MOD 18 Normalized Water-leaving Radiance

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Atmospheric Correction

$$\rho_t(\lambda) = \rho_r(\lambda) + \rho_{A(\lambda)} + t(\lambda)\rho_w(\lambda)$$

Note: $\rho_w(765) \approx \rho_w(865) \approx 0$, and define

$$\varepsilon^{MS}(765{,}865) = \frac{\rho_t(765) - \rho_r(765)}{\rho_t(865) - \rho_r(865)}$$

The correction algorithm then does the following

$$\varepsilon^{MS}(765,865) \Rightarrow \varepsilon^{SS}(765,865) \Rightarrow Aerosol\ Model$$
$$\Rightarrow \varepsilon^{SS}(\lambda,865) \Rightarrow \varepsilon^{MS}(\lambda,865)$$

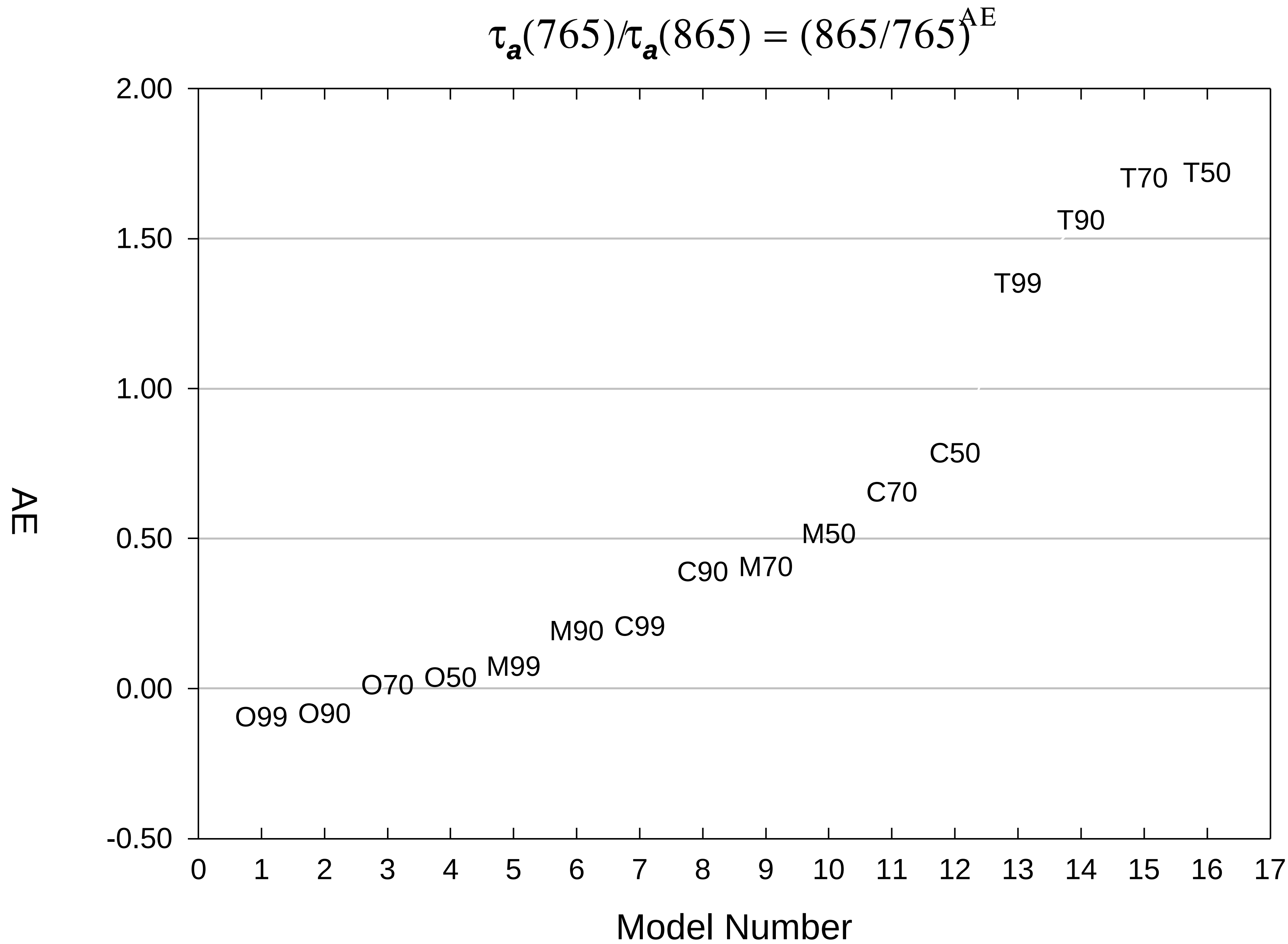
$$\rho_{A(\lambda)} = \varepsilon^{MS}(\lambda,865)\rho_{A(865)}$$

Also,

$$Aerosol\ Model\ and\ \rho_t(865) - \rho_r(865) \Rightarrow t(\lambda)$$

so

$$\rho_w(\lambda) = t^{-1}(\lambda)\left[\rho_t(\lambda) - \rho_r(\lambda) - \rho_A(\lambda)\right]$$



$\tau_a(765)/\tau_a(865) = (865/765)^{AE}$
AE
Model Number
2.00
1.50
1.00
0.50
0.00
-0.50
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
O99
O90
O70
O50
M99
M90
C99
C90
M70
M50
C70
C50
T99
T90
T70
T50

GOOD CALIBRATION IS REQUIRED

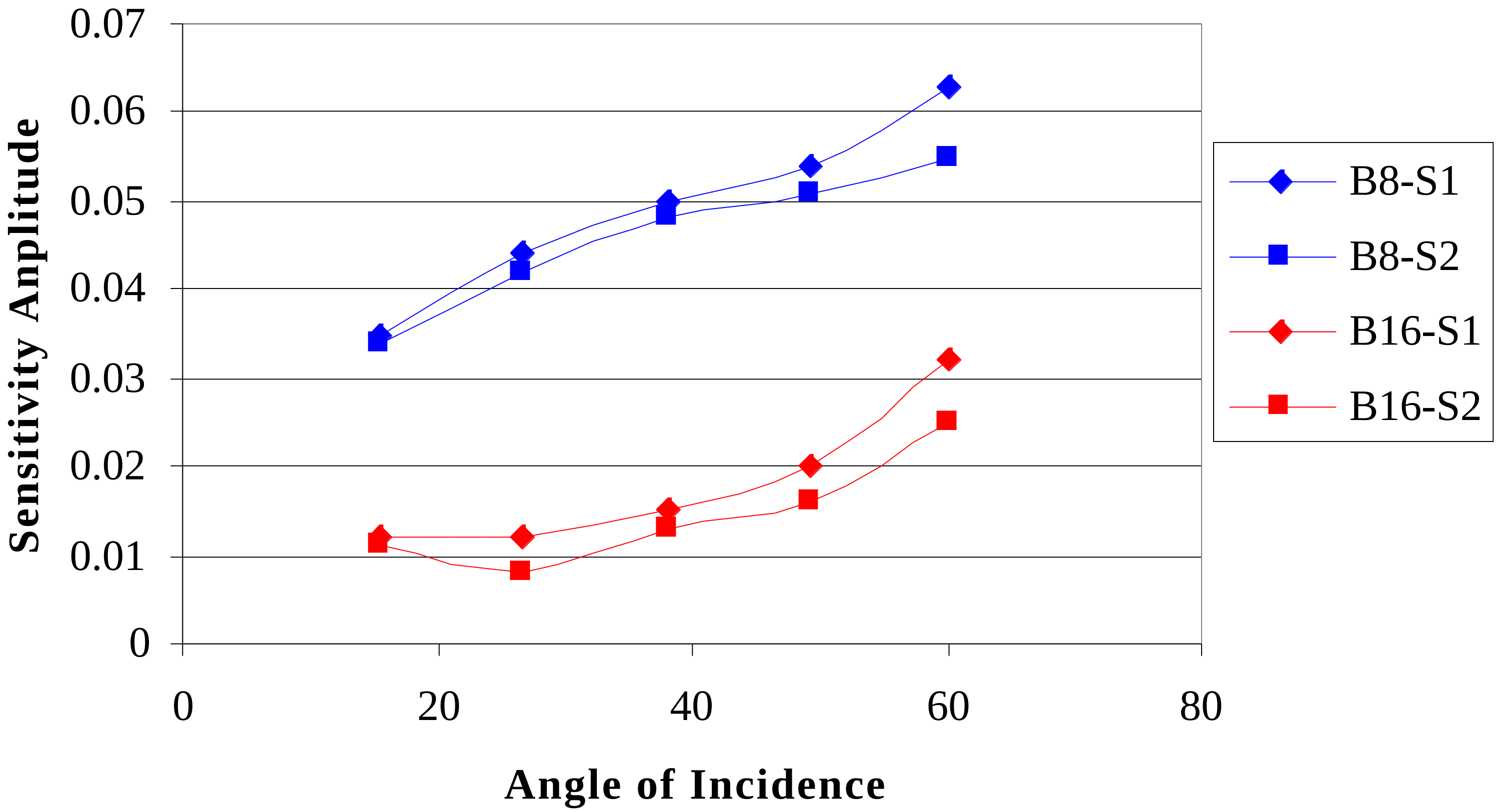
Typical values (clear atmosphere)

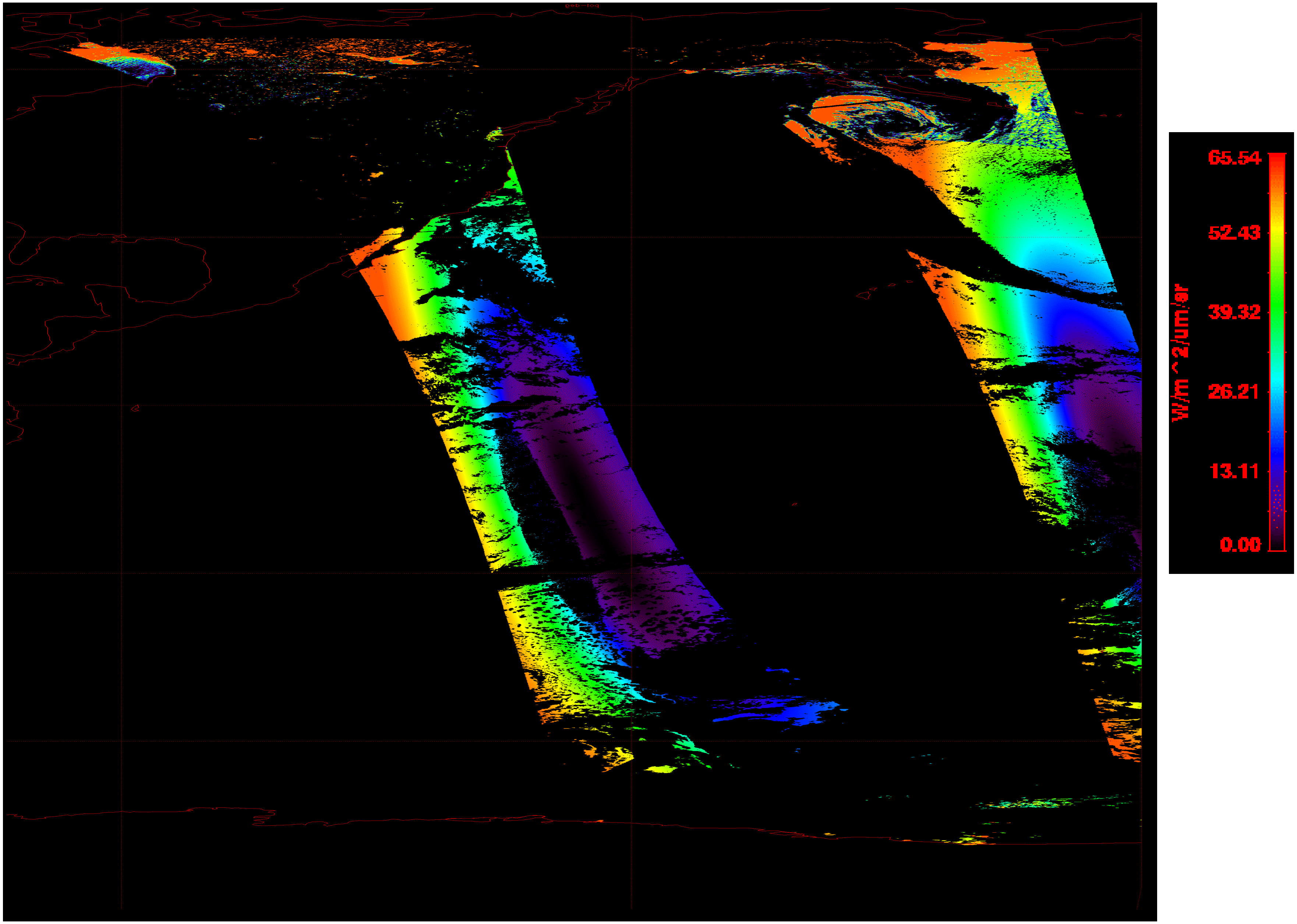
λ	$\rho_t(\lambda)$	$\rho_w(\lambda)$
412	0.34	0.040
443	0.29	0.038
488	0.23	0.024
531	0.19	0.009
551	0.15	0.005
670	0.10	0.0004

$\Rightarrow$ Successful operation requires excellent *relative* calibration

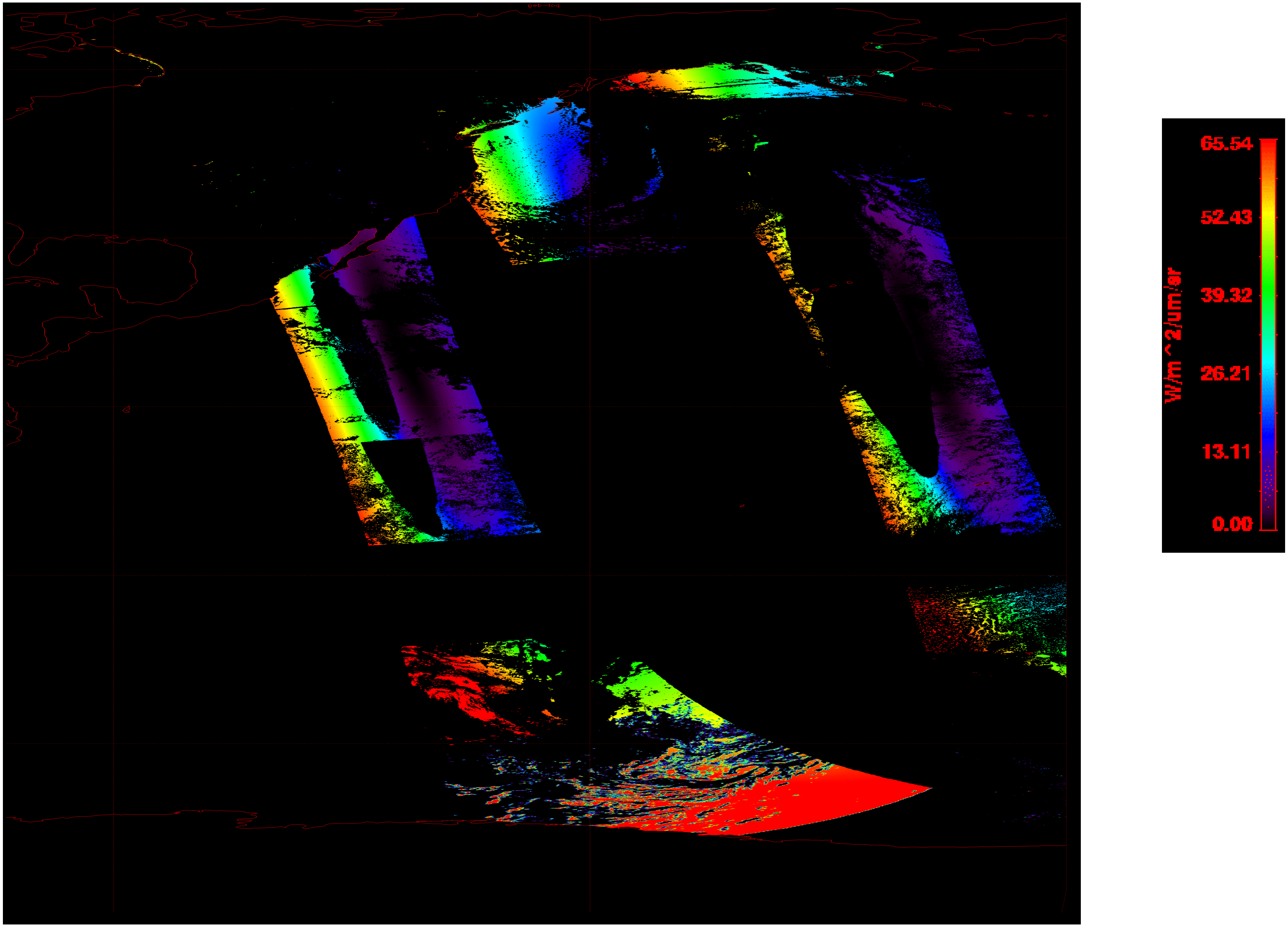
POLARIZATON

MODIS polarization sensitivity can lead to significant error:





Degree of Polarization (December)



Degree of Polarization (April)

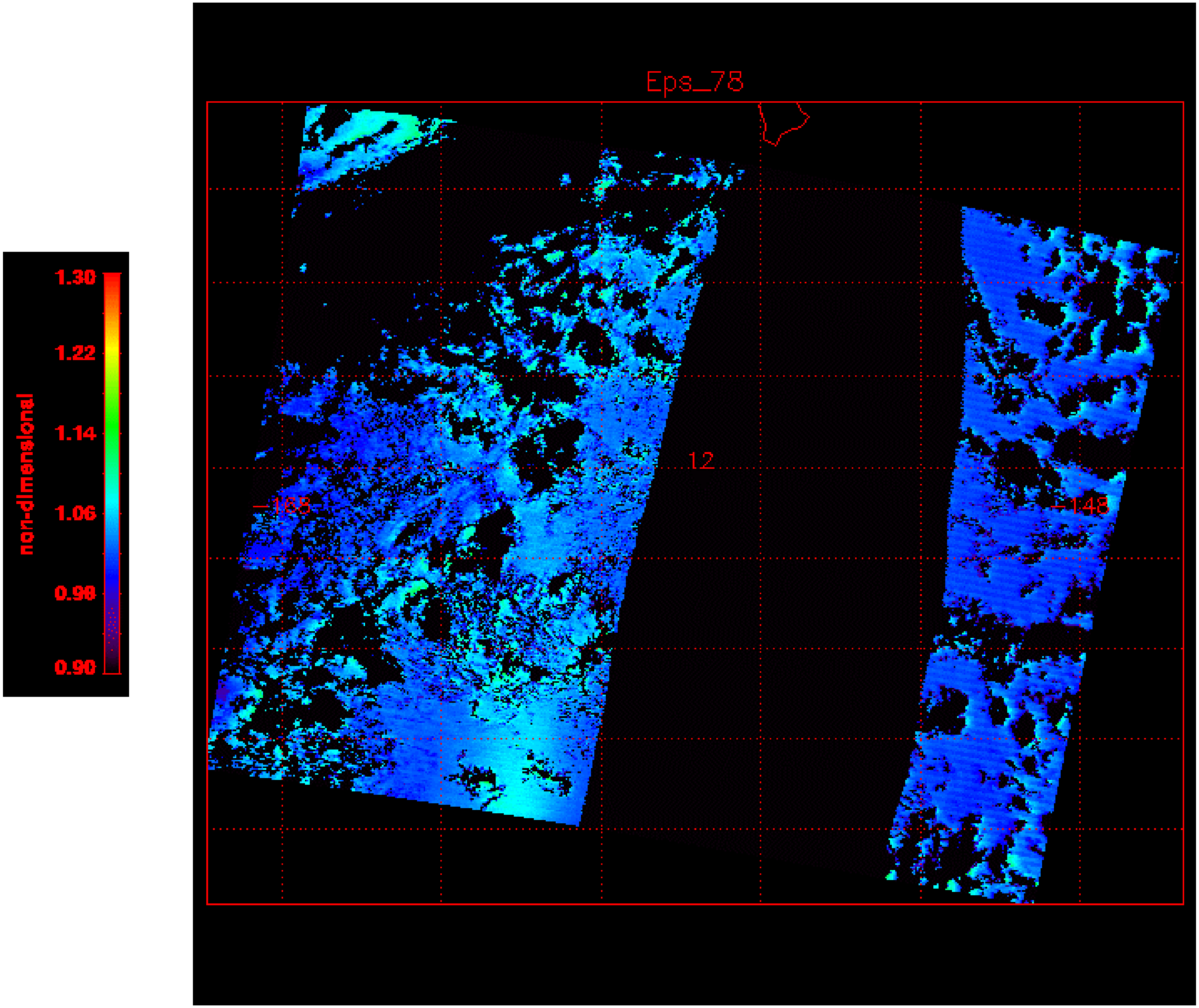
- Original Polarization Sensitivity Correction: *Assume that* $\rho_t(\lambda)$ *is polarized in a manner identical to the Rayleigh component* $\rho_r(\lambda)$
- Revised Polarization Sensitivity Correction: *Assume that all of the components of* $\rho_t(\lambda)$*, other than* $\rho_r(\lambda)$*, i.e.,* $\rho_A(\lambda)$ *and* $\rho_w(\lambda)$*, are completely unpolarized.*

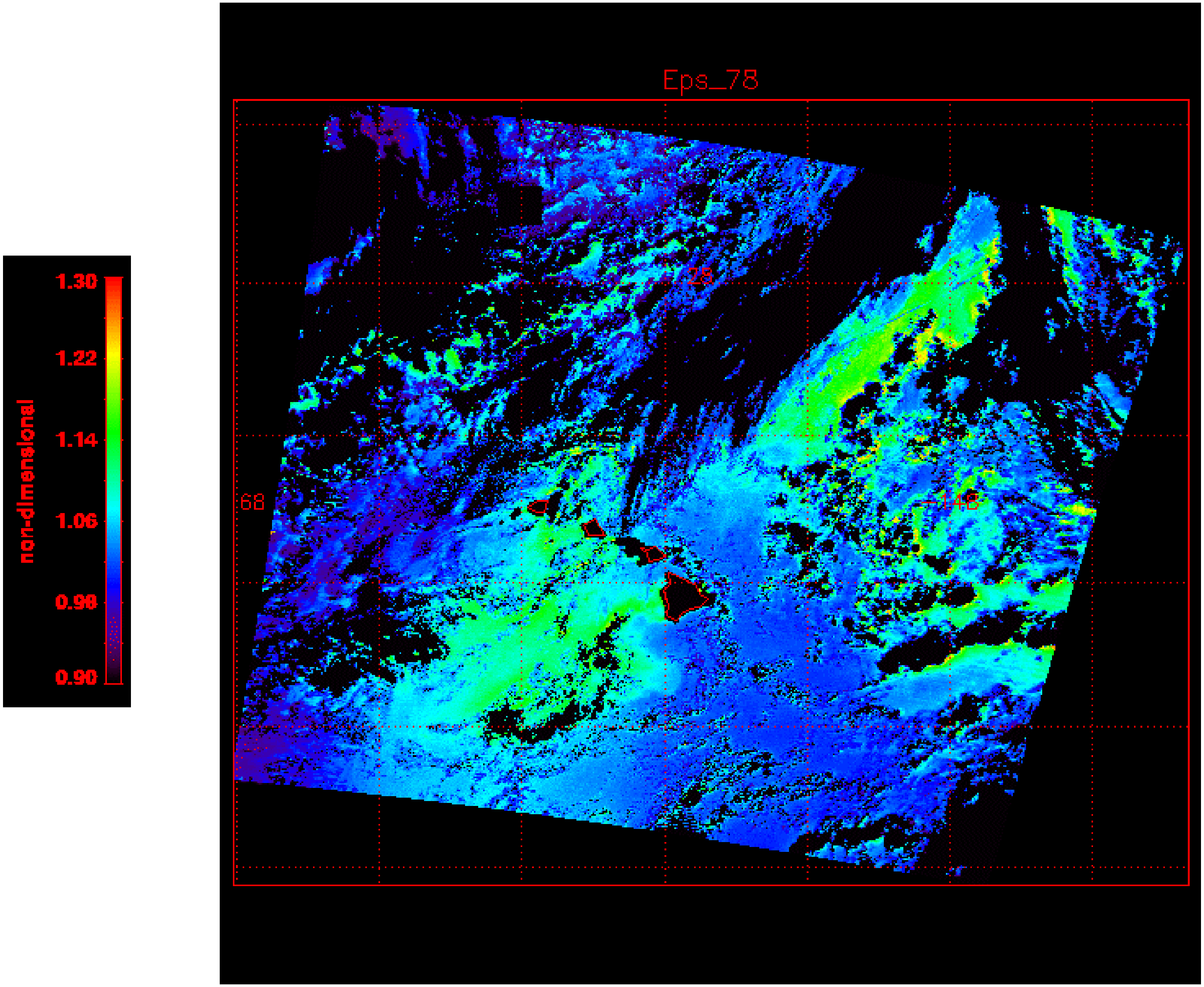
INDICIA OF ALGORITHM PERFORMANCE

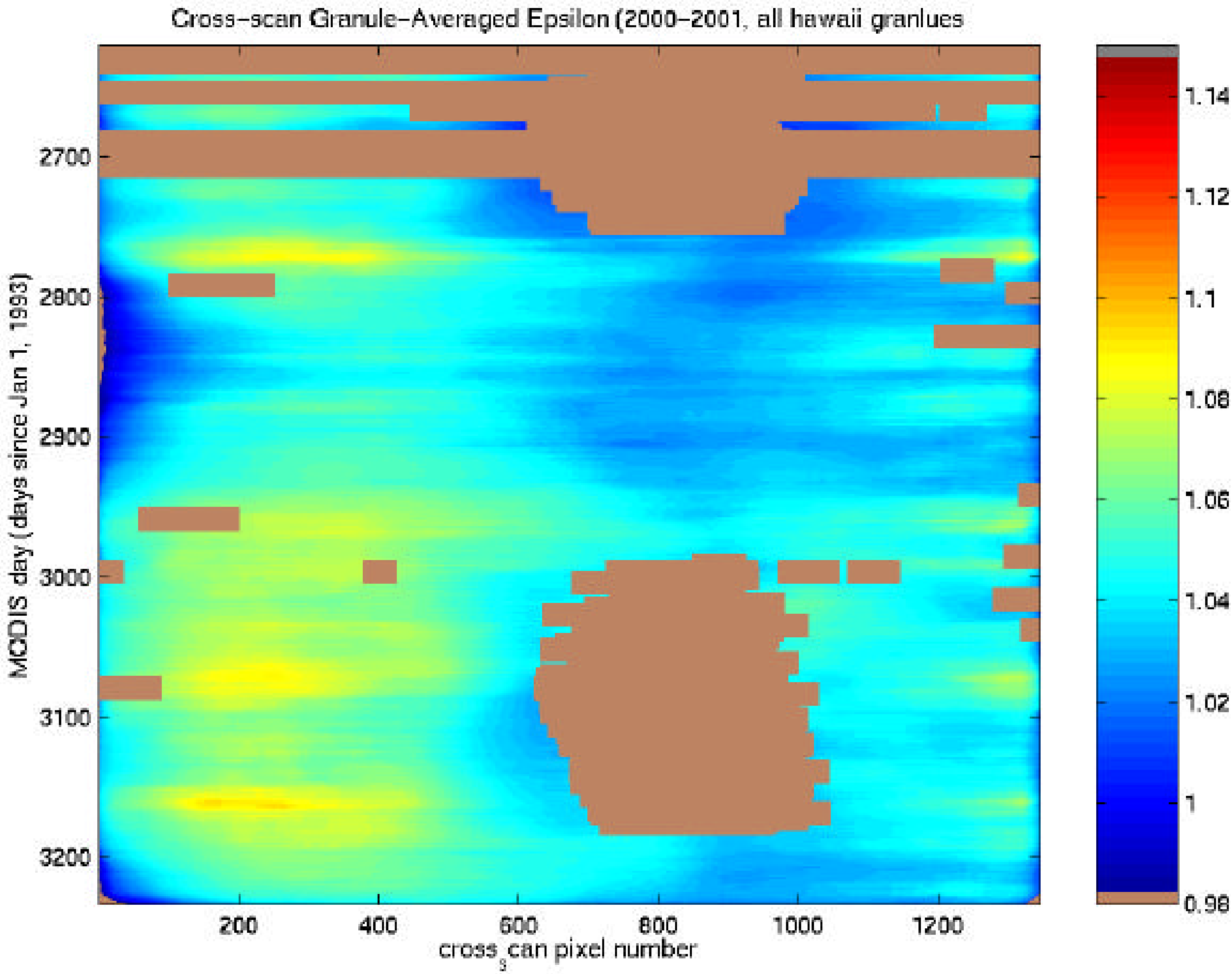
1. Variation of $\varepsilon^{SS}(765,865)$ across the MODIS scan

At a given location and time, $\varepsilon^{SS}(765,865)$ varies in a systematic manner across the scan that is characteristic of each of the candidate aerosol models.

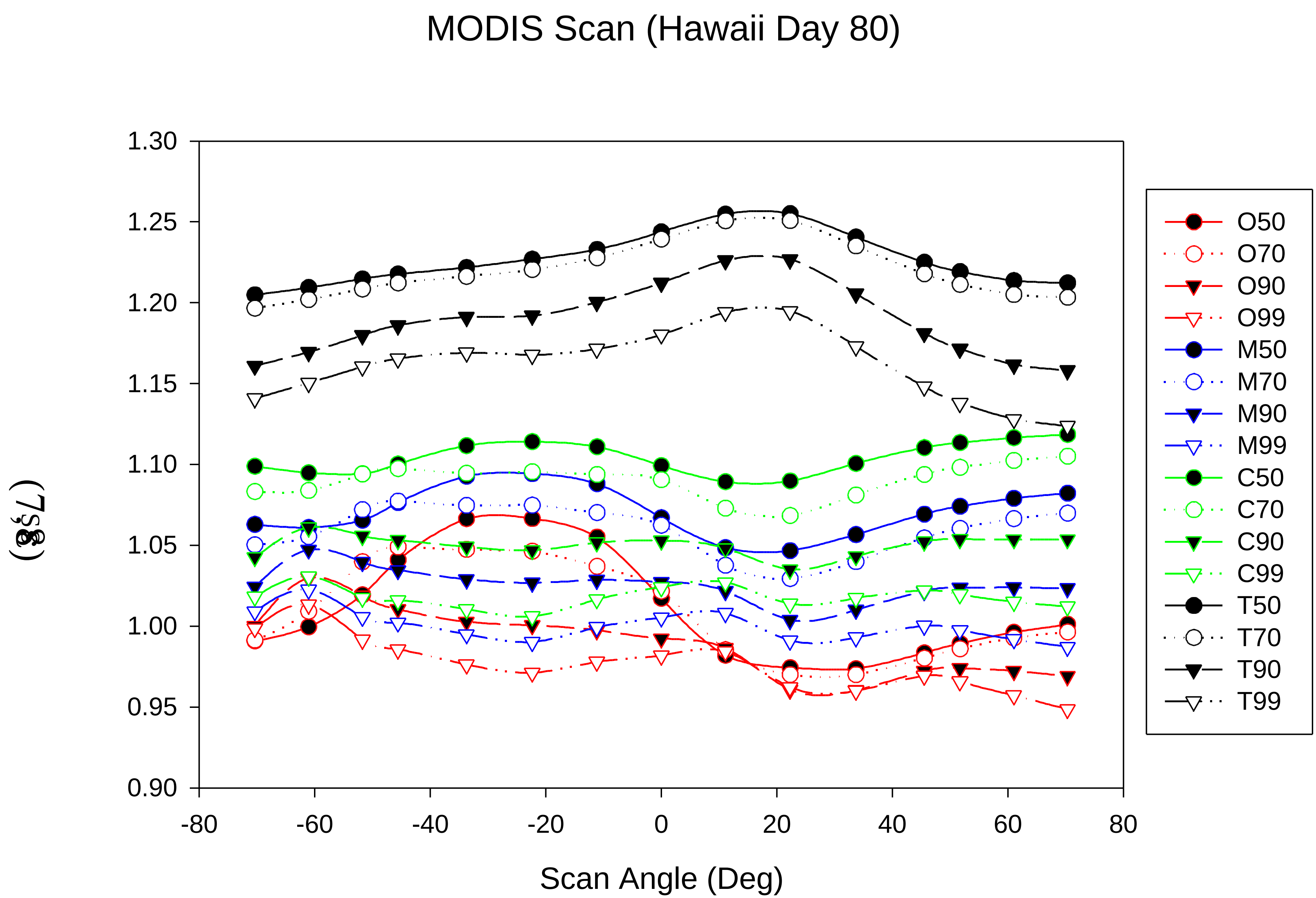
How does $\varepsilon^{SS}(765,865)$ vary across the MODIS scan?


1.30
1.22
1.14
1.06
0.98
0.90
non-dimensional
Eps_78
12
-168
-148


Eps_78
28
68
-148
1.30
1.22
1.14
1.06
0.98
0.90
non-dimensional



Cross-scan Granule-Averaged Epsilon (2000-2001, all hawaii granlues
MODIS day (days since Jan 1, 1993)
2700
2800
2900
3000
3100
3200
200
400
600
800
1000
1200
cross_scan pixel number
1.14
1.12
1.1
1.08
1.06
1.04
1.02
1
0.98



MODIS Scan (Hawaii Day 80)
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
-80
-60
-40
-20
0
20
40
60
80
Scan Angle (Deg)
O50
O70
O90
O99
M50
M70
M90
M99
C50
C70
C90
C99
T50
T70
T90
T99

- The fact that $\varepsilon^{SS}(765,865)$ shows the predicted behavior across the scan suggests that the relative calibration of Bands 15 and 16 are very close to correct.

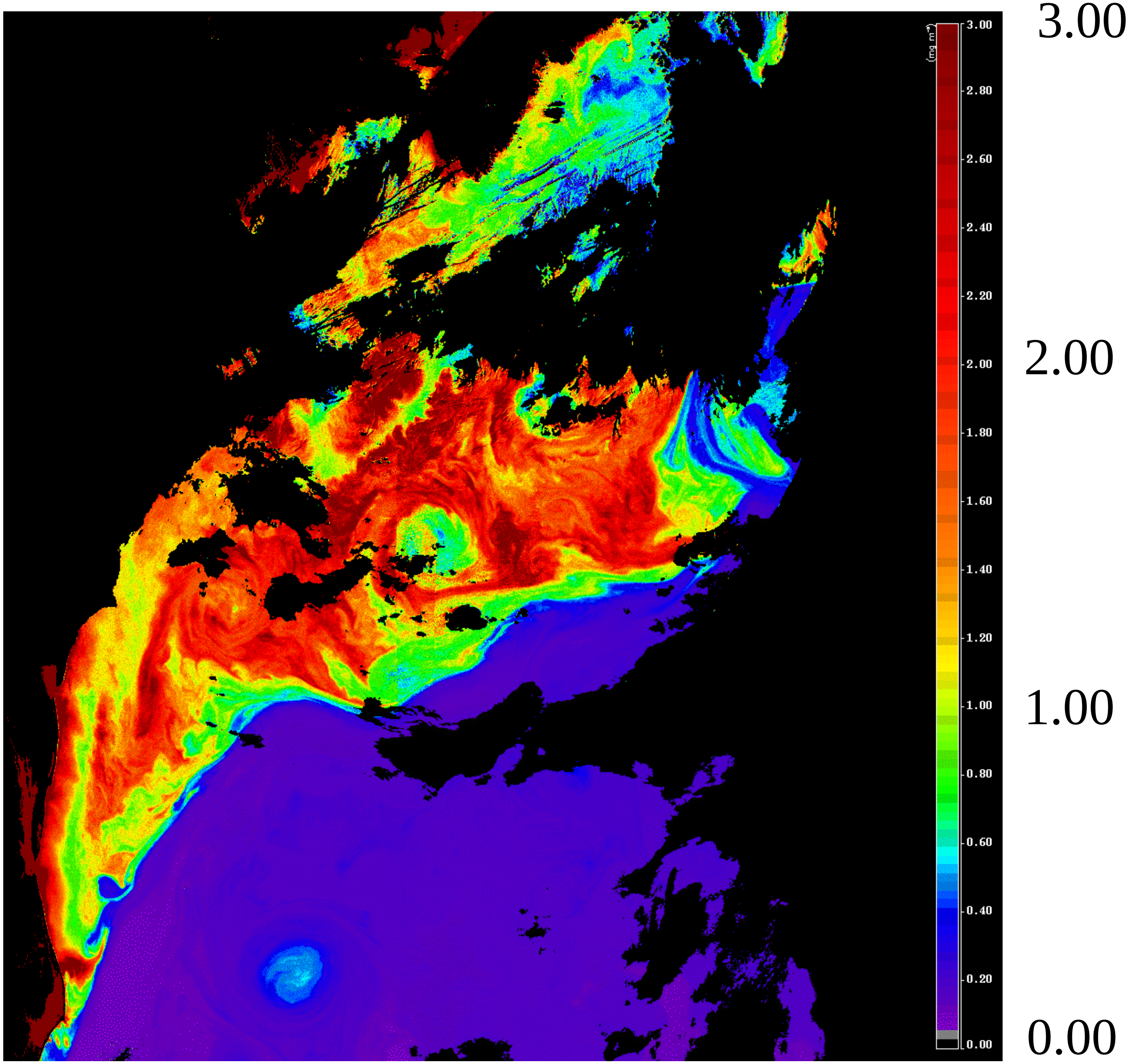
- However, the absolute values of $\varepsilon^{SS}(765,865)$ are a little higher than the range of the models, suggesting that the calibration factor (counts to radiance) of the 765 nm band may be a little too large relative to the 865 nm band.

- Note that changing the relative calibration factors of these two bands will necessitate recalibrating the others as well.

2. Comparison of water-leaving radiance with SeaWiFS

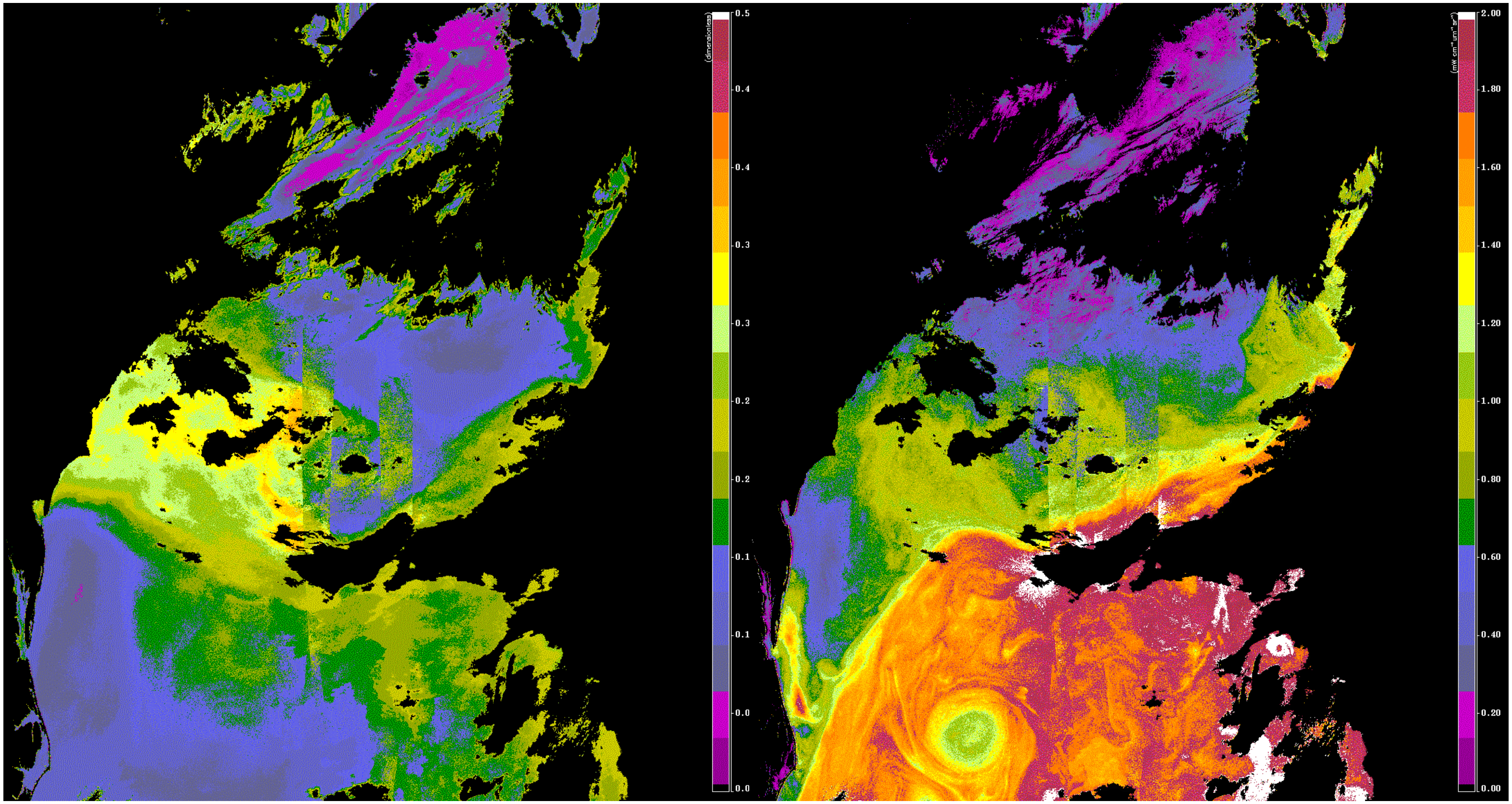
Look at 2000129 off U.S. East Coast

SeaWiFS
Chl *a*



SeaWiFS

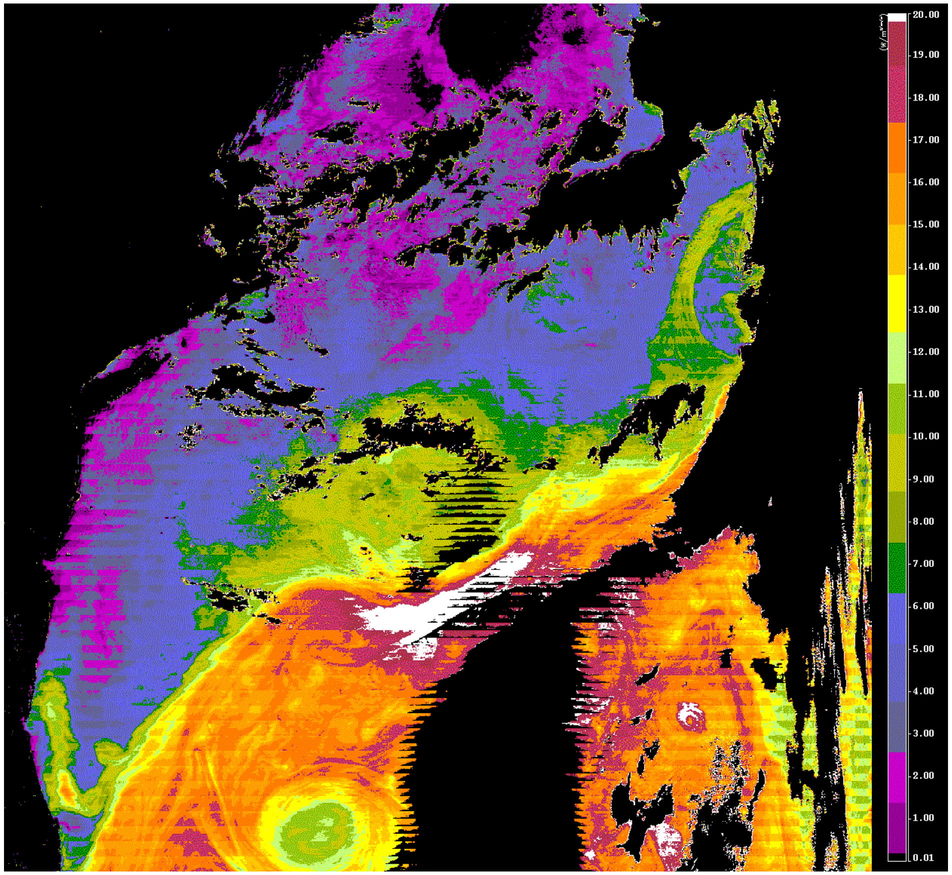
0.5 2

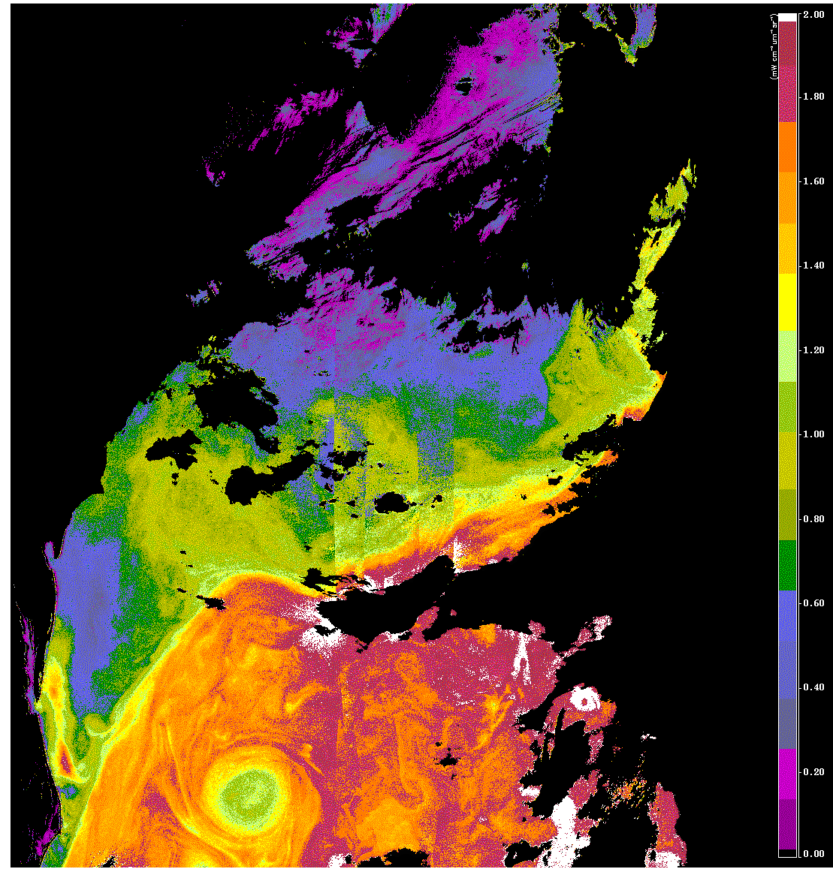


0 0

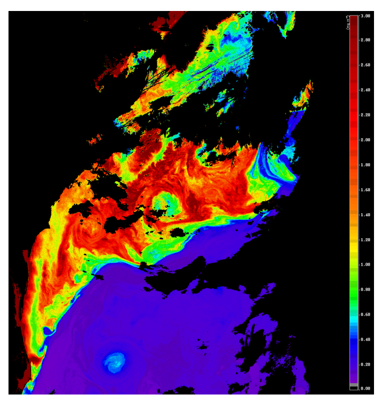
AOD(865) *nLw*(443)

nLw(443)



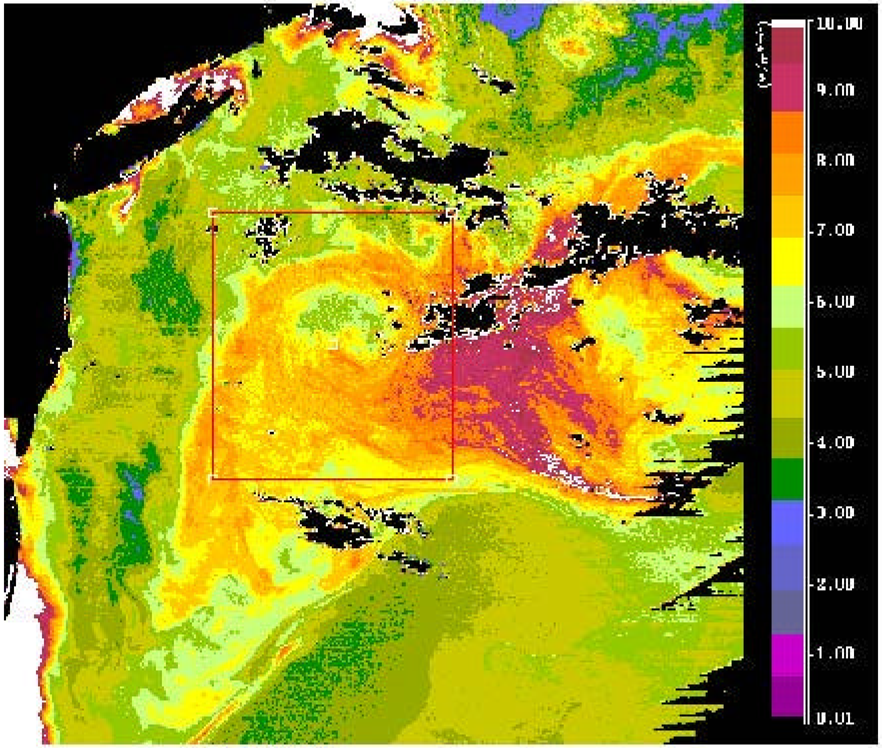


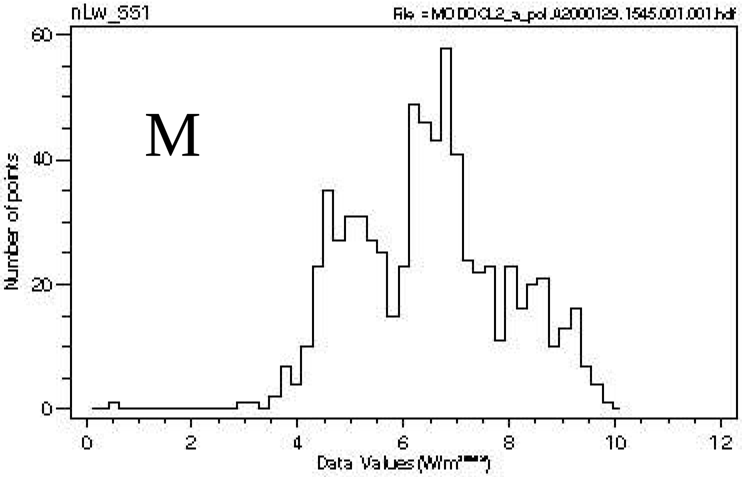
MODIS



SeaWiFS

MODIS nLw(551)

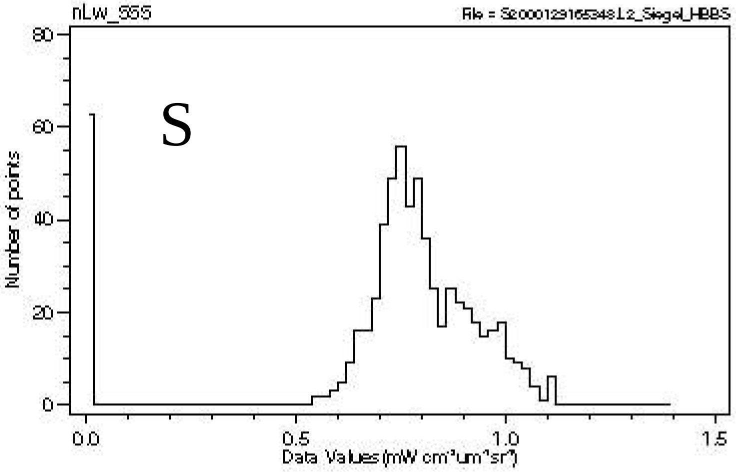




Min : 0.4800
Max : 9.8150
Median: 6.5000

Mean: 6.4849
STD : 1.4340
Mode : 6.8105

Binsize : 0.203000, No. of bins : 50
No. pts selected/No. pts in area : 711/746 (95.3083%)
Area : Blotch = 1

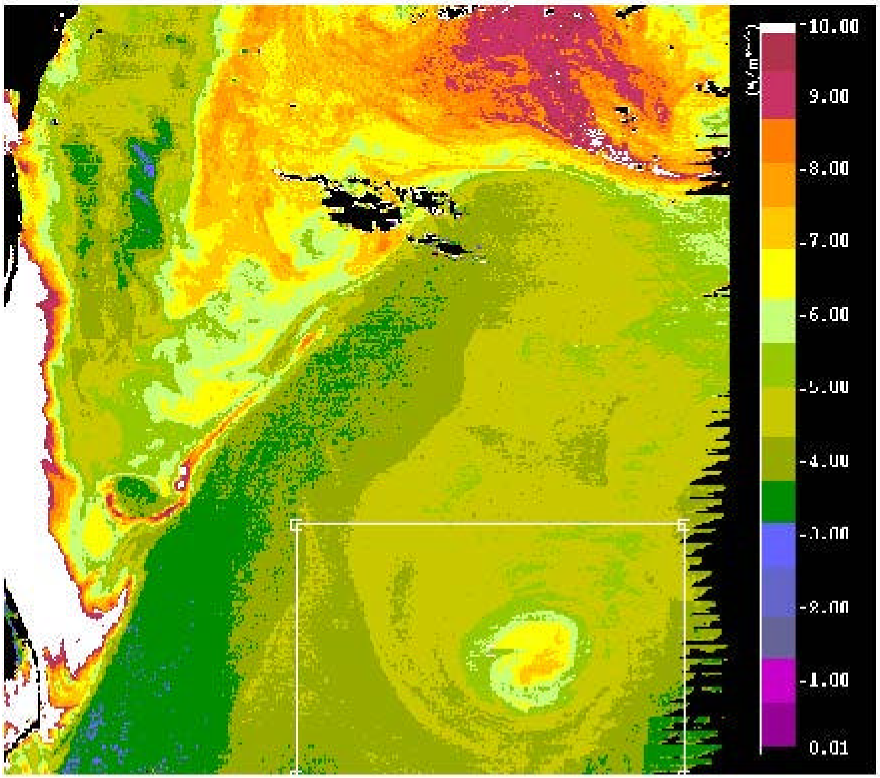


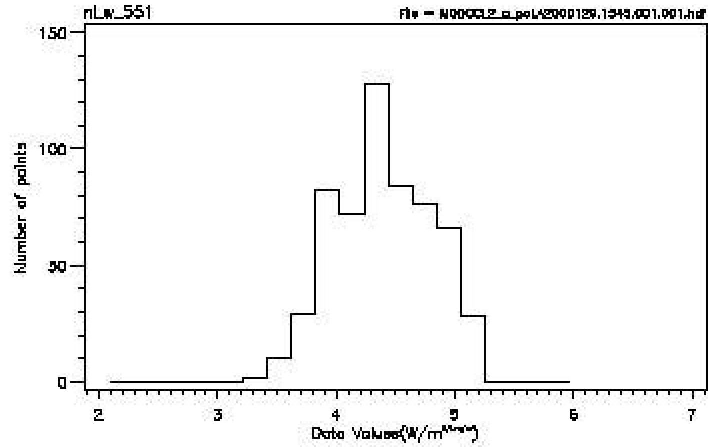
Min : 0.0000
Max : 1.1100
Median: 0.7720

Mean: 0.7285
STD : 0.2662
Mode : 0.0100

Binsize : 0.0200000, No. of bins : 70
No. pts selected/No. pts in area : 626/626 (100.000%)
Area : Blotch = 1

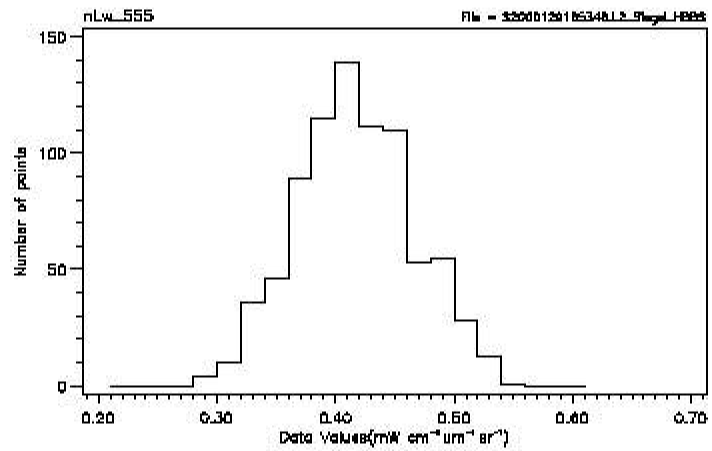
MODIS nLw(551)





Min :	3.3920	Mean:	4.3988
Max :	5.1810	STD :	0.3992
Median:	4.3790	Mode :	4.3345

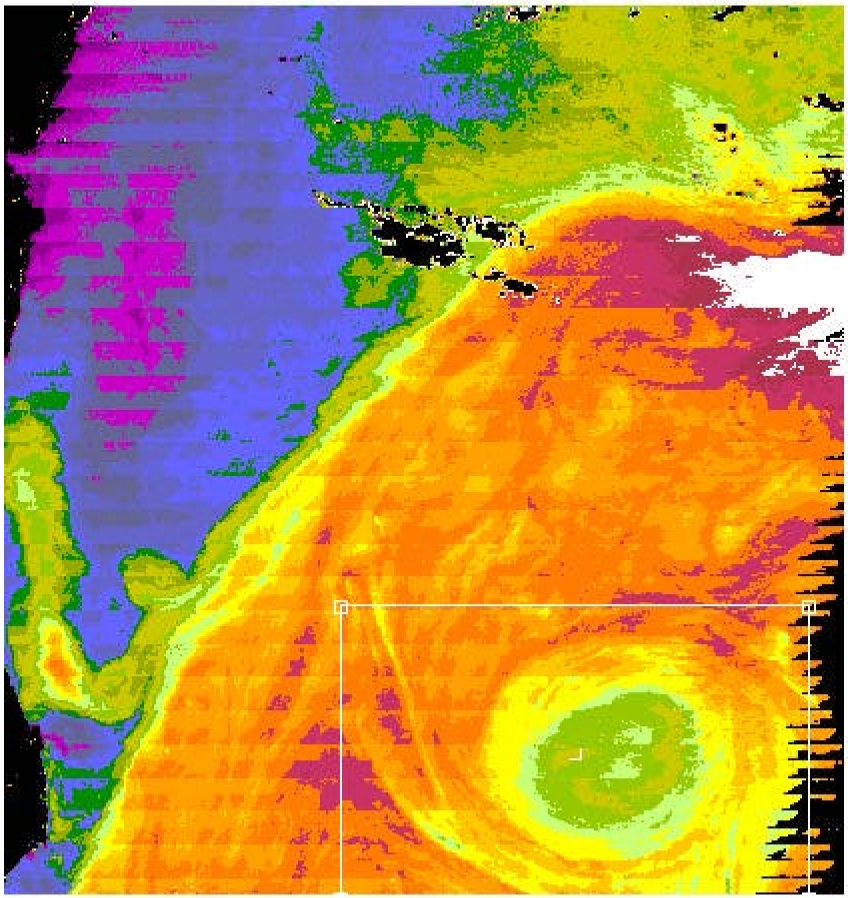
Binsize : 0.203000, No. of bins : 20
No. pts selected/No. pts in area : 577/606 (95.2145%)
Area : Blotch color = 7

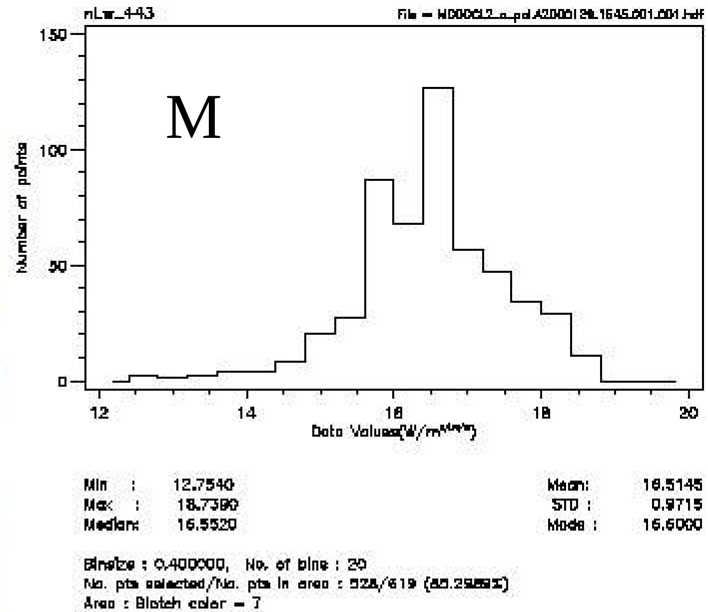


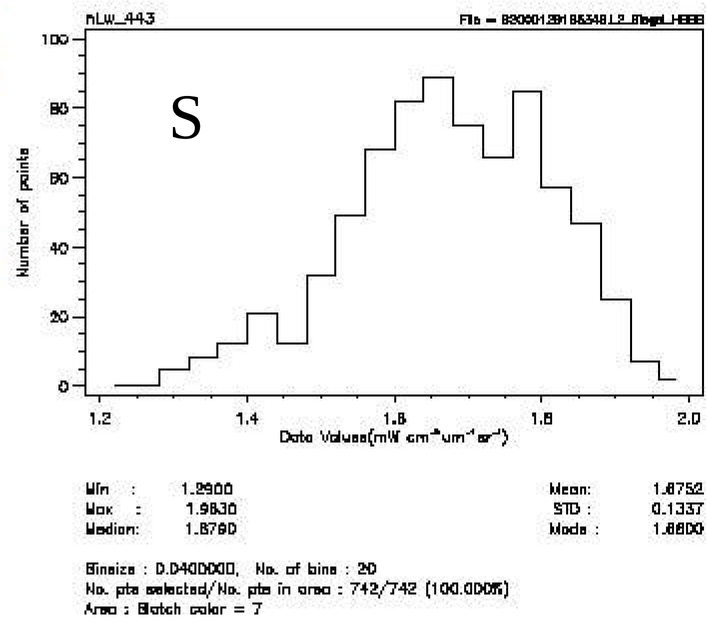
Min :	0.2870	Mean:	0.4173
Max :	0.5580	STD :	0.0488
Median:	0.4150	Mode :	0.4100

Binsize : 0.0200000, No. of bins : 21
No. pts selected/No. pts in area : 810/810 (100.000%)
Area : Blotch color = 7

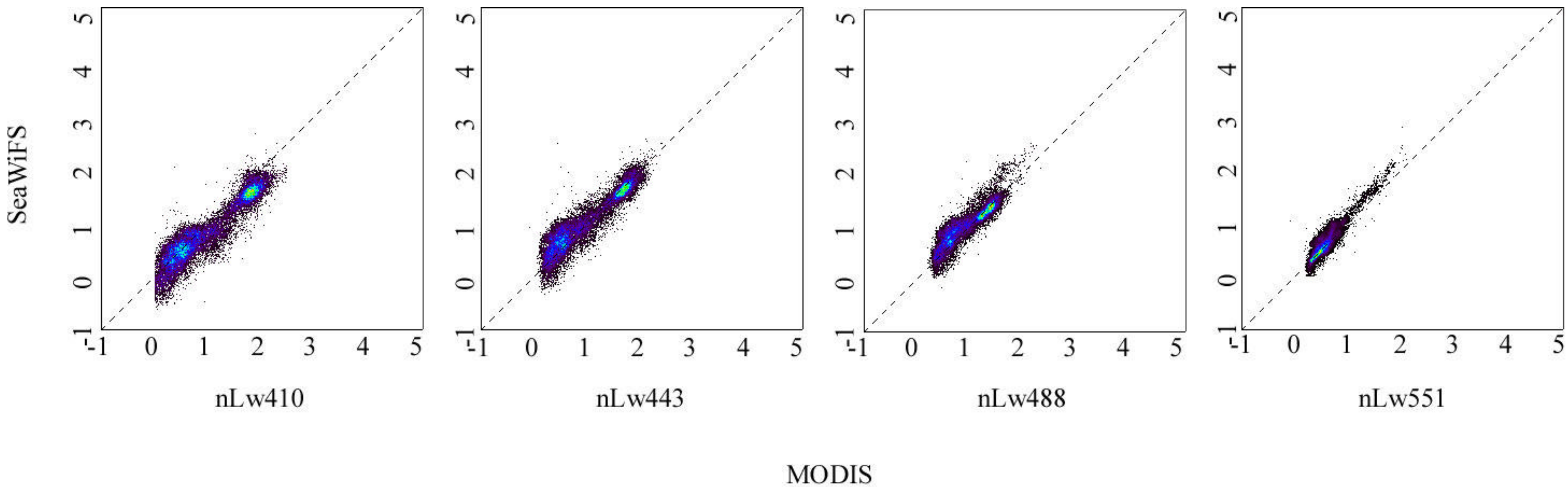
MODIS nLw(443)





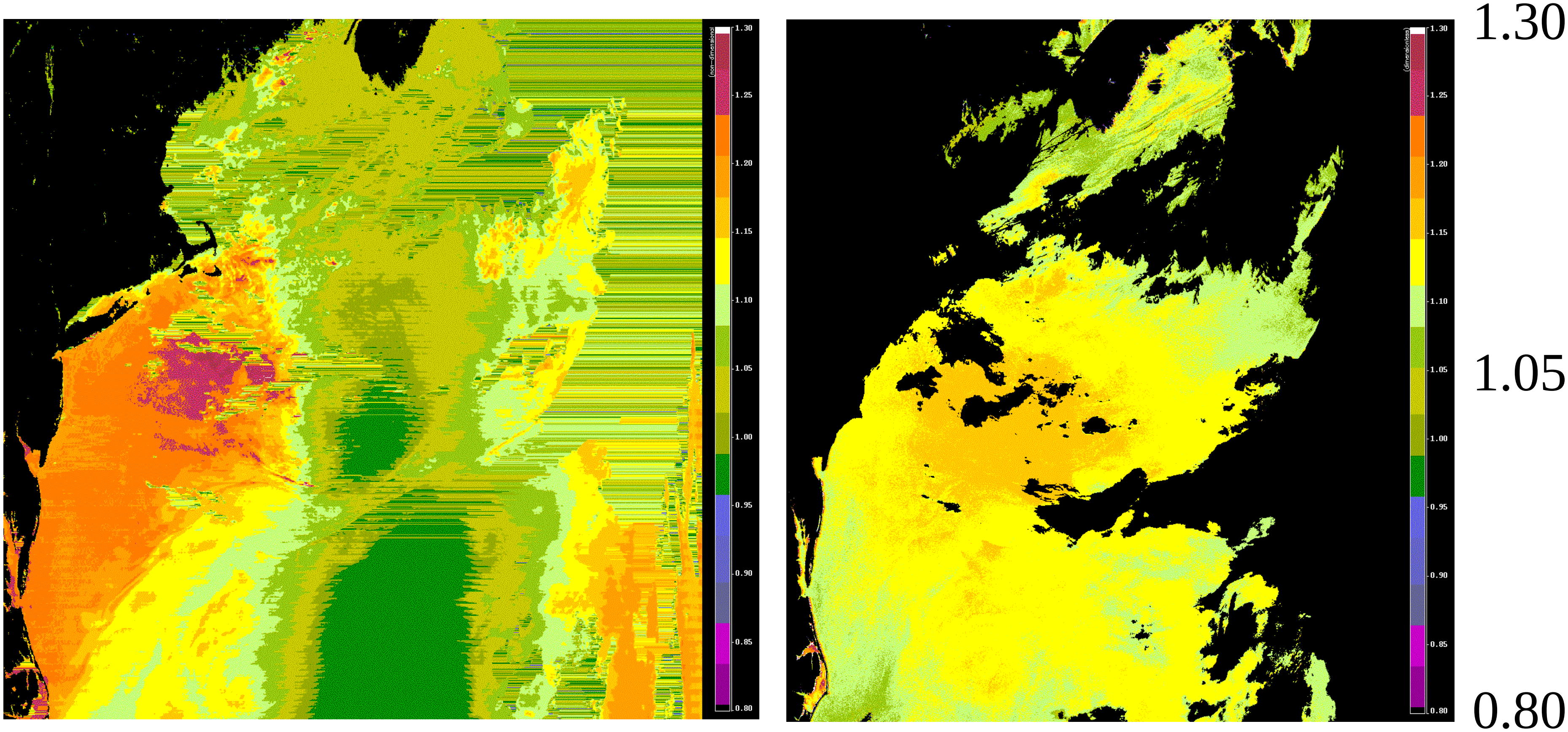


- When AOD(865) $<$ 0.20, there is good agreement between SeaWiFS and MODIS. This implies that the MODIS calibration is very close to being correct.



MODIS scene A2000.129.1545 5apol
SeaWiFS scene S2000129165158 Quality 0

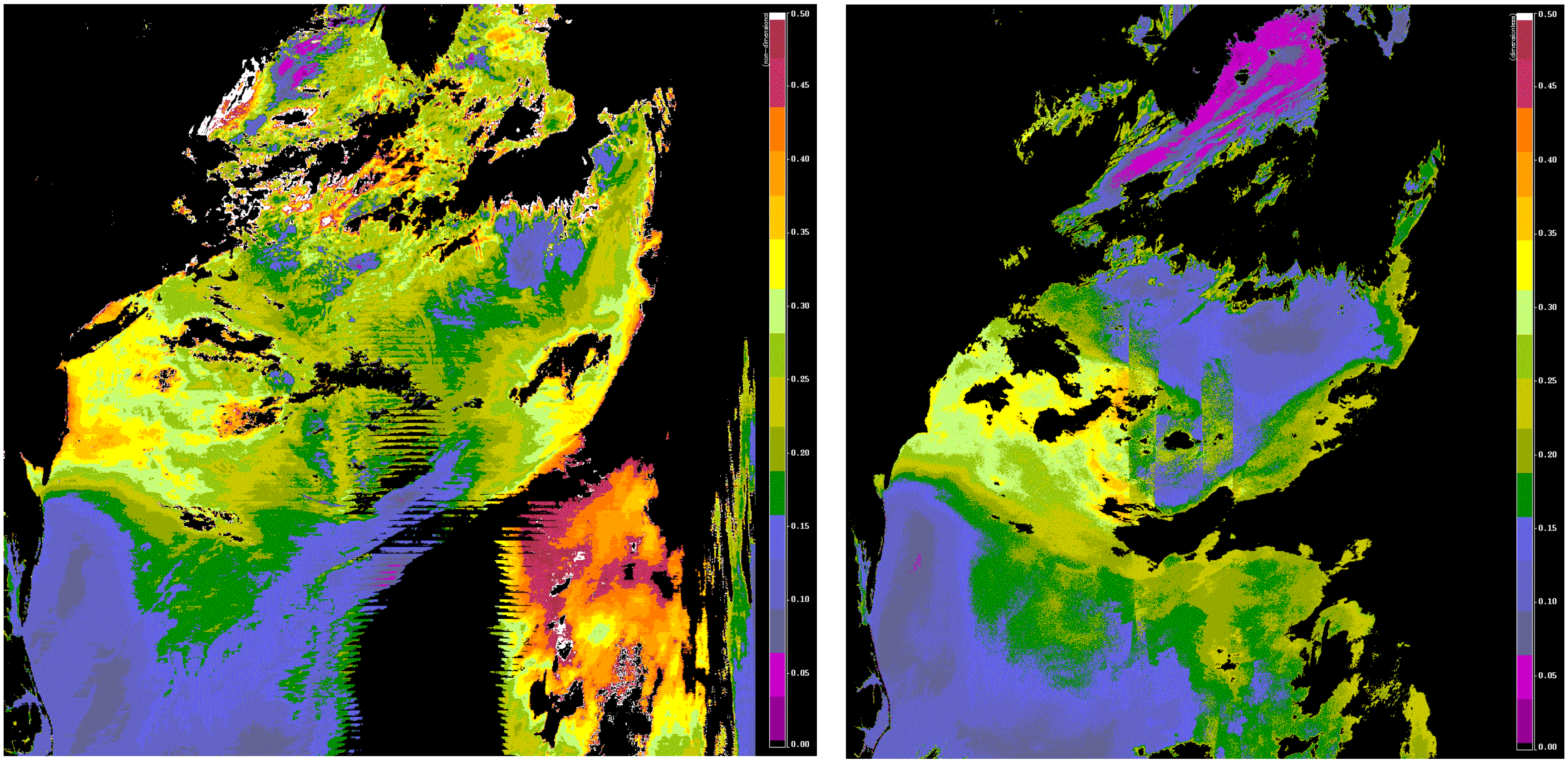
$\varepsilon^{SS}(765,865)$



MODIS

SeaWiFS

AOD(865)



0.50

0.25

0.00

MODIS

SeaWiFS

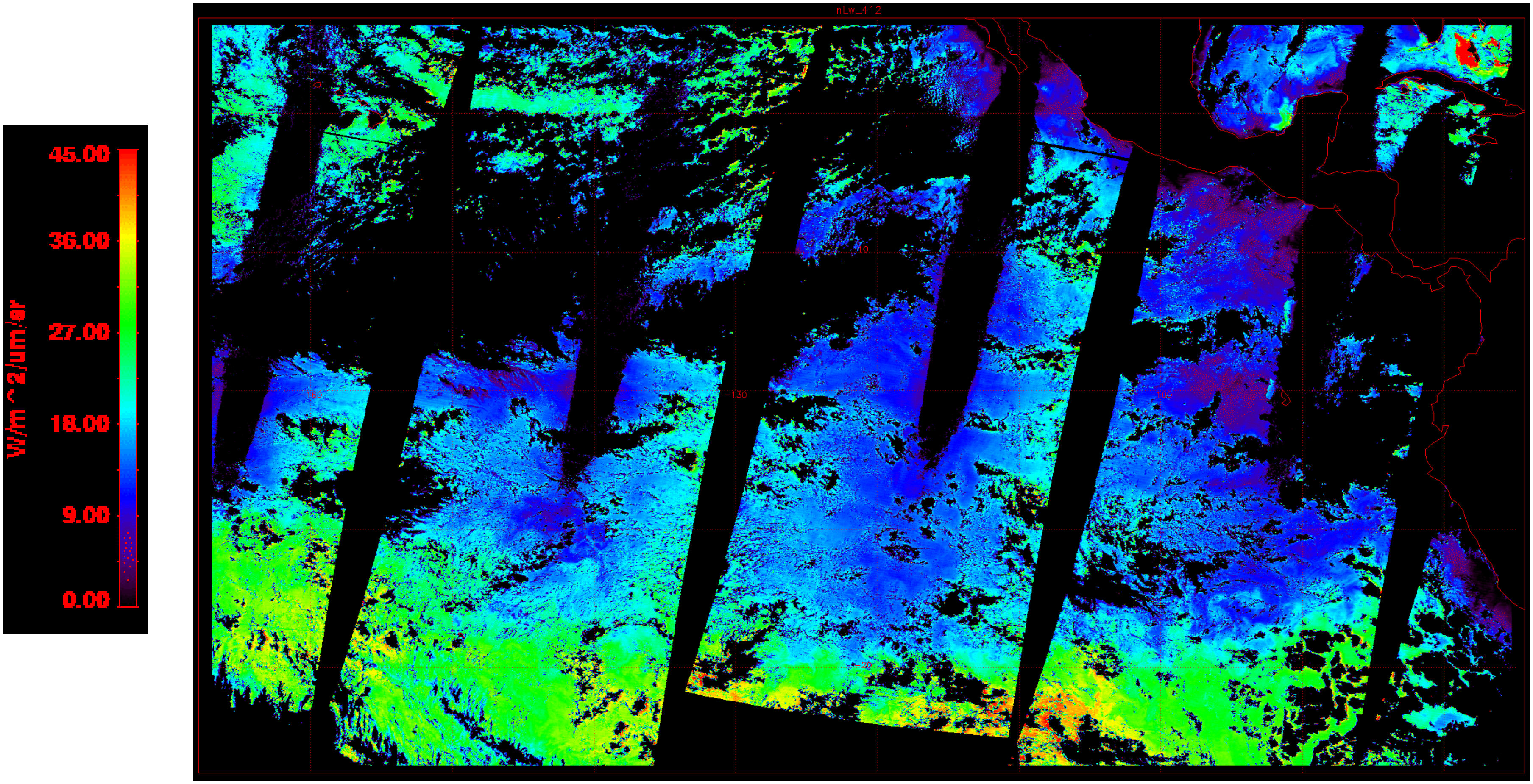
- The fact that $\varepsilon^{SS}(765,865)$ shows water structure in 2000129 indicates that there is residual water radiance in the NIR. *Add a correction to the* $\rho_w(765) \approx \rho_w(865) \approx 0$ *assumption. Note, this may increase the processing time.*

- MODIS AOD(865) compares reasonably well with SeaWiFS except in the vicinity of the sun glint.

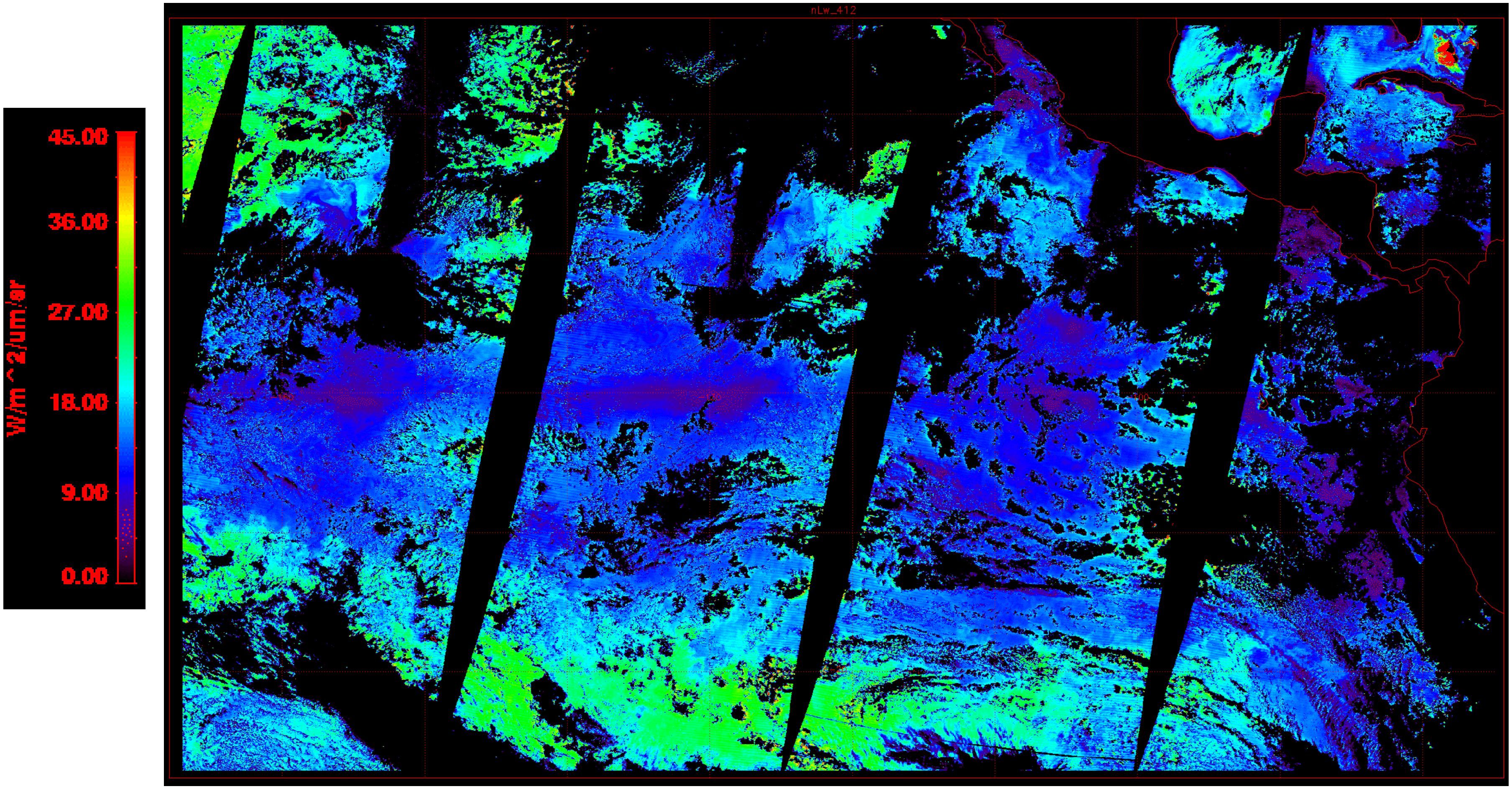
3. Global Behavior of *nLw*(λ)

- Do the *nLw*'s vary from orbit-to-orbit in an expected manner?

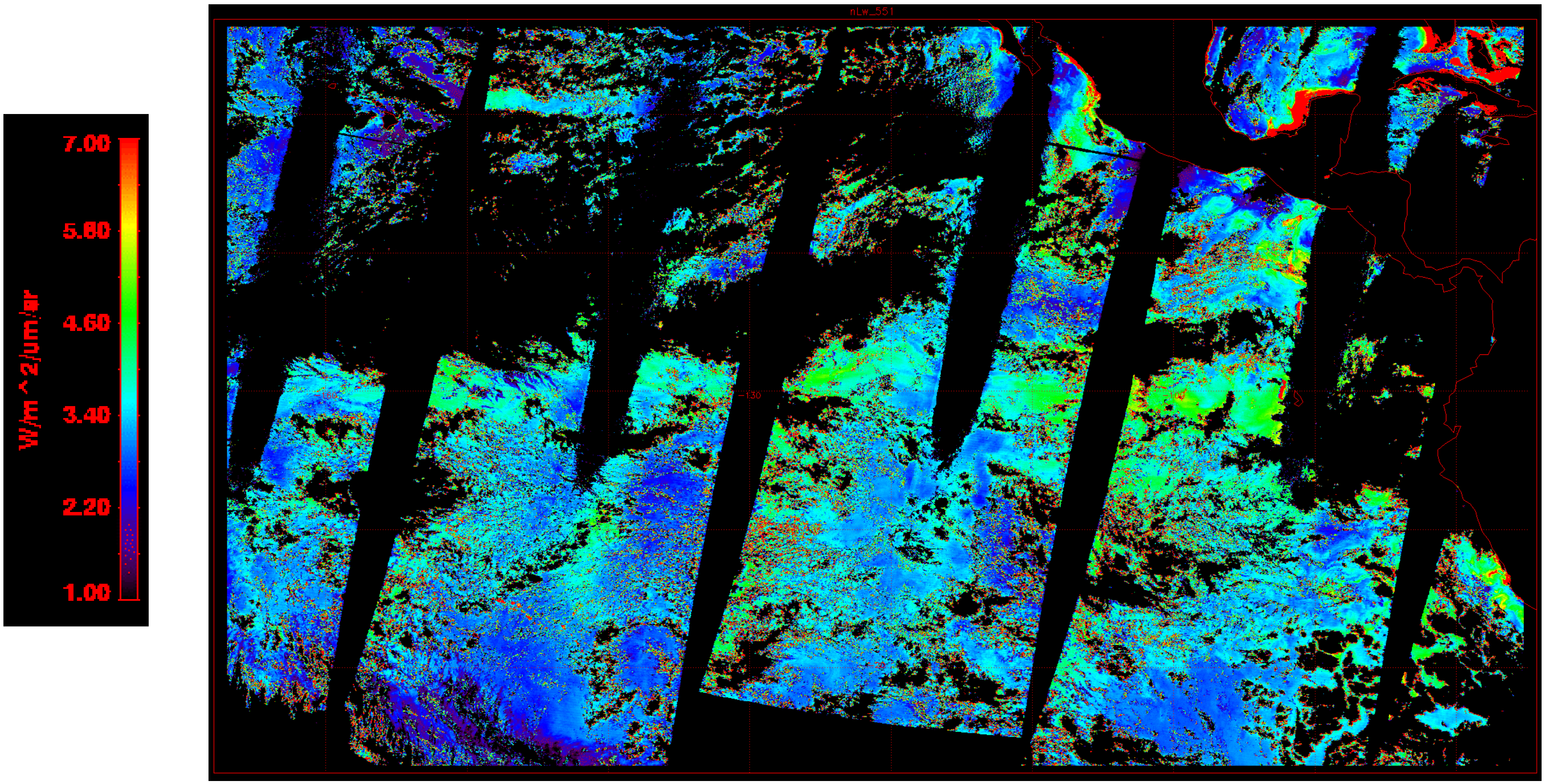
nLw(412) Apr. Quality "All"



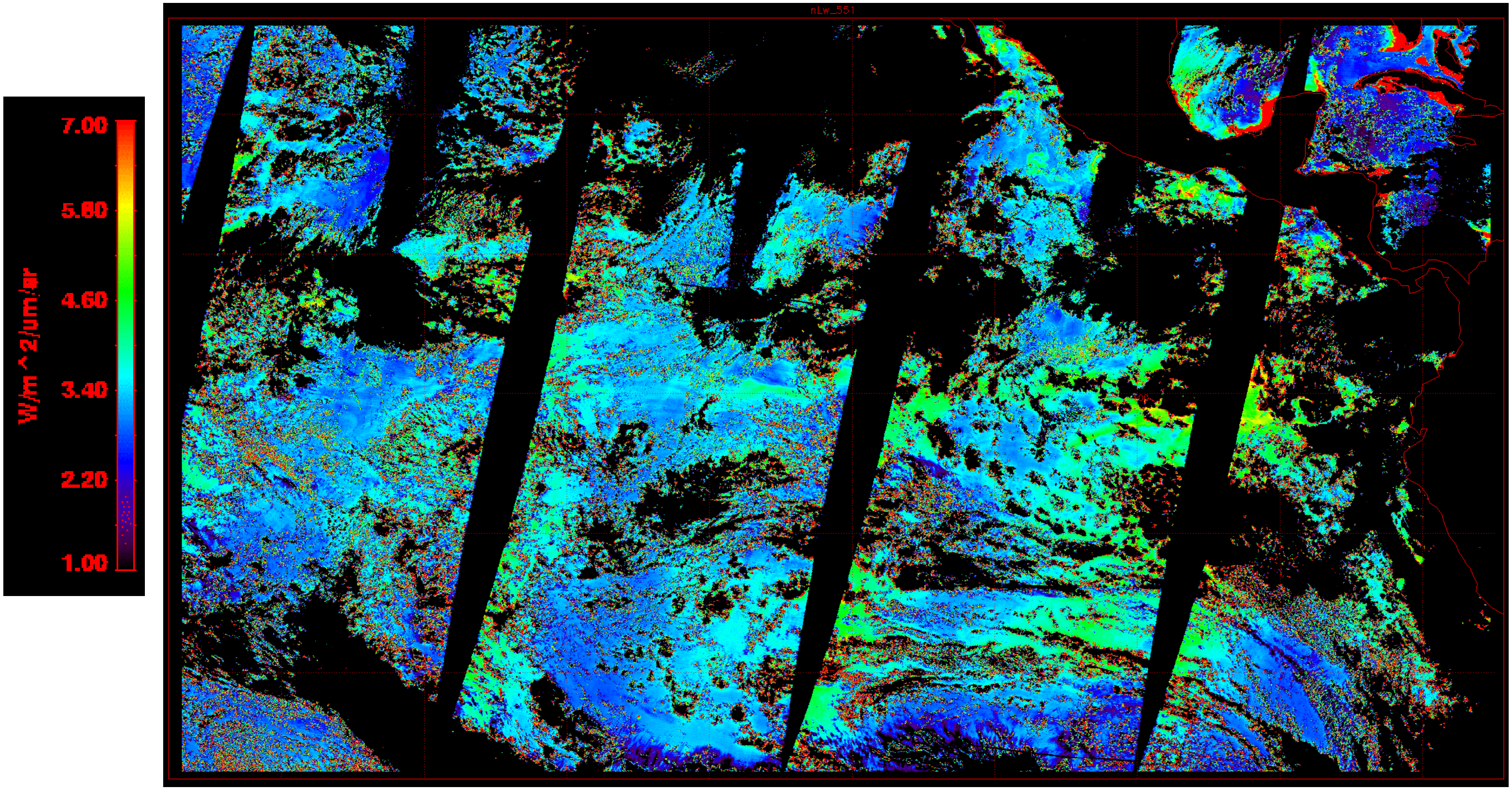
nLw(412) Jun. Quality “All”



nLw(551) Apr. Quality "All"



nLw(551) Jun. Quality "All"



- Cross-scan and orbit-to-orbit behavior of *nLw*(412) is now excellent.
- Cross-scan and orbit-to-orbit behavior of *nLw*(551) implies that more work is required for this band.

Next Steps (Near Term)

- Refine calibration in NIR and then visible
- Add routine to include estimate of ρ_w in the NIR
- Adjust calibration of the fluorescence bands using an ocean-atmosphere model in the red and NIR.
- Add BRDF correction for a better comparison with SeaWiFS

Our intention is to have the first three in place for the reprocessing software.

Next Steps (Farther Term)

- Retrieval in dust.

- Case 2 waters (coastal)

These require coupled ocean and atmosphere retrievals, and the concomitant significant changes to the structure and speed of the processing algorithms.