

# Comparison of MODIS and SeaWiFS Chlorophyll Products: **Collection 4 Results**

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The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) was launched in August 1997. It continues to operate and produce ocean color and land color data. Earlier this month, the entire data set was reprocessed for the 4<sup>th</sup> time.



# Comparison of MODIS and SeaWiFS Chlorophyll Products: **Collection 4 Results**

- MODIS Oceans: Collection 4  
began June 2, 2002
- SeaWiFS: Reprocessing V.4  
as of July 9, 2002

## MODIS Chlorophylls:

- Chlor\_MODIS (MOD19: Dennis Clark)
- Chlor\_a\_2 (MOD21: Janet Campbell)
- Chlor\_a\_3 (MOD21: Ken Carder)

## SeaWiFS Chlorophyll:

- OC4.v4 John E. O'Reilly  
(NASA TM 2000-206892, Vol. 11)

# Why so many MODIS chlorophylls? What's the difference?

Originally there were 2 algorithms:

- “Case 1” waters: Chlor\_MODIS (Clark)

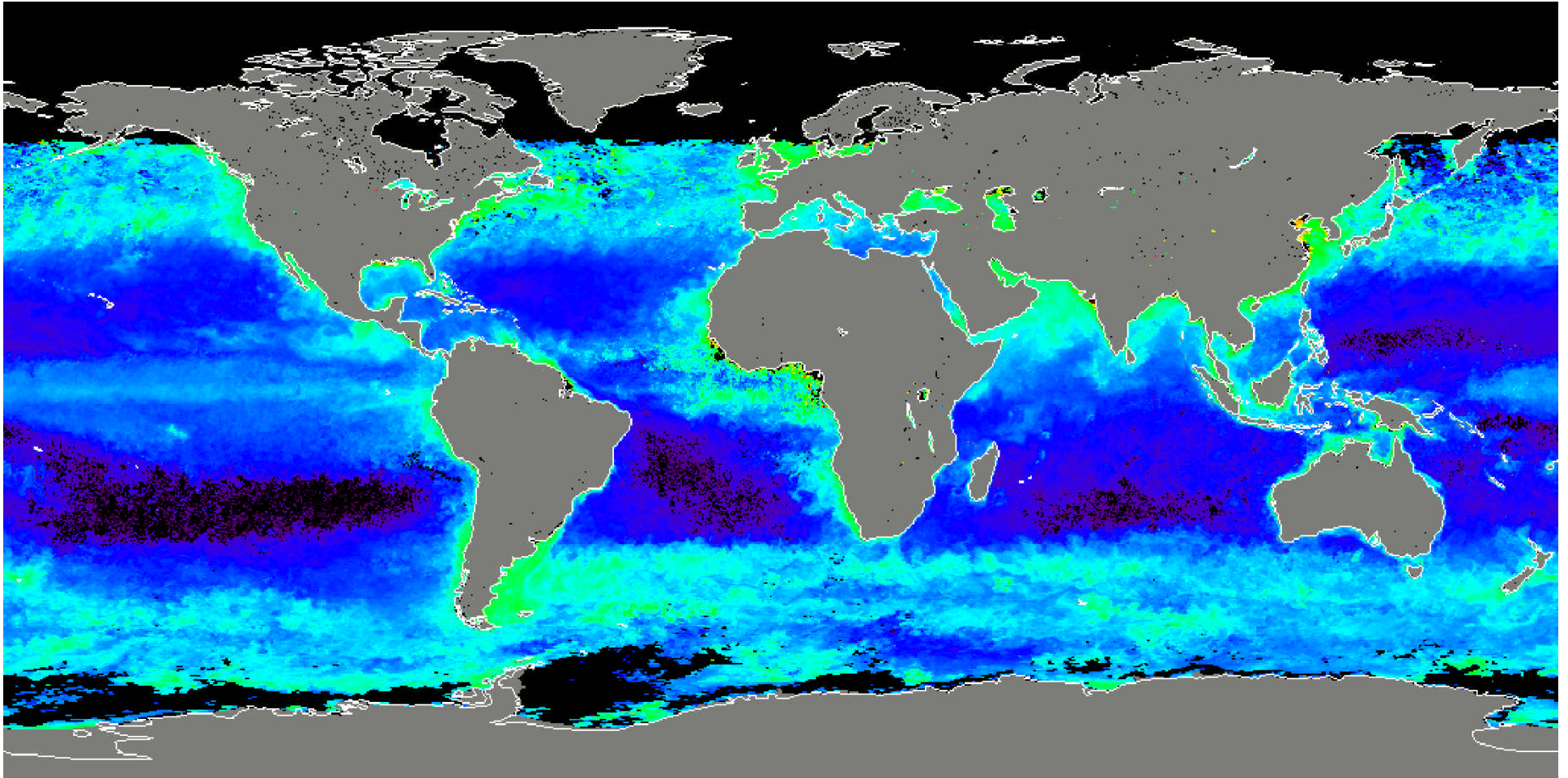
This is an empirical algorithm based on a statistical regression between chlorophyll and radiance ratios.

- “Case 2” waters: Chlor\_a\_3 (Carder)

This is a semi-analytic (model-based) inversion algorithm. This approach is required in optically complex “case 2” (coastal) waters.



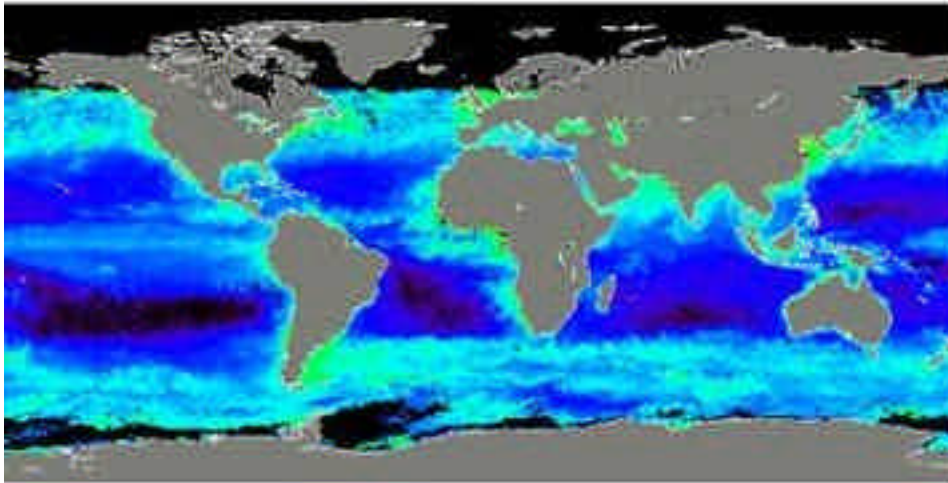
## Chlor\_MODIS December 2000 (Collection 3)



This algorithm was based on regression involving HPLC chlorophyll(s).  $n=93$ ,  $r^2=0.915$ , std error of estimate = 0.047.

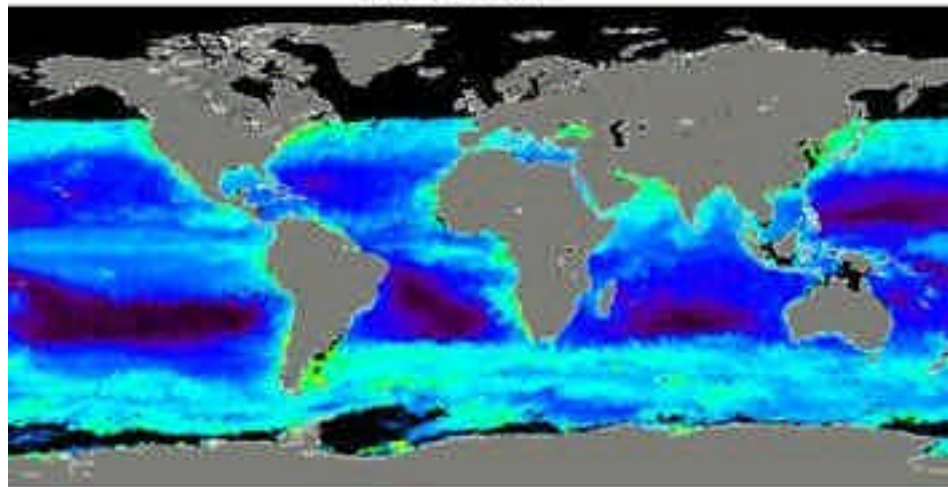
## Chlor\_MODIS (Dennis Clark): December 2000

Chlor\_modis



Collection 3: Based on 443 to 551 band ratio... analogous to CZCS algorithm.

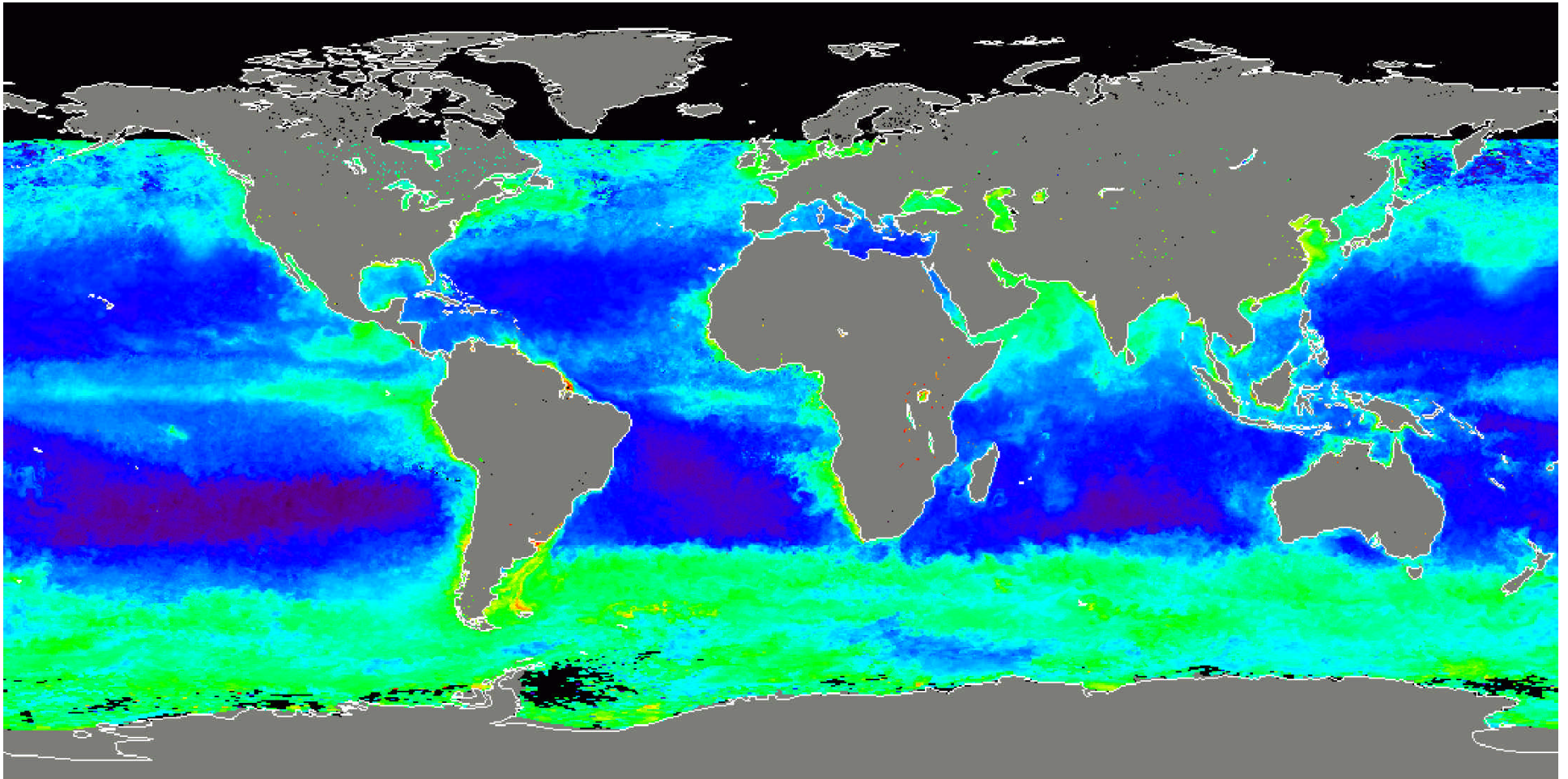
chlor\_MODIS



Collection 4: Based on ratio  $443 + 488$  to 551.



## Chlor\_a\_3 December 2000 (Collection 3)

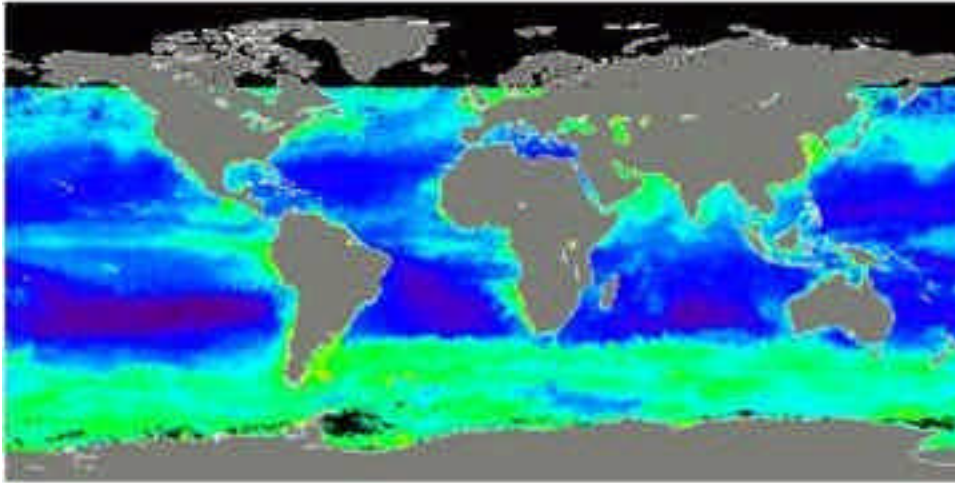


This “semi-analytic” algorithm accounts for pigment packaging effects in nutrient-replete and nutrient-deplete conditions.



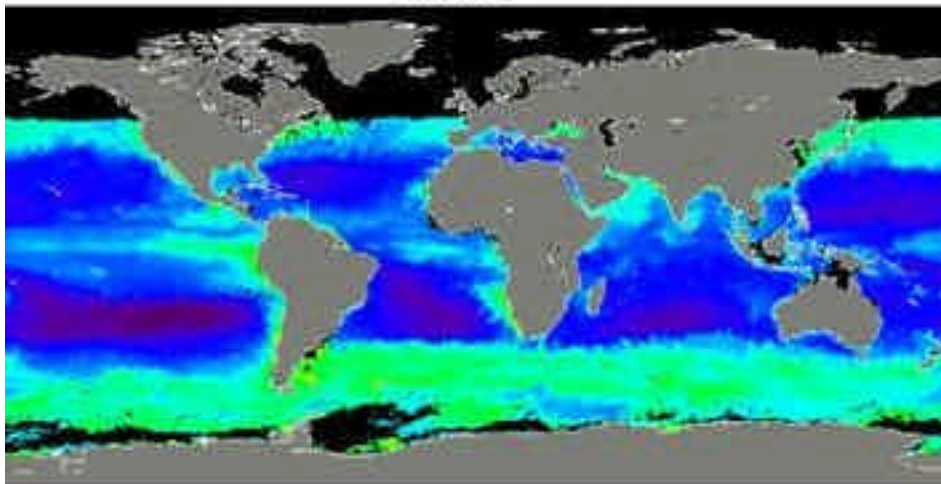
## Chlor\_a\_3 (Ken Carder): December 2000

Chlor\_a3



Collection 3: Used Reynolds SST to determine nutrient deplete/replete status

chlor\_a3



Collection 4: Uses MODIS SST (daytime 11-12  $\mu\text{m}$ ) to determine nutrient deplete/replete status.

More recently a 3<sup>rd</sup> algorithm was added:

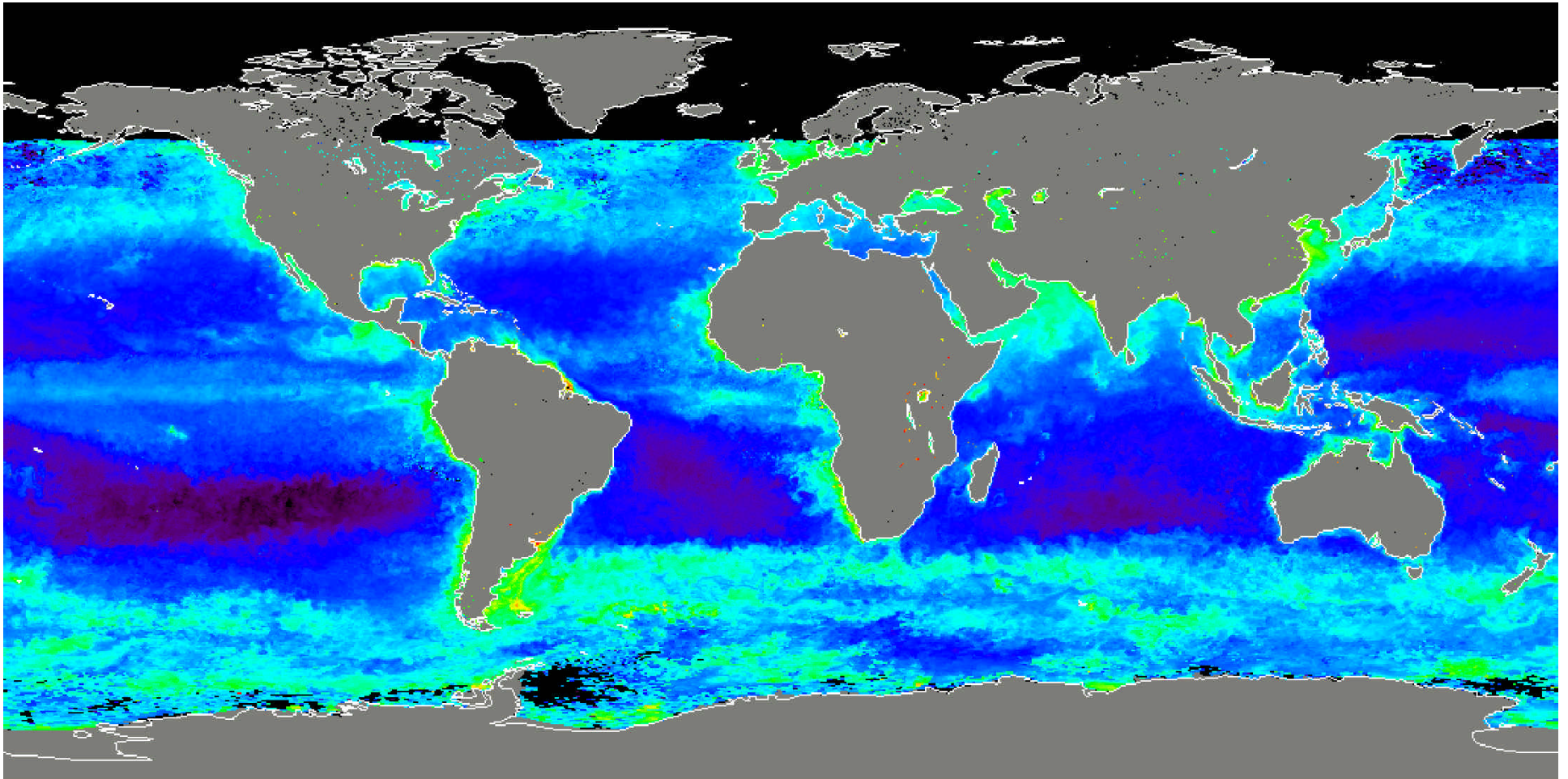
- “SeaWiFS-analog” Chlor\_a\_2 (Campbell)

This is an empirical algorithm using the 443:551 and 488:551 band ratios whichever is greater.

- SeaWiFS algorithm OC4.v4 (O’Reilly)

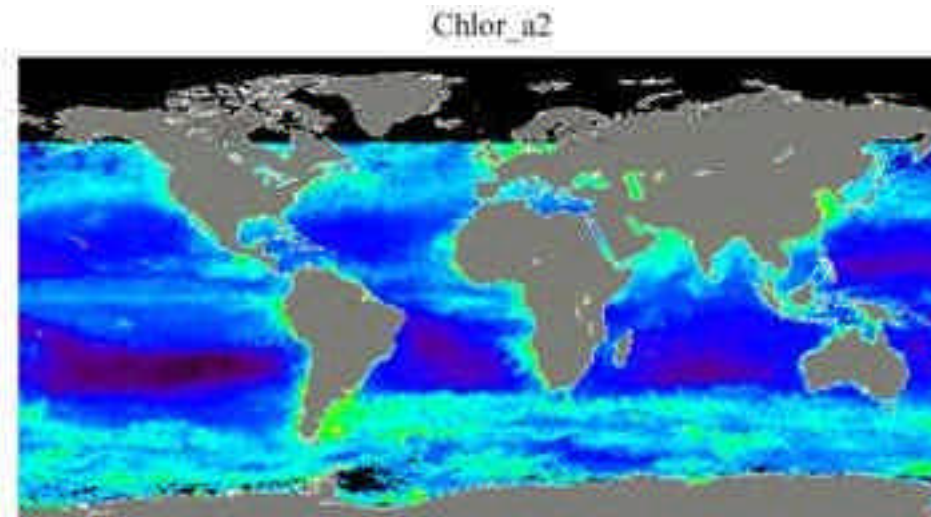
This is an empirical algorithm using the 443:555, 490:555 and 510:555 band ratios whichever is greater.

## Chlor\_a\_2 December 2000 (Collection 3)

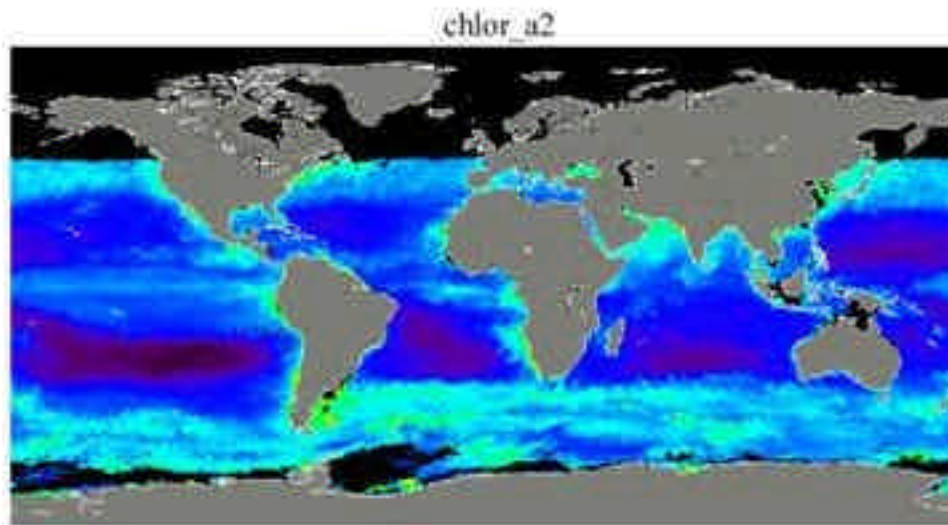


This “SeaWiFS analog” algorithm is based on the same data set used to parameterize the SeaWiFS algorithm.

## Chlor\_a\_2 (“SeaWiFS analog”): December 2000



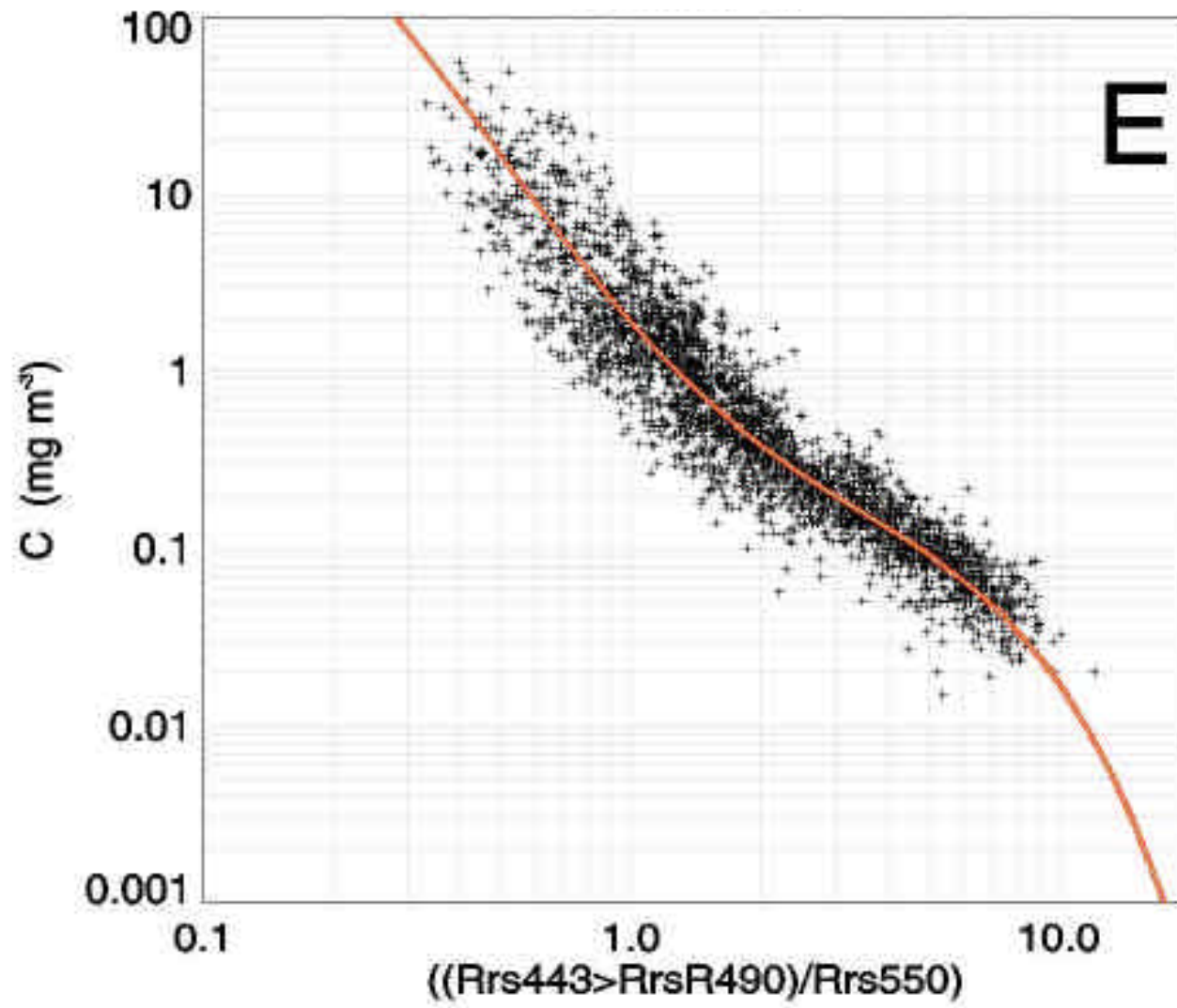
Collection 3: Used OC3M algorithm developed by Jay O'Reilly et al.

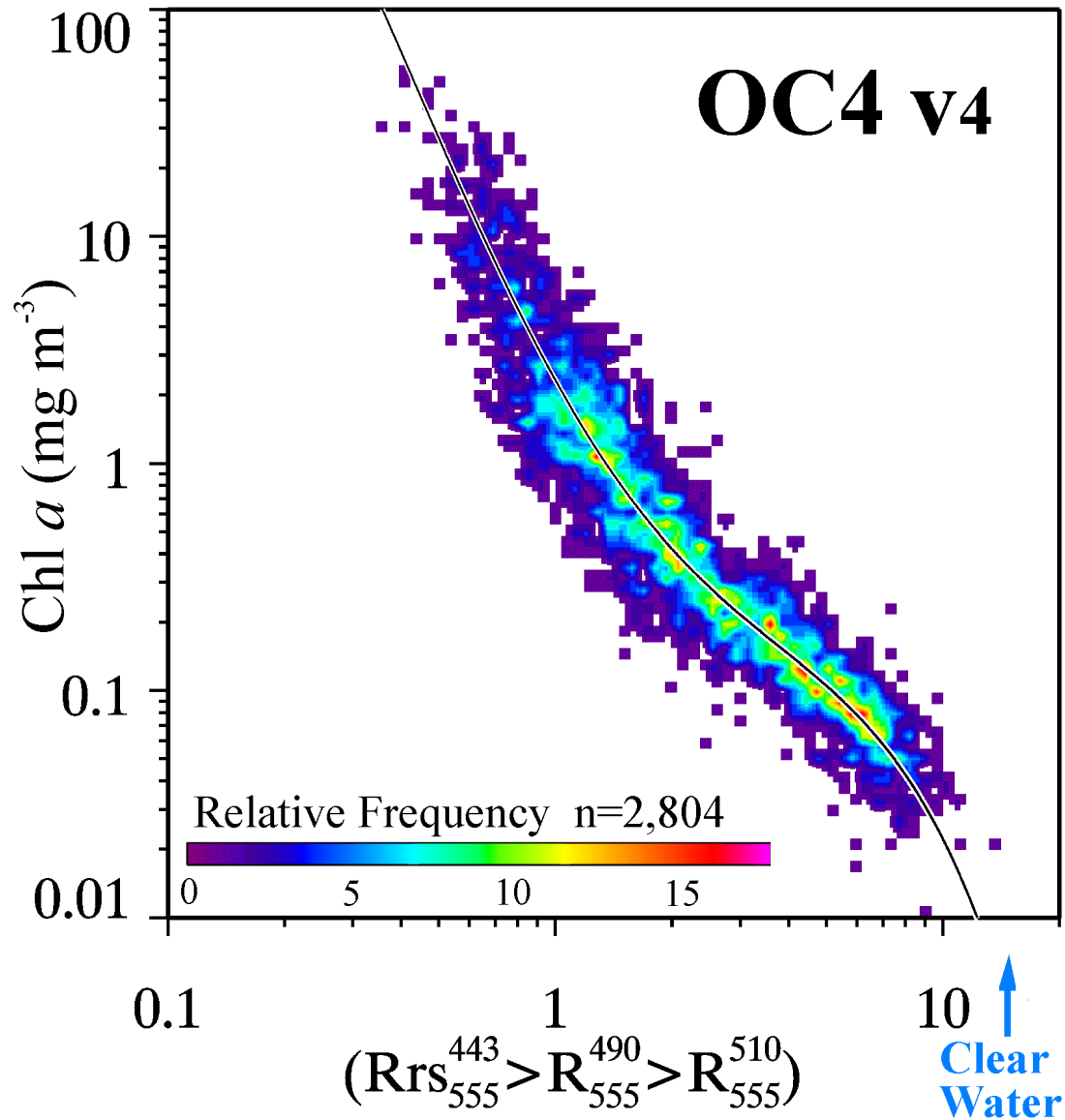


Collection 4: Uses the same OC3M algorithm applied to reprocessed radiances.

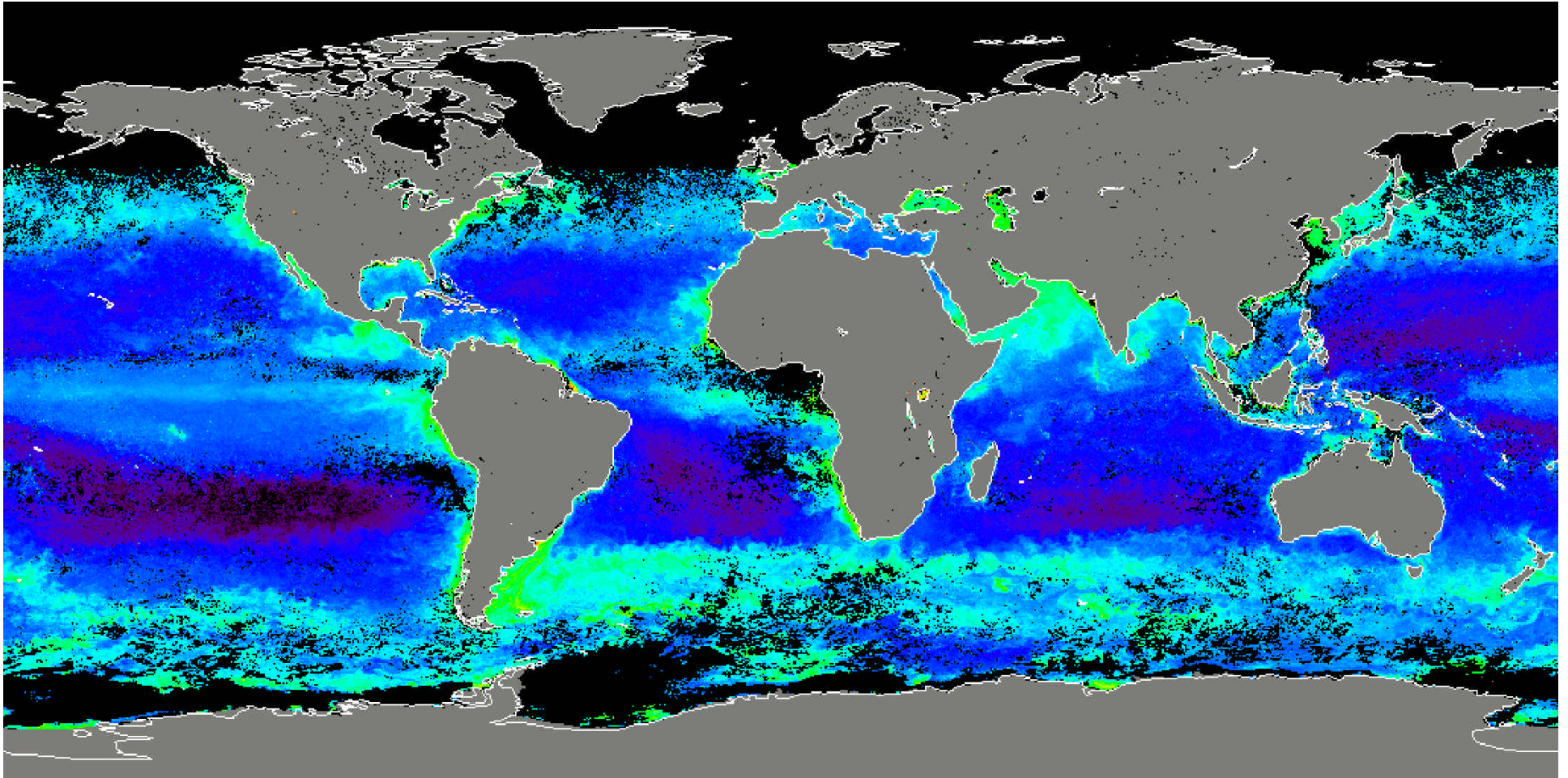


The Chlor\_a\_2 algorithm was proposed by the developers of the OC4.v4 SeaWiFS algorithm. It was called OC3M (3 band, M for MODIS)

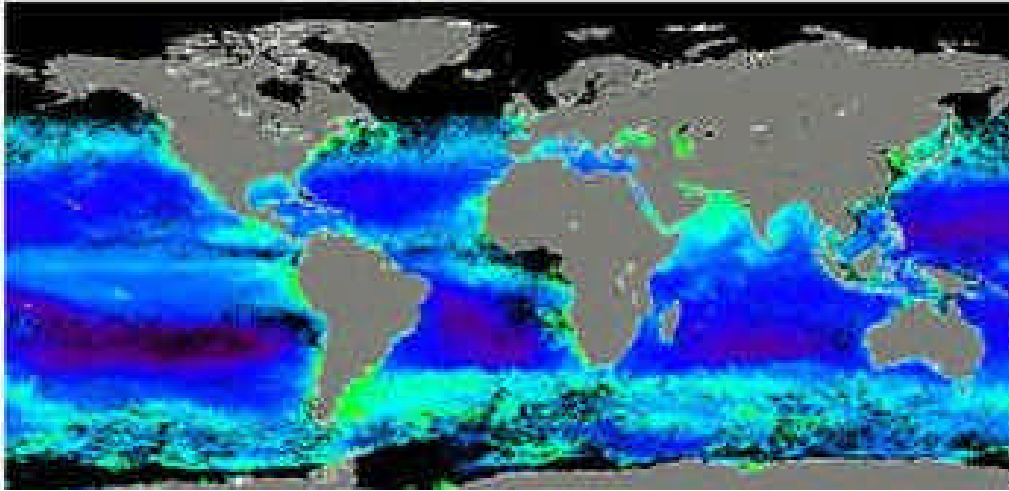




# SeaWiFS December 2000 (Reprocessing 3)

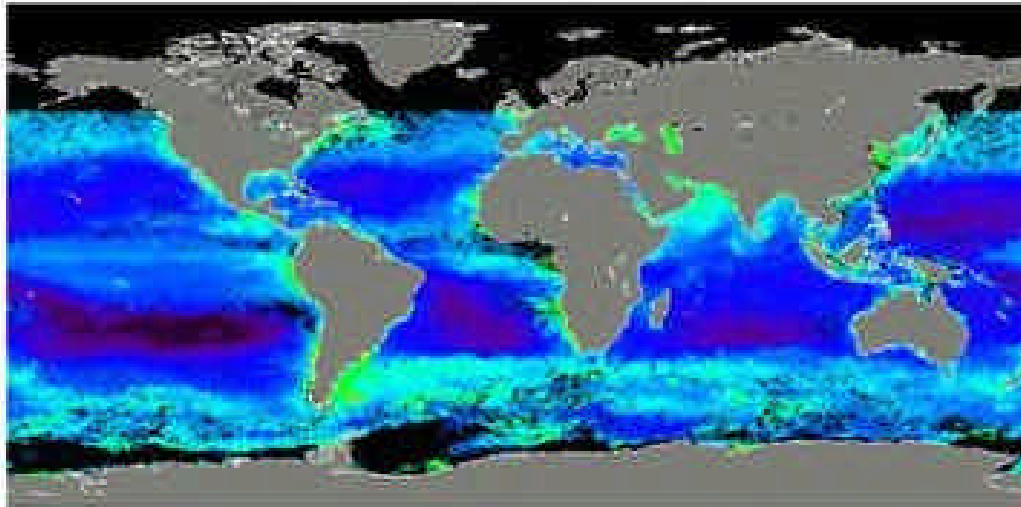


# SeaWiFS: December 2000



Reprocessing 3

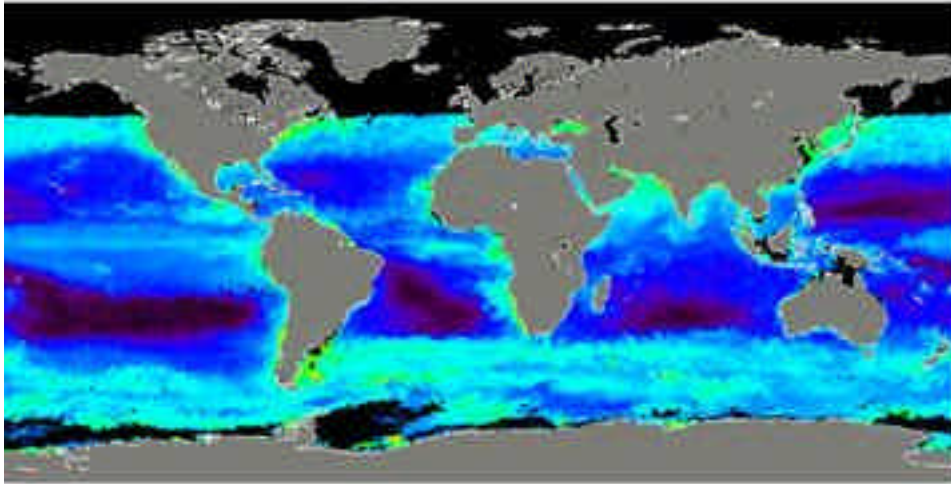
SeaWiFS OC4



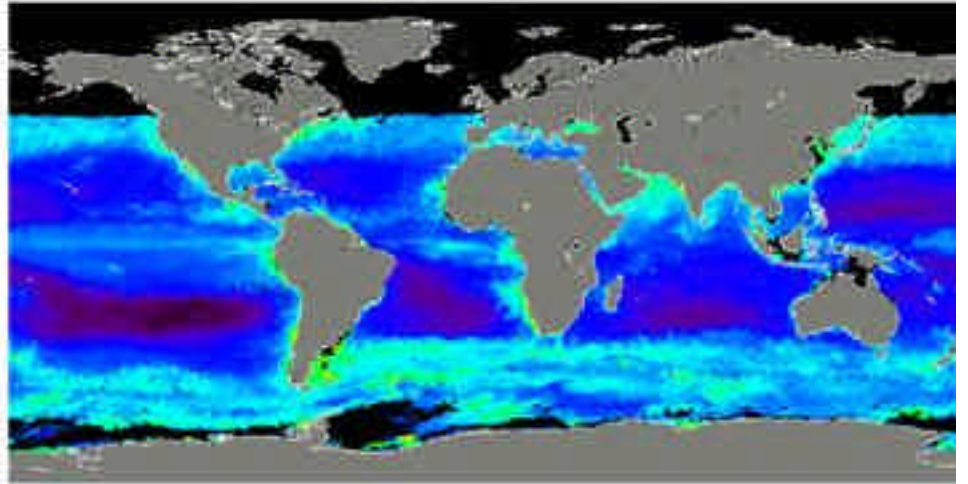
Reprocessing 4



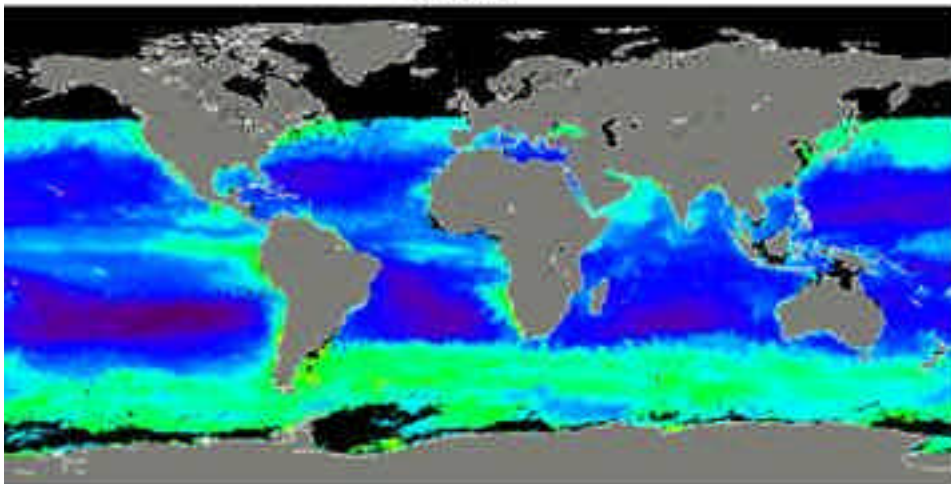
chlor\_MODIS



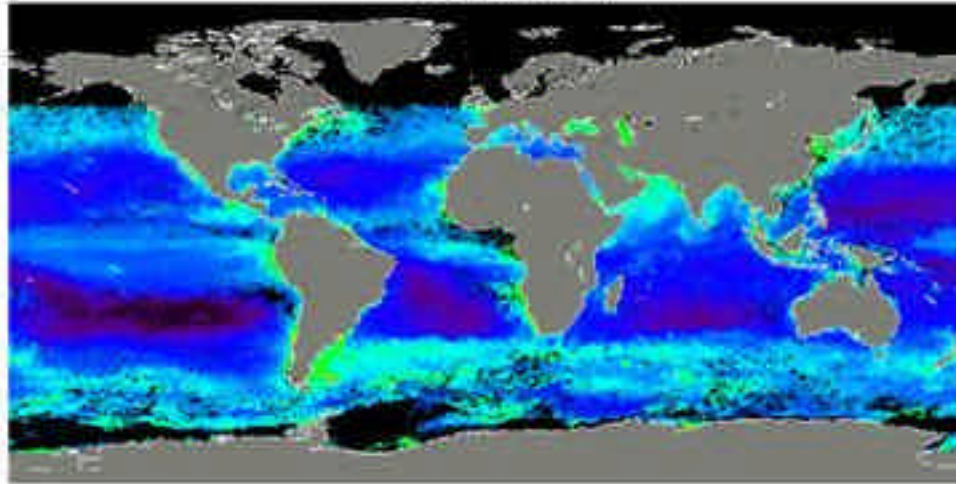
chlor\_a2



chlor\_a3



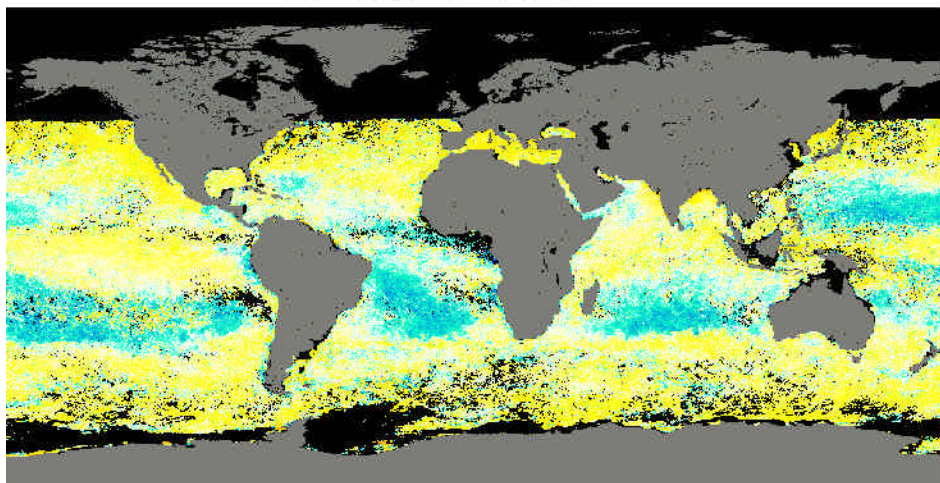
SeaWiFS OC4



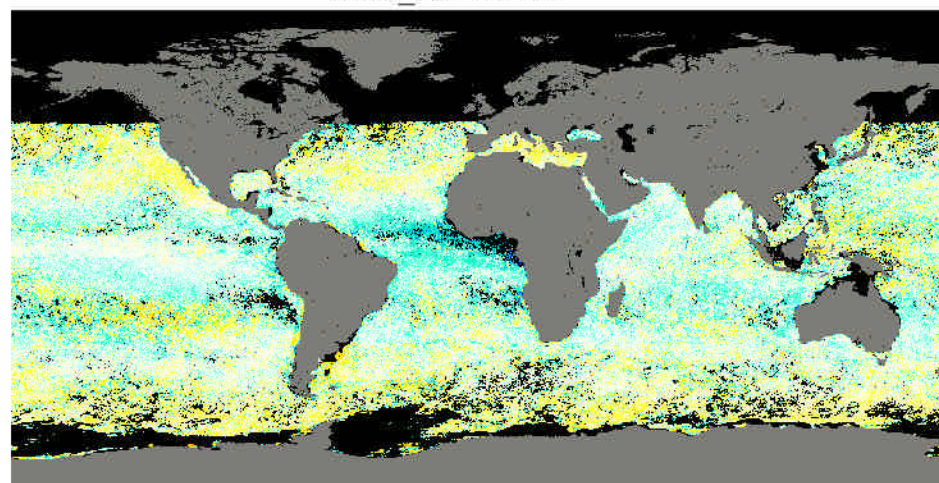
Collection 4 December 2000



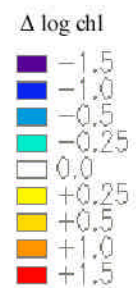
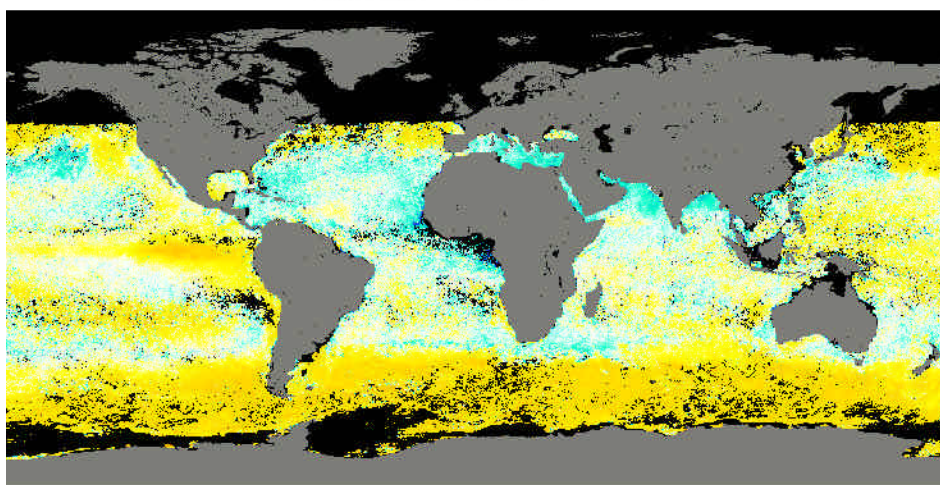
chlor\_MODIS - OC4v4



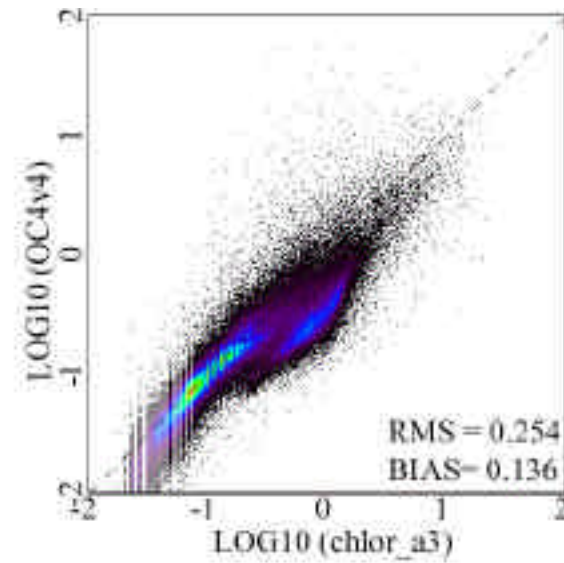
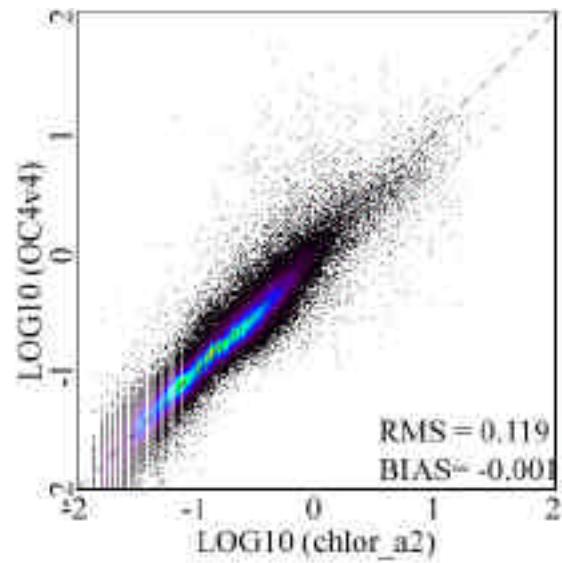
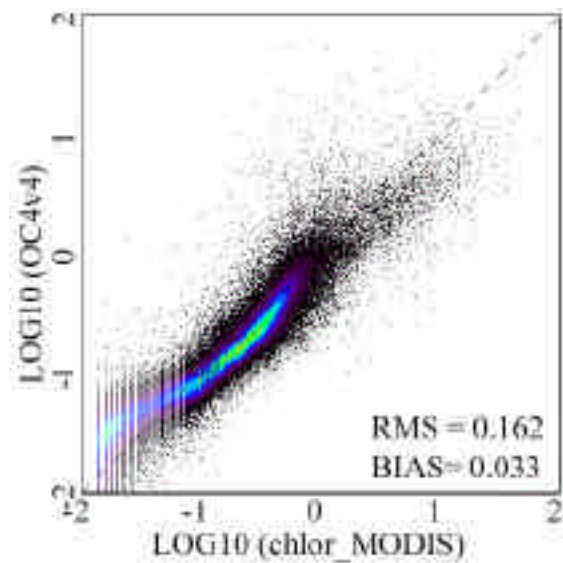
chlor\_a2 - OC4v4



chlor\_a3 - OC4v4



December 2000



Dec. 2000 - Monthly  
MODIS v4 ; SeaWiFS v4  
Quality 0

## Comparisons of Global 36-km MODIS Chlorophyll with SeaWiFS

<b>Global 36 km Product for</b>	<b>Chlor_MODIS</b>		<b>Chlor_a2</b>		<b>Chlor_a3</b>	
	<b>RMS</b>	<b>Bias</b>	<b>RMS</b>	<b>Bias</b>	<b>RMS</b>	<b>Bias</b>
<b>Dec. 2000</b>	<b>0.16</b>	<b>0.03</b>	<b>0.12</b>	<b>0.00</b>	<b>0.25</b>	<b>0.14</b>
<b>Dec. 2-9, 2000</b>	<b>0.18</b>	<b>0.03</b>	<b>0.15</b>	<b>0.00</b>	<b>0.26</b>	<b>0.13</b>
<b>Jun. 2-9, 2002</b>	<b>0.24</b>	<b>0.08</b>	<b>0.19</b>	<b>0.03</b>	<b>0.20</b>	<b>0.05</b>
<b>Jun. 2, 2002</b>	<b>0.25</b>	<b>0.08</b>	<b>0.22</b>	<b>0.03</b>	<b>0.24</b>	<b>0.06</b>
<b>Dec. 4, 2000</b>	<b>0.21</b>	<b>0.02</b>	<b>0.17</b>	<b>-0.02</b>	<b>0.27</b>	<b>0.11</b>
<b>Apr. 8, 2001</b>	<b>0.24</b>	<b>0.08</b>	<b>0.19</b>	<b>0.04</b>	<b>0.24</b>	<b>0.07</b>

Note: Units are decades of log. Bias is average difference of MODIS minus SeaWiFS; RMS is root-mean-square difference.



## CONCLUSIONS (as of December 2001)

- MODIS and SeaWiFS chlorophylls agree reasonably well. RMS  $\sim 0.2$  log units
- RMS  $\sim 0.3$  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).
- The Chlor\_a\_2 product is ready to be validated after the next reprocessing. By definition, if it is compatible with SeaWiFS, then it is valid.

## CONCLUSIONS (Today)

- ✓ MODIS and SeaWiFS chlorophylls agree reasonably well. 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).
- ✓ The **Collection 4** Chlor\_a\_2 product is now validated, since it is consistent with SeaWiFS.



Can the high-resolution MODIS bands be used to develop a chlorophyll algorithm with improved resolution in coastal waters?

Chlor\_a\_2 algorithm uses:

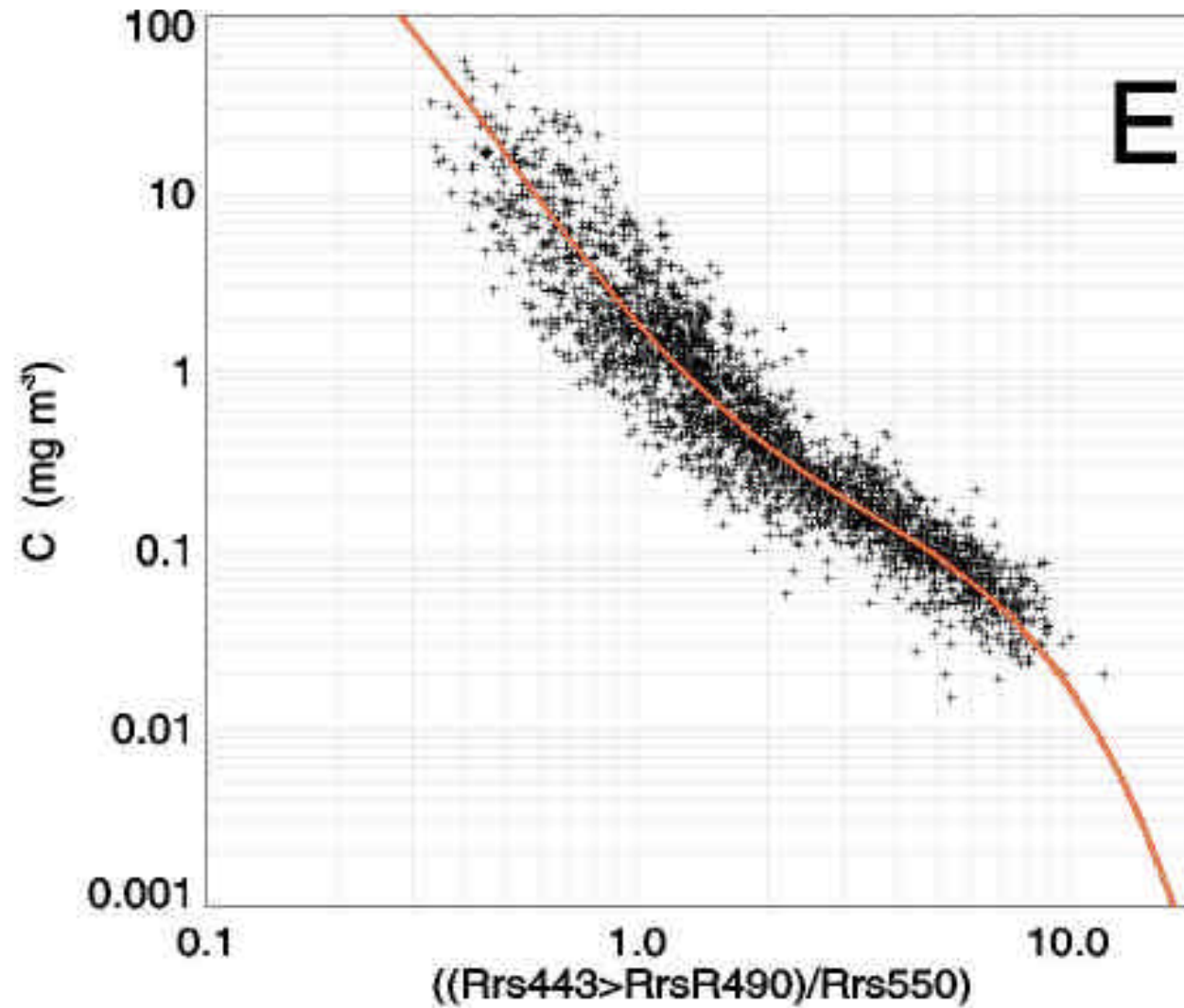
- 3 bands at 1 km: **443**, **488**, **551** nm

High resolution bands are:

- 2 bands at 250 m: **645**, 860 nm
- 5 bands at 500 m: **469**, **555**, 1240, 1640, 2130 nm



The Chlor\_a\_2 algorithm uses the ratio of 443 to 551  
or 488 to 551 whichever is greater



In a Level-2 granule from the Northern Gulf of Mexico, we regressed:

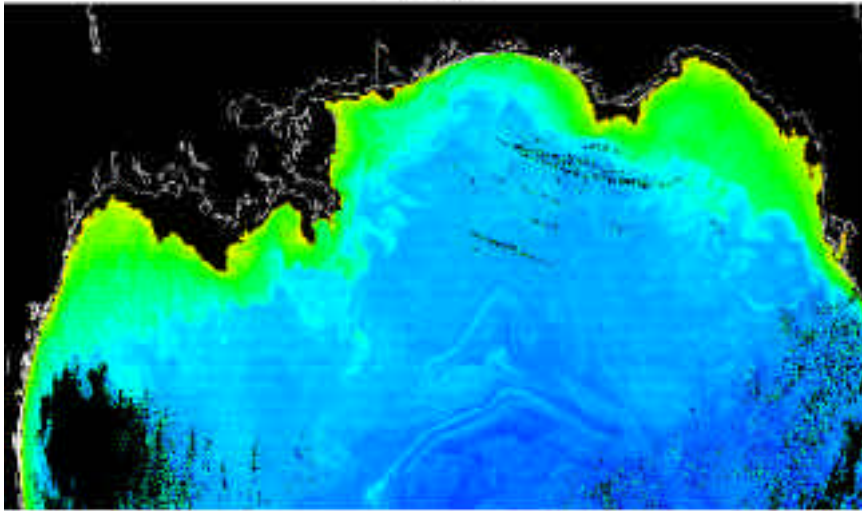
Chlor\_a\_2 *versus* 469:555 ratio

and

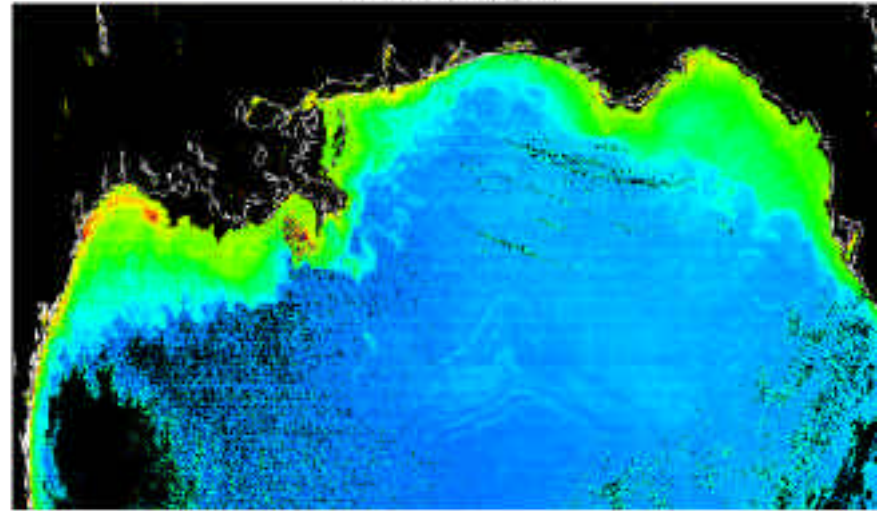
Chlor\_a\_3 *versus* 469:555 ratio

where the radiance ratio was based on 500-m bands (MOD09 Surface Reflectance Product) degraded to 1 km and co-registered with the ocean color data.

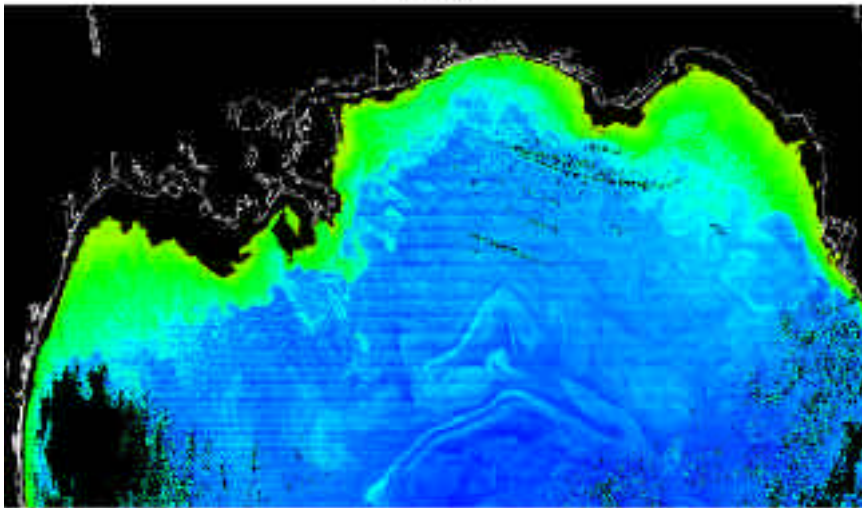
chlor\_a2



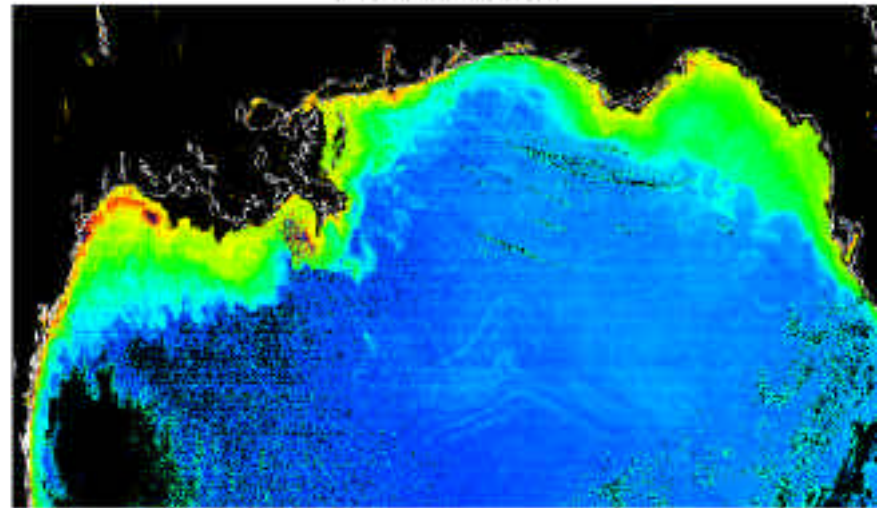
MOD09 (chlor\_a2)



chlor\_a3



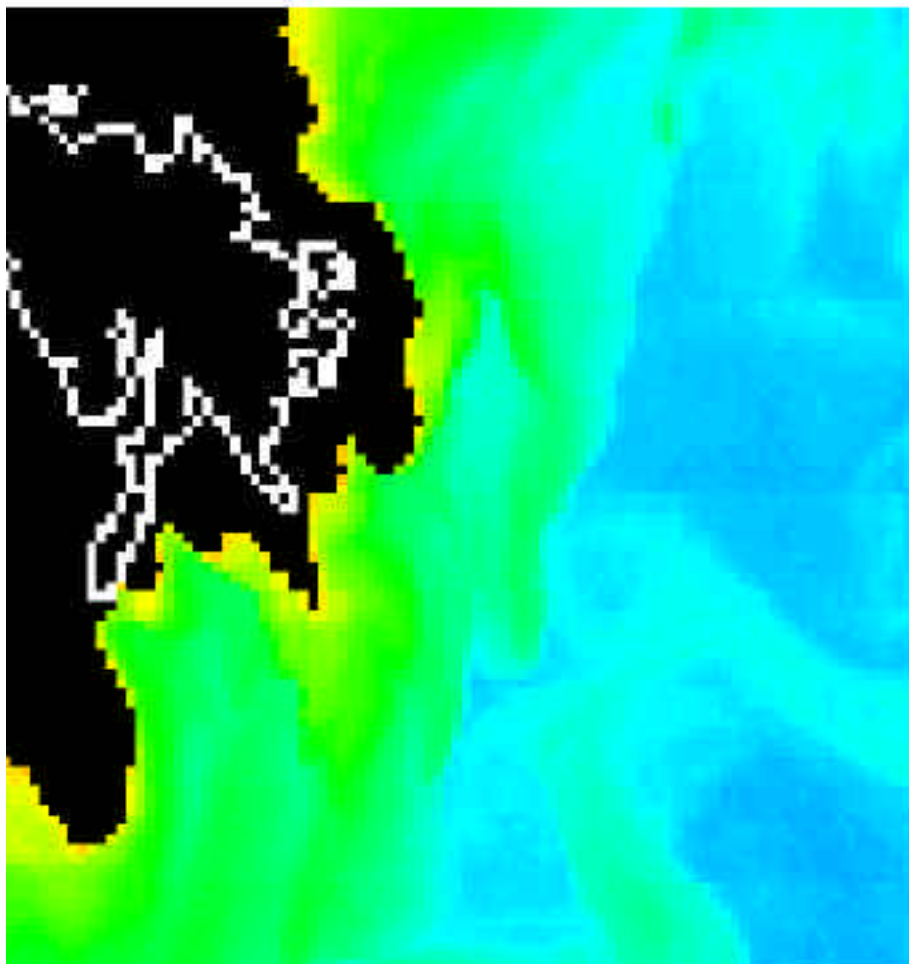
MOD09 (chlor\_a3)



Chlor\_a2 and Chlor\_a3.

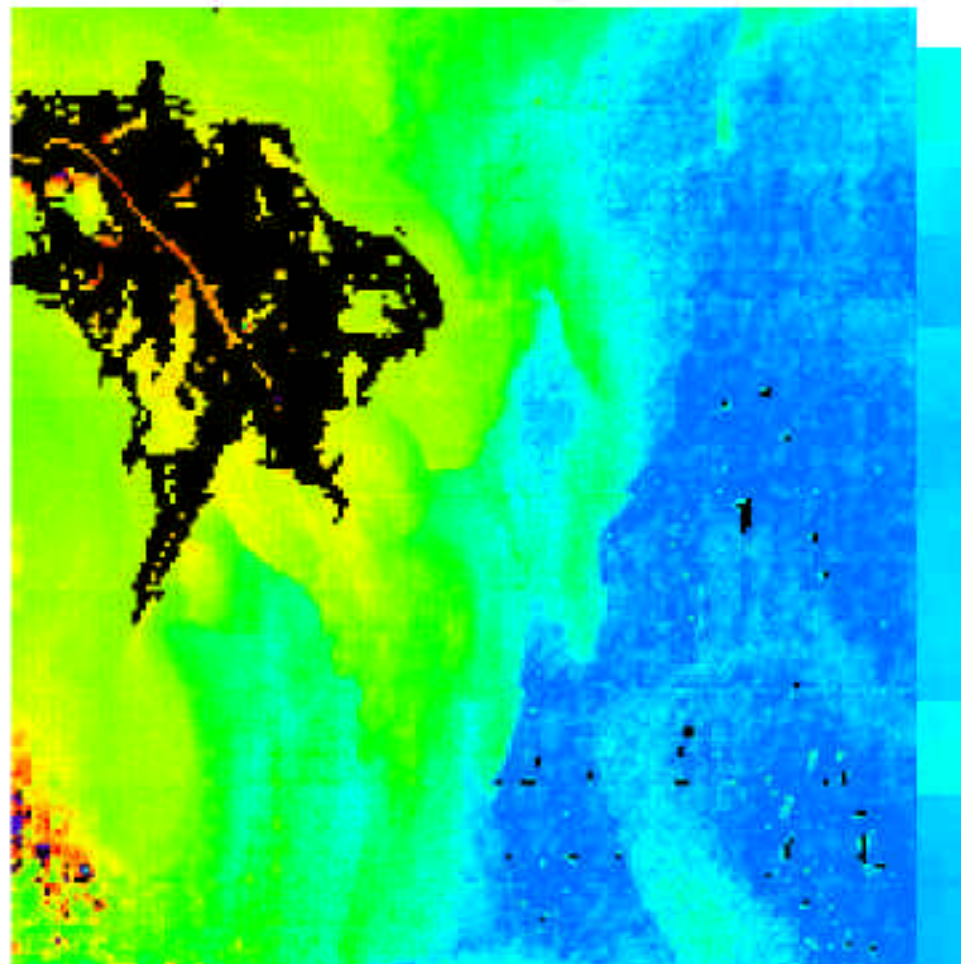
Chlorophylls derived with MOD09 data.

chlor\_a2



1-km Chlor\_a2

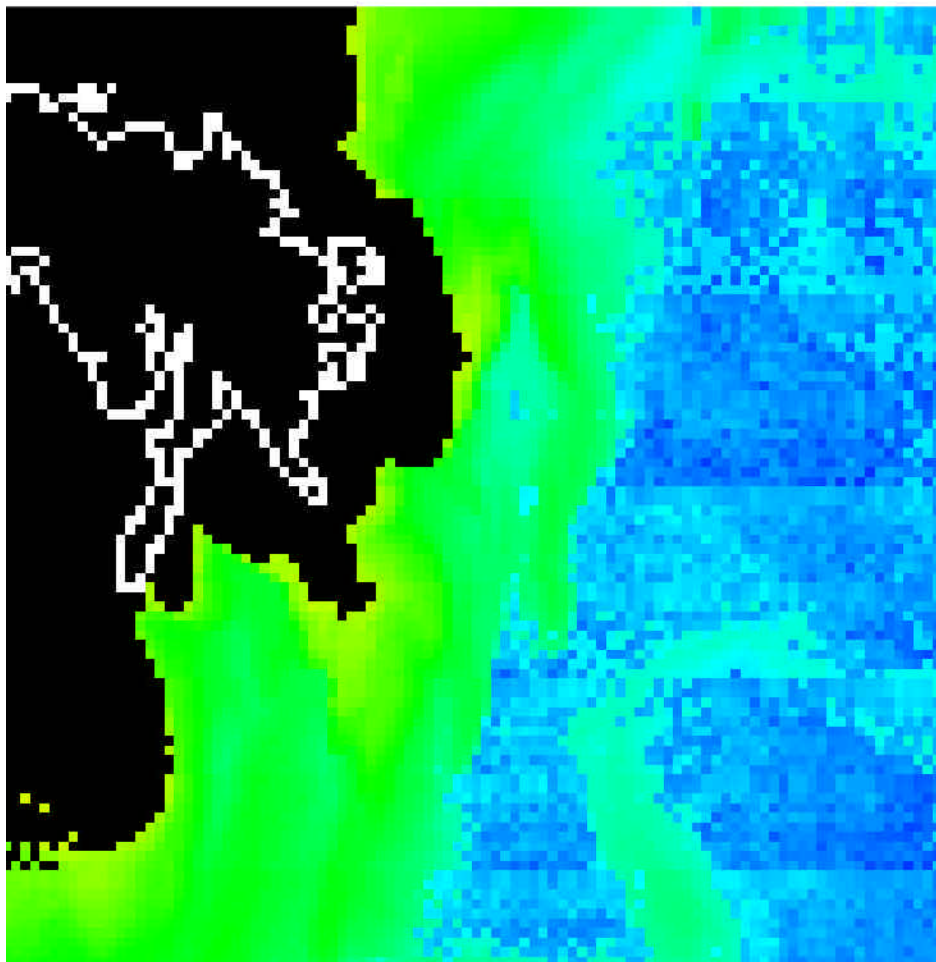
MOD09 (chlor\_a2)



500-m “Chlor\_a2”

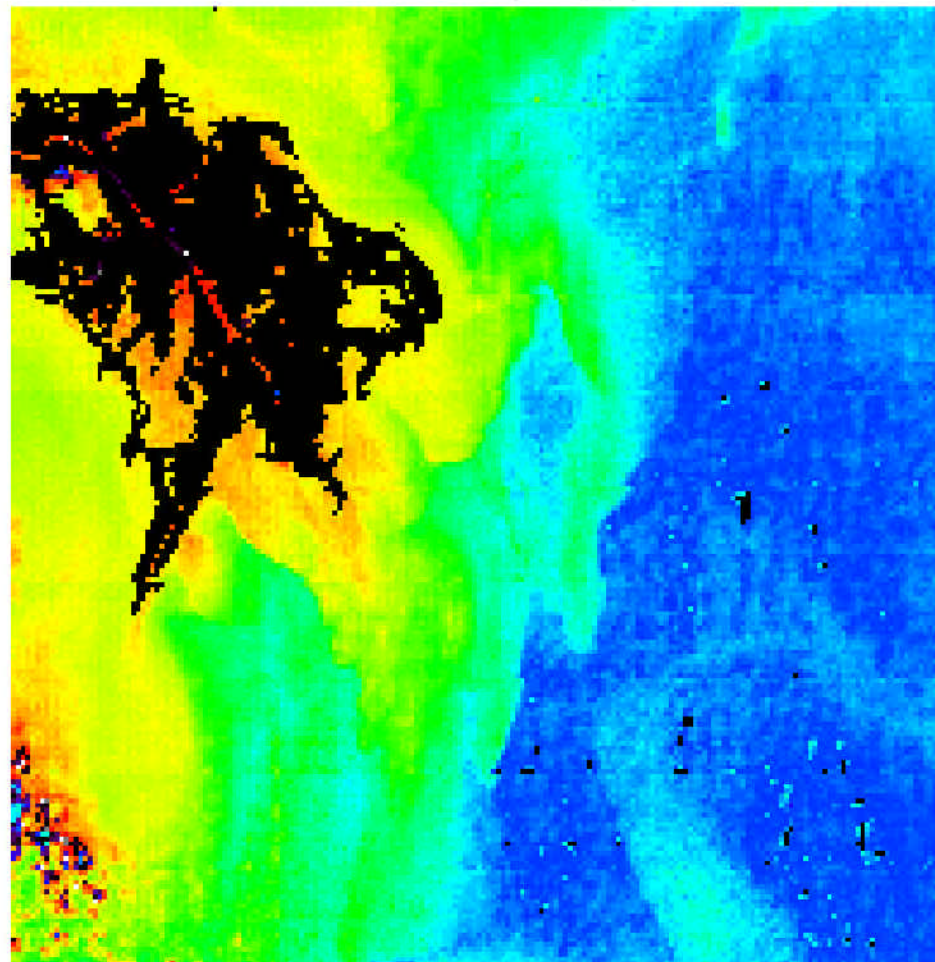


chlor\_a3



1-km Chlor\_a3

MOD09 (chlor\_a3)



500-m "Chlor\_a3"









