Summary of MODIS Ocean Product Status

Wayne Esaias

January 15, 2002

http://modis-ocean.gsfc.nasa.gov

1990’S EXPECTATIONS FOR MODIS OCEAN

Produce baseline set of ocean products, with science quality equivalent to, or better than heritage data.

- Exceed in accuracy, coverage, variety

Develop independent validation/calibration of observables.

- M-AERI and others - in-situ SST uncertainty <0.1K
- MOBY time series - in-situ nLw uncertainty <3%
- These are the SOA for the international community.

Develop New Ocean Science Capabilities.

- Chlorophyll Fluorescence, ONPP, IOP’s.
- 4 mm split window SST

Both SST and Ocean Color depend upon highly precise radiances due to sensitivity of the atmospheric correction.

This requires accounting for radiometric biases (trends) in a retrospective fashion due to instrument configuration and algorithm development changes.

MODIS instrument changes precluded declaring time-series “valid” in a forward sense.

Demands viable reprocessing - would like >10x on occasion.

MODIS Ocean Last Year - Present

SST

1/01 Struggling to make RT approach give acceptable results.
Unable to provide a “validated” date.

April PI decision to fall back to regressive approach.
Began production in July (Complete year)

1/02 Performance exceeds April expectations
ready to declare 11-12 micron SST as “Valid”

Visible

1/01 Instrument effects normalized for a few periods-
results showed tremedous detail, but were time dependent.

April - Decision to splice normalization tables for Complete Year
Expected “valid” status at end of Complete Year (now).

Sept/Oct- Time trends in ocean radiances, need to reprocess identified.

1/02 Reprocessing beginning in spring ‘02 is expected to
produce “valid” data time series for the full mission.

SST

Validation is continuing, and results look excellent:

rms difference ~0.21- 0.26 K for M-AERI vs MODIS 11-12 μm

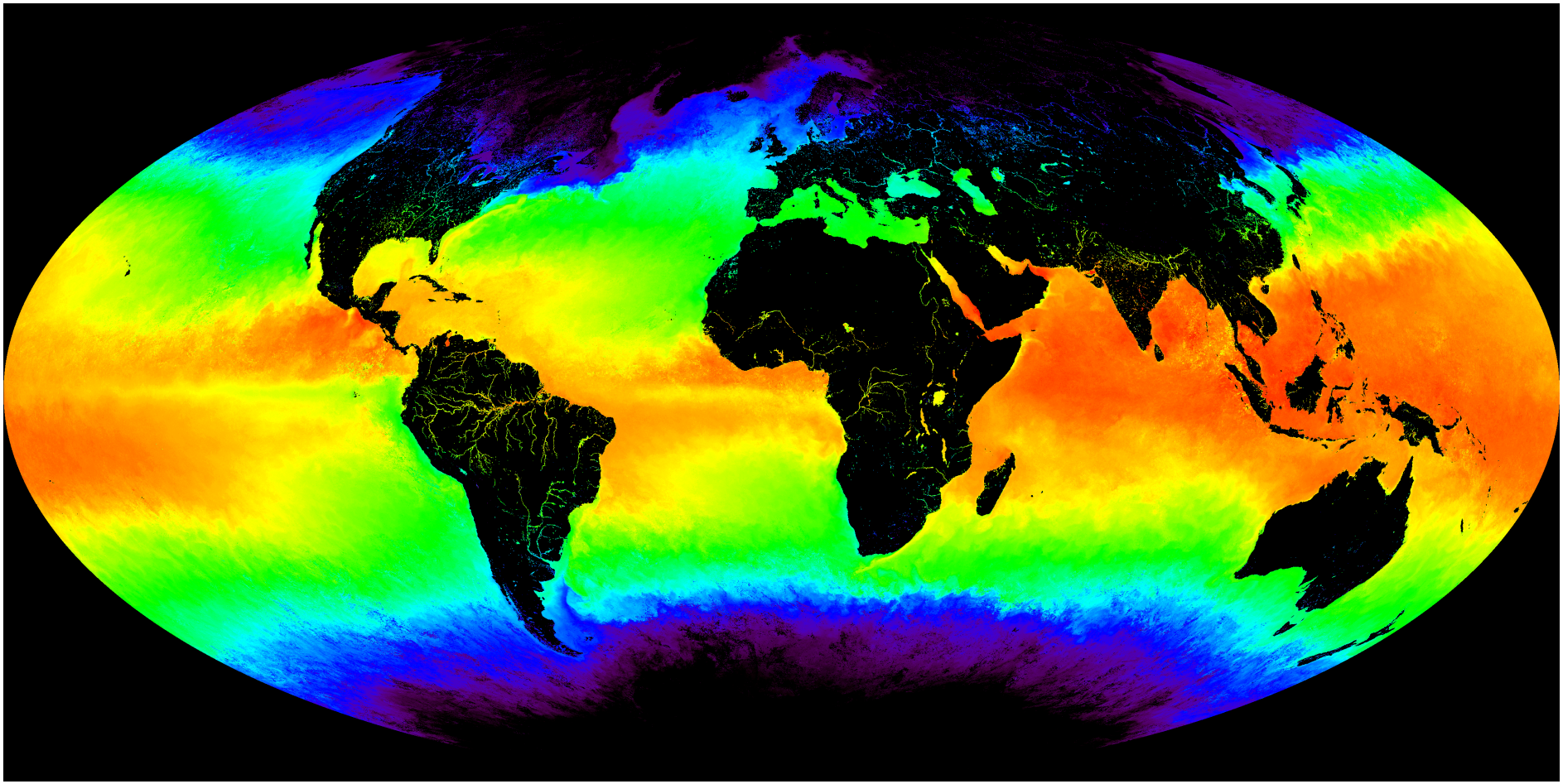
11-12 μm - Version 3.3 products should be declared valid upon examination of complete year ie February 02.

4 μm - Version 3.3 shows some temporal anomalies which are under examination.

0.15 K bias in 11-12 μm SST and temporal bias in 4 μm SST are expected to be removed in the spring/summer reprocessing.

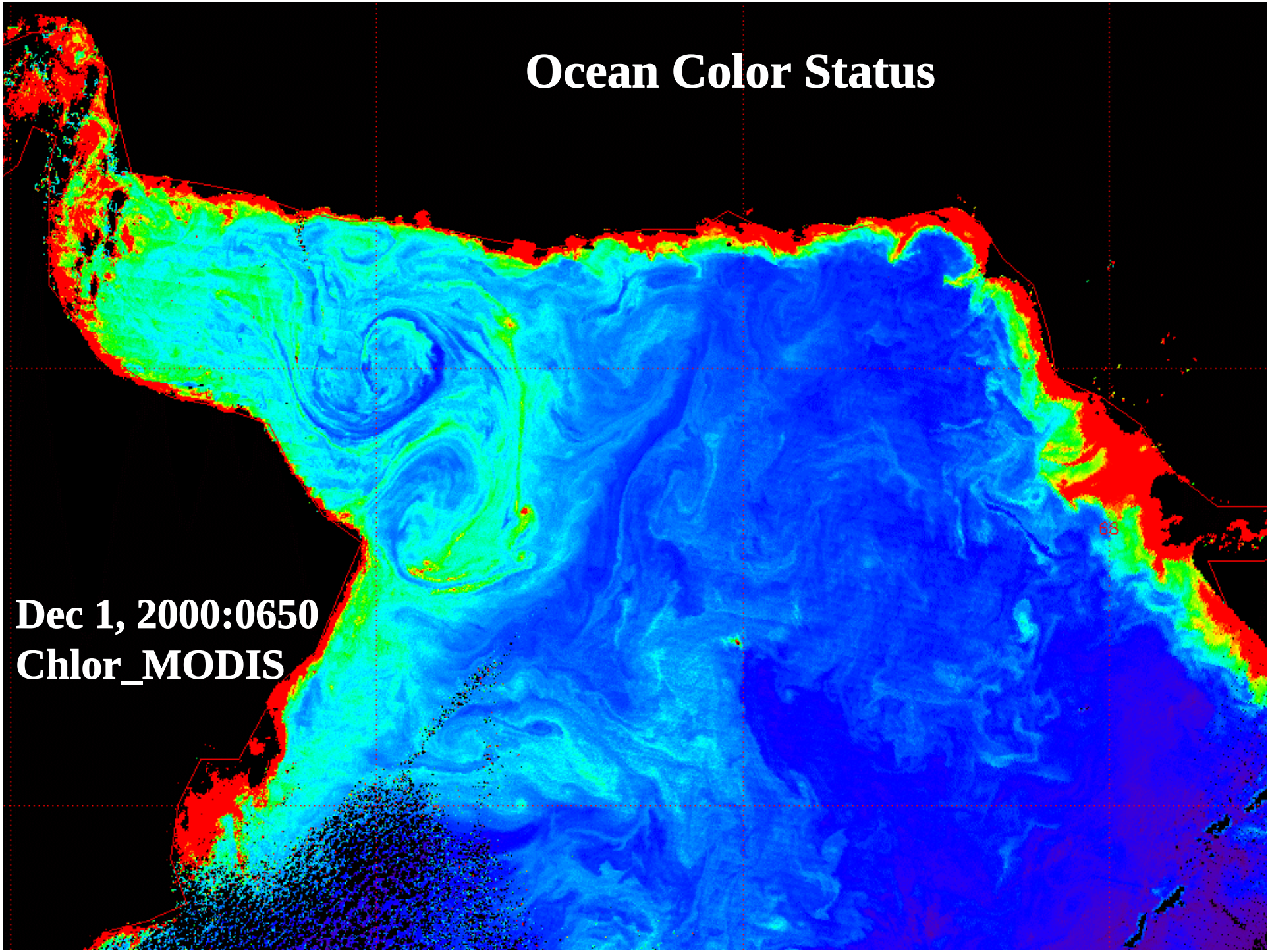
This places MODIS SST within the range of CLIVAR goals!

MODIS TERRA NIGHTTIME 11 μm SST



-2 5 10 15 20 25 30 35
°C

MAY 2001
V 3.3.1


Ocean Color Status
Dec 1, 2000:0650
Chlor_MODIS

MODIS Ocean Color - Visible Bands

Trends present in Version 3.3 radiances precludes “Valid” status.

Earth-sun distance duplication, instrument calibration trends

Higher level product (Chlorophylls, etc) show good performance

but suffer from trends present in the radiances.

Preliminary corrections (3.4.0) are in Terra forward stream.

Expect acceptable code to be in operations by April for reprocessing.

Reprocessing of Nov 00 - April 02 may be complete by August.

(The corrections should be be applicable to the full mission).

Ocean Color Calibration and Validation

Detector normalization, mirror side and rvs, polarization sensitivity adjustments, band-band ratios, and time trends are identified and removed by comparing Clark's MOBY and MOCE optical data against MODIS water-leaving radiances for specific periods for bands 8-12.

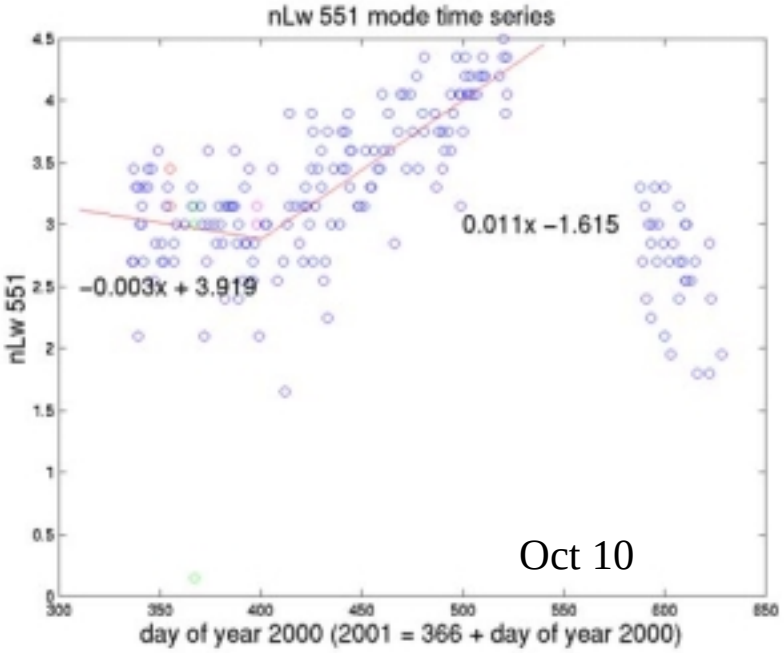
Relative calibration of the fluorescence and NIR bands is then performed in collaboration with Gordon, Abbott, Hoge in-situ and a/c results and analyses.

Resulting adjustments to L1b radiances are included in L2 PGE's, keyed to L1 LUTS.

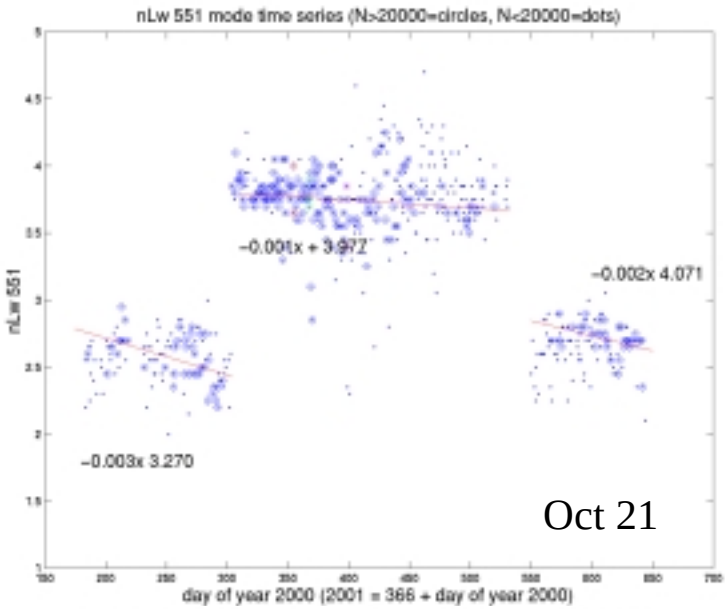
Higher level products (eg chlorophyll) are validated by comparison with in-situ measurements and SeaWiFS. Algorithm coefficients are based on independent radiance-property relationships.

We have begun joint "match-up" activities with SIMBIOS. Working to automate diagnostic sites subsetting and subscription during reprocessing.

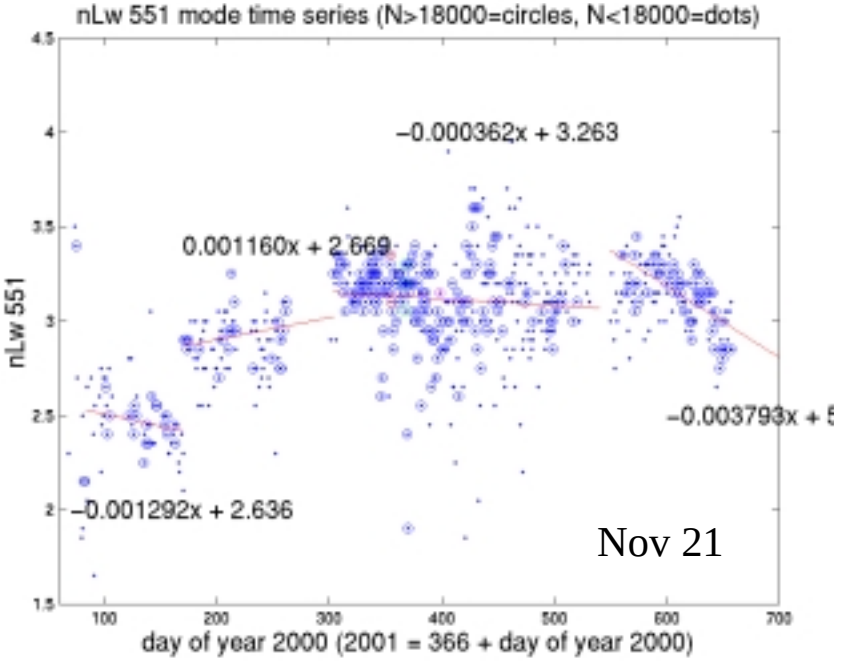
Trend Removal Progress at RSMAS



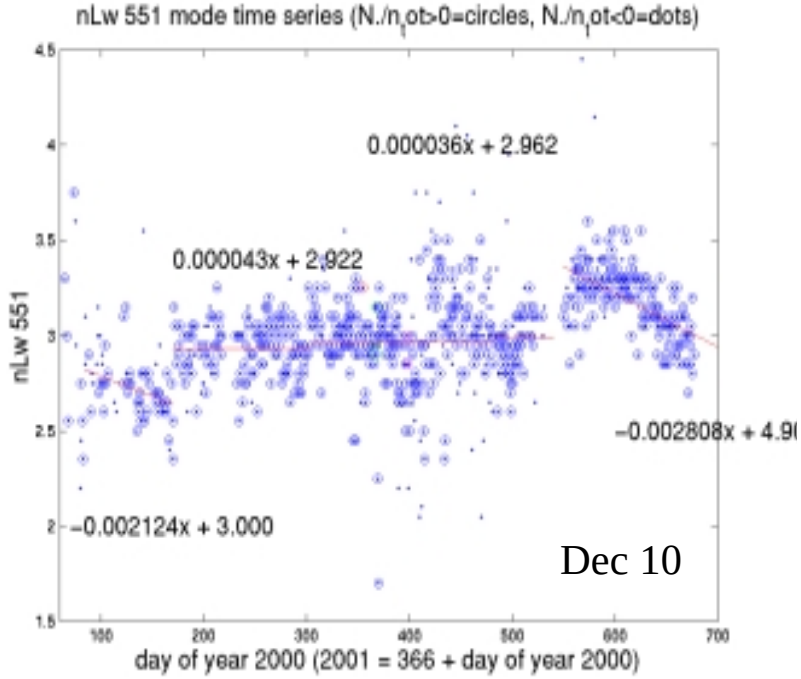
Oct 10



Oct 21



Nov 21



Dec 10

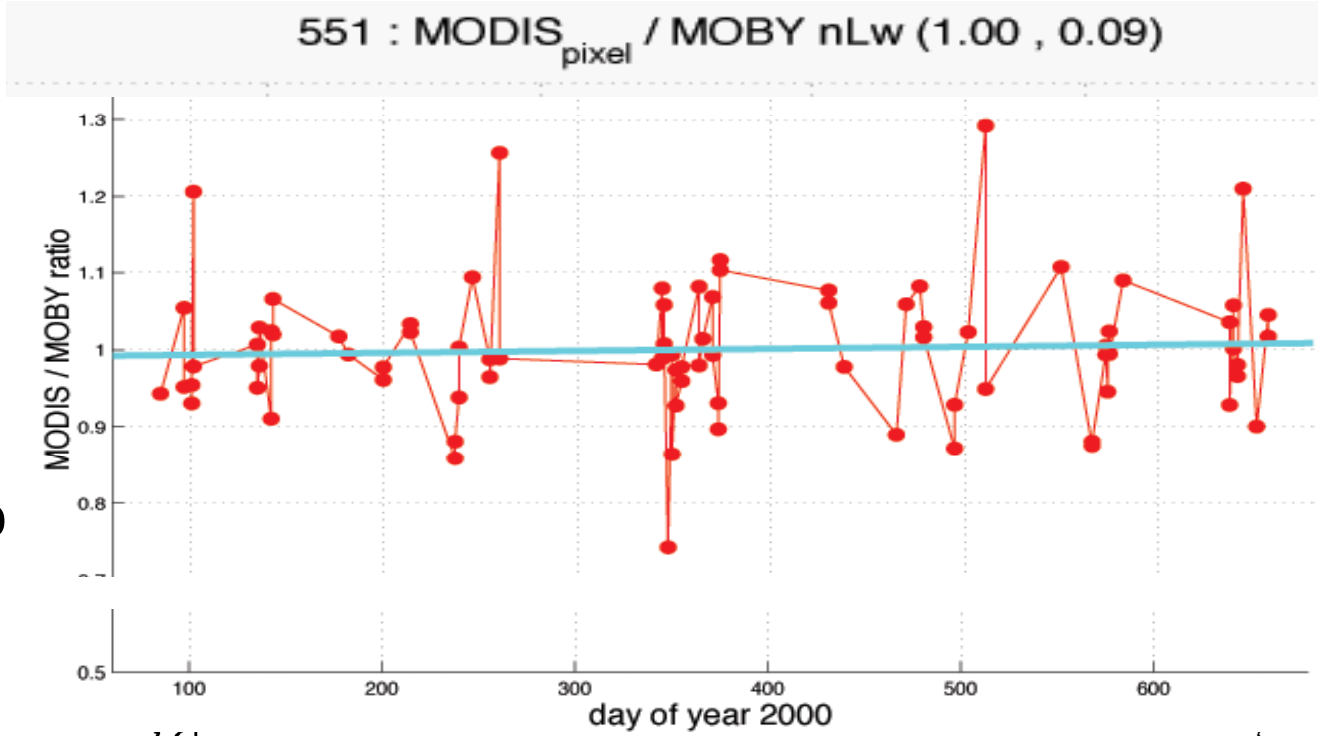
MODIS/MOBY

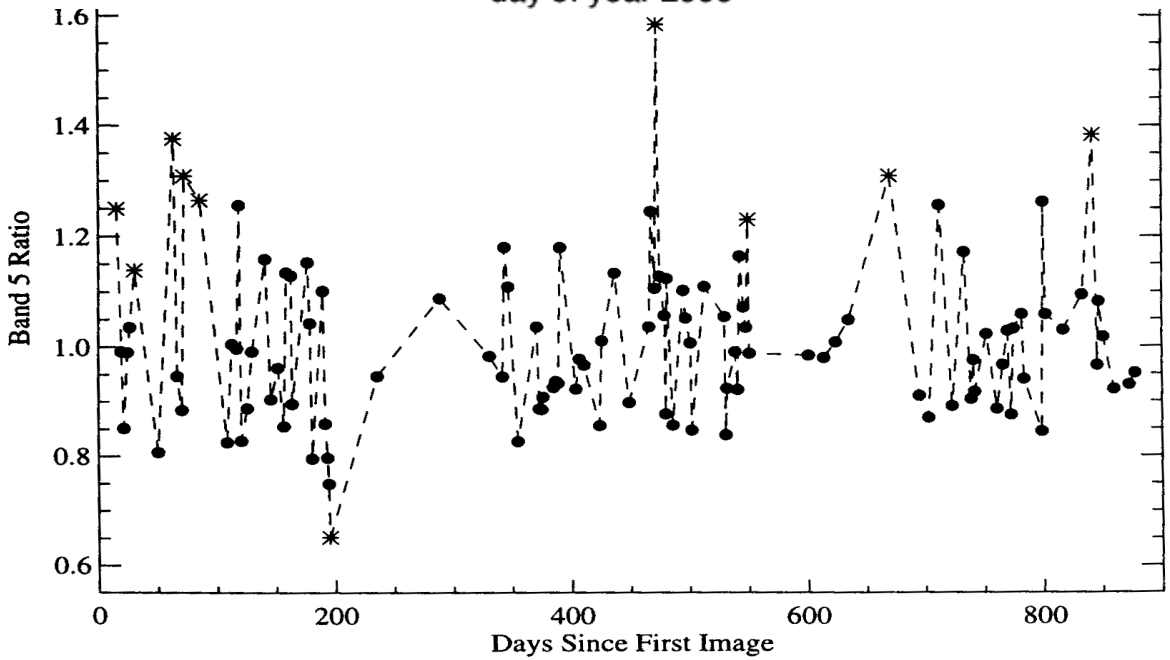
ratio, 551 nm

Time periods do not overlap

SeaWifs/MOBY

ratio, 550 nm





Evans et al.

15-Jan-02

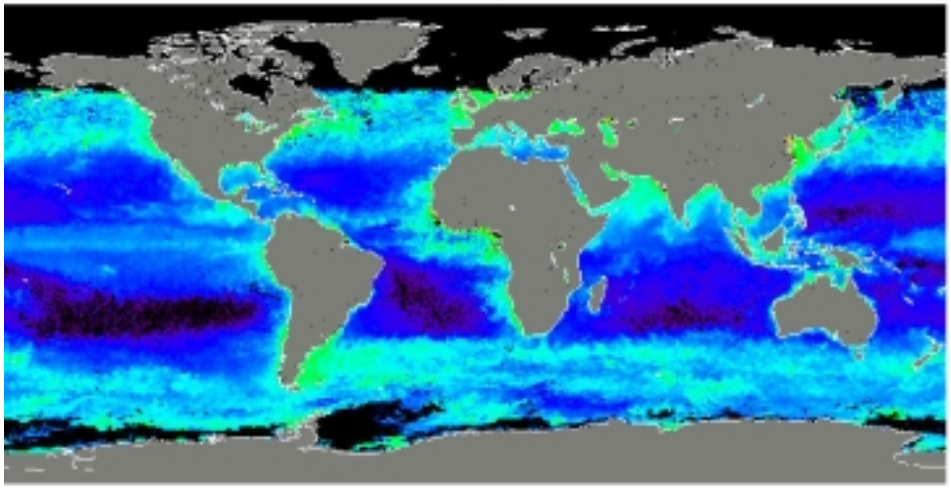
MODIS Ocean Visible Band and SST Performance

MODIS Band	Wavelength (nm)	RMS (% of nLw) Bias ~ 1%
8	412	12
9	443	8
10	488	7
11	531	8
12	551	9
22-23	SST4	Seasonal bias <0- 0.6K Std. Dev < 0.25K
31-32	SST	Bias 0.15K Std. Dev <0.25K

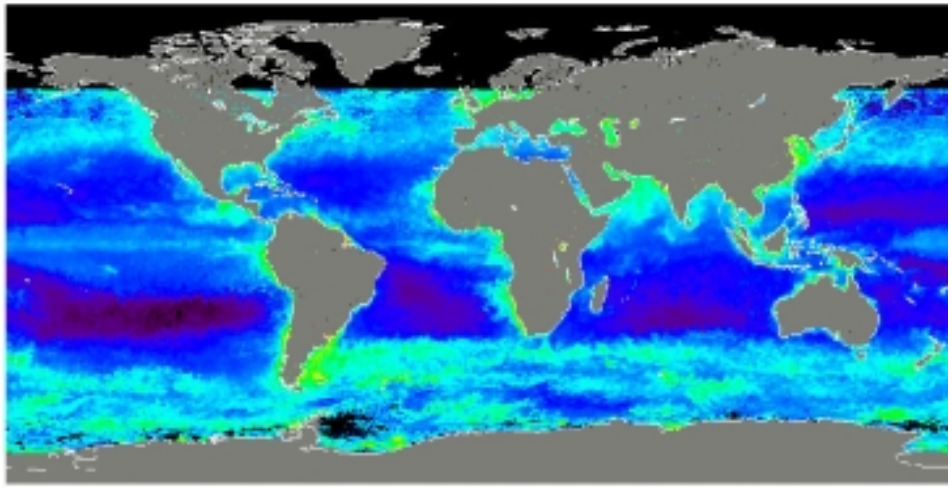
Evans et al.

chlorophyll - DAAC

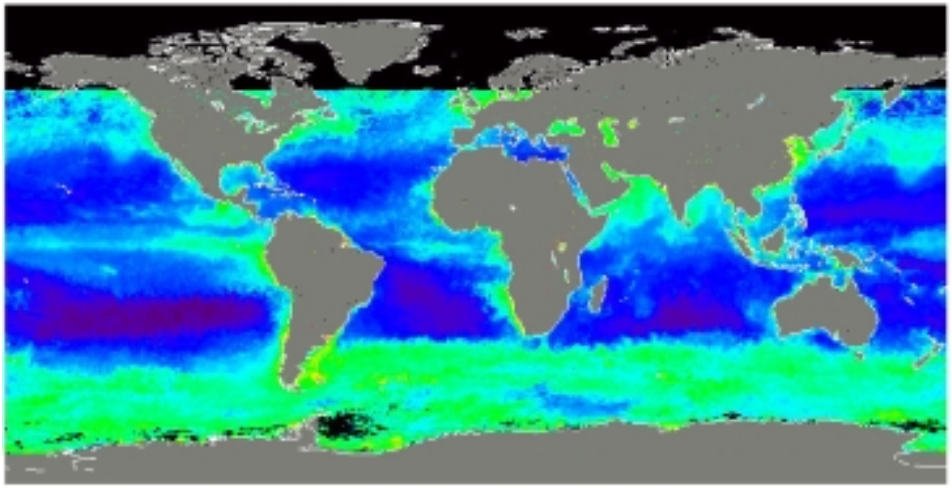
Chlor_modis



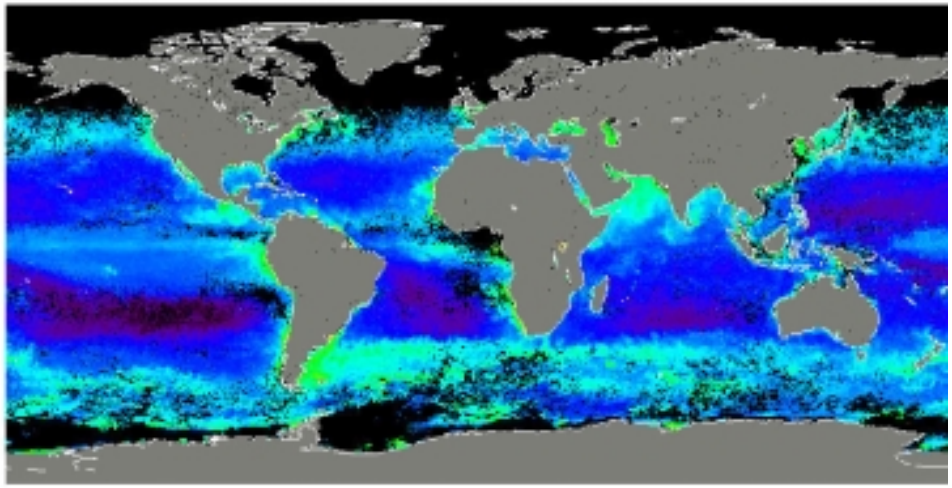
Chlor_a2



Chlor_a3



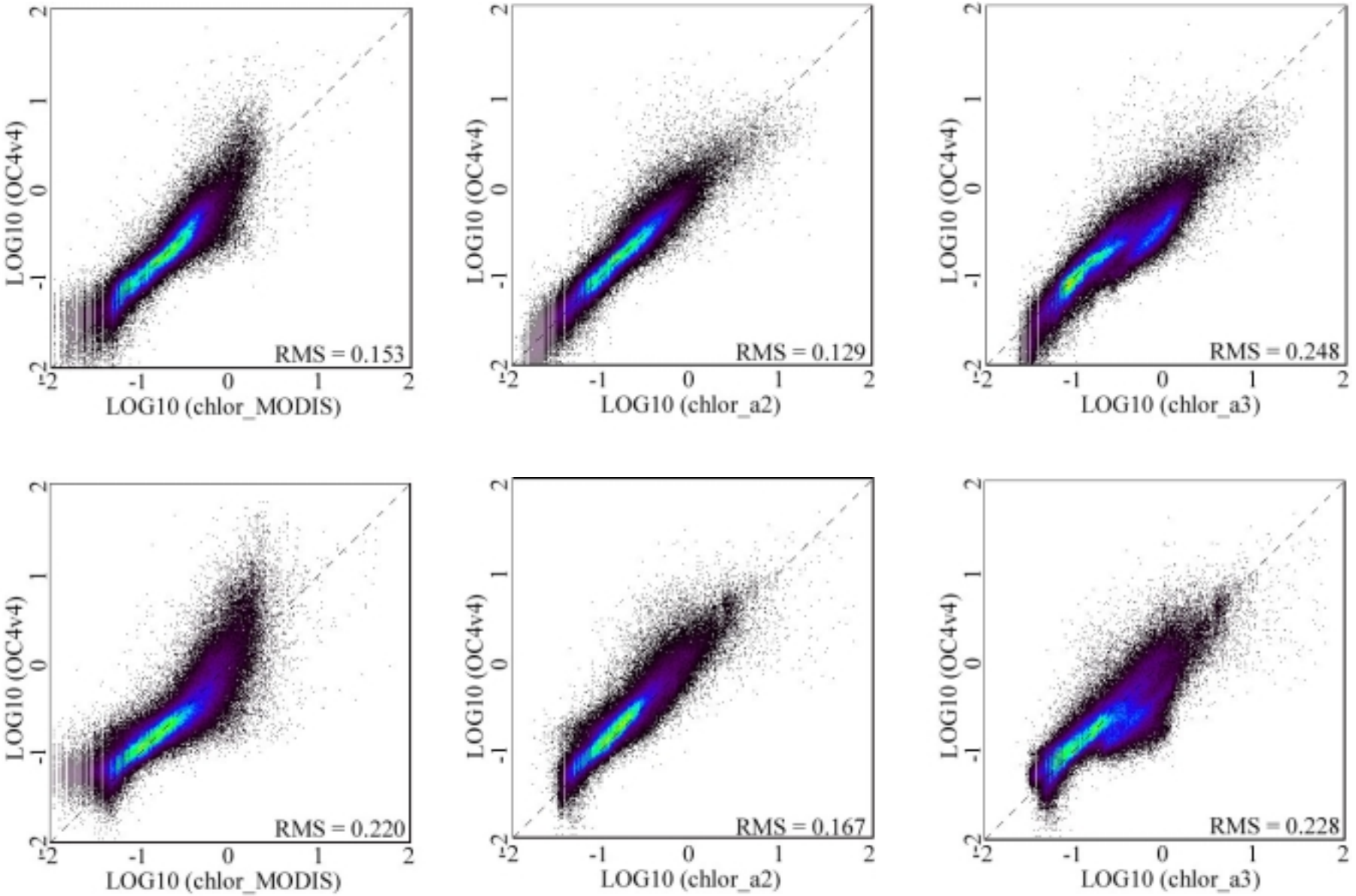
SeaWiFS



December 2000

MODIS Ocean/Campbell

SeaWiFS Chlorophyll

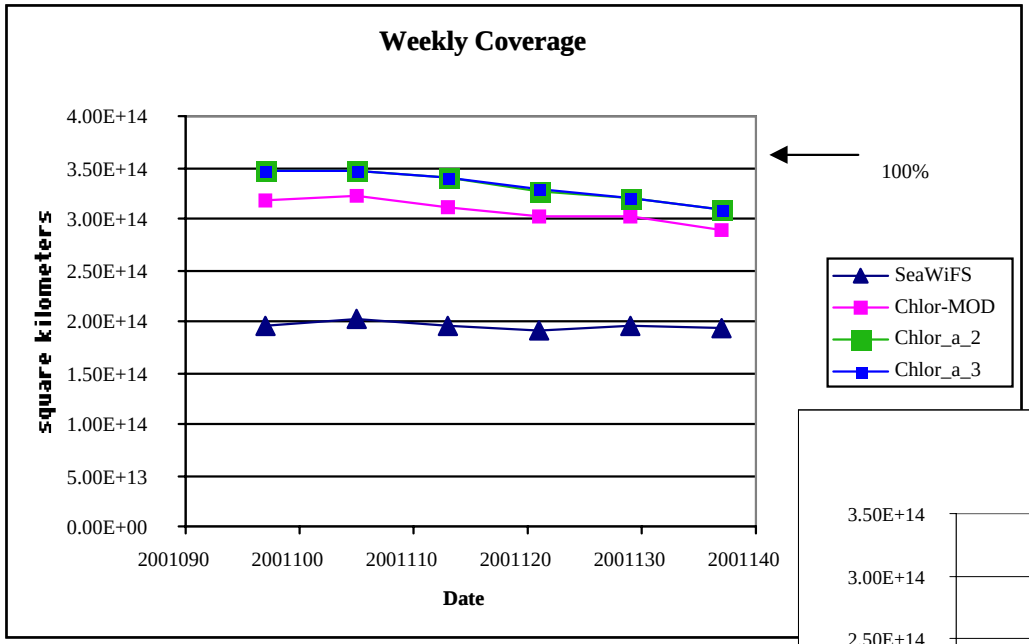


Top row: Global Dec. 2000. Bottom row: Global Aug. 2001.
Both are 36-km products from the DAAC.

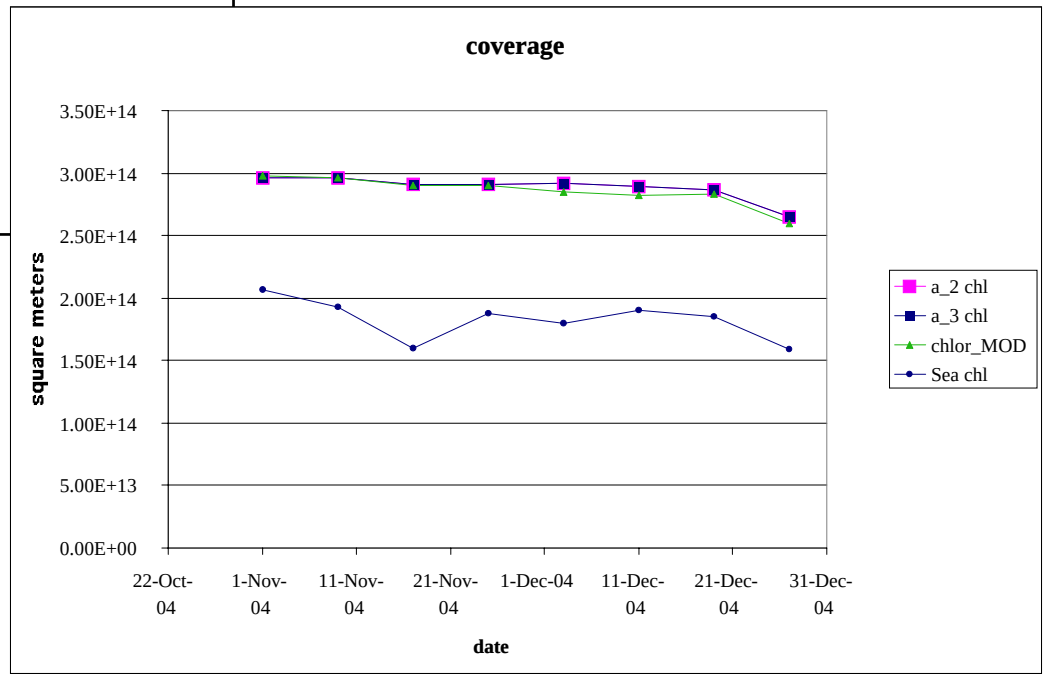
Campbell

Chlorophyll Validation

- MODIS and SeaWiFS chlorophylls agree well when corrections were correct. RMS ~ 0.2 log units
- RMS ~ 0.3 log units when comparing MODIS or SeaWiFS with in-situ chlorophyll measurements.
- The differences can be explained in terms of pigment packaging (Chlor_a_3 vs. SeaWiFS), or surface layer drift (e.g. Liu et al. 2001), or populations.
- The products are ready to be declared “valid” with the next reprocessing. By definition, if it is compatible with SeaWiFS, then it is valid.

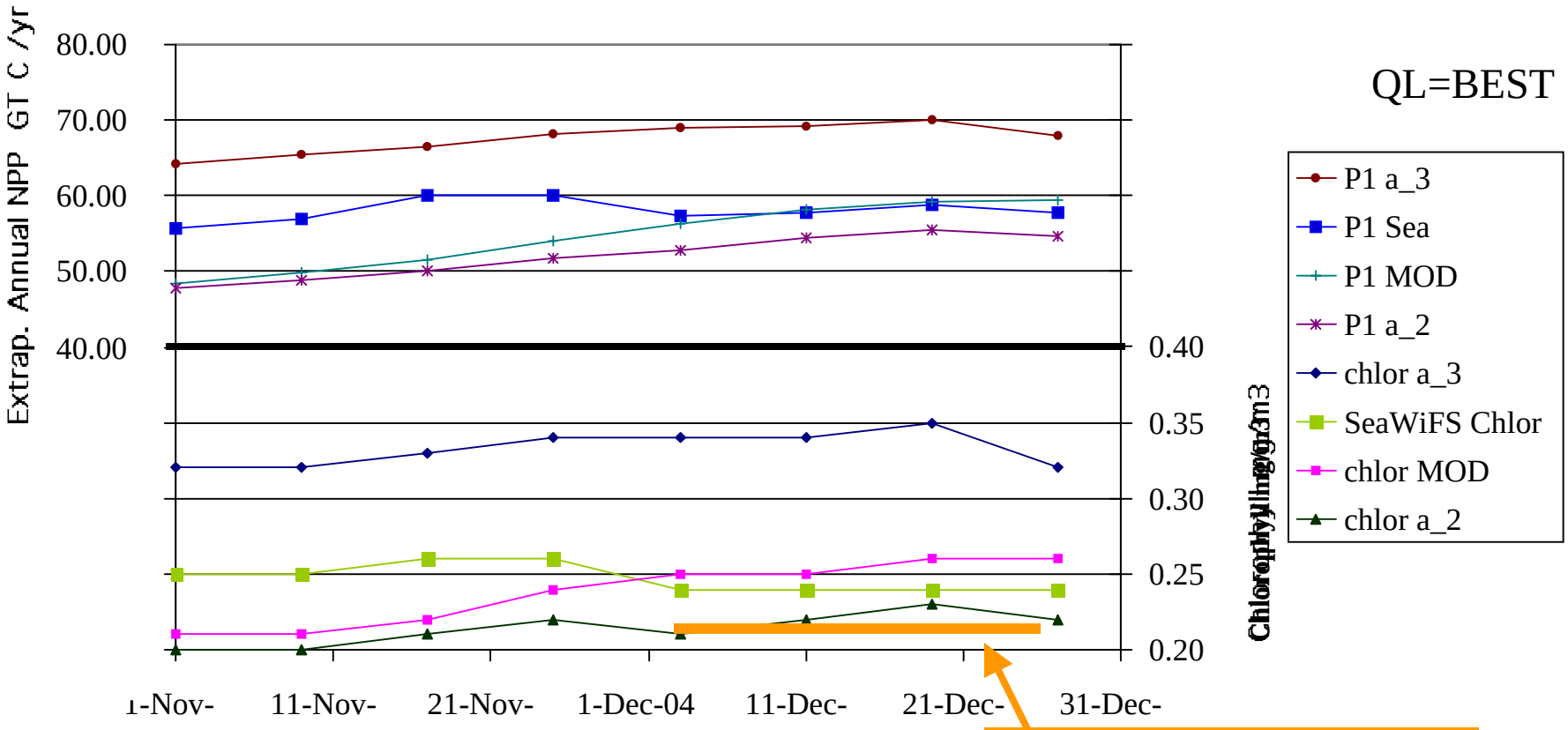


MODIS "best" only quality



MODIS coverage is excellent, due to:
Wider swath, greater duty cycle (50 vs 40 min/orbit),
Less cloud obscuration (1 km pixels), morning orbit. Product dependent.

Provisional (V 3.3) Global ONPP & Chlorophyll

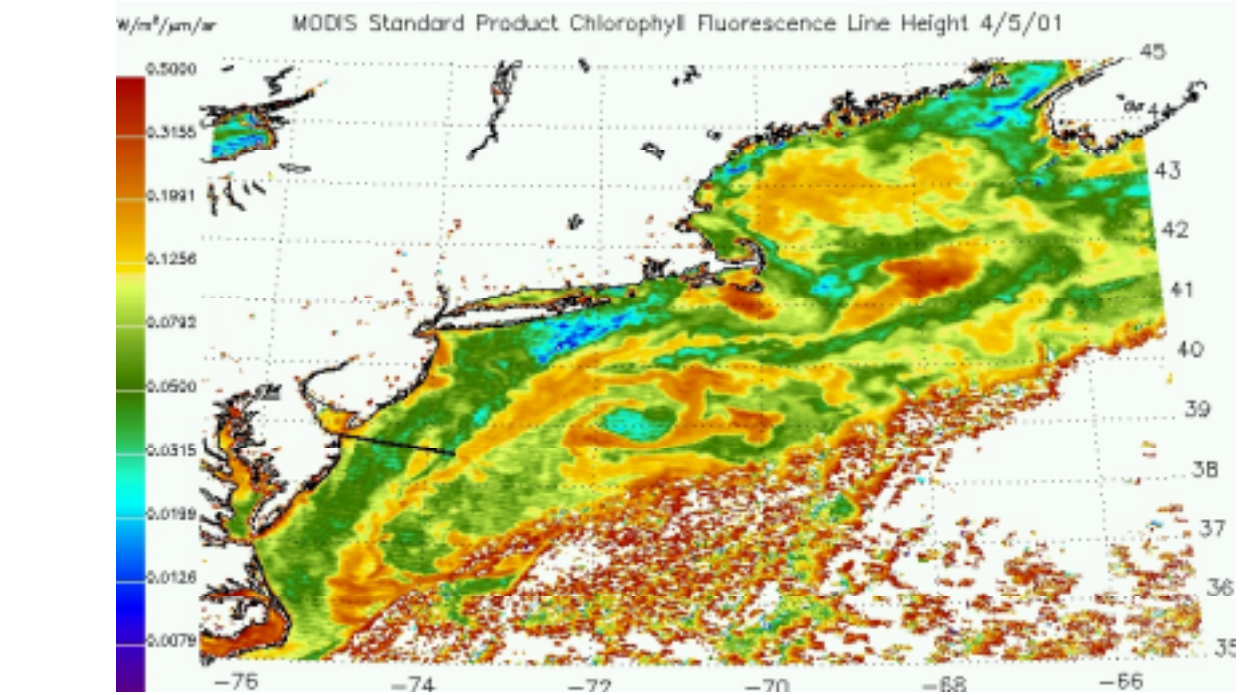


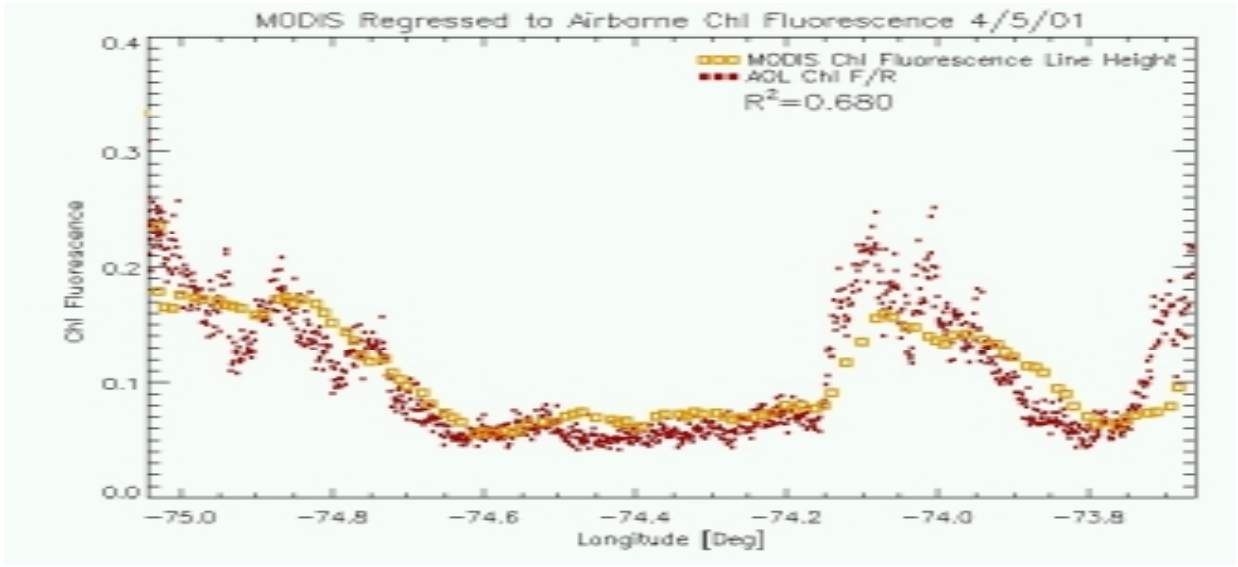
Esaias, Turpie

Steps to ONPP Validation

- Algorithms are validated, published.
- PGE 51 code computes the correct ONPP for given inputs.
- Requires “validation” of Chlor_a_3, SST.
  - •Acceptance” of higher global means from Chlor_a_3.
- Investigating issues with DAO PAR, & quality flag propagation.
  - Can be accomplished in <1 month from a stable input.
- Expect to meet spring schedule for code readiness.
- Initial uncertainties will be based on:
  - Heritage (SeaWiFS and Published Literature)
  - Consistency
  - Comparison with Ocean Time Series
- Participant in PP Round Robin - M.E. Carr, JPL.
- Expect a validated status ~ 1 month after reprocessing.

Fluorescence Line Height Validation with AOL





Hoge

Summary of Expected "Validated" Designations for MODIS Oceans

Product ID	Product Name	Level/Frequency*			Planned release on 12/18/99	Beta Data Released	Start of Data Series	Provisional Data Released	Start Date of Data Series	Expect Validated Status*	Start of Data Series*
MOD18	Normalized Water-leaving Radiance	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD19	Pigment Concentration	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD20	Chlorophyll Fluorescence	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD21	Chlorophyll_a Pigment Concentration	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD22	Photosynthetically Active Radiation (PAR)	2	3 (d, 8d, M)		80-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD23	Suspended-Solids Conc, Ocean Water	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD24	Organic Matter Concentration	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD25	Coccolith Concentration	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD26	Ocean Water Attenuation Coefficient	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD27	Ocean Primary Productivity			4 (8d, M)	150-210 (7/15)	2/8/01	10/15/00	8/22/01	Nov-00	Aug-02	Nov-00
MOD28	Sea Surface Temperature	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Feb-02	Nov-00
MOD31	Phycoerythrin Concentration	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00			?	
MOD36	Total Absorption Coefficient	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD37	Ocean Aerosol Properties	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00
MOD39	Clear Water Epsilon	2	3 (d, 8d, M)		150-210 (7/15)	10/13/00	9/15/00	7/4/01	Nov-00	Aug-02	Nov-00

* Visible Products Dependent on Reprocessing, SST is 11-12 μm product

ISSUES, CHALLENGES

Rapid Reprocessing of Ocean Color Products

Expect code readiness in March-April

MODAPS at >10x dedicated to Ocean

Maximize DAAC - MODAPS -DAAC transfer rate

Team will then focus on QA, matchups of reprocess data, & Aqua.

Begin reprocess by June (May if possible)

Complete by Sept.

Aqua - March/April Launch looks very promising.

Hope for a more stable instrument vis-à-vis calibration.

Will still require retrospective calibration, reprocessing.

L+90 for validated products is unrealistic for ocean products.

Product Distribution

SIMBIOS users are encouraged to order and comment on

ordering tools, data, etc. December 00 is best month.

Comments from Oceans to ESDIS, DAAC are very sparse.

Need to become more involved in GDAAC, SEEDS, LTA.

MODIS Data Processing Review Team (MDPRT)
December 11-13, 2001

Moshe Pniel -- JPL (chair)
Graham Bothwell –JPL
Gene Feldman – GSFC
Tom Kalvelage – EROS Data Center
Graeme Stephens – Colorado State University
Eric Stocker – GSFC
Compton Tucker – GSFC

Recommendation #1:
A reduced set (a total of less than ten) of the MODIS products should be identified specifically to promote a more interdisciplinary and wider use of MODIS data. These ‘core’ products will be compiled on common space-time grids at a resolution reduced from its native resolution the original and using a common data format.

MODIS is in the discussion phase regarding recommendations.
Your thoughts on which ocean products should constitute a core set is solicited.

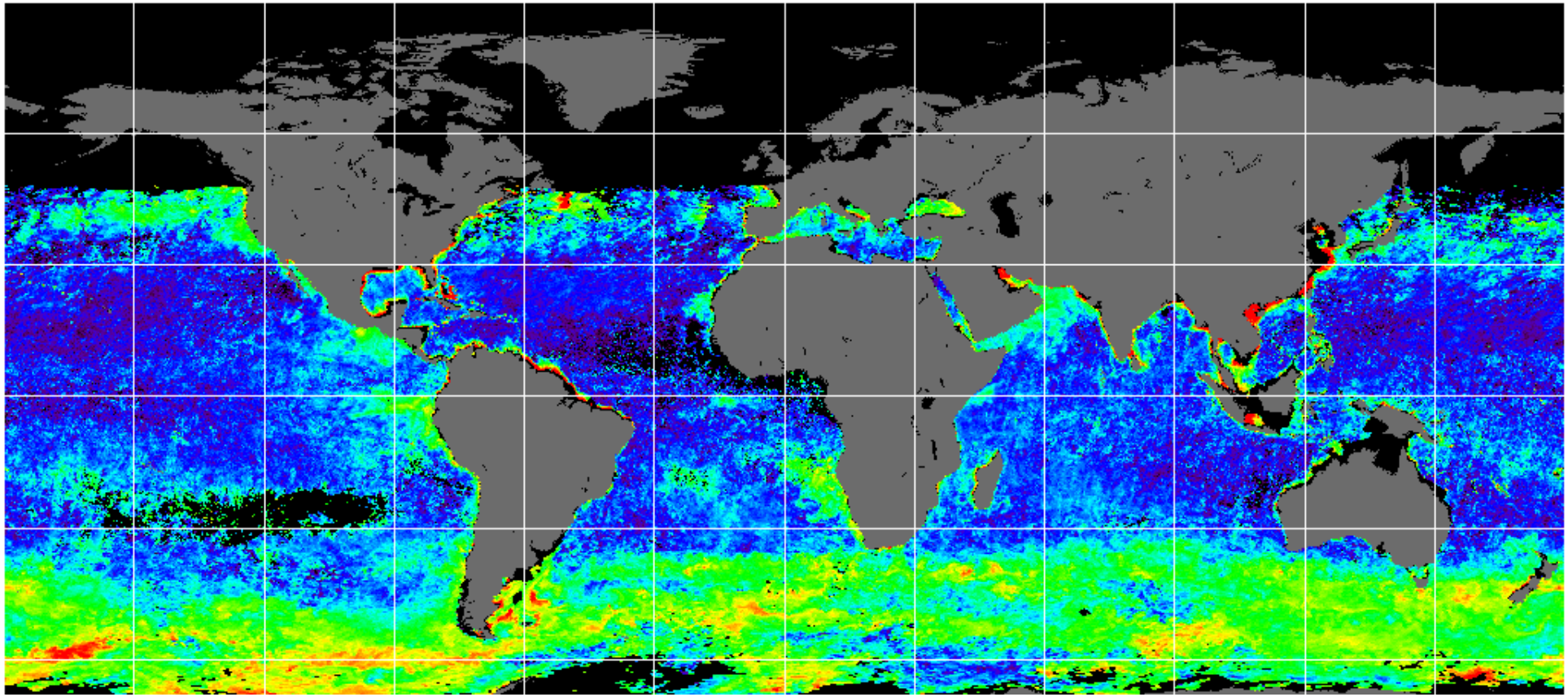
Candidate set at 4.6 km, daily resolution is:

L1b

Land Sfc reflectance	Cloud Mask	SST
NDVI	Aerosol	Chlor_a2
Snow	Cloud Phase	nLw’s

Other votes for CaCO3, Fluorescence, ONPP

MODIS TERRA Calcite



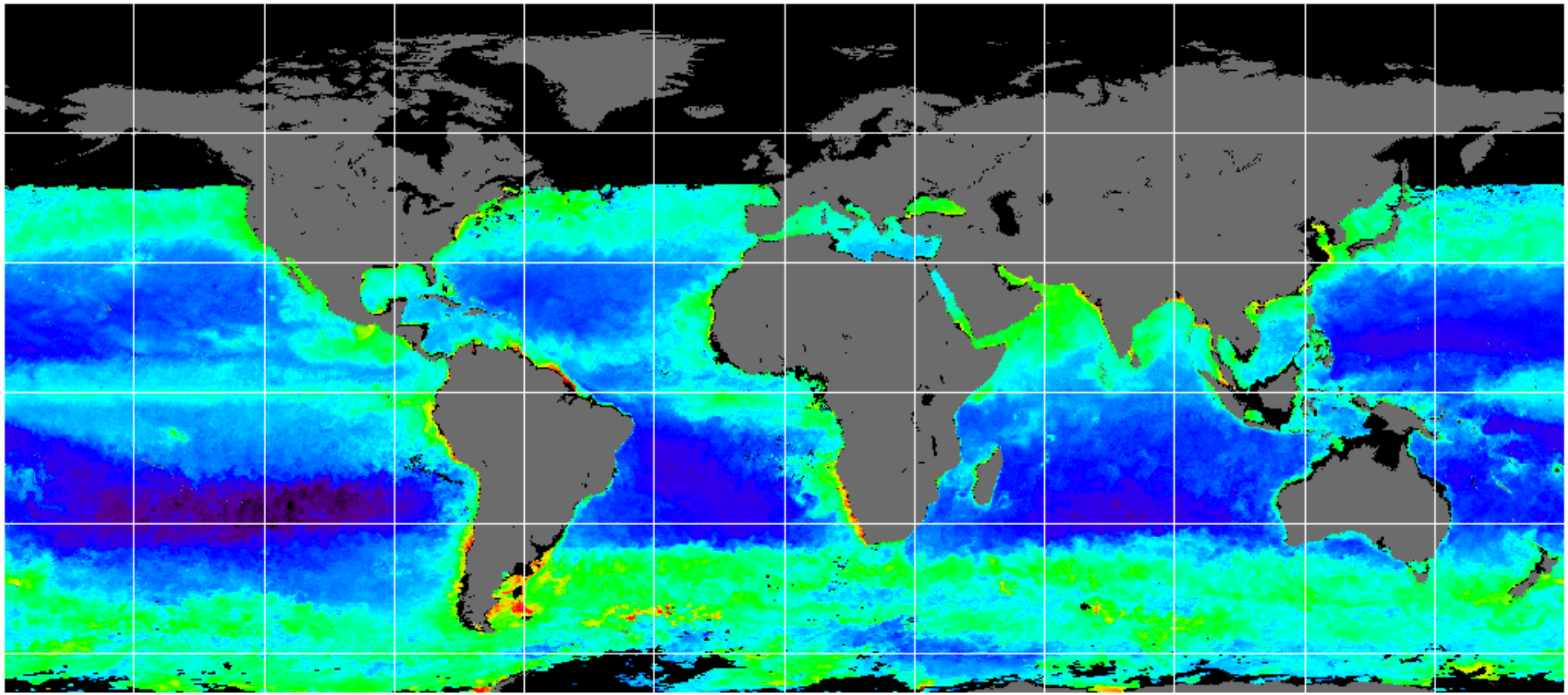
Quality Level = Best

0.1 1.0 10. 25.

mg m^{-3}

MODIS/OCEAN GROUP V3.3.0 December 2000

MODIS TERRA CHLOROPHYLL Chlor_a_2



Quality Level = Best

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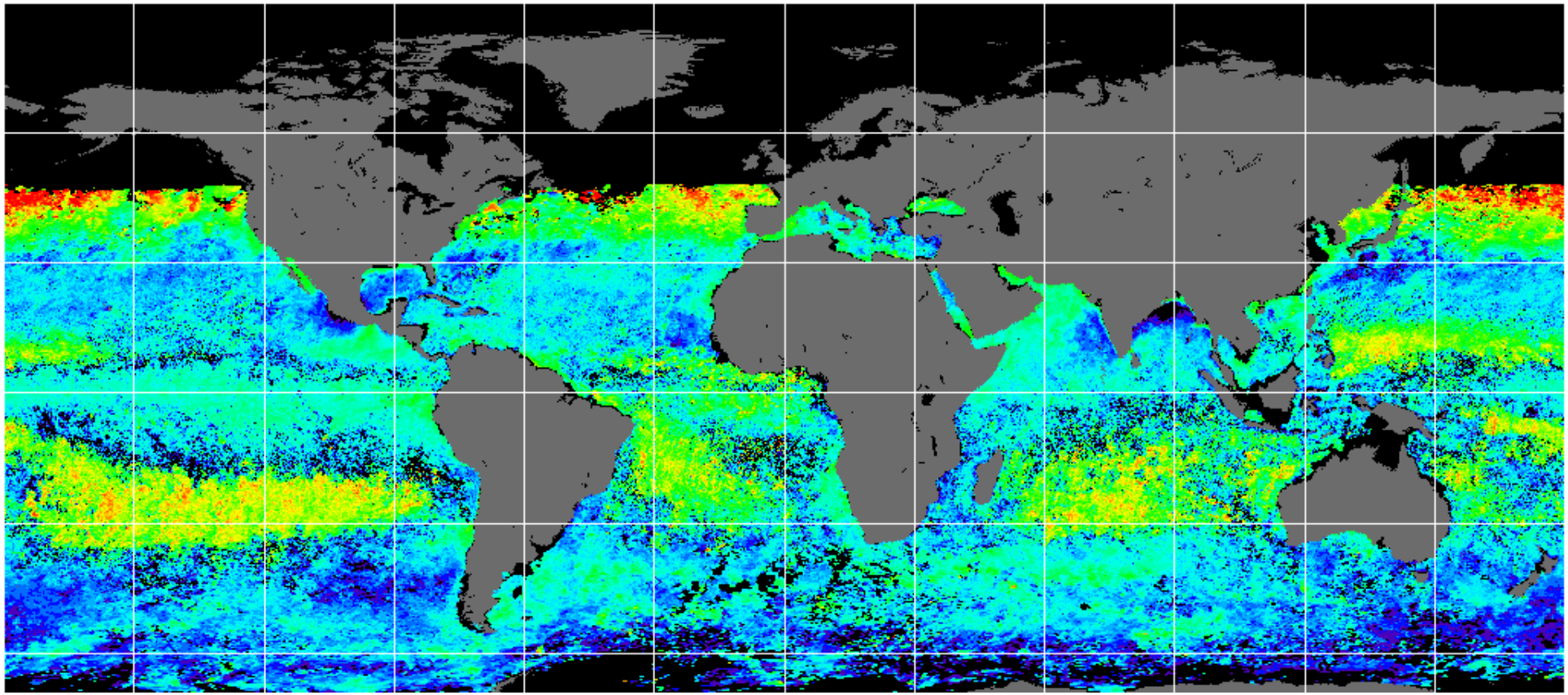
Chlor_a_2 (mg m^{-3})

MODIS/OCEAN GROUP V3.3.0 December 2000

MODIS TERRA Chlorophyll Fluorescence Efficiency



Quality Level = Best

0.001 0.01 0.1

MODIS/OCEAN GROUP

V3.3.0 December 2000

MODIS Ocean

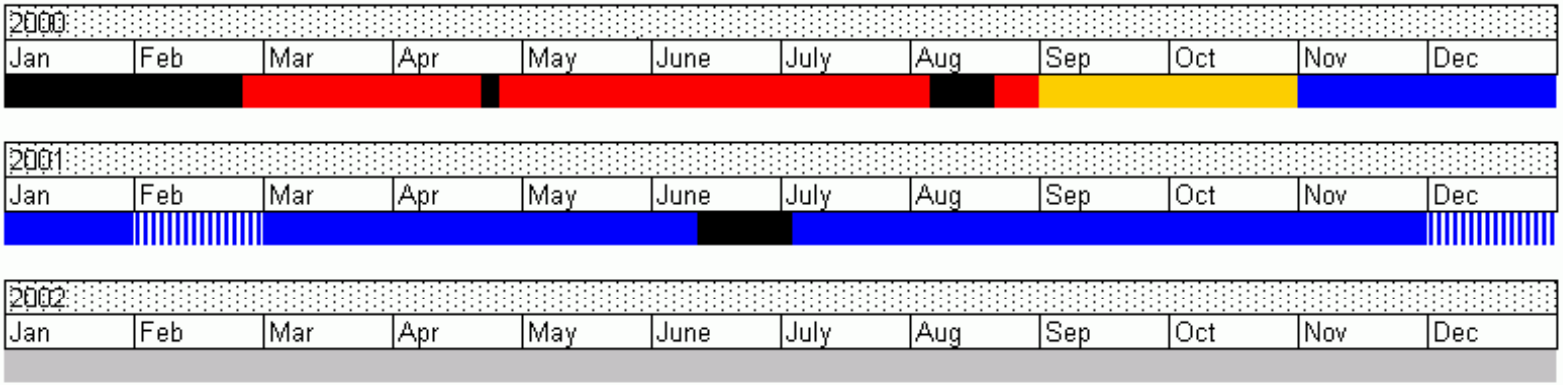
Home Data Products Quality Assurance Validation Data Processing References Links

Processing Status

Last updated: 1/4/2002

Data Maturity

Click on a portion of the timeline to view details and **known problems** about that period:



Data Maturity/Processing Status:

= Pre-release data, not available to public
= **Beta** data
= **Provisional** data
= **Provisional** data, currently being processed
= Data to be collected
= No data collected

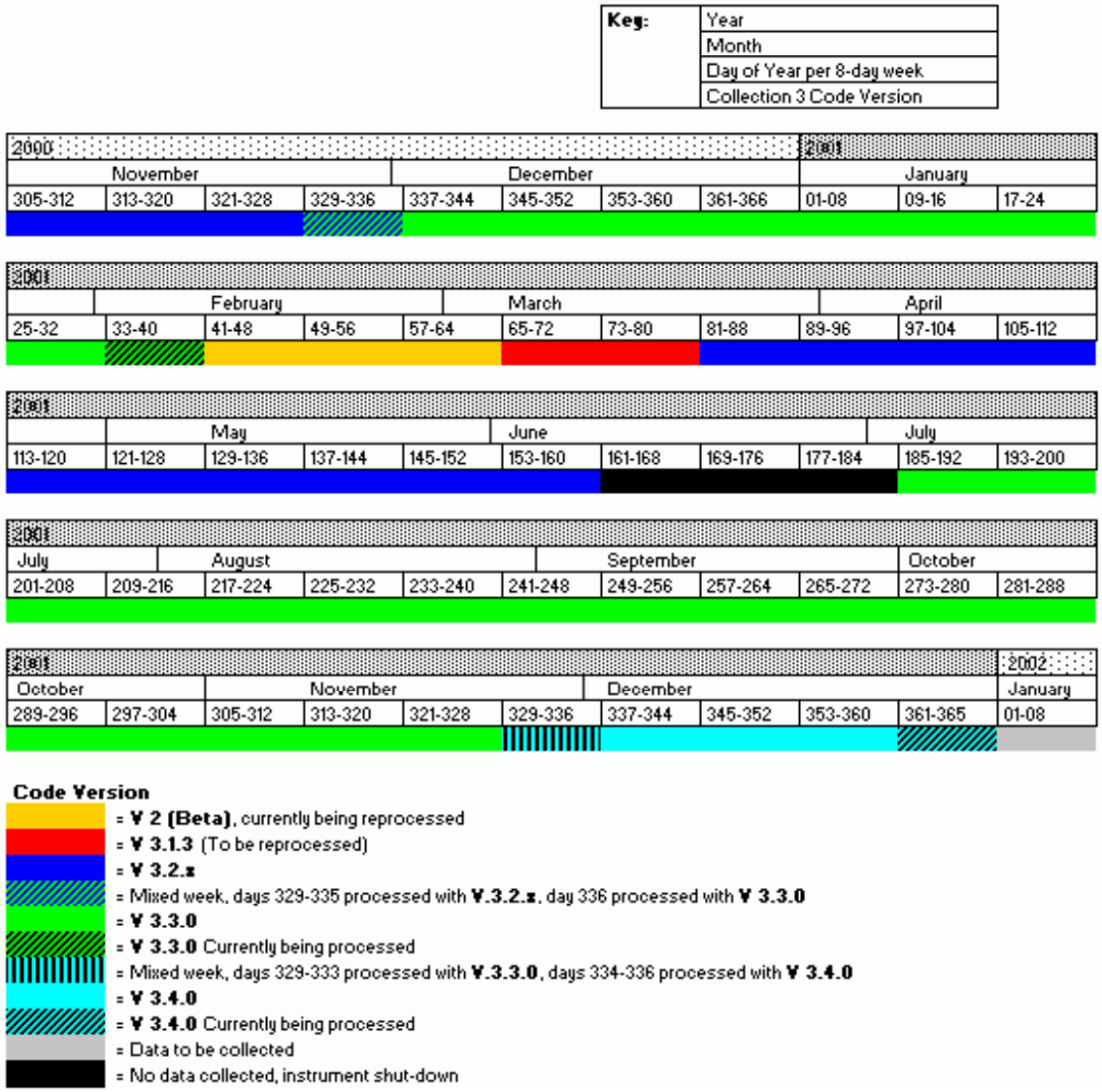
Data Maturity Definitions

Esaias, Vogel

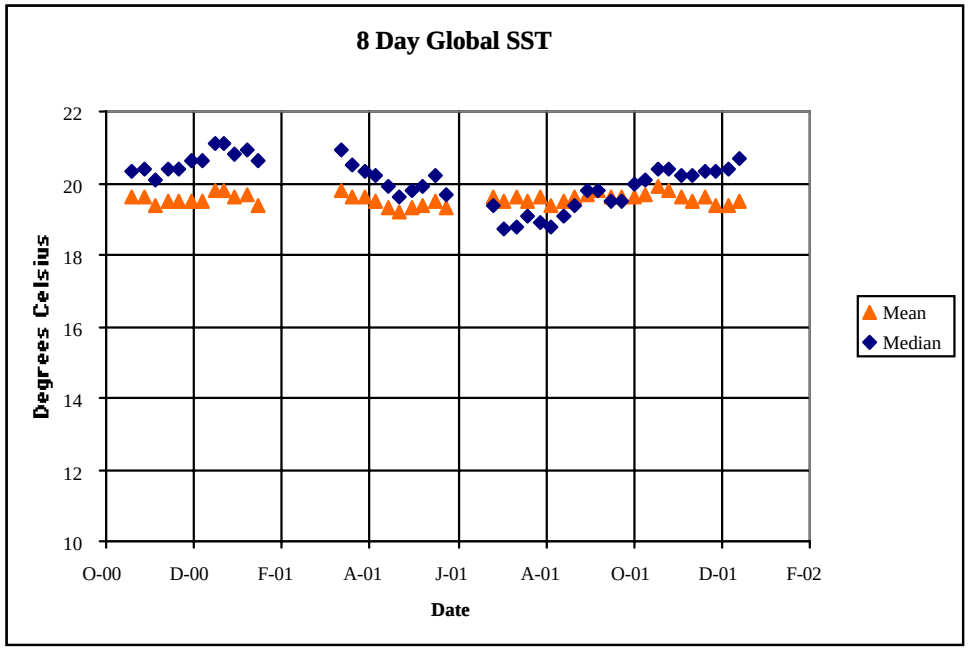
Collection 3 Provisional Products

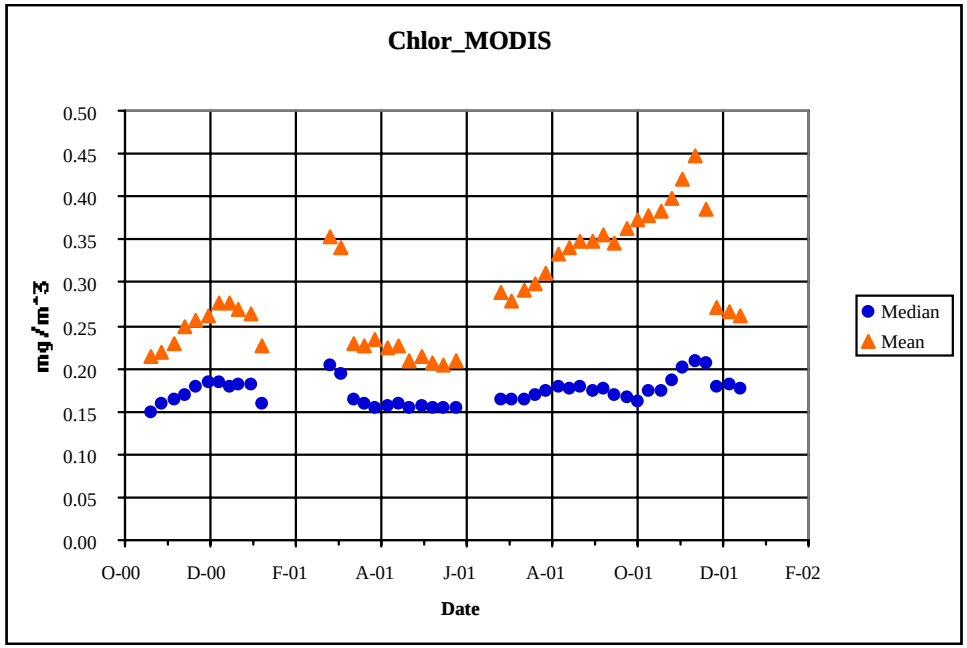
Last updated: 1/4/2002

Code Version Changes

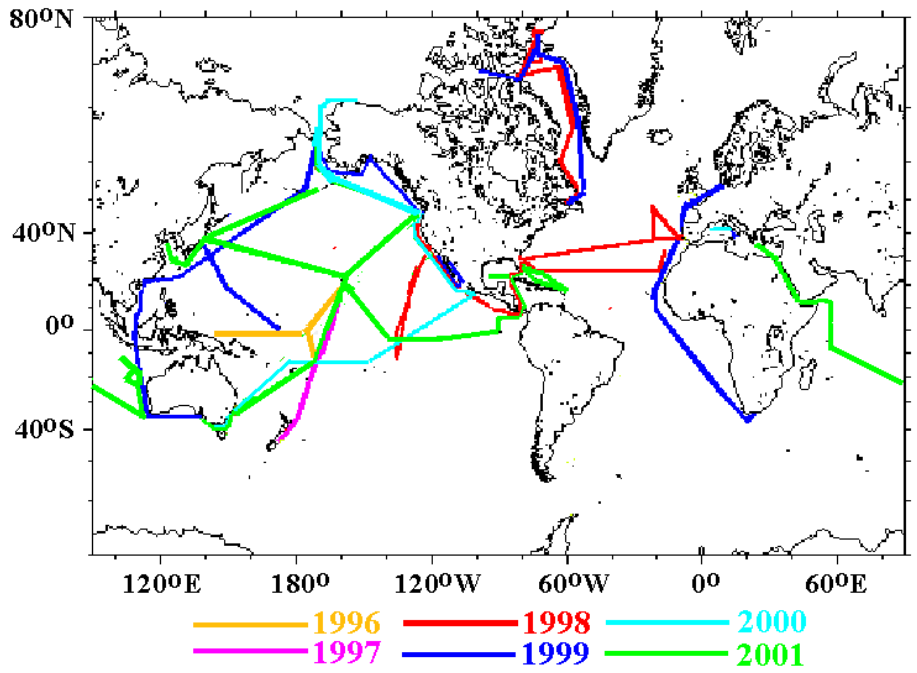


Esaias, Vogel


8 Day Global SST
Degrees Celsius
22
20
18
16
14
12
10
O-00
D-00
F-01
A-01
J-01
A-01
O-01
D-01
F-02
Date
Mean
Median

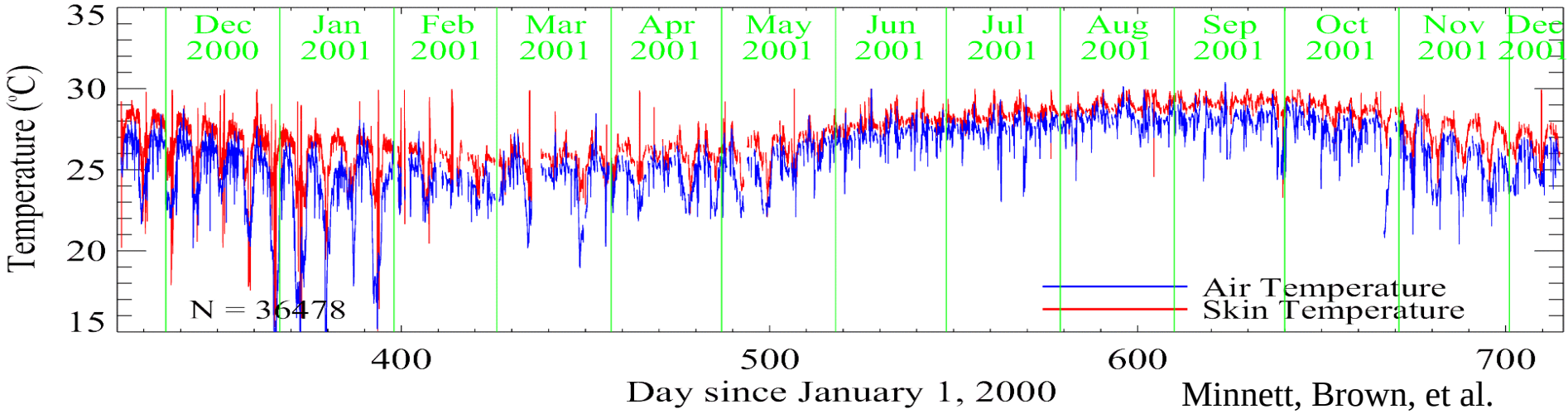

Chlor_MODIS
mg/m^3
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
O-00
D-00
F-01
A-01
J-01
A-01
O-01
D-01
F-02
Date
Median
Mean

Top: M-AERI Cruises



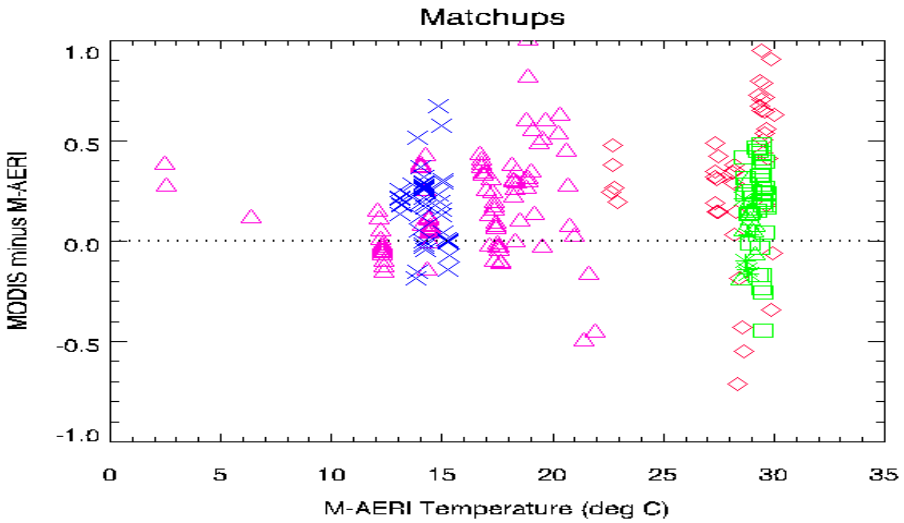
Bottom: M-AERI data

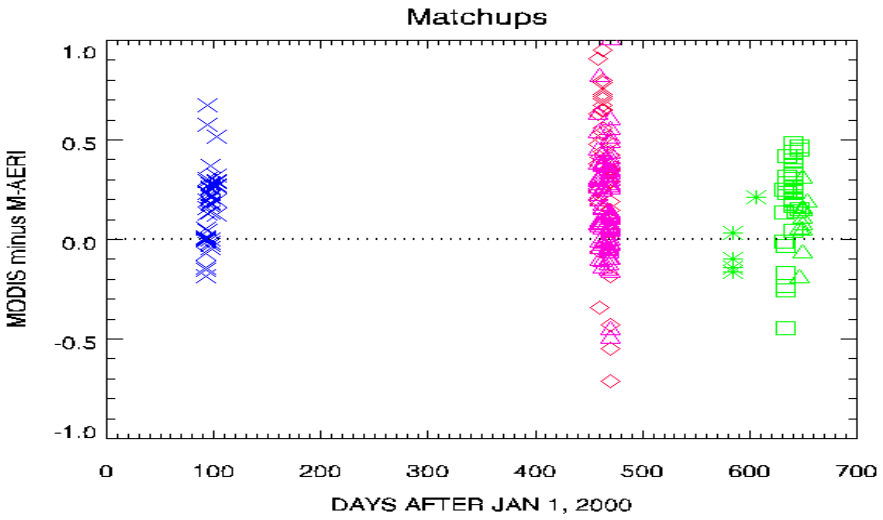
Explorer of the Seas



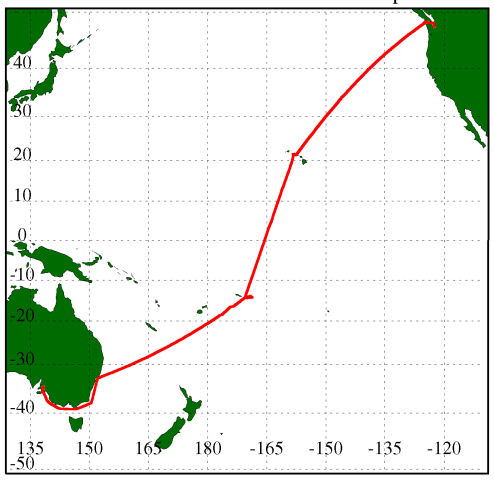
MODIS-M-AERI Matchups

Blue = Mediterranean – April 2000; Red =Pacific – March, April 2001;
Pink = Pacific – March, April 2001; Green = Atlantic - Explorer of the Seas.



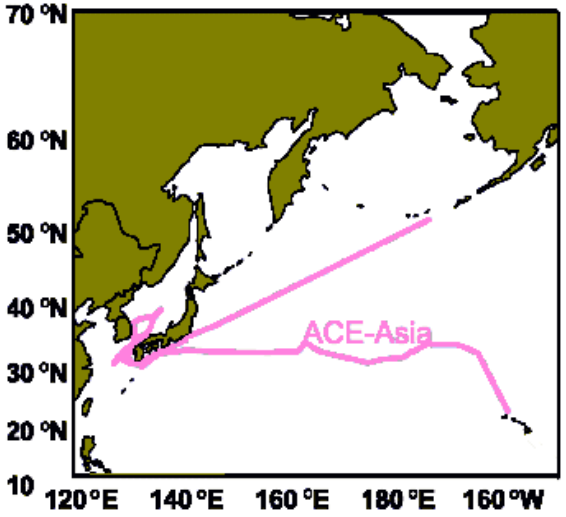


USCGC Polar Sea GPS. 3 March - 30 April 2001



15-Jan-02

All data	***Explorer of the Seas***
M = 0.20K	**M = 0.15K**
std= 0.26K	**std= 0.21K**
N = 242	**N = 50**



Are MODIS SSTs Validated?

- VALIDATED PRODUCTS: science quality with well defined uncertainties; improvements ~~may still be~~ are ongoing.
- These are high quality products suitable for longer term or systematic scientific studies and publication. There ~~may~~ will be later improved versions.
- Within the limits of current analyses, (temporal and regional) ….. **YES**.

Minnett, Brown et al.