MODIS 250 & 500-meter Bands for Remote Sensing of Coastal and Inland Waters

Bryan Franz

and the

NASA Ocean Biology Processing Group

Some History

Gao, B.-C., M.J. Montes, Z. Ahmad, and C. O. Davis (2000). Atmospheric correction algorithm for hyperspectral remote sensing of ocean color from space, *Applied Optics*, 39, 887-896.

Arnone, R.A, Z.P. Lee, P. Martinolich, B. Casey, and S.D. Ladner (2002). Characterizing the optical properties of coastal waters by coupling 1 km and 250 m channels on MODIS – Terra, *Proc. Ocean Optics XVI*, Santa Fe, New Mexico, 18-22 November.

Li, R.-R., Y.J. Kaufman, B.-C. Gao, and C.O. Davis (2003). Remote Sensing of Suspended Sediments and Shallow Coastal Waters, *IEEE Trans. on Geoscience and Remote Sensing*, Vol. 41, No. 3 pp. 559.

Miller, R.L. and B.A. McKee (2004). Using MODIS Terra 250 m imagery to map concentrations of total suspended matter in coastal waters, *Remote Sensing of Environment*, 93, 259-266.

Hu, C., Z. Chen, T.D. Clayton, P. Swarzenski, J.C. Brock, and F.E. Müller-Karger (2004). Assessment of estuarine water-quality indicators using MODIS medium-resolution bands: Initial results from Tampa Bay, FL, *Remote Sensing of Environment*, 93, 423-441.

Kahru, M., B.G. Mitchell, A. Diaz, M. Miura (2004). MODIS Detects Devastating Algal Bloom in Paracas Bay, Peru, *EOS Trans. AGU*, 85 (45), 465-472.

Wang, M. and W. Shi (2005). Estimation of ocean contribution at the MODIS near-infrared wavelengths along the east coast of the U.S.: Two case studies, Geophys. Res. Lett., 32, L13606.

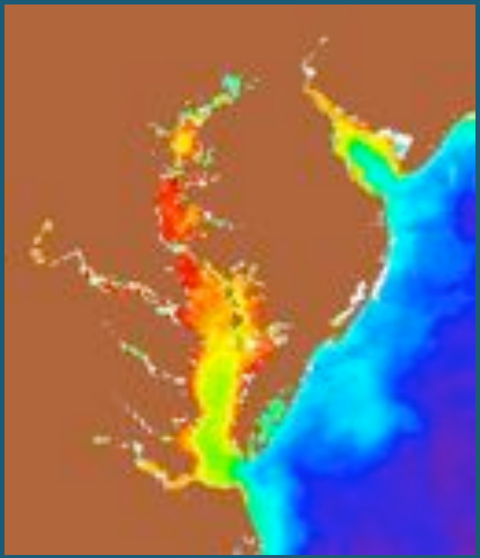
MODIS Land/Cloud Bands of Interest

Band	Wavelength	Resolution	Potential Use
1	645 nm	250 m	sediments, turbidity, IOPs
2	859	250	aerosols
3	469	500	C_a, IOPs, $CaCO_3$
4	555	500	C_a, IOPs, $CaCO_3$
5	1240	500	aerosols
6	1640	500	aerosols
7	2130	500	aerosols

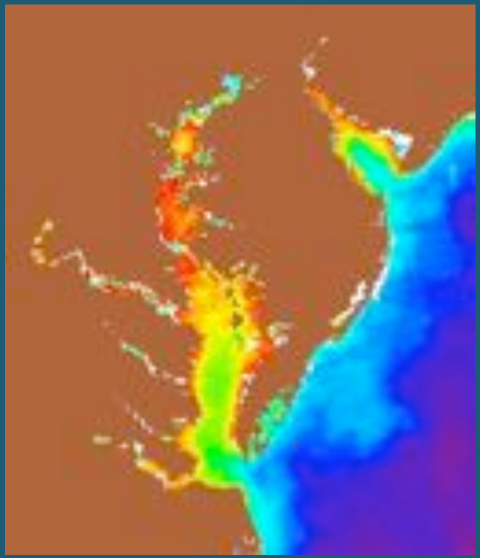
spatial resolution and expanded dynamic range come at the cost of increased digitization error (reduced sensitivity at ocean radiances) and reduced signal to noise

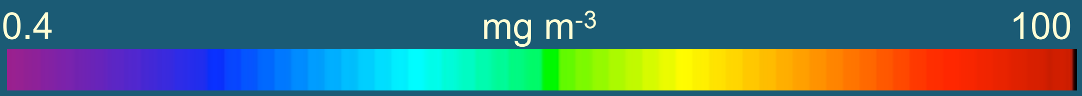
Chlorophyll: 1000-meter resolution

OC3 = f(443,488,551)

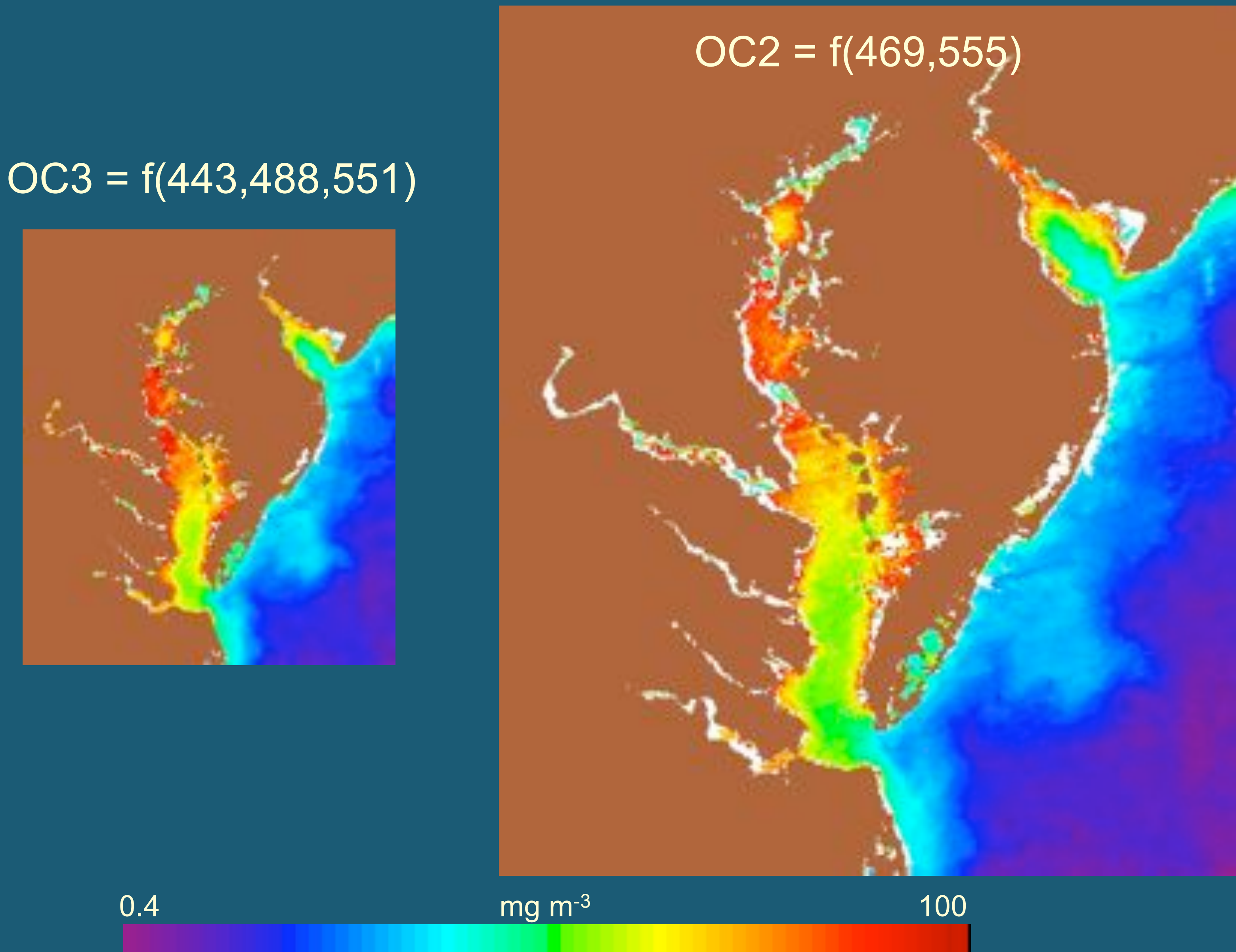


OC2 = f(469,555)

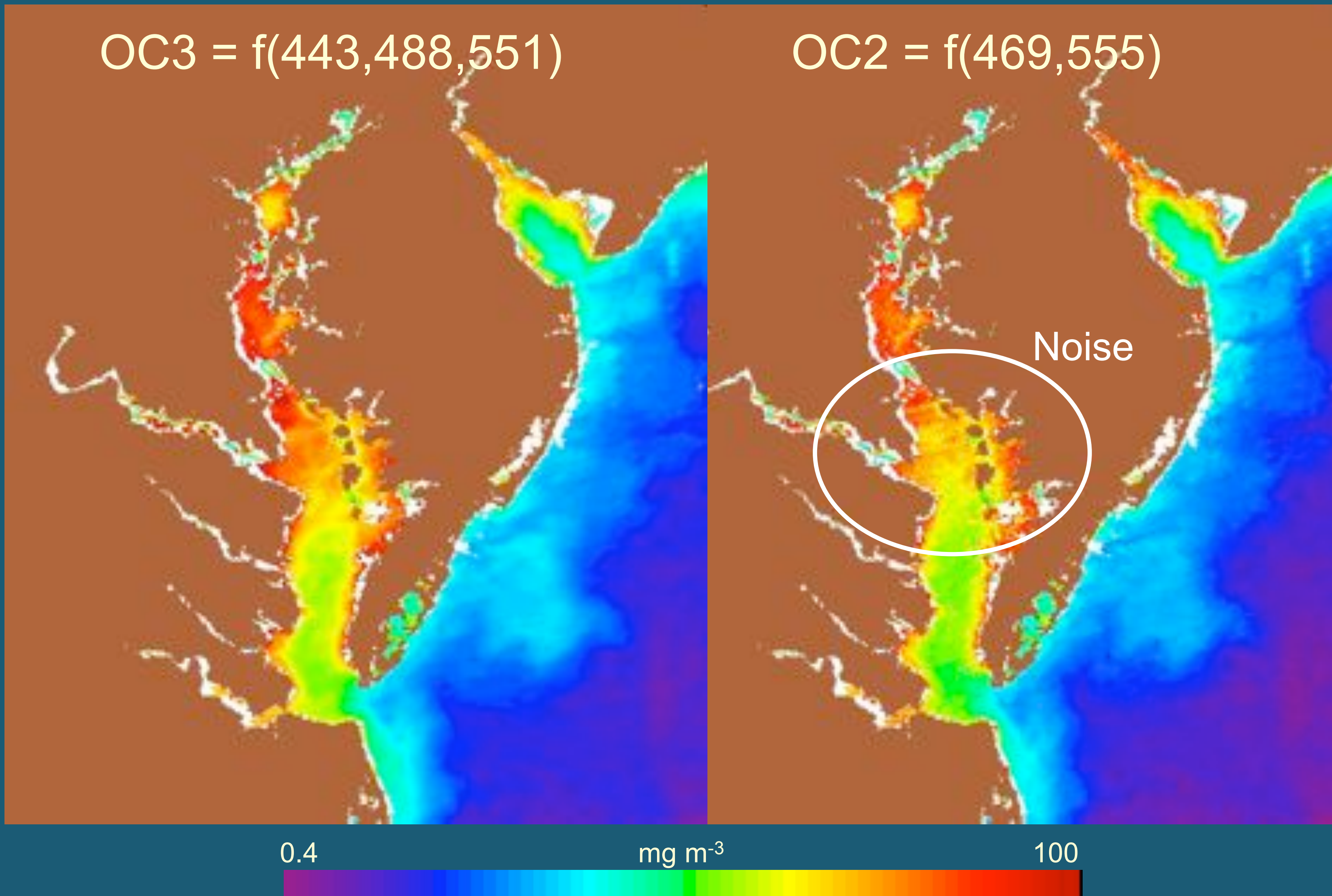




Chlorophyll: 1000 & 500-meter



Chlorophyll: 500-meter Resolution



MODIS Land/Cloud Bands of Interest

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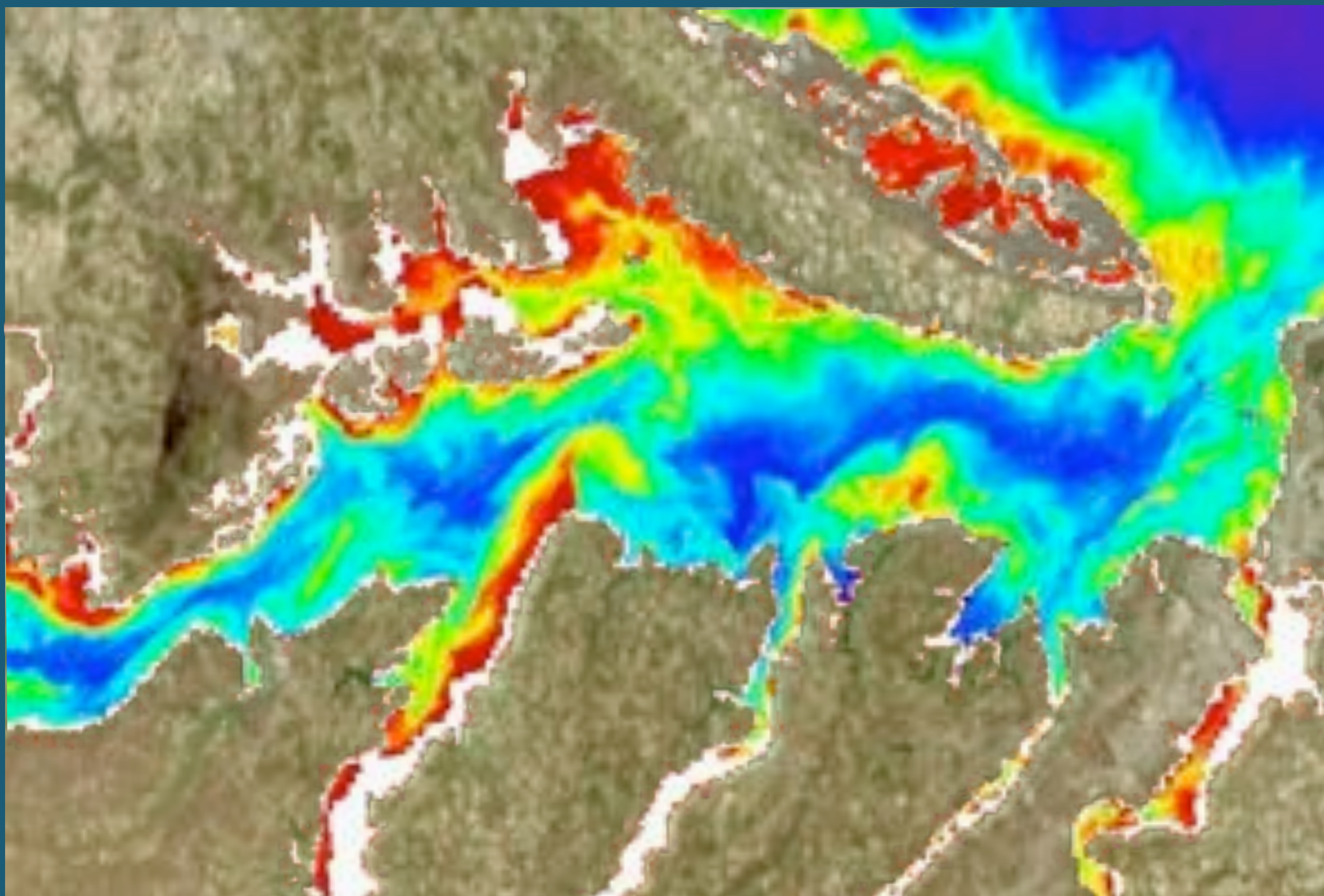
6	1640	500	aerosols
7	2130	500	aerosols

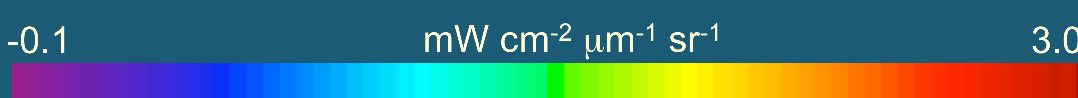
RGB Image: 645, 555, 469

showing river sediments

RGB Image at 250-meter Resolution

nLw(645) at 250-meter resolution





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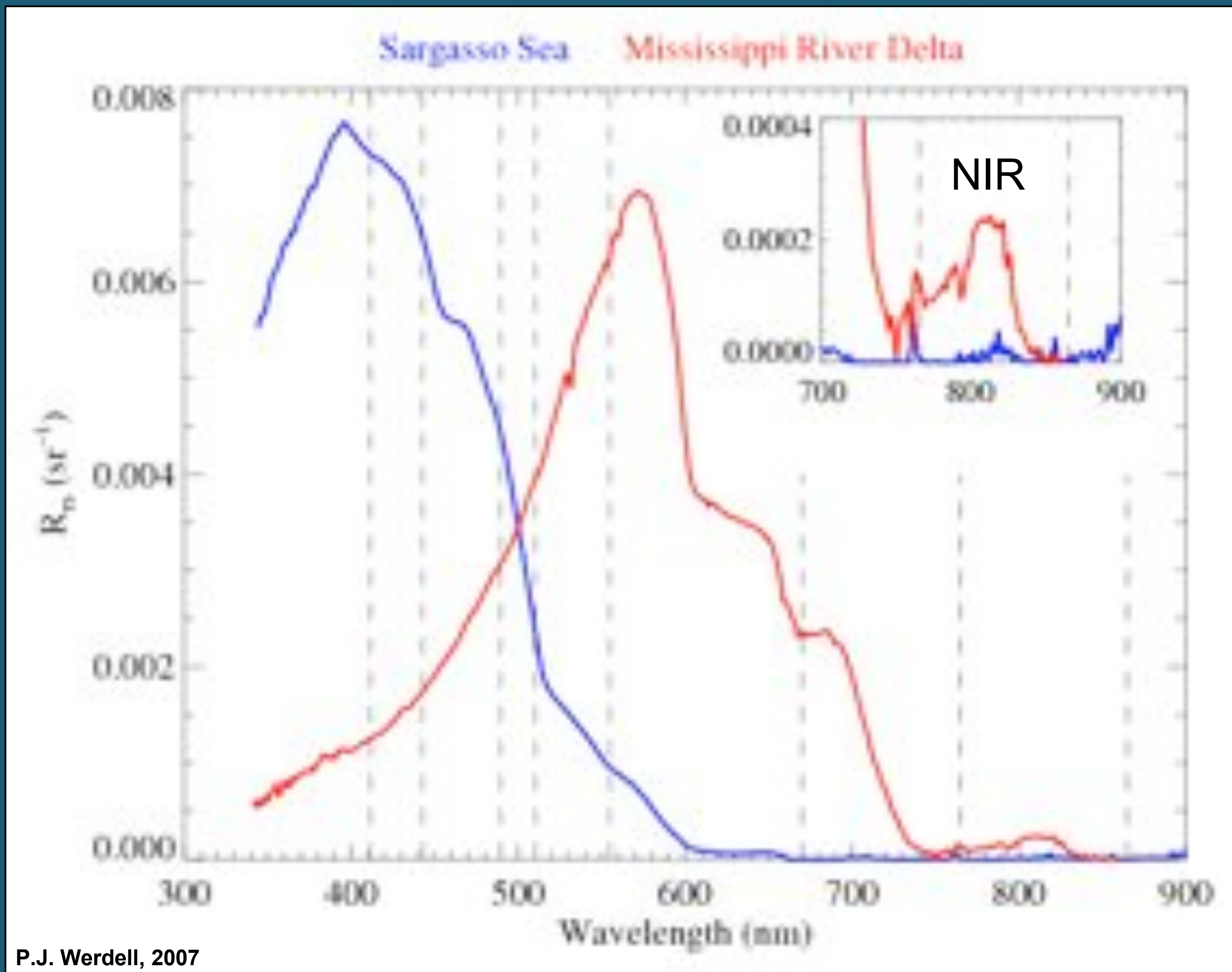
SWIR

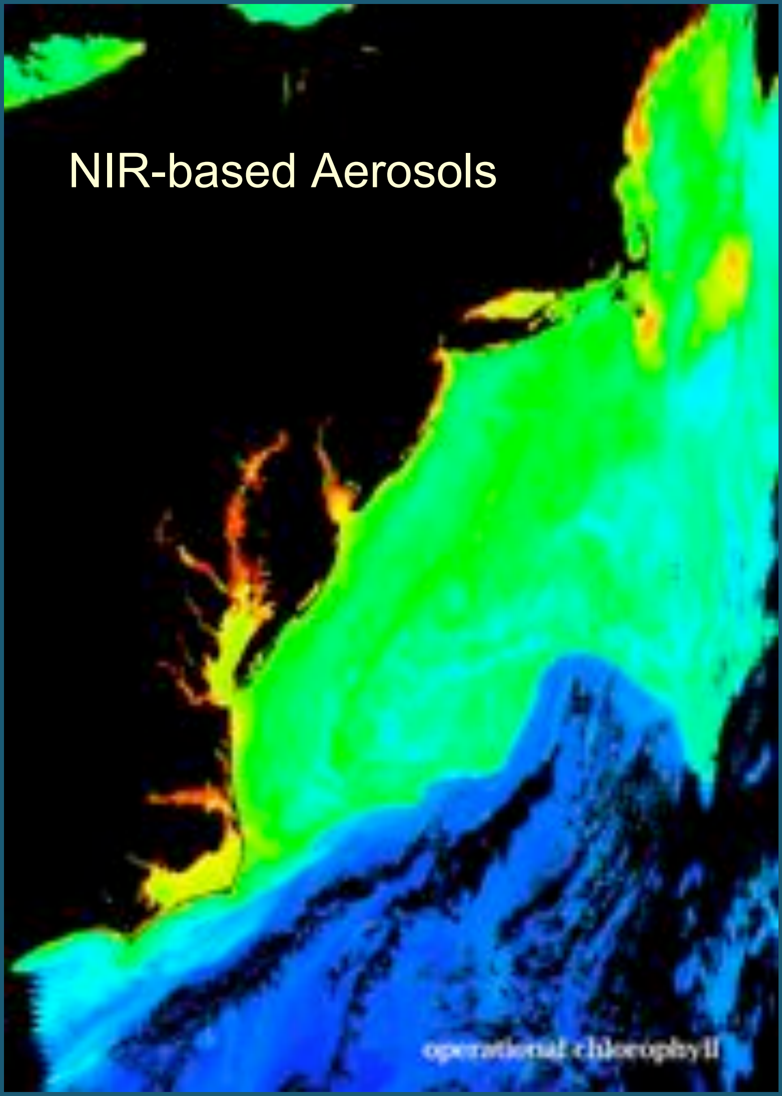
Why the SWIR?

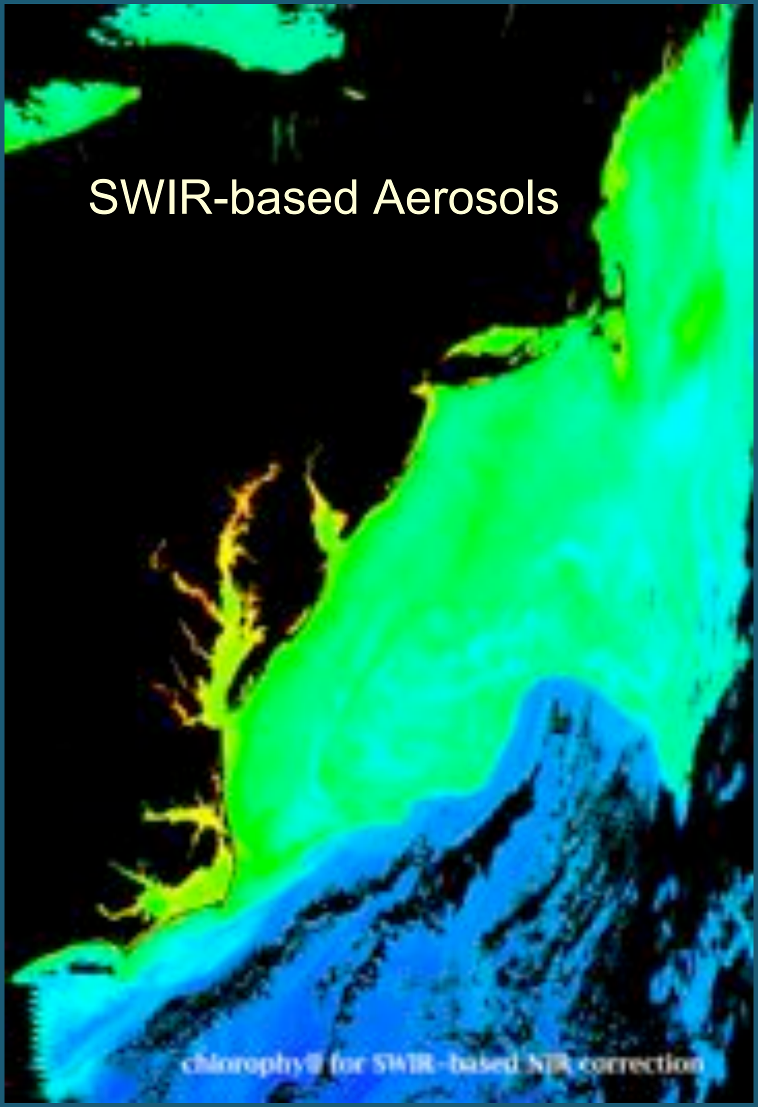
separation of aerosol and water contributions



SWIR

Change in Chlorophyll Retrieval with Alternate Aerosol Determination Methods





More Info

Sample application in Chesapeake Bay:

in next talk by Jeremy Werdell

Software in SeaDAS (msl12)

Implementation details:

http://oceancolor.gsfc.nasa.gov/DOCS/modis_hires/

Conference paper:

Franz, B.A., P.J. Werdell, G. Meister, E.J. Kwiatkowska, S.W. Bailey, Z. Ahmad, and C.R. McClain (2006). MODIS Land Bands for Ocean Remote Sensing Applications, *Proc. Ocean Optics XVIII*, Montreal, Canada, 9-13 October 2006.

Poster at this meeting:

MODIS Land Bands for Ocean Remote Sensing Applications

Thank You !

Expanded MODIS Ocean Band Suite

Band Number	Wavelength (nm)	Band Width (nm)	Spatial Resolution (m)	SNR at L_{typ}	L_{typ} mW cm^{-2} µm^{-1} sr^{-1}	L_{max} mW cm^{-2} µm^{-1} sr^{-1}
8	412	15	1000	1773	7.84	26.9
9	443	10	1000	2253	6.99	19.0
3	469	20	500	556	6.52	59.1
10	488	10	1000	2270	5.38	14.0
11	531	10	1000	2183	3.87	11.1
12	551	10	1000	2200	3.50	8.8
4	555	20	500	349	3.28	53.2
1	645	50	250	140	1.65	51.2
13	667	10	1000	1962	1.47	4.2
14	678	10	1000	2175	1.38	4.2
15	748	10	1000	1371	0.889	3.5
2	859	35	250	103	0.481	24.0
16	869	15	1000	1112	0.460	2.5
5	1240	20	500	25	0.089	12.3
6	1640	35	500	19	0.028	4.9
7	2130	50	500	12	0.008	1.7

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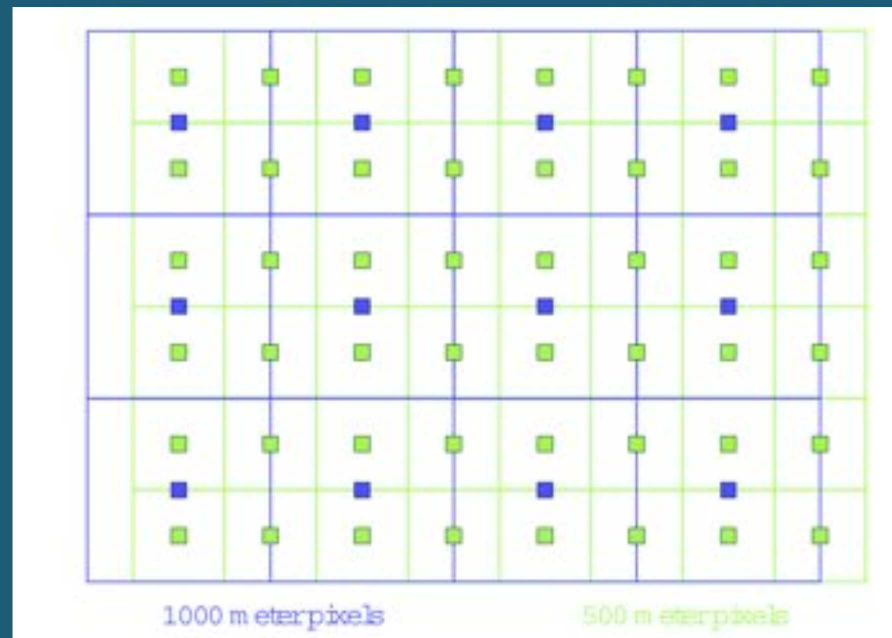
Multi-Resolution Implementation

Aggregation

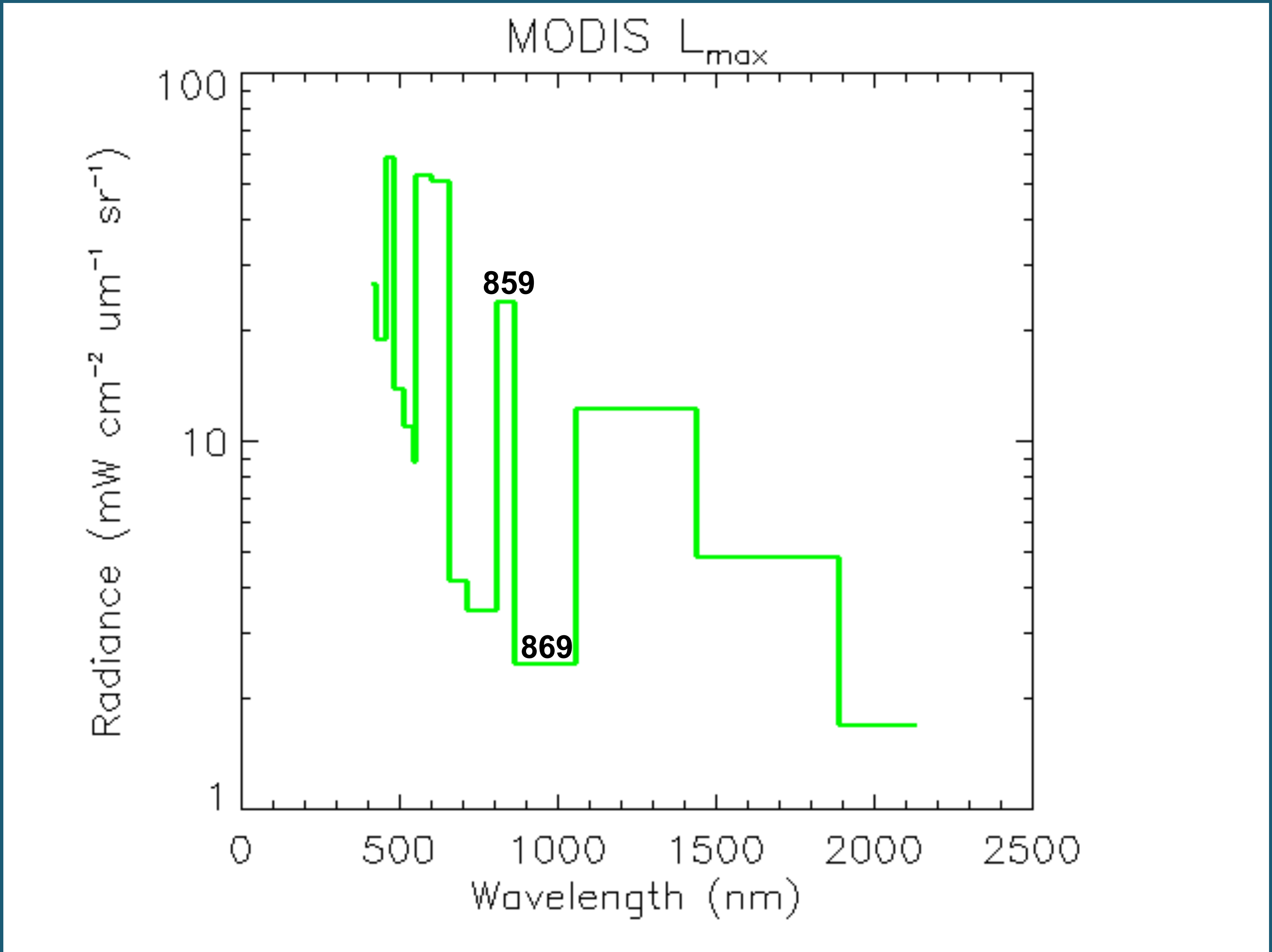
QKM	HKM	1KM
645 nm	469 nm	412 nm
859 nm	555 nm	443 nm
	645 nm [1]	469 nm [3]
	859 nm [1]	488 nm
	1240 nm	531 nm
	1640 nm	551 nm
	2130 nm	555 nm [3]
		645 nm [2]
		667 nm
		678 nm
		748 nm
		859 nm [2]
		869 nm
		1240 nm [3]
		1640 nm [3]
		2130 nm [3]
		3.9 um
		4.0 um
		11 um
		12 um

Interpolation

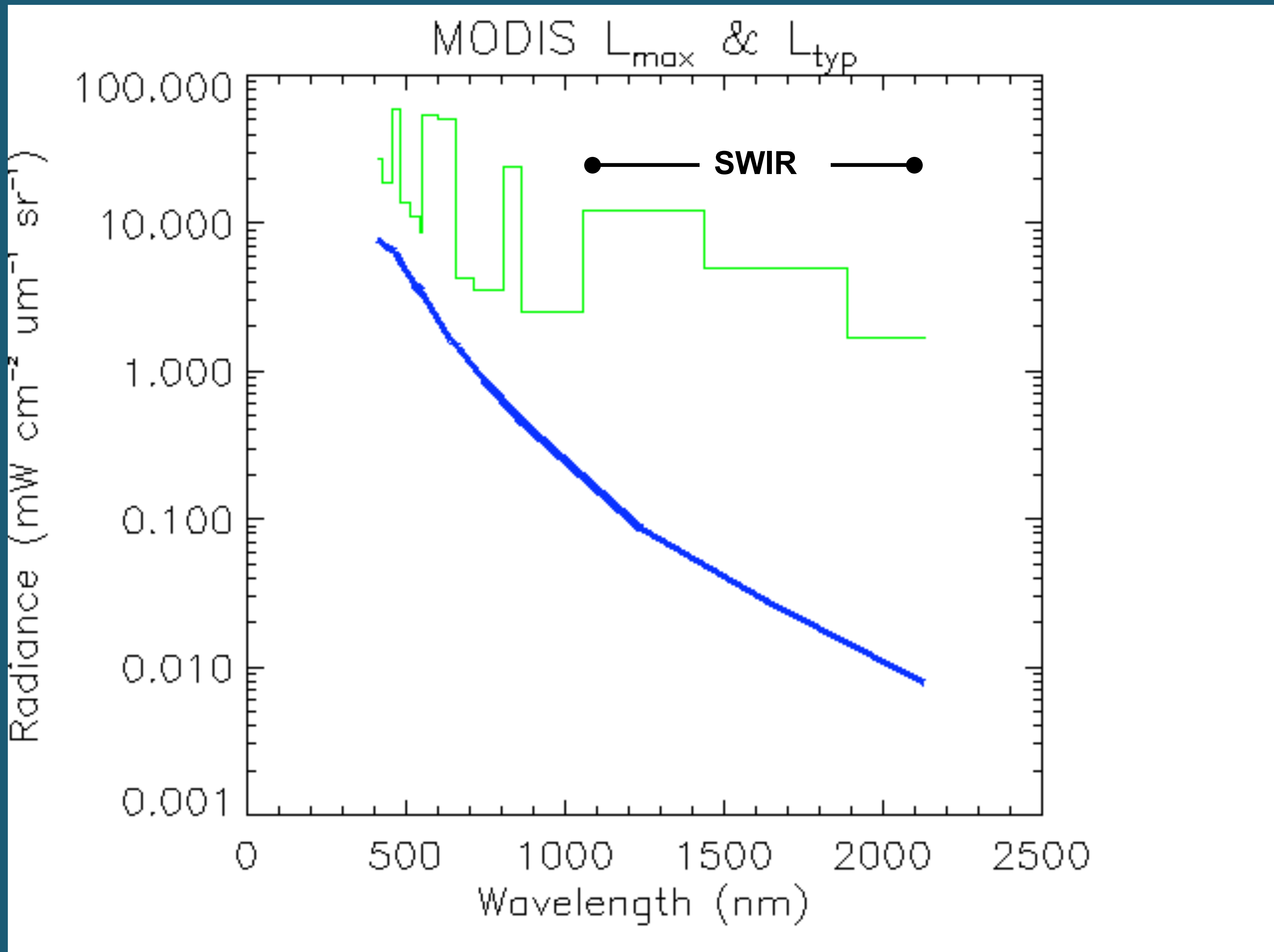


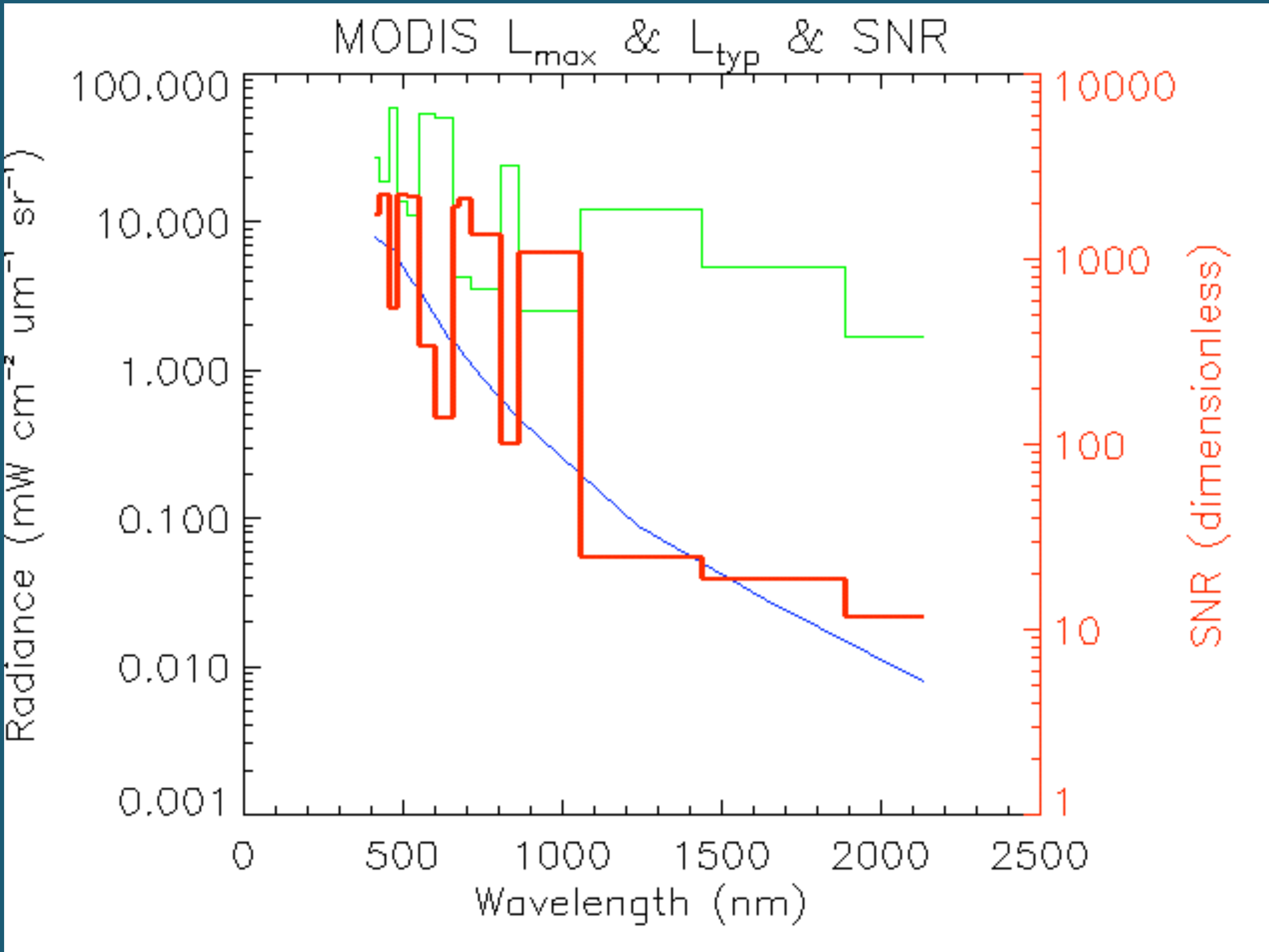
from Gumley, et al.

Observed (TOA) radiances, geolocation, radiant path geometries interpolated or aggregated to a common resolution.



MODIS L_{max}
100
10
1
Radiance (mW cm^{-2} um^{-1} sr^{-1})
859
869
0
500
1000
1500
2000
2500
Wavelength (nm)


MODIS L_{max} & L_{typ}
SWIR
Radiance (mW cm^{-2} um^{-1} sr^{-1})
100.000
10.000
1.000
0.100
0.010
0.001
0
500
1000
1500
2000
2500
Wavelength (nm)



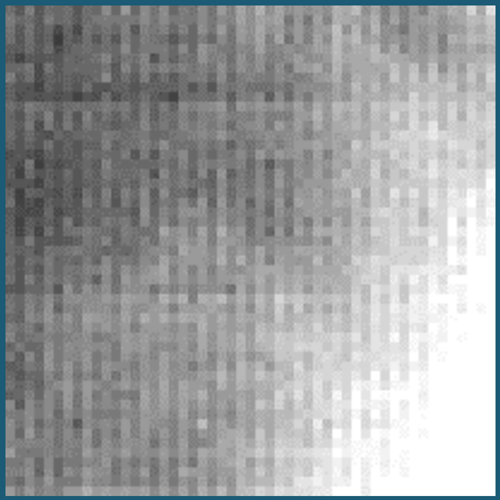
MODIS L_{max} & L_{typ} & SNR
100.000
10.000
1.000
0.100
0.010
0.001
Radiance (mW cm^{-2} um^{-1} sr^{-1})
10000
1000
100
10
1
SNR (dimensionless)
0
500
1000
1500
2000
2500
Wavelength (nm)

Characterization & Calibration

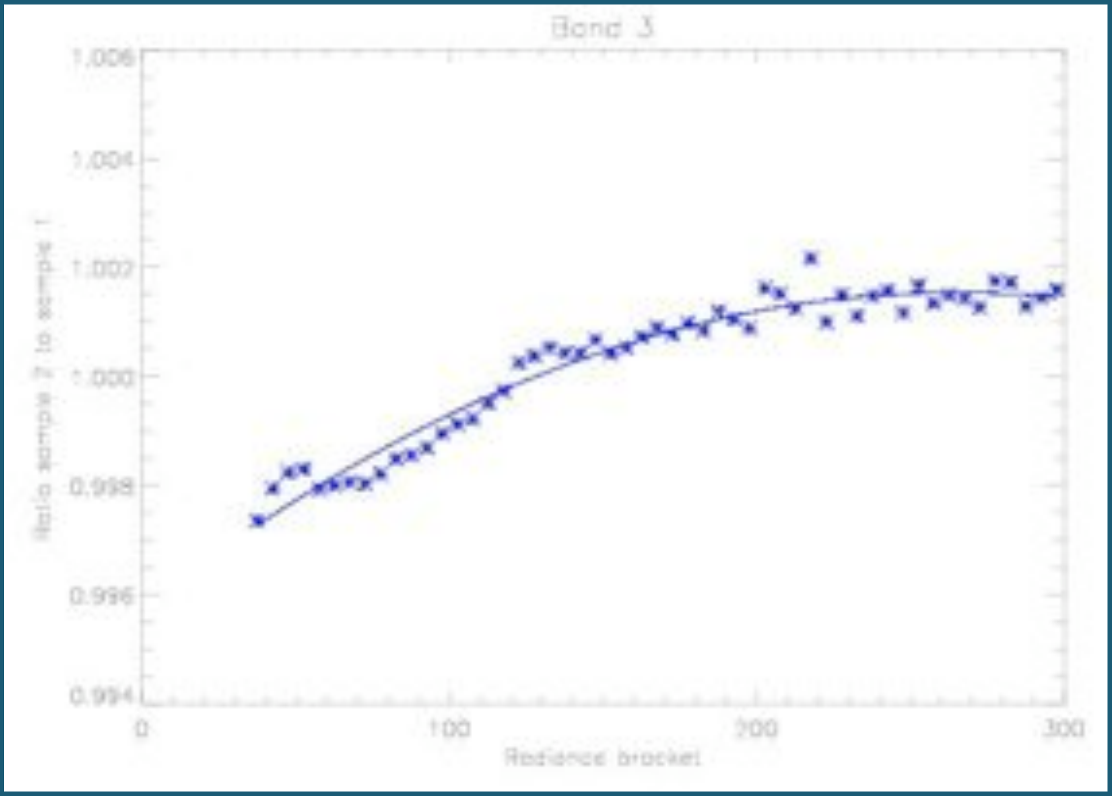
- Relative spectral response functions: Rayleigh & aerosol tables
- Polarization sensitivities (reanalysis of pre-launch testing)
- Relative detector and sub-sampling corrections (striping)
- Vicarious calibration to MOBY (preliminary)

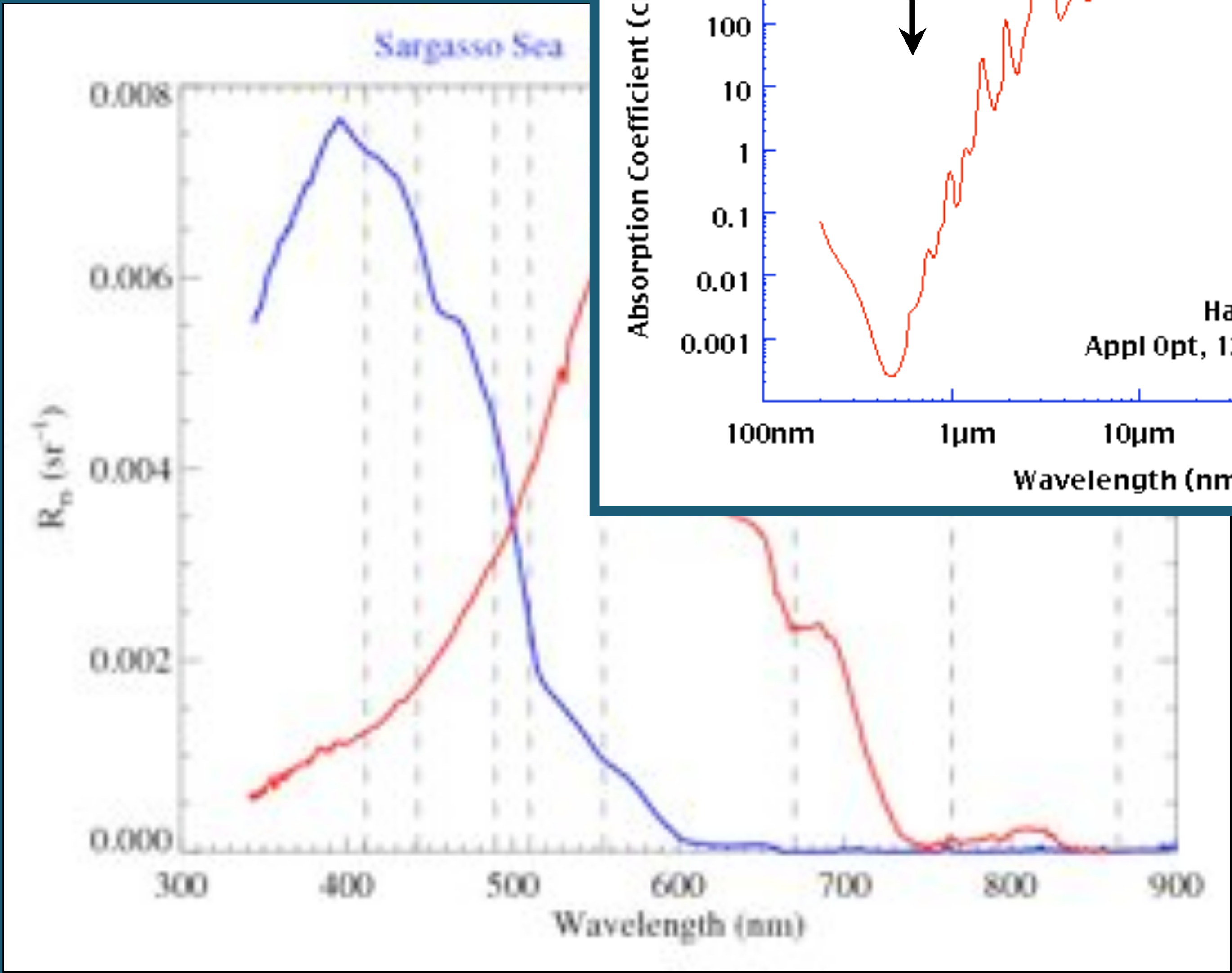
Detector and Sub-sample Striping

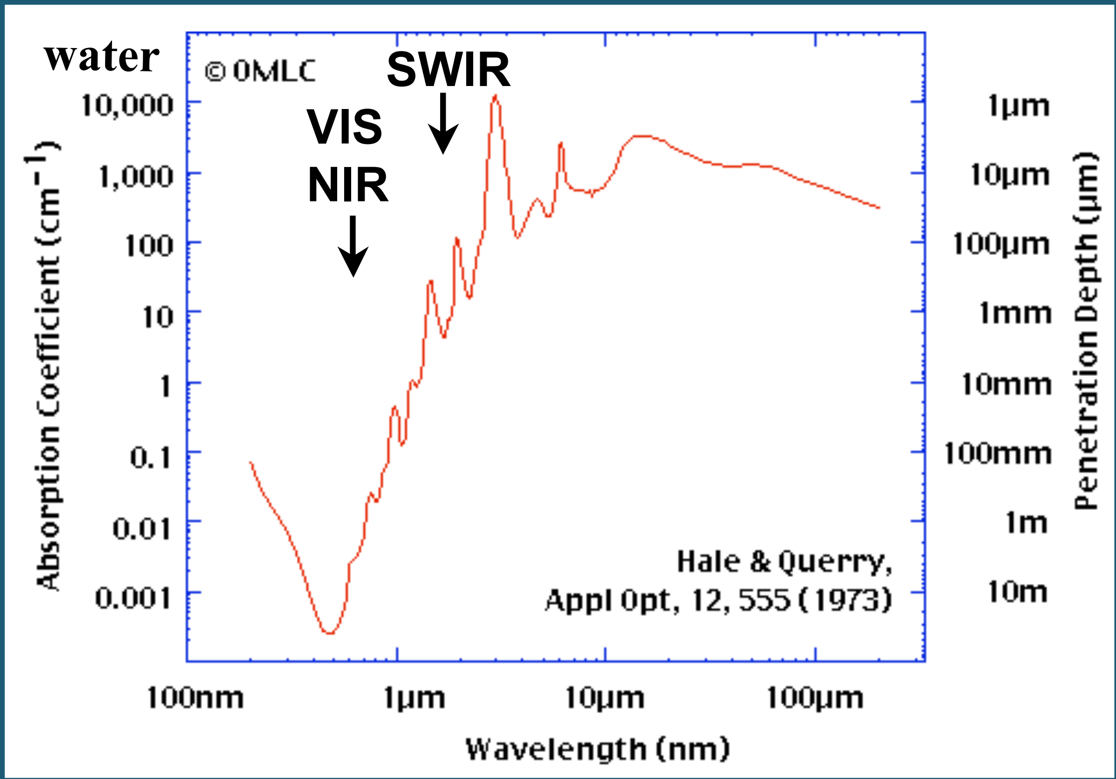
TOA radiance 469 nm



ratio of adjacent samples along scan, 469 nm







SWIR →

P.J. Werdell, 2007