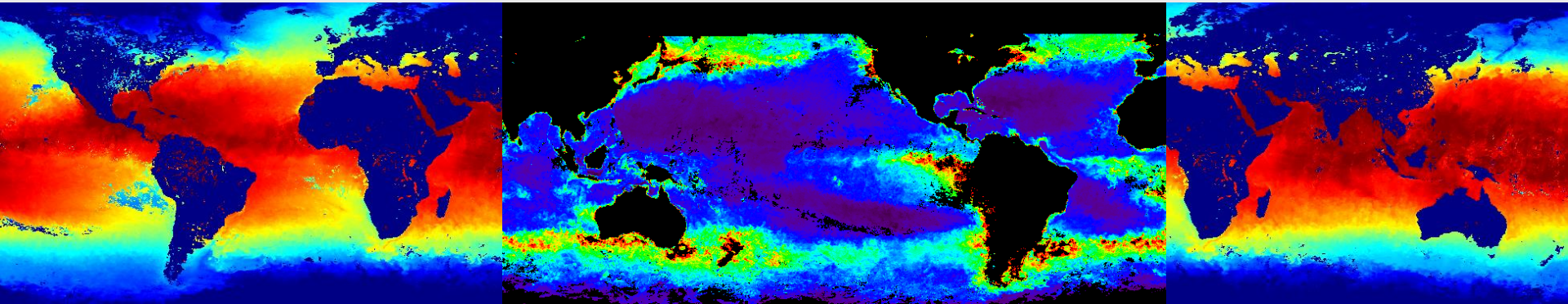


MODIS Ocean Products



Leon Majewski

Remote Sensing & Satellite Research Group

Curtin University

Overview

- ◆ Standard Ocean Products
- ◆ New MODIS Products
- ◆ Validation
- ◆ Obtaining Data

Standard Ocean Products

◆ Sea Surface Temperature (SST)

- SST TIR (11-12 μ m)
- SST MW(3-4 μ m)
- TIROS, AVHRR, ATSR

◆ Ocean Colour

- Chlorophyll-a (chl-a) / pigment concentration
- Diffuse attenuation coefficient (490nm; K490)
- CZCS, SeaWiFS

Sea Surface Temperature

◆ Sea Surface Temperature

- Generally regarded as the temperature of the ocean at a depth of 1m.

◆ Sea Surface Skin Temperature

- Radiometers (including space-based radiometers) can be used to estimate the sea surface temperature.
- Sophisticated buoys can also be used.
- The optical depth of seawater at infrared wavelengths is less than 1mm.

Sea Surface Temperature

◆ Algorithms

– Longwave-infrared, Day, Nonlinear SST

- $SST = a + bT_{31} + c(T_{31}-T_{32})T_{sfc} + d(T_{31}-T_{32})(\sec(\theta)-1)$

T₃₁, T₃₂: Brightness temperatures measured in bands 31 and 32

T_{sfc}: A first guess SST, taken from the NCEP SST

θ: Satellite zenith angle

– Midwave-infrared, Night

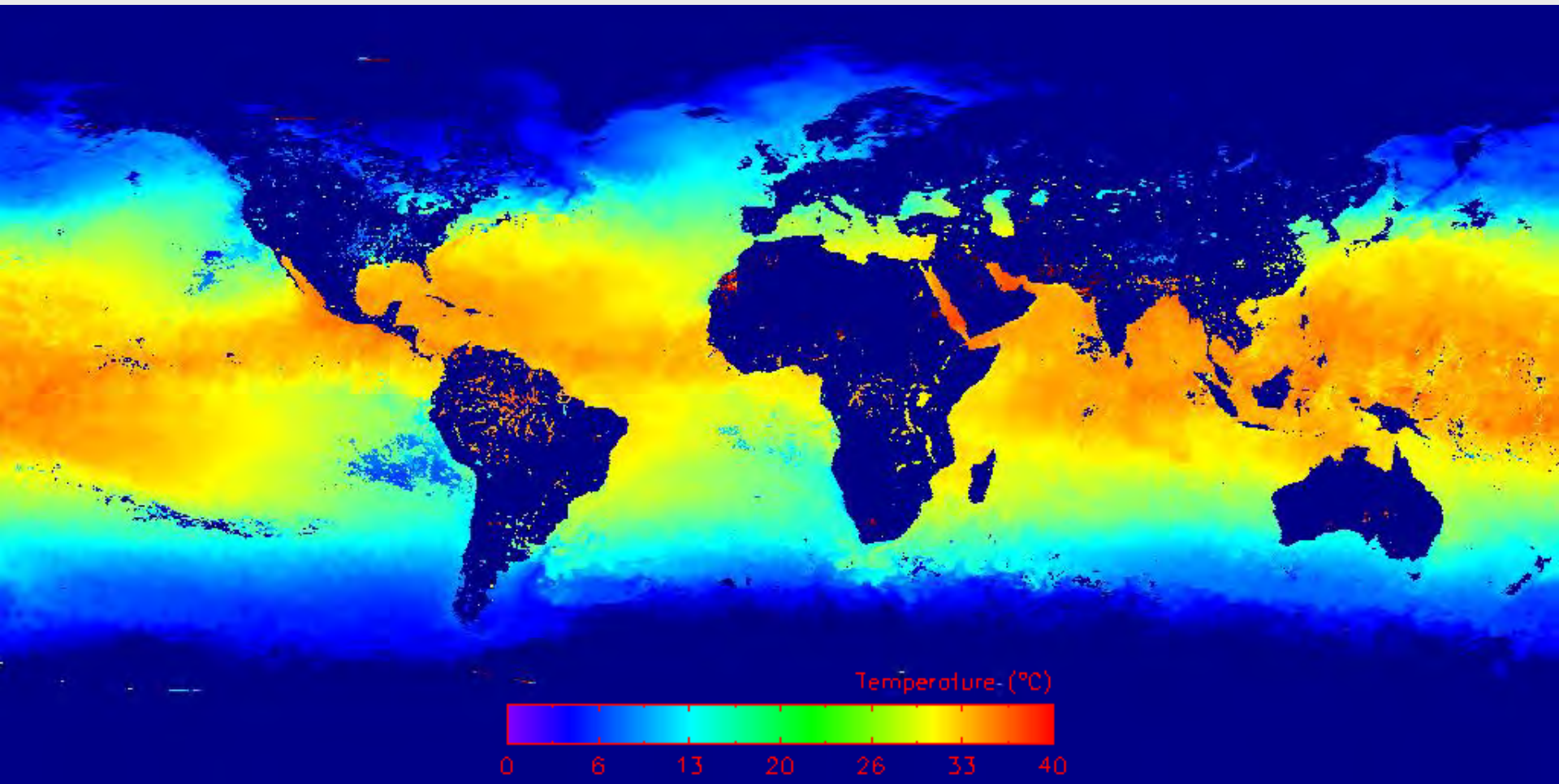
- $SST = a + bT_{20} + cT_{23}$

T₂₀, T₂₃: Brightness temperatures measured in bands 20 and 23

Band number	Centre Wavelength μm	Bandwidth μm	NEΔT at T=300K	SNR at T=300K	Saturation Temperature K
Midwave IR					
20	3.7882	0.1826	0.026	900.0	333
23	4.0567	0.0878	0.026	987.5	329
Longwave Thermal IR					
31	11.0144	0.5103	0.024	2808.8	399
32	12.0282	0.4935	0.040	1824.5	391

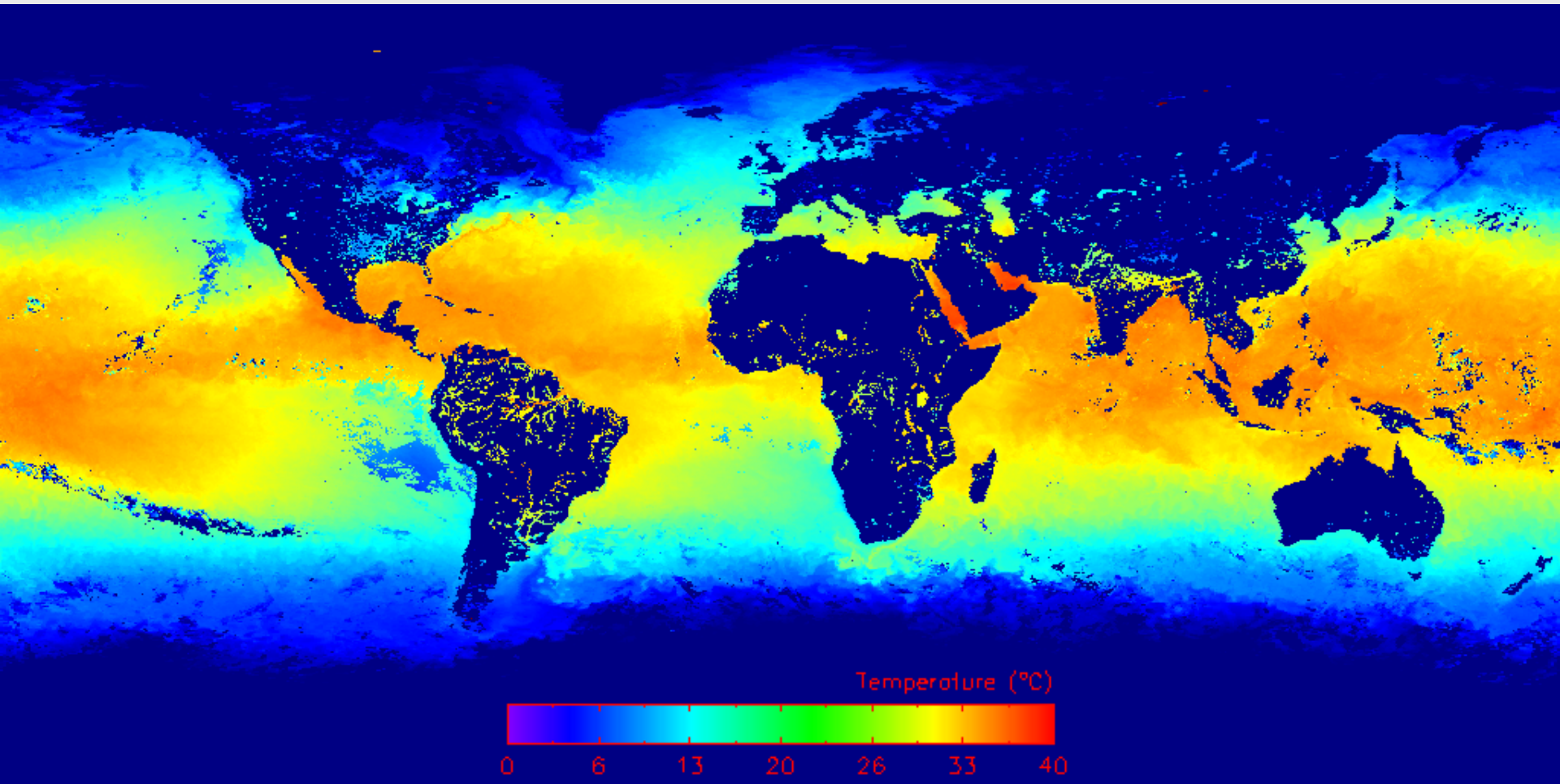
MODIS SST

- ◆ Terra v4, Global Coverage, Weekly composite, 36km
- ◆ TIR 11 μ m, Day



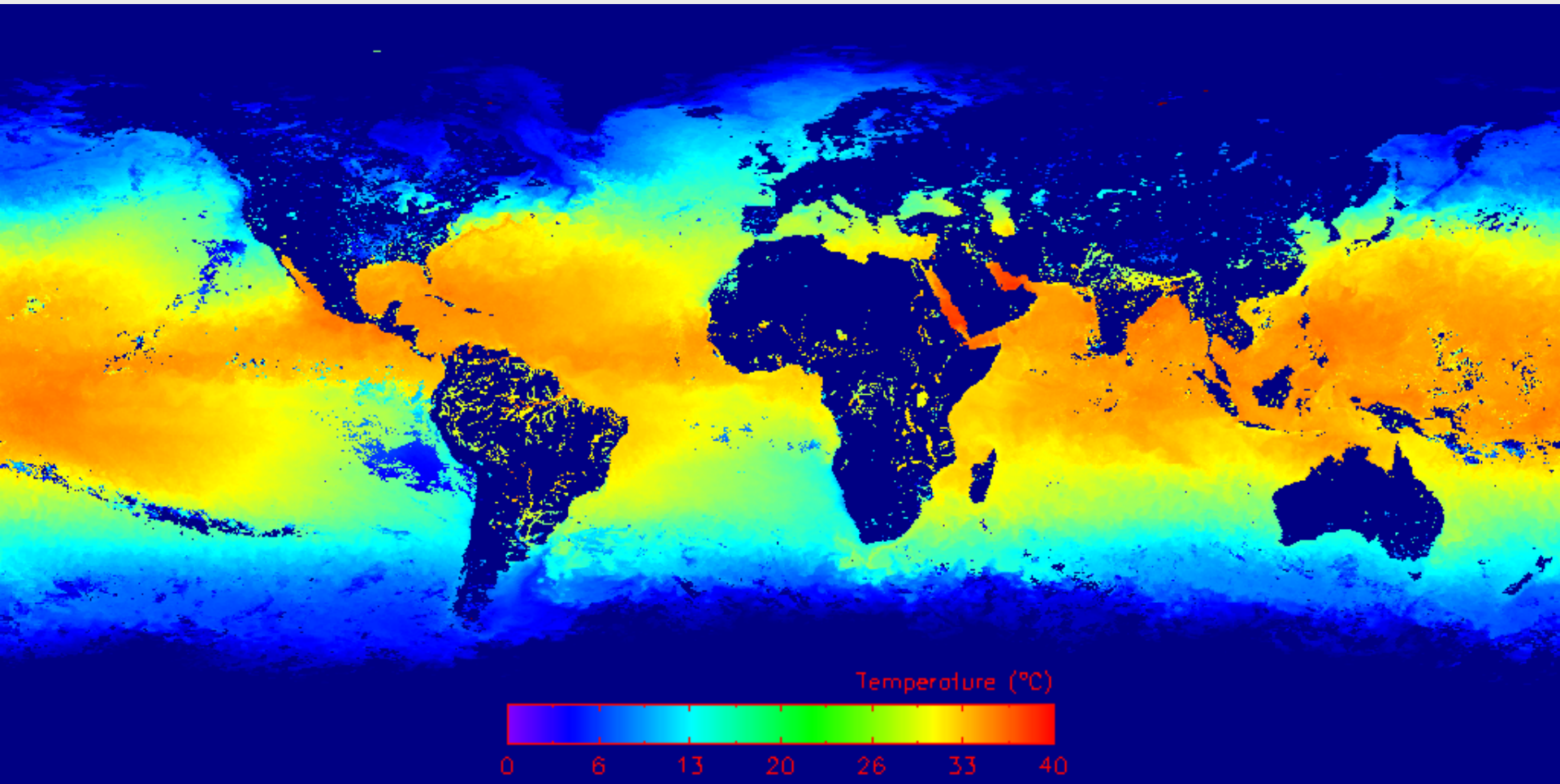
MODIS SST

- ◆ Terra v4, Global Coverage, Weekly composite, 36km
- ◆ TIR 11 μ m, Night



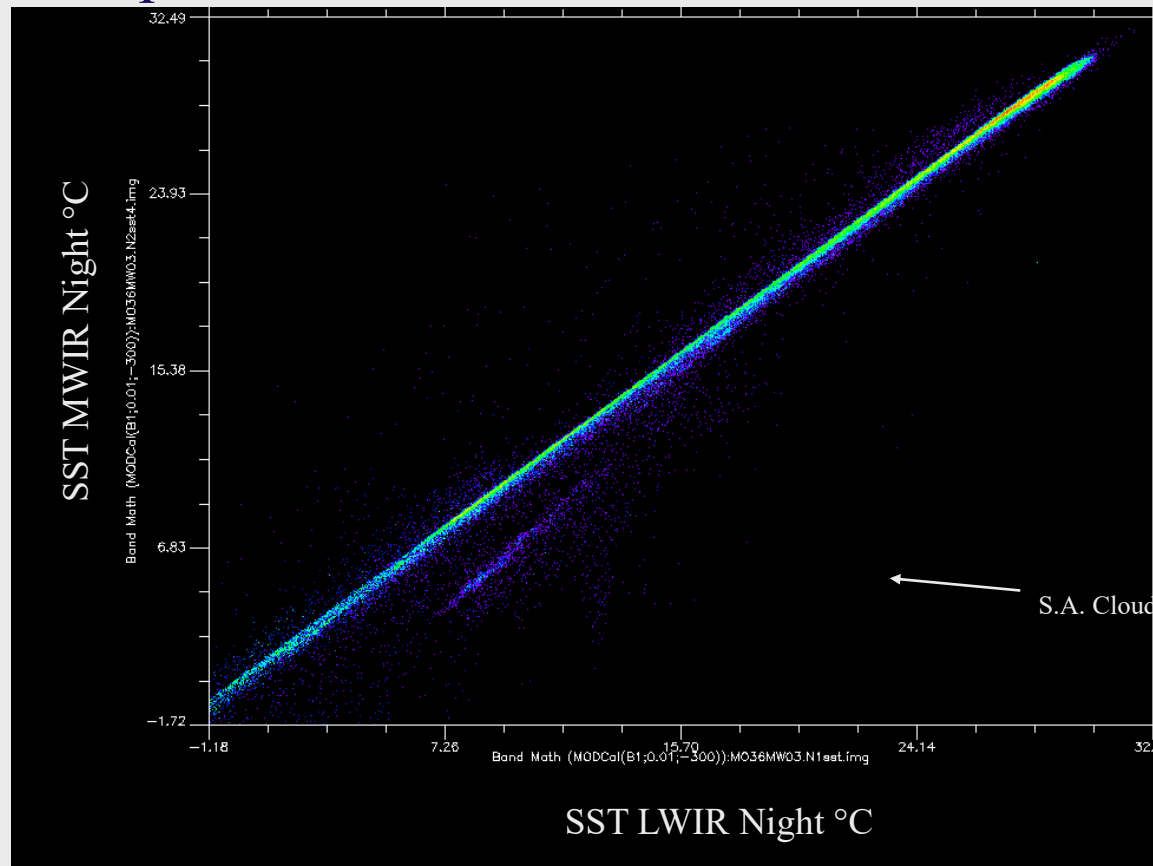
MODIS SST

- ◆ Terra v4, Global Coverage, Weekly composite, 36km
- ◆ MWIR 4 μ m, Night



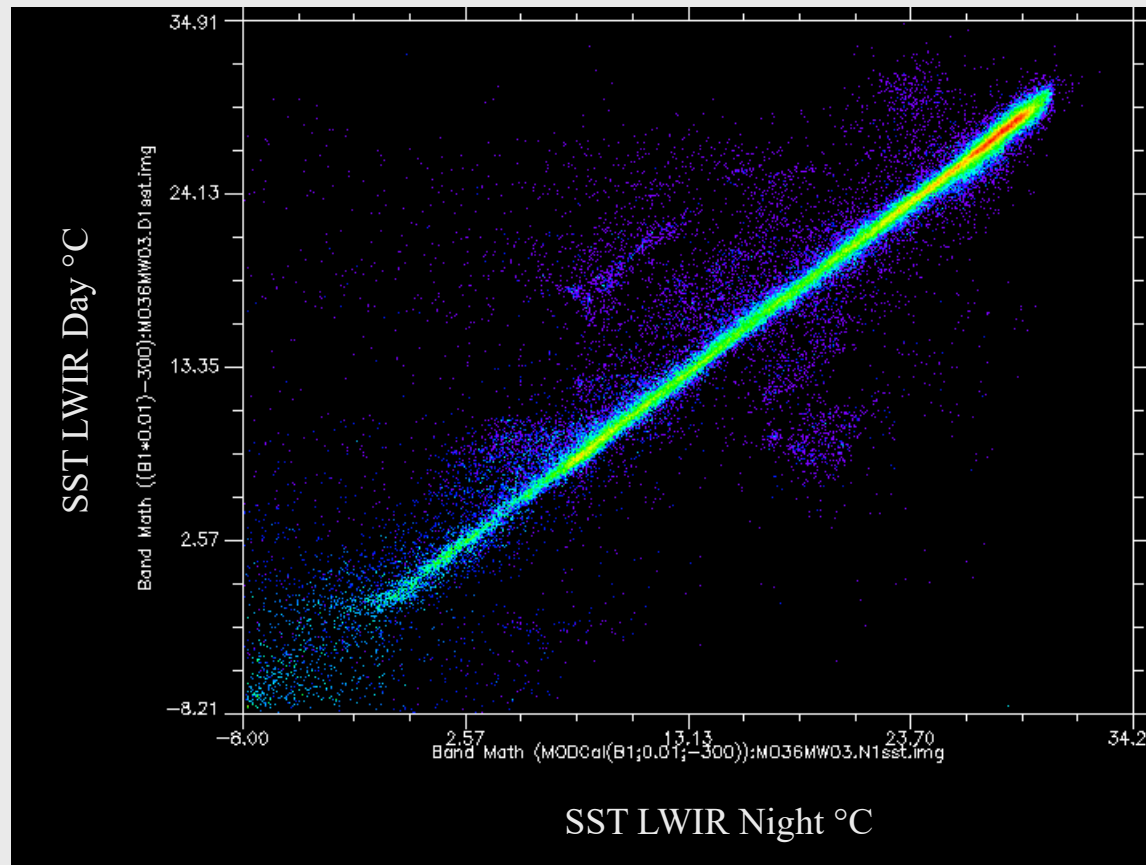
MODIS SST

- ◆ Comparison: night products
 - Seem to handle cloud differently (slightly); Quality flags are important



MODIS SST

- ◆ Comparison: day and night products
 - Slight difference in temperatures--spread of points

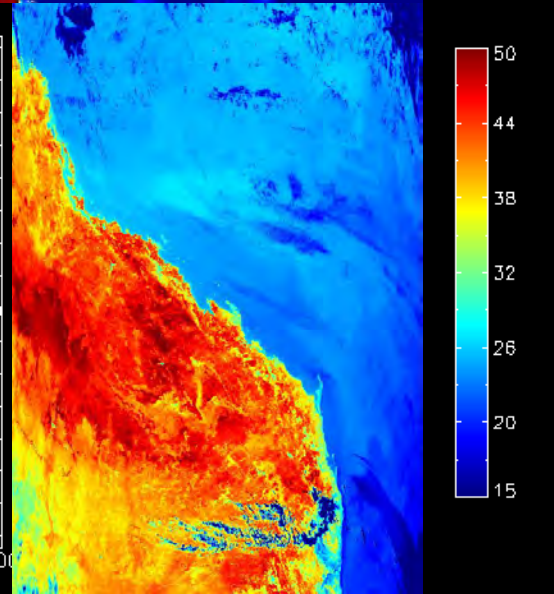
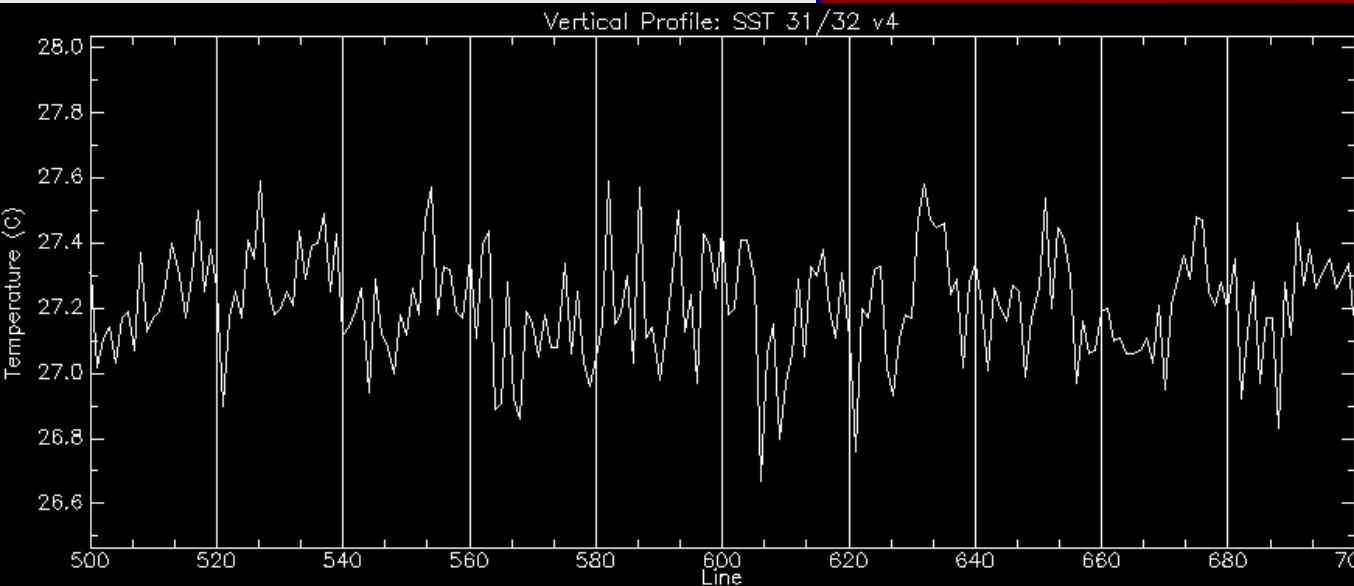
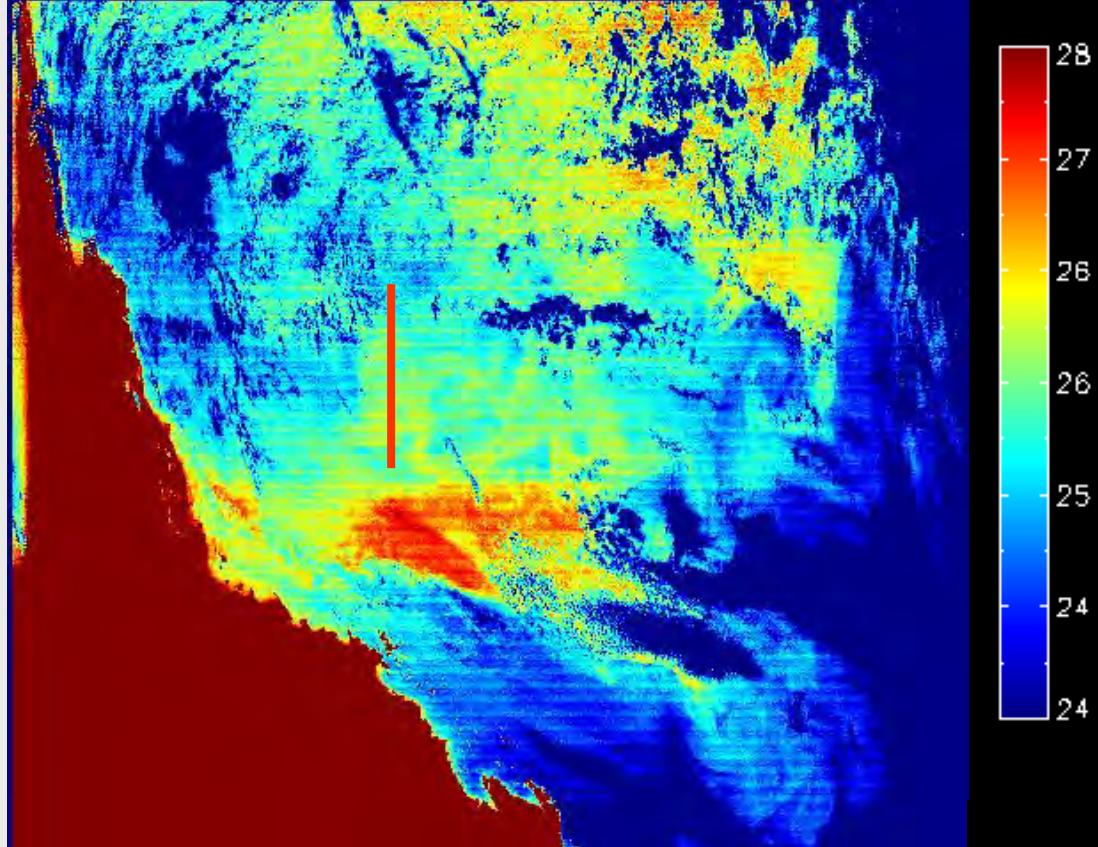


MODIS SST

◆ MOD28L2

NLSST, Bands 31/32

Queensland, 20th October
2002

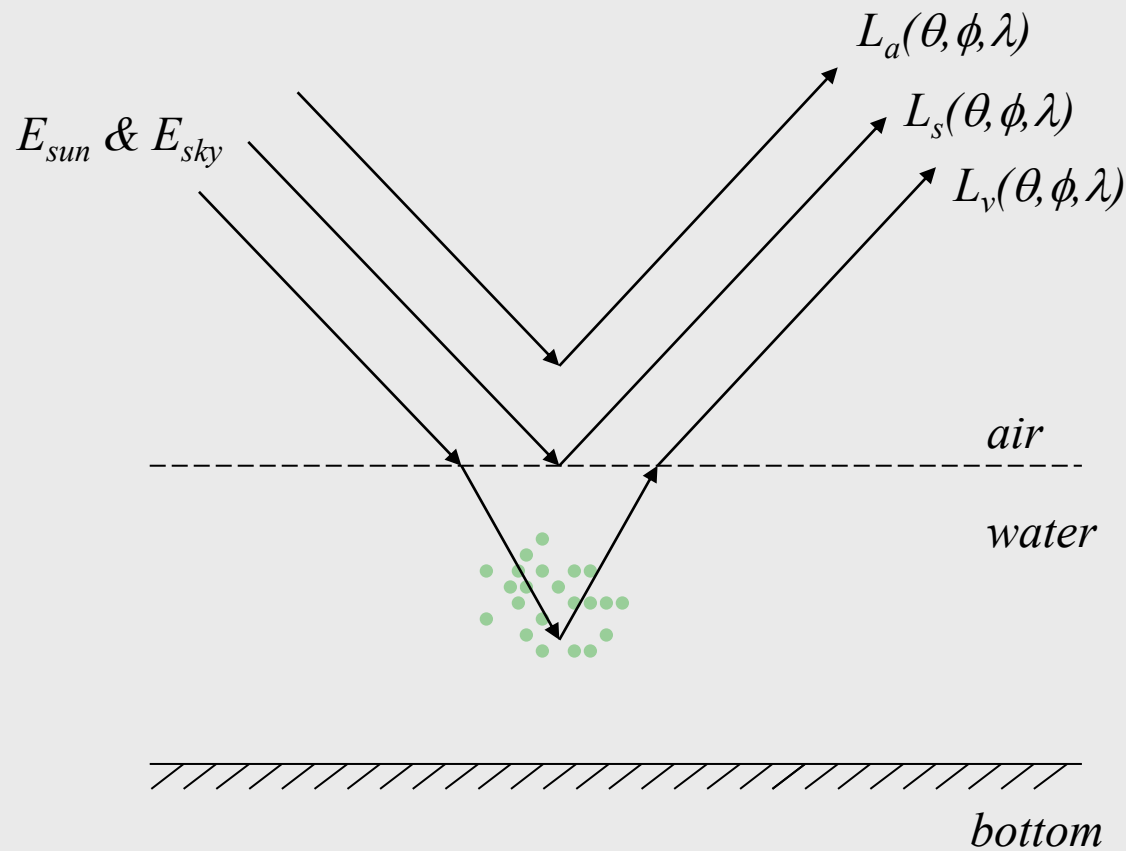


Ocean Colour

- ◆ The colour of the ocean gives an indication of the concentration of its optical constituents.
- ◆ In Case 1 waters the main constituent influencing the ocean colour is phytoplankton—the absorption by pigments such as the green pigment chlorophyll-a.
 - The higher the concentration of phytoplankton the greener the water. If little phytoplankton is present, then the water will appear blue.
- ◆ In Case 2 waters (generally shallow, coastal waters) other constituents (such as coloured dissolved organic matter) influence the colour.

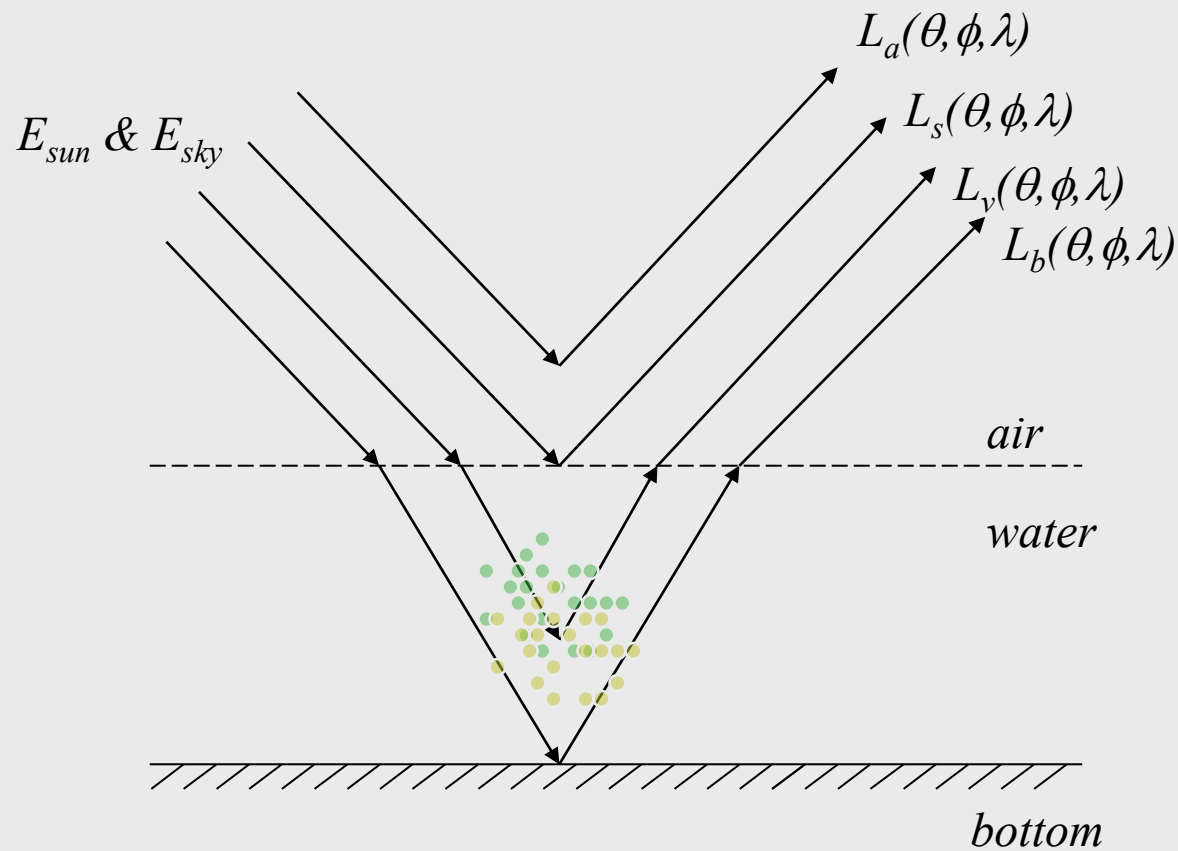
Ocean Colour

- ◆ Water leaving radiance: Case 1
 - Need to remove the influence of the atmosphere
 - Atmospheric correction (H.R. Gordon and M. Wang)

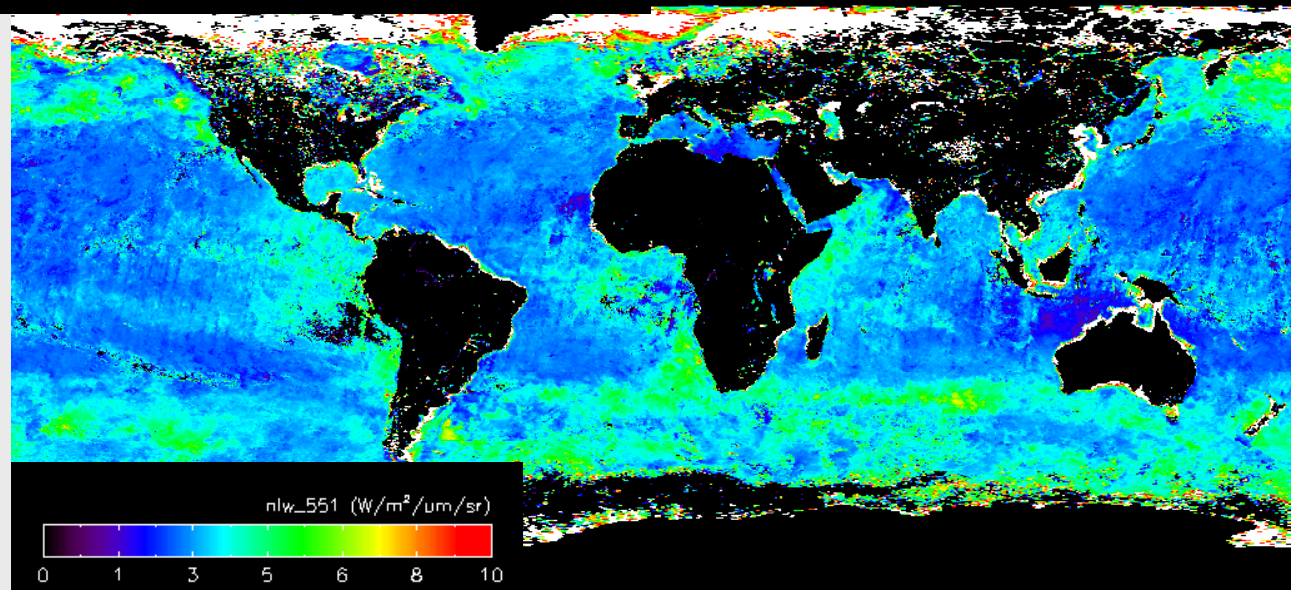
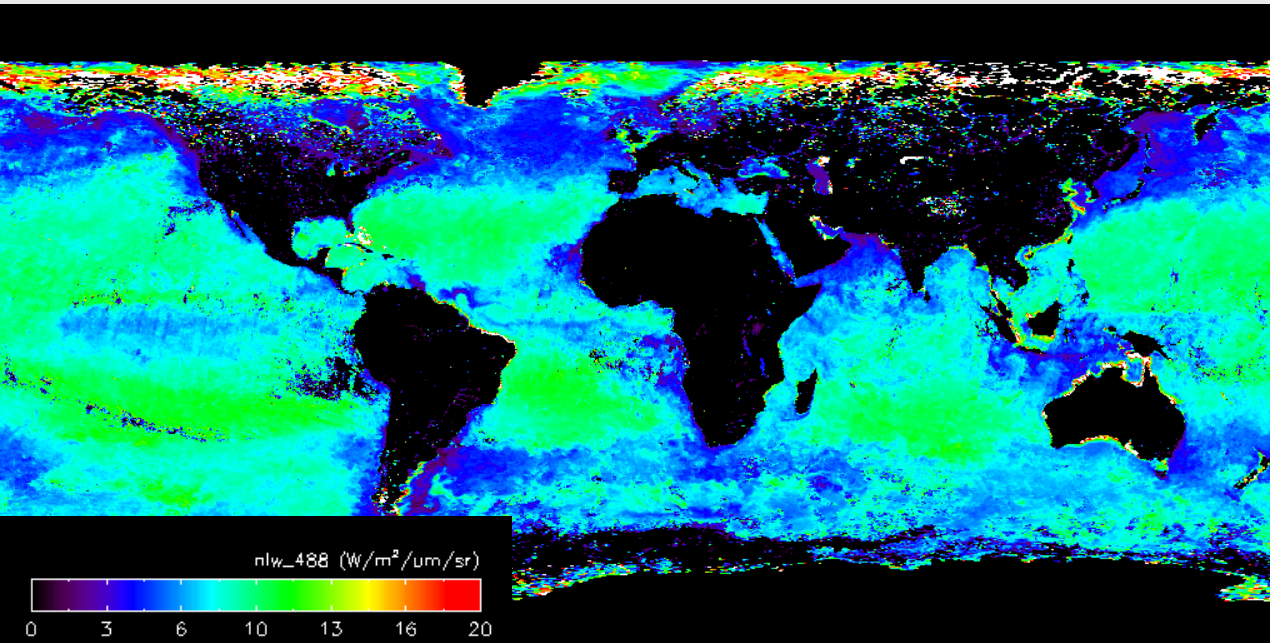


Ocean Colour

- ◆ Water leaving radiance: Case 2
 - Need to remove the influence of the atmosphere
 - Atmospheric correction (H.R. Gordon and M. Wang)



MODIS Water Leaving Radiance



Ocean Colour

◆ Algorithms

- General form:

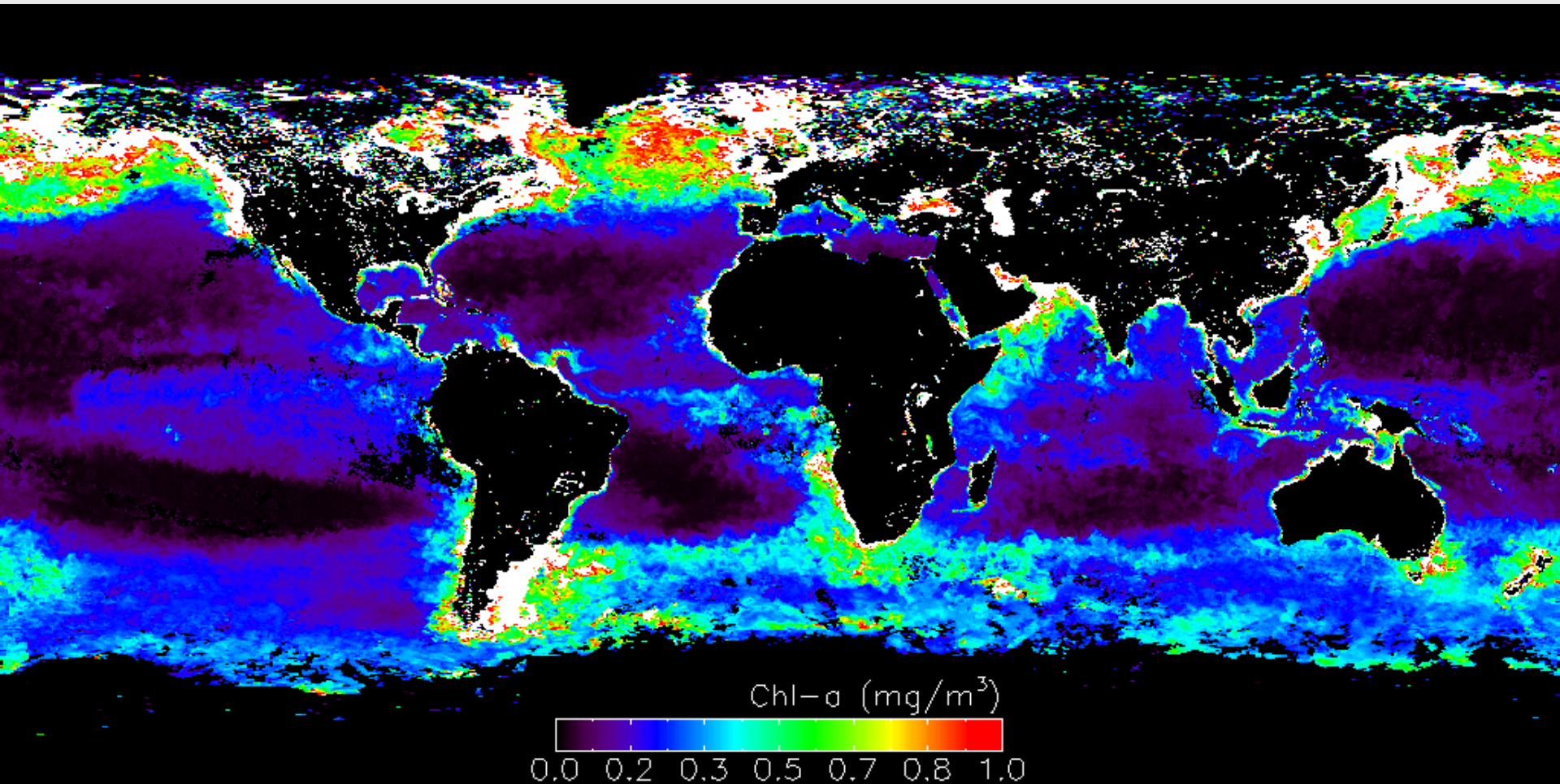
$$\log(\text{Product}) = A(\log X)^3 + B(\log X)^2 + C(\log X) + D / E$$

$$X = \frac{(e)L_{wn}(443) + (f)L_{wn}(488) + (g)L_{wn}(531)}{L_{wn}(555)}$$

- MODIS chl-a
- MODIS Diffuse Attenuation Coefficient
- SeaWiFS Pigment
- CZCS Pigment

MODIS Chl-a

- ◆ Terra v4, Global Coverage, Weekly composite, 36km
- ◆ Clark HPLC, empirical

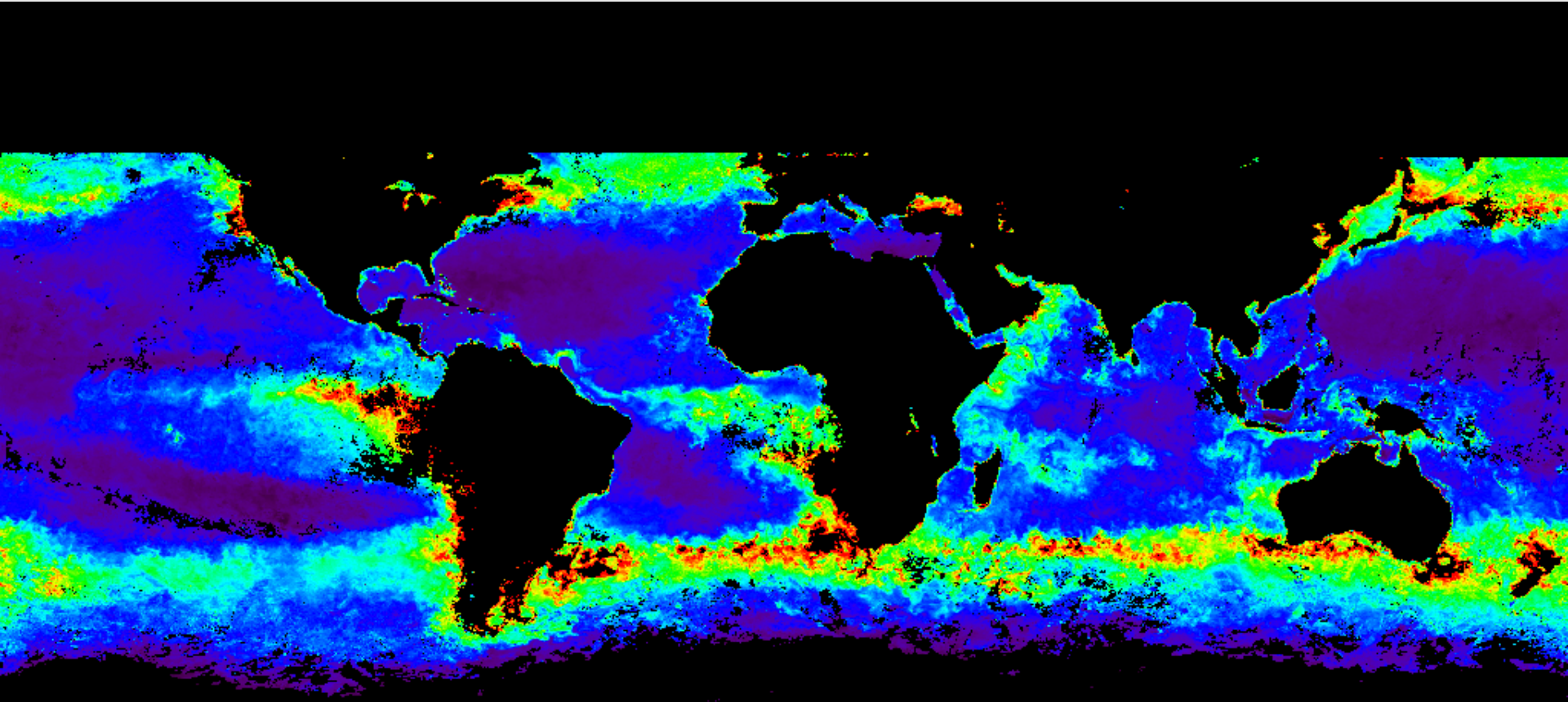


New / Improved MODIS Products

- ◆ Fluorescence
 - Fluorescence Line height, Base, Efficiency
- ◆ Suspended solids concentration
- ◆ Coccolithophore concentration
- ◆ Phycoeryth concentration
- ◆ Instantaneous Photosynthetically Available Radiation
- ◆ Radiation absorbed by phytoplankton
- ◆ Total absorption (412,443,488,531,551)
- ◆ Phytoplankton primary production

MODIS: Primary Production

- ◆ Terra v4, Global Coverage, Weekly composite, 36km
- ◆ VGPM (Behrenfeld and Falkowski)

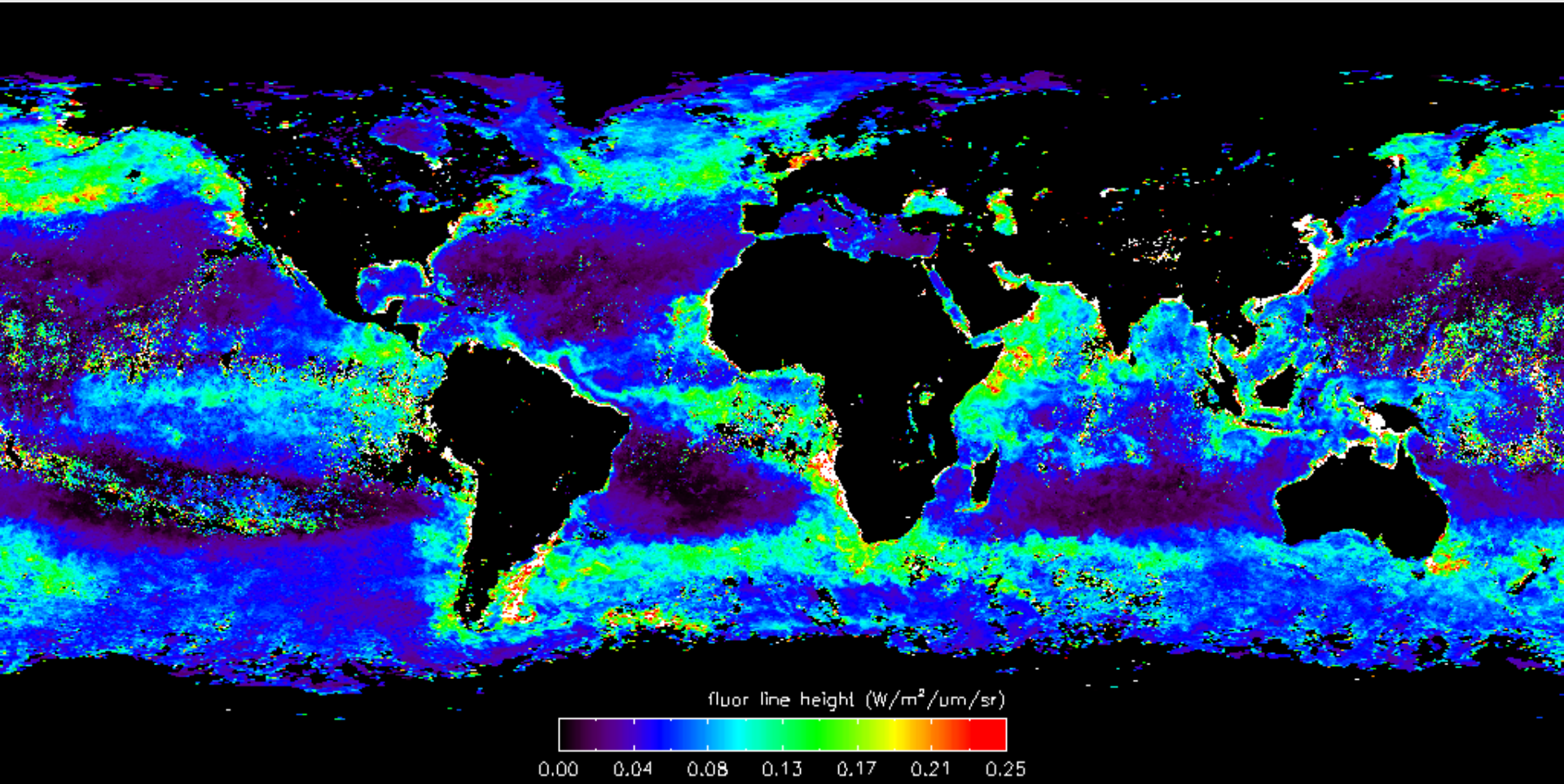


New / Improved MODIS Products

- ◆ Fluorescence
- ◆ Suspended solids concentration
- ◆ Coccolithophore concentration
- ◆ Instantaneous Photosynthetically Available Radiation
- ◆ Radiation absorbed by phytoplankton
- ◆ Total absorption (412,443,488,531,551)
- ◆ Phytoplankton primary production
- ◆ ...

MODIS: Fluorescence Line Height

- ◆ Terra v4, Global Coverage, Weekly composite, 36km

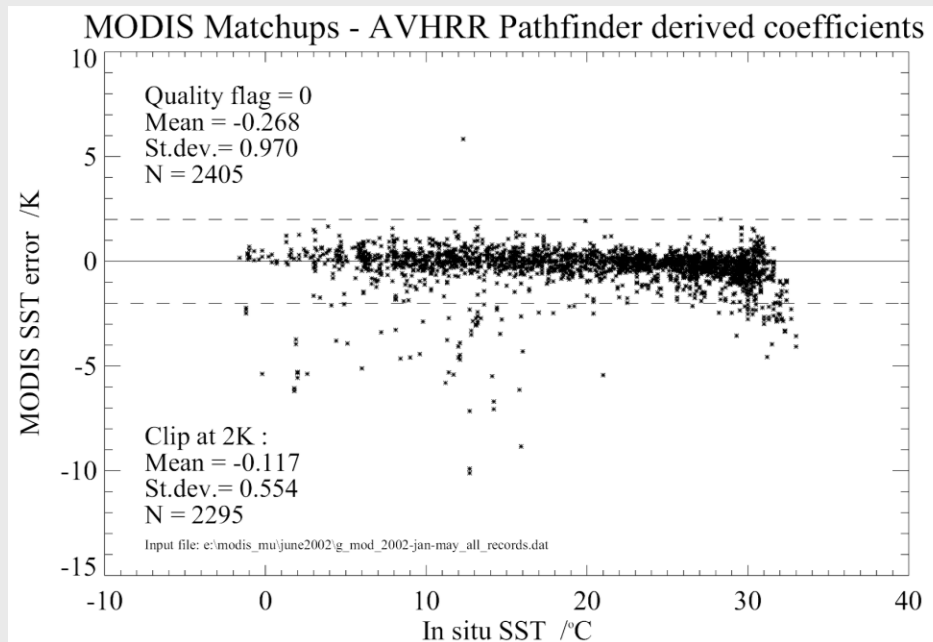


Validation

- ◆ MODIS ocean products need to be validated and refined
 - Ensure atmospheric correction is being performed correctly
 - Check algorithm coefficients, algorithm performance
- ◆ Instruments Required
 - SST: Thermometers, Radiometers
 - Chl-*a*: HPLC Analysis, Profiling Spectroradiometers, Hyperspectral radiometers
 - Other sensors (AVHRR, SeaWiFS)
 - These instruments / sensors need to be characterised before they can be used to validate the MODIS products

Validation: RSMAS SST

- ◆ MODIS matchups with insitu data
 - Average difference is -0.117°C (2295/2405 samples)

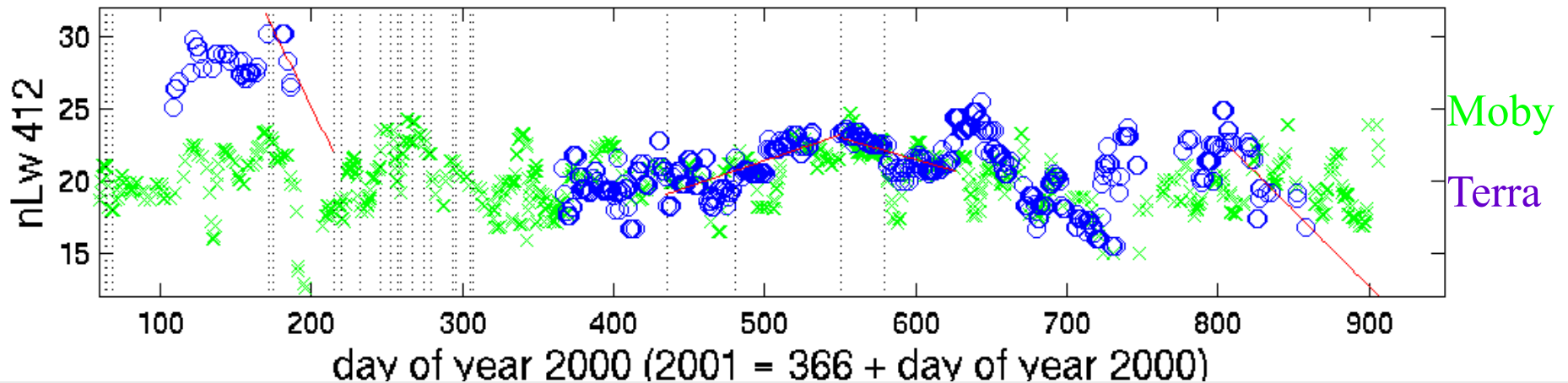


- ◆ P. J. Minnett, R. H. Evans, E. J. Kearns, O. B. Brown
Rosenstiel School of Marine and Atmospheric Science
University of Miami

Validation: RSMAS OC

- ◆ MODIS matchups with MOBY data
 - Marine Optical Buoy

nLw 412 mode time series (bias = 6.2%, std = 14.2%)



- ◆ R. H. Evans, E. J. Kearns, H. R. Gordon, K. Voss, D. Clark
Rosenstiel School of Marine and Atmospheric Science
University of Miami

Validation of the MODIS Chl-a Product

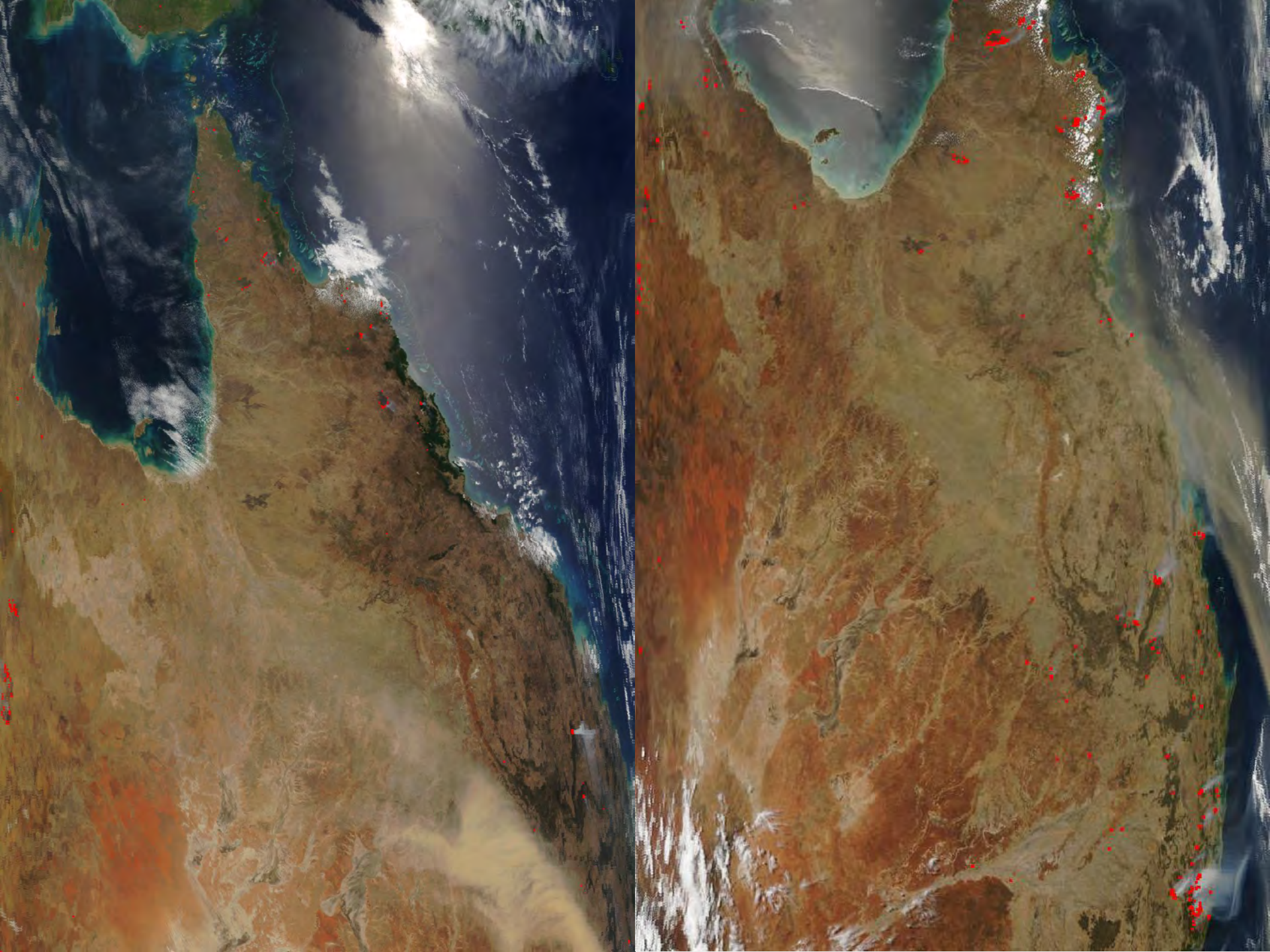
◆ Townsville Voyage

– 21-30 October, RV Lady Basten

- CSIRO Marine Research (Hobart)
- CSIRO Land and Water (Canberra)
- Australian Institute of Marine Science (Townsville)
- Curtin University (Perth)

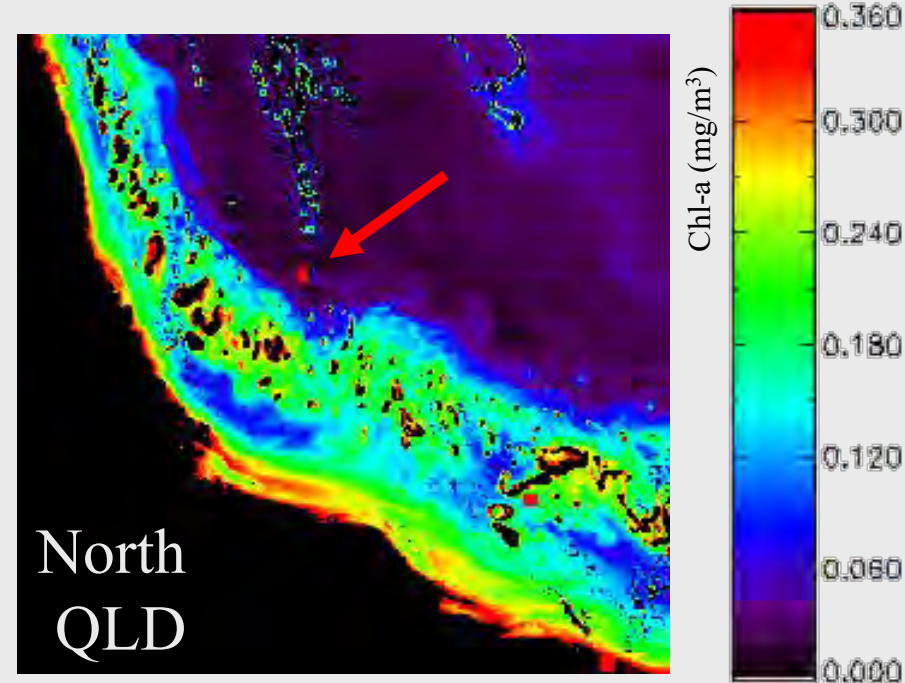
◆ Measurements / Sampling

– Water samples taken at multiple depths at all (daytime) stations for High Performance Liquid Chromatography (HPLC) analysis.

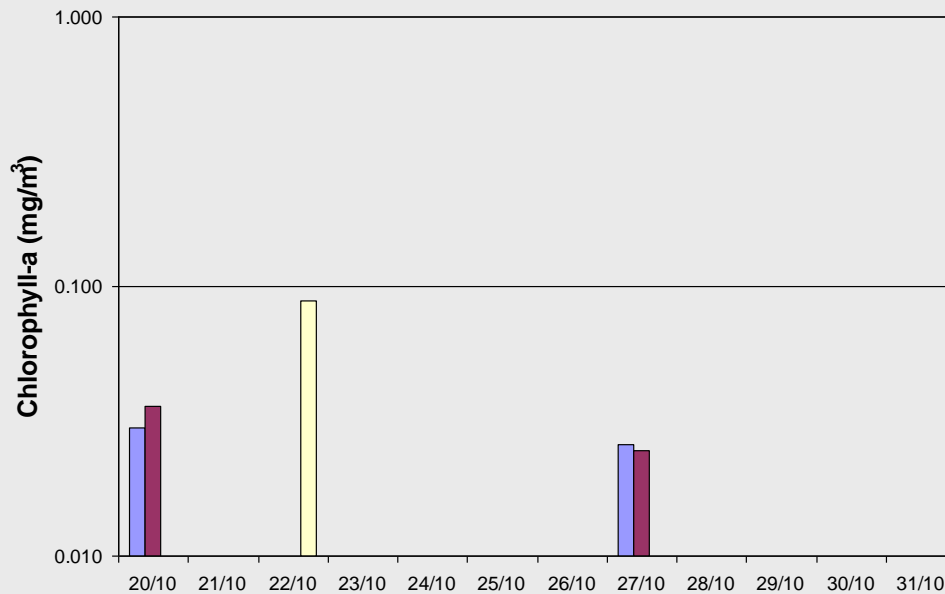


SAT005: Chl-*a*

- ◆ Deep water (100m)
- ◆ Assumed to be Case 1 waters



In situ and Satellite Comparison

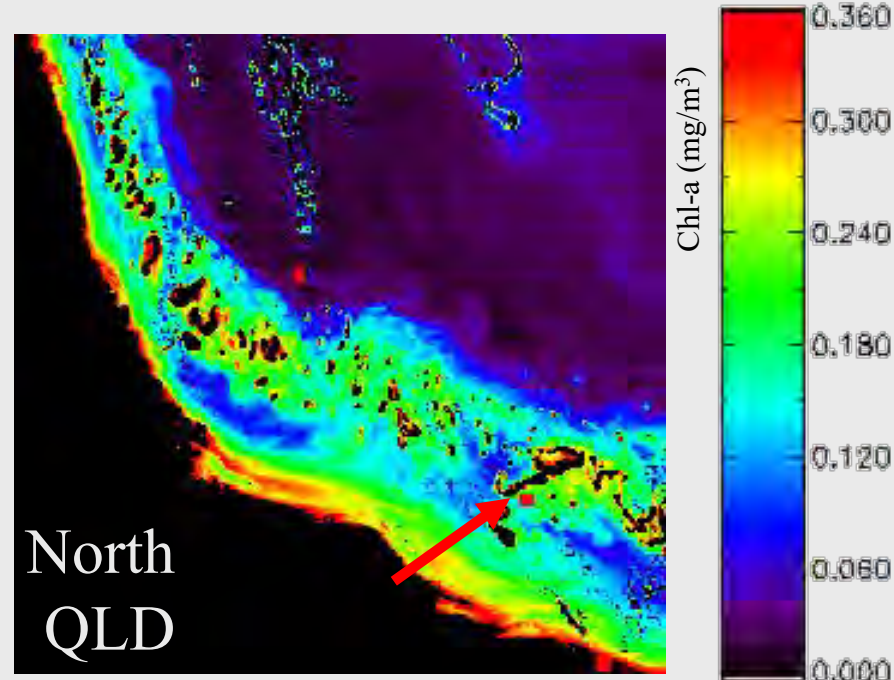


Date	SAT005	SAV005	HPLC005
20-Oct-02	0.030	0.036	
21-Oct-02			
22-Oct-02			0.089
23-Oct-02			
24-Oct-02			
25-Oct-02			
26-Oct-02			
27-Oct-02	0.026	0.025	
28-Oct-02			
29-Oct-02			
30-Oct-02			
31-Oct-02			

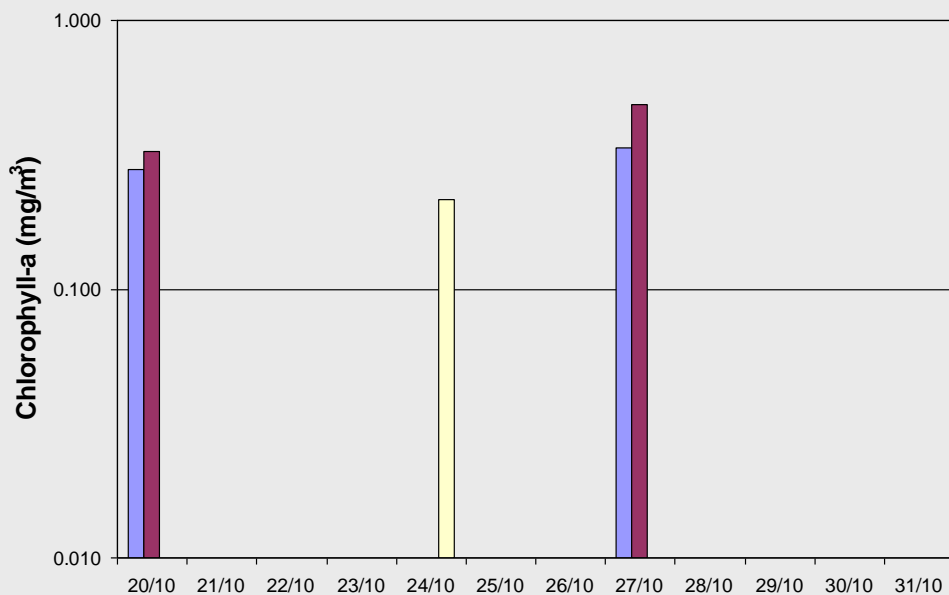
HPLC analysis: Lesley Clementson (CSIRO Marine Research)

SAT009: Chl-*a*

- ◆ Shallow water (30m)
- ◆ Near reef



In situ and Satellite Comparison

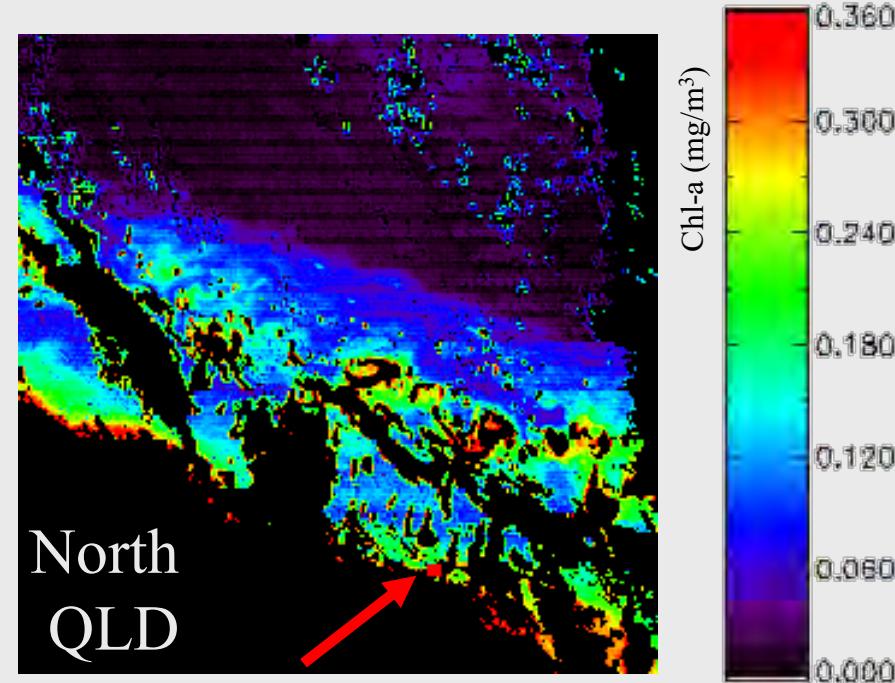


Date	SAT009	SAV009	HPLC009
20-Oct-02	0.278	0.326	
21-Oct-02			
22-Oct-02			
23-Oct-02			
24-Oct-02			0.215
25-Oct-02			
26-Oct-02			
27-Oct-02	0.336	0.487	
28-Oct-02			
29-Oct-02			
30-Oct-02			
31-Oct-02			

HPLC analysis: Lesley Clementson (CSIRO Marine Research)

SAT024: Chl-*a*

- ◆ Shallow water (10m)
- ◆ Near shore – Case 2 waters



In situ and Satellite Comparison

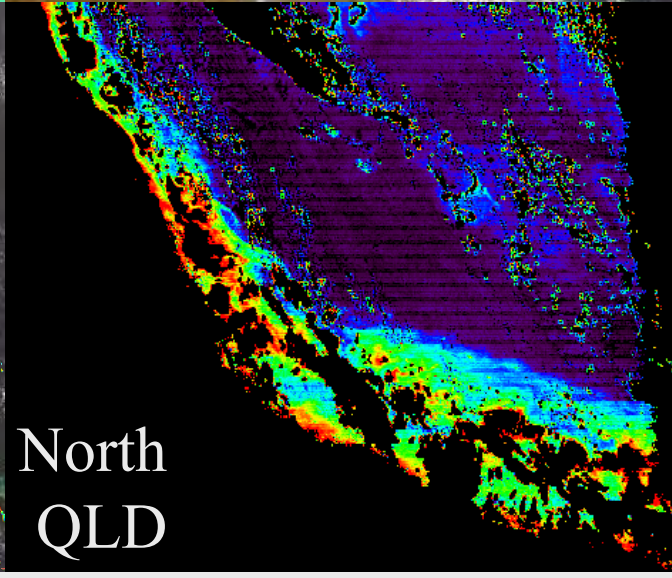
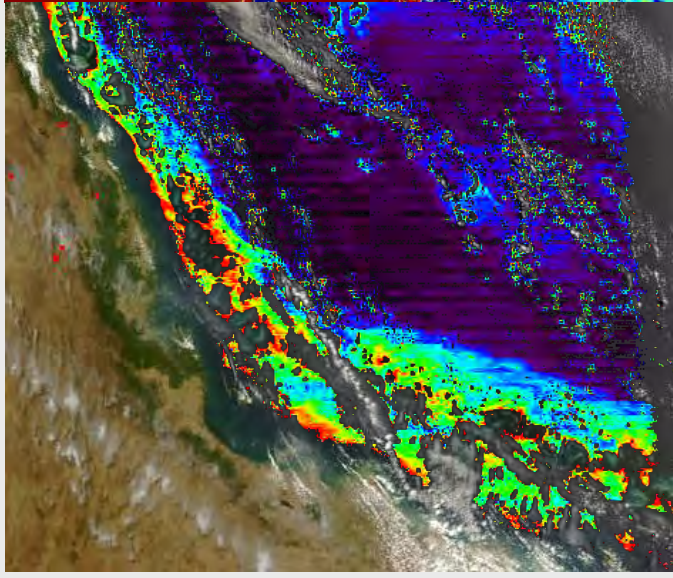
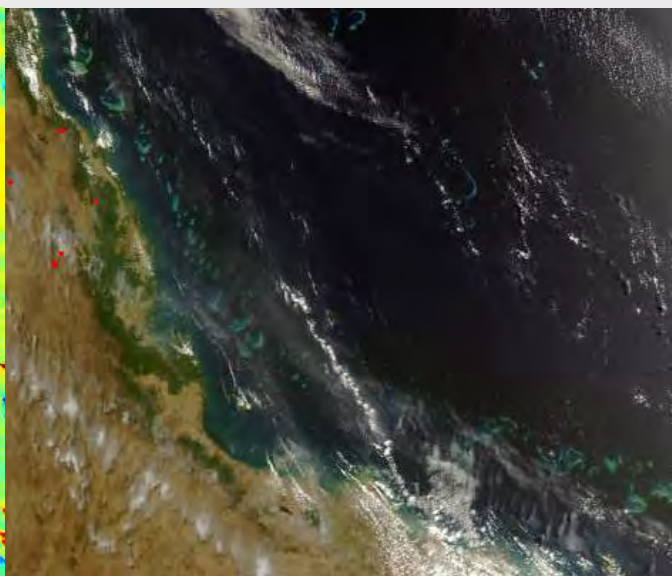
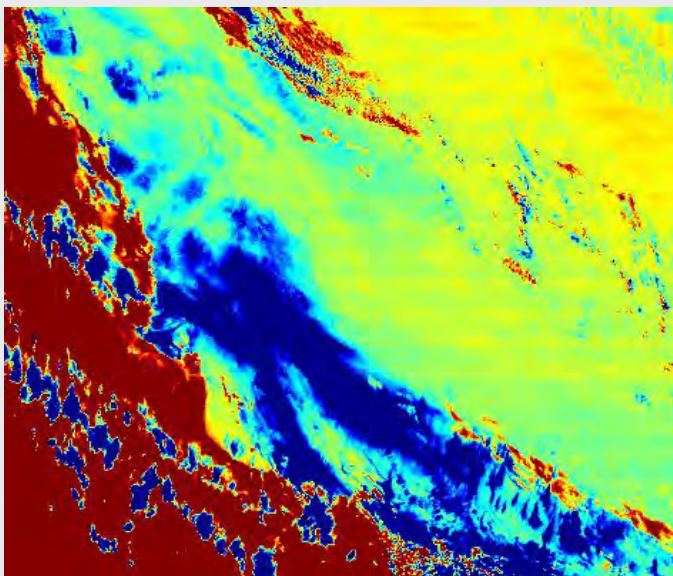
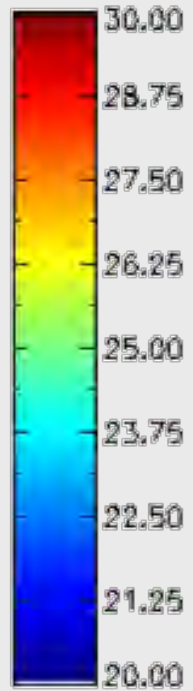


Date	SAT024	SAV024	HPLC024
20-Oct-02	0.730	0.682	
21-Oct-02			
22-Oct-02	0.768	0.869	
23-Oct-02			
24-Oct-02			
25-Oct-02			
26-Oct-02			
27-Oct-02	0.420	0.382	
28-Oct-02			
29-Oct-02			0.583
30-Oct-02			
31-Oct-02			

HPLC analysis: Lesley Clementson (CSIRO Marine Research)

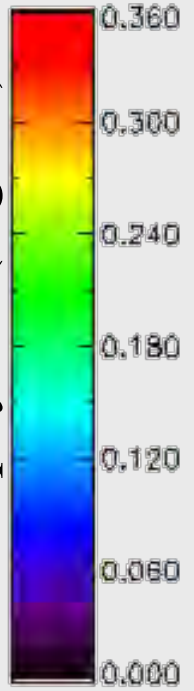
TIR SST (v4)

Temperature (°C)



North
QLD

Chlorophyll-a (mg/m³)



MODIS Chl-*a* (v4)

Obtaining Data

- ◆ True Colour Imagery
 - MODIS Land Rapid Response System
- ◆ Level 1B
 - GSFC DAAC
 - WASTAC/DOLA, TERSS, GA, CSIRO
- ◆ Level 2
 - GSFC DAAC
 - MQABI



Land Rapid Response System

[Home](#)[Design](#)[Gallery](#)[Real-Time](#)[Products](#)[Links](#)[Contacts](#)

Near-Real-Time Level-2 Browse

Search a specific date:

November 2002

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1 305	2 306
3 307	4 308	5 309	6 310	7 311	8 312	9 313
10 314	11 315	12 316	13 317	14 318	15 319	16 320
17 321	18 322	19 323	20 324	21 325	22 326	23 327
24 328	25 329					

October 2002

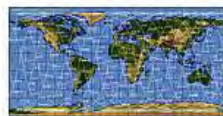
Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1 274	2 275	3 276	4 277	5 278
6 279	7 280	8 281	9 282	10 283	11 284	12 285
13 286	14 287	15 288	16 289	17 290	18 291	19 292
20 293	21 294	22 295	23 296	24 297	25 298	26 299
27 300	28 301	29 302	30 303	31 304		

September 2002

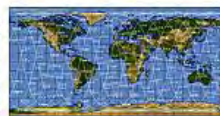
Sun	Mon	Tue	Wed	Thu	Fri	Sat

Near-Real-Time Level-2 Browse

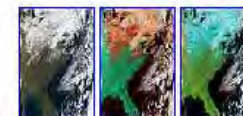
Date: 2002/328 - 11/24/02

[prev](#)[next](#)

[Terra Orbit Tracks](#)



[Aqua Orbit Tracks](#)



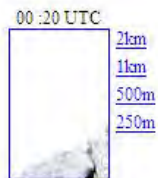
[Display true-color and false-color](#)



[MODIS Land Rapid Response site at University of Maryland](#)



Terra/MODIS



MODIS Land Rapid Response System

<http://rapidfire.sci.gsfc.nasa.gov/>

MODIS Data Support at the GES DISC-DAAC

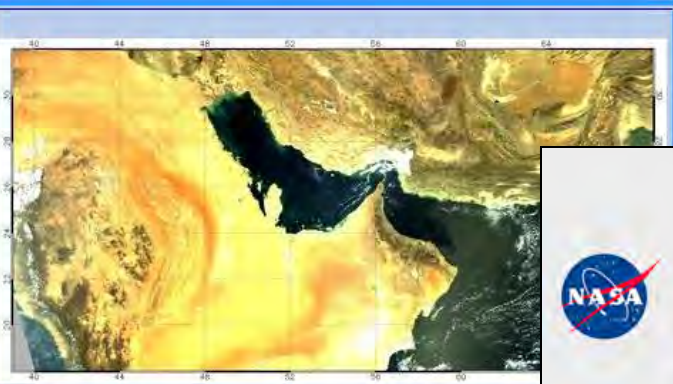
 [Data Ordering](#)

 [Data Products](#)

 [Tools & Services](#)

 [Documentation](#)

 [Contacts](#)



MDST Home
[MDST Home](#)
[MDST Site Map](#)
[Aqua](#)
[Terra](#)

The power of Terra and Aqua flying in formation is demonstrated by this combined true color MODIS image, from September 16, 2002. MODIS/Terra passed over the Gulf of Oman at 6:50 (GMT), and later MODIS/Aqua passed over the Persian Gulf making it possible to combine the two overpasses into a single image. Thus, both platforms allow for unprecedented daily coverage. In the near future users will be able to view their own combined products, similar to the one above, for high resolution parameters such as Sea Surface Temperatures, chlorophylls, aerosol concentrations, etc. The above image was created using [SIMA](#)

To access the MODIS/Terra and MODIS/Aqua informational pages, click on the images below:

MODIS User Services: Phone: 301-614-5473, Fax: 301-614-5304 -- daac_usg@gsgfscv4.gsfc.nasa.gov
 MODIS Data Support Team: modis@daac.gsfc.nasa.gov
 Web Curator: web-curator@daac.gsfc.nasa.gov
 Responsible NASA Official: Steve Kempler, DAAC Manager -- kempler@daac.gsfc.nasa.gov

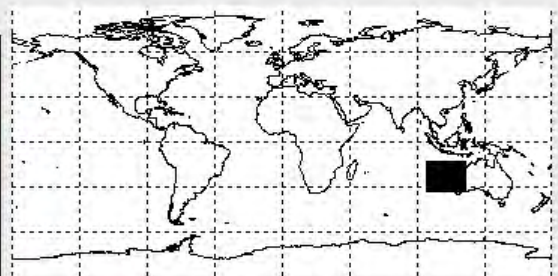
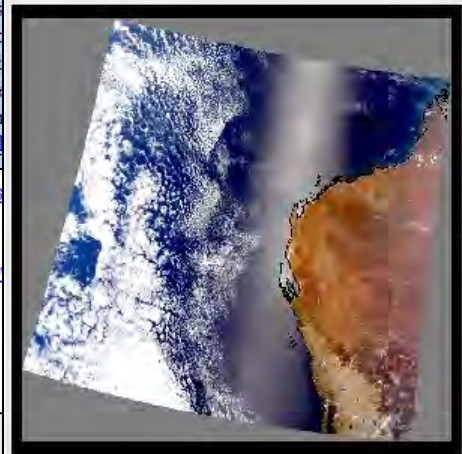
Page Author: [Dana Ostrenga](#)

Last modified: Wed Nov 20 15:17:56 EST 2002



MODIS MOD02SSH
 Browse Image and Coordinates for
 2002-NOV-20 02:50:00 to 2002-NOV-20 02:55:00

[Advanced Text Search](#)



Browse Image Corner Coordinates

No	Latitude	Longitude
1	-12.5092	102.5531
2	-15.6160	123.8496
3	-33.6166	121.2554
4	-30.0496	96.7269

GSFC DAAC: MODIS Data Support Home Page

<http://daac.gsfc.nasa.gov/MODIS/>

Welcome to MODIS Oceans QA Browse Imagery (MQABI Browse Tool)

MQABI allows members of GSFC/QA team, scientific, and general community access to the various data products of MODIS Oceans in an organized and useful manner. Data can be viewed as either Product Series or Time Series; access to data statistics is also provided, and can be viewed as Single Product Statistics or Time Series Statistics.

Platform Selection



- Terra Collection 3
- Terra Collection 4



Note:
Terra Collection 3 uses the MQABI Version 1 interface.
Terra Collection 4 & Aqua Collection 3 use the MQABI Version 2 interface.

Created by: [Aumber Bhatti](#)
Authorized by: [Dr. Wayne Esaias](#)
Code 971, NASA Goddard Space Flight Center
[NASA SECURITY & PRIVACY STATEMENT](#)

Welcome to MQABI for Terra Collection 4

PRODUCT SERIES

<input type="checkbox"/>	Daily
<input type="checkbox"/>	Weekly
<input type="checkbox"/>	Monthly
<input type="checkbox"/>	Yearly

TIME SERIES

<input type="checkbox"/>	Daily
<input type="checkbox"/>	Weekly
<input type="checkbox"/>	Monthly

The **reprocessing** time period begins with data day October 31, 2000 to June 1, 2002.
The **forward** processing stream begins with data day June 2, 2002 and continues with current time.

Created by: [Aumber Bhatti](#)
Authorized by: [Dr. Wayne Esaias](#)
Code 971, NASA Goddard Space Flight Center
[NASA SECURITY & PRIVACY STATEMENT](#)

MQABI: MODIS (Oceans) Quality Assurance Browse Imagery

<http://jeager.gsfc.nasa.gov/browsetool/>

Weekly Product Series

PRODUCT SERIES

<input type="checkbox"/>	Daily
<input type="checkbox"/>	Weekly
<input type="checkbox"/>	Monthly
<input type="checkbox"/>	Yearly

TIME SERIES

<input type="checkbox"/>	Daily
<input type="checkbox"/>	Weekly
<input type="checkbox"/>	Monthly

Select a Week

Beginning with Day:

- Aug 5 2002 (2002217)
- Aug 13 2002 (2002225)
- Aug 21 2002 (2002233)
- Aug 29 2002 (2002241)
- Sept 6 2002 (2002249)
- Sept 14 2002 (2002257)
- Sept 22 2002 (2002265)
- Sept 30 2002 (2002273)
- Oct 8 2002 (2002281)
- Oct 16 2002 (2002289)

Select a Product:

- tot_absorb_531
- tot_absorb_551
- D1.sst
- D2.sst4
- N1.sst
- N2.sst4
- P1
- P2
- MLD
- PAR

Go

Choose either "View"
To select multiple pr
Windows: Hold down
Mac: Hold down App
UNIX: Click to select

MQABI

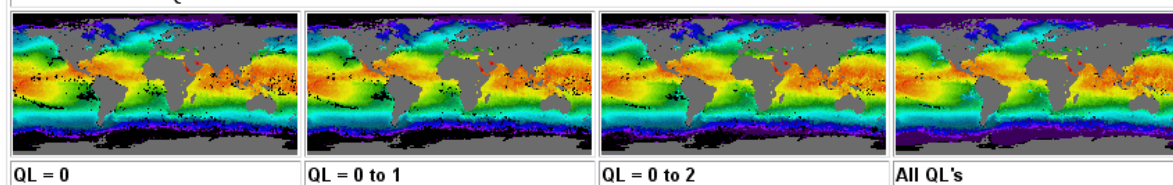
MODIS (Oceans) Quality Assurance Browse Imagery

for **TERRA** Collection 4

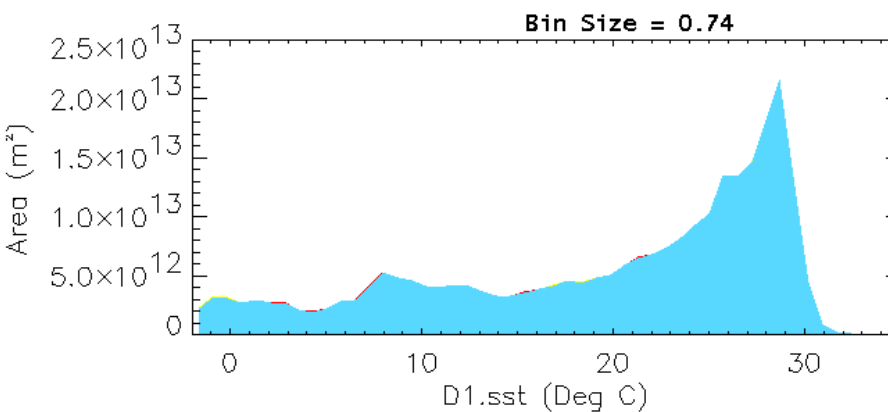
MQABI Home MQABI Terra Collection 3 MQABI Terra Collection 4 Statistics Order Help

DATA DATE:	08-Oct-2002	PRODUCTION DATE:	2002-10-24T04:21:48.000Z
RANGE:	[-2.000, 35.00]	UNITS:	Deg_C
FILE(S):	MO36MWD1.sst.ADD2002281.004.2002297042148.hdf MO36QWD1.sst.ADD2002281.004.2002297042140.hdf		

CUMULATIVE QUALITY LEVEL MAPS



Nominal Range Cumulative Quality Level Histogram of D1.sst



MQABI: MODIS (Oceans) Quality Assurance Browse Imagery

<http://jeager.gsfc.nasa.gov/browsetool/>

Satellite image archives

Satellite Remote Sensing Services (SRSS) holds a wide selection of raw and processed datasets derived from a variety of satellite sensors. Hardcopy prints and digital data products derived from these images can be viewed and/or purchased at SRSS, DOLA.

Please search our raw image archives:

Landsat TM Data

- by [search engine](#)
- by [SRSS tape number listing](#)

Landsat MSS Data

- by [SRSS tape number listing](#)

SeaWiFS Data (note: imagery)

- by [date](#)
- by [search engine](#)

MODIS Data

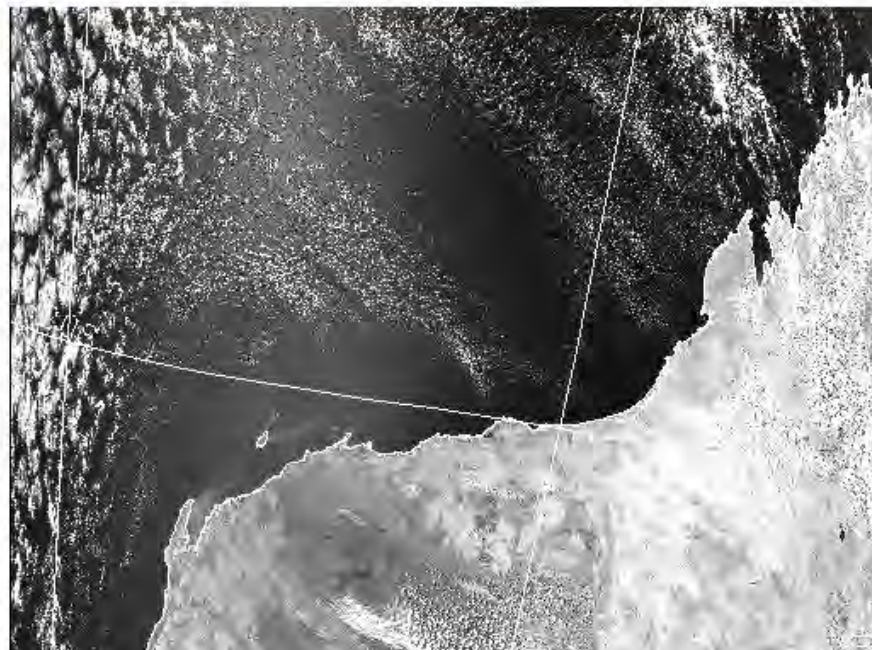
- by [date](#)

[Corporate DOLA](#)[Aerial
Photography](#)[Crown Land](#)[Available Land](#)[Map Products](#)[Names &
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DOLA: Satellite Image Archives

[http://www.dola.wa.gov.au/home.nsf/\(FrameNames\)/Satellite+Images](http://www.dola.wa.gov.au/home.nsf/(FrameNames)/Satellite+Images)

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