Enhanced Satellite Remote Sensing of Coastal Waters: Increasing the Resolution of VIIRS Bio-optical Products

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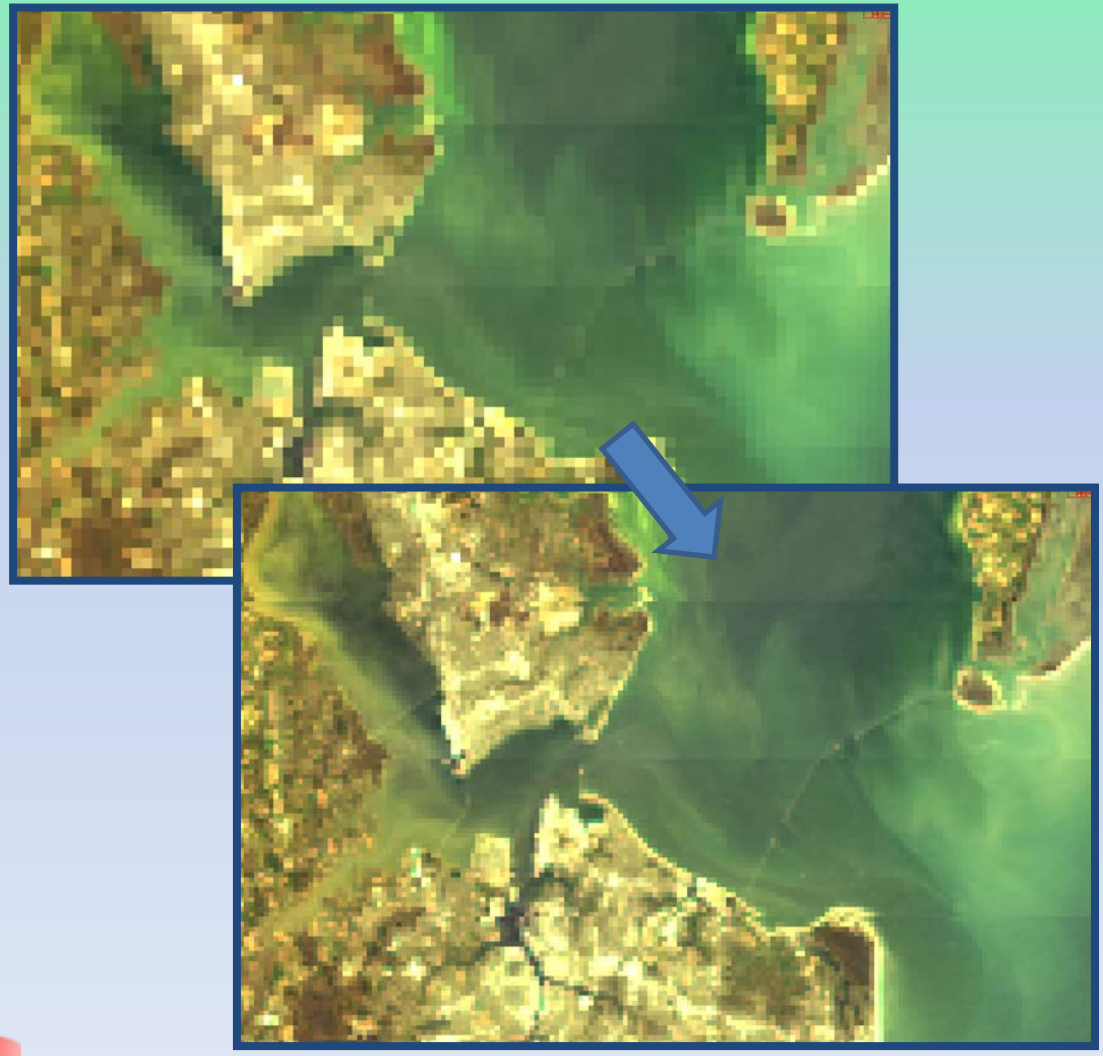
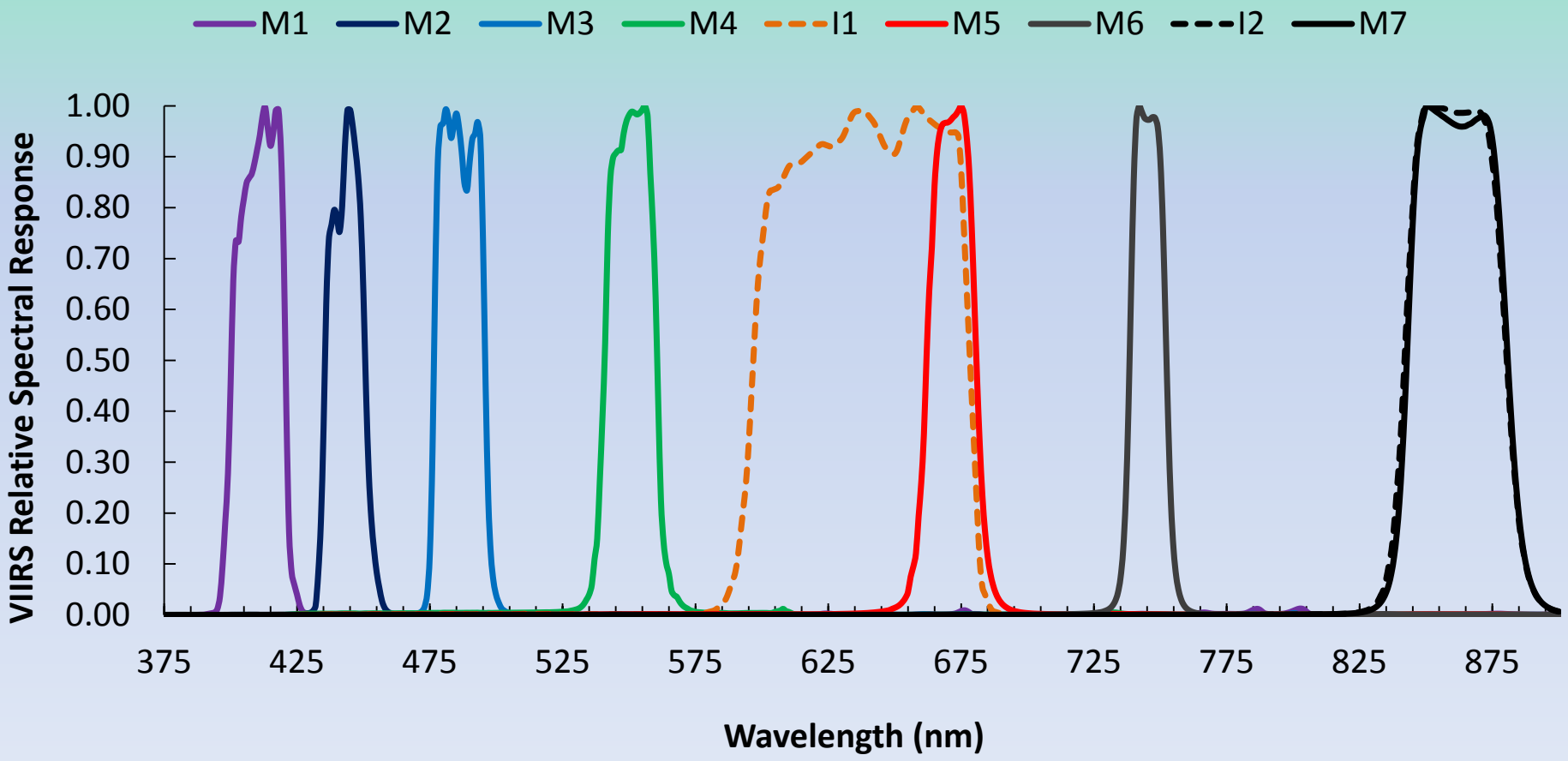


2014 OCEAN SCIENCES MEETING

Objectives:

- Utilize high resolution I1-band (375-m) to sharpen visible spectrum (750-m)
- Ensure optical integrity is maintained across the spectrum
- Use high resolution radiance as input into various bio-optical algorithms
- Show that high resolution products yield more information than standard



Challenge:

$b_b/a_{\text{I-1 band}} \neq b_b/a_{\text{M}(\lambda)\text{ bands}}$

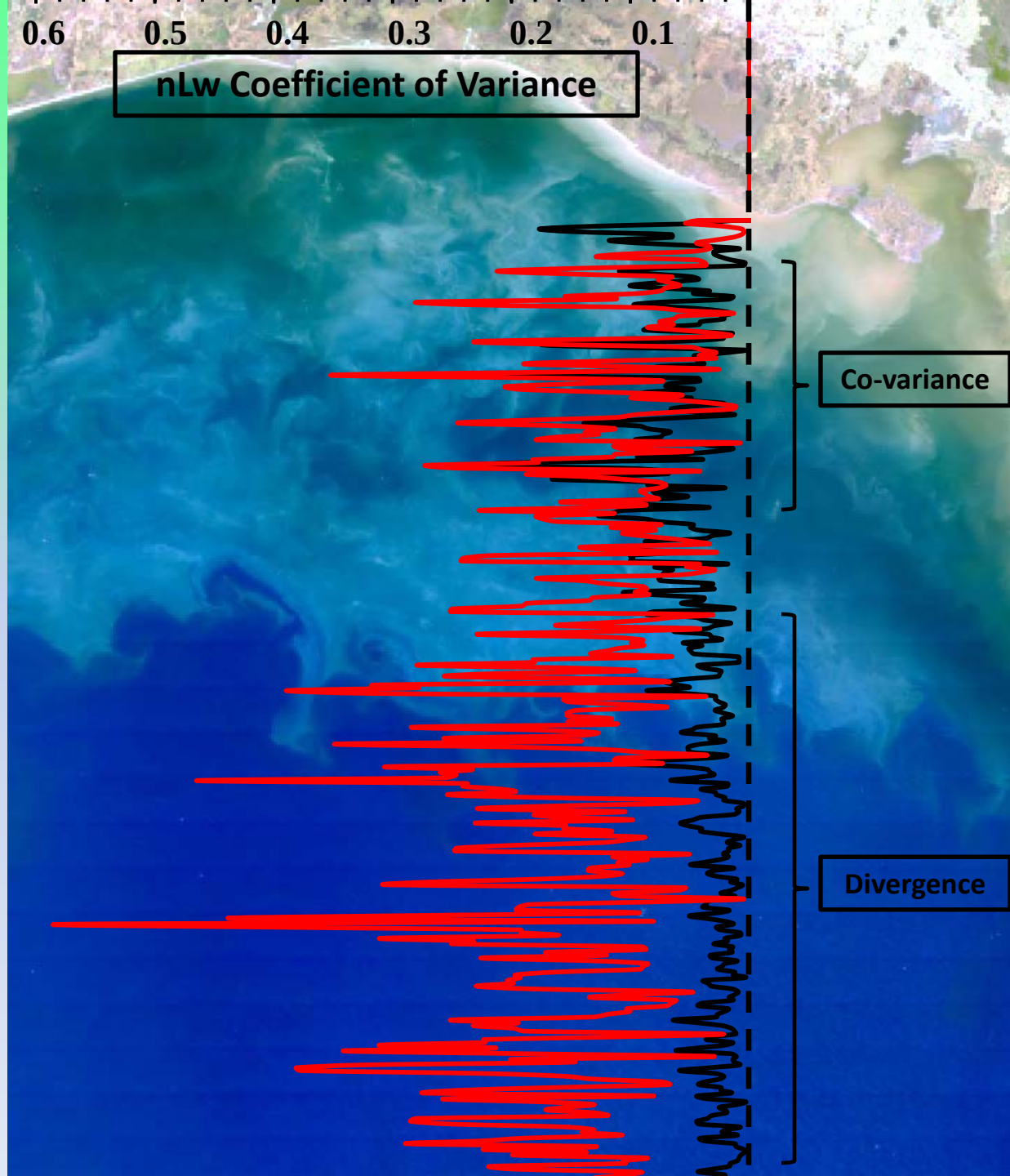
$1/Kd_{\text{I-1 band}} \neq 1/Kd_{\text{M}(\lambda)\text{ bands}}$

$CV_{\text{I-1 band}} \neq CV_{\text{M}(\lambda)\text{ bands}}$

OC variability is spectrally dependent!

— 410 Variance

— 640 Variance

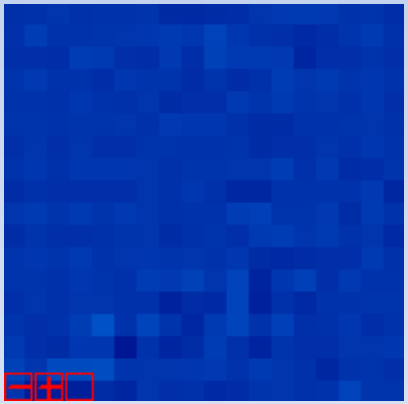


Approach:

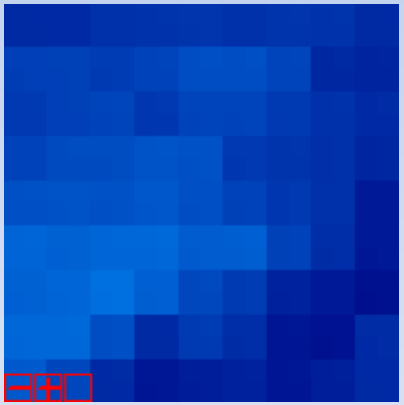
- Compute a ***Wavelength dependent*** spatial resolution ratio

$$R(\lambda) = ([(I1_{375} - I1_{750}) \times (CV_{M(\lambda)}/CV_{I1})] + I1_{750}) / I1_{750}$$

- Compare the relative spatial variability present at each wavelength → Re-define I-1 band
- For each pixel, the sharpening is independently weighted as a direct function of variability (relative to I1-band) at each wavelength
- Modify l2gen (post atm_corr) to accept high resolution spectrum as input for bio-optics



X



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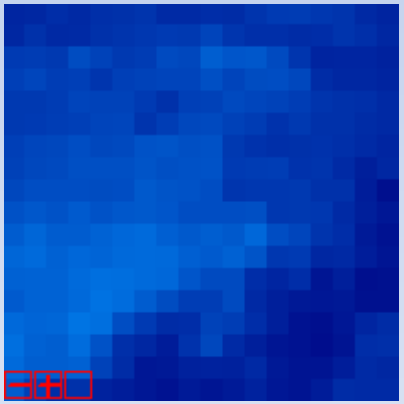


Dynamic R(λ)
λ-dependent spectral ratio

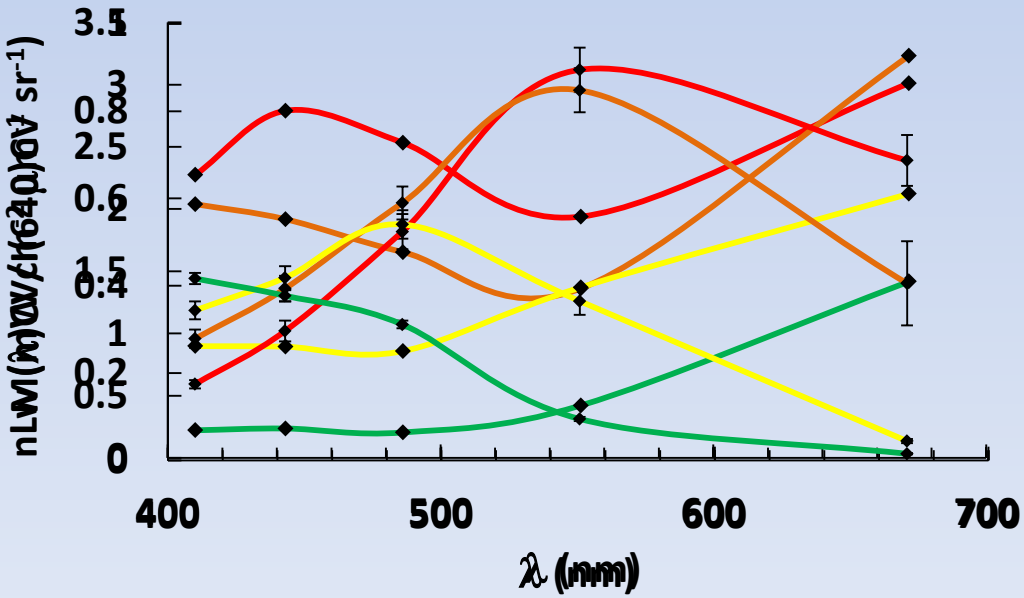
M(λ)-band
(750-m resolution)

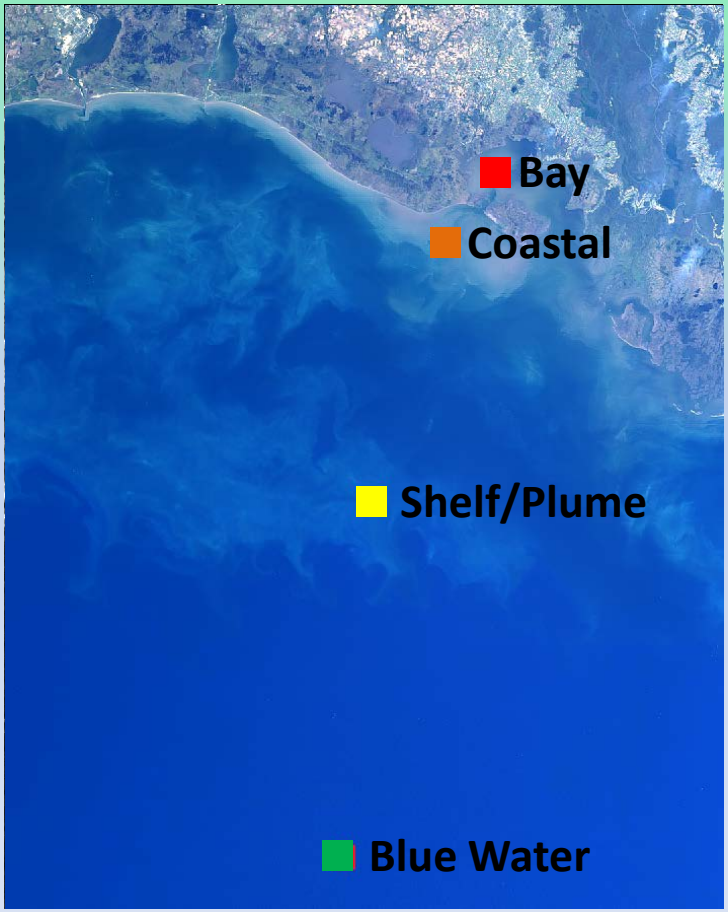
Hires M(λ)-band
(pseudo 375-m resolution)

Approach: Sharpening Across Diverse Water Types

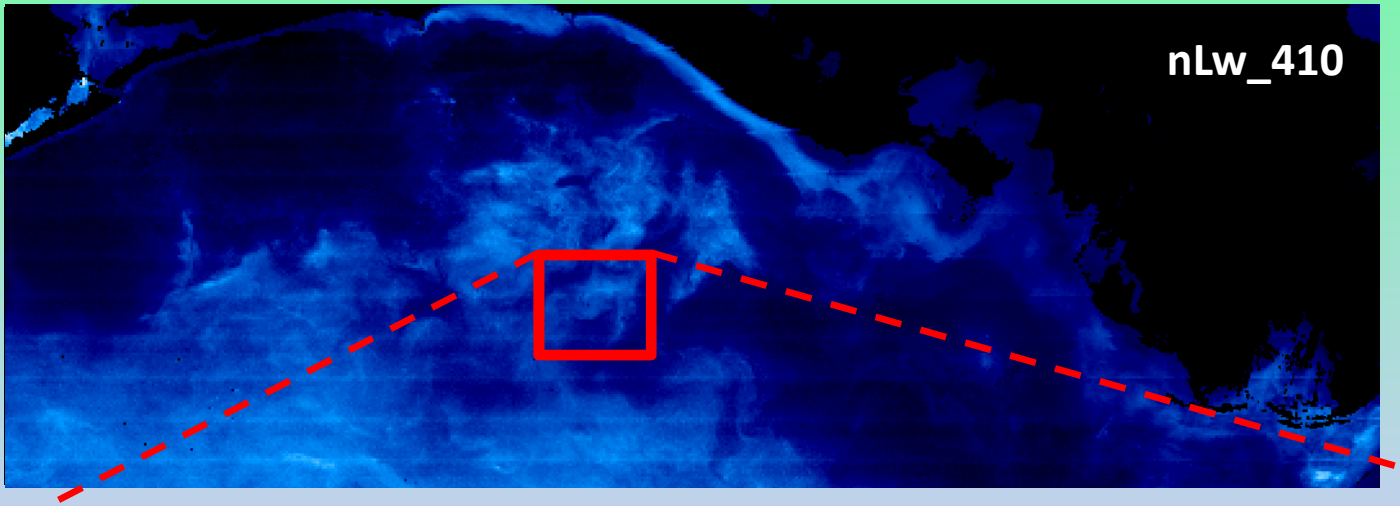
Cross Shelf ROI analysis

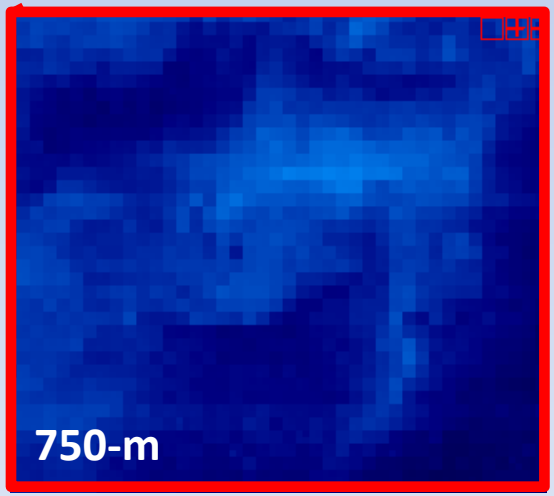
- 4 distinctly different water types
- 4 different shapening routines
- Every pixel is *proportionally* sharpened according to the ratio of M:I band variance (5 x 5 box).
- **Covariance = More sharpening**



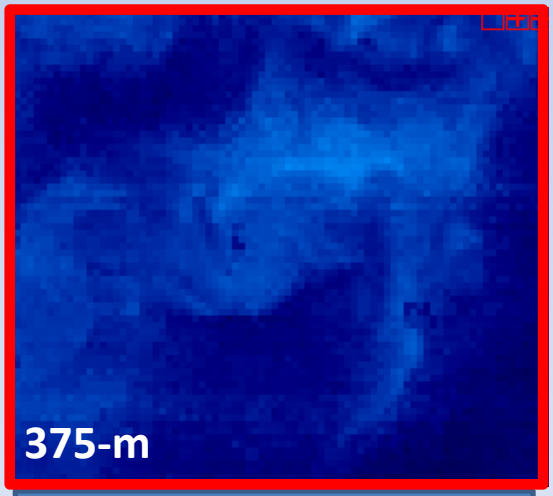


Results: Water Leaving Radiance

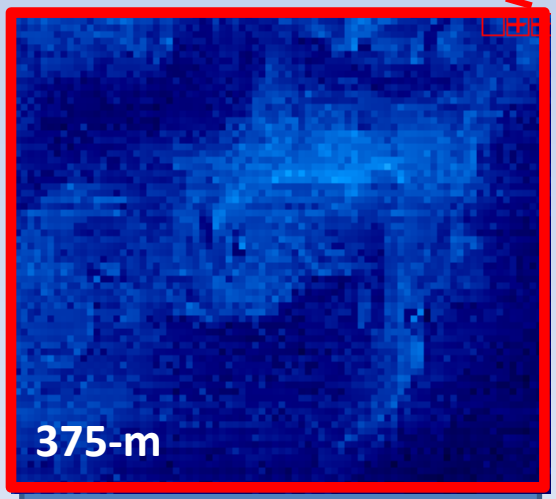




nLw_410
Native resolution



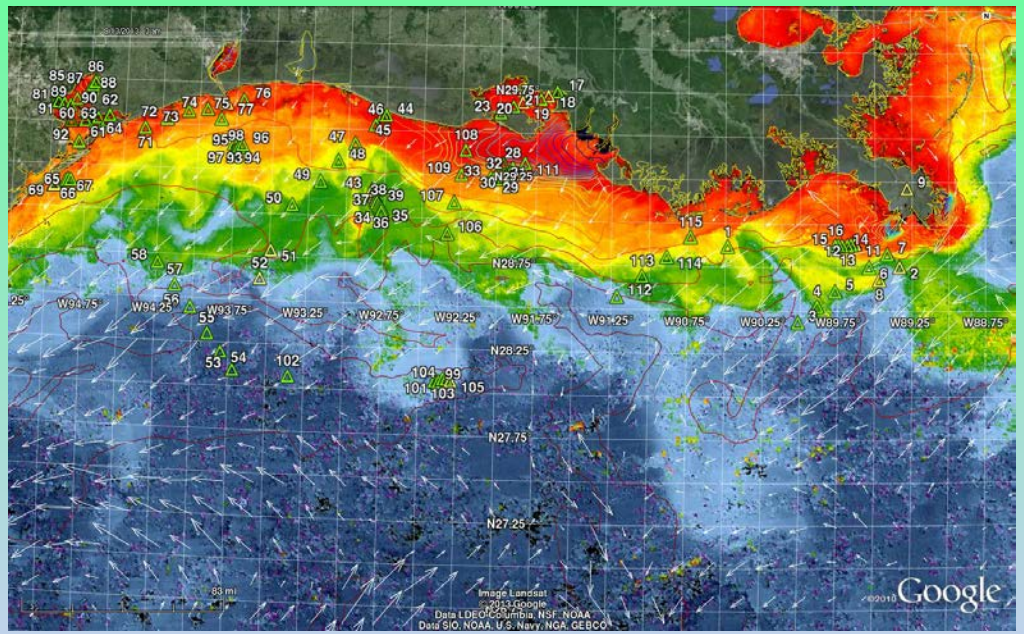
nLw_410 Sharpened
Dynamic Ratio



nLw_410 Sharpened
Static Ratio

VALIDATION – STEP 1 :

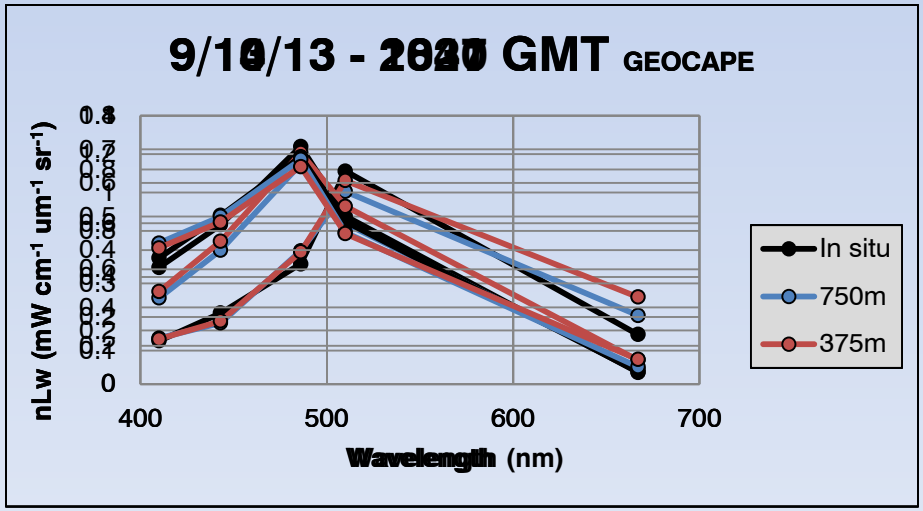
Radiance Matchups
(Hyperpro, AERONET, ASD)

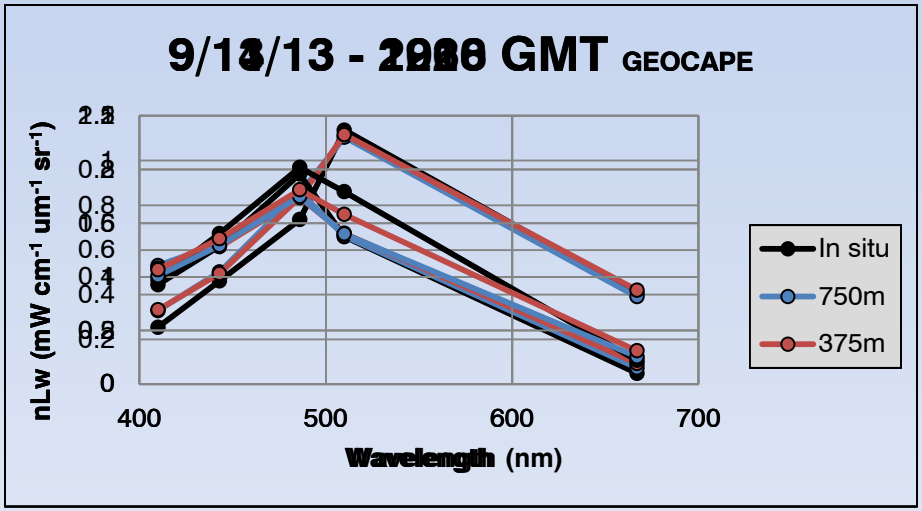


MATCHUP : Spectral Response

NASA - GEOCAPE
09/10/13 – 09/22/13

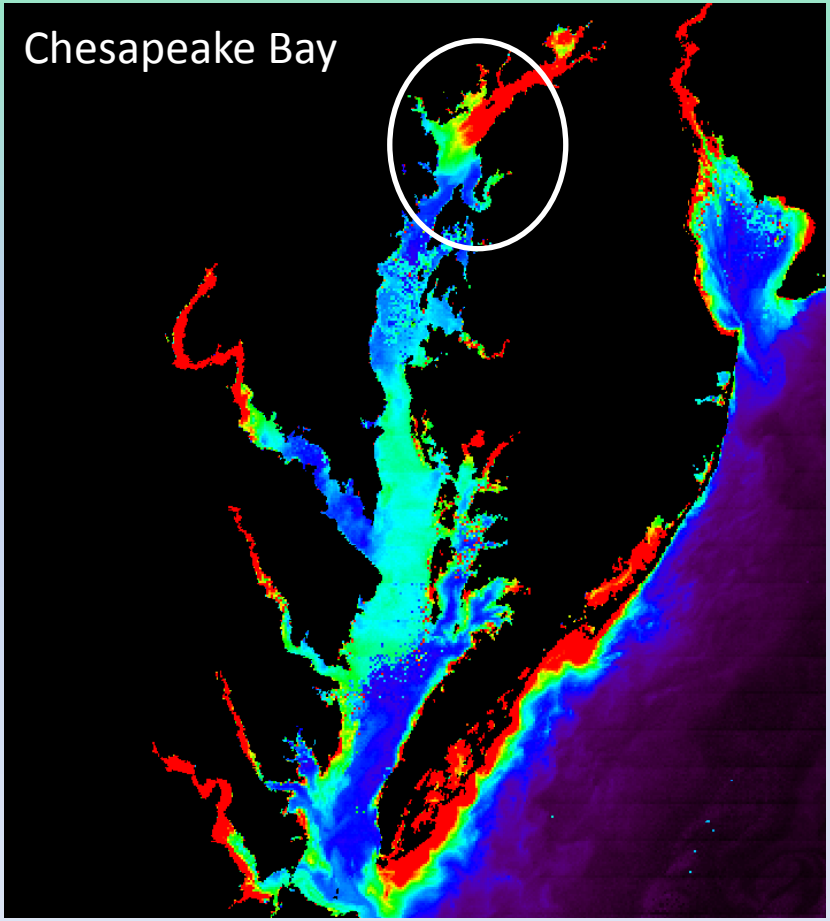
Ondrusek et al. Cal/Val

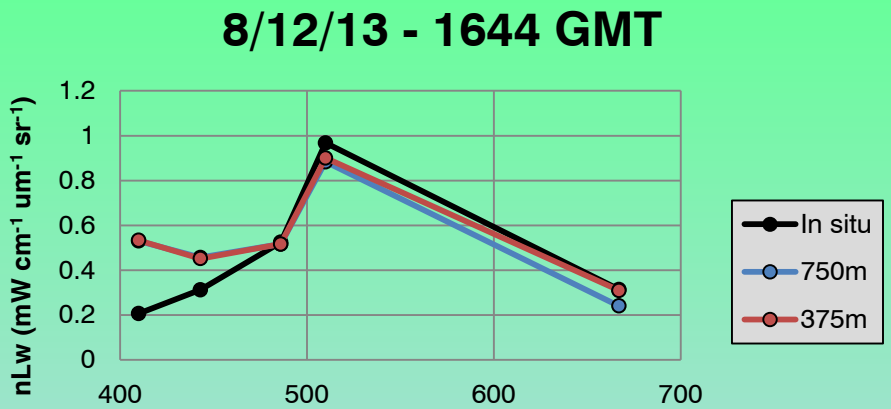


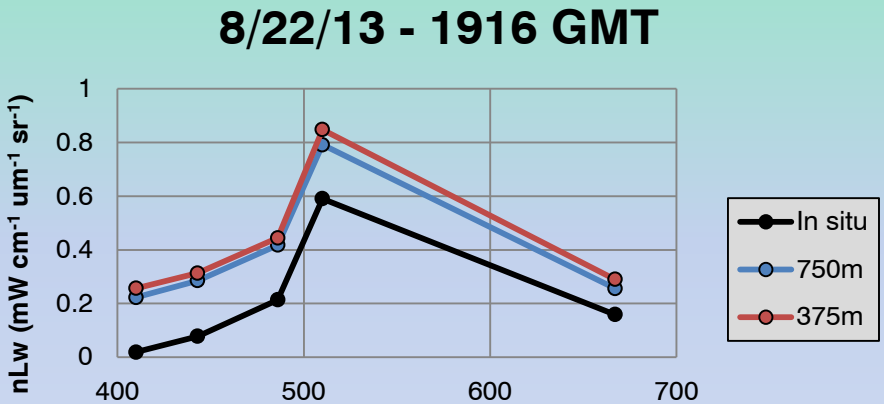


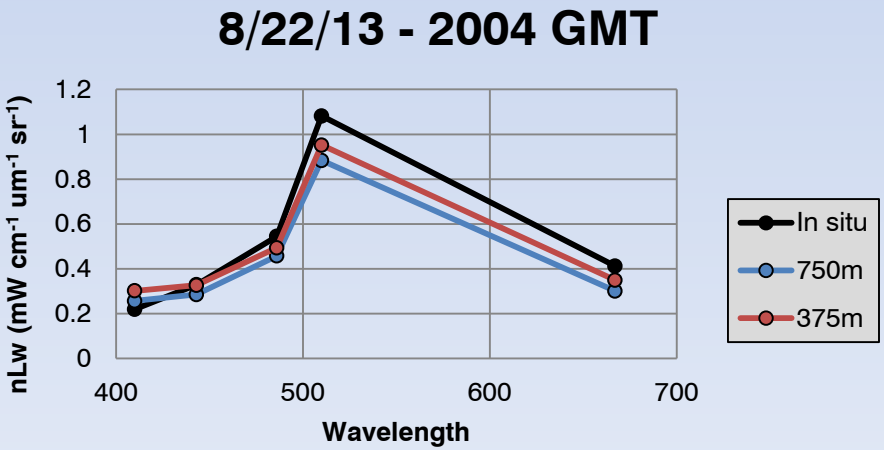
MATCHUP :
Spectral Response

Ondrusek et al. Cal/Val



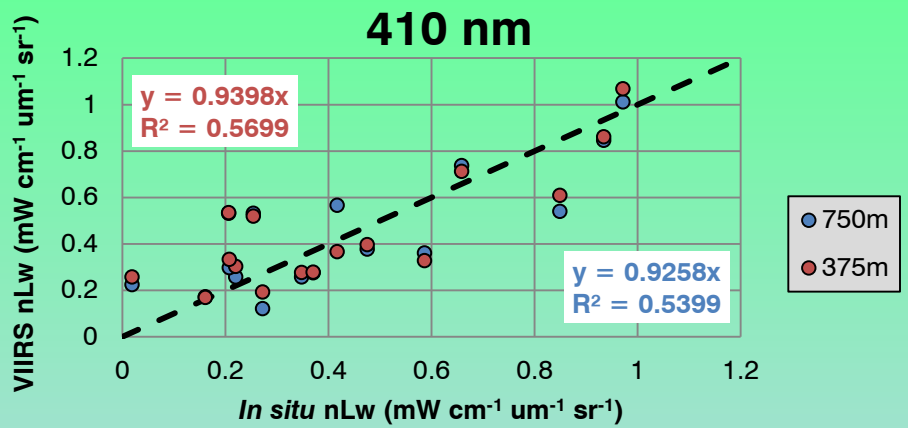


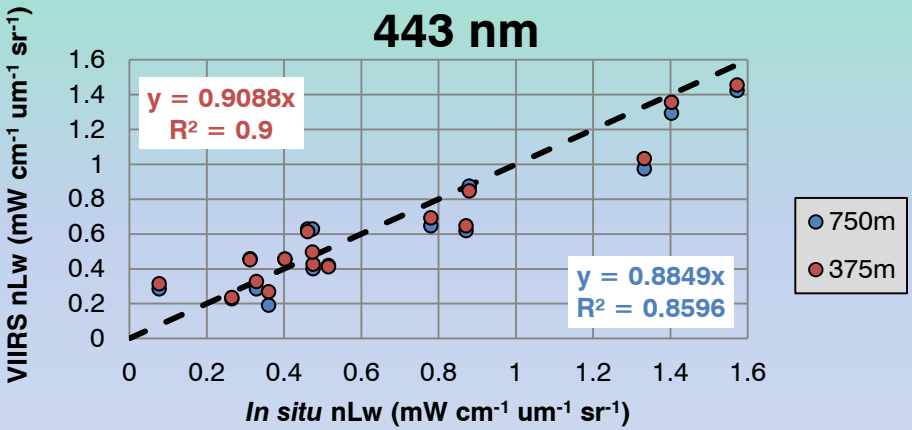


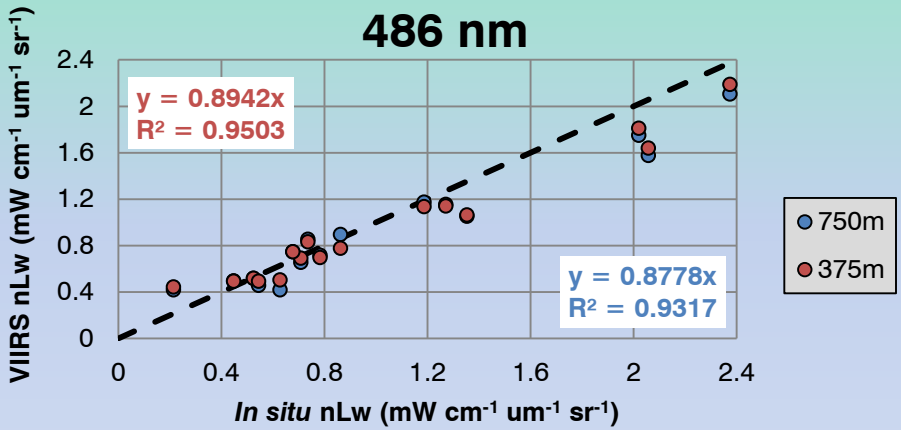


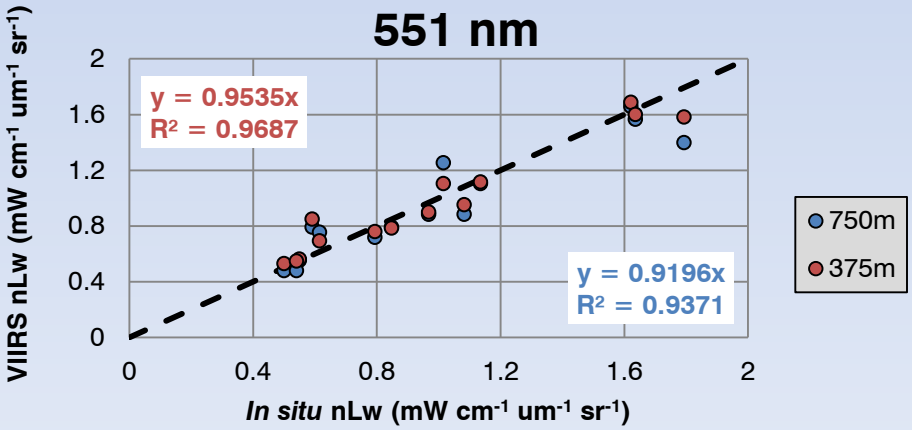
TOTAL MATCHUPS: 16

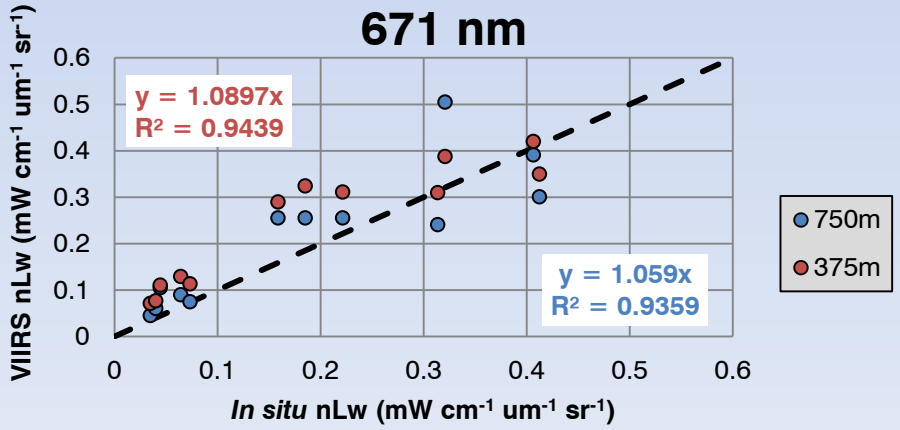
No significant spectral artifacts introduced through sharpening





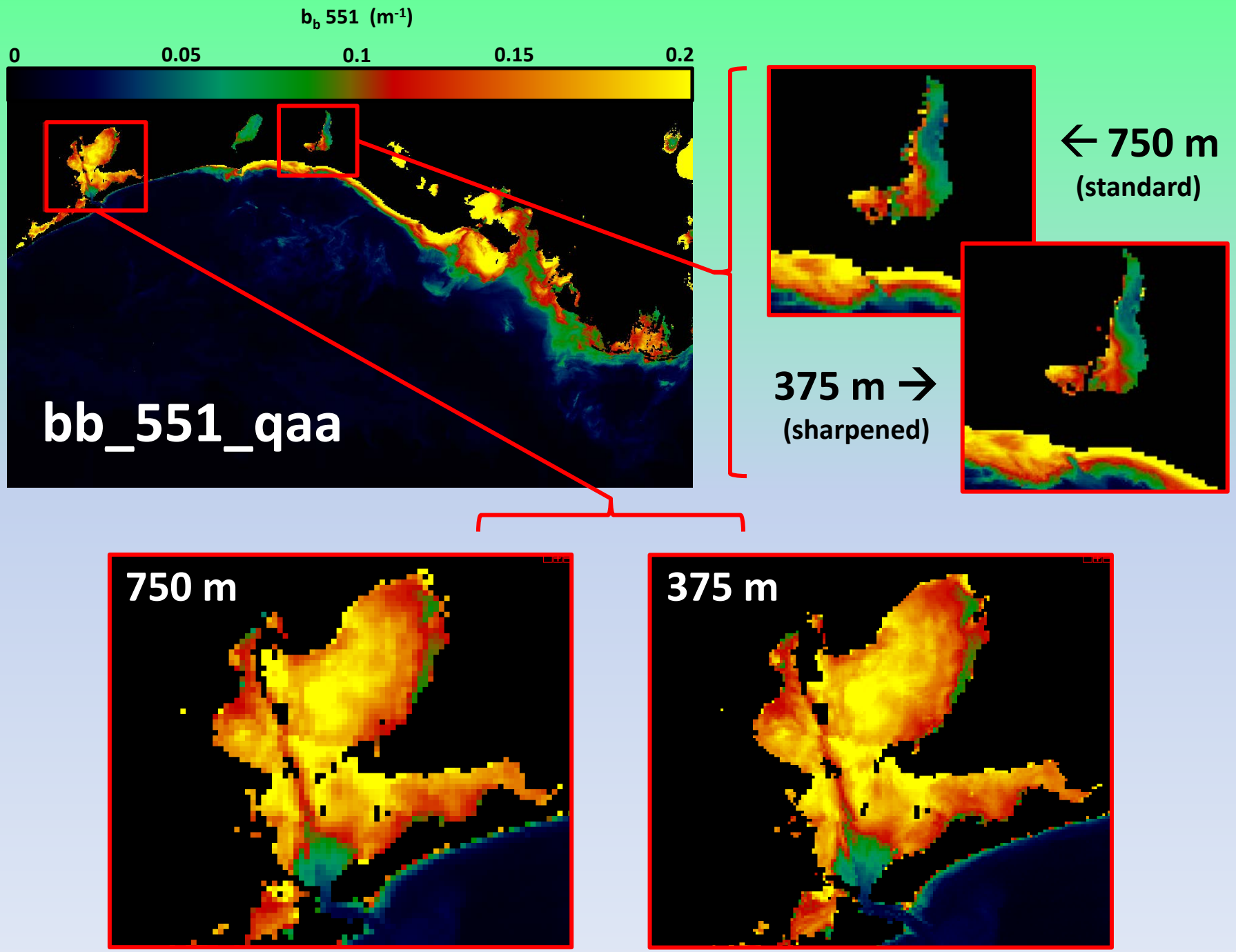


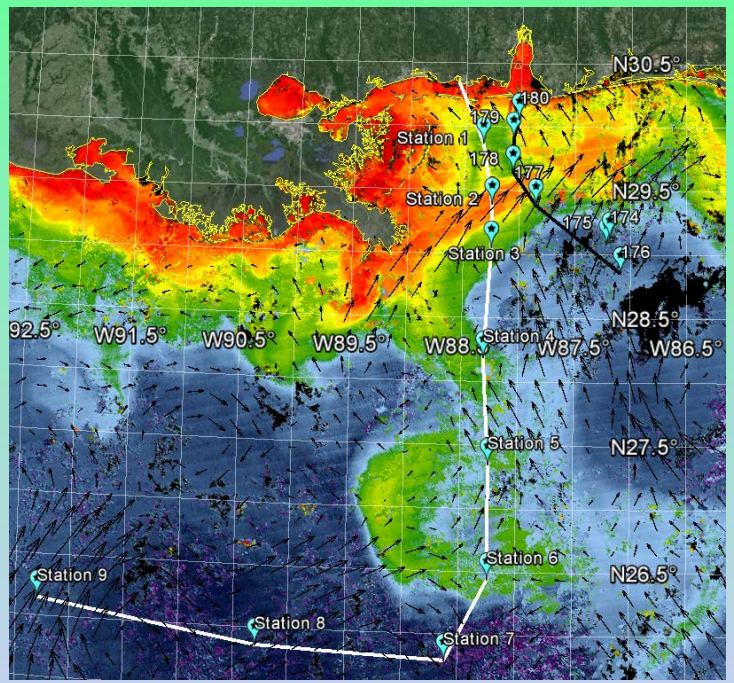




VALIDATION – STEP 2 :

Bio-optical Product Matchups
(Ratios - chlor_a , QAA – a,bb)


b_b 551 (m^{-1})
0
0.05
0.1
0.15
0.2
bb_551_qaa
← 750 m
(standard)
375 m →
(sharpened)
750 m
375 m

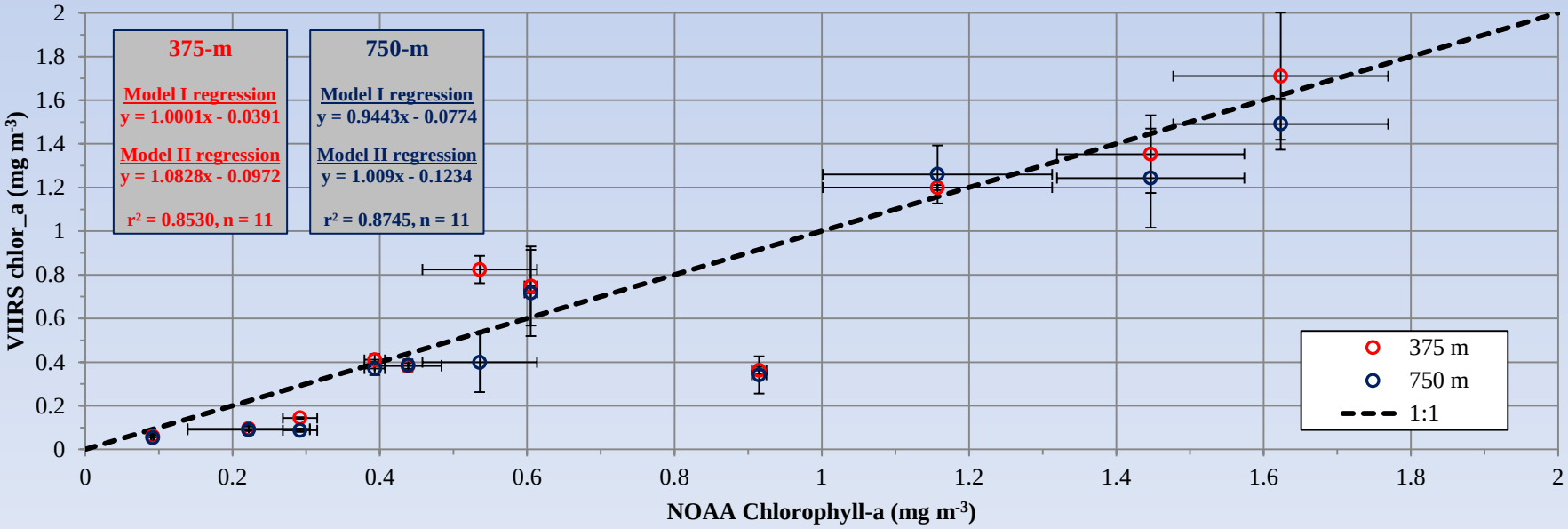


MATCHUP : TEST RATIO ALGORITHMS

NOAA National Marine Fisheries
08/21/13 – 08/23/13 , 09/27/13

Chlorophyll-a Fluorescence

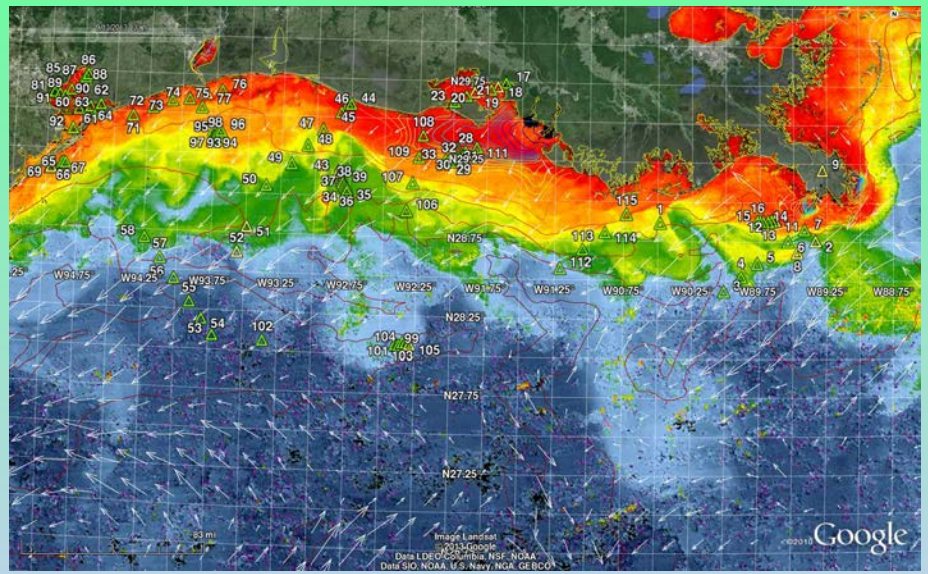
VIIRS (375-m v. 750-m) matchup, APS

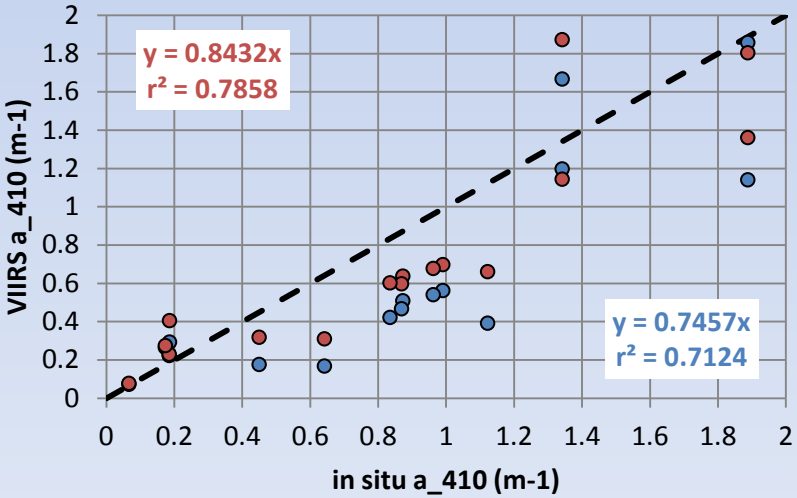


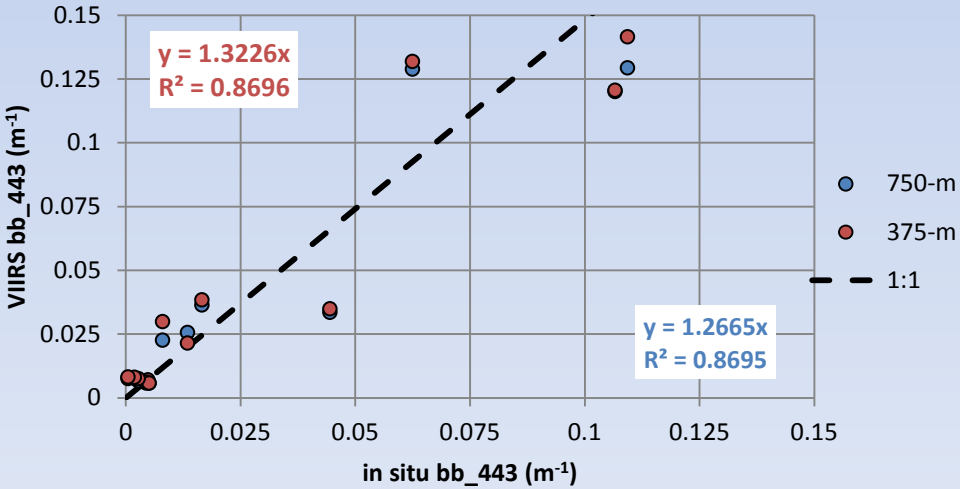
MATCHUP :
TEST QAA ALGORITHMS

NASA - GEOCAPE
09/10/13 – 09/22/13

Absorption (Zhongping Lee)
Backscattering (Ondrusek)

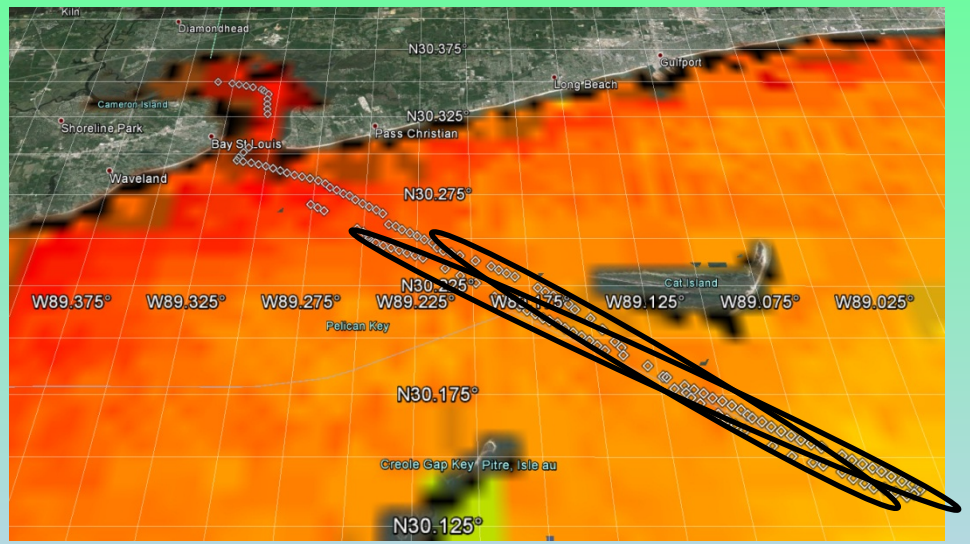






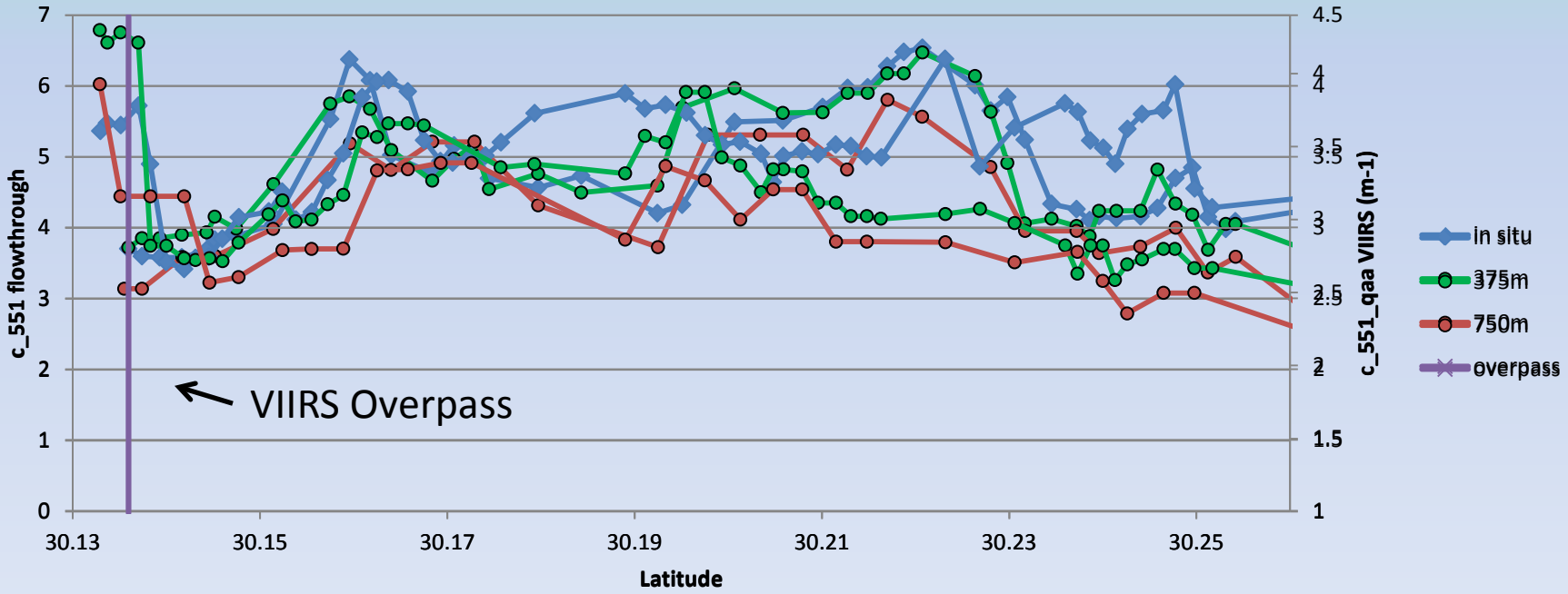
VALIDATION – STEP 3 :

Address enhanced feature detection (Flow through ac-9 data set)



MATCHUP :
TEST FEATURE DETECTION

Naval Research Lab
R/V Ocean Color
Flow-through Beam_C
11/20/13



Summary:

- Increased resolution of the visible spectrum
  - Utilize the I1-band as basis for sharpening, modify the weight based on the relative variability between the I- and M-band for each pixel (self regulating).

- Methodology does not introduce substantial bias to radiometric quantities, ratios, or QAA (a, b_b, c).

- High spatial resolution (375-m) bio-optical products available for VIIRS, yield information not found at native resolution (750-m).

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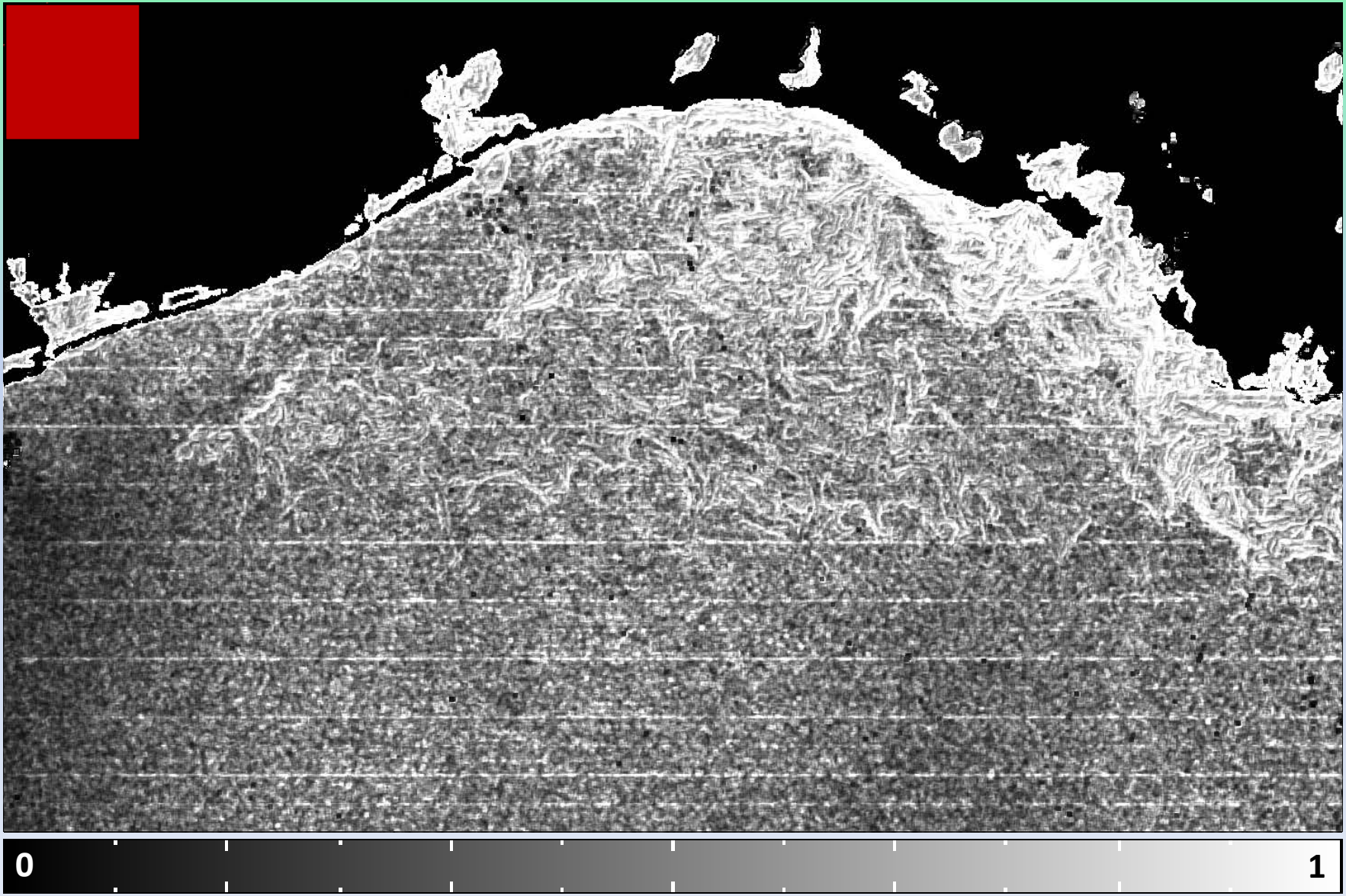
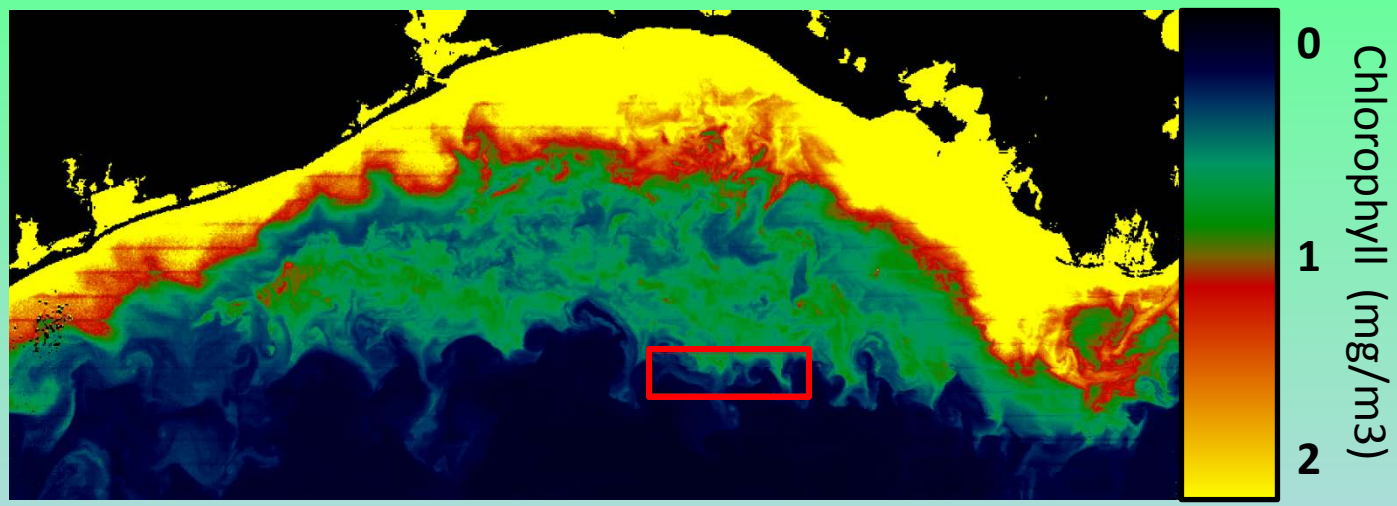
Questions??

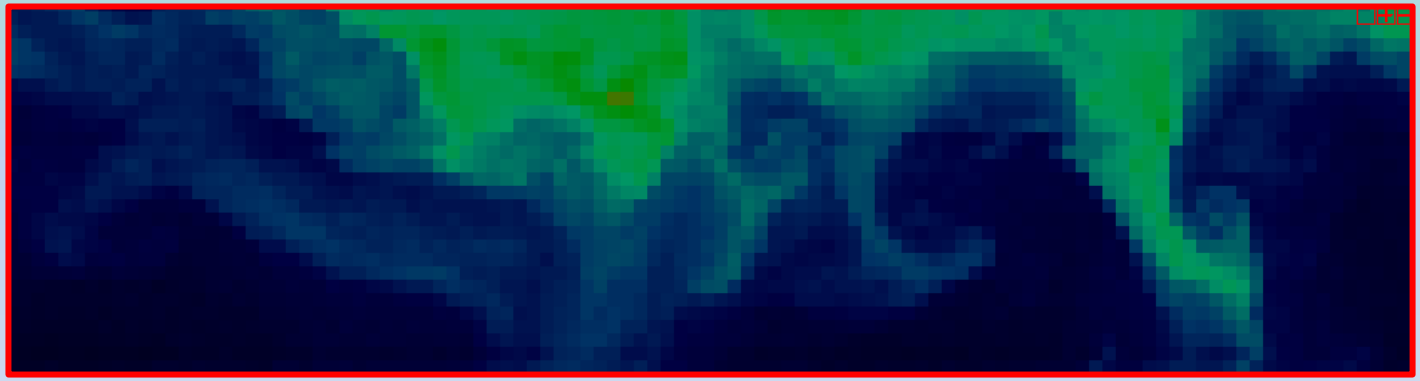
Extras

Sharpening Probability Map →



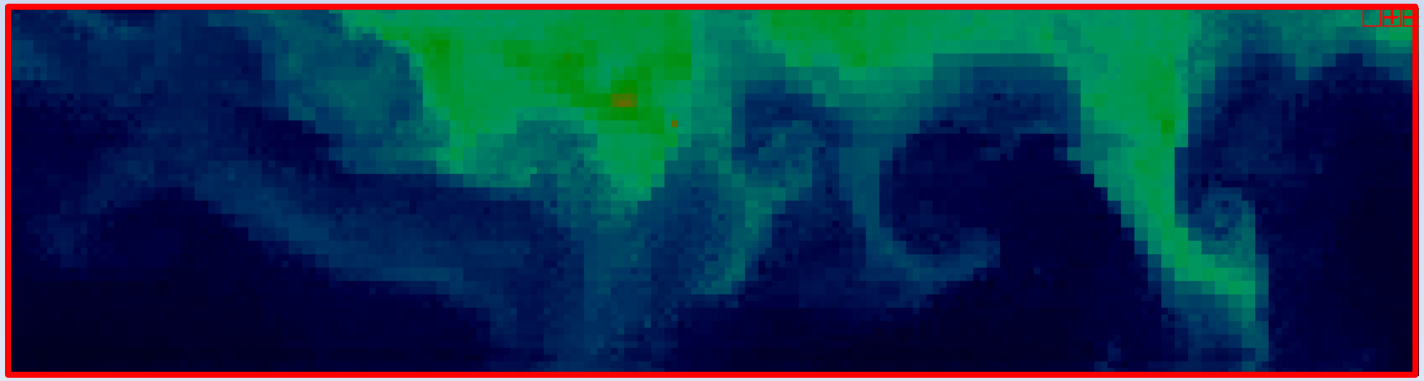
Chlor_a
Nov_08
2012





750 – m
projection
(standard)

375 – m
projection
(sharpened)



Approach:

Adapted from Gumley et al. (2007):

R = I1 / I1* , where

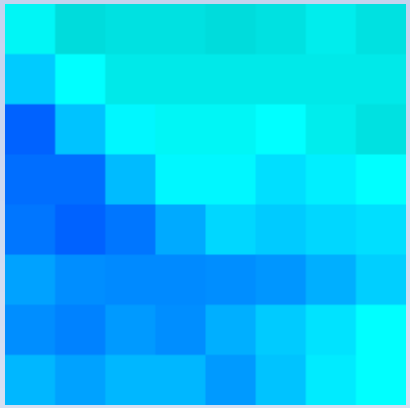
I1 = I1-band at 375-m resolution
I1* = I1-band at 750-m resolution

Static Ratio, R

X

M(λ)-band

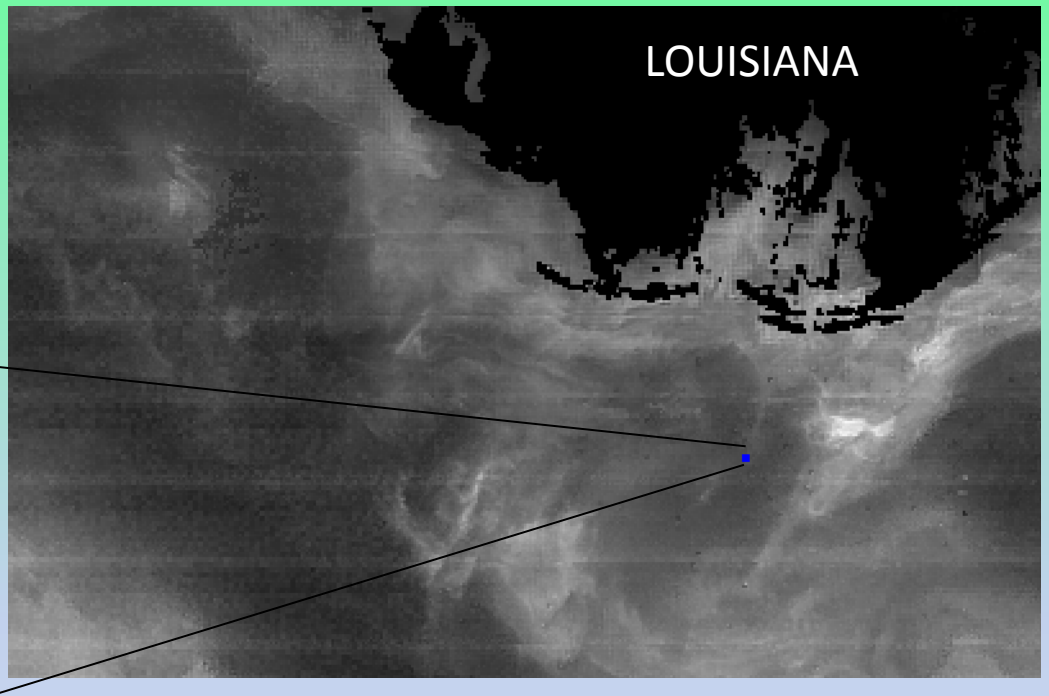
=

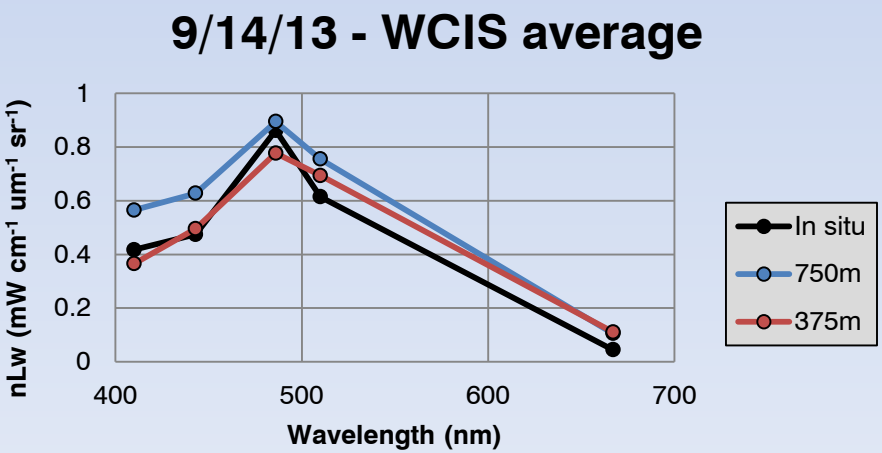


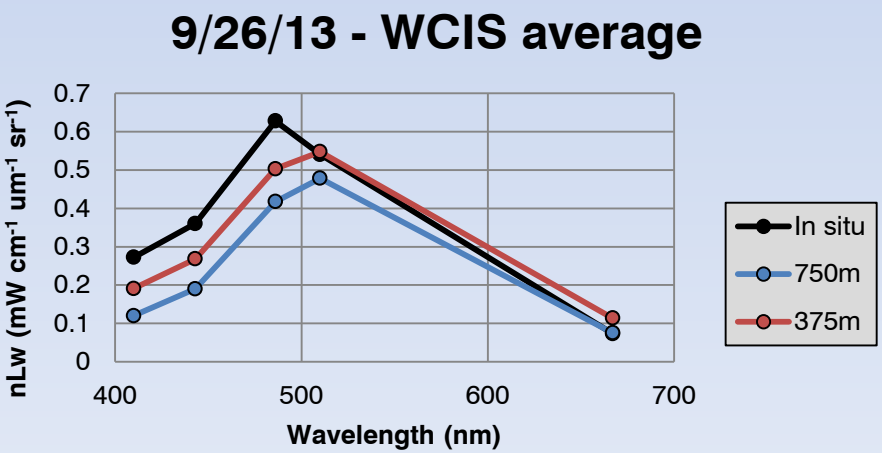
Hires M-band

MATCHUP :
Spectral Response

AERONET - WavCIS
Station CSI-06

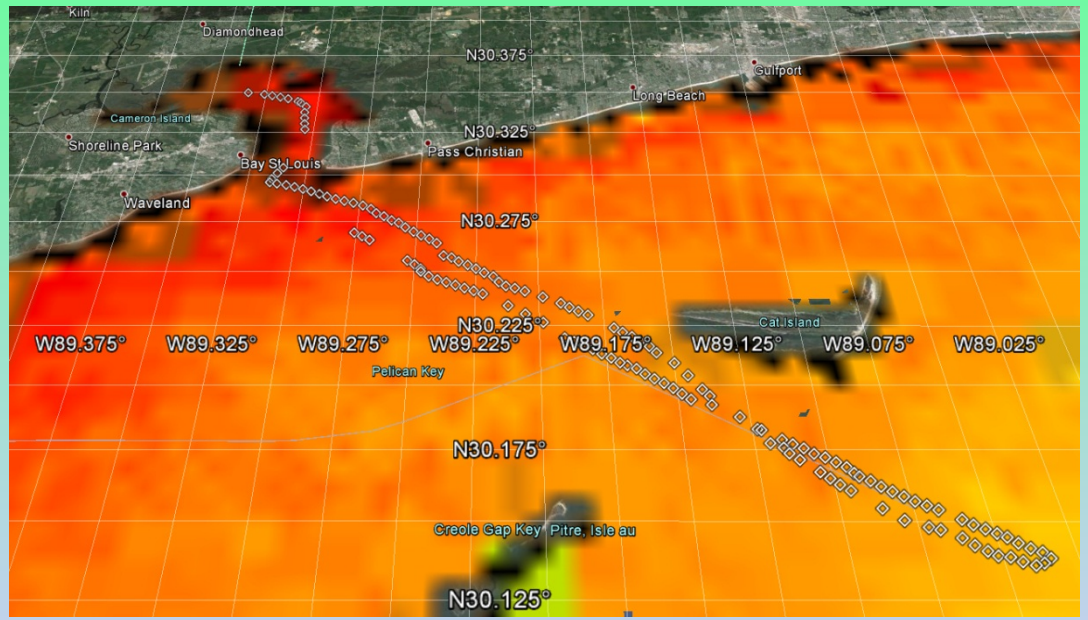


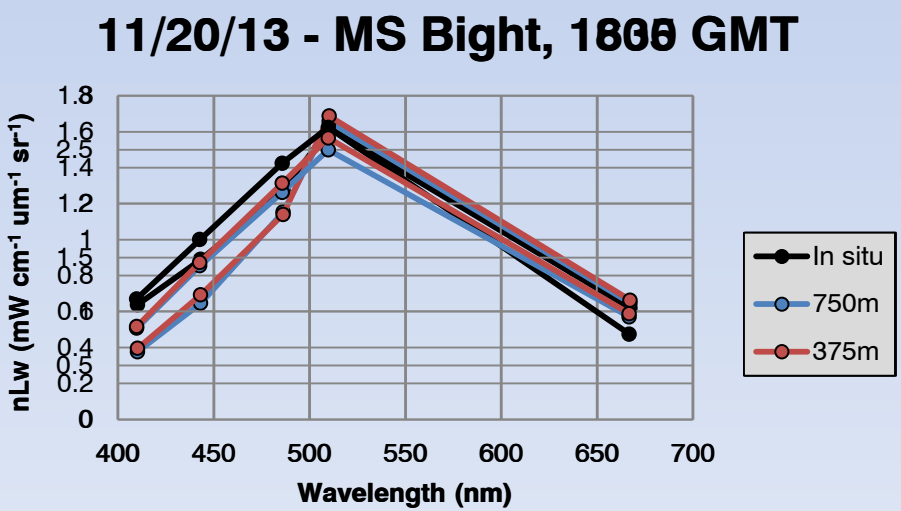


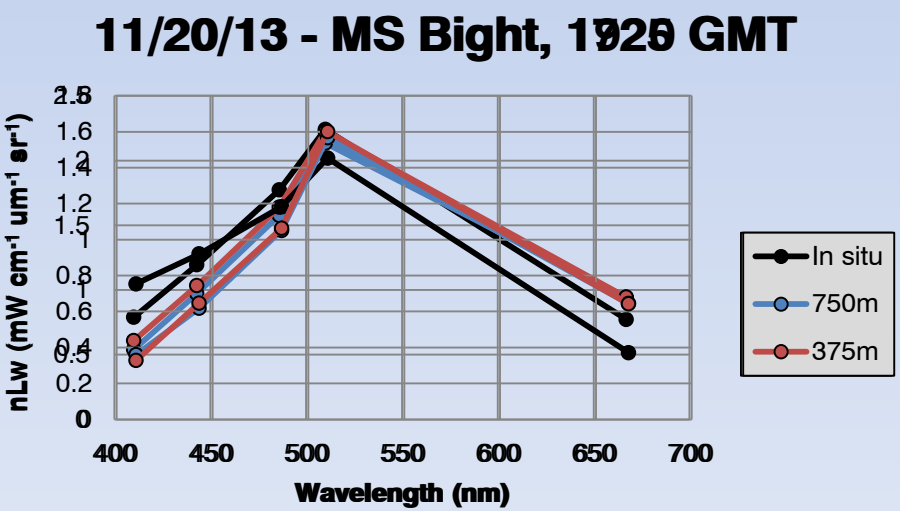


MATCHUP : Spectral Response

Naval Research Lab
R/V Ocean Color
11/20/13







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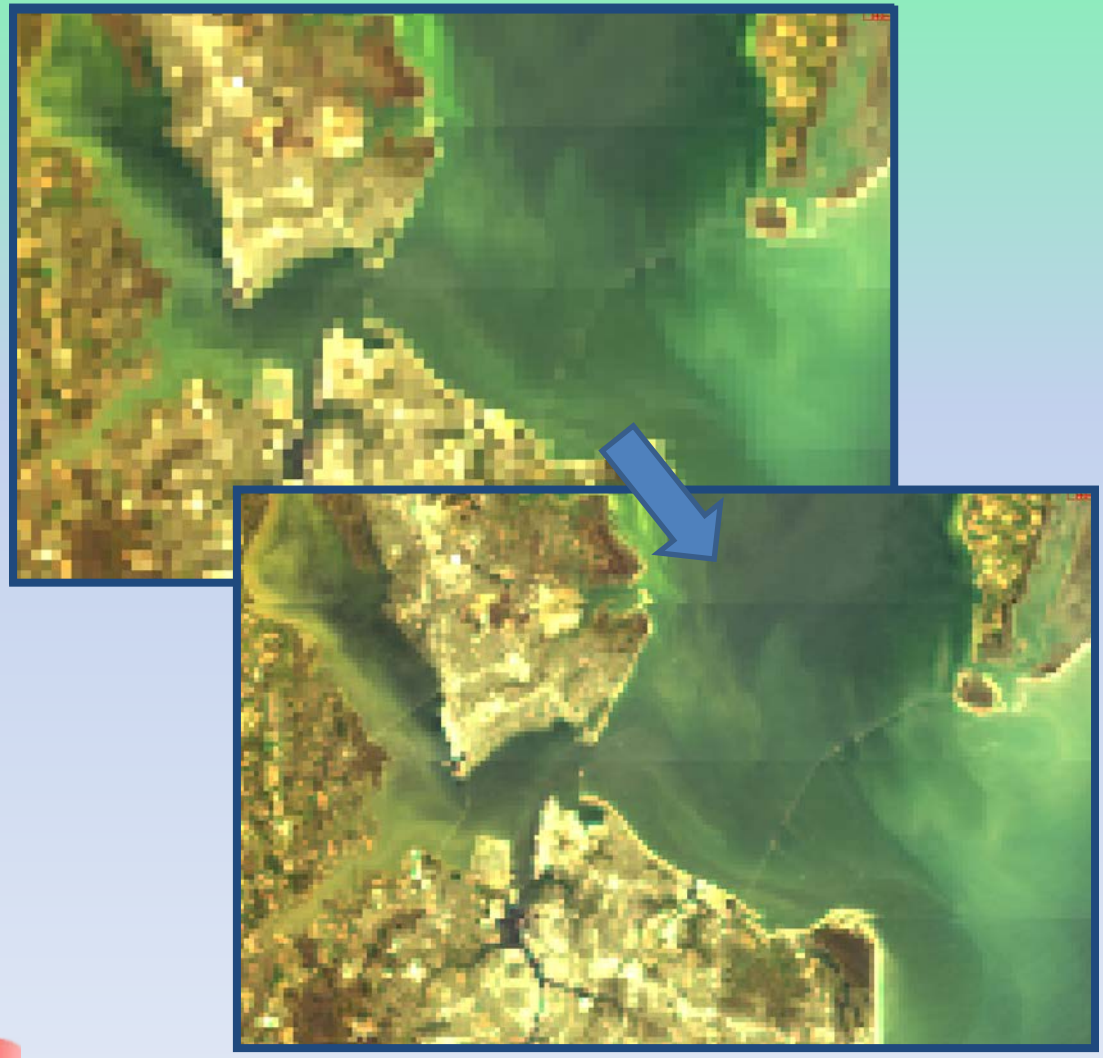

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