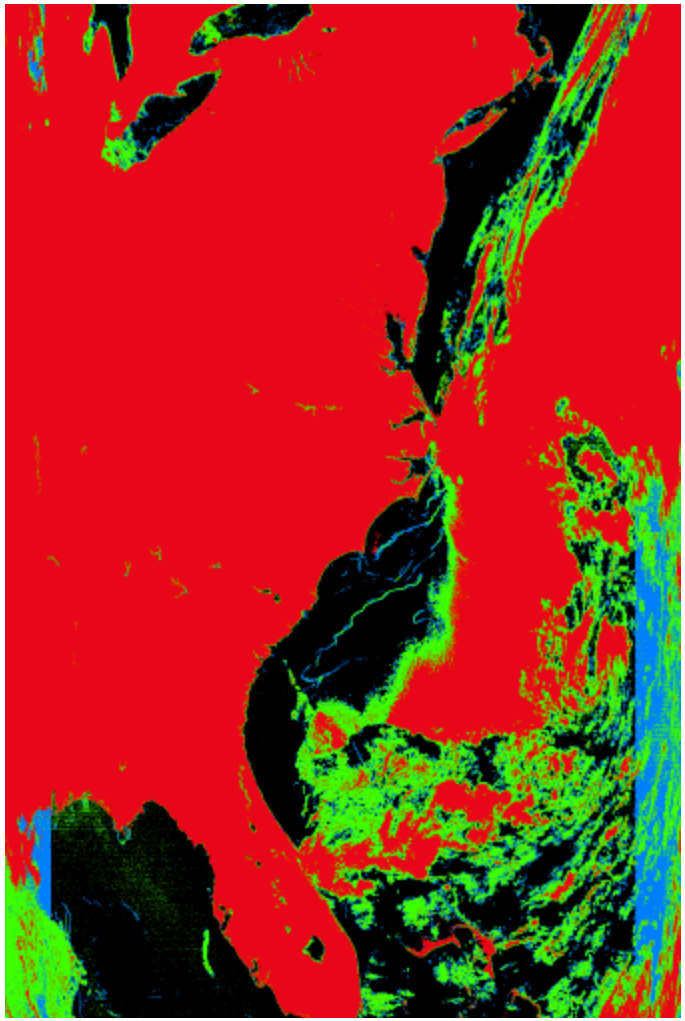


OBPG (msl12)

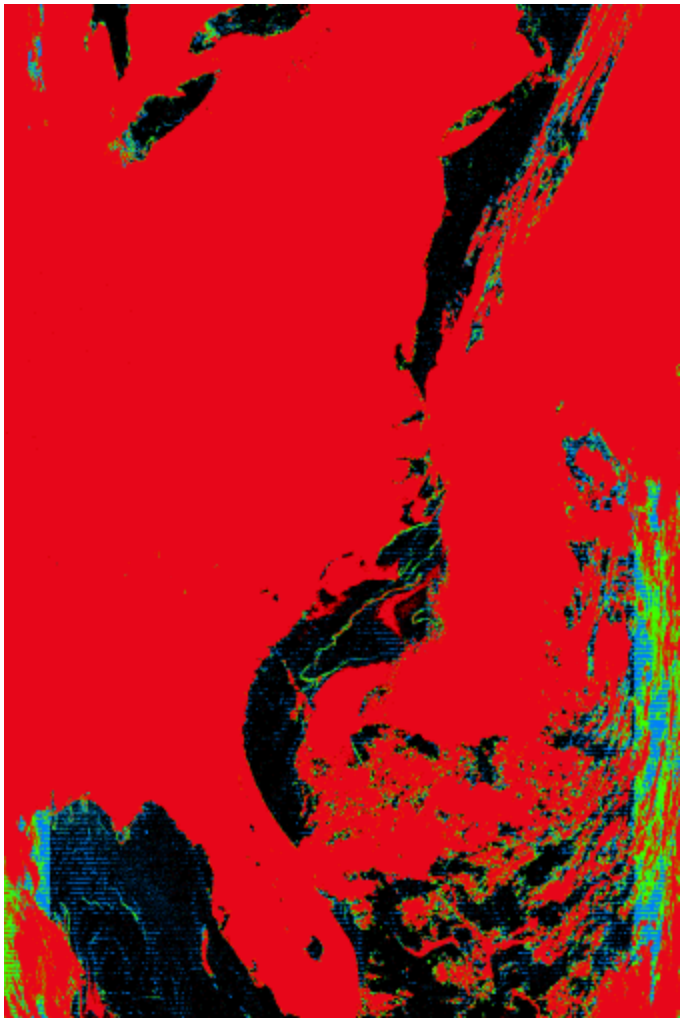


Nighttime 11-12um SST Quality
"Collection 5" Changes

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 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.

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 GHRSST

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

Intermediate Level-2 GHRSST File Content

Scientific Data Set	Description	Size
year, day, msec	scan time	16 K
longitude	pixel longitude	10.5 MB
latitude	pixel latitude	10.5 MB
sst	11-12um SST	5.2 MB
sst4	4um SST	5.2 MB
sstref	Reynolds SST (co-located)	5.2 MB
flags_sst	flags for 11-12um SST	5.2 MB
flags_sst4	flags for 4um SST	5.2 MB
qual_sst	quality levels for 11-12um SST	2.6 MB
qual_sst4	quality levels for 4um SST	2.6 MB
windspeed	wind speed (co-located NCEP)	10.5 MB
l2_flags	standard ocean flags (land, etc)	10.5 MB

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 GHRSST 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

- Aqua (ftp:// oceans.gsfc.nasa.gov/MODISA/GHRSST/)
  - Quicklook, average latency 4 hours, 52 minutes
  - Refined, available within 2-8 days

- Terra (ftp:// oceans.gsfc.nasa.gov/MODIST/GHRSST/)
  - Quicklook, average latency 4 hours, 38 minutes
  - Refined, available within 2-8 days

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

- ✓ 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

- ✓ 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

- ✓ 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

- ✓ 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

- ✓ 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

- ✓ 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.