MODIS Atmospheric Correction Performance: Initial Evaluation

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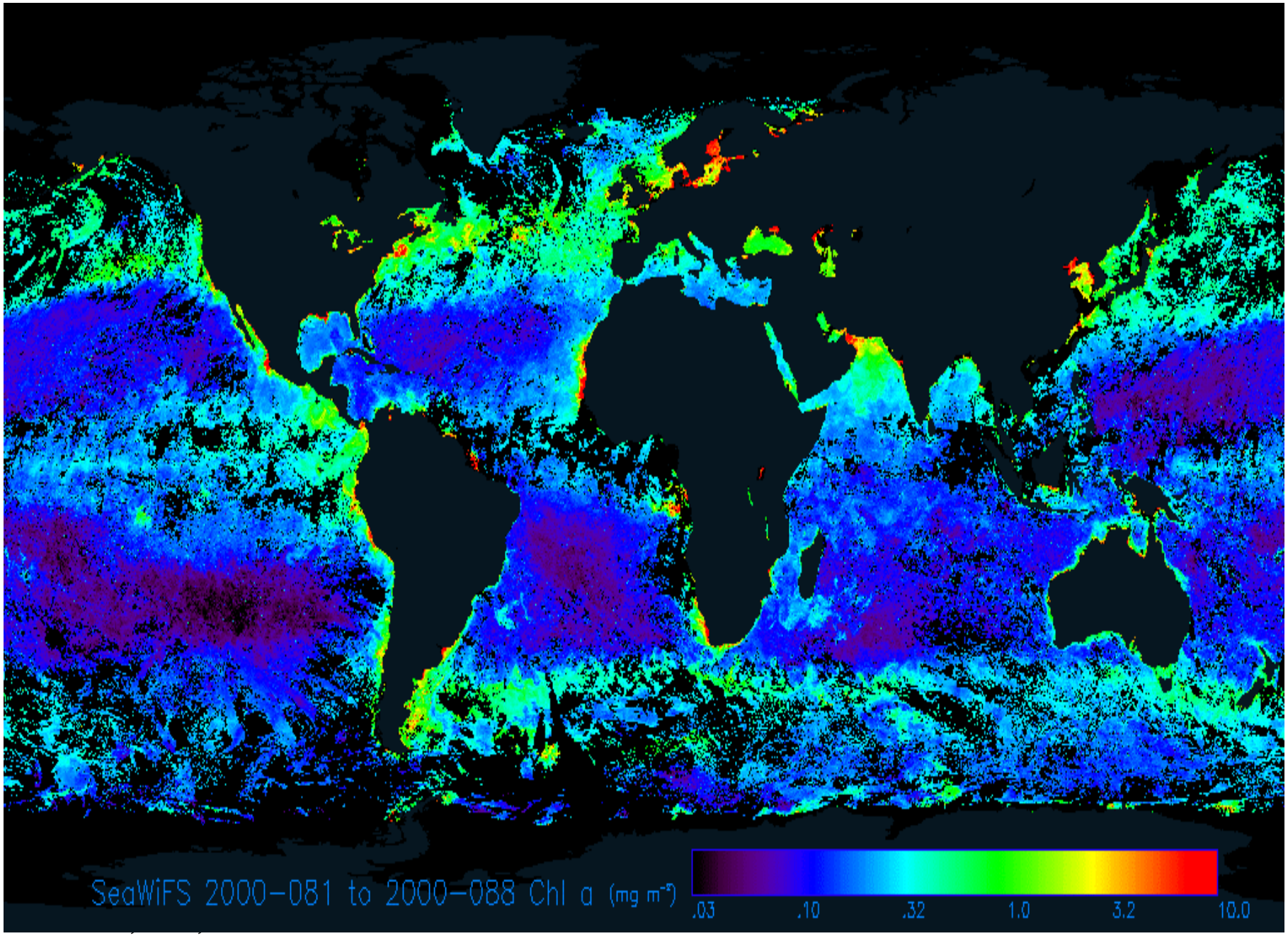
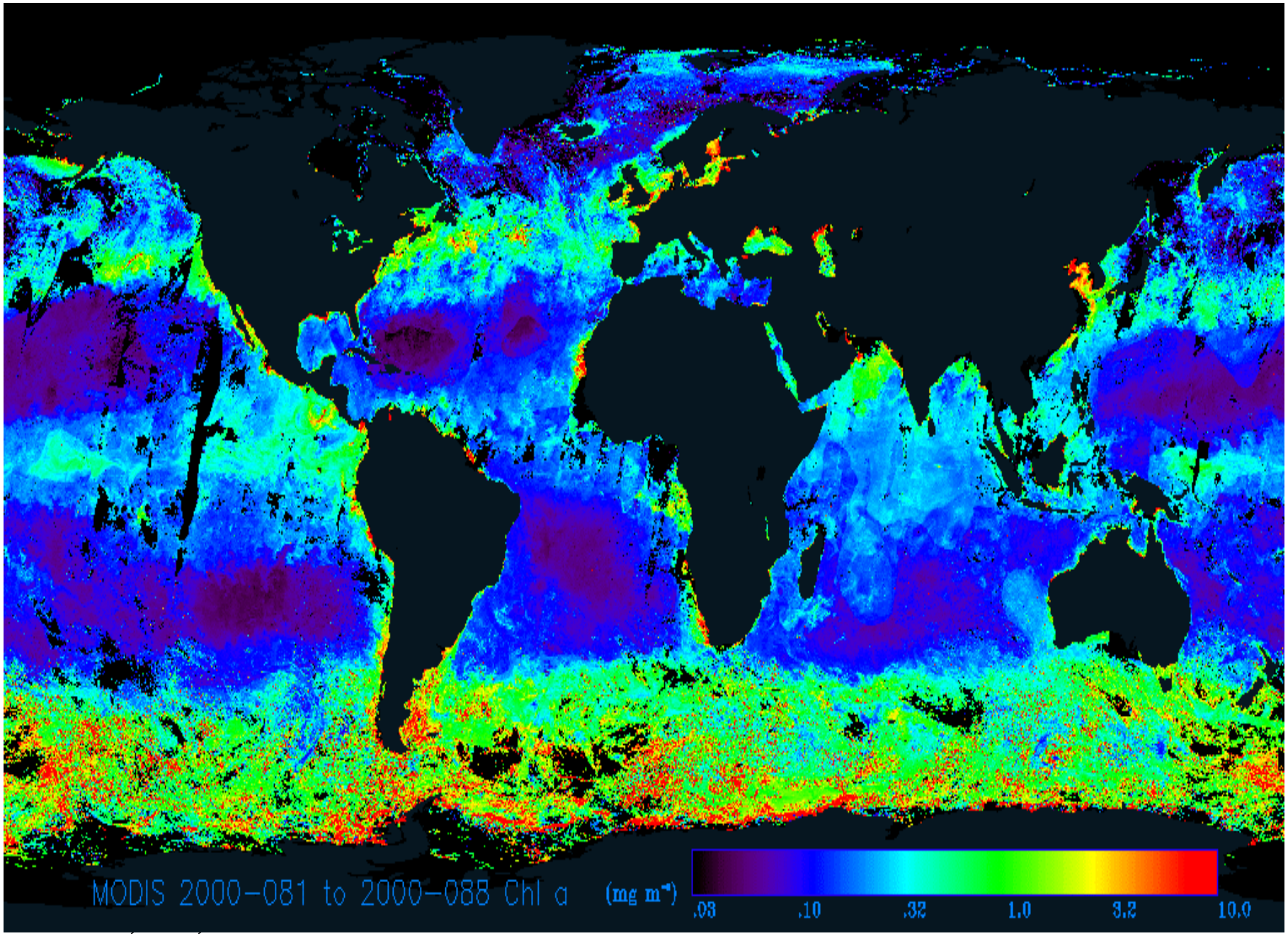
MODIS Science Team Meeting June 2000

MODIS Atmospheric Correction
Initial Evaluation

- MODIS/SeaWiFS Chl *a* at 36 km resolution
- Examine $nL_w(\lambda)$ for a Single Granual at Full Resolution
- Examine Retrieved Values for a Single AOI and Single Scan Line
- Review Atmospheric Correction Algorithm
- Evaluate Performance of Atmospheric Correction Bands 15 and 16
- Overall Evaluation


SeaWiFS 2000-081 to 2000-088 Chl a (mg m⁻³)
.03
.10
.32
1.0
3.2
10.0


MODIS 2000-081 to 2000-088 Chl a
(mg m⁻³)
.03
.10
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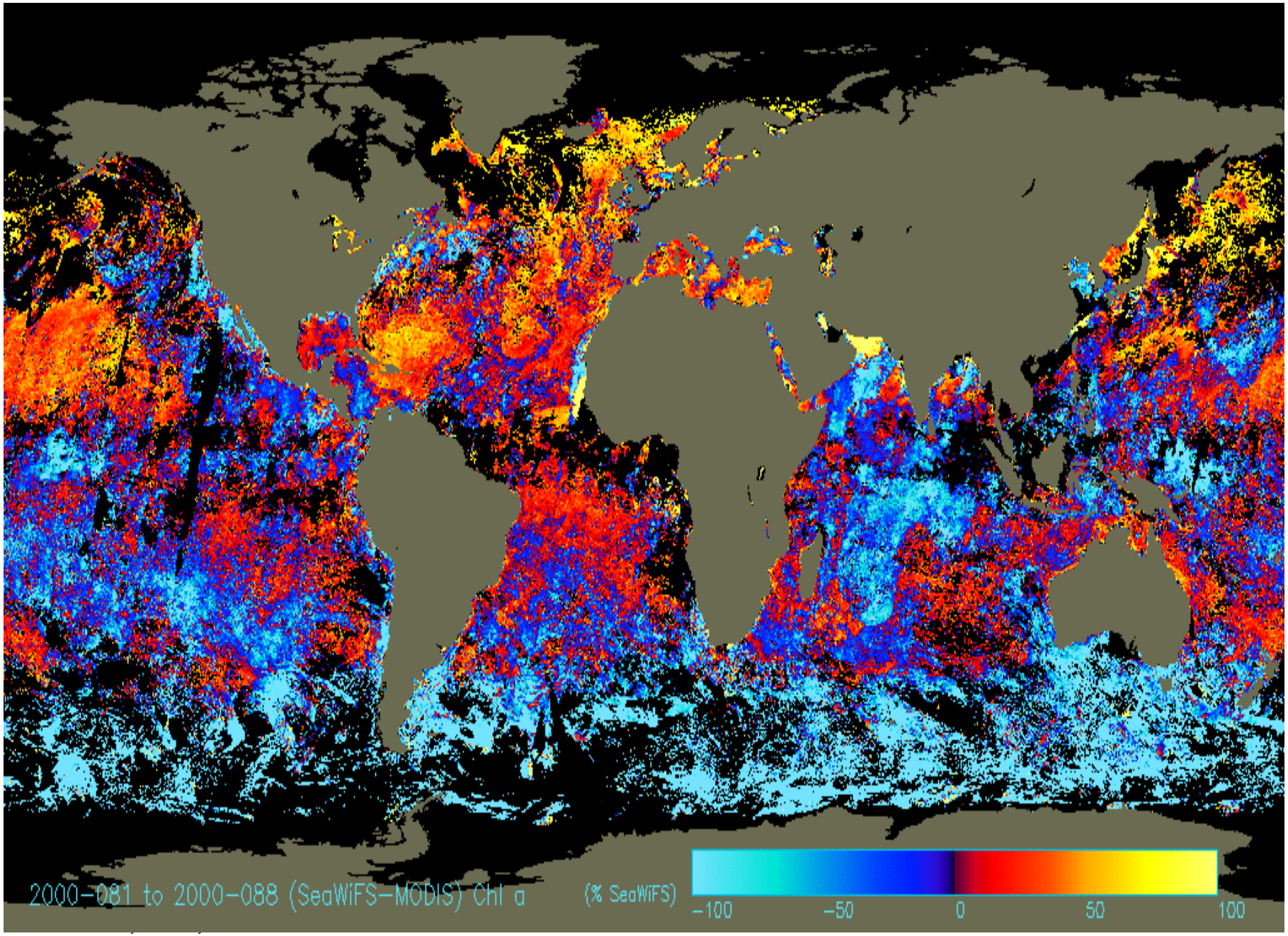
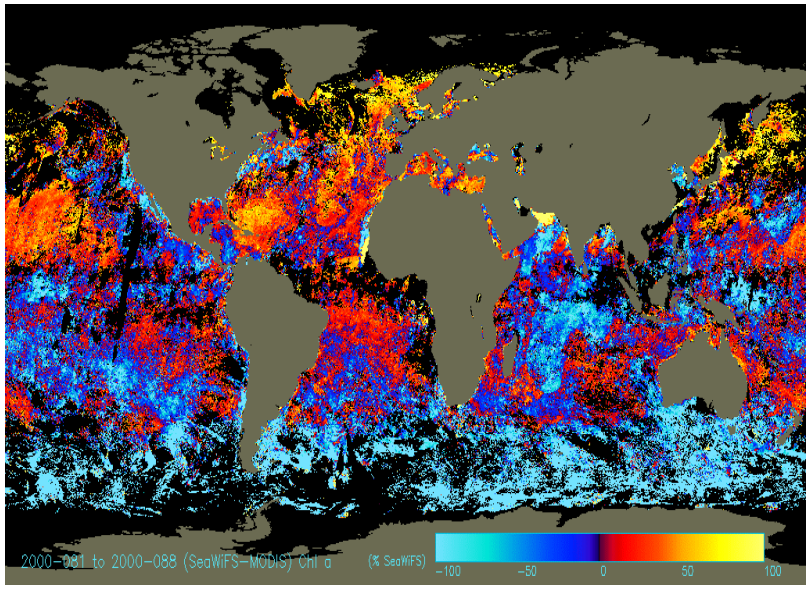
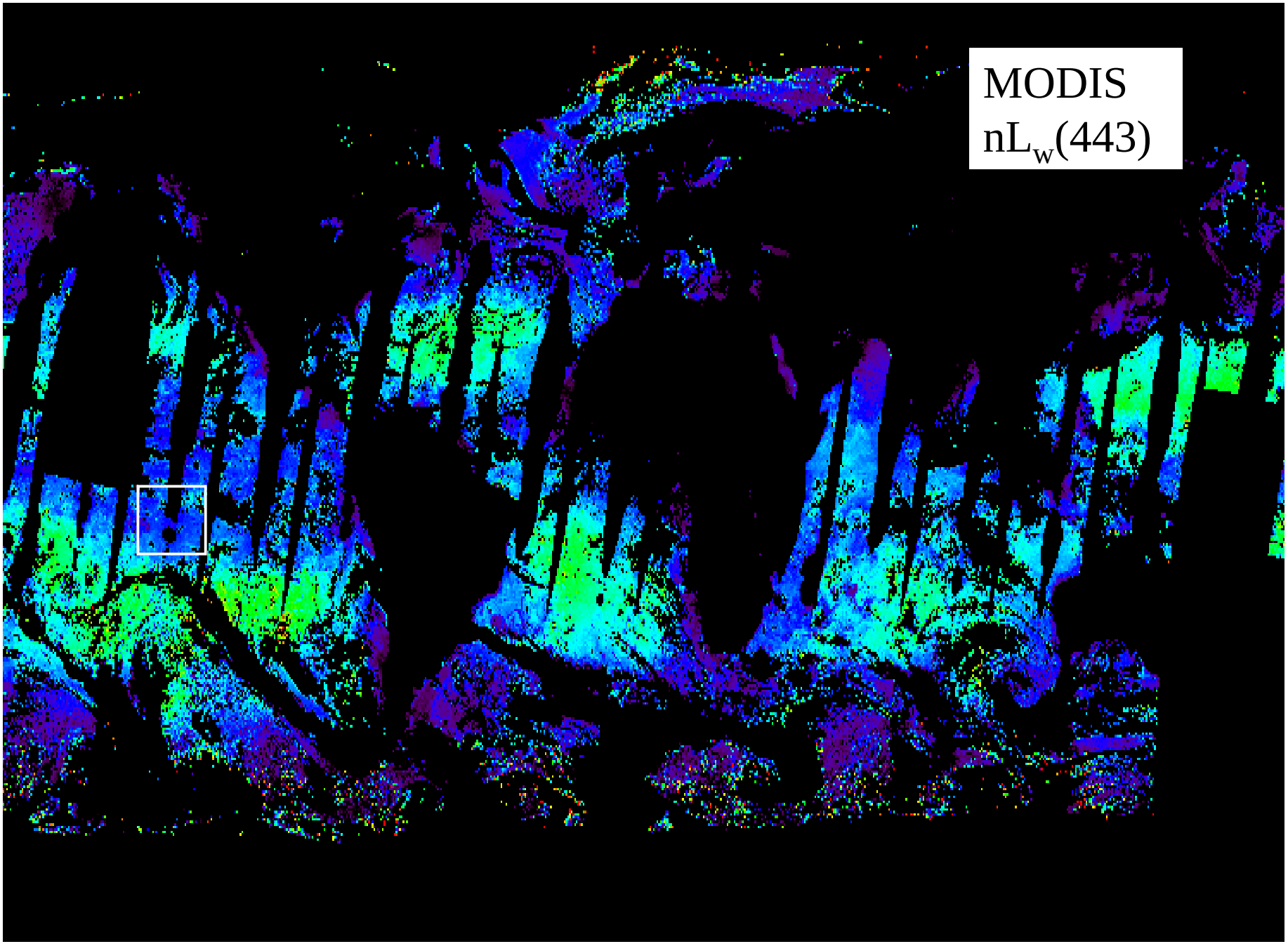

2000-081 to 2000-088 (SeaWiFS-MODIS) Chl a
(% SeaWiFS)
-100
-50
0
50
100

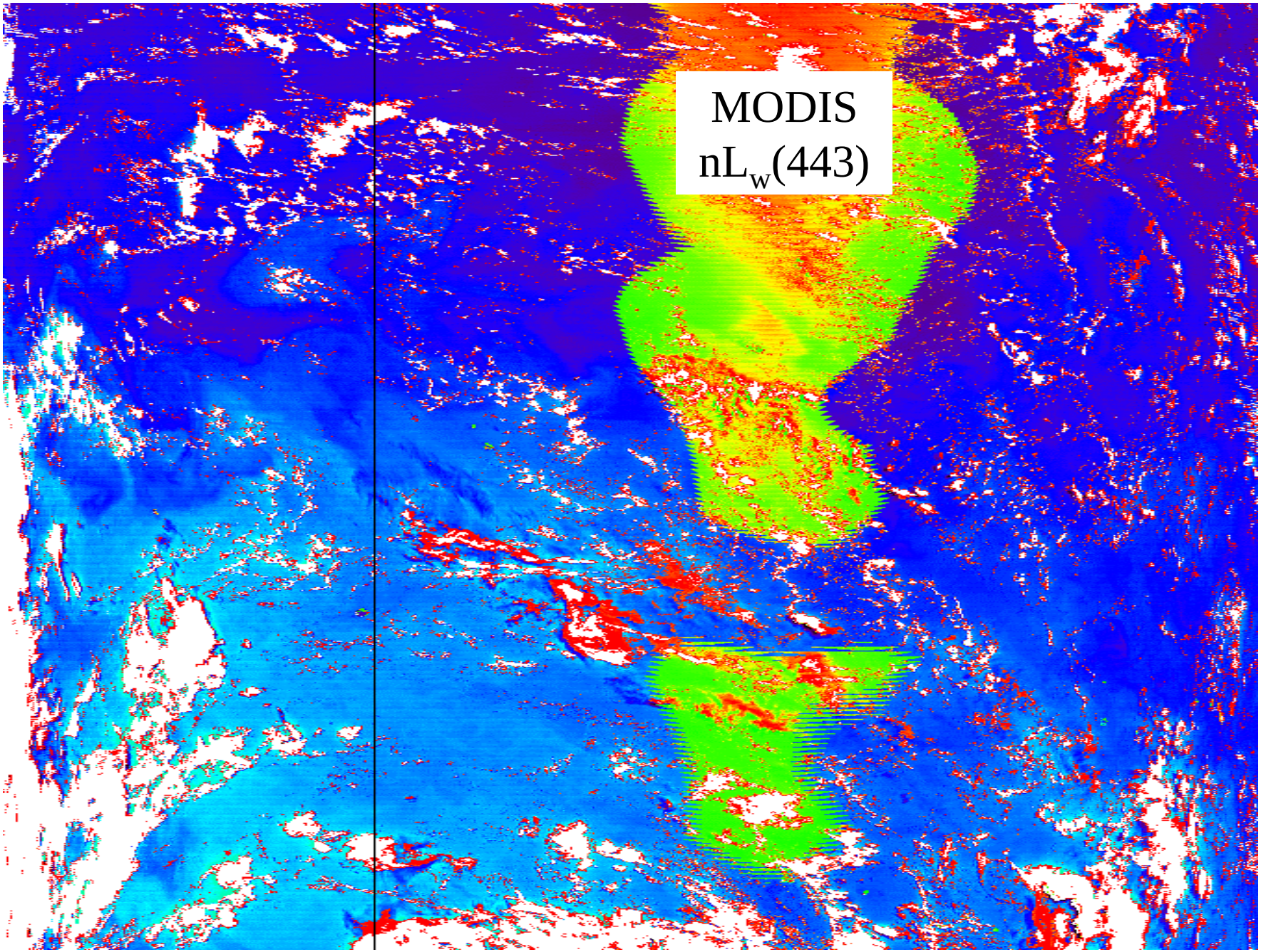
SeaWiFS - MODIS Chl *a*



- Difference ~ factor of 2
- Difference is equally likely to be positive or negative
- No obvious pattern
- MODIS **high** at high Southern latitudes
- MODIS **low** at high Northern latitudes

HRG, MST, June 2000


MODIS
nL$_w$(443)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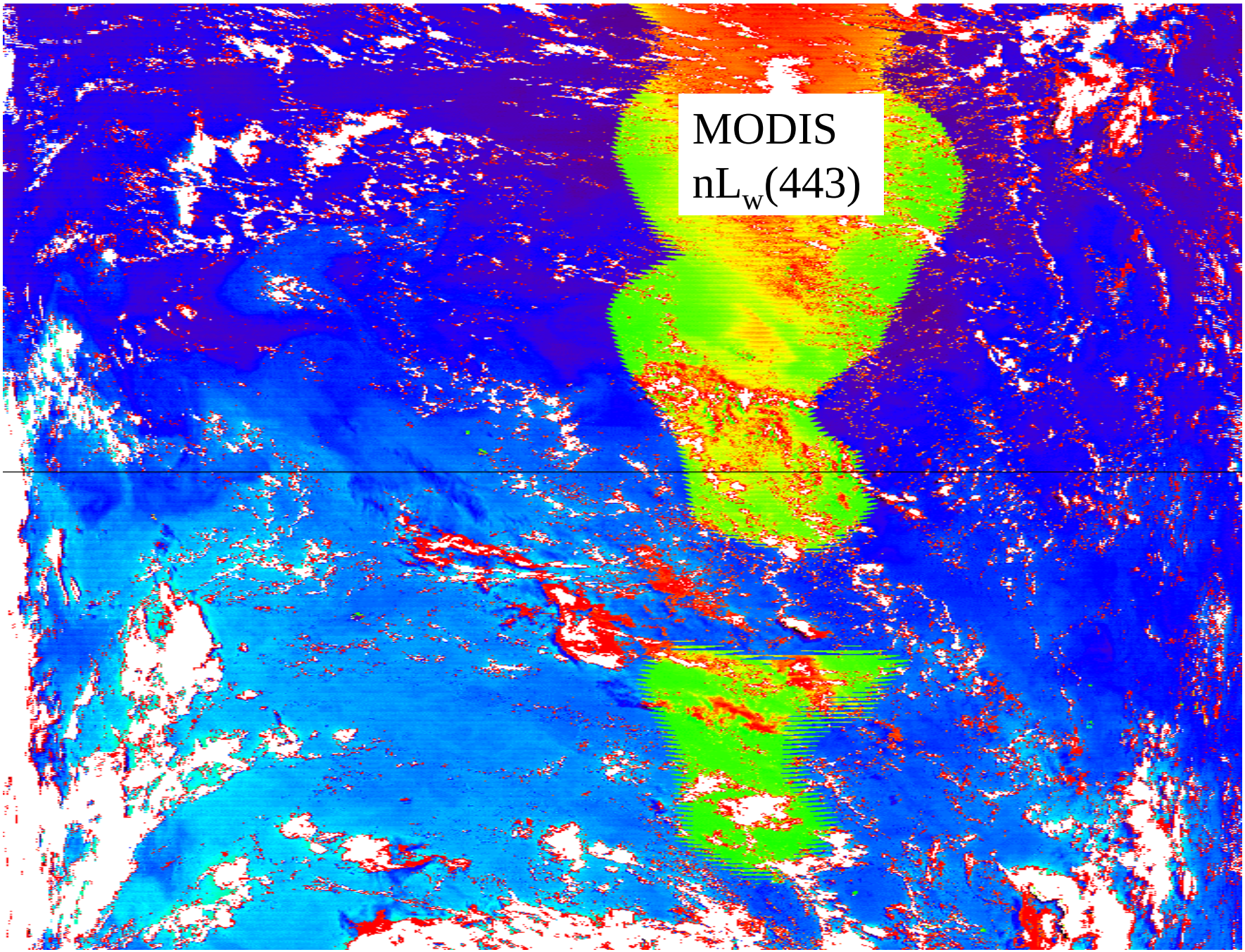
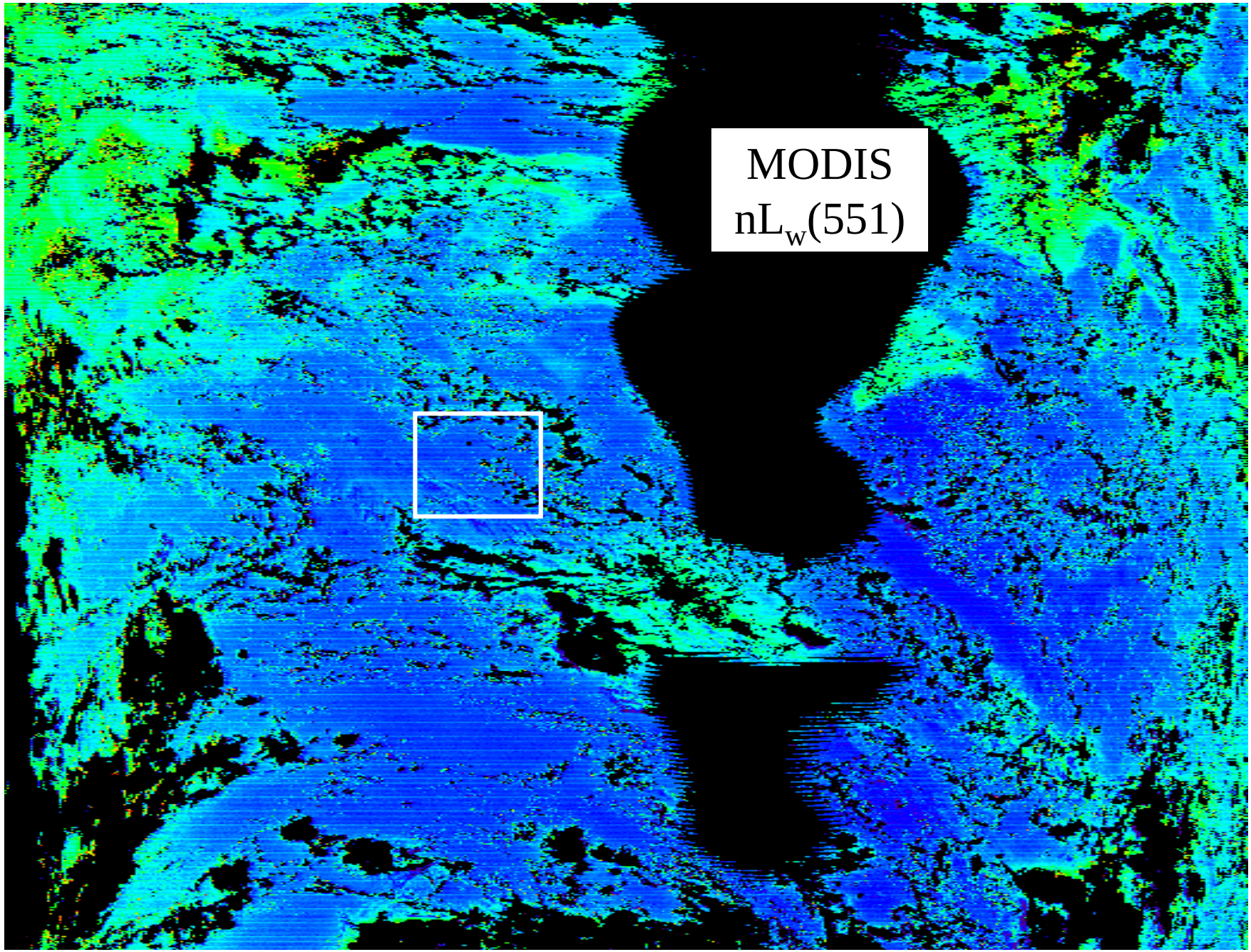
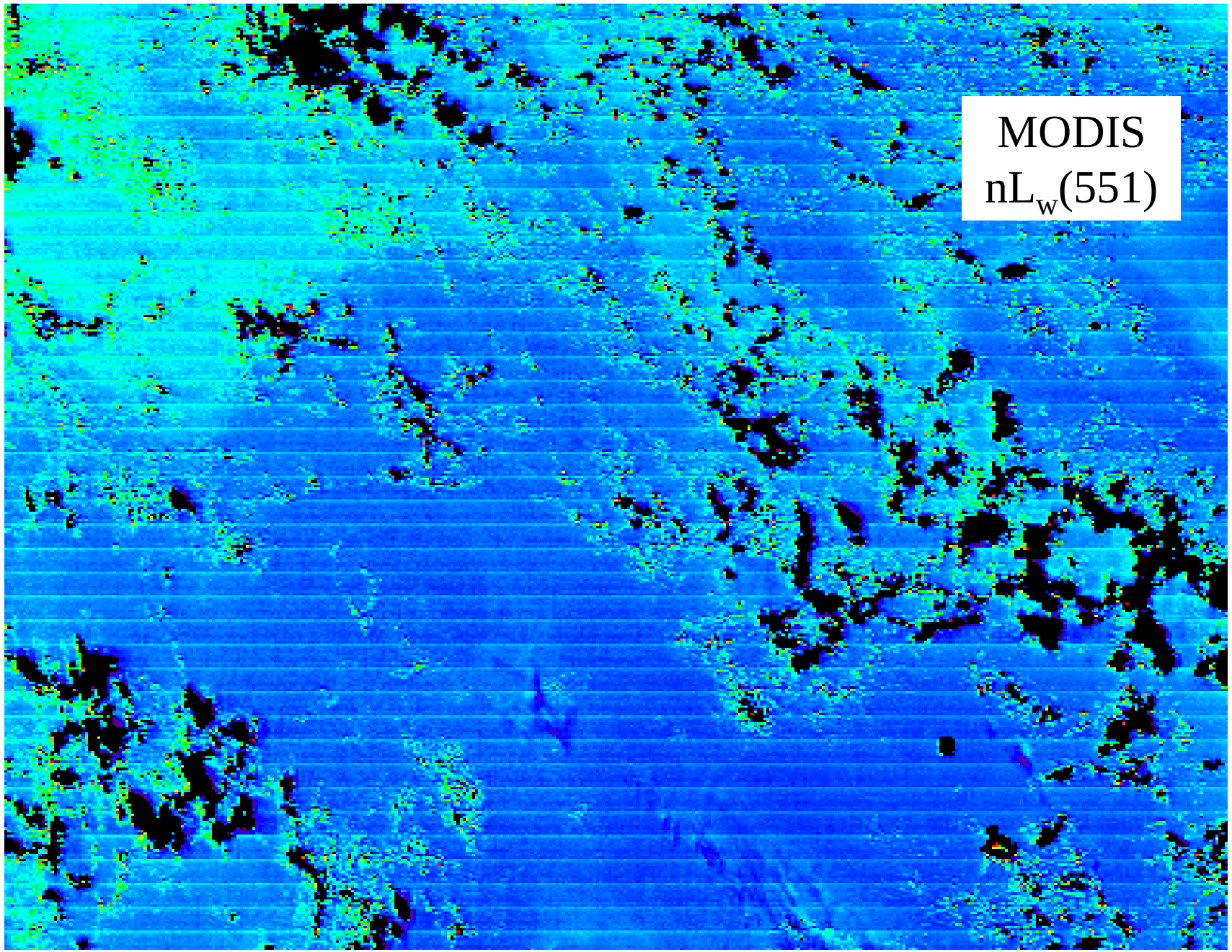
nL$_w$(443)


MODIS
nL$_w$(443)


MODIS
nL$_w$(551)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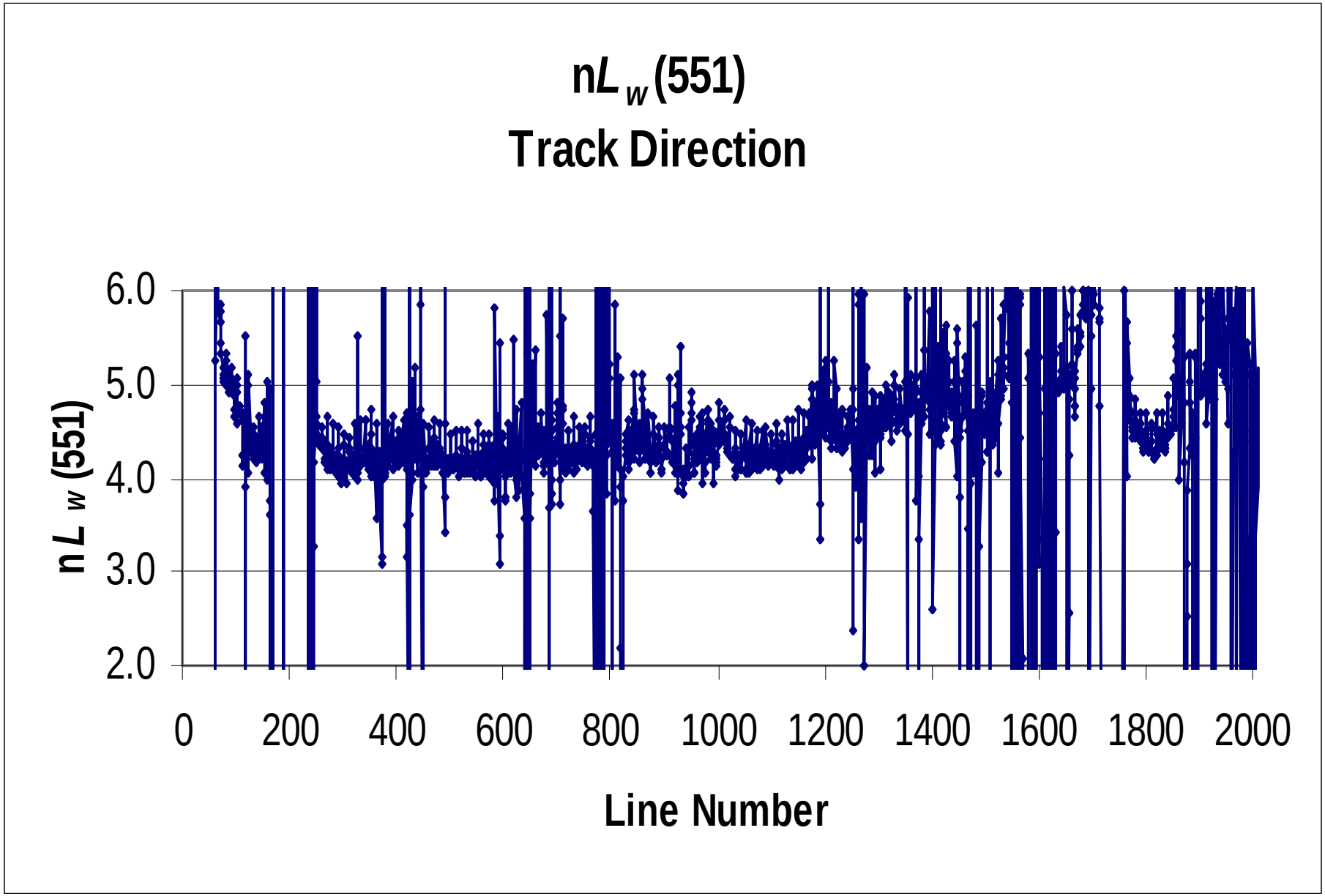
nL$_w$(551)



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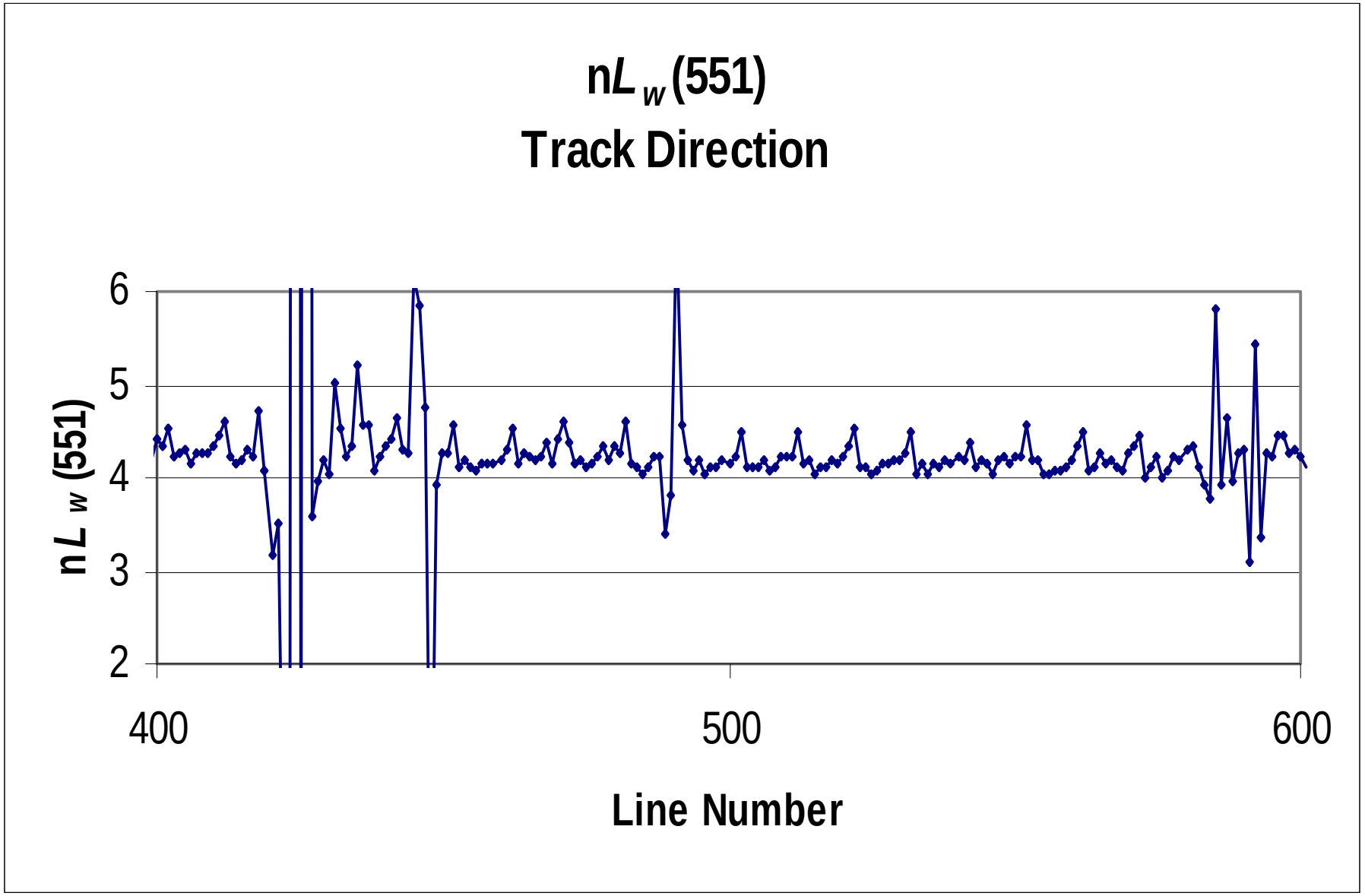

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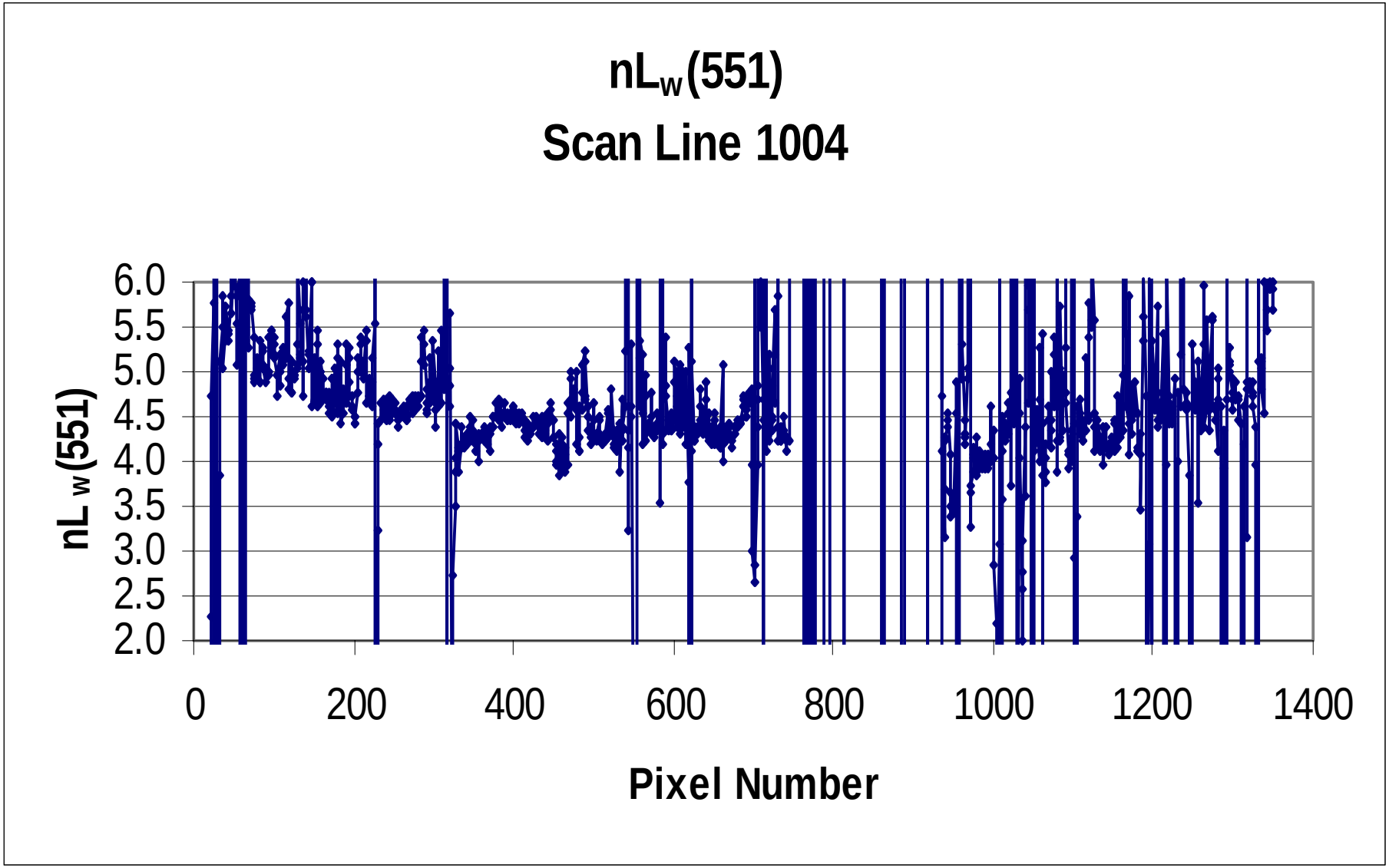

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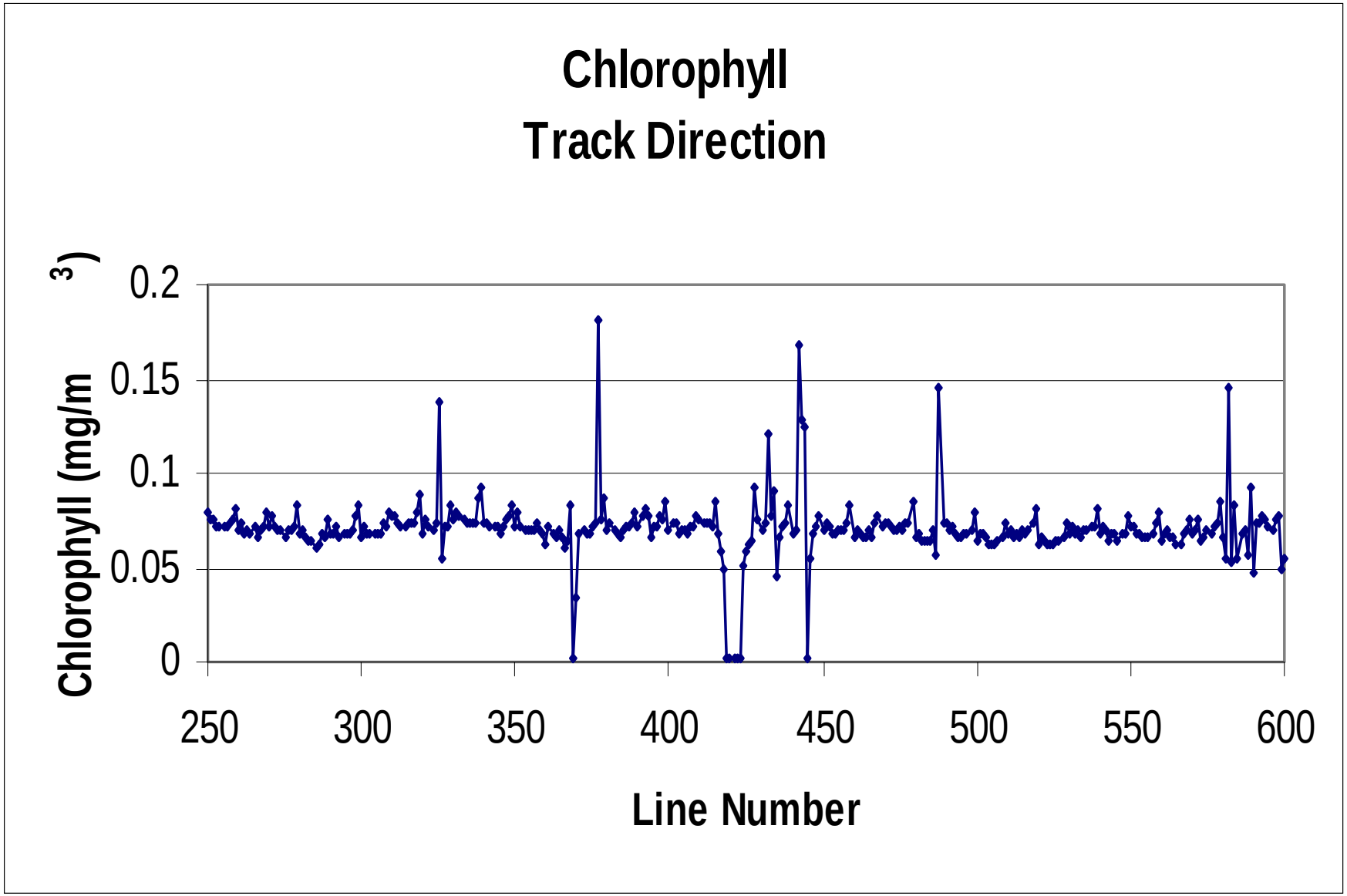

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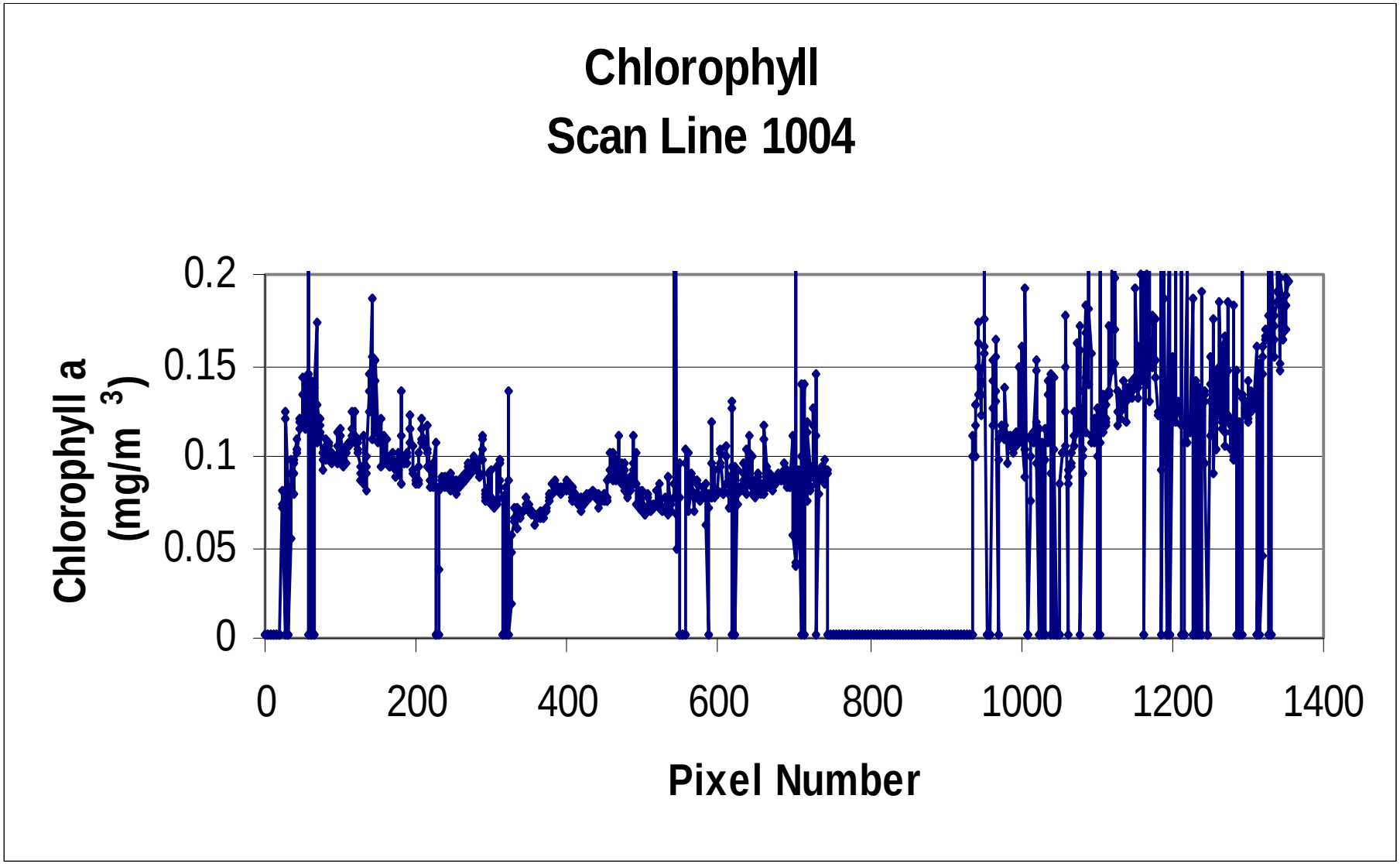


HRG, MST, June 2000

Atmospheric Correction (Simplified)

$$\rho = \frac{\pi L}{F_0 \cos\theta_0}$$

$$\rho_t(\lambda) = \rho_r(\lambda) + \underbrace{\rho_a(\lambda) + \rho_{ra}(\lambda)}_{\rho_A(\lambda)} + t_0(\lambda)t_v(\lambda)n\rho_w(\lambda)$$

$$\varepsilon(\lambda,\lambda_0) \approx \frac{\rho_A(\lambda)}{\rho_A(\lambda_0)}$$

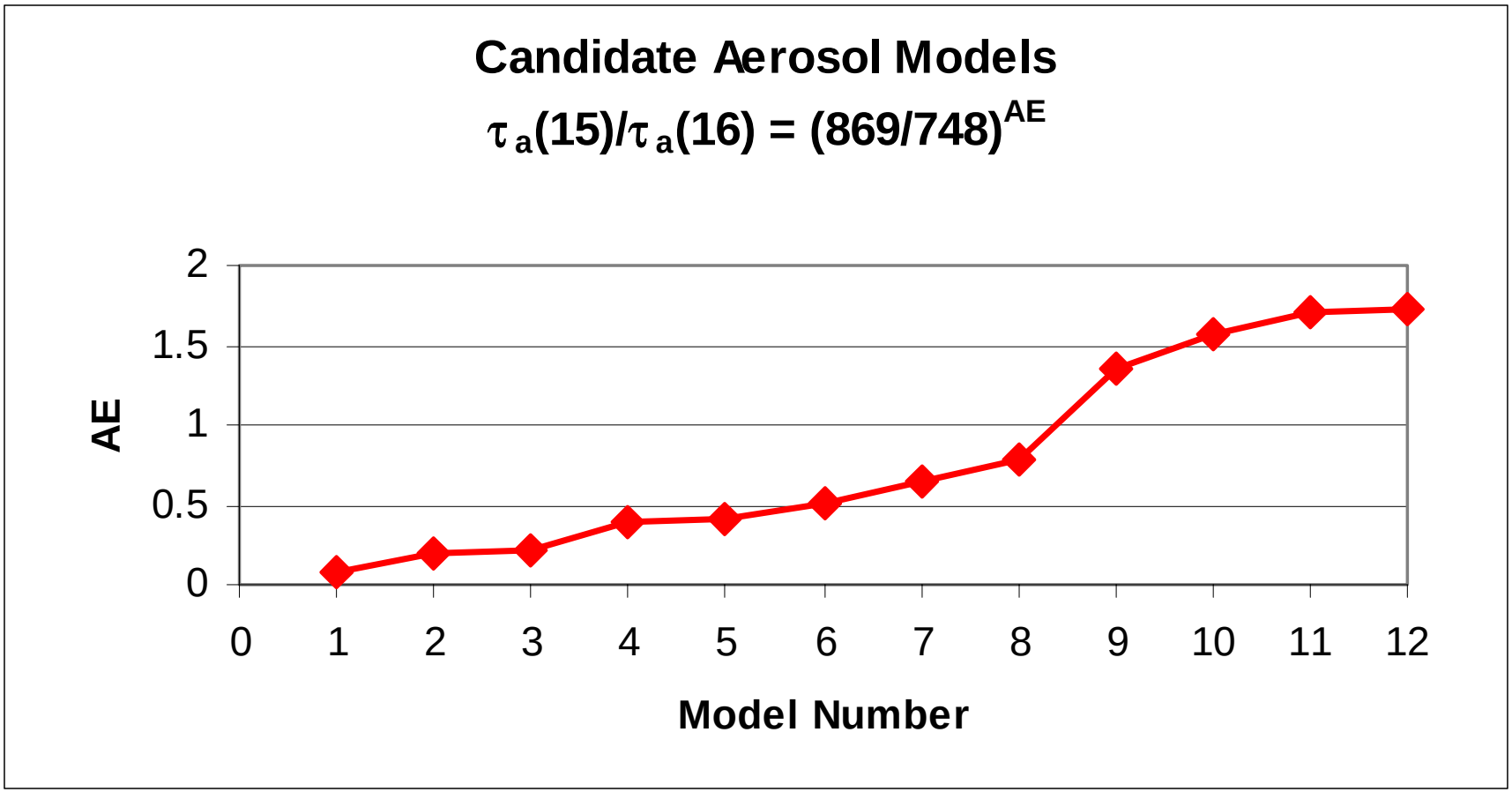
In NIR $n\rho_w$=0, so

$$\varepsilon(15,16) \approx \frac{\rho_A(15)}{\rho_A(16)}$$

Get $\varepsilon(\lambda,16)$ from $\varepsilon(15,16)$ using aerosol models. Then

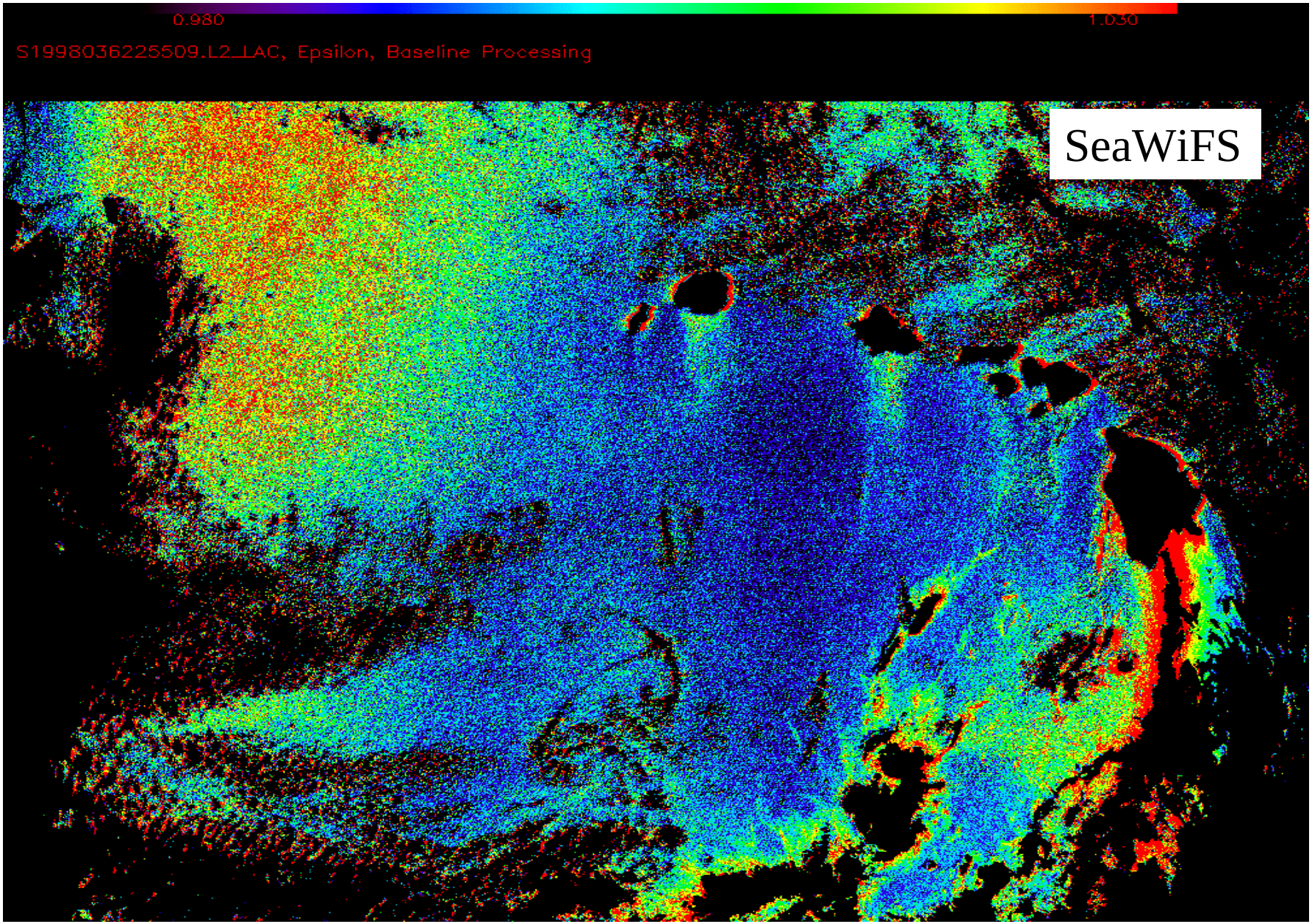
$$n\rho_w(\lambda) = t_0^{-1}(\lambda)t_v^{-1}(\lambda)\{\rho_t(\lambda) - \rho_r(\lambda) - \varepsilon(\lambda,16)[\rho_t(16) - \rho_r(16)]\}$$

HRG, MST, June 2000

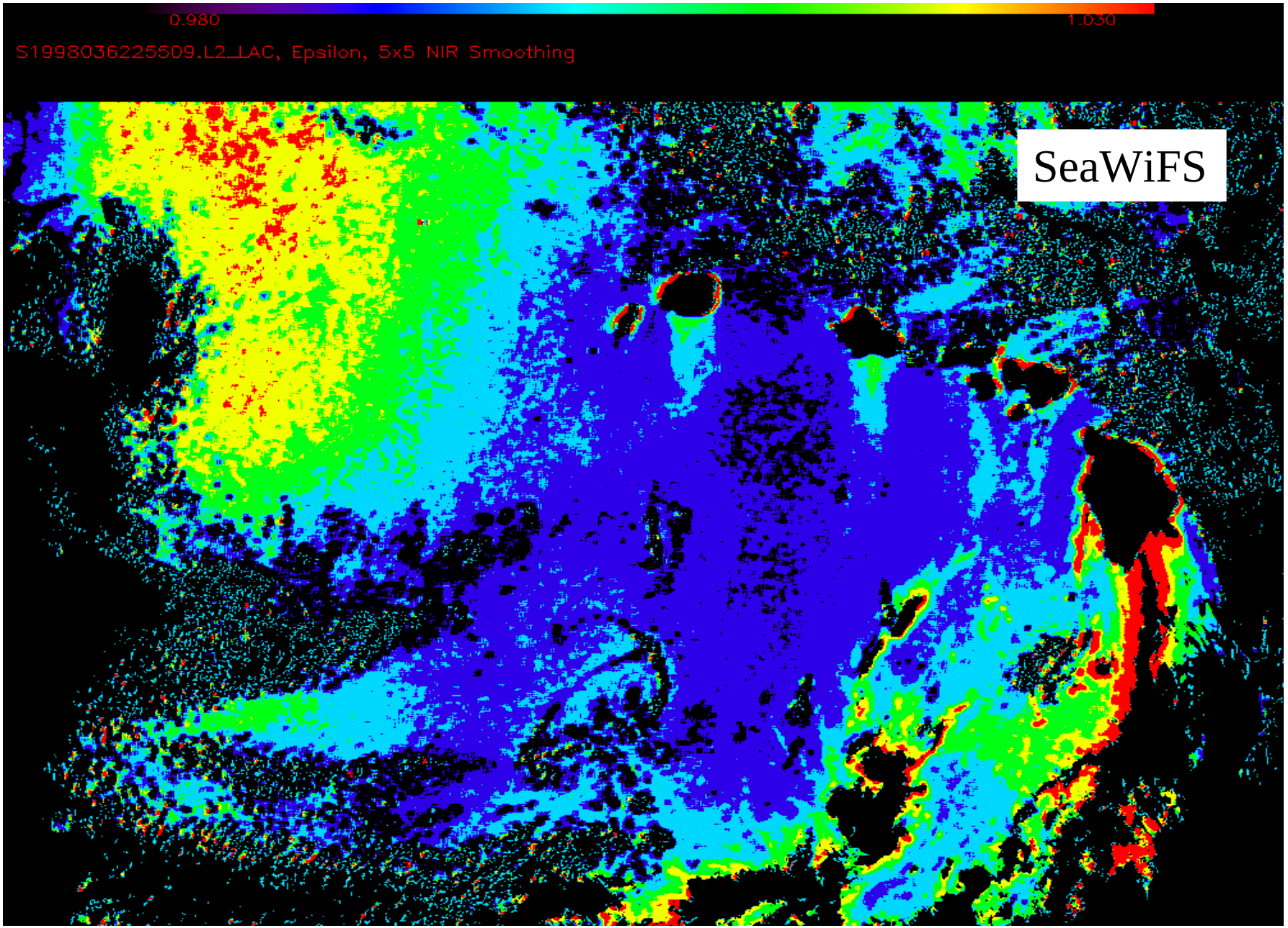


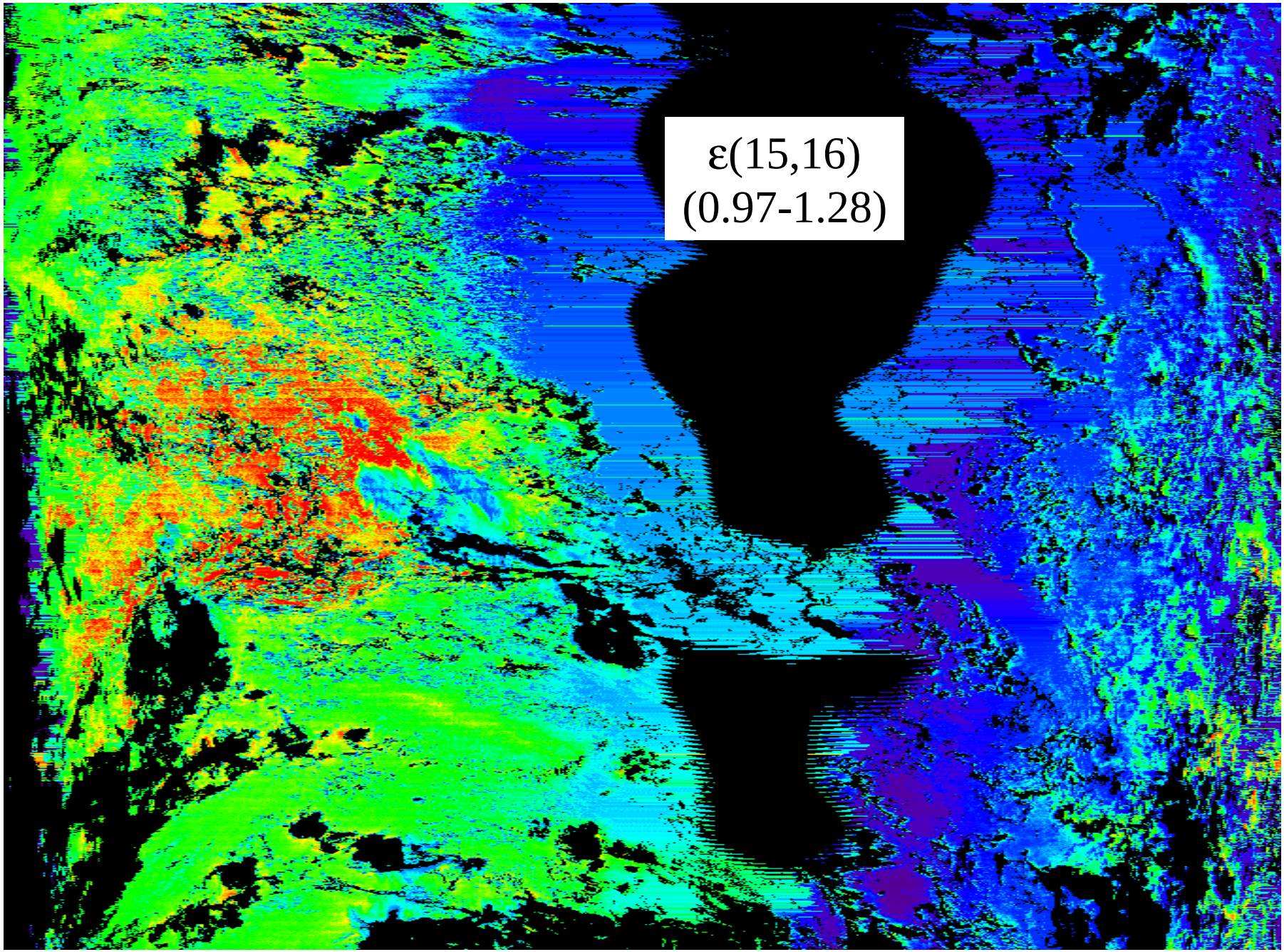
HRG, MST, June 2000

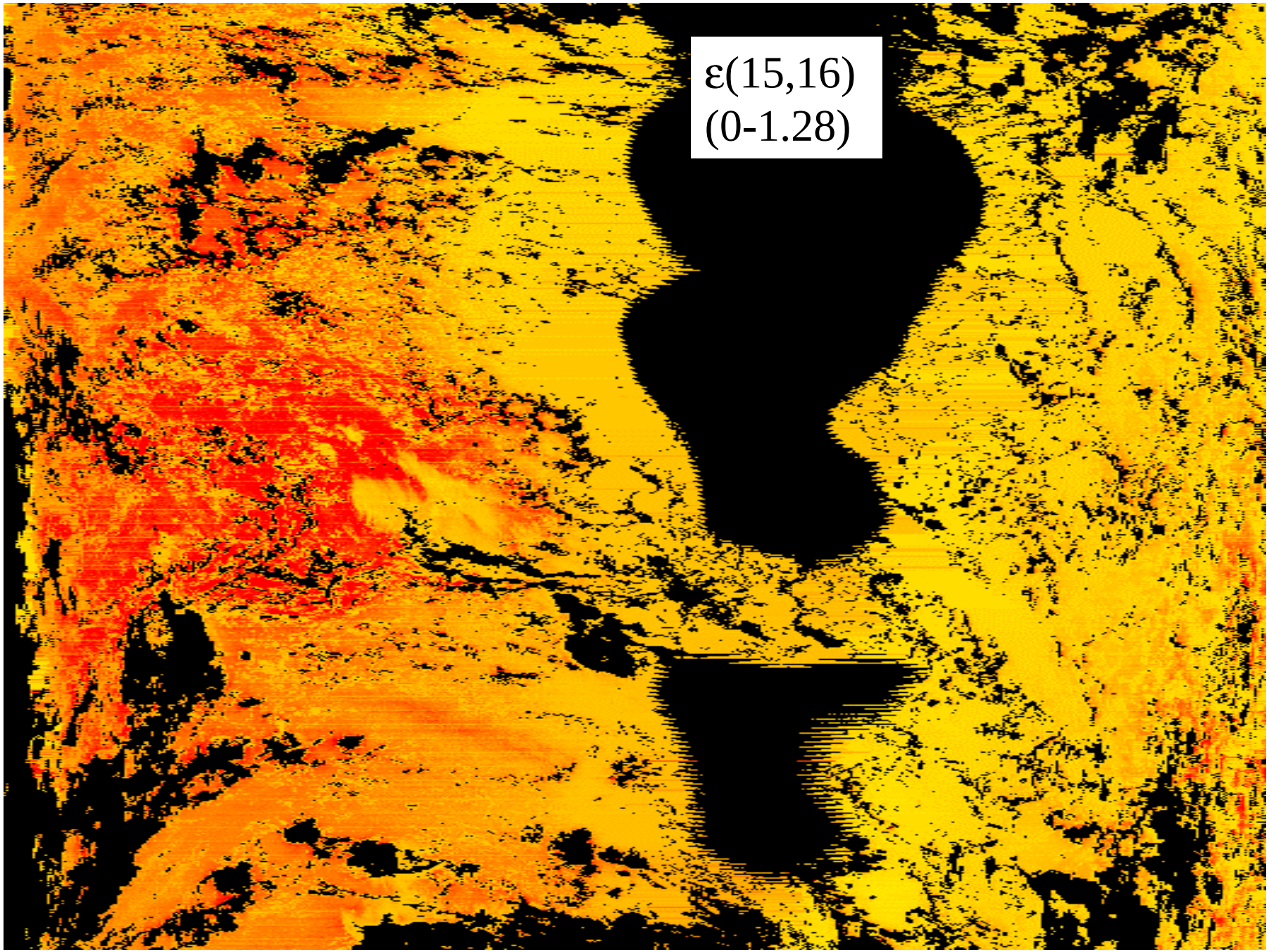
0.98 **ε(7,8)** 1.03

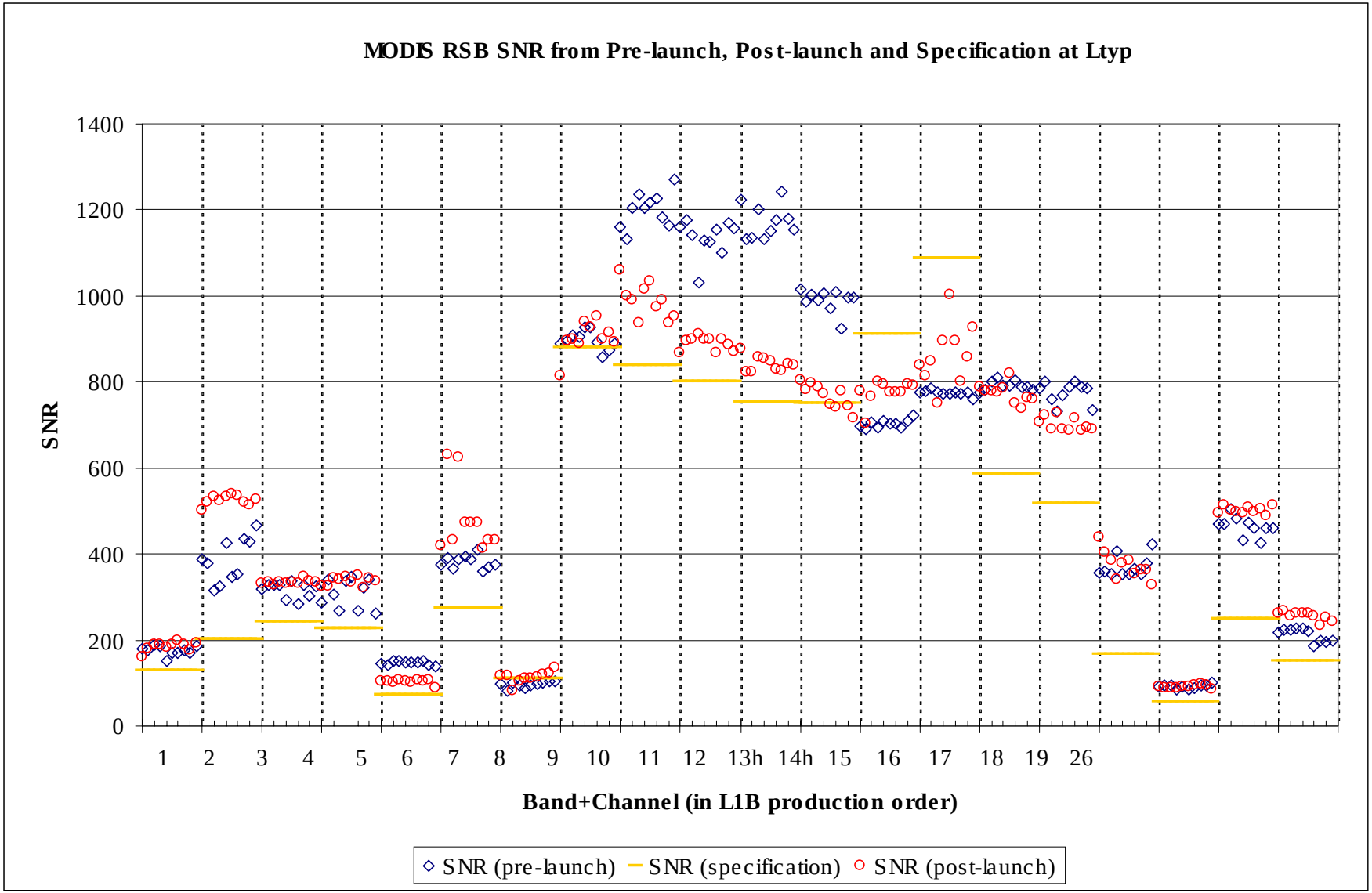

0.980
1.030
S19980362255O9.L2_LAC, Epsilon, Baseline Processing
SeaWiFS

0.98 **ε(7,8)** 1.03


0.980
1.030
S1998036225509.L2_LAC, Epsilon, 5x5 NIR Smoothing
SeaWiFS


ε(15,16)
(0.97-1.28)


ε(15,16)
(0-1.28)



HRG, MST, June 2000

Characteristic Values (M80)

(θ_0=0, θ_v=45°)

Band	ρ_t	ρ_r	$\rho_a + \rho_{ra}$
15	0.017759	0.010964	0.006795
16	0.013219	0.006648	0.006574

$\varepsilon(15,16) = 0.006795/0.006574 = 1.0336$

Expected Noise in ρ_t

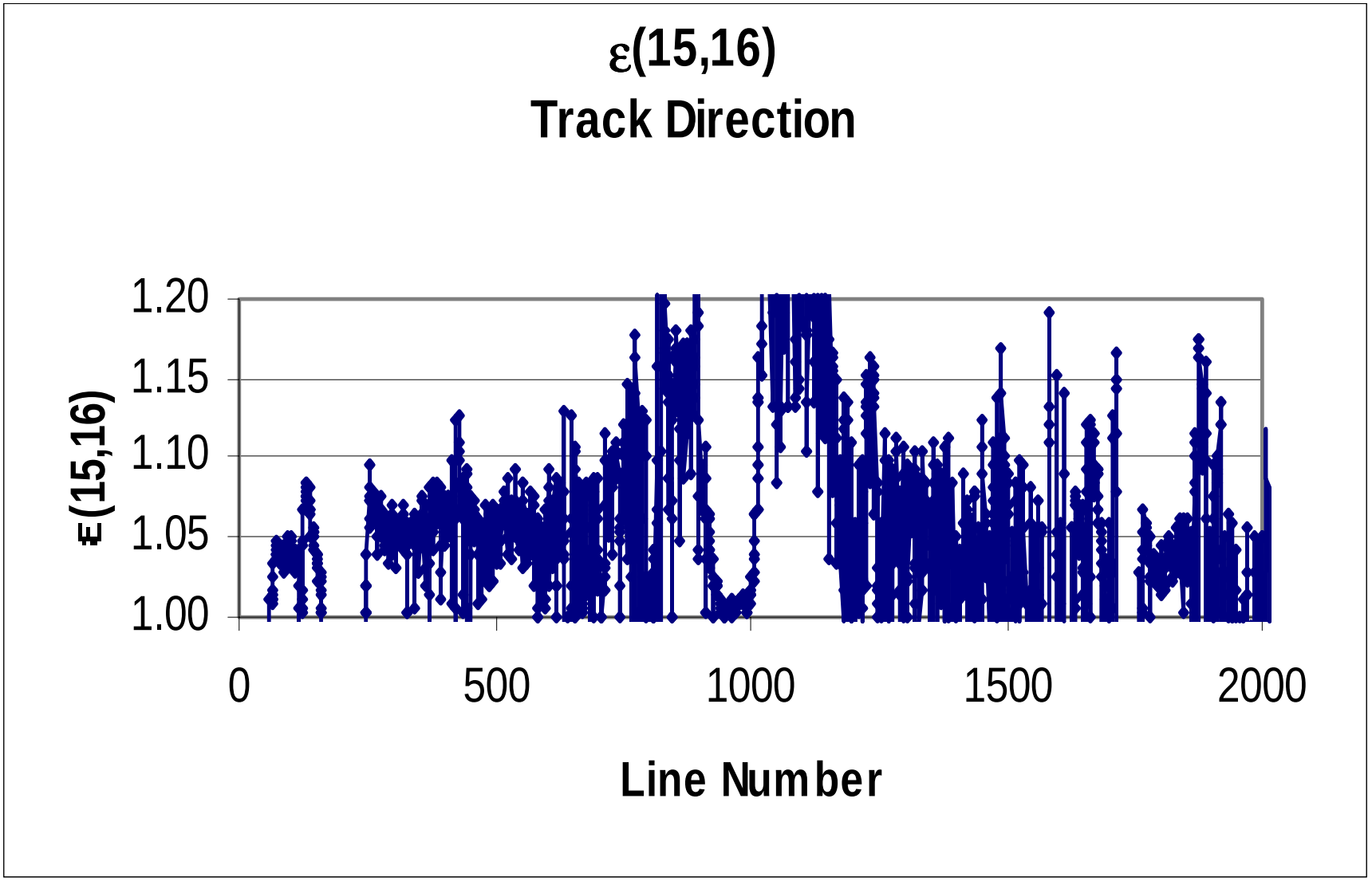
Band	SNR	$\Delta(\rho_t)$
15	800	2.22×10^{-5}
16	700	1.88×10^{-5}

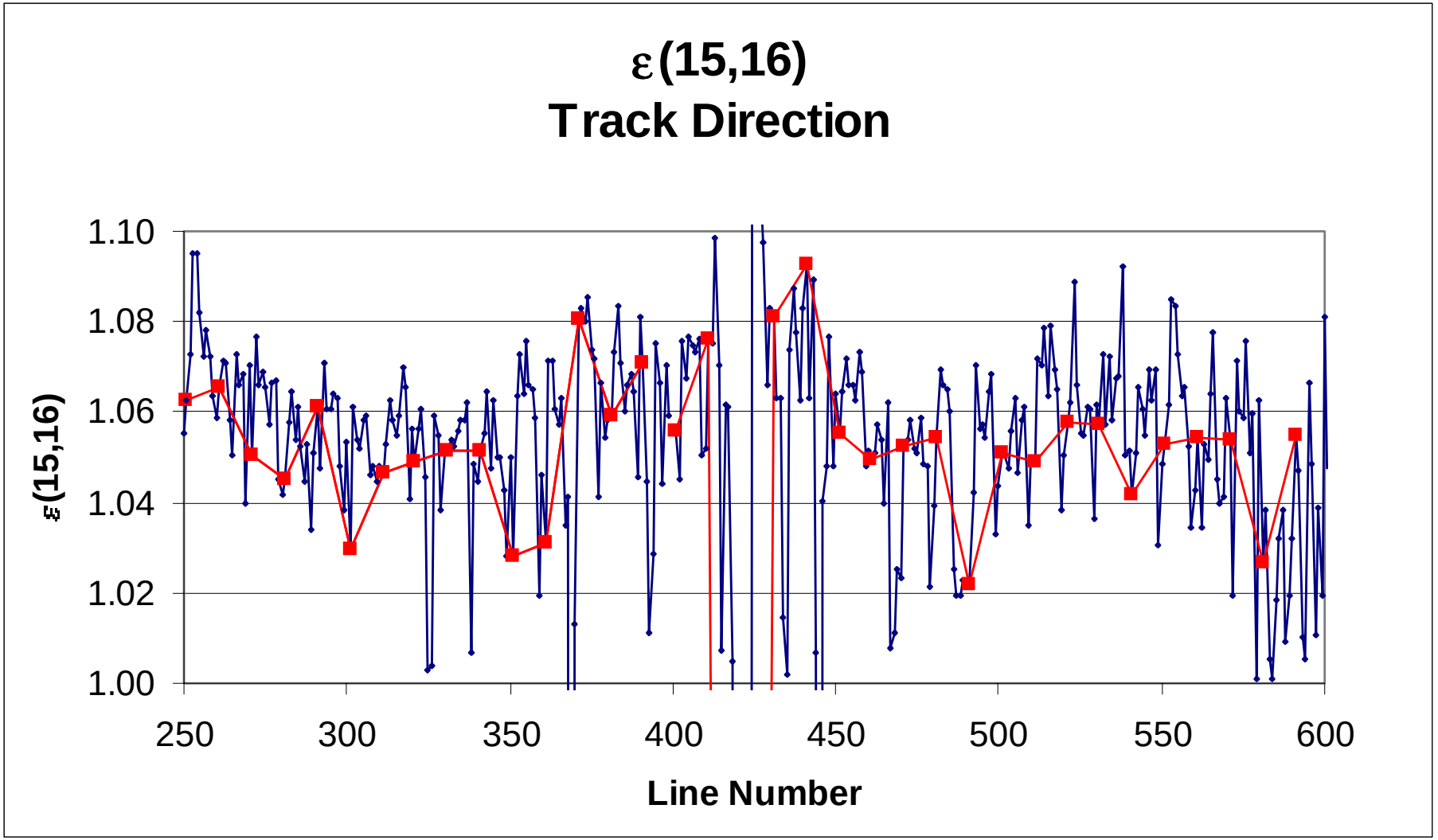
Expected Noise in ε(15,16)

$$\varepsilon(15,16)^+ = \frac{\rho_a(15) + \rho_{ra}(15) + \Delta\rho_t(15)}{\rho_a(16) + \rho_{ra}(16) - \Delta\rho_t(16)} = 1.0398$$

$$\varepsilon(15,16)^- = \frac{\rho_a(15) + \rho_{ra}(15) - \Delta\rho_t(15)}{\rho_a(16) + \rho_{ra}(16) + \Delta\rho_t(16)} = 1.0274$$

HRG, MST, June 2000


ε(15,16)
Track Direction
ε(15,16)
1.20
1.15
1.10
1.05
1.00
0
500
1000
1500
2000
Line Number



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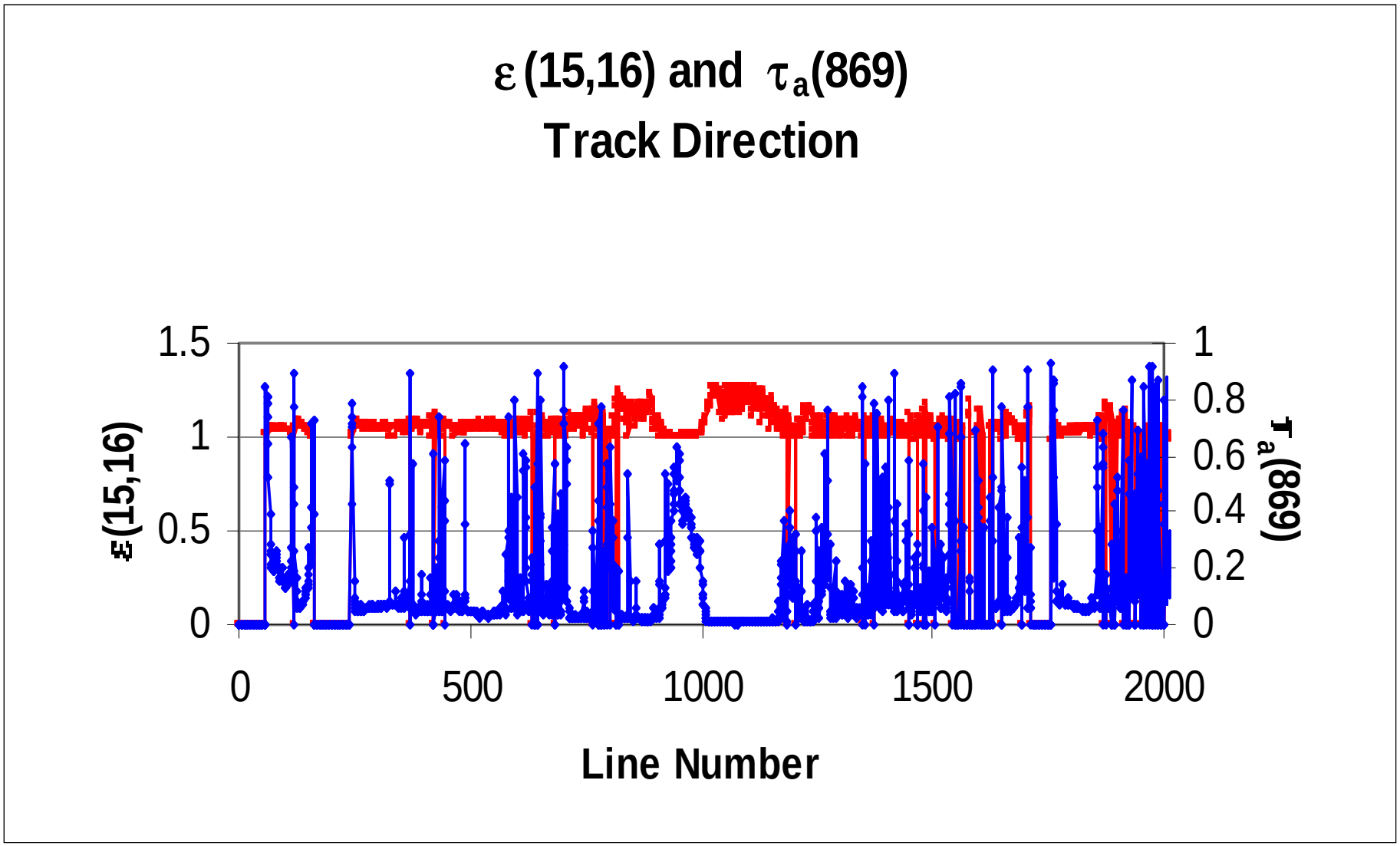

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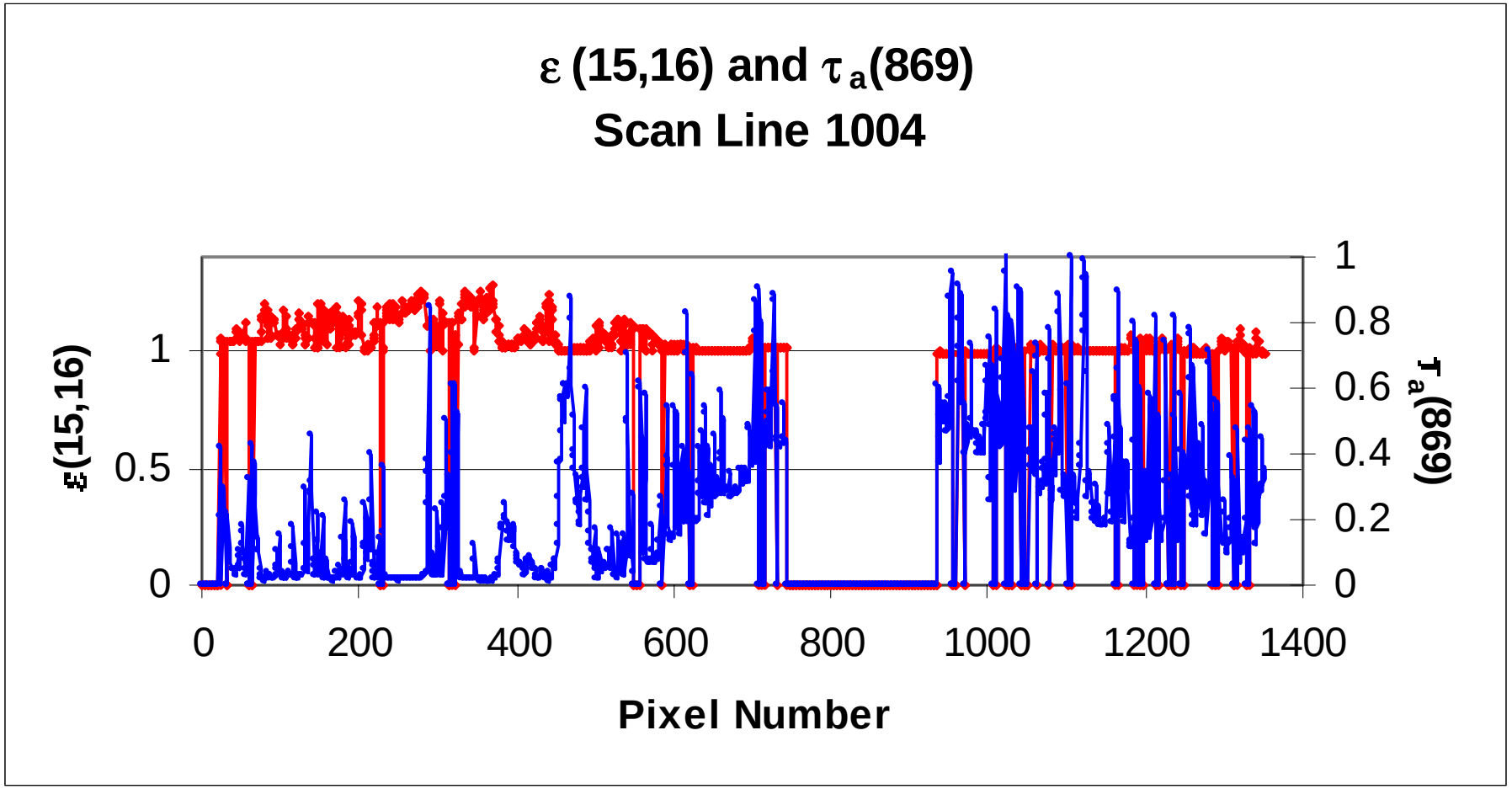

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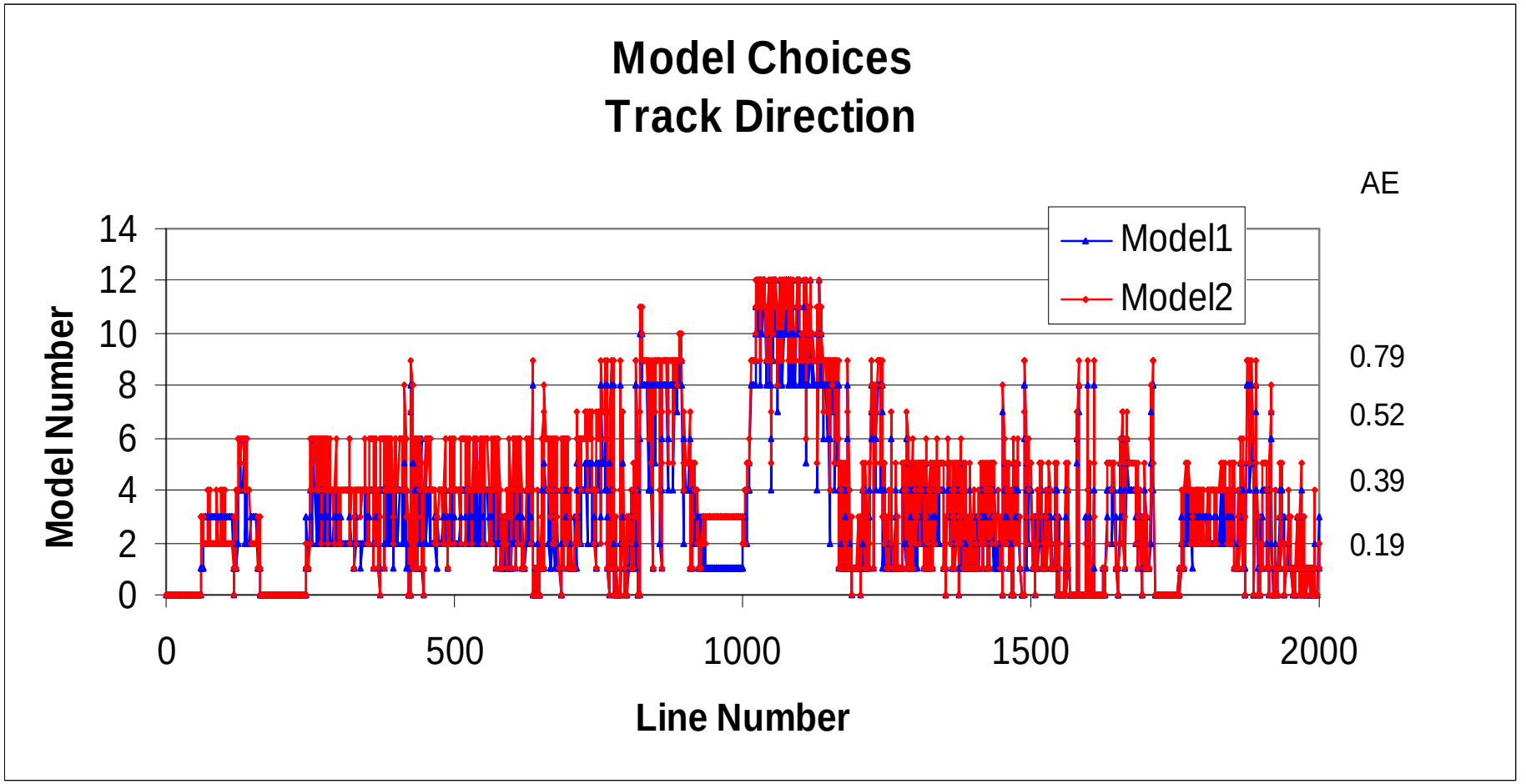

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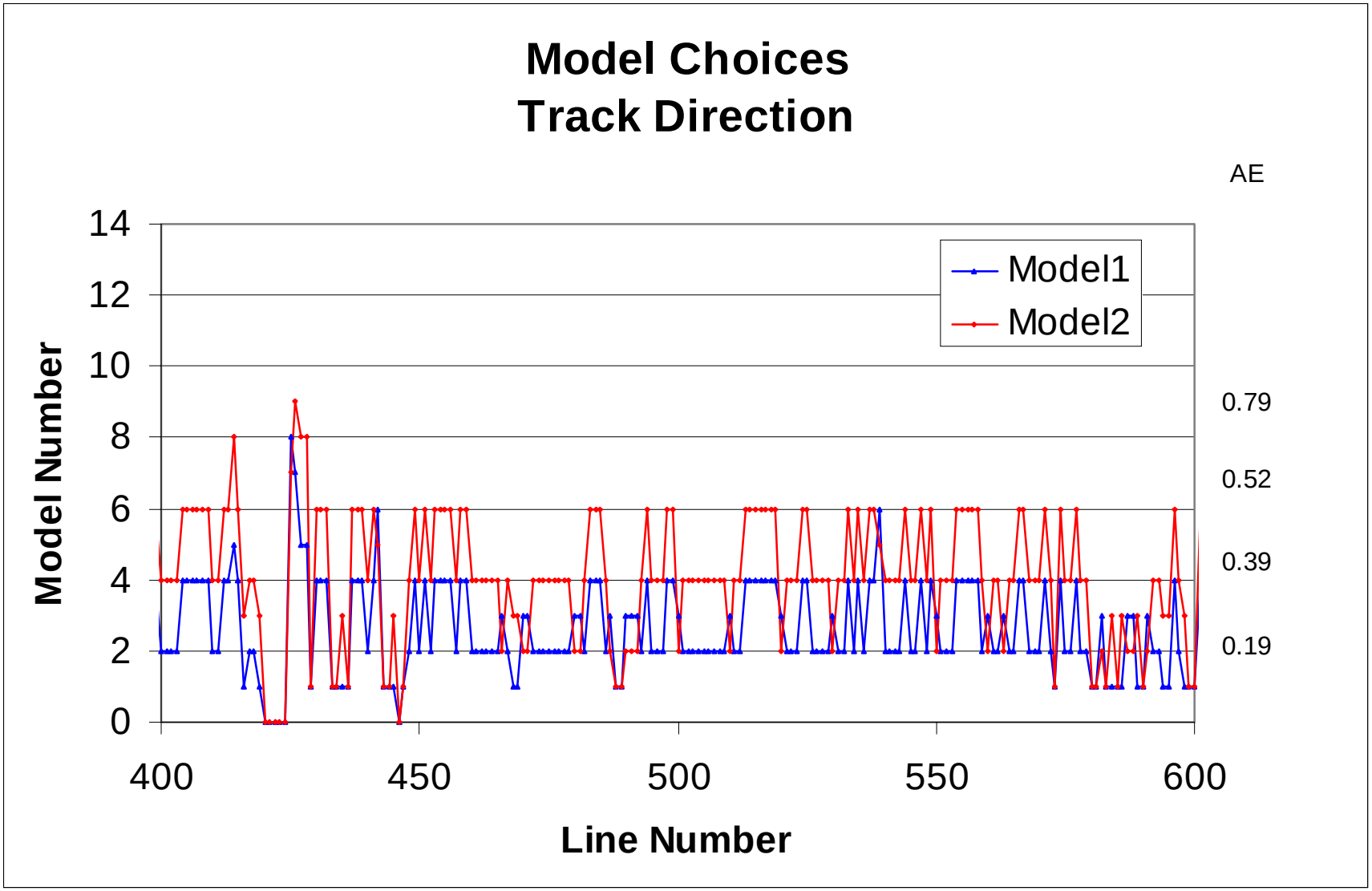

HRG, MST, June 2000

Summary

- Examined MODIS/SeaWiFS Chl *a* at 36 km Resolution
  - ⇒ Differences ± a factor of 2

- Examined $nL_w(\lambda)$ for a Single Granual at Full Resolution
  - ⇒ Severe Striping in $nL_w(443)$
  - ⇒ Severe Striping in $nL_w(551)$
  - ⇒ $nL_w(551)$ Is 50% Too High (March 17, Calibration used by MODAPS)
  - ⇒ $nL_w(551)$ Is Improved (April 20, “Research” Calibration)
  - ⇒ $nL_w(551)$ Striping Improved But Not Eliminated (R. Evans)

Summary (Continued)

- Examined Retrieved Values for a Single Scan Line
  - $\Rightarrow$ $nL_w(\lambda)$ and Chl *a* Reasonably Clean
  - $\Rightarrow$ $nL_w(\lambda)$ and Chl *a* May Show RSV Effect
  - $\Rightarrow$ Strong Effect of Sun Glint in $\tau_a(869)$
  - $\Rightarrow$ Sun Glint Will Destroy Eastern Half of Scan in Tropics

- Evaluated Performance of Bands 15 and 16
  - $\Rightarrow$ Bands show excessive noise
  - $\Rightarrow$ Severe Striping in $nL_w(551)$ Likely Not Due to Atmospheric Correction
  - $\Rightarrow$ Some Striping in Bands 15 and 16
  - $\Rightarrow$ Atmospheric Model Choices are Reasonable

Summary (Continued)

- Overall Evaluation
  - ⇒ MODIS Visible Bands Need Flat-Fielding
  - ⇒ NIR Bands Appear to be Noisy
  - ⇒ NIR Bands are Striped
  - ⇒ Visible Bands Show Incorrect Overall nL_w's (MODAPS Processing With March 17 Calibration, Improved With Later Calibration)

- Prognosis
  - ⇒ Usable Data Requires Incremental/Iterative Resolution of Remaining Problems
  - ⇒ Multiple Processing/Reprocessing Will Be Necessary