GEO-CAPE Requirements

on Measurement Sensitivity, Saturation, and Solar Angles

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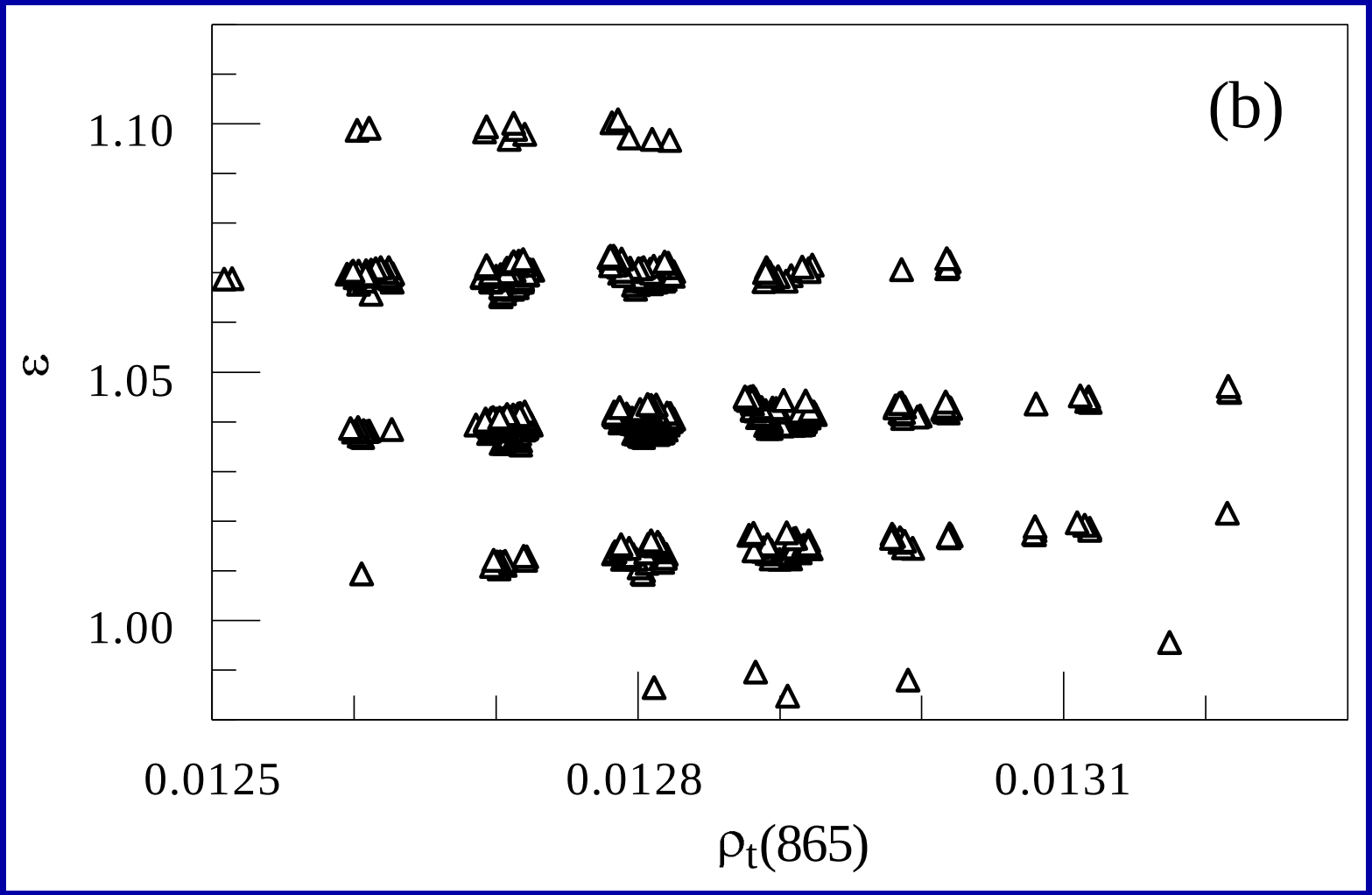
Objectives

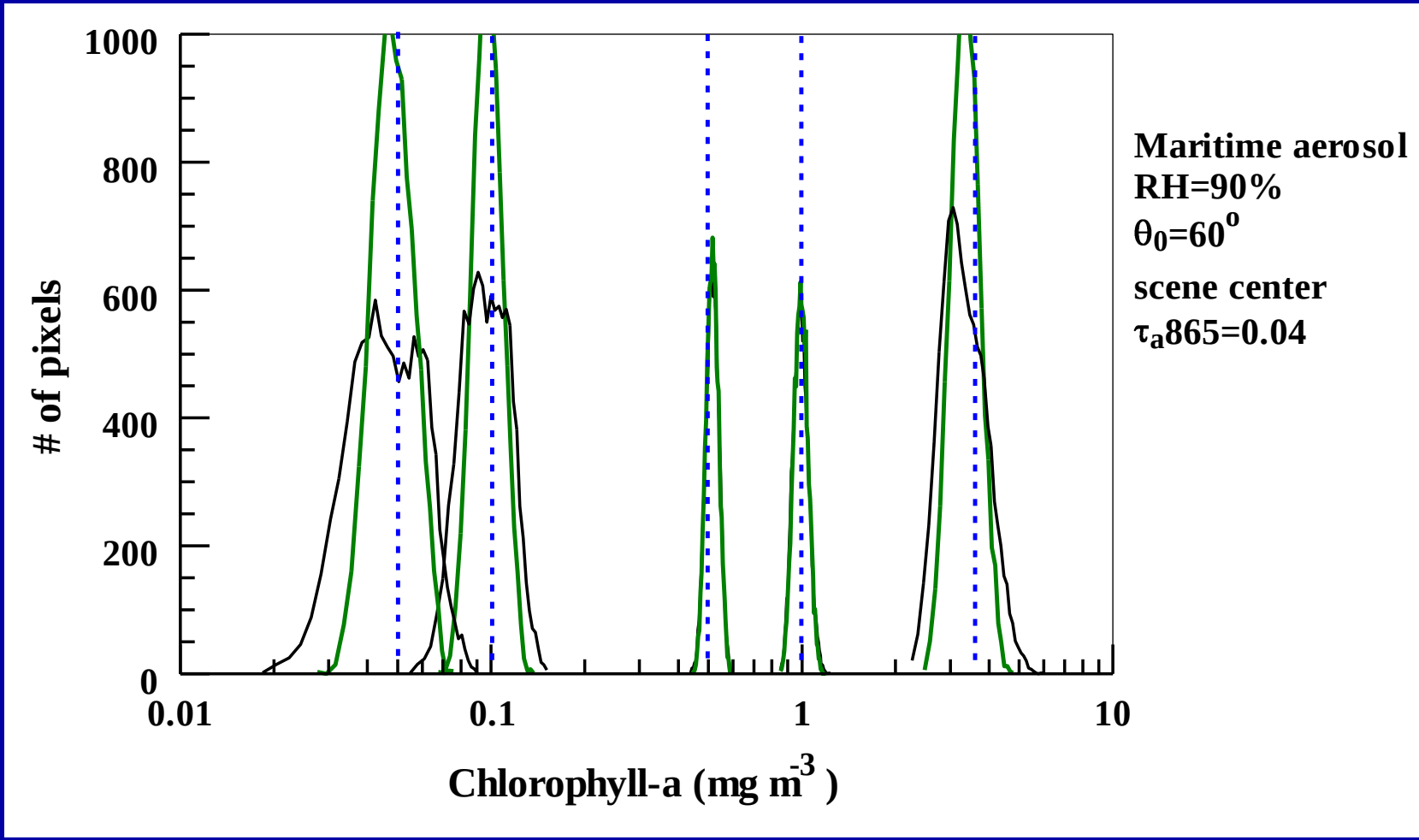
- Help define sensor constraints
- Help implement measurement plans

Problem with "Low" Sensitivity



From Hu et al. (2001, RSE)

Problem with "Low" Sensitivity



From Hu et al. (2001, RSE)

MODIS versus SeaWiFS

Band	λ (nm)	Res.	*L* (1 DN)	NE∆*L*
1	620-670	250 m	0.0217	0.0170
2	841-876	250 m	0.0083	0.0123
3	459-479	500 m	0.0167	0.0145
4	545-565	500 m	0.0145	0.0127
	438-448	1 km	0.0039 (0.0136)	0.0050 (0.0130)
	546-556	1 km	0.0018 (0.0076)	0.0028 (0.0080)
	673-683	1 km	0.0007 (0.0042)	0.0008 (0.0056)

Radiance (*L*) units: $mW \cdot cm^{-2} \cdot \mu m^{-1} \cdot sr^{-1}$. Numbers in () are for SeaWiFS

1 DN of MODIS 678 band is corresponding to 0.1 – 0.2 mg m^{-3} Chl

MODIS versus Others

Band Center (Bandwidth)

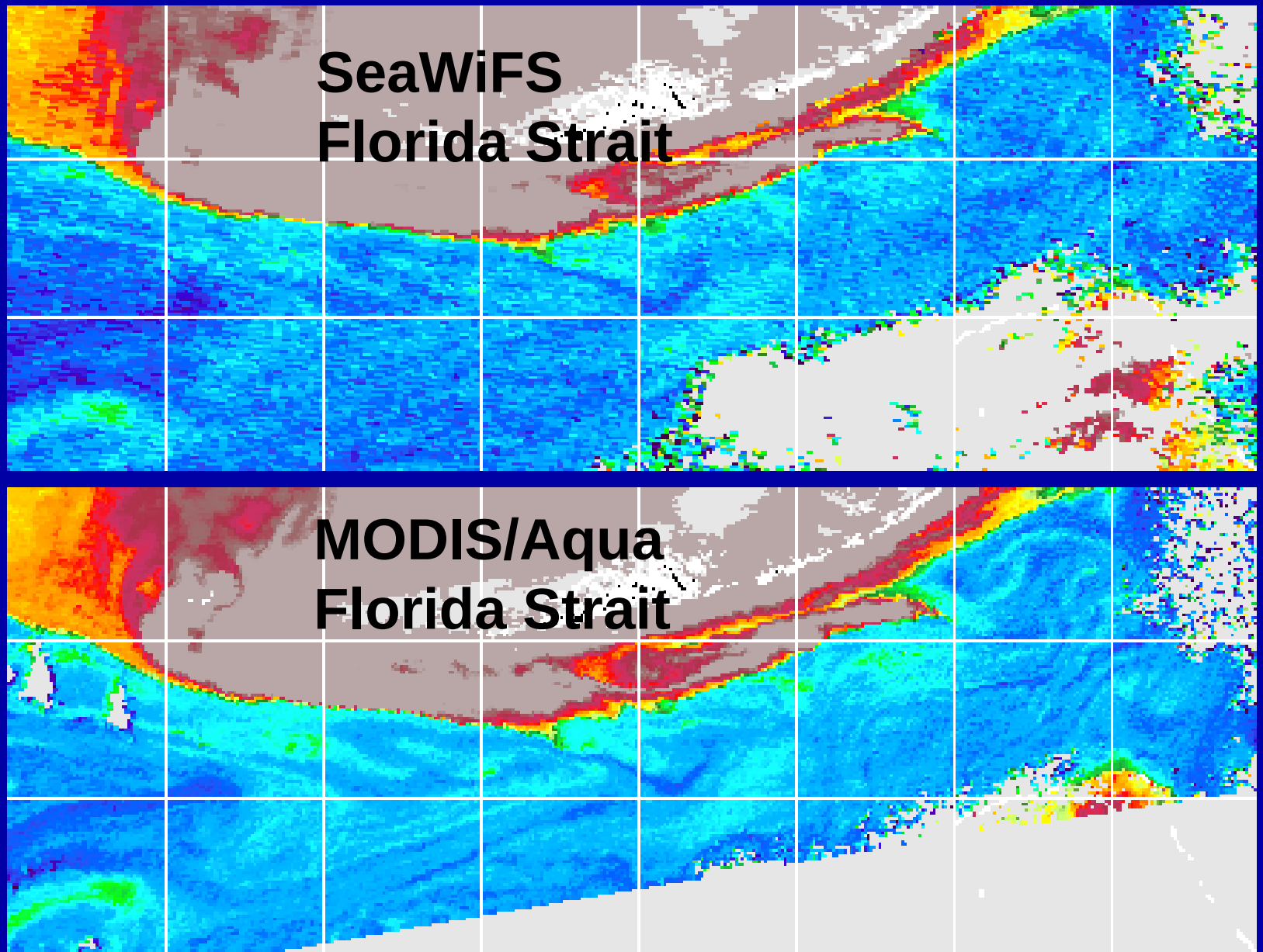
MODIS	665.1 (10)	676.7 (10)	746.4 (10)
MERIS	665.0 (10)	681.3 (7.5)	709.0 (9)
GLI	666.7 (10)	679.9 (10)	710.5 (10)
GOCI	660.0 (20)	680.0 (10)	745.0 (20)

NEΔL ($mW \cdot cm^{-2} \cdot \mu m^{-1} \cdot sr^{-1}$)

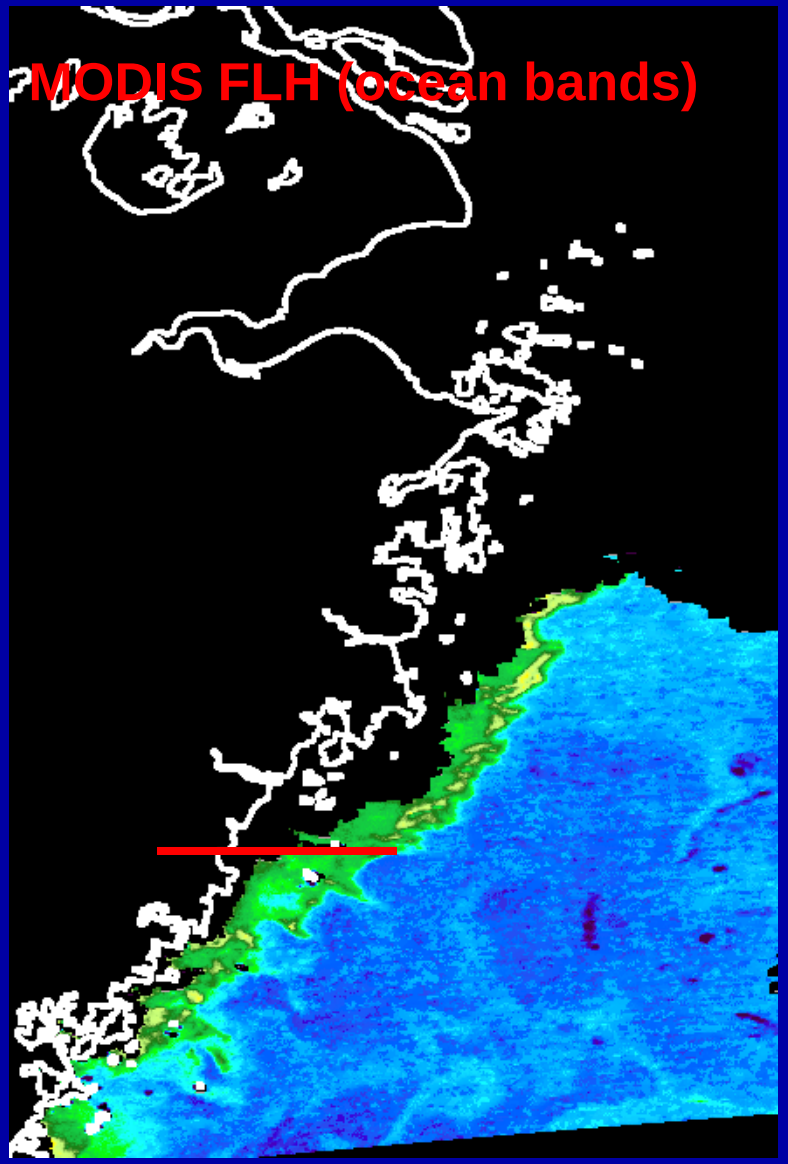
MODIS	0.0008	0.0007	0.0009
MERIS	0.0013	0.0014	0.0011
GLI	0.0015	0.0014	0.0012
GOCI	0.0032	0.0031	0.0020

From Xing et al. (2007, Ocean Science Journal)

MODIS versus SeaWiFS



Problem with Low Saturation



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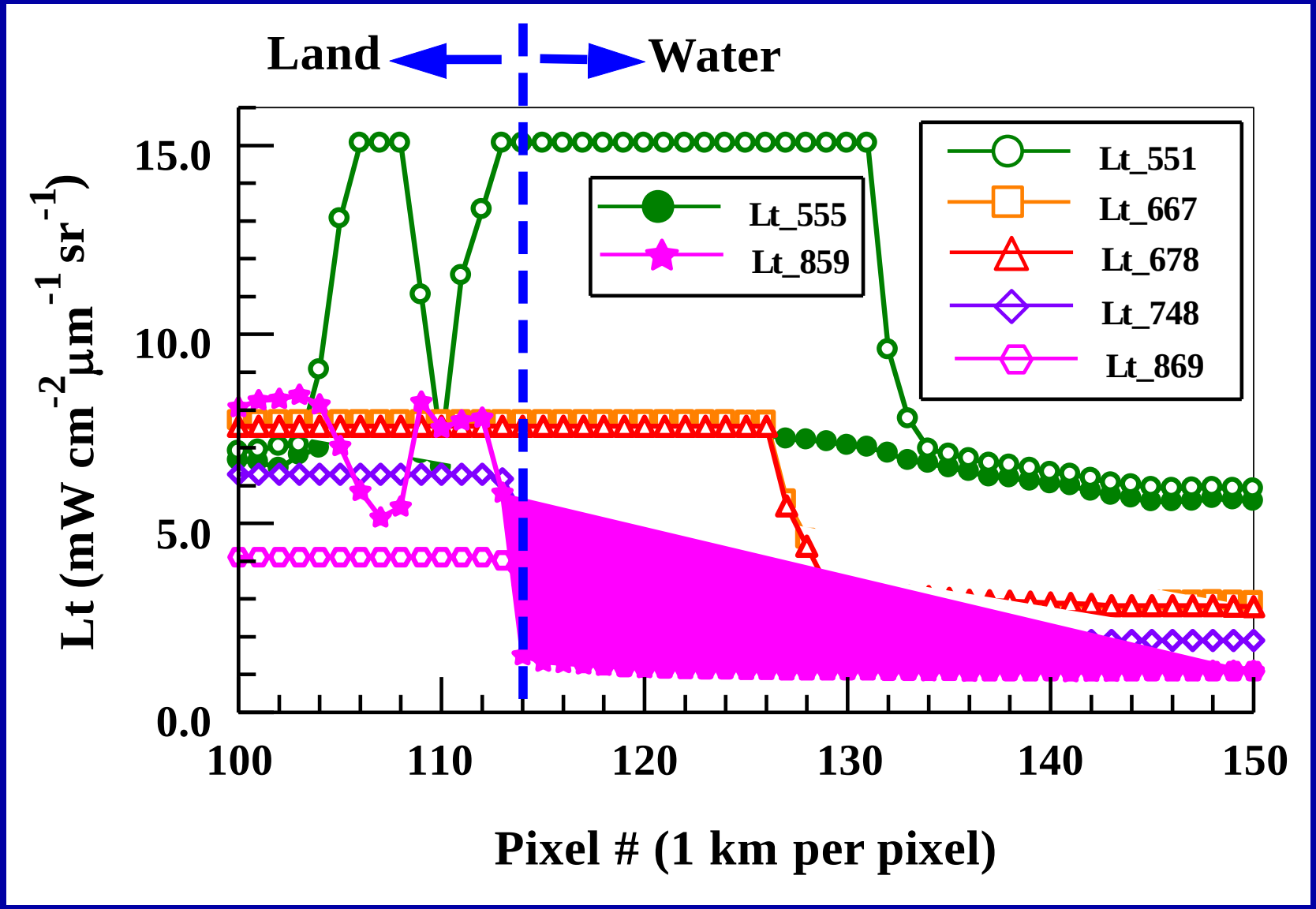
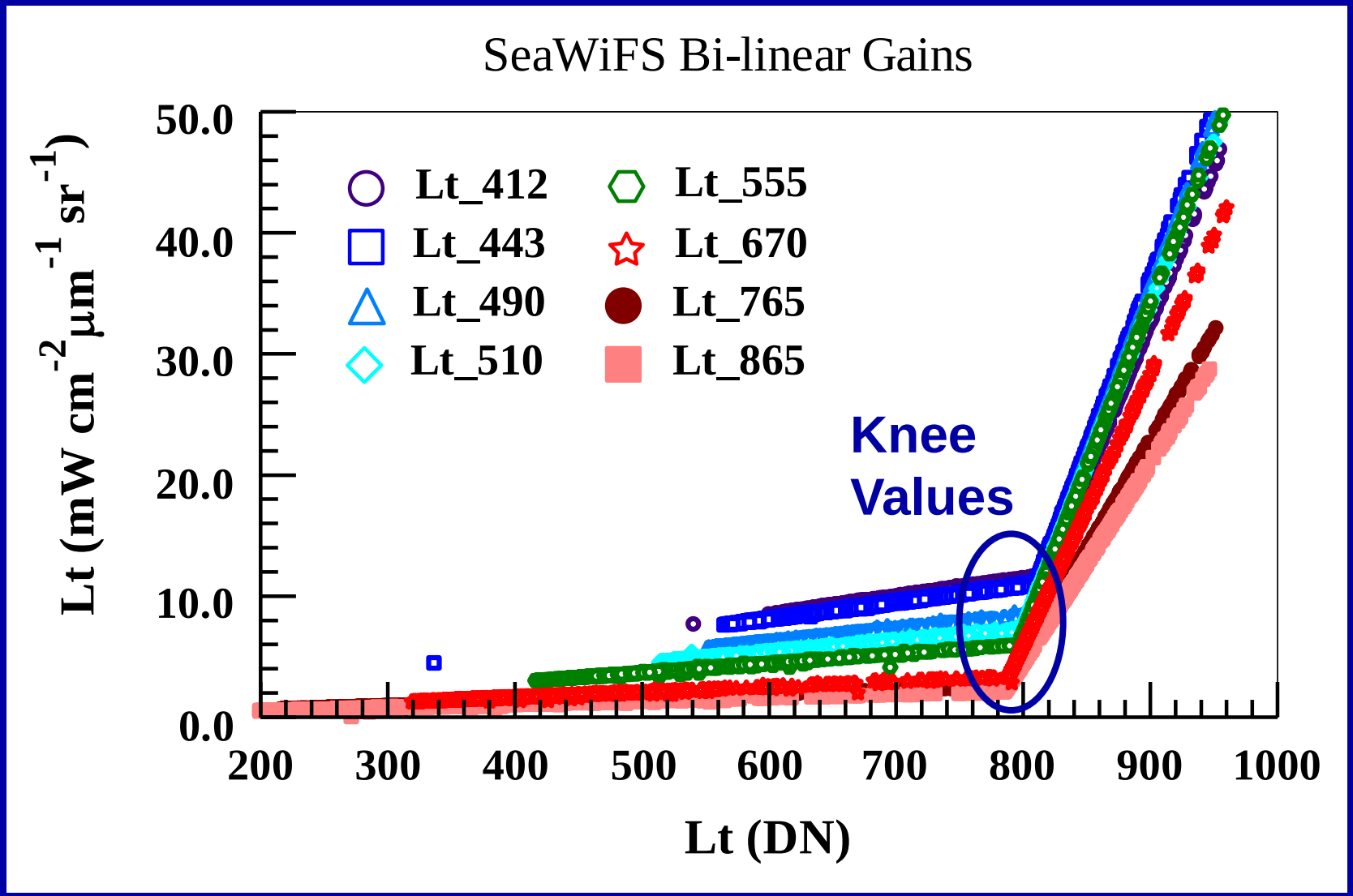


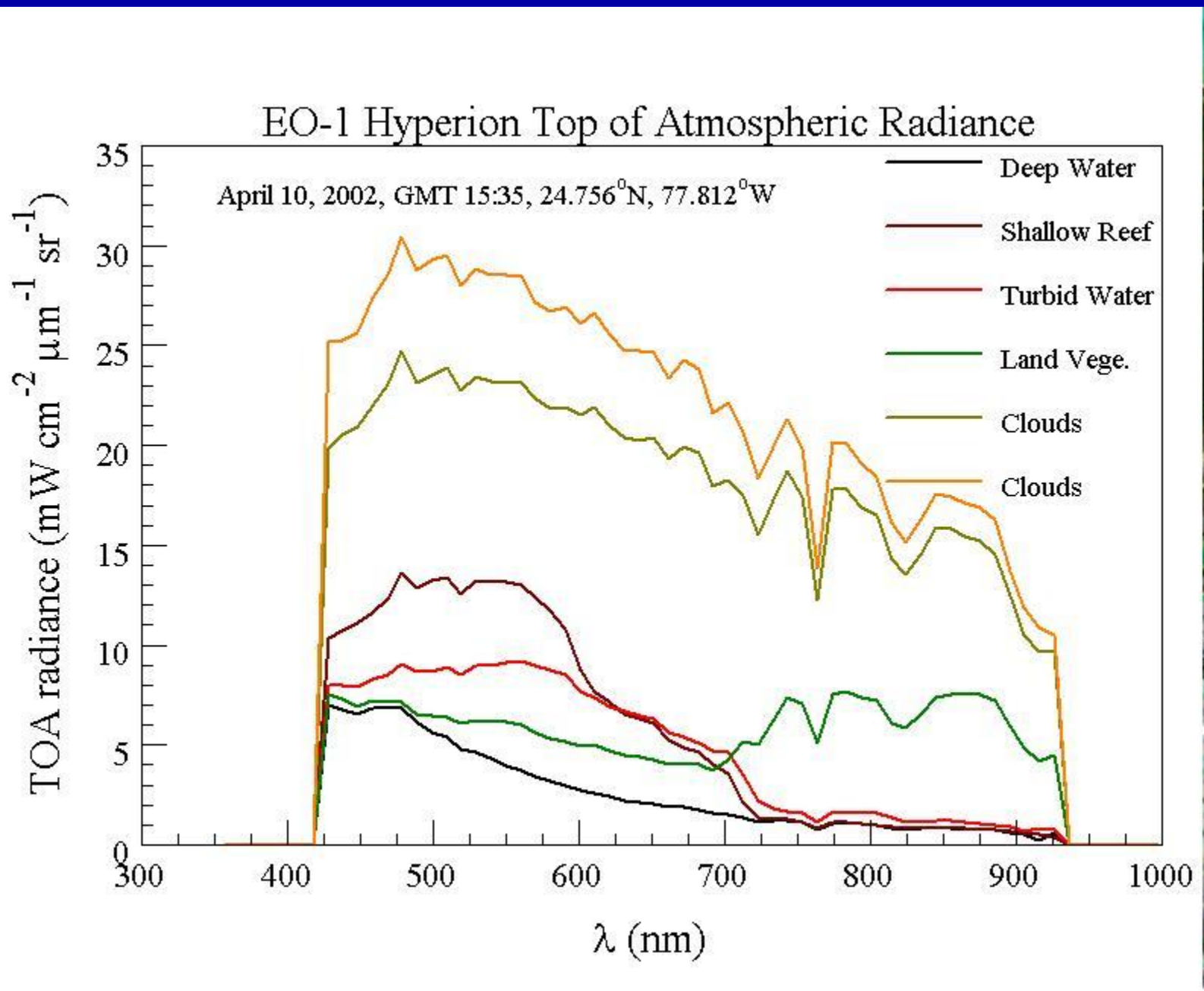
SeaWiFS Solution



MODIS versus SeaWiFS

	551 (555)	667 (670)	748 (765)	869 (865)
MODIS Saturation	6.96	3.50	2.23	1.30
SeaWiFS Knee	6.00	3.35	2.46	2.03

Units: $mW \cdot cm^{-2} \cdot \mu m^{-1} \cdot sr^{-1}$


EO-1 Hyperion Top of Atmospheric Radiance
April 10, 2002, GMT 15:35, 24.756°N, 77.812°W
Deep Water
Shallow Reef
Turbid Water
Land Vege.
Clouds
Clouds
TOA radiance (mW cm-2 μm-1 sr-1)
λ (nm)
0
5
10
15
20
25
30
35
300
400
500
600
700
800
900
1000

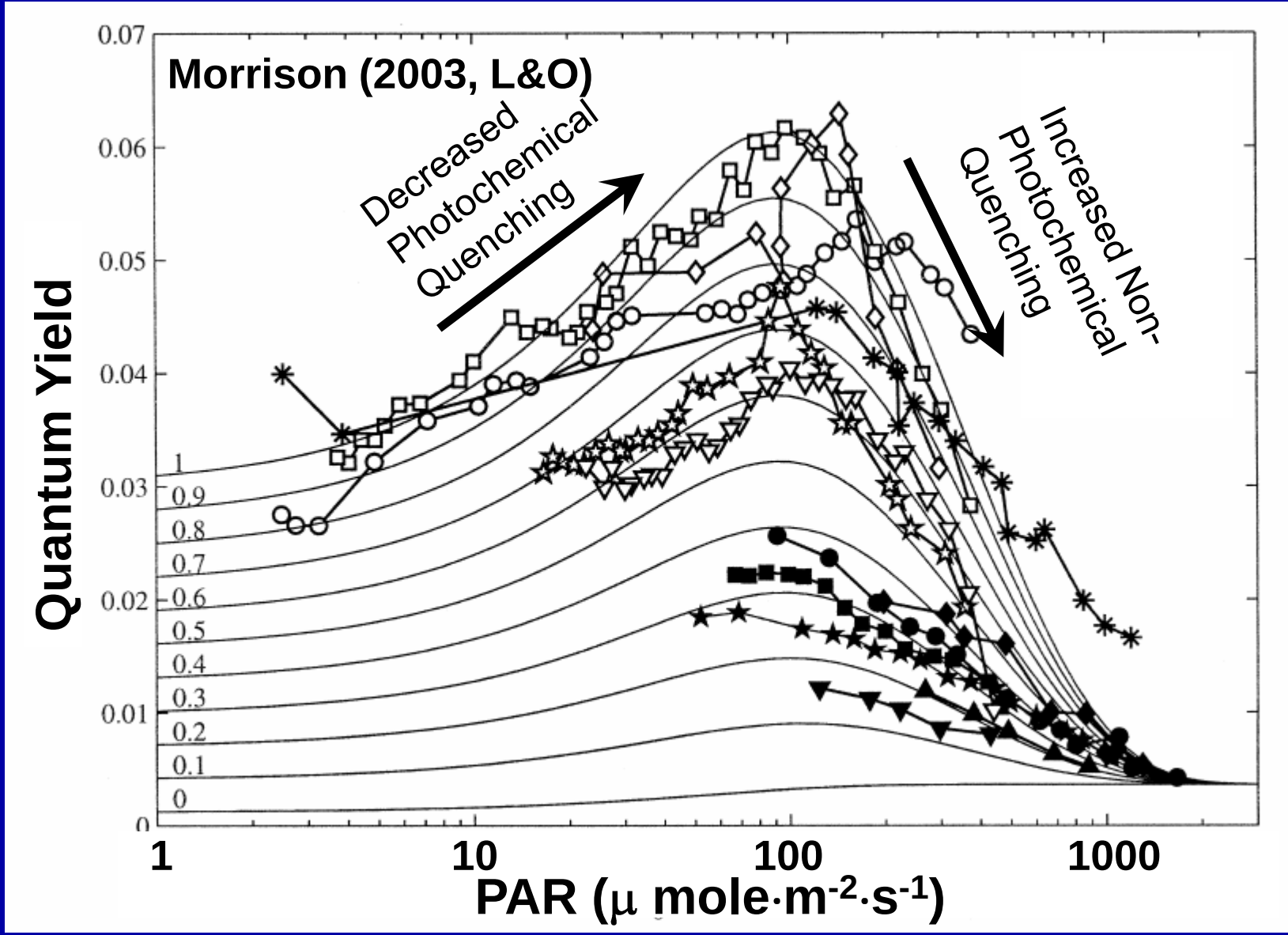
Summary

- MODIS sensitivity can serve as a good template
- Saturation radiance needs to be better determined
  - Statistics from MODIS/Hyperion measurements
  - Simulations

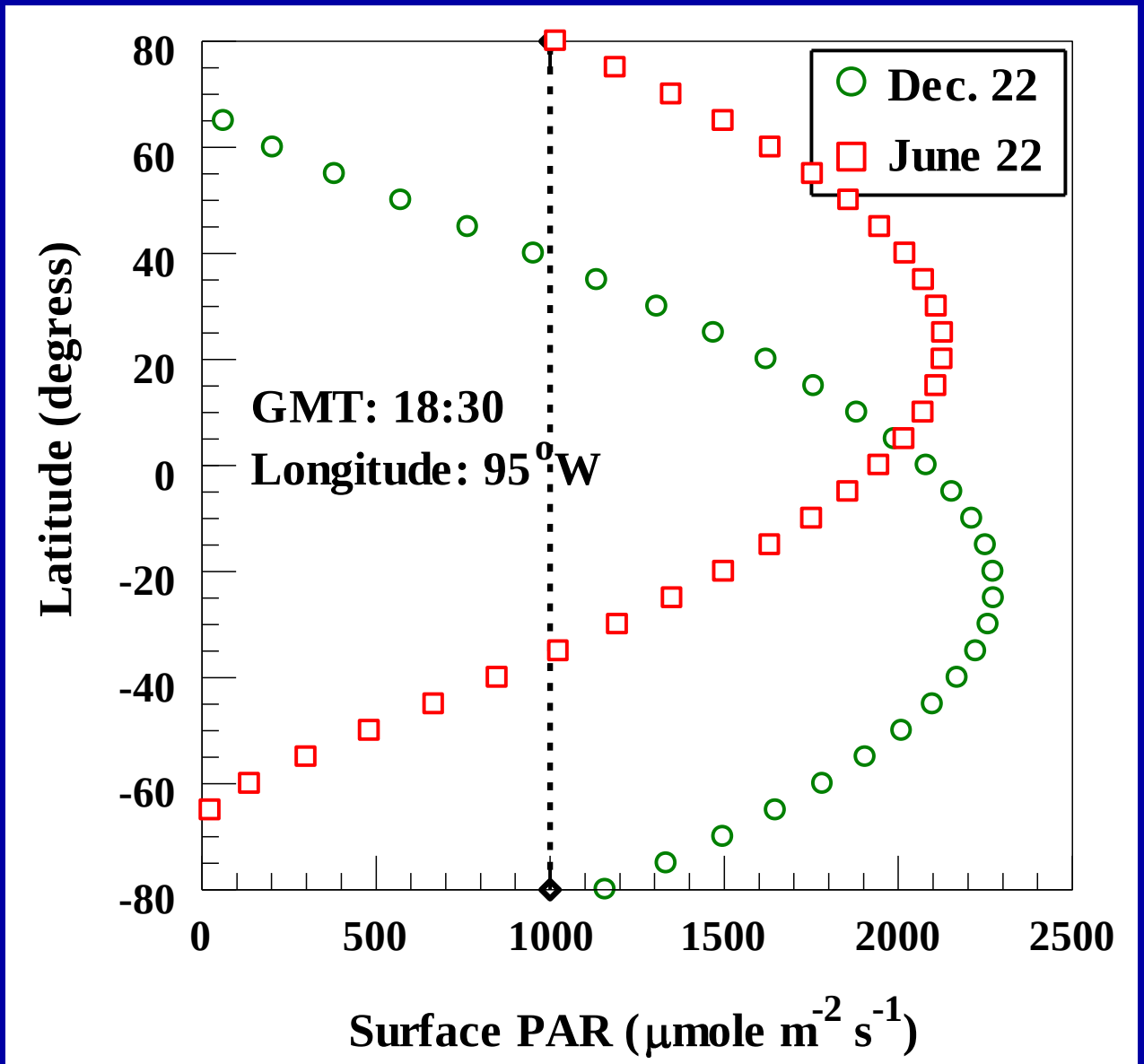
Next – solar angles?

- Integration time considerations
- Sun glint considerations
- Fluorescence efficiency – phytoplankton physiology

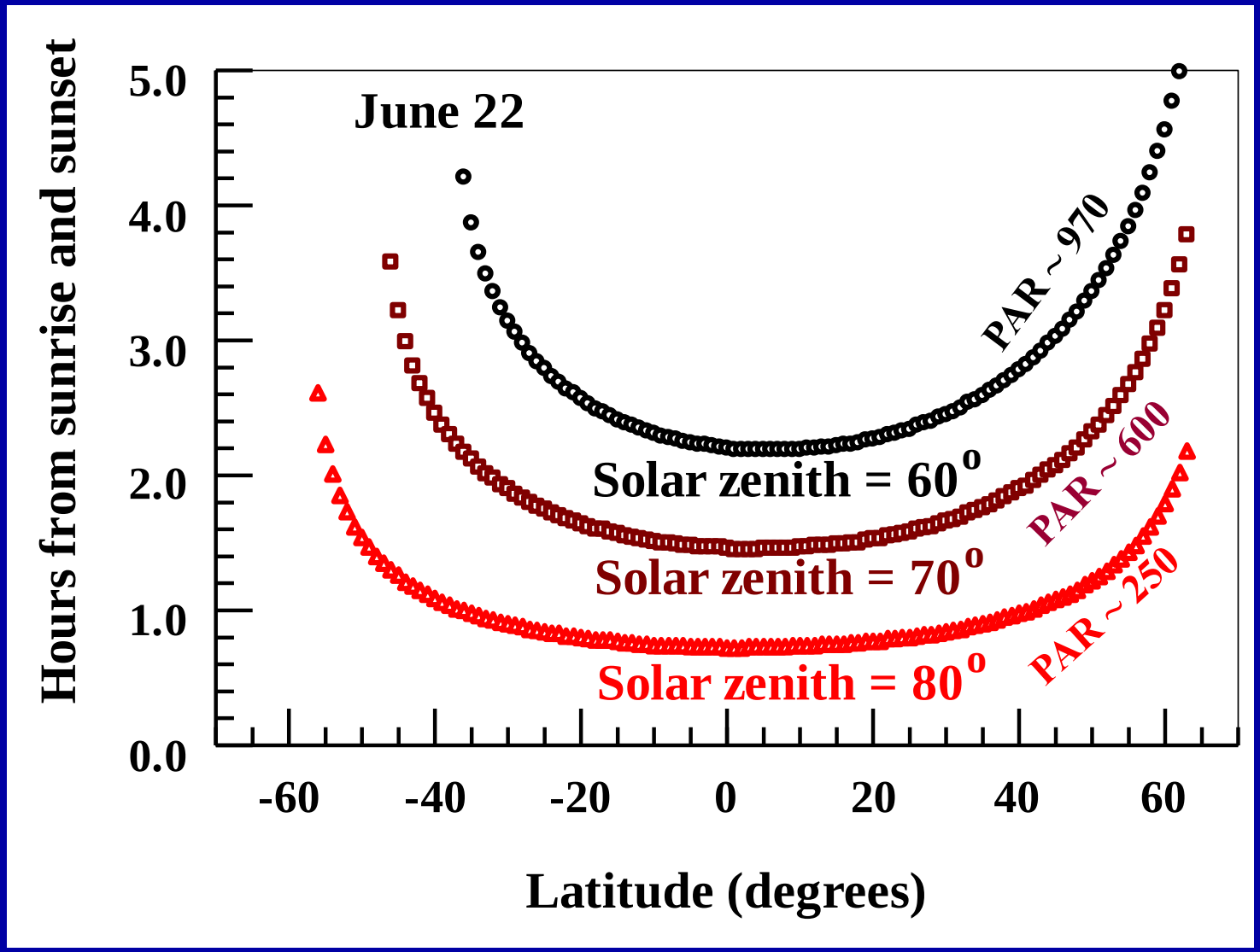
Chlorophyll fluorescence quantum yield



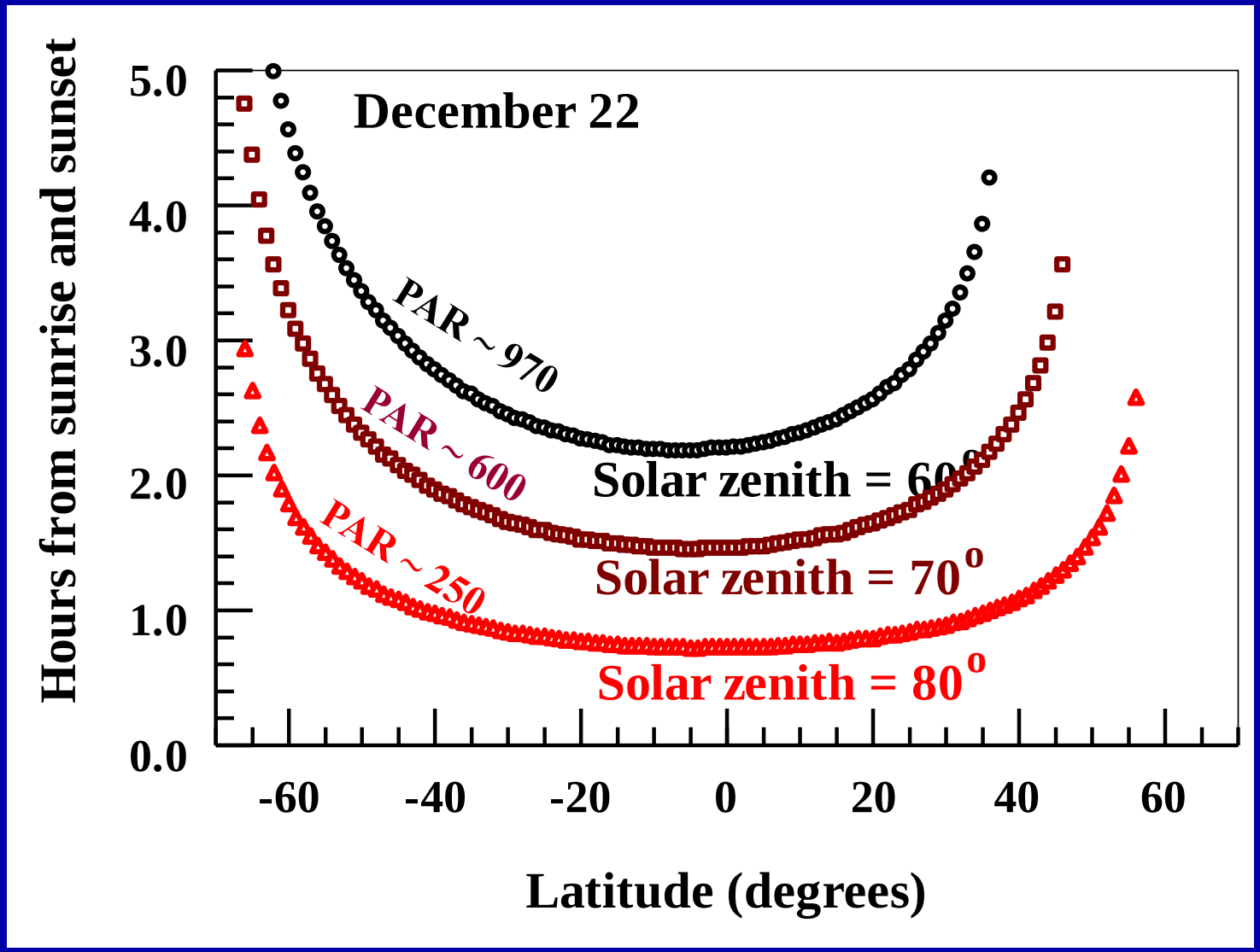
Surface PAR

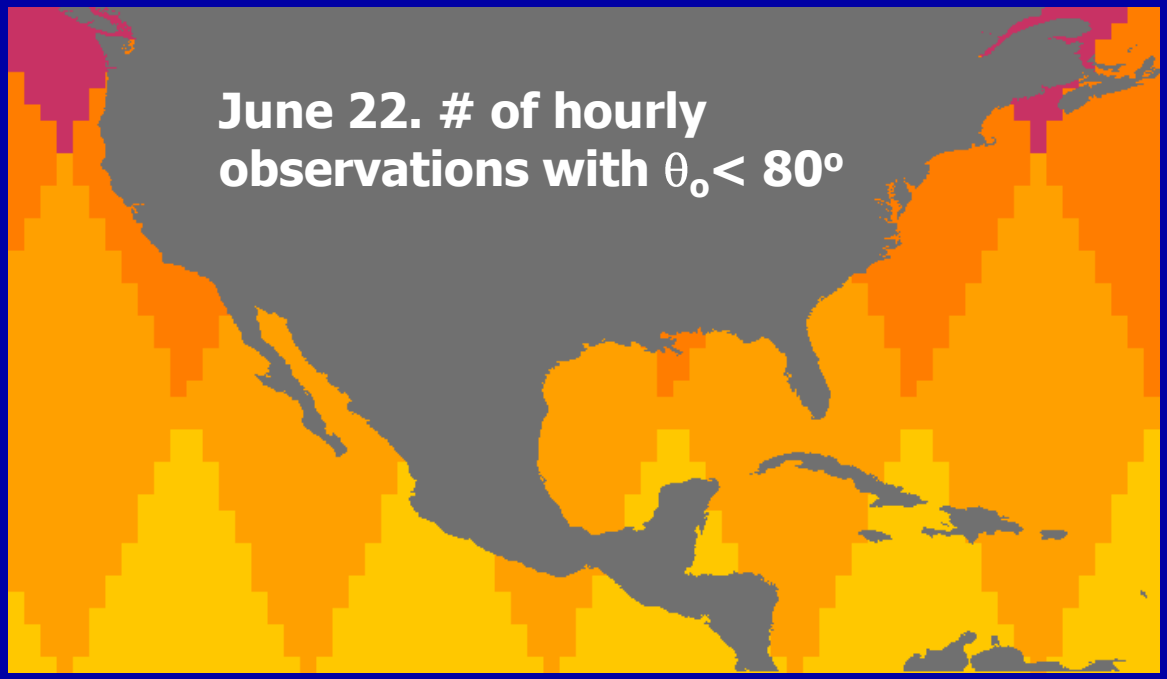

Dec. 22
June 22
GMT: 18:30
Longitude: 95 °W
Latitude (degress)
80
60
40
20
0
-20
-40
-60
-80
0
500
1000
1500
2000
2500
Surface PAR (μmole m-2 s-1)

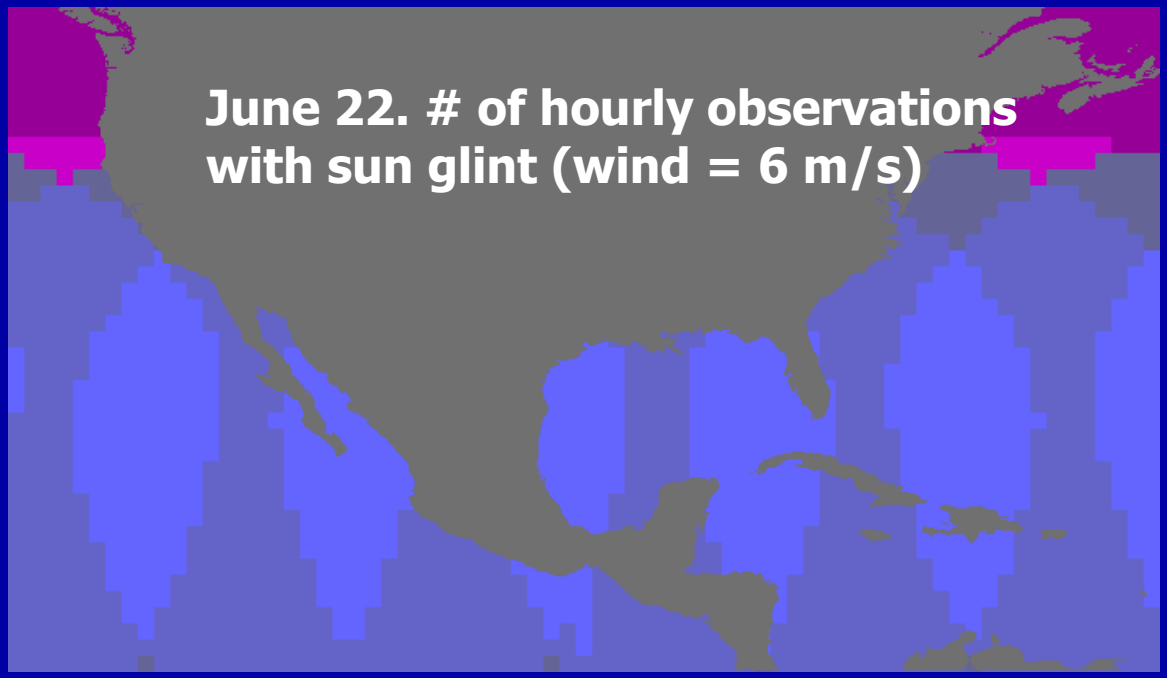
Hours from Sunrise and Sunset

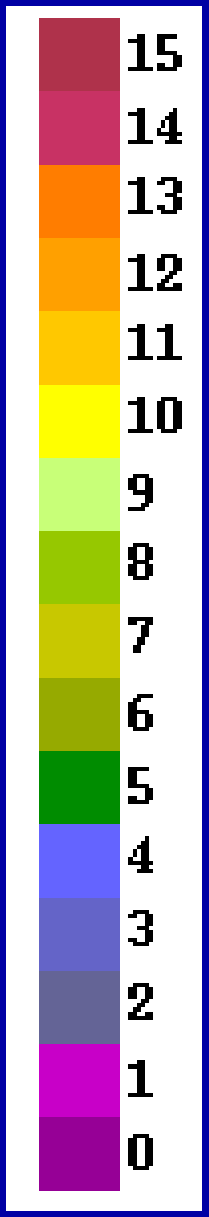


Hours from Sunrise and Sunset




June 22. # of hourly observations with θ_o< 80°


June 22. # of hourly observations with sun glint (wind = 6 m/s)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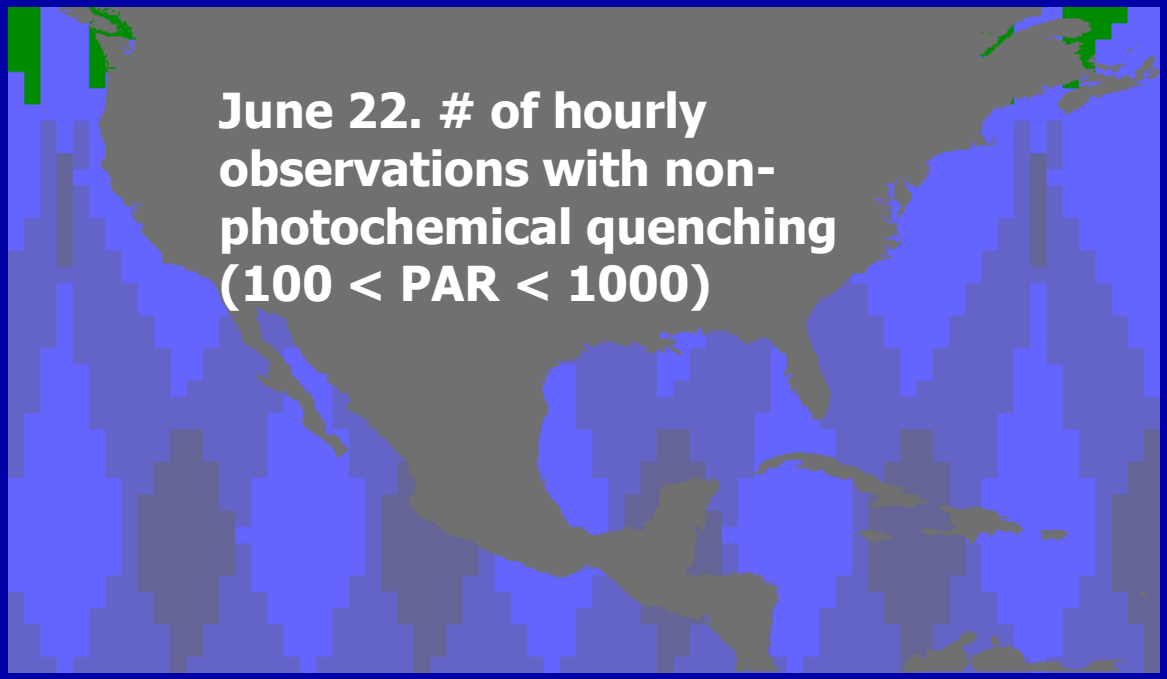
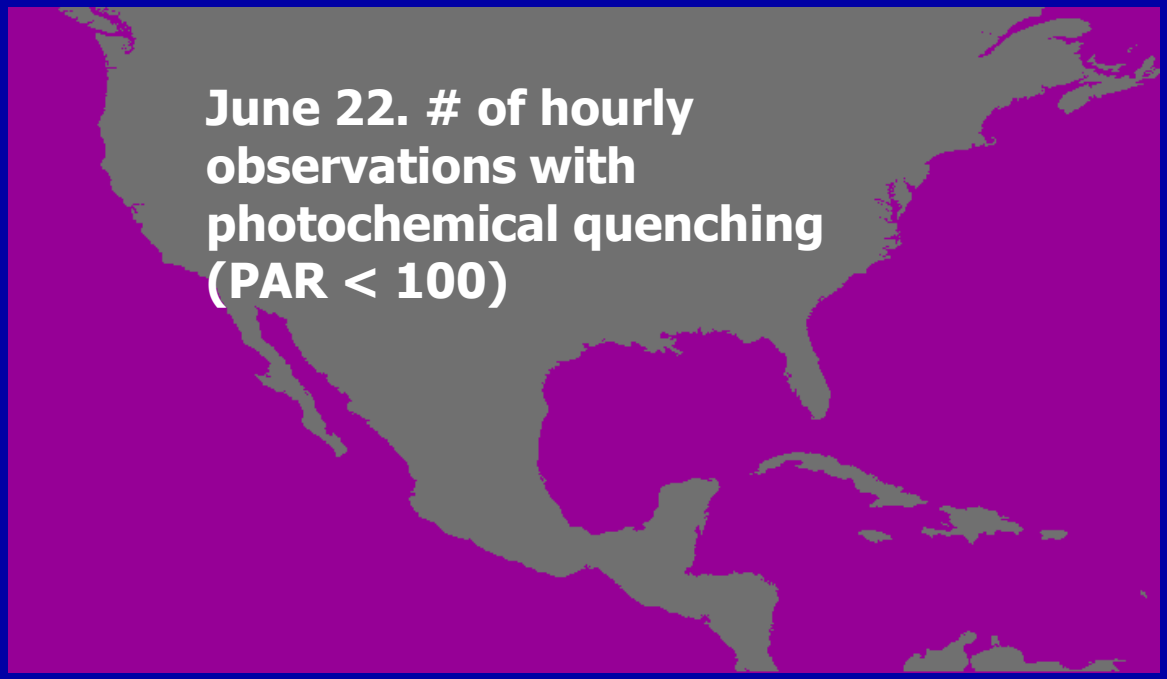
1
0


June 22. # of hourly observations with non-photochemical quenching (100 < PAR < 1000)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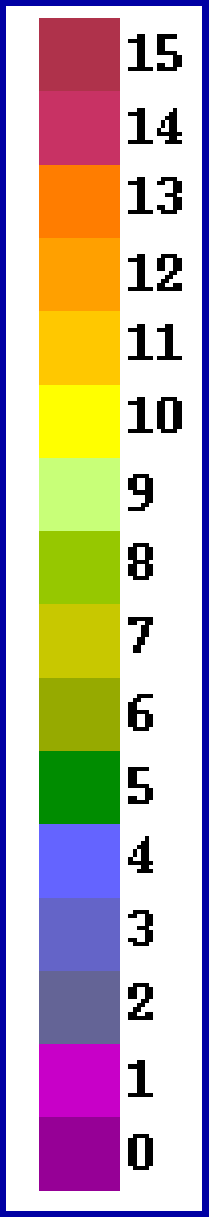
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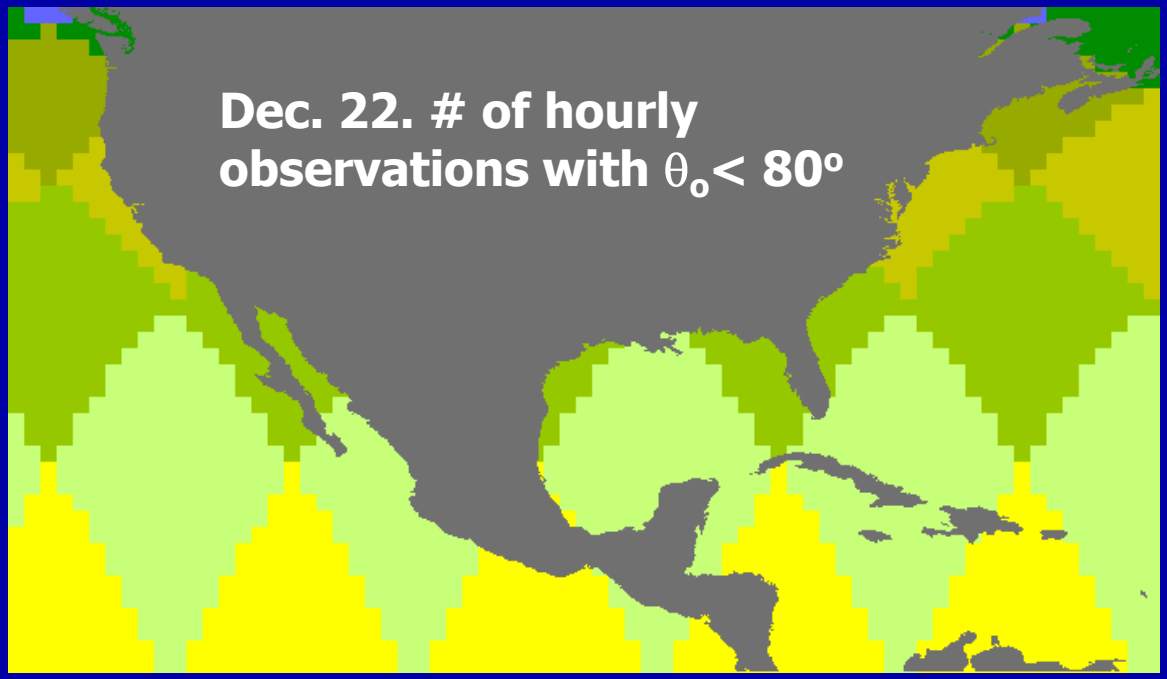
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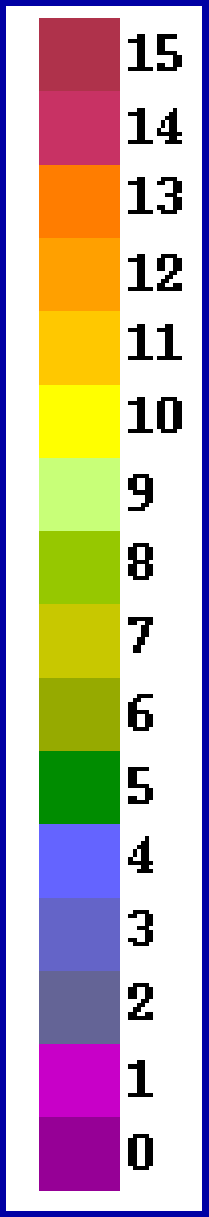
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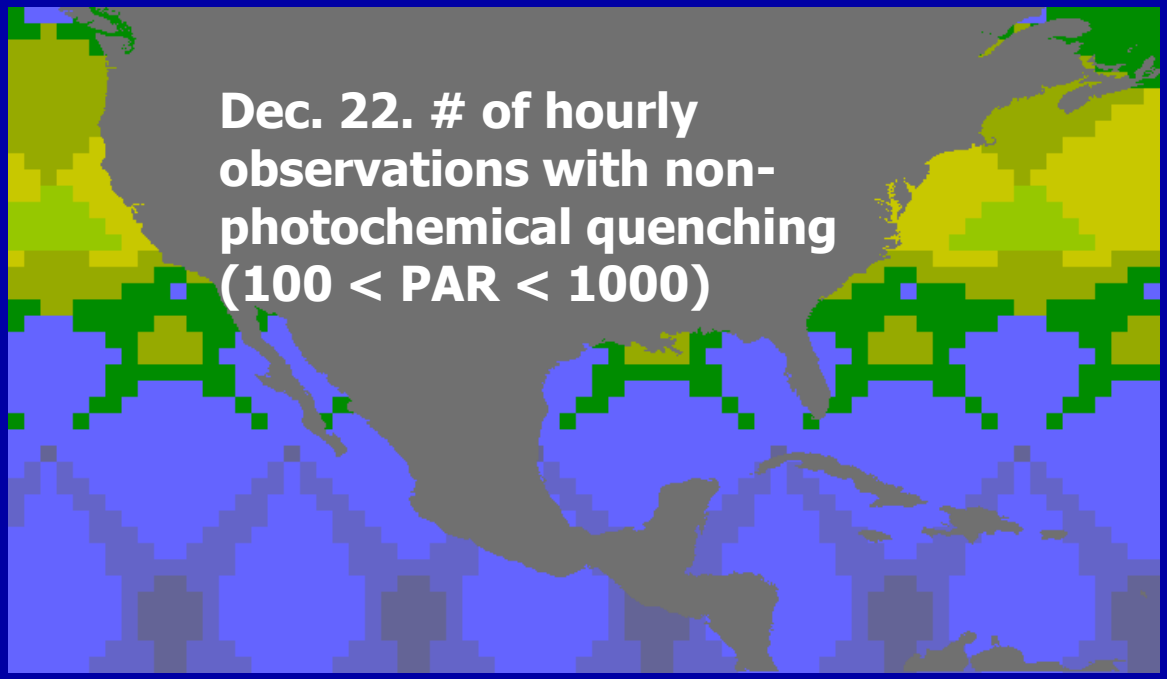
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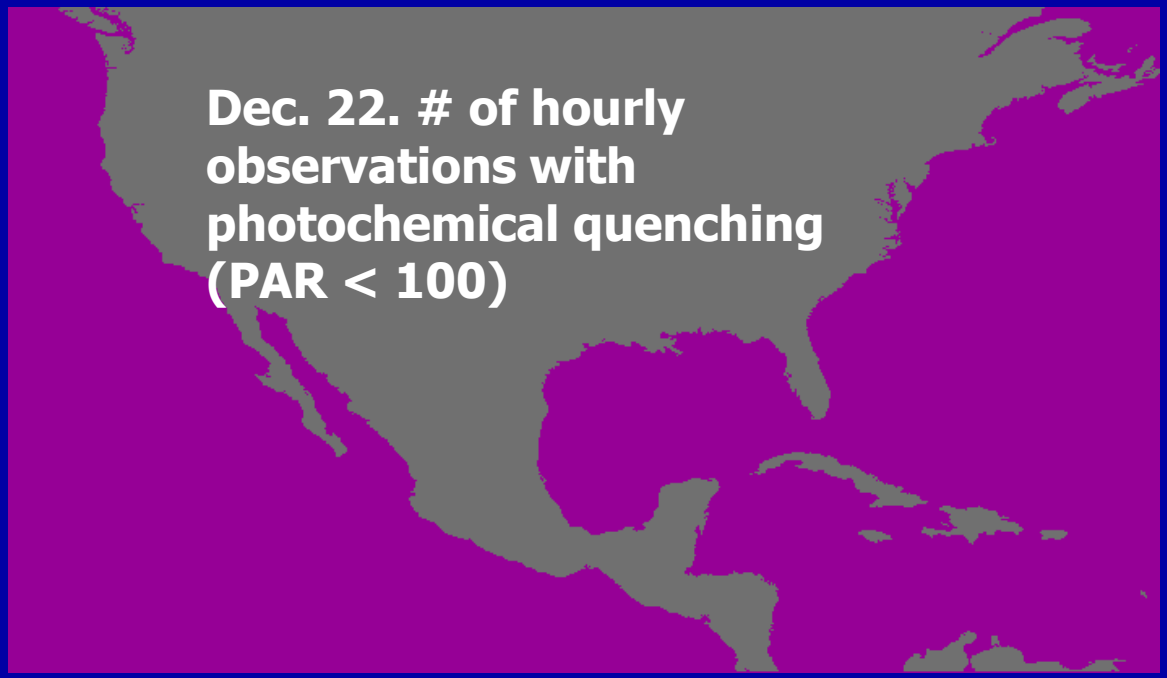
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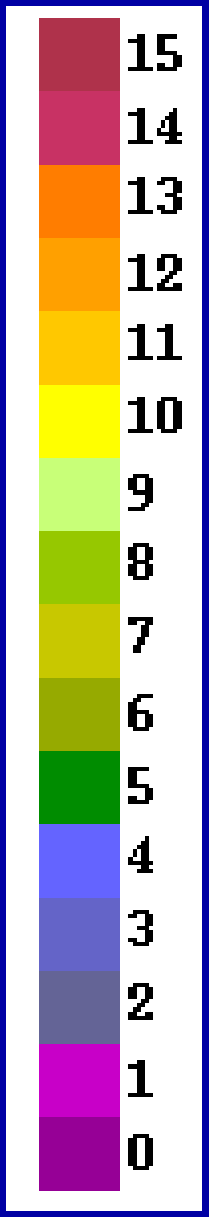
15
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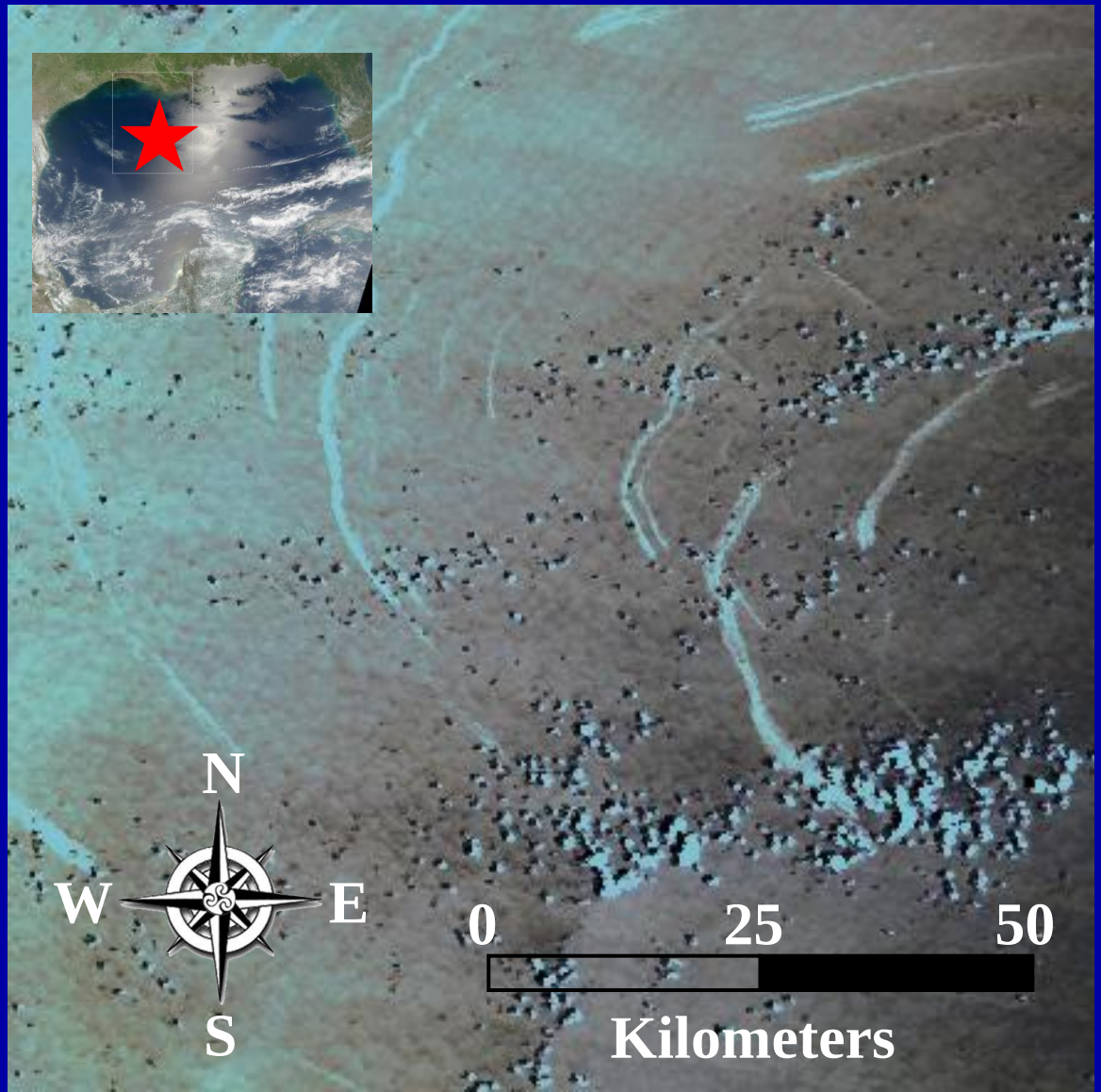
9
8
7
6
5
4
3
2
1
0

Importance of Glint Measurements
(require higher saturation)



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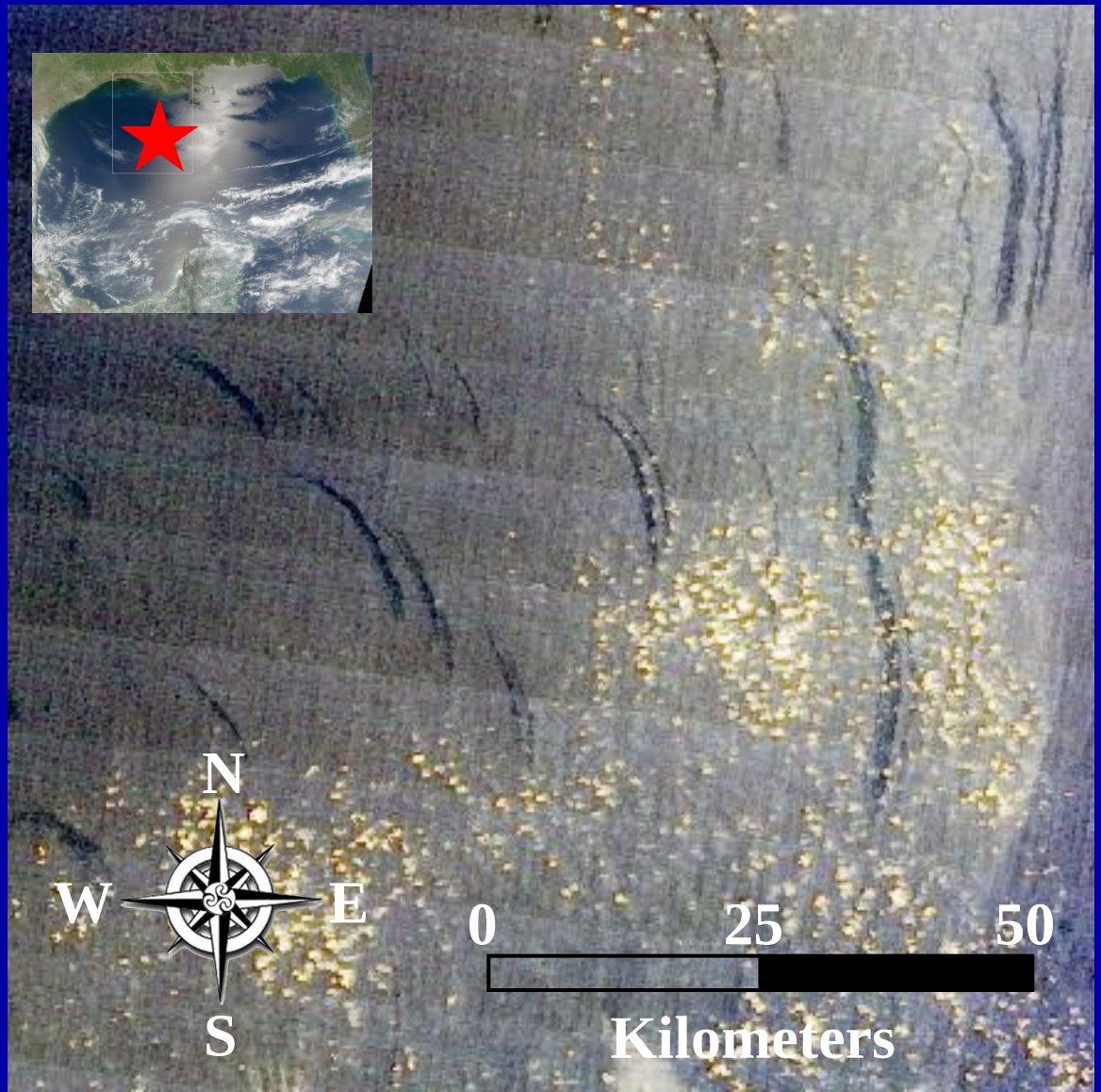

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Conclusions

- MODIS sensitivity can be followed
- Saturation radiance needs adjustment
- Work with instrument team on sensitivity, saturation, and integration time
- Work with instrument and science teams to implement data acquisition plan

MODIS, MERIS, GLI, etc.

MODIS (9): 412.5 443 488 531 551 667 678 748 869.5

(SNR) 880 838 802 754 750 910 1087 586 516

(all 10-nm bandwidth except 412.5 and 869.5)

MERIS (15): 412.5 442.5 490 510 560 665 681.25 708.75 753.75 760.625 778.75

(SNR) Not available. But 681.25 has SNR > 2000 for typical TOA radiance

(all 10-nm bandwidth except 681.25, 753.75, and 760.625)

GLI (19): 380 400 412 443 460 490 520 545 565 625 666 680 678 710(2) 749 763 865(2)

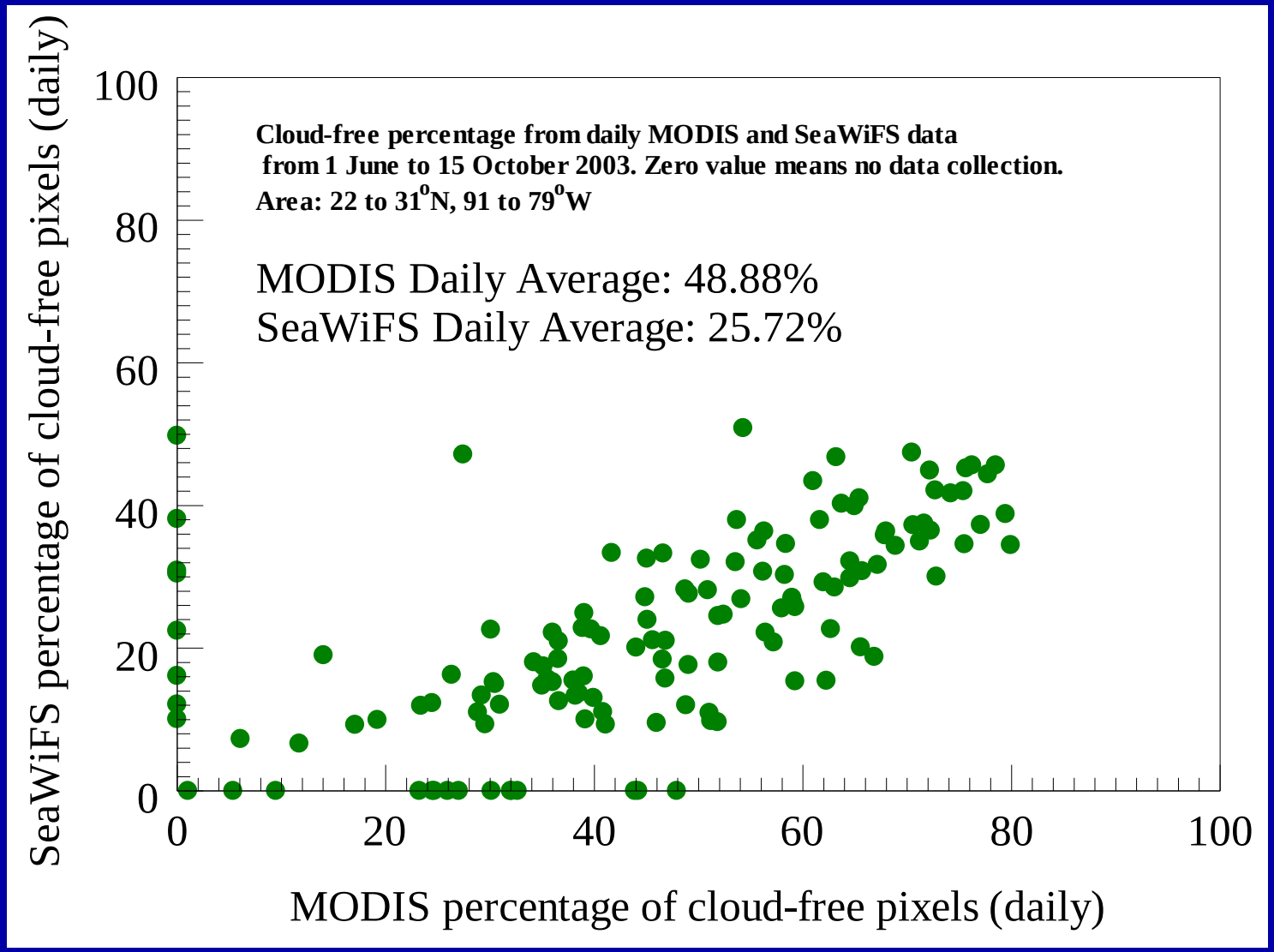
(SNR) Not available.

(all 10-nm bandwidth except 763 and 865)

For coral reef mapping: 451 482 498 526 556 580 610 647 (Hochberg et al., 2003)

For inter-tidal benthic algae: <500, 540, 565, 580, 610, 790 (Borstad, pers. comm.)

Twice/day versus once/day



Hyperspectral surface reflectance

Different Minerals