Towards consistent VIIRS AOP and IOP products

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Acknowledgements:

NOAA/STAR

UMB activities:

1. Evaluation of VIIRS Rrs products

1a. Compare VIIRS Rrs with climatological Rrs of gyre waters

1b. Compare VIIRS Rrs with in situ measurements in MassBay

1c. Participate NOAA Cal/Val cruise and other cruises

2. Development of new products

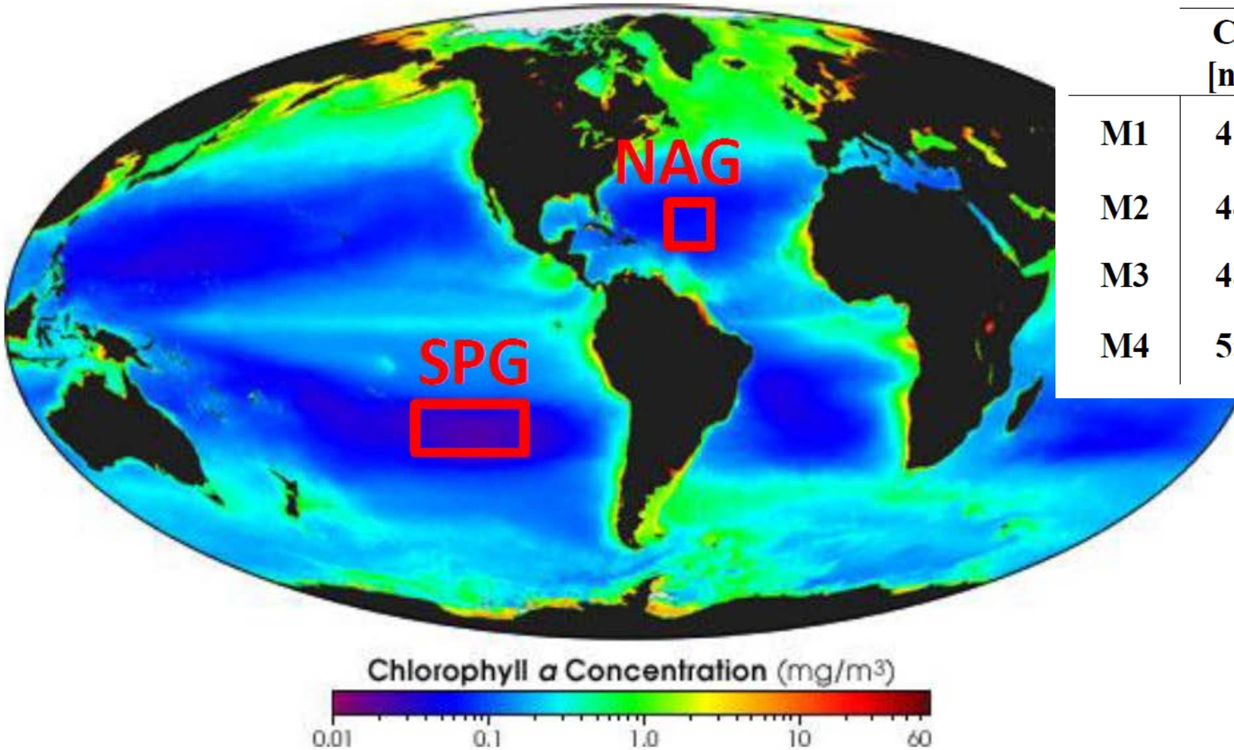
2a. Quality Assurance System for Rrs

2b. IOPs from in situ AOPs

2c. Secchi disk depth (Z_{SD}) for VIIRS

1. Evaluation of VIIRS Rrs products

1a. Compare VIIRS Rrs with MODIS climatological Rrs of gyre waters



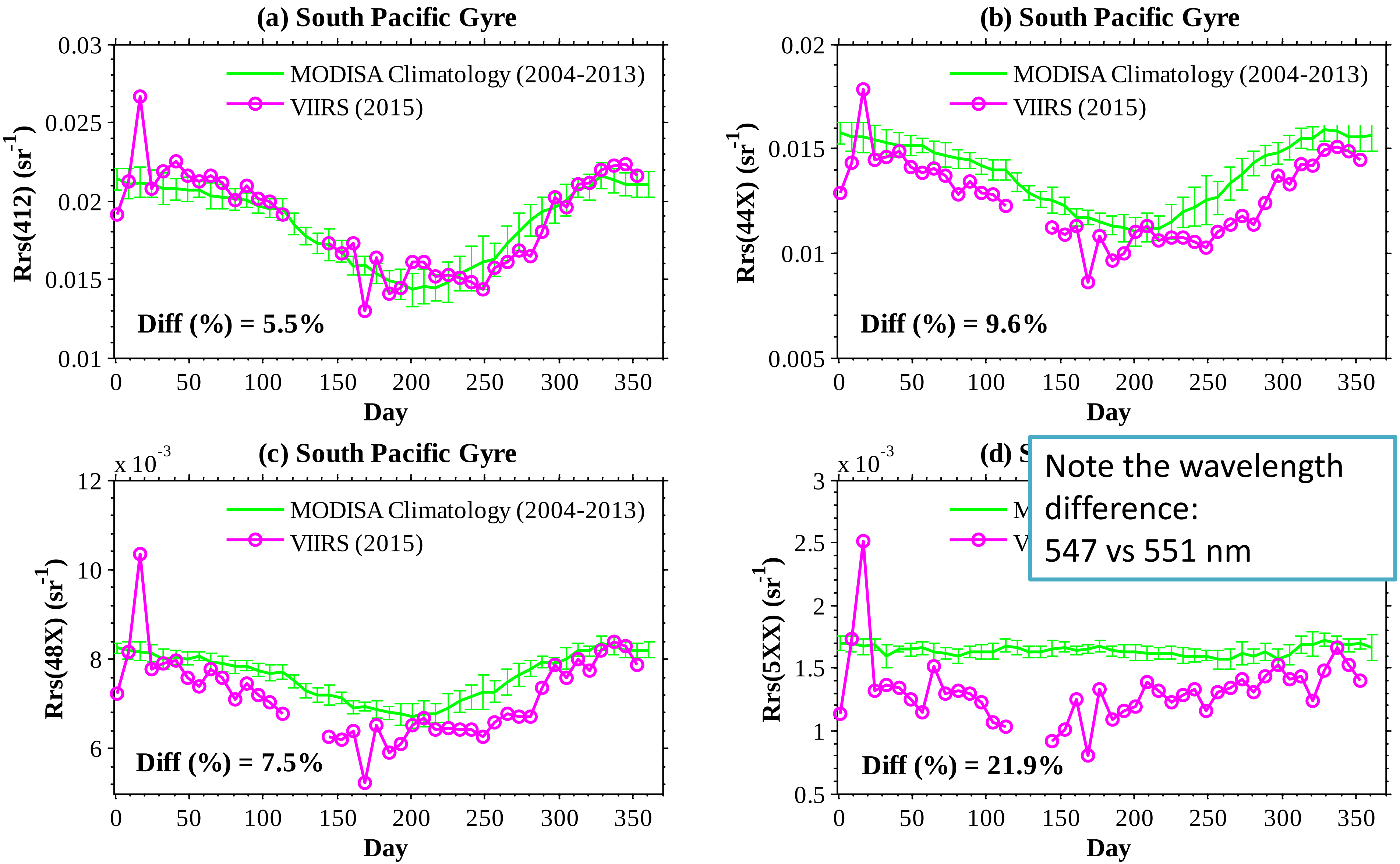
Band characteristics

	VIIRS		MODISA	
	CW [nm]	Bandwidth [nm]	CW [nm]	Bandwidth [nm]
M1	410	20	412	15
M2	443	15	442	10
M3	486	19	488	10
M4	551	19	547	10

Location: South Pacific Gyre (SPG) and North Atlantic Gyre (NAG)

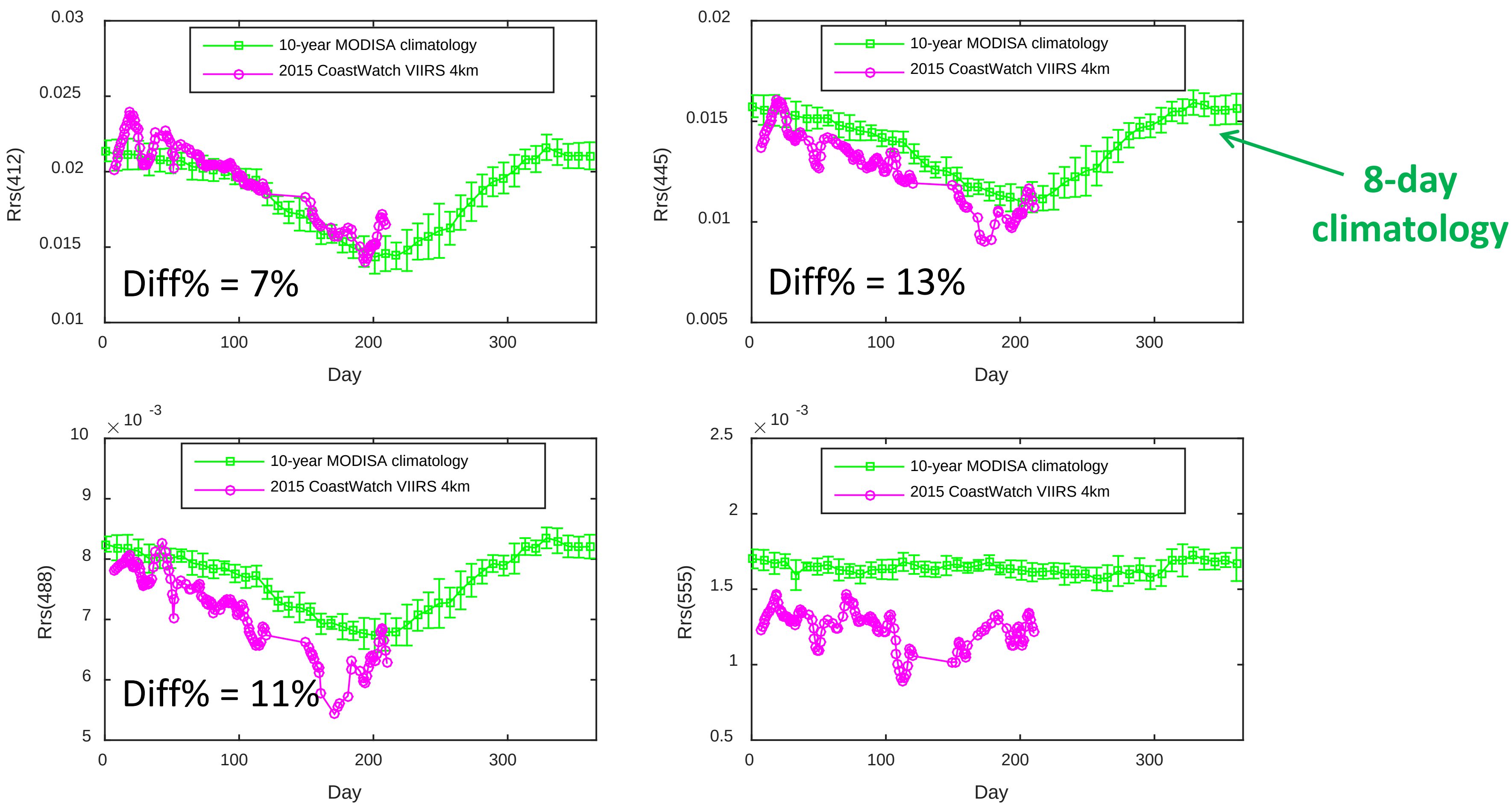
Data (8-day composite): VIIRS: latest reprocessing (from CoastWatch)
MODIS_Aqua (from OBPG; 8-day climatology)
all are area average

2015 South Pacific Gyre

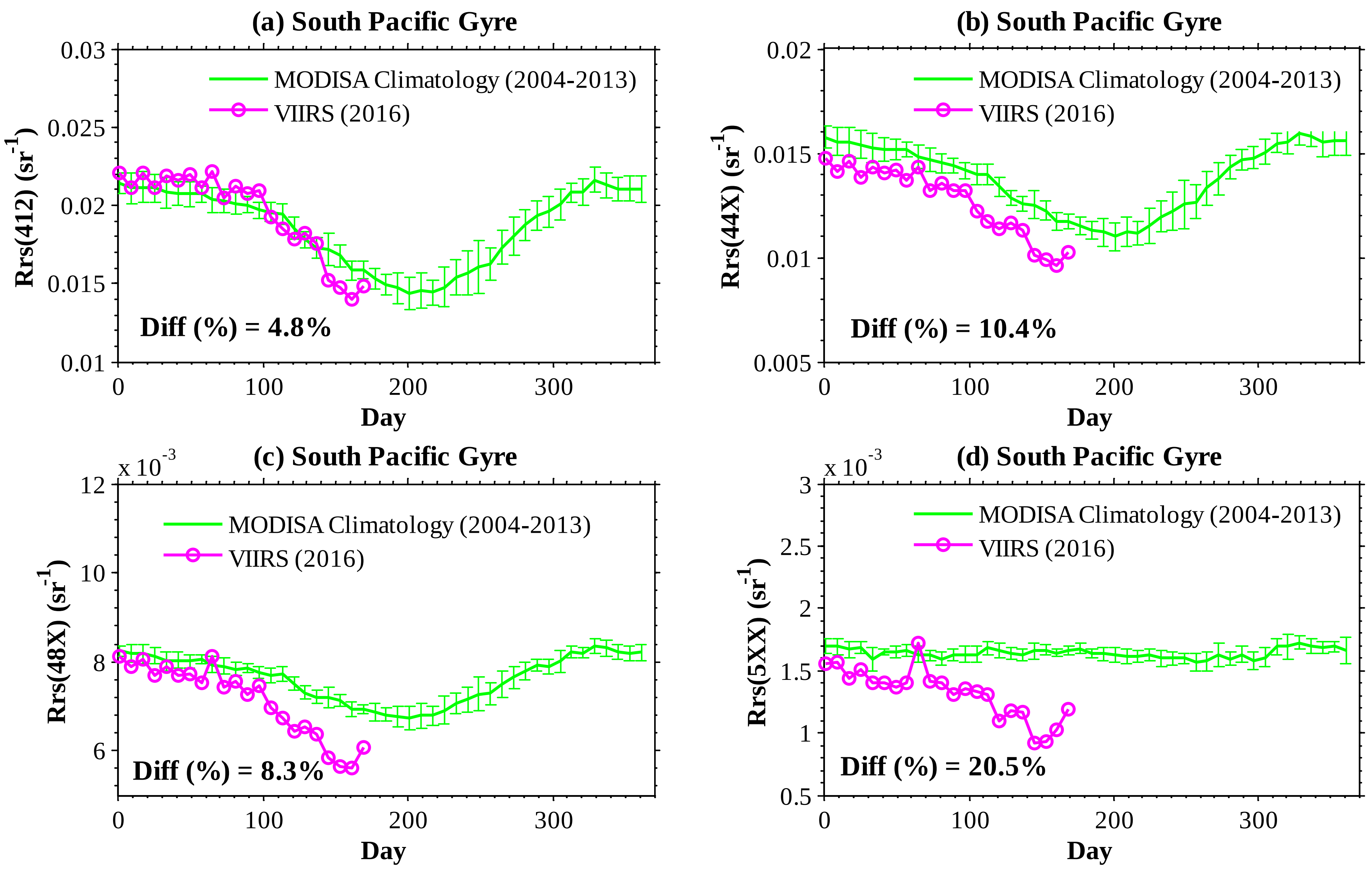


Note the wavelength difference:
547 vs 551 nm

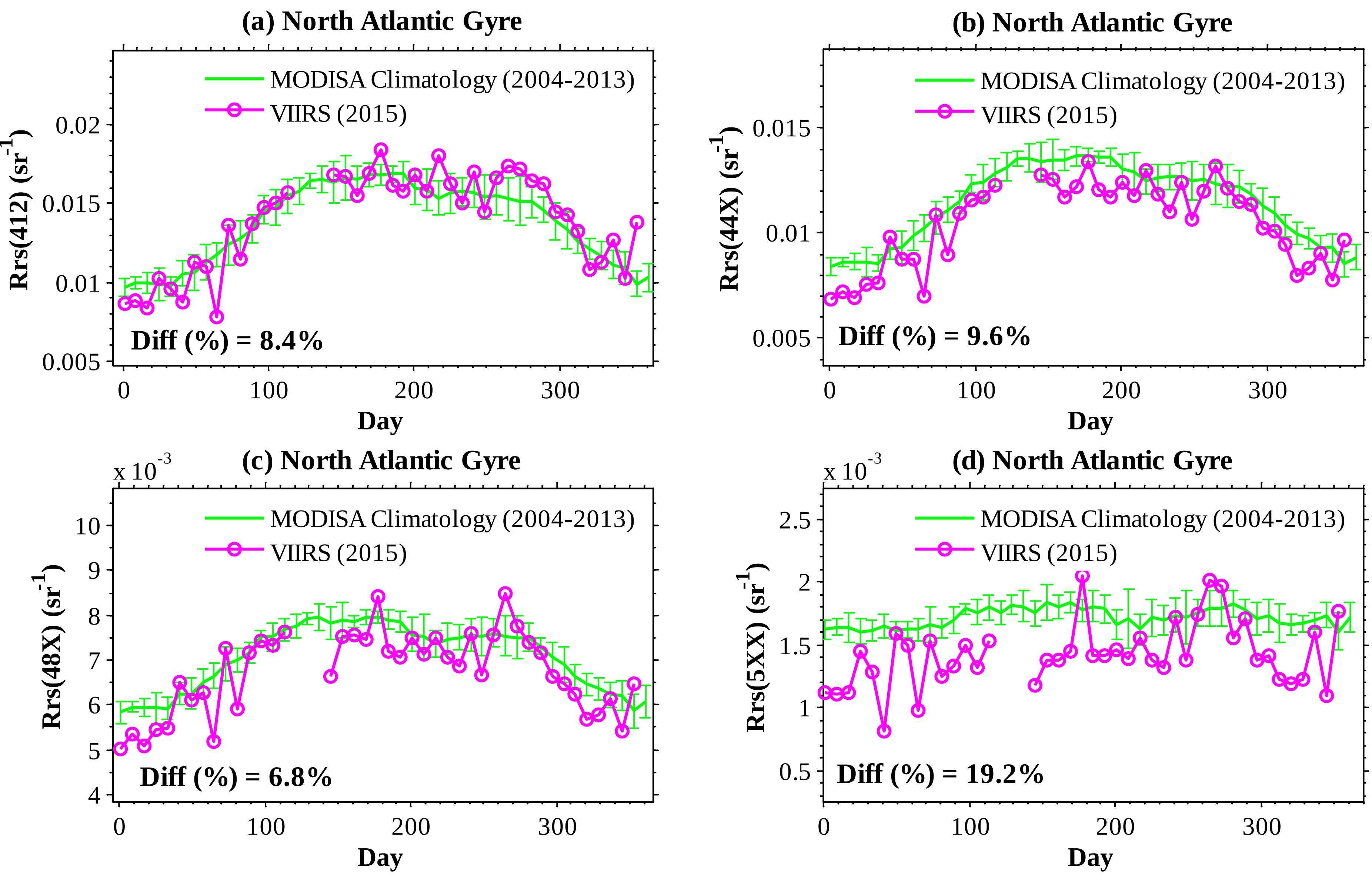
“Previous” VIIRS Rrs vs MODIS climatology



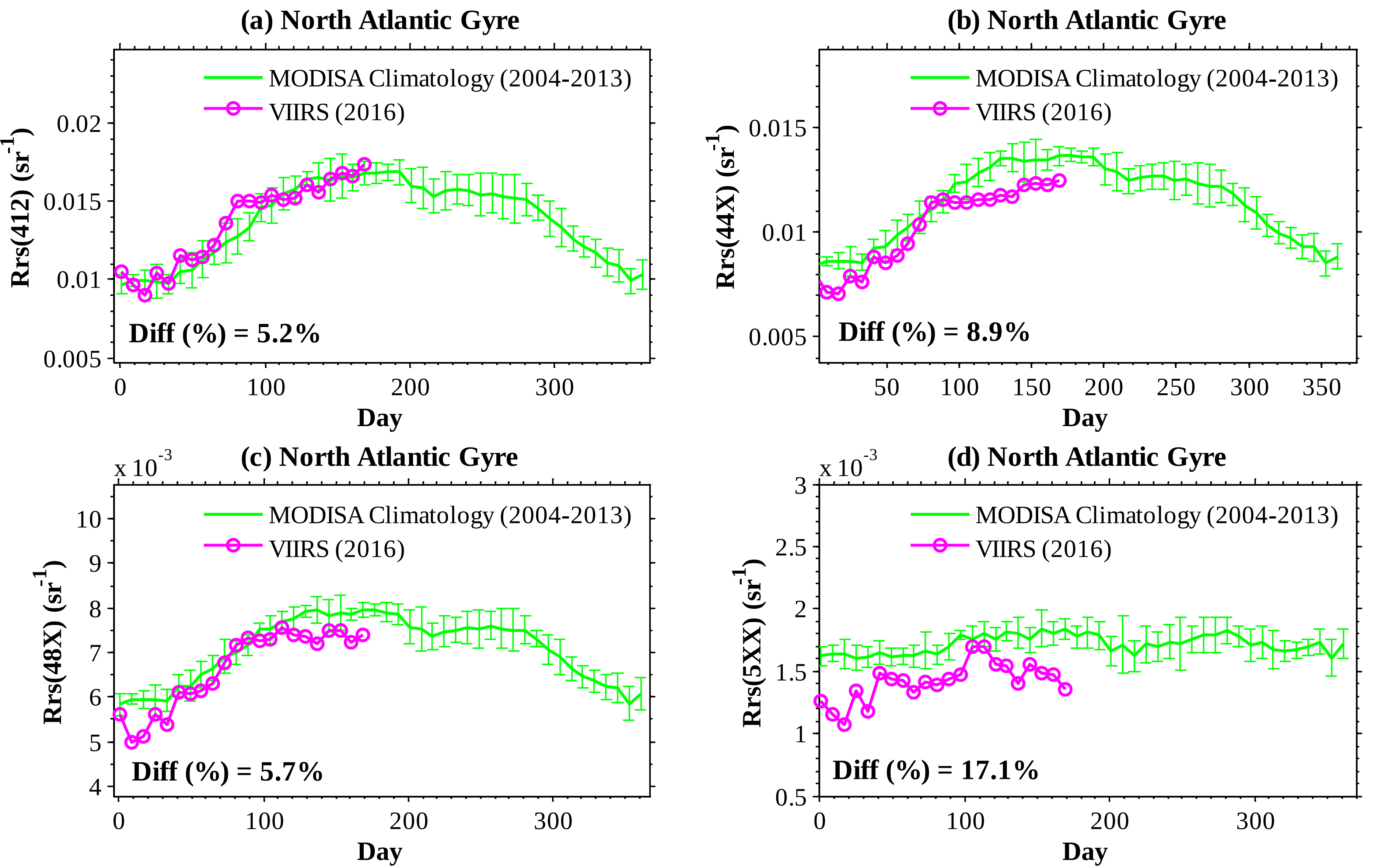
2016 South Pacific Gyre

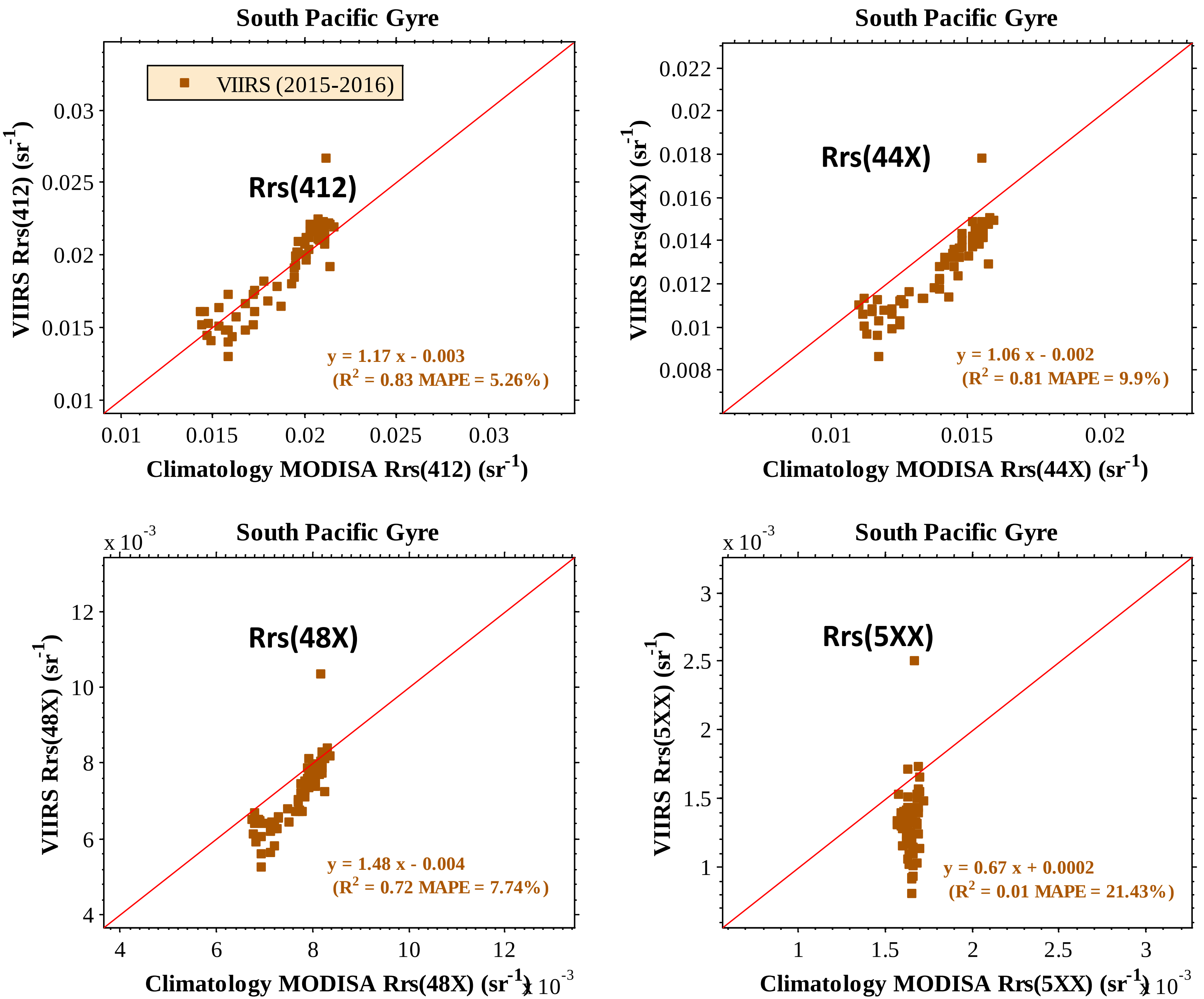


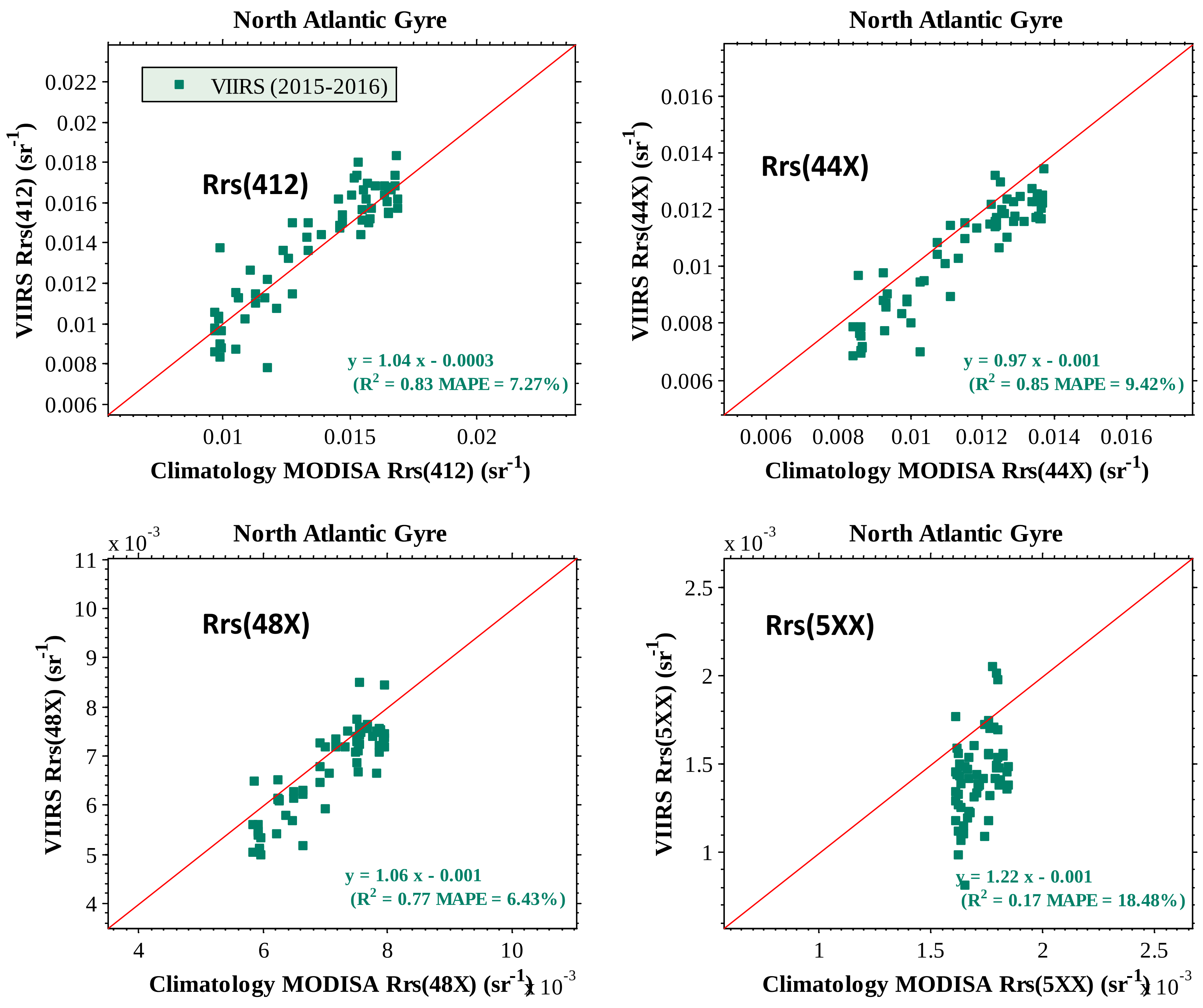
2015 North Atlantic Gyre



2016 North Atlantic Gyre




South Pacific Gyre
VIIRS (2015-2016)
Rrs(412)
y = 1.17 x - 0.003
(R2 = 0.83 MAPE = 5.26%)
VIIRS Rrs(412) (sr-1)
Climatology MODISA Rrs(412) (sr-1)
South Pacific Gyre
Rrs(44X)
y = 1.06 x - 0.002
(R2 = 0.81 MAPE = 9.9%)
VIIRS Rrs(44X) (sr-1)
Climatology MODISA Rrs(44X) (sr-1)
South Pacific Gyre
Rrs(48X)
y = 1.48 x - 0.004
(R2 = 0.72 MAPE = 7.74%)
VIIRS Rrs(48X) (sr-1)
Climatology MODISA Rrs(48X) (sr-1)
x 10-3
South Pacific Gyre
Rrs(5XX)
y = 0.67 x + 0.0002
(R2 = 0.01 MAPE = 21.43%)
VIIRS Rrs(5XX) (sr-1)
Climatology MODISA Rrs(5XX) (sr-1)
x 10-3


North Atlantic Gyre
VIIRS (2015-2016)
Rrs(412)
VIIRS Rrs(412) (sr-1)
Climatology MODISA Rrs(412) (sr-1)
y = 1.04 x - 0.0003
(R2 = 0.83 MAPE = 7.27%)
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
0.022
0.01
0.015
0.02
North Atlantic Gyre
Rrs(44X)
VIIRS Rrs(44X) (sr-1)
Climatology MODISA Rrs(44X) (sr-1)
y = 0.97 x - 0.001
(R2 = 0.85 MAPE = 9.42%)
0.006
0.008
0.01
0.012
0.014
0.016
North Atlantic Gyre
x 10-3
Rrs(48X)
VIIRS Rrs(48X) (sr-1)
Climatology MODISA Rrs(48X) (sr-1)
x 10-3
y = 1.06 x - 0.001
(R2 = 0.77 MAPE = 6.43%)
4
5
6
7
8
9
10
11
North Atlantic Gyre
x 10-3
Rrs(5XX)
VIIRS Rrs(5XX) (sr-1)
Climatology MODISA Rrs(5XX) (sr-1)
x 10-3
y = 1.22 x - 0.001
(R2 = 0.17 MAPE = 18.48%)
1
1.5
2
2.5

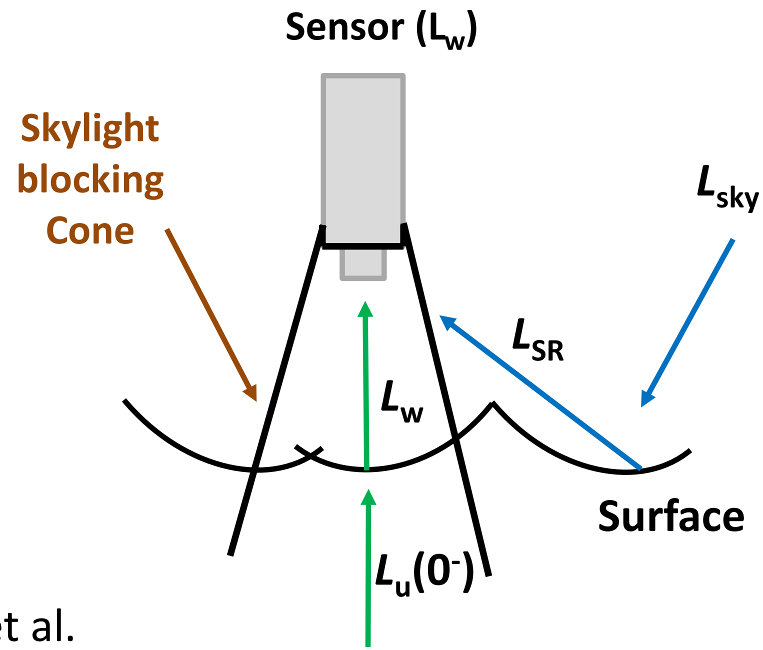
1. Evaluation of VIIRS Rrs products

1b. Compare VIIRS Rrs with in situ measurements in MassBay

Satellite - insitu Matchup

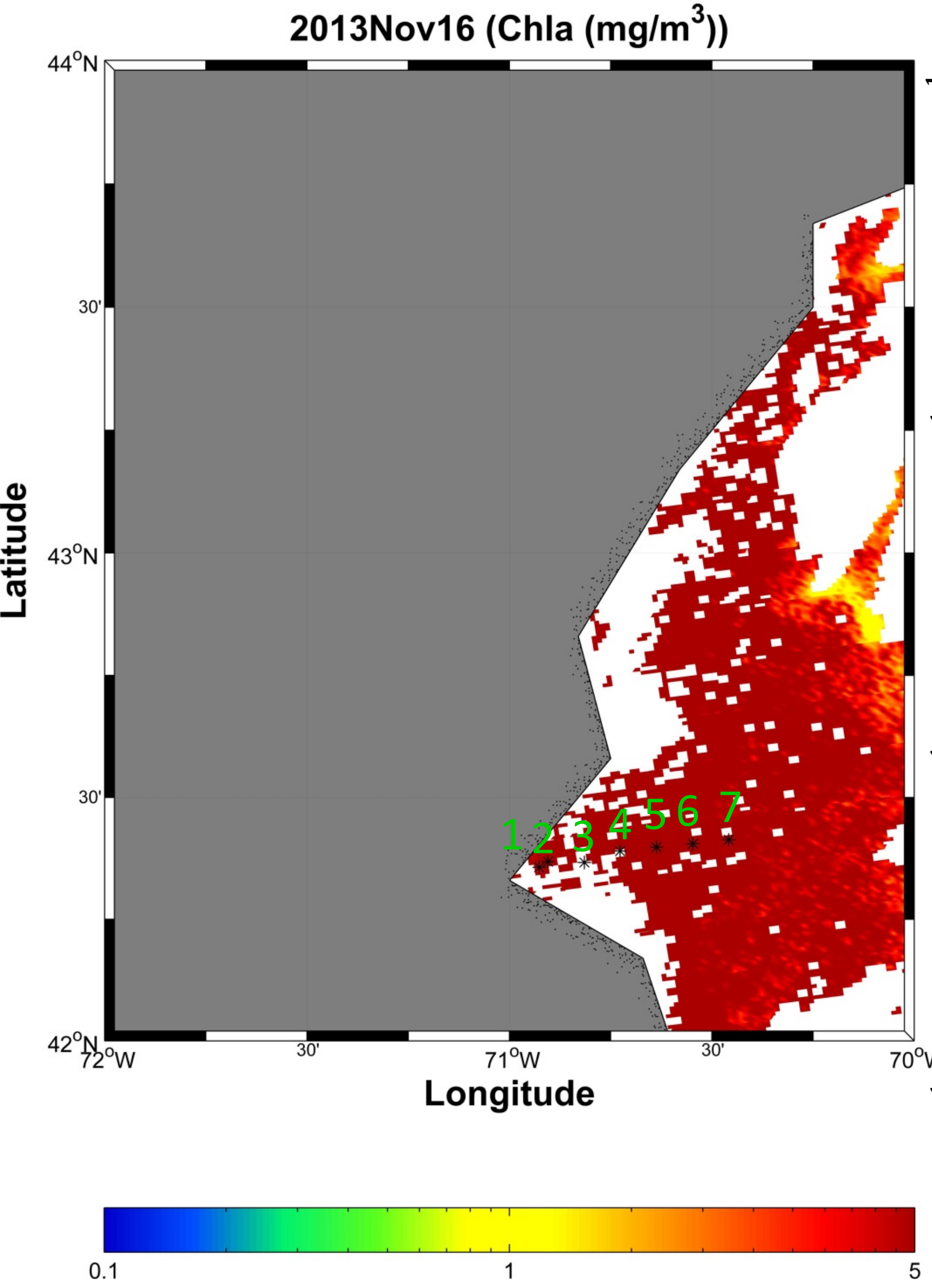
(1). VIIRS CoastWatch Level-2 750 m daily data
(2). Mean Rrs in 3x3 box
(3). Flags Applied: Atmospheric correction failure, Sun glint (high glint and moderate glint), Cloud

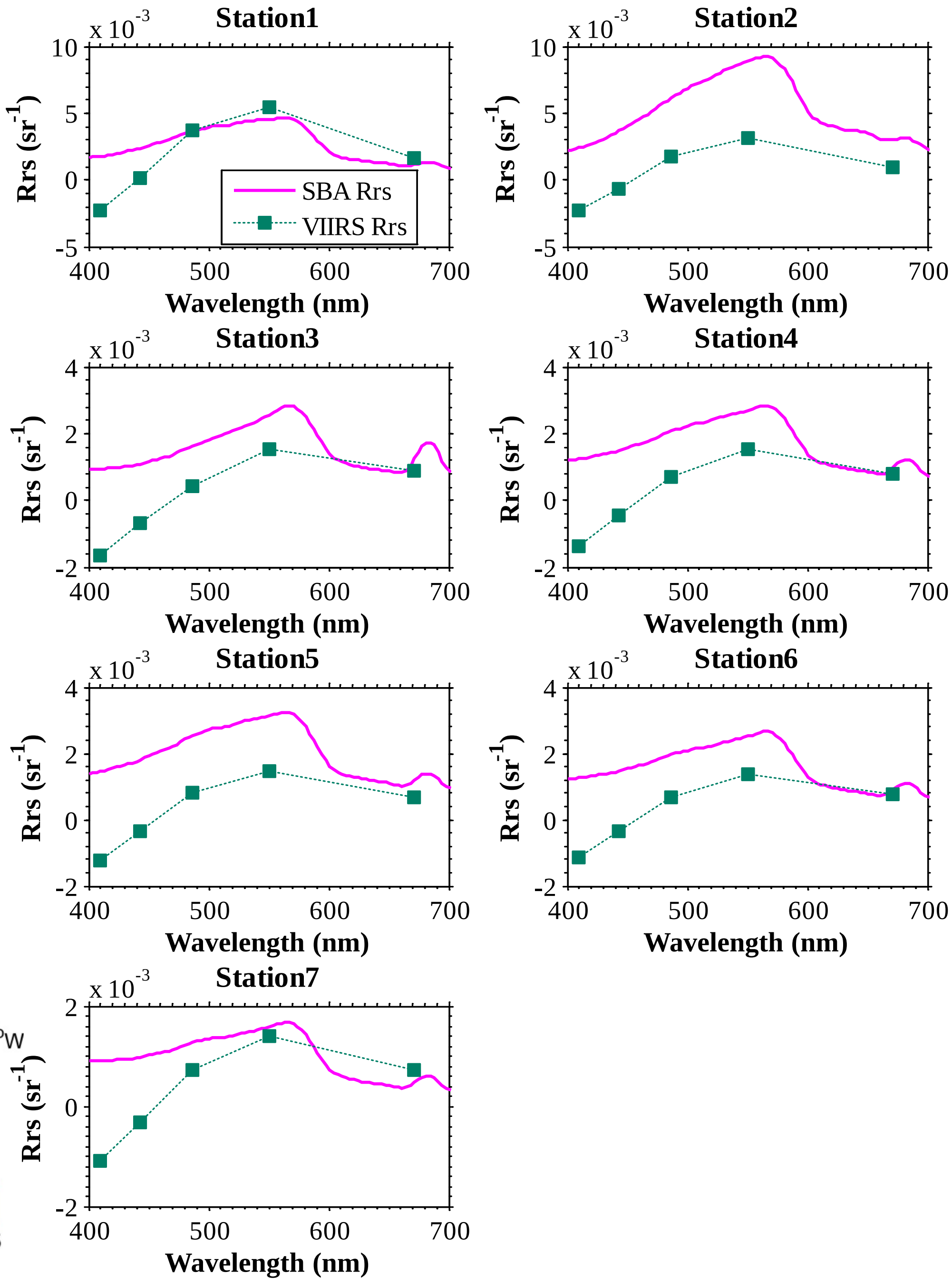
Direct Measurement of Water-leaving Radiance (L_w)



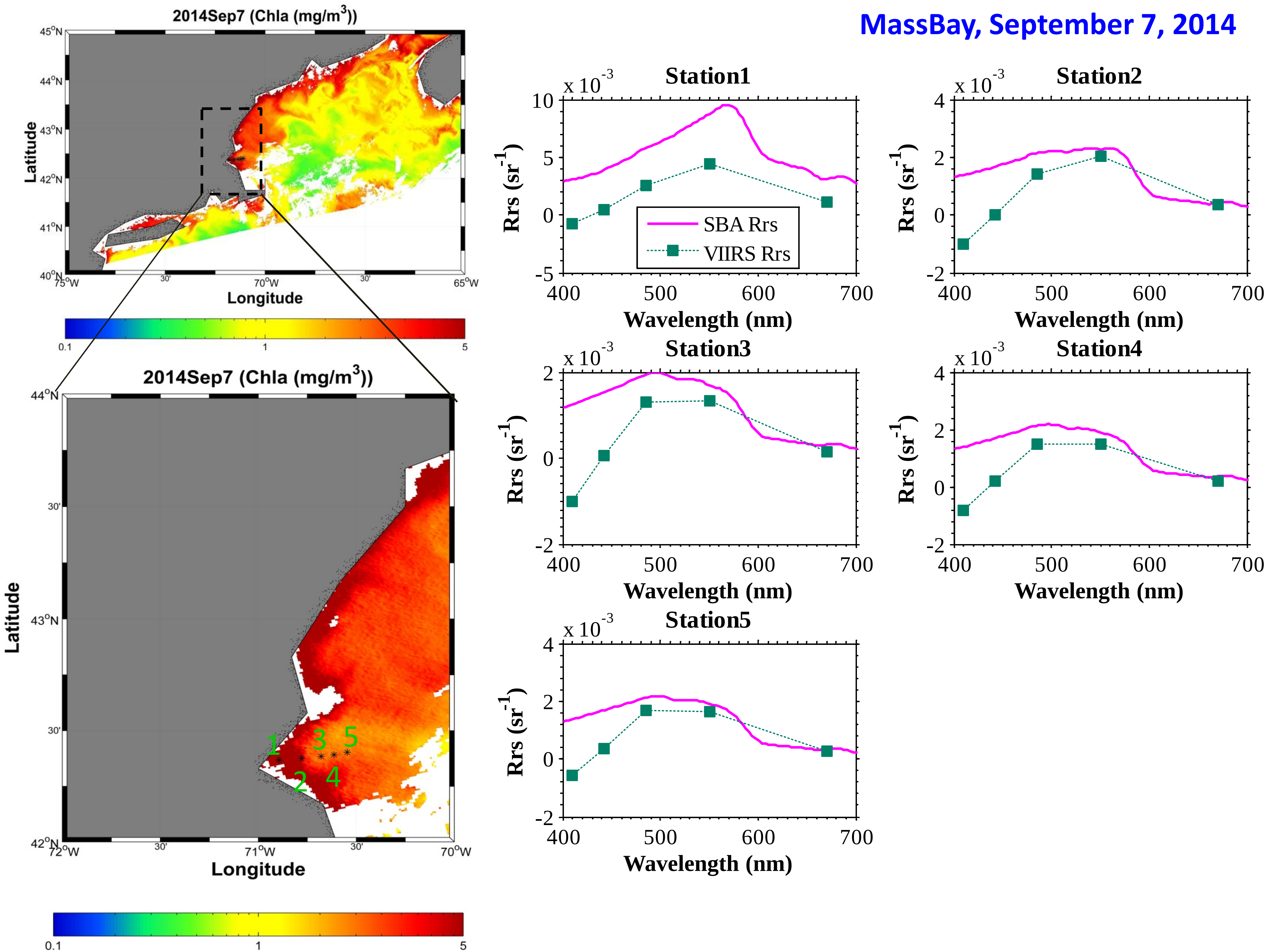
Lee et al. (2013)

MassBay, November 16, 2013

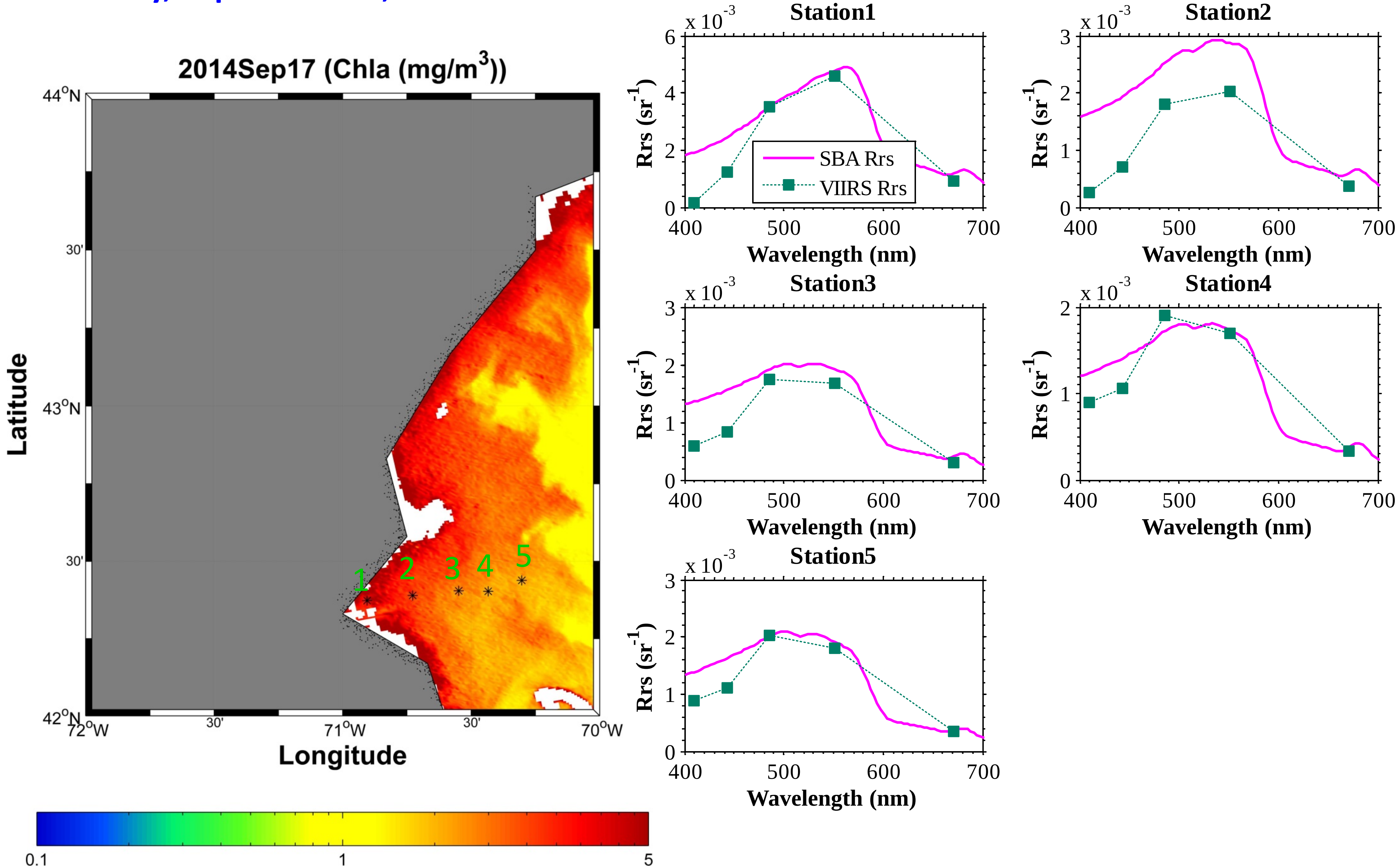




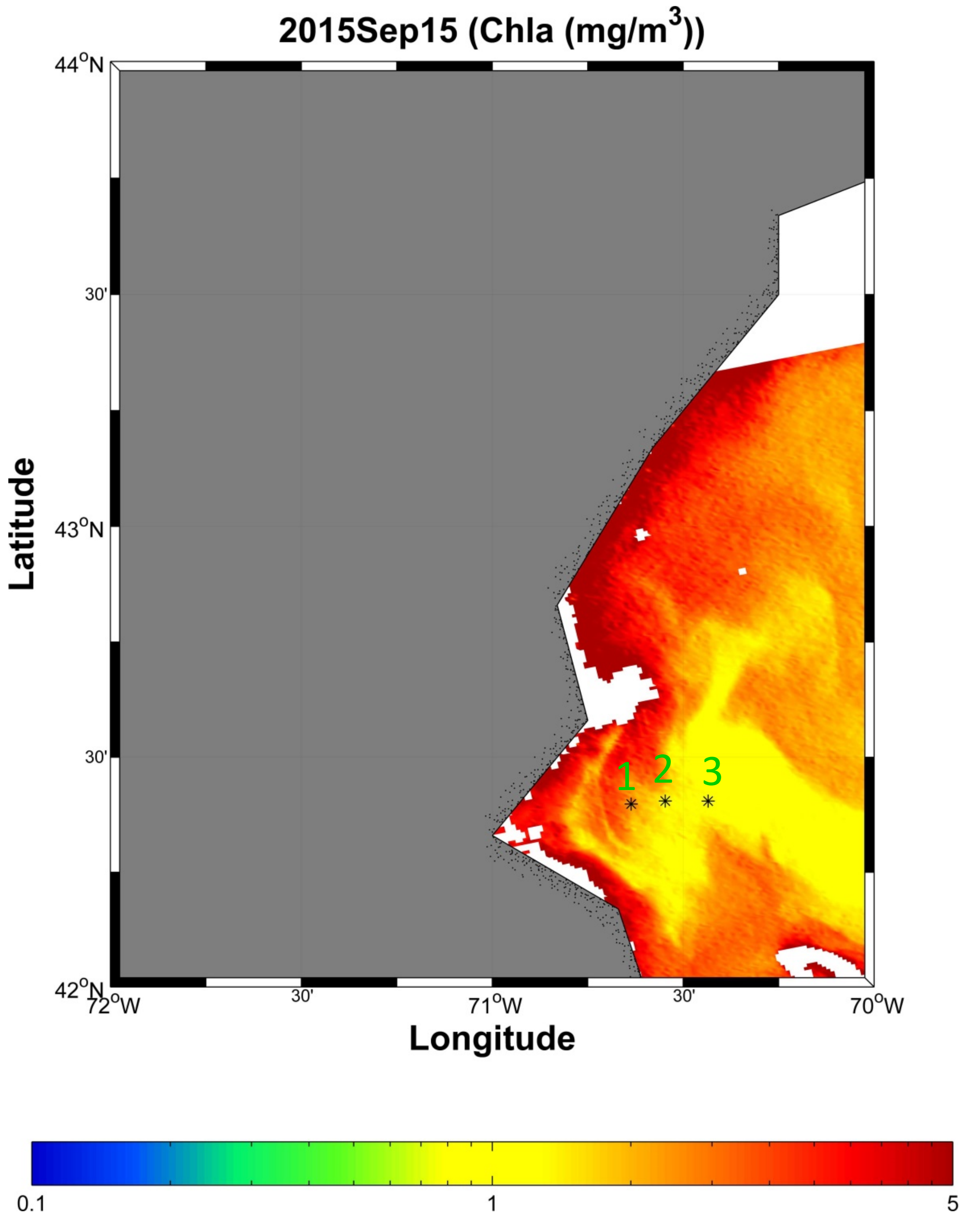
MassBay, September 7, 2014

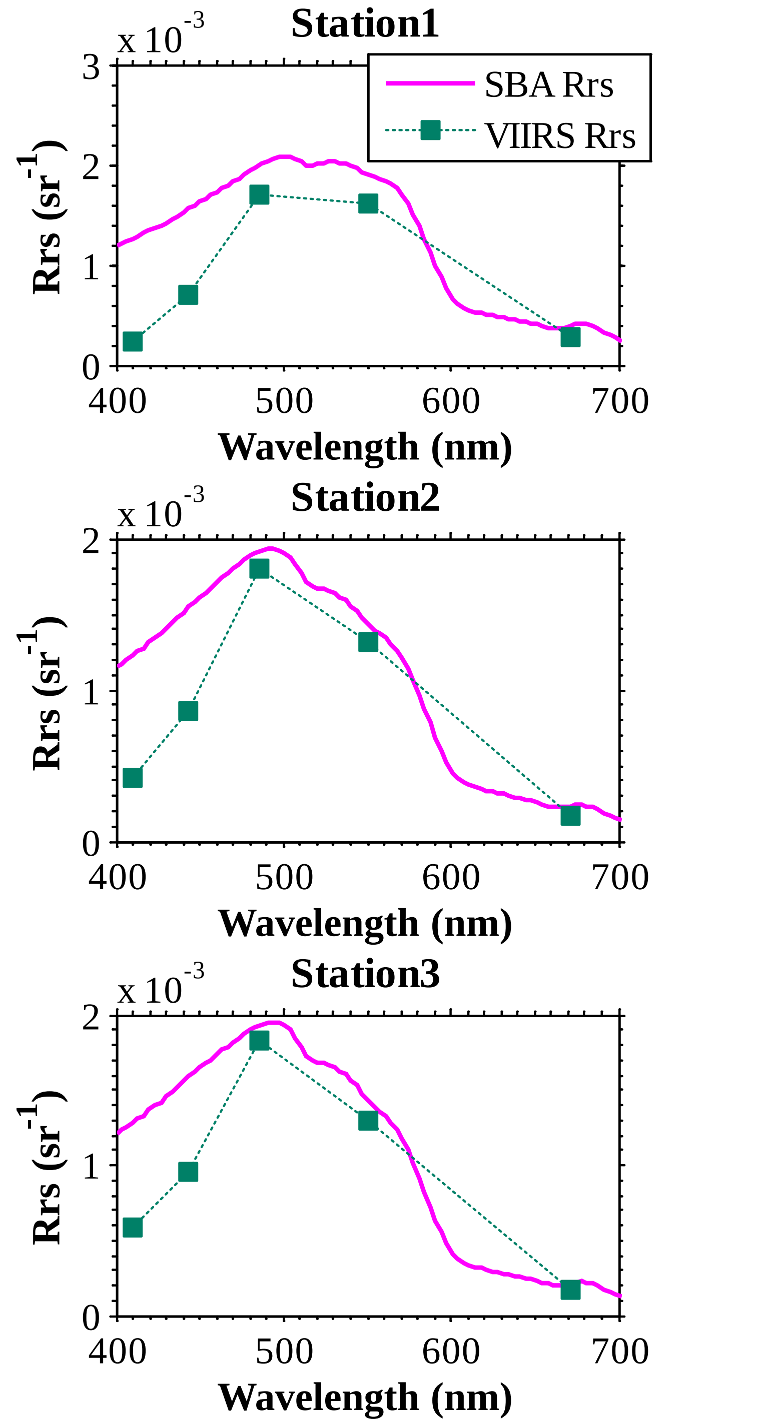


MassBay, September 17, 2014

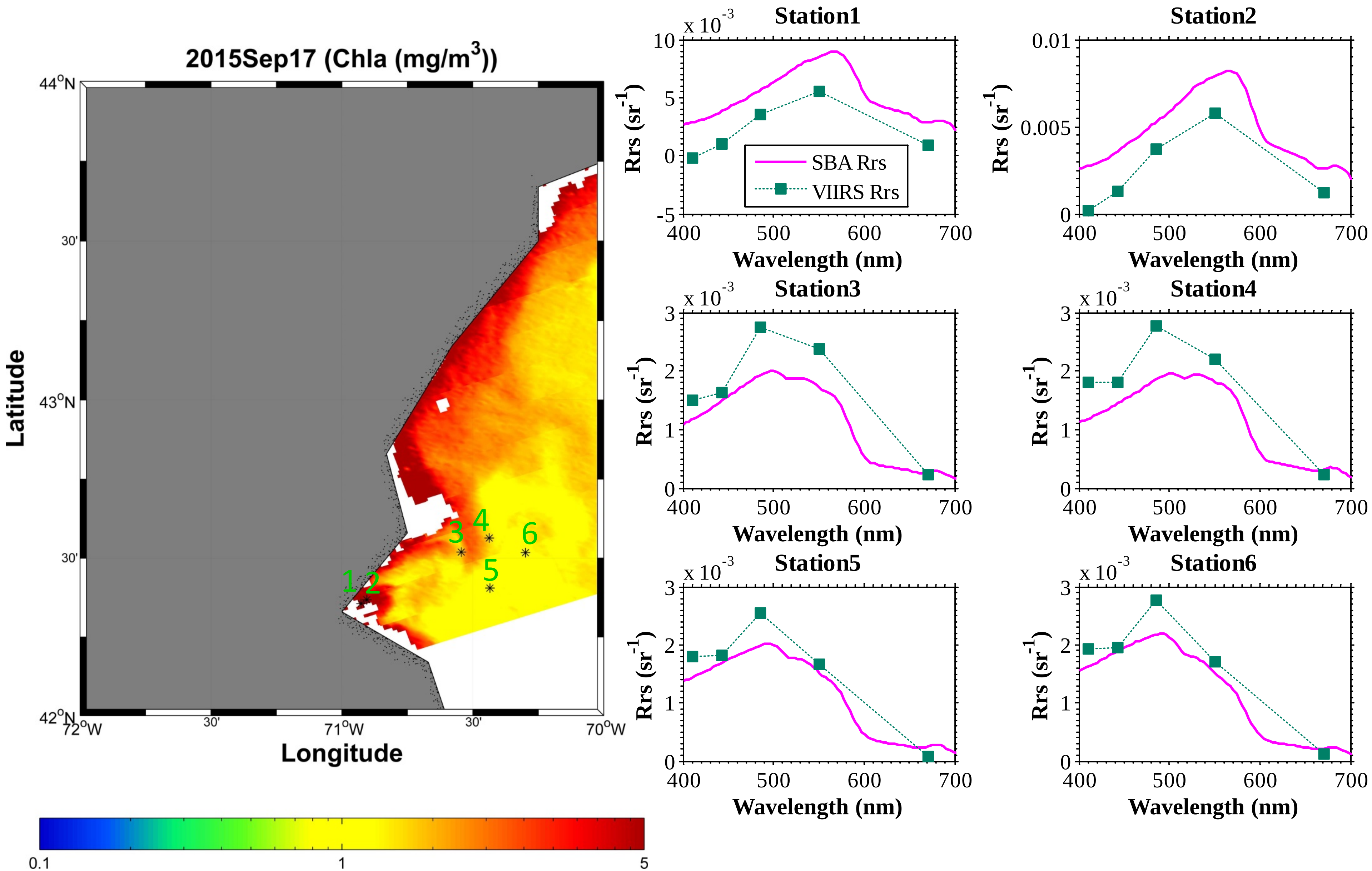


MassBay, September 15, 2015

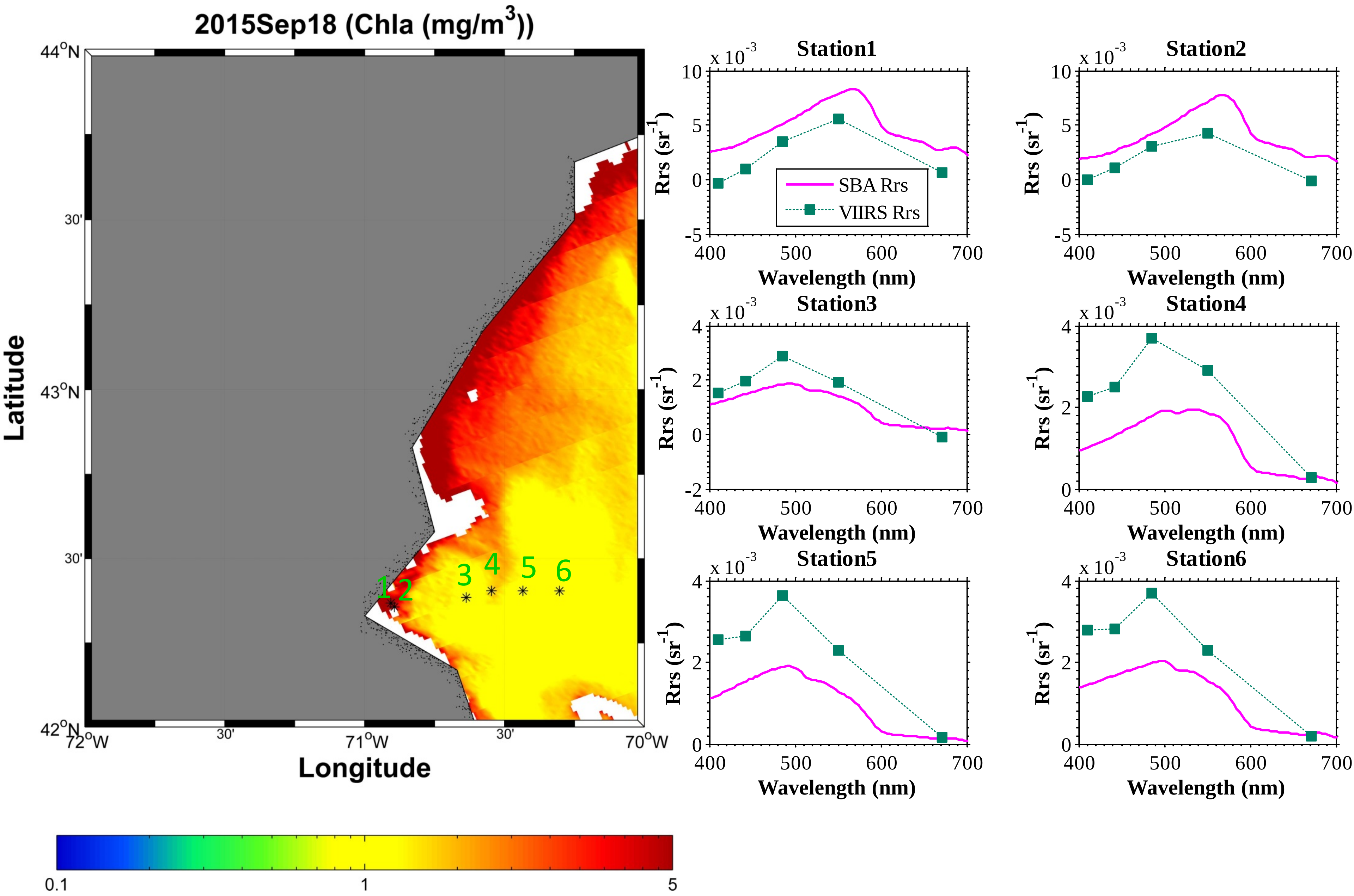




MassBay, September 17, 2015



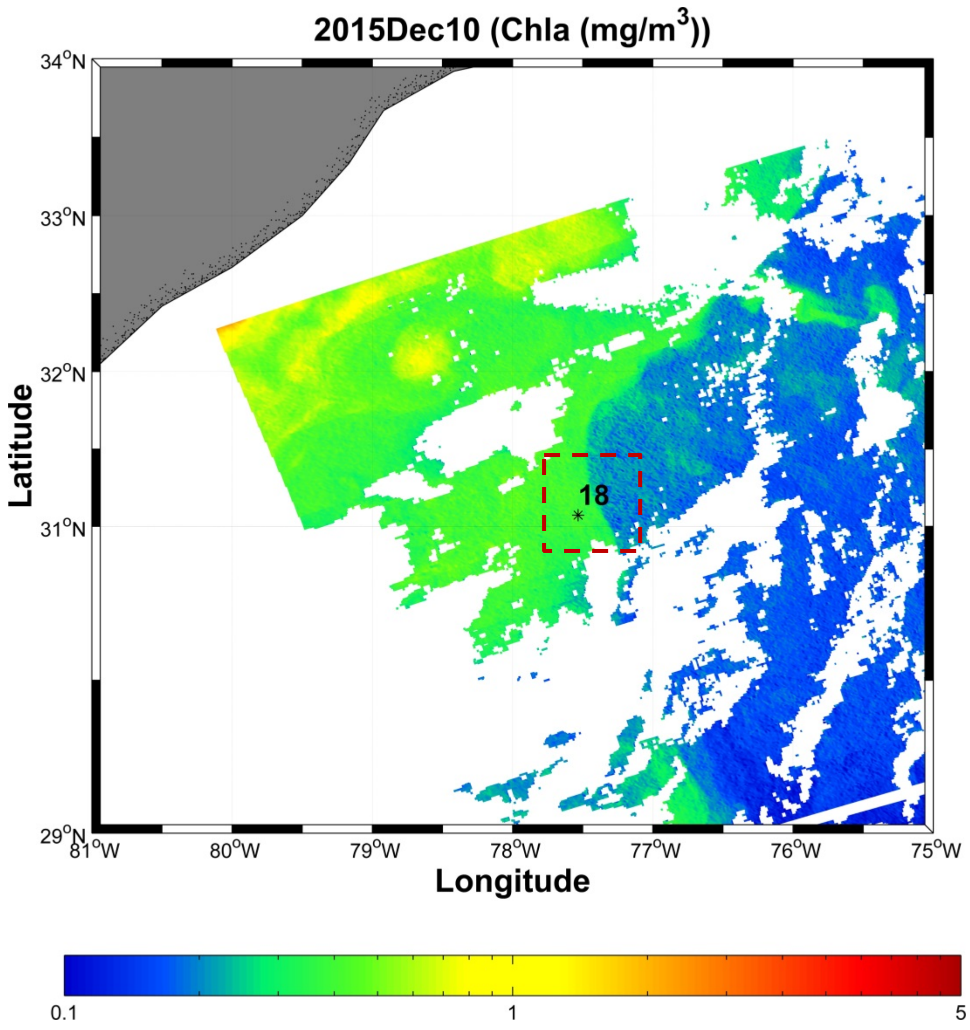
MassBay, September 18, 2015

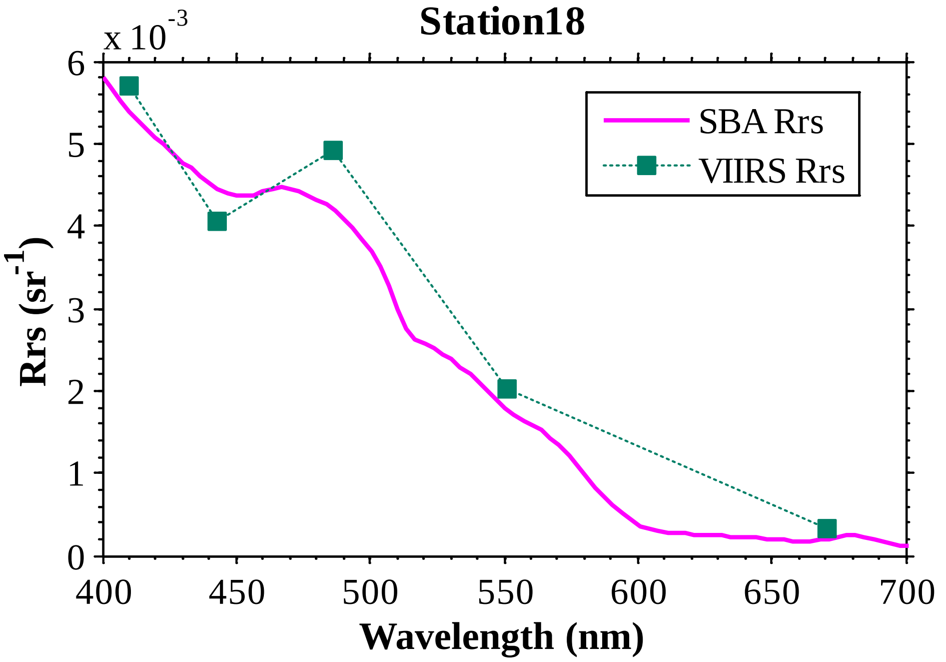


1. Evaluation of VIIRS Rrs products

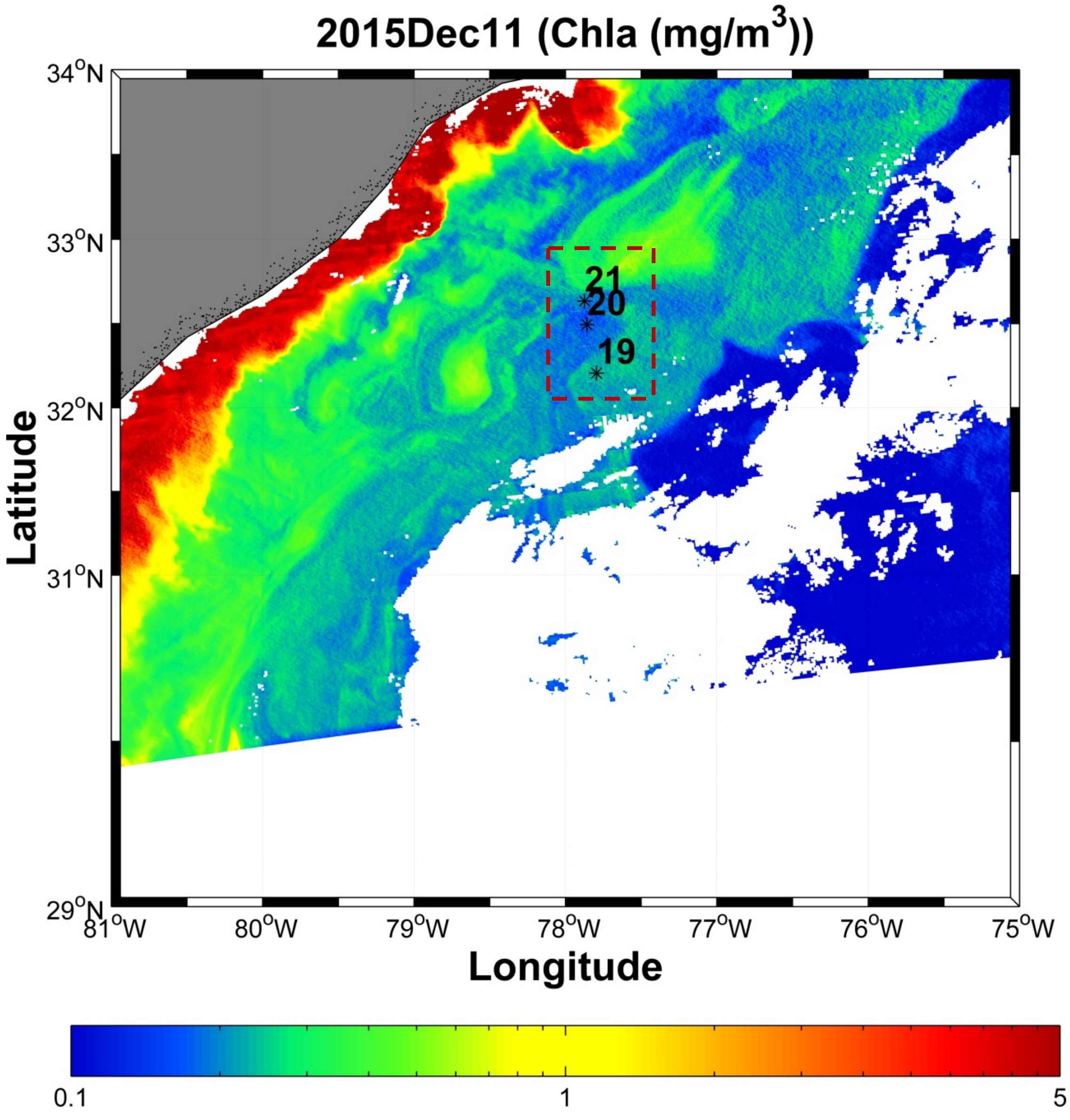
1c. Participate NOAA Cal/Val cruise and other cruises

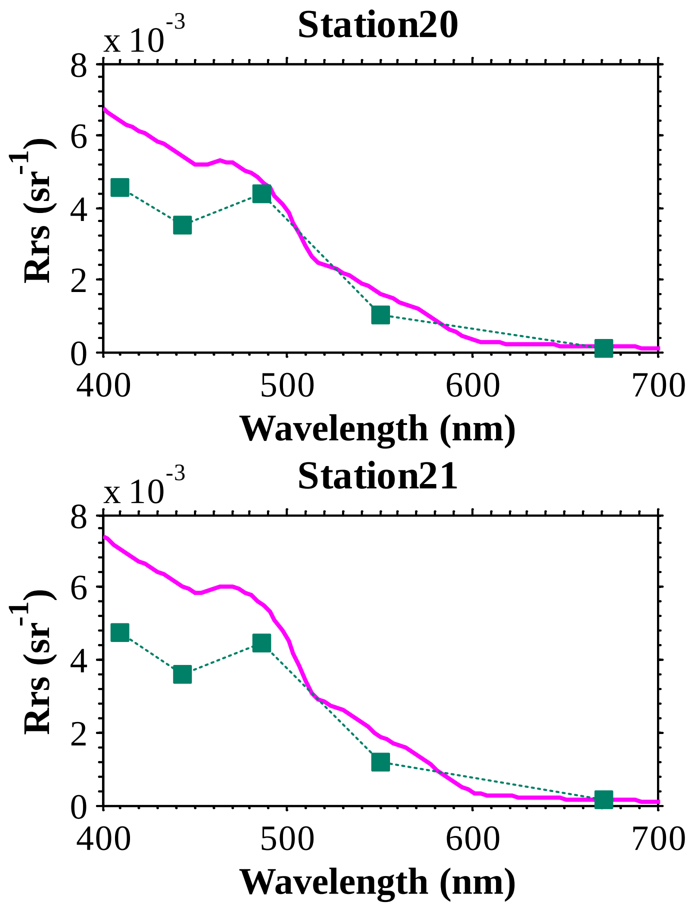
NOAA/VIIRS Cruise, December 10, 2015



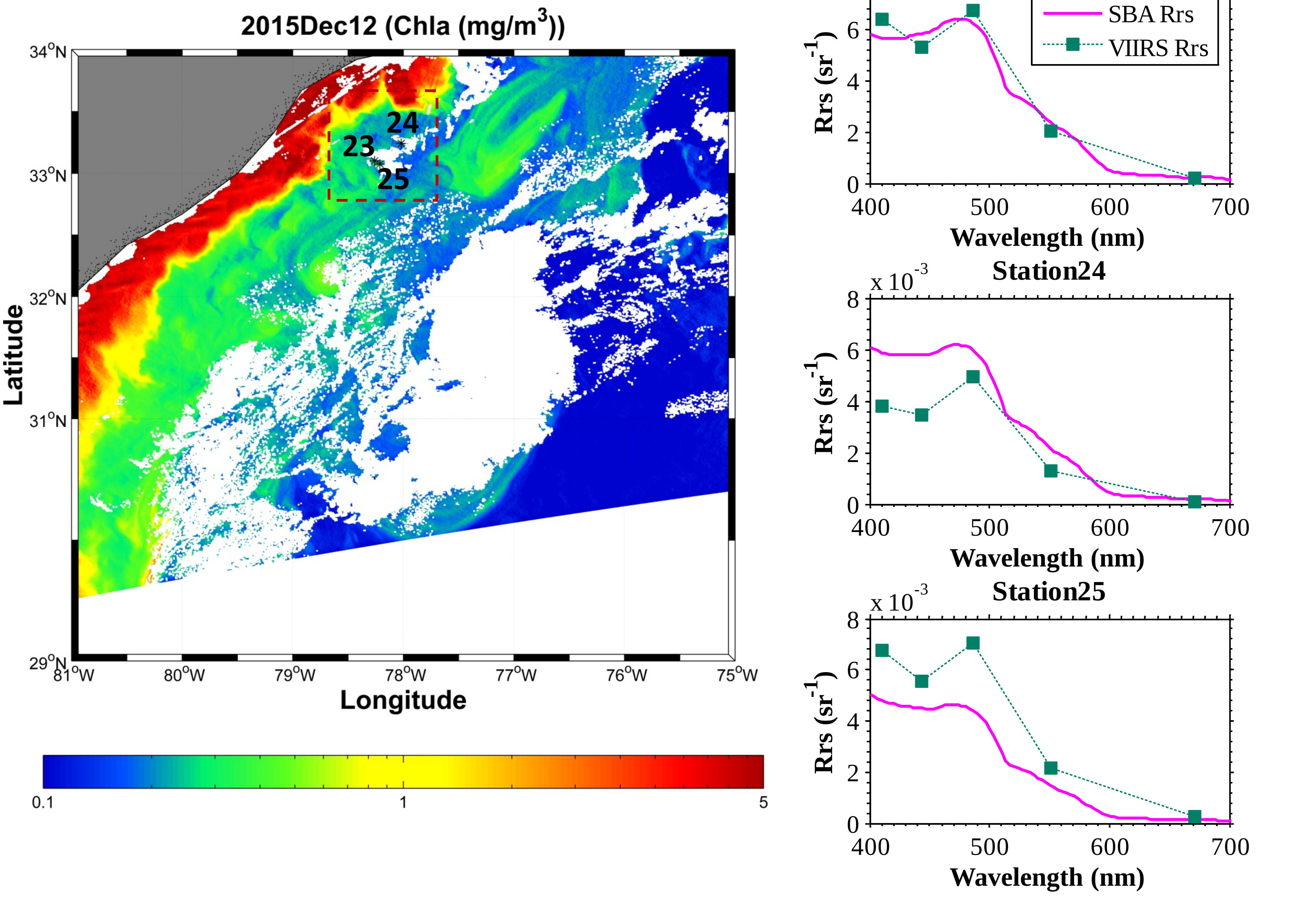


VIIRS Cruise, December 11, 2015





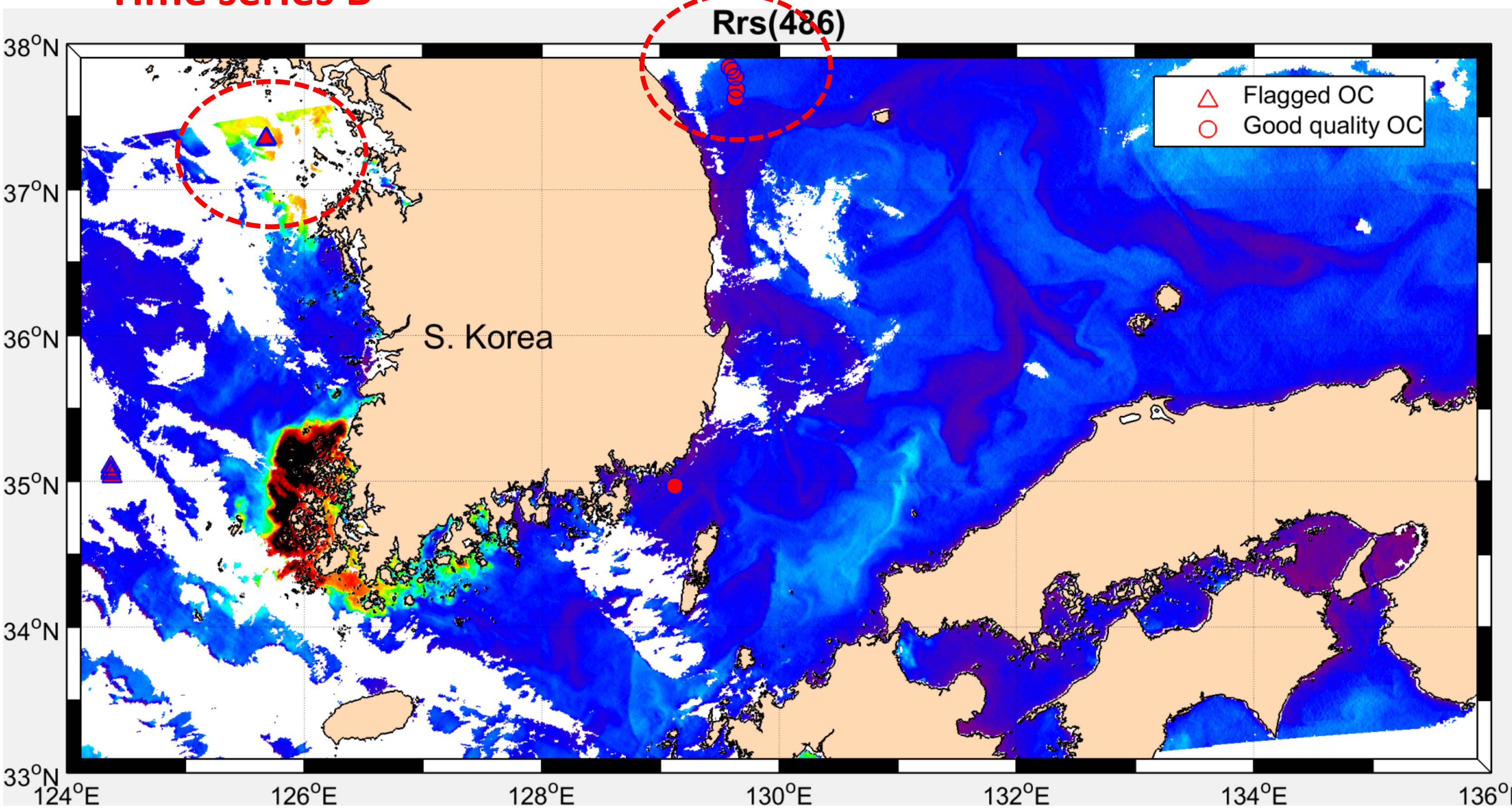
VIIRS Cruise, December 12, 2015



Cruise just finished in the Yellow Sea and East Sea (June 2016): Preliminary results

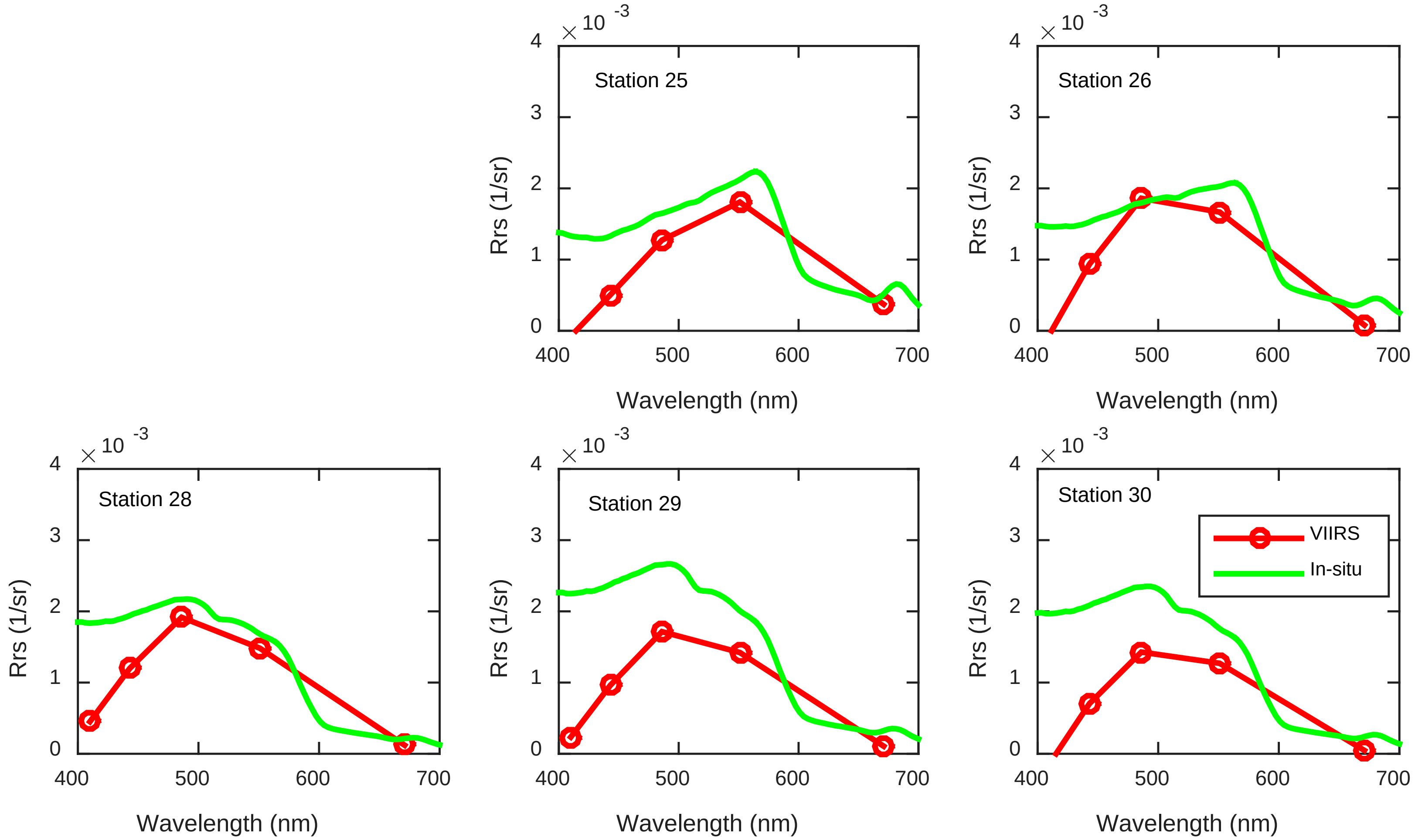
Time series A

Time series B



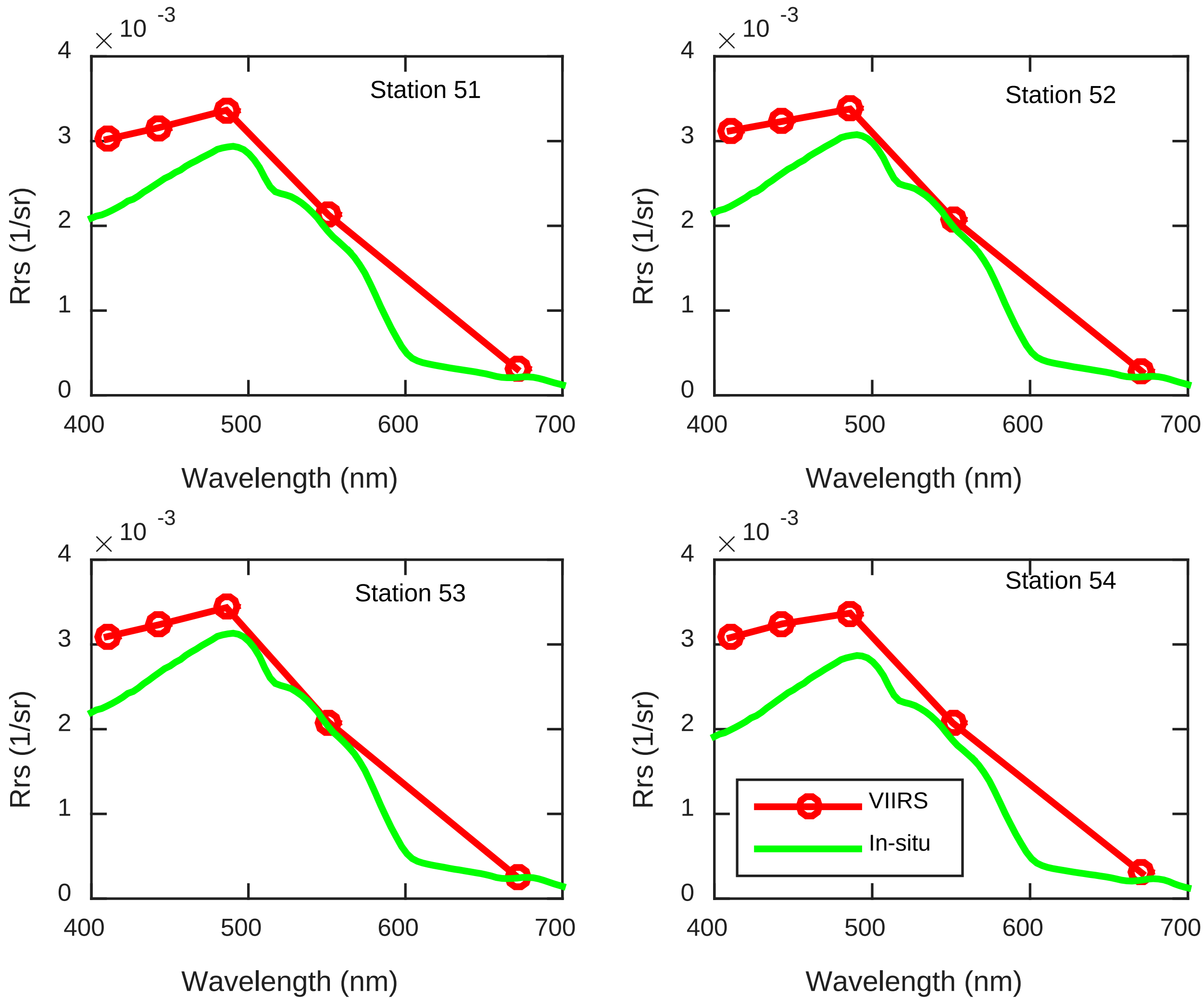
Time Series A: offshore waters in the northeast of S. Korea

OC data were "good", with no flags invoked; Time difference < 3 hours



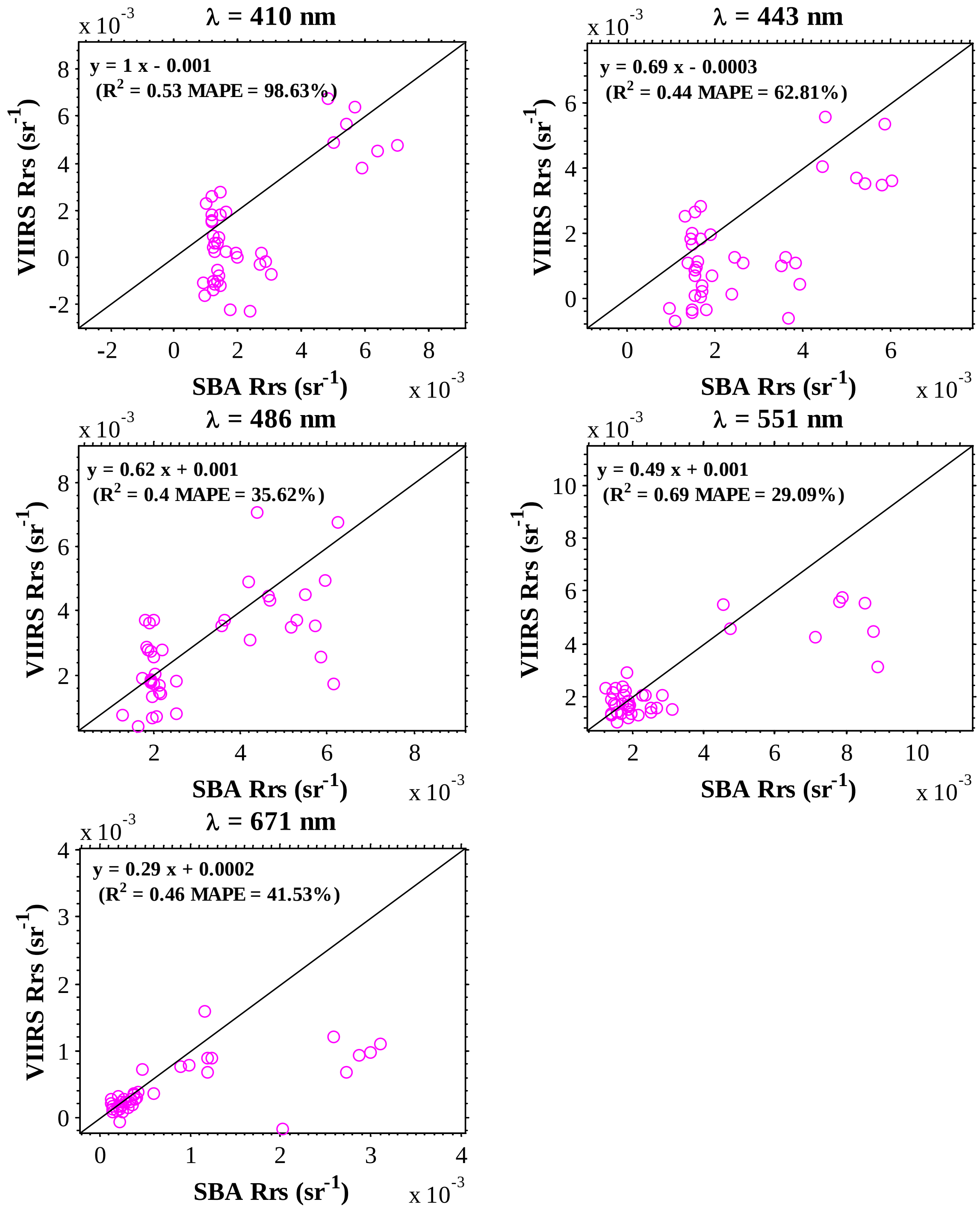
The location was slightly changing; so different pixels are used for VIIRS data.

Time Series B: offshore waters in west of Seoul, S. Korea
OC data were "questionable", with flags invoked; Time difference < 3 hours



Same location; so the same VIIRS data are used.

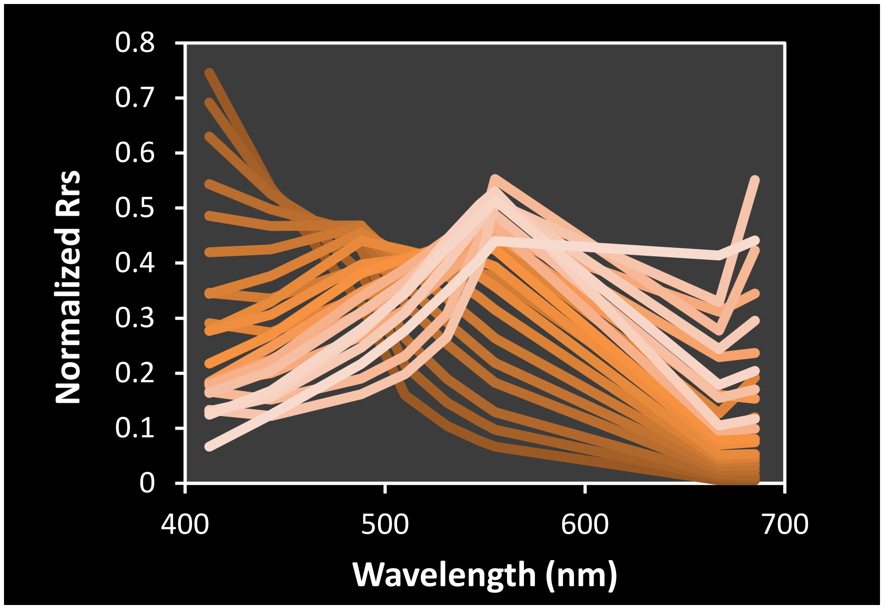
SBA Rrs vs VIIRS Rrs



2. Development of new products

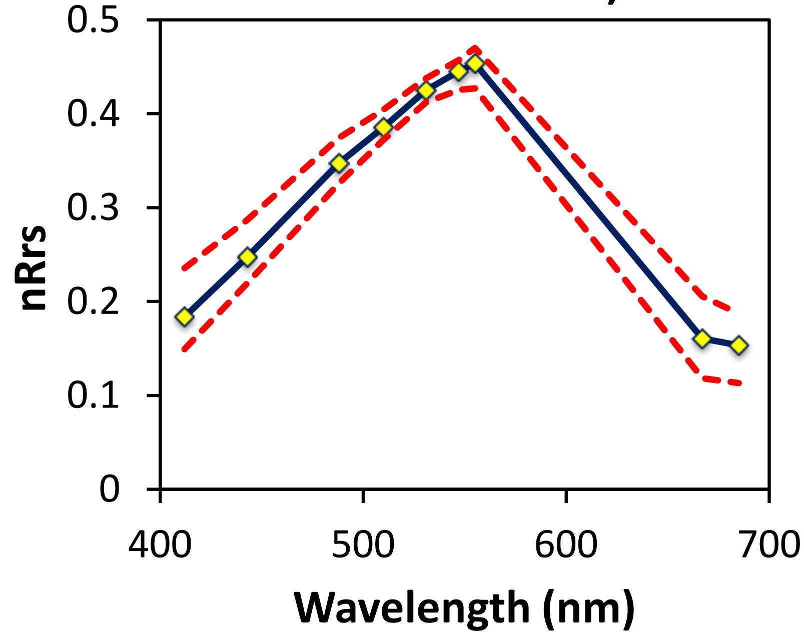
2a. Quality Assurance System

23 spectral Rrs reference system



23 water types are developed from a large Rrs data base, according to the Rrs spectral shapes (cosine distance).

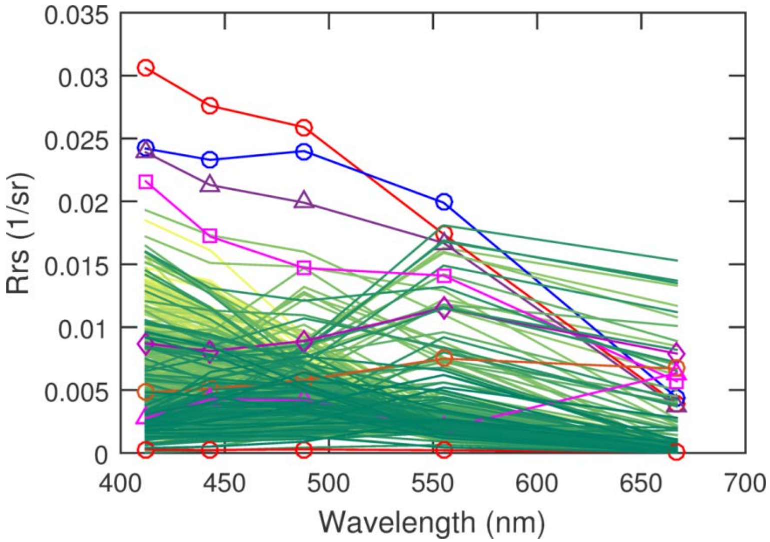
Scoring system (reference, upper and lower boundaries)



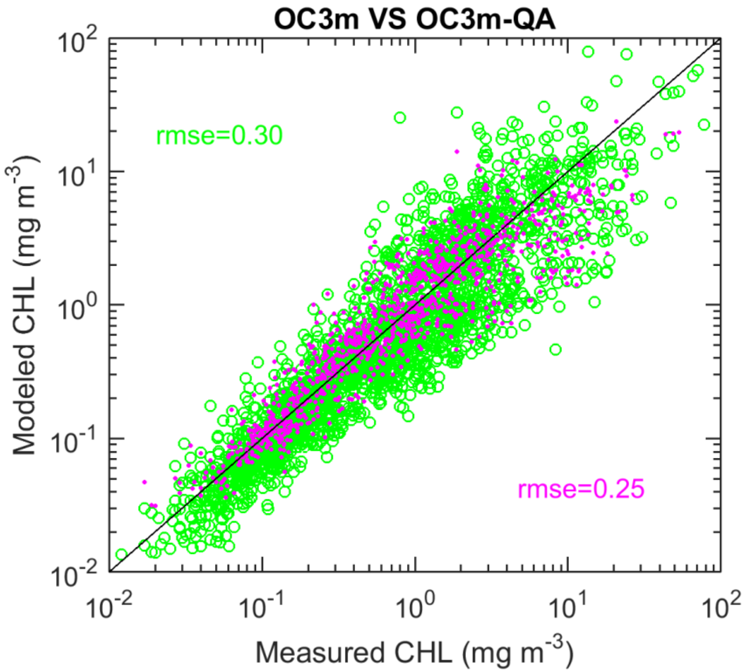
The score system is to compare target Rrs spectrum with the reference (and its upper and lower boundary)…

2a. Quality Assurance System

Examples of applications



NOMAD Rrs spectra: A few spectra highlighted as "questionable" data



"**pink**" **points refer to measurements with the highest scores (=1)**

The quality assurance system can be readily applied to satellite and in situ ocean color measurements.

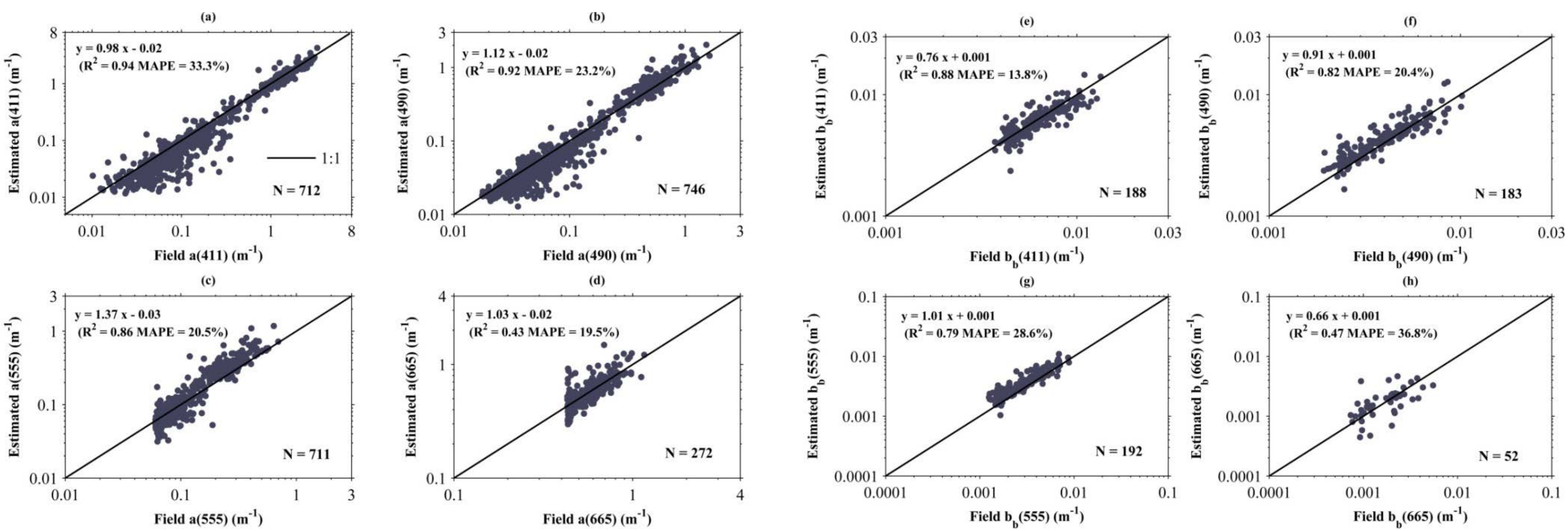
2. Development of new products

2b. IOPs from in situ AOPs

$$R_{rs} = f_1(a, b_b) \qquad nK_d = f_2(a, b_b)$$

$$\{a, b_b\}$$

(NOMAD)



2. Development of new products

2c. Secchi disk depth (Z_{SD}) for VIIRS

$$Z_{SD} \approx \frac{1}{2.5 K_d^{tr}} \ln\left(\frac{\left| r_T - r_w^{tr} \right|}{0.013} \right)$$

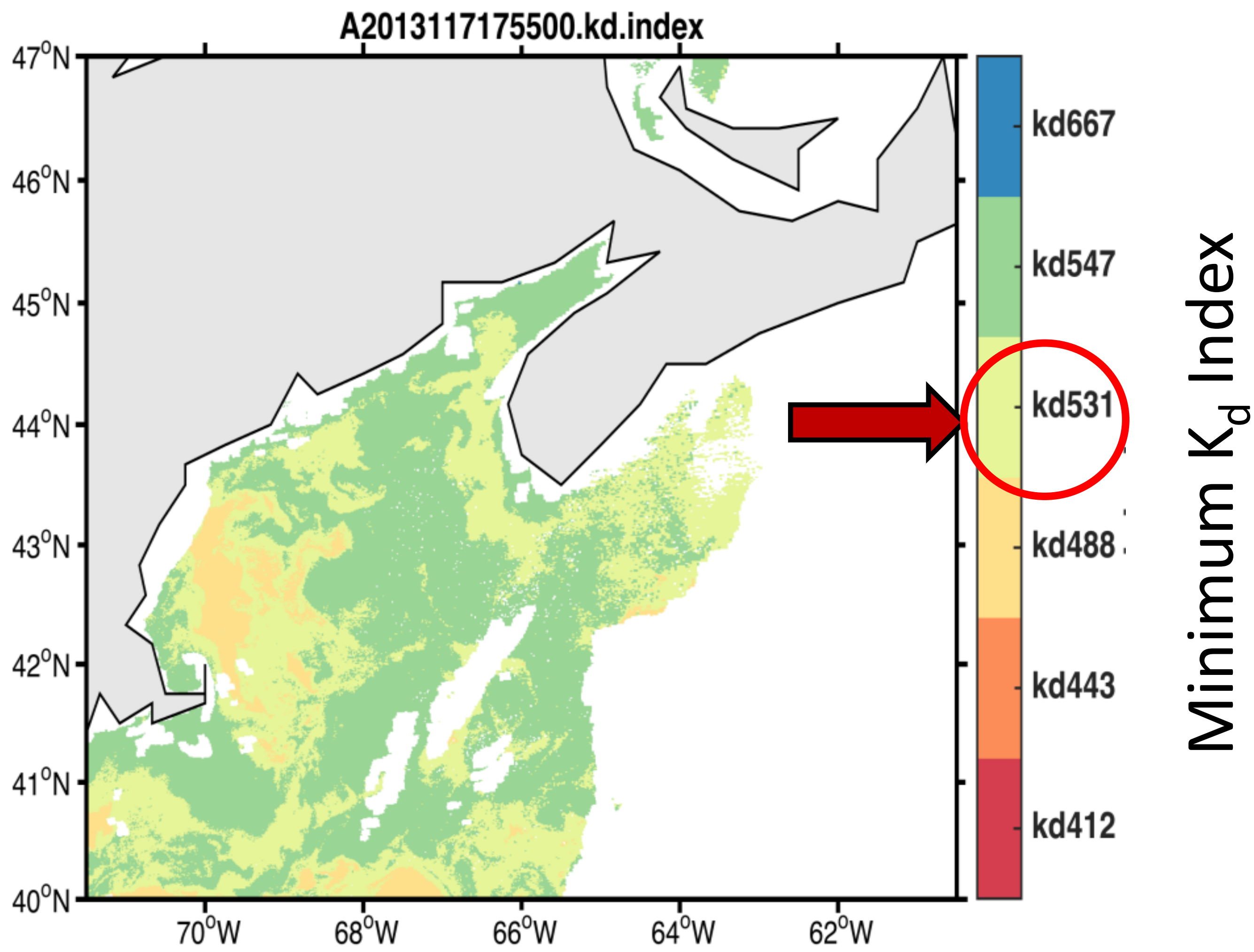
K_d^{tr} : attenuation coefficient in the transparent window

(Lee et al 2015)

For MODIS:

$$K_d^{tr} = \min(K_d(412,443,490,531,547,667))$$

Wavelength of MODIS for Minimum K_d



$$K_d^{tr} = \min(K_d(412,443,490,531,547,667))$$

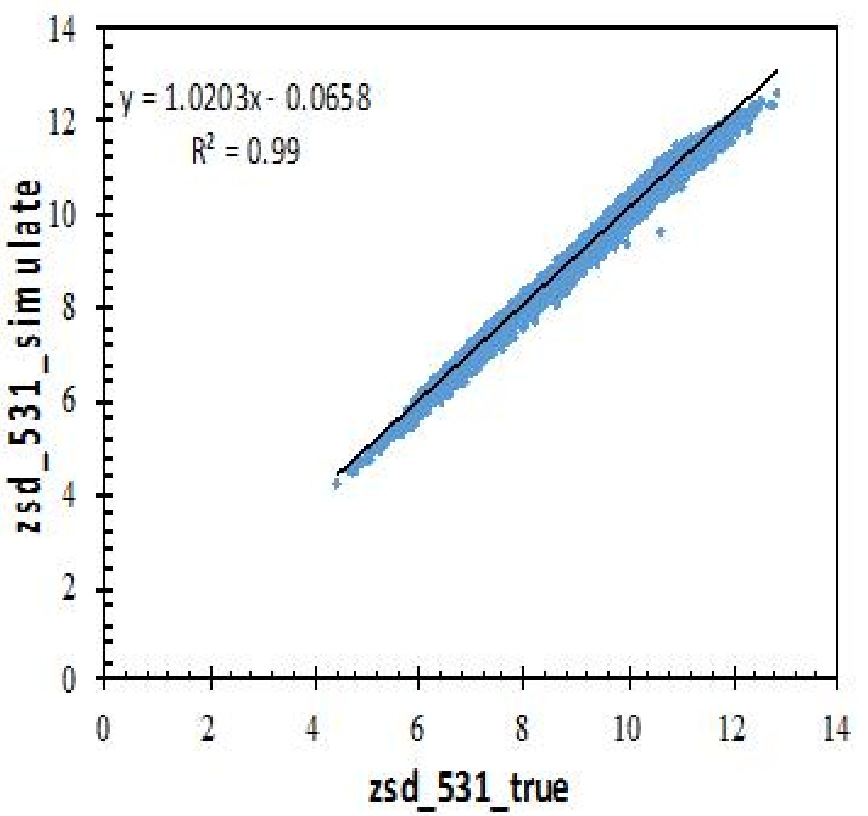
No 531 nm …?

Simulate $K_d(531)$

$K_d531\_simulate = 0.2*K_d488 + 0.75*K_d547$

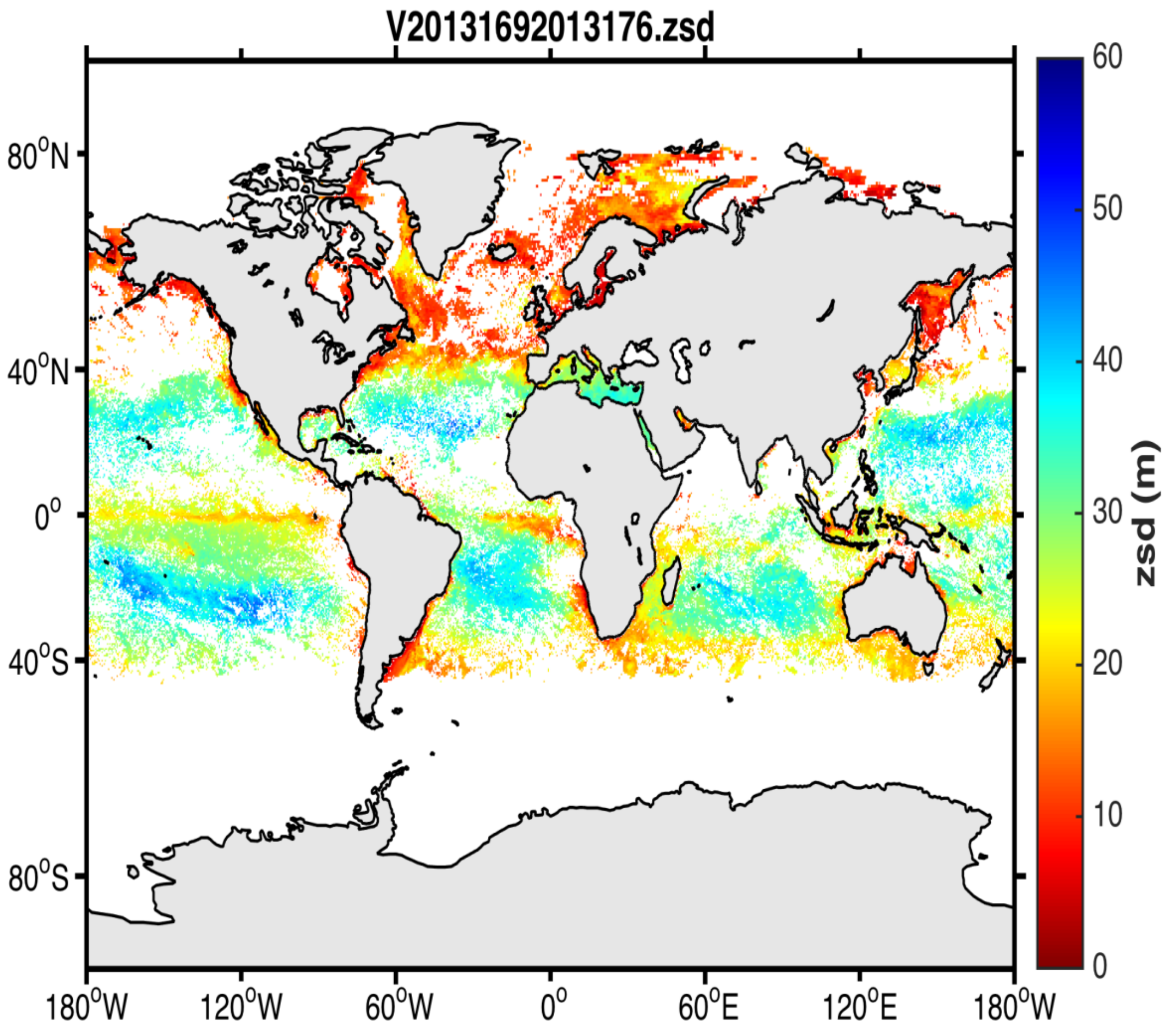
QAA（2002,2013） Lee et al (2005,2013)

$R_{rs} \rightarrow a\&b_b \rightarrow K_d$



VIIRS global Z_{SD}

VIIRS weekly Z_{SD}, Jun 2013



Plan of FY17

Continue monitoring VIIRS Rrs and IOPs …

1a. Compare VIIRS Rrs with climatological Rrs of gyre waters

1b. Compare VIIRS Rrs with in situ measurements
(Puerto Rico, Mass Bay, other opportunities)

1c. Evaluate VIIRS IOPs with improved in situ IOPs

1d. Evaluate VIIRS other products (e.g., Z_{SD})

2a. Participate NOAA Cal/Val cruise to collect AOP/IOP

Thank you!