

Global Processing of MODIS for Operational SST, Ocean Color, and GHRSSST

Bryan Franz
and the
NASA Ocean Biology Processing Group

OBPG Ocean Color Activities

- Global processing & distribution (Level-0 through Level-3)
 - SeaWiFS
 - MODIS/Aqua (& MODIS/Terra)
 - CZCS
 - OCTS
- Missions to Measurements
 - Sensor calibration/characterization
 - Product validation (SeaBASS MDB)
 - Algorithm development and evaluation (NOMAD)
 - User processing and display (SeaDAS)
 - User support (Ocean Color Forum)

http://oceancolor.gsfc.nasa.gov/

SeaWiFS User Login

SeaWiFS
 GAC
 LAC
 MLAC
 OCTS (ADEOS)
 MODIS (Aqua)
 CZCS (Nimbus-7)

Radius (km) about map click or typed-in location:
 36 400 800 1200 1500

Select swaths containing (at least):
 any part 25 % 50 % 75 % all of the area of interest.

Display results at a time.

Monday, 30 October 1978 through Wednesday, 5 October 2005

Chlorophyll

Select one or more regions:
 AdriaticSea
 AegeanSea
 Antarctica
 ArabianSea
 AralSea
 Australia
 Azores

or specify boundary coordinates or a single location:
 N:
 W: :E:
 S:

or check this box to select all of this time period's scenes.

M
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1978	J	F	M	A	M	J	J	A	S	O	N	D
1979	J	F	M	A	M	J	J	A	S	O	N	D
1980	J	F	M	A	M	J	J	A	S	O	N	D
1981	J	F	M	A	M	J	J	A	S	O	N	D
1982	J	F	M	A	M	J	J	A	S	O	N	D
1983	J	F	M	A	M	J	J	A	S	O	N	D
1984	J	F	M	A	M	J	J	A	S	O	N	D
1985	J	F	M	A	M	J	J	A	S	O	N	D
1986	J	F	M	A	M	J	J	A	S	O	N	D
1996	J	F	M	A	M	J	J	A	S	O	N	D
1997	J	F	M	A	M	J	J	A	S	O	N	D
1998	J	F	M	A	M	J	J	A	S	O	N	D
1999	J	F	M	A	M	J	J	A	S	O	N	D
2000	J	F	M	A	M	J	J	A	S	O	N	D
2001	J	F	M	A	M	J	J	A	S	O	N	D
2002	J	F	M	A	M	J	J	A	S	O	N	D
2003	J	F	M	A	M	J	J	A	S	O	N	D
2004	J	F	M	A	M	J	J	A	S	O	N	D
2005	J	F	M	A	M	J	J	A	S	O	N	D

August 2005							September 2005							October 2005						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
	1	2	3	4	5	6					1	2	3							1
	xxx	xxx	xxx	xxx	aaa	aaa					xxx	xxx	xxx							xxx
7	8	9	10	11	12	13	4	5	6	7	8	9	10	2	3	4	5	6	7	8
aaa	aaa	aaa	aaa	aaa	aaa	ooo	xxx	xxx	aaa	aaa	aaa	aaa	aaa	xxx	xxx	xxx	xxx	xxx	xxx	aaa
14	15	16	17	18	19	20	11	12	13	14	15	16	17	9	10	11	12	13	14	15
ooo	ooo	ooo	ooo	ooo	ooo	ooo	aaa	aaa	aaa	ooo	ooo	ooo	ooo	aaa	aaa	aaa	aaa	aaa	aaa	aaa
21	22	23	24	25	26	27	18	19	20	21	22	23	24	16	17	18	19	20	21	22
***	***	***	***	***	***	***	ooo	ooo	ooo	ooo	***	***	***	ooo	ooo	ooo	ooo	ooo	ooo	ooo
28	29	30	31				25	26	27	28	29	30	23	24	25	26	27	28	29	
***	xxx	xxx	xxx				***	***	***	***	***	xxx	ooo	***	***	***	***	***	***	
													30	31						
													***	***						

OBPG Ocean Color Activities

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 - SeaWiFS
 - MODIS/Aqua (& MODIS/Terra)
 - CZCS
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- Missions to Measurements
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 - Product validation (SeaBASS MDB)
 - Algorithm development and evaluation (NOMAD)
 - User processing and display (SeaDAS)
 - User support (Ocean Color Forum)
- We anticipate a full reprocessing of all OC missions to begin sometime in late 2007
 - 10 years SeaWiFS, 7-8 years Terra, and 5 years Aqua.

OBPG SST Activities

- MODIS/Aqua & MODIS/Terra
 - global near-realtime SST production & distribution (Level-0 through Level-3)
 - intermediate Level-2 production for GHRSSST
 - community processing and display support through SeaDAS
 - user support through the Ocean Color Forum
- MODIS/Aqua Mission Reprocessing & Distribution
 - completed March 2006
- MODIS/Terra Mission Reprocessing & Distribution
 - completed April 2007
- Algorithm development and validation provided by Minnett, Evans, and Kilpatrick, University of Miami

MODIS SST Interaction

Miami

algorithm development
and coefficient updates
quality assessment

algorithms

coefficients

PO.DAAC

Level-3 distribution (POET)

OBPG

software development
and algorithm integration
production processing
quality control
archive & distribution

L3 Operational Products

Level-3

L2 & L3 Operational Products

User Support & Software

Science
Community

MODIS SST Interaction

+ GHRSSST

Miami

algorithm development
and coefficient updates
quality assessment
uncertainties (SSES)

algorithms

coefficients

SSES tables

PO.DAAC

Level-3 distribution (POET)
GHRSSST product reformatting
and ancillary merge (L2P)
GHRSSST L2P distribution

OBPG

software development
and algorithm integration
production processing
quality control
archive & distribution

L3 Operational Products

L2 GHRSSST-specific

L2 & L3 Operational Products

User Support & Software

Level-3

L2P

Science
Community

GHRSSST
Users

MODIS GHRSSST-specific Level-2 File Distribution

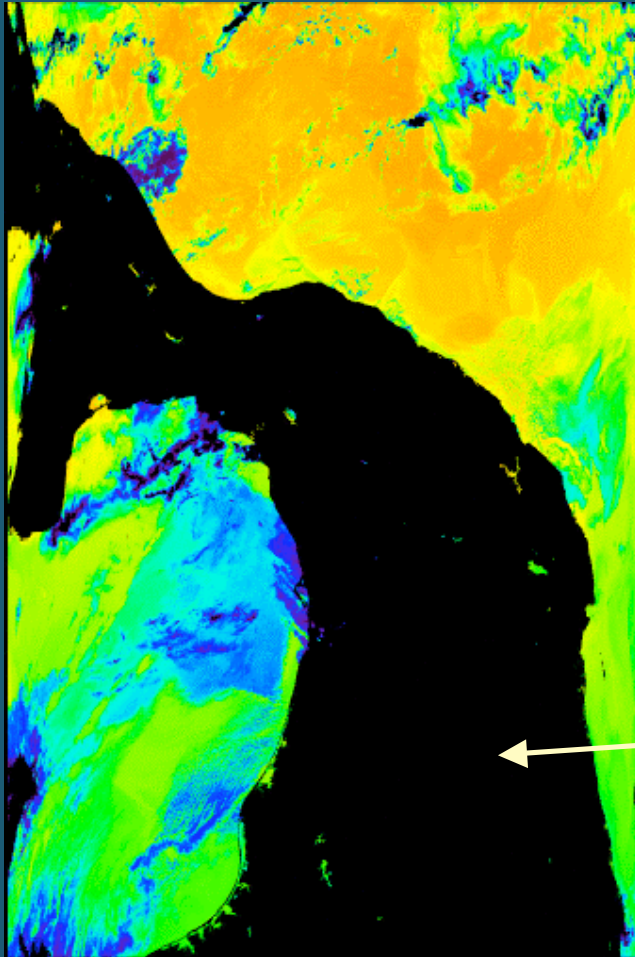
- HDF4 format, nearly identical to operational L2 SST products, but with additional content (e.g., SSES fields)

SSES Fields

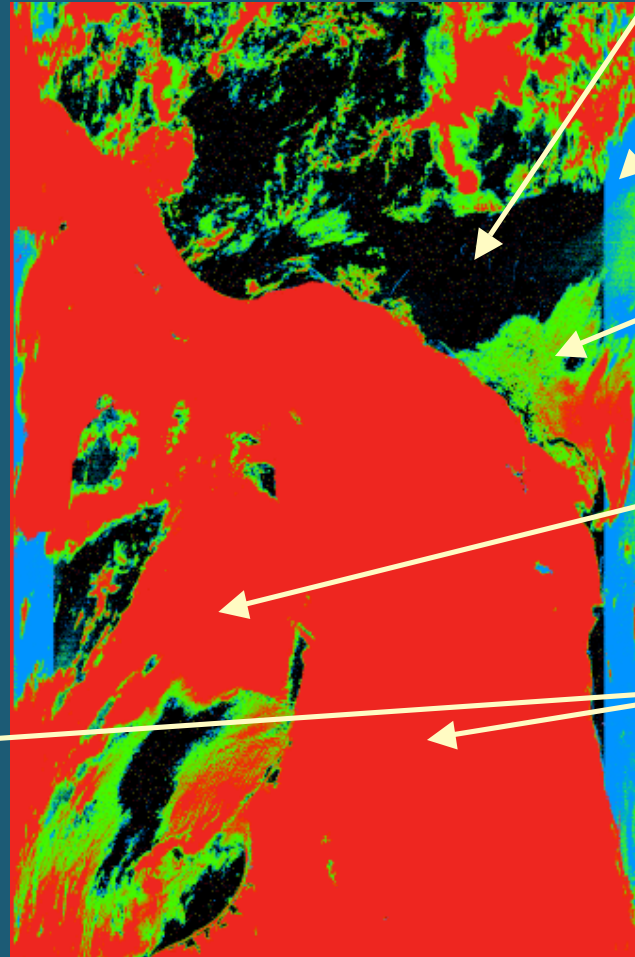
- Determined from static table (hyper-cube) developed by Miami, derived my validation against *in situ* MDB
- Updated April 2007
- SSES hyper-cube stratified by
 - SST level
 - day or night
 - season
 - view zenith
 - brightness temperature difference
 - latitude
 - quality level

Quality Levels

4 μ m Night SST



4 μ m Night QL



QL=0

QL=1

QL=2

QL=3

QL=4

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

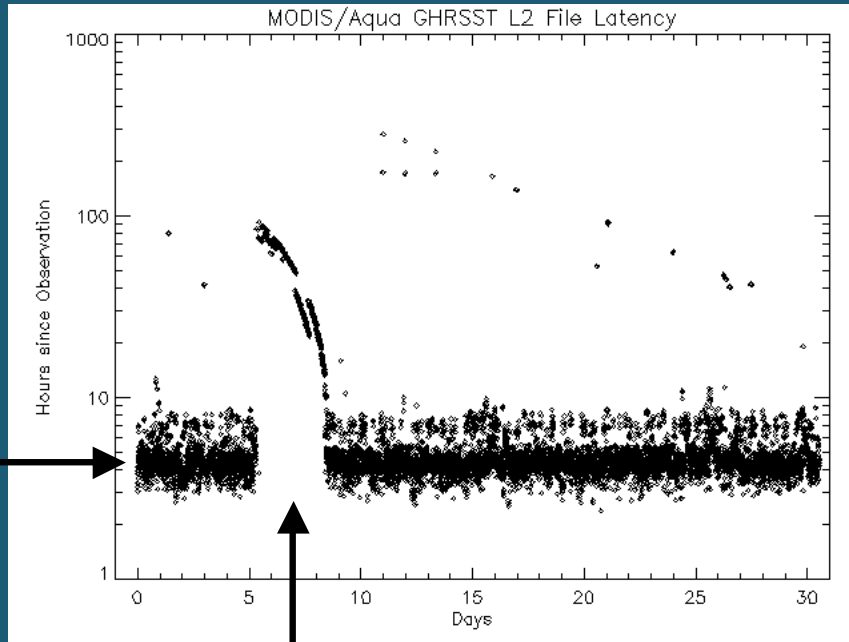
MODIS GHRSSST-specific Level-2 File Distribution

- HDF4 format, nearly identical to operational L2 SST products, but with additional content (e.g., SSES fields)
- Files currently distributed to RDAC (JPL) via rolling ftp archive
 - Quicklook (best available ancillary, near real-time)
 - Refined (best ancillary, 4-8 days delay)
 - Operational since October 2005
- Aqua (<ftp://oceans.gsfc.nasa.gov/MODISA/GHRSSST/>)
- Terra (<ftp://oceans.gsfc.nasa.gov/MODIST/GHRSSST/>)

GHRSSST-specific L2 Data Latency

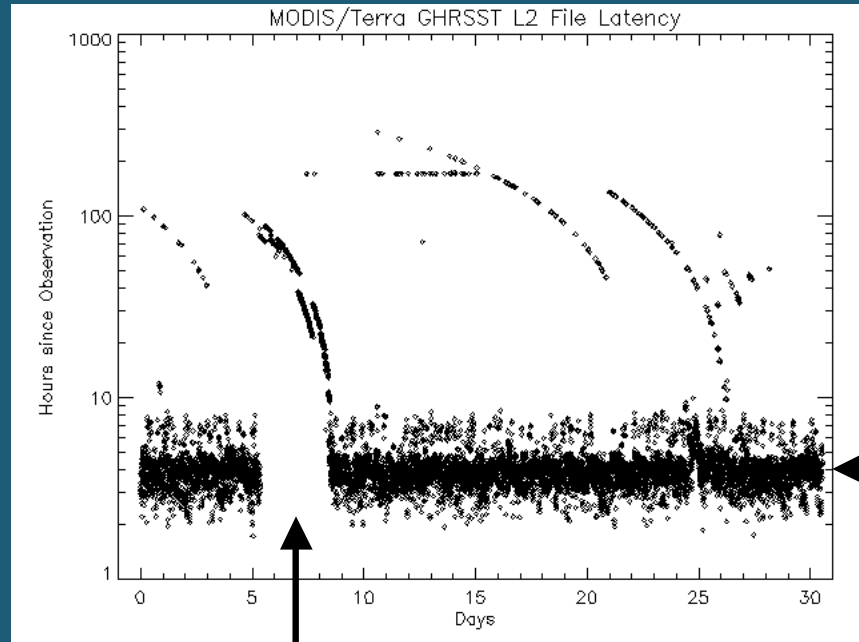
Time of Observation to Time of Distribution to RDAC (JPL)

MODIS/Aqua



4.5 hours

MODIS/Terra



4 hours

NOAA NRTPE Outage - Failover to MODAPS Feed

What exactly is in these GHRSSST-specific
MODIS L2 HDF files?

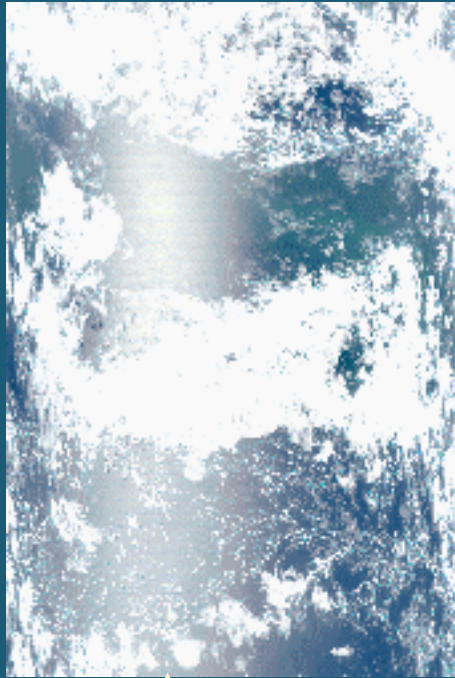
Revised GHRSSST Daytime L2 File Content

	Data Set	Description
	year, day, msec	scan time
	longitude	pixel longitude (subsamp by 8)
	latitude	pixel latitude (subsamp by 8)
	sstref	Reynolds SST (co-located)
	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
OC Products {	chlor_a	Chlorophyll-a
	K_490	Diffuse attenuation at 490 nm
	tau_551	Aerosol optical depth 551 nm

Are the OC products being utilized?

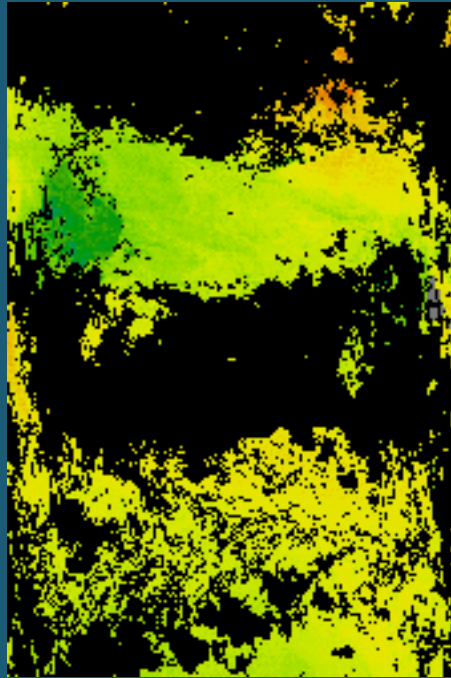
Retrieval Coverage Differences Between SST and OC

RGB Image

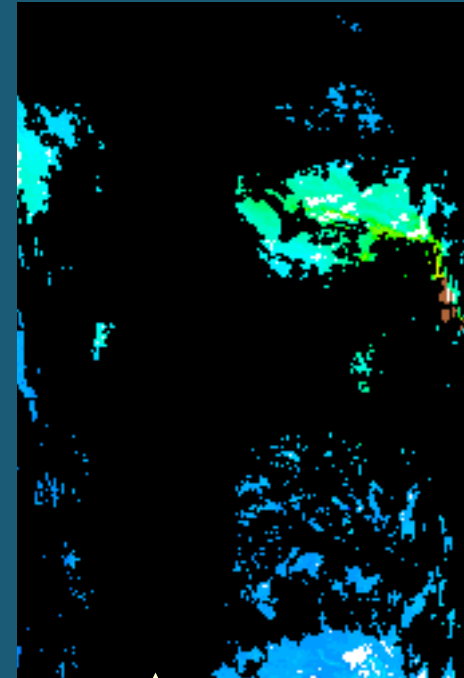


Sun glint

SST



Chlorophyll



Sun glint

Revised GHRSSST Nighttime L2 File Content

	Data Set	Description
	year, day, msec	scan time
	longitude	pixel longitude (subsamp by 8)
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	sstref	Reynolds SST (co-located)
	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
4 μ m SST {	sst4	4um SST
	bias_sst4	4um SST SSES bias
	stdv_sst4	4um SST SSES std. dev.
	qual_sst4	4um SST quality levels

Now, we plan to merge operational and
GHRSSST-specific L2 production

Revised MODIS SST Interaction

+ GHRSSST

Miami

algorithm development
and coefficient updates
quality assessment
uncertainties (SSES)

algorithms

coefficients

SSES tables

PO.DAAC

Level-3 distribution (POET)
GHRSSST product reformatting
and ancillary merge (L2P)
GHRSSST L2P distribution

OBPG

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and algorithm integration
production processing
quality control
archive & distribution

L3 Operational Products

L2 GHRSSST-specific

L2 & L3 Operational Products

User Support & Software

Level-3

L2P

Science
Community

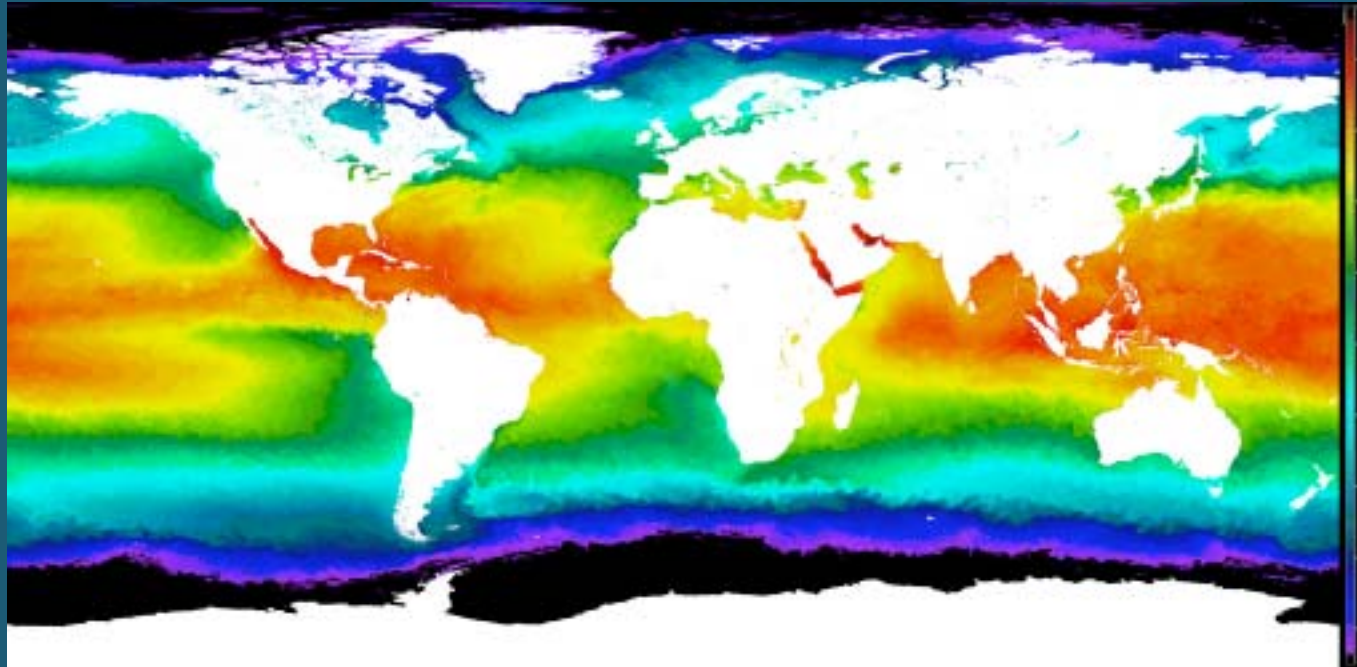
GHRSSST
Users

Merging Operational and GHRSSST-specific L2 Production

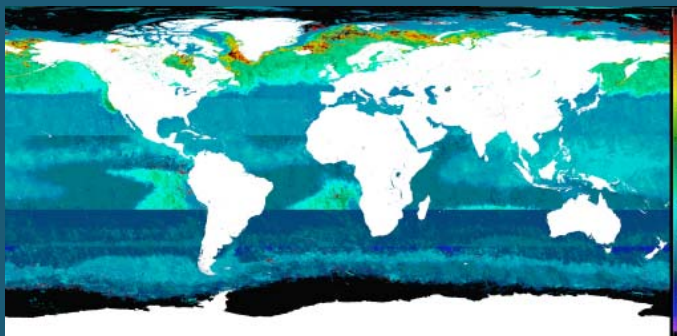
- Advantages:
 - Reduced production cost (disk space, CPU, problem tracking)
 - GHRSSST-compatible L2 products online for full mission lifespan
 - Reprocessing support
 - Level-3 capabilities

Daytime 11-12 μ m SST

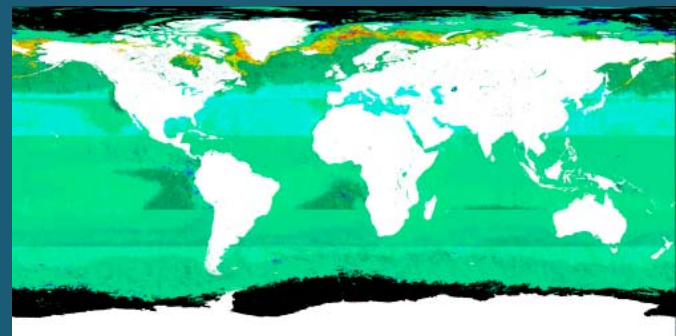
MODISA - Monthly Mean - September 2005



SSES Std Dev (0 $^{\circ}$ - 2 $^{\circ}$ C)



SSES Bias (-2 $^{\circ}$ - 2 $^{\circ}$ C)



Merging Operational and GHRSSST-specific L2 Production

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Merging Operational and GHRSSST-specific L2 Production

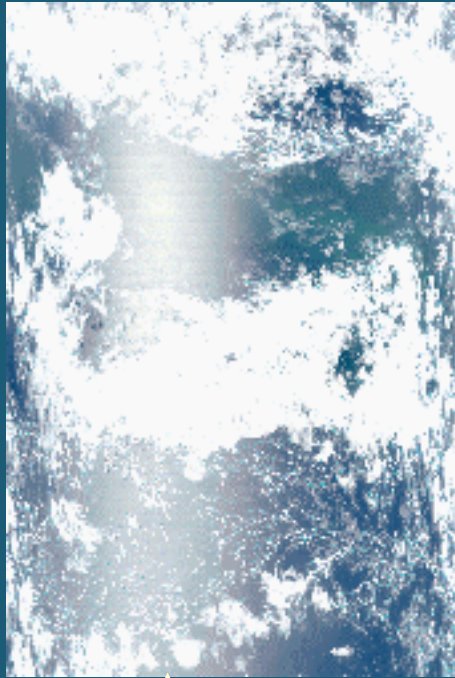
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 - Level-3 capabilities
- Disadvantages:
 - Changes to L2 file content will be restricted to reprocessing events
 - We prefer to eliminate the overlap with operational OC files
 - same product in multiple files causes user confusion
 - the RDAC can merge data from separate OC and SST files

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- Also, consider that:
 - Merging from multi-day OC composites may be more useful

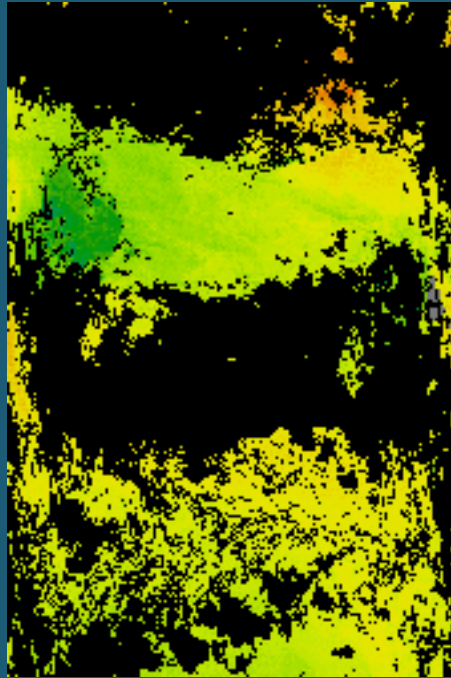
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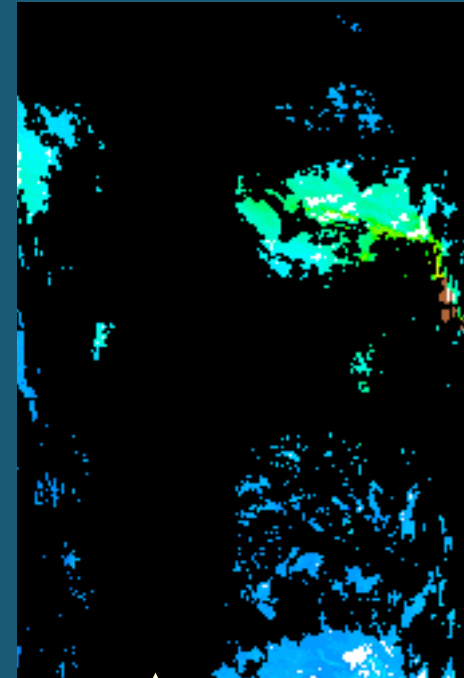


Sun glint

SST



Chlorophyll



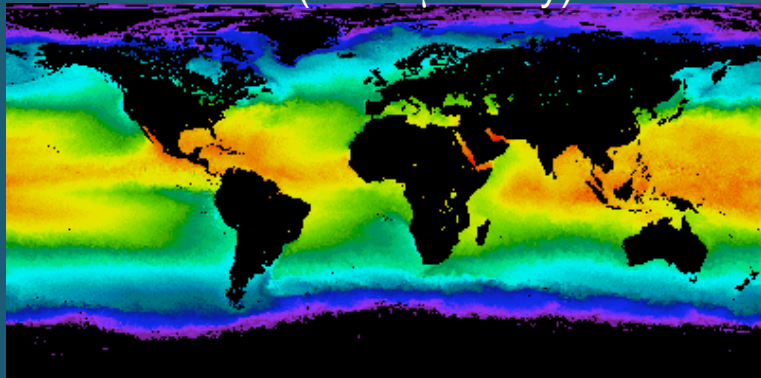
Sun glint

Consider using multi-day (L3) composites of OC products to merge with SST

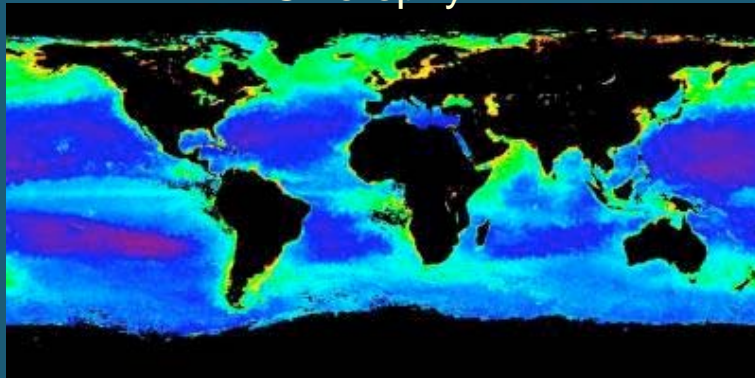
Merging Operational and GHRSSST-specific L2 Production

- Advantages:
 - Reduced production cost (disk space, CPU, problem tracking)
 - GHRSSST-compatible L2 products online for full mission lifespan
 - Reprocessing support
 - Level-3 capabilities
- Disadvantages:
 - Changes to L2 file content will be restricted to reprocessing events
 - We prefer to eliminate the overlap with operational OC files
 - same product in multiple files causes user confusion
 - the RDAC can merge data from separate OC and SST files
- Also, consider that:
 - Merging from multi-day OC composites may be more useful
 - Other non-operational products may be of more interest

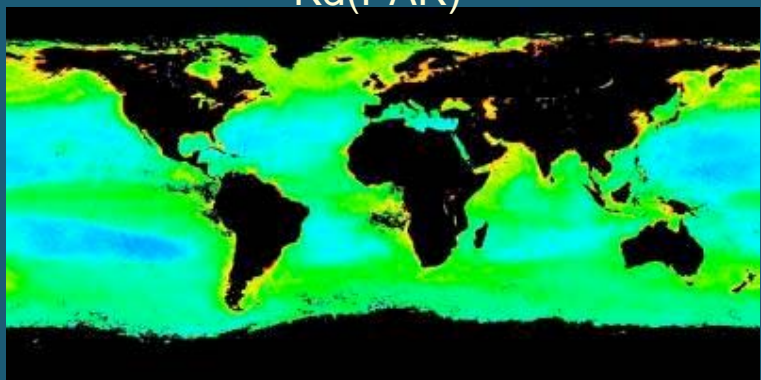
SST (11-12 μ m day)



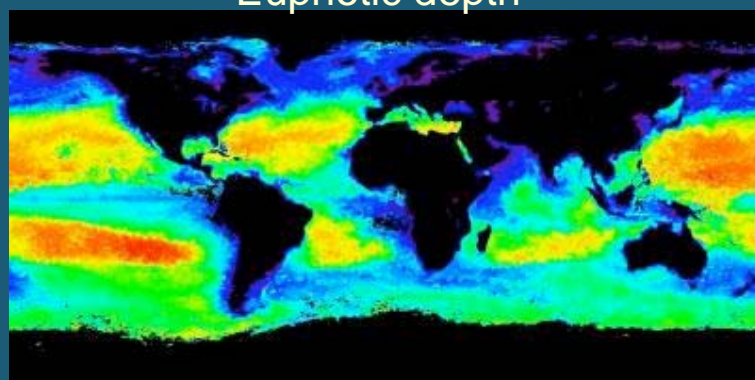
Chlorophyll



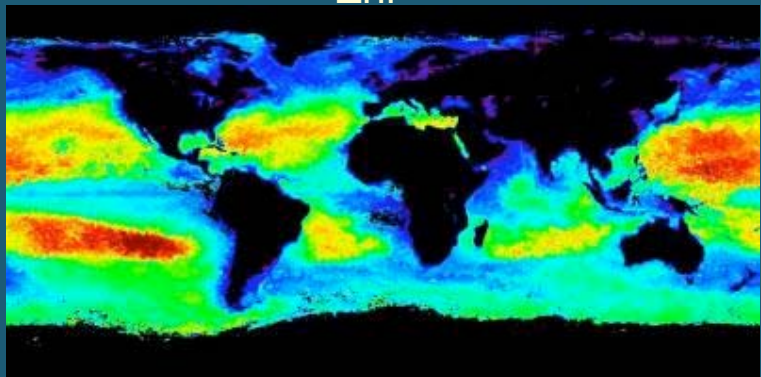
Kd(PAR)



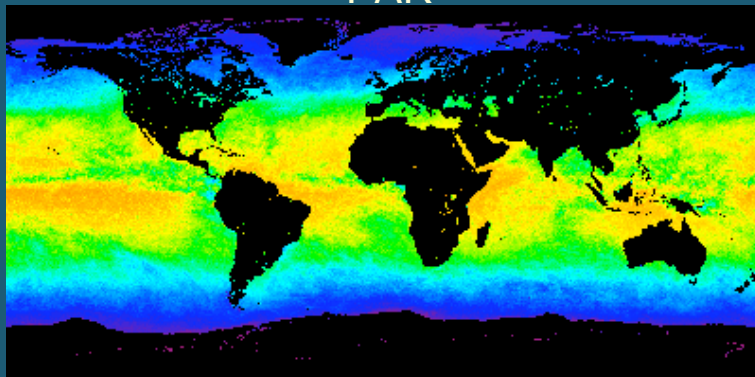
Euphotic depth



Zhl



PAR



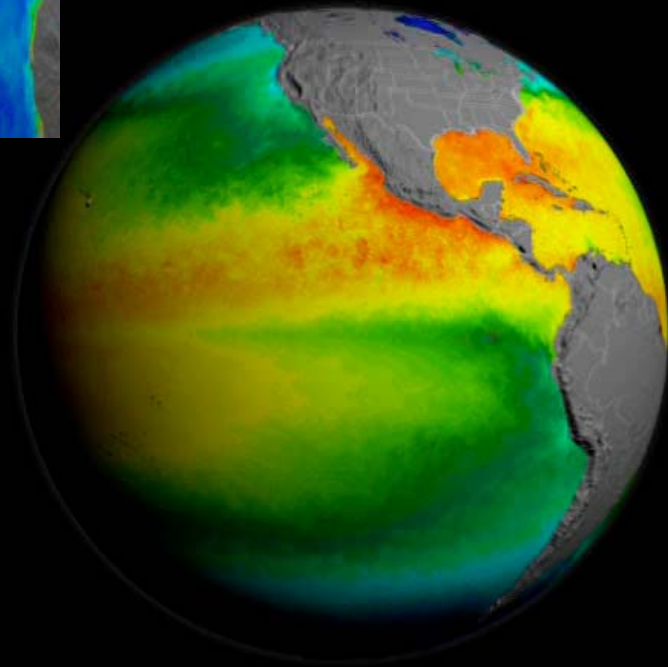
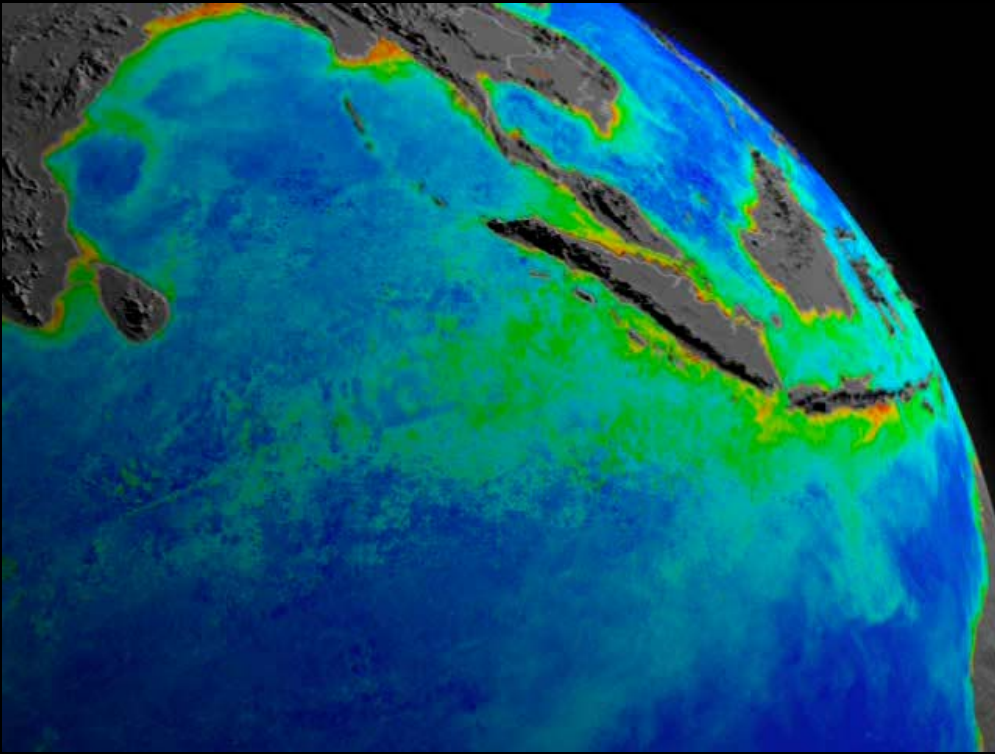
Summary

- The OBPG currently produces the Level-2 MODIS data for input to the GHRSSST RDAC.
- We also produce the operational Level-2 and Level-3 SST and Ocean Color products for general distribution (including to 3rd-party distributors such as POET, Giovanni, and GlobColor).
- We plan to merge the two Level-2 SST streams to a common Level-2 HDF format in the next reprocessing (2007).
- As such, we'd like to remove any overlap in product content between operational SST and OC products (e.g., chlorophyll, Kd(490)).
- The GHRSSST ST (diurnal variability working group) may wish recommend the incorporation of alternative OC products which better complement SST.

Movies

- 1) East Coast of Australia, MODIS SST
- 2) Global, MODIS SST and SeaWiFS OC

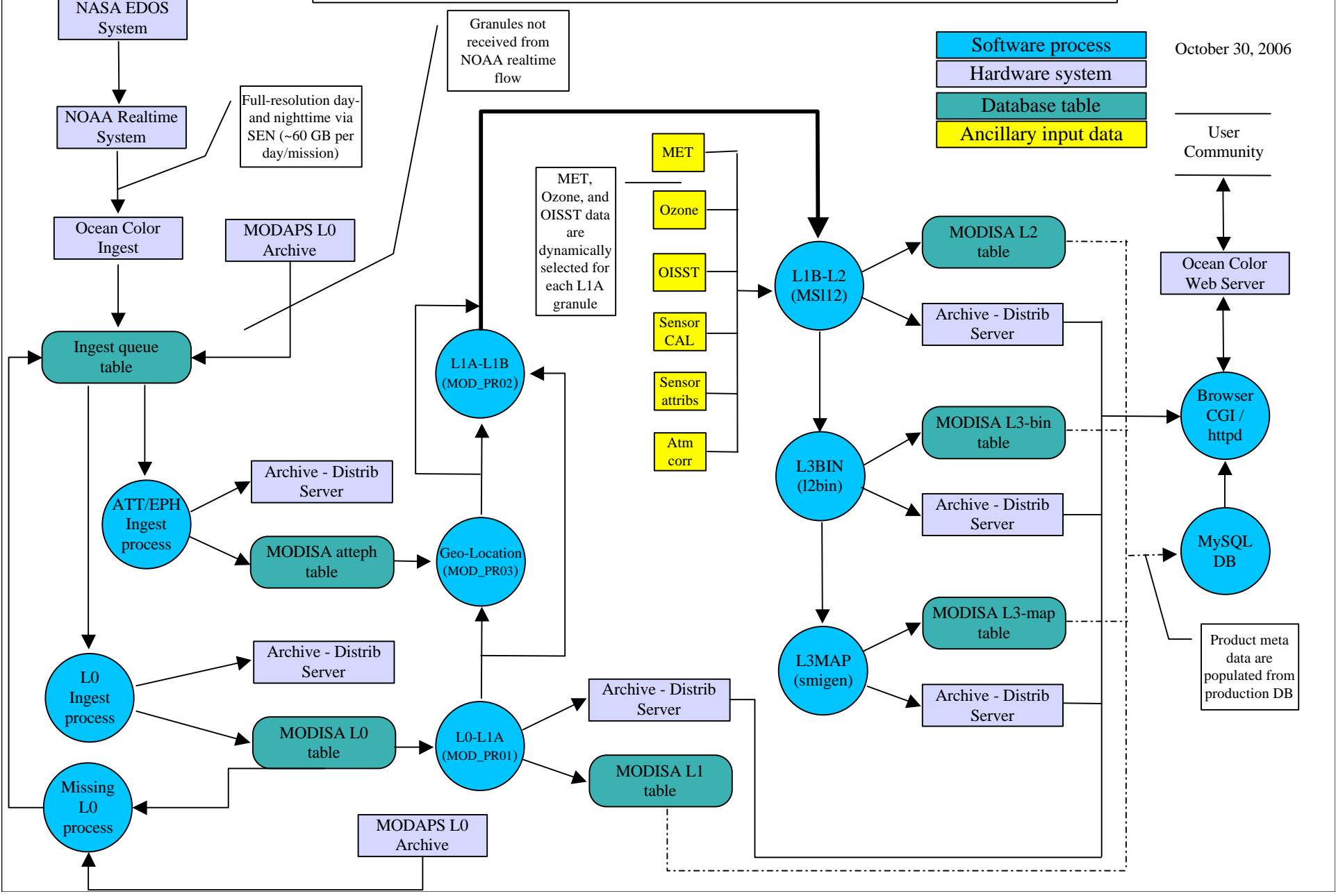




Thank You!



Operational MODIS-Aqua Data Flow (NRTPE) Terra and Aqua



October 30, 2006

- Software process
- Hardware system
- Database table
- Ancillary input data

User Community

Granules not received from NOAA realtime flow

Full-resolution day-and nighttime via SEN (~60 GB per day/mission)

MET, Ozone, and OISST data are dynamically selected for each L1A granule

Product meta data are populated from production DB

GHRSSST L2 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 GHRSSST L2 File Size Reduction

- 1) Deal with it ! The “H” stands for high-resolution.
 - a) our only intended customer is Ed
 - b) is this an OBPG or RDAC issue ?
- 2) Sub-sample lon/lat along-scan by 8 (28% reduction)
- 3) 4um SST
 - a) eliminate from L2 (19% reduction)
 - b) produce separate L2 for 4um (night) and 11-12um
 - c) eliminate from daytime L2 (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)

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“Potential” Options for GHRSSST L2 Expansion

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

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SeaDAS

