Looking back GOCI towards the upcoming GOCI-II and beyond

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GOCI & GOCI-II related projects

1. GOCI-II development with KARI and AIRBUS DS
- GOCI-II has been equipped on the GK-2B satellite, which is planned to launch in March 2020.

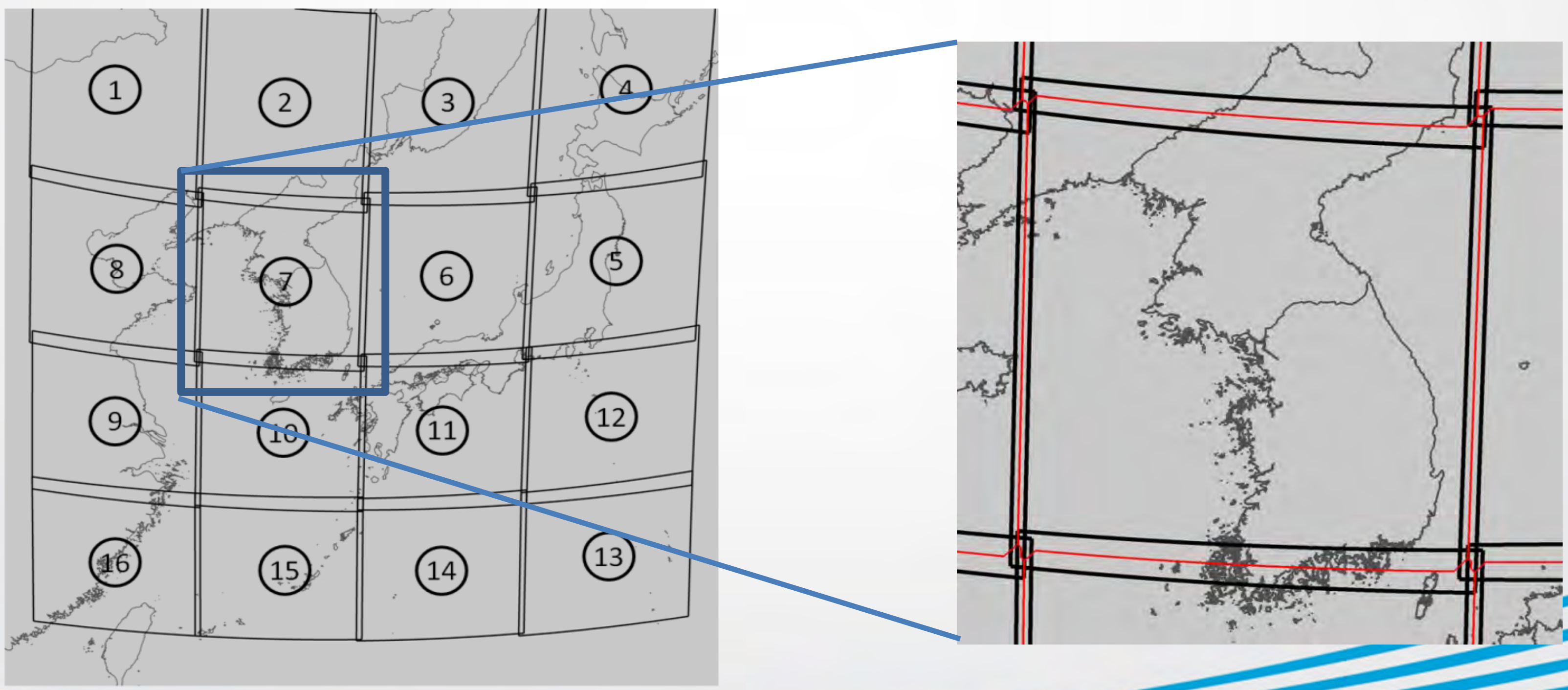
2. GOCI-II ground processing system(G2GS) development
- G2GS shall be ready by end of this year. Various tests including In-orbit test will be conducted in 2020.

3. Ocean satellite practical applications (OSPA) aiming to better use multi-satellite based information to coastal and ocean issues ('19~'22)
- Algorithms will be validated and implemented to user oriented satellite applications modules/system development

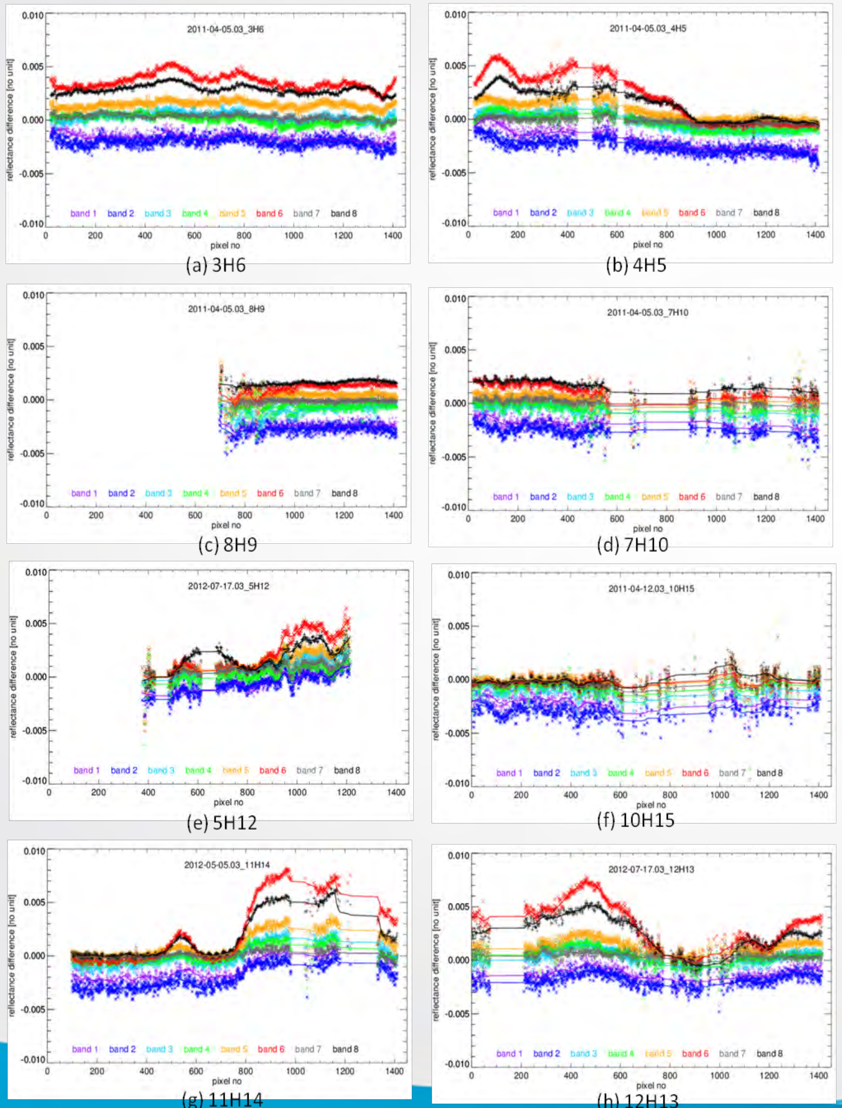
ISRD issue in GOCI image

ISRD: GOCI image acquisition

16 slot images taken by the step-and-stare method are mosaicked to produce a L1B image **(time interval between two adjacent slots: 103 sec ~ 12 mins)**



ISRD across horizontal slot borders

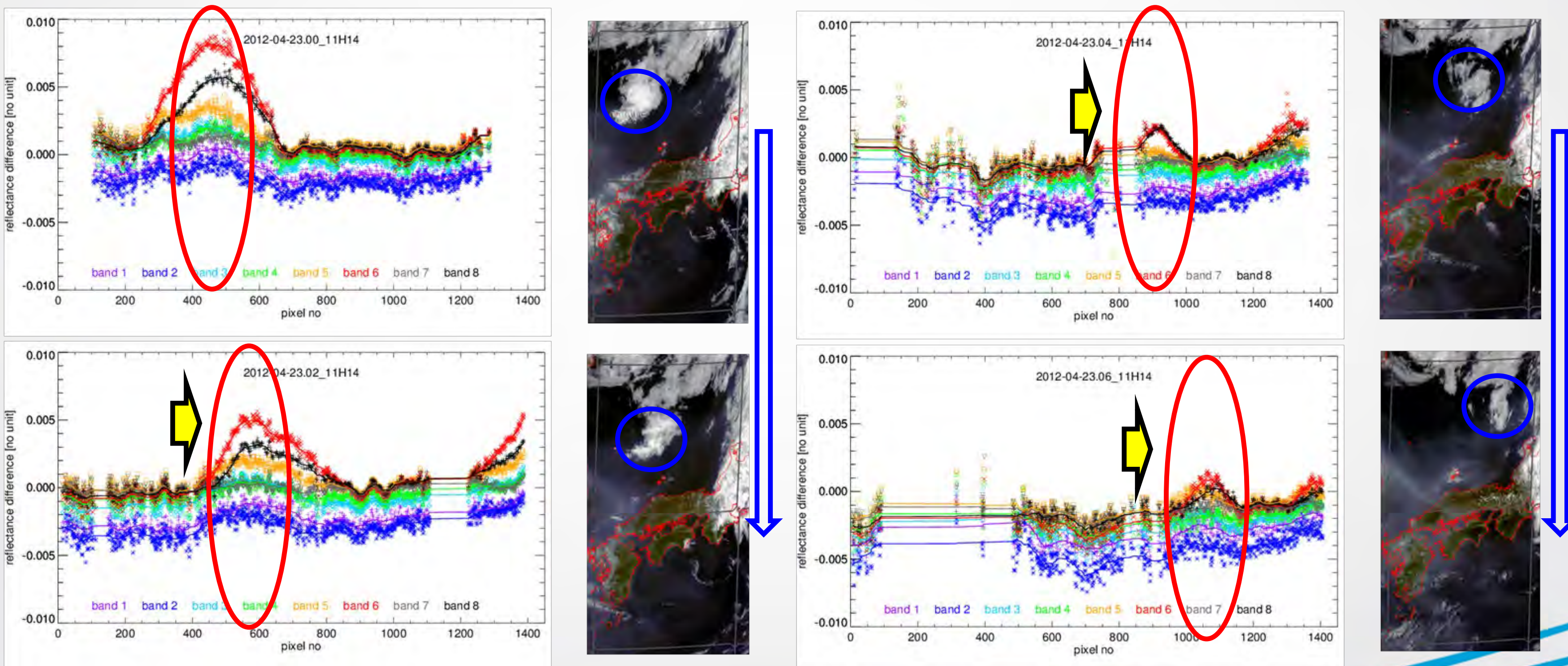


(a) 3H6 (b) 4H5 (c) 8H9 (d) 7H10 (e) 5H12 (f) 10H15 (g) 11H14 (h) 12H13

- ❑ High variability with location
- ❑ High variability with band
  - o Band-6 & 8 : strongly positive
  - o Band-1 & 2 : negative
  - o Band-3,4,5,7 : middle
  - o Band-7 : least variable

Causes of ISRD

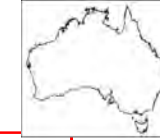
ISRD caused by the **cloud ghost image**, straylight and sensor calibration irregularities

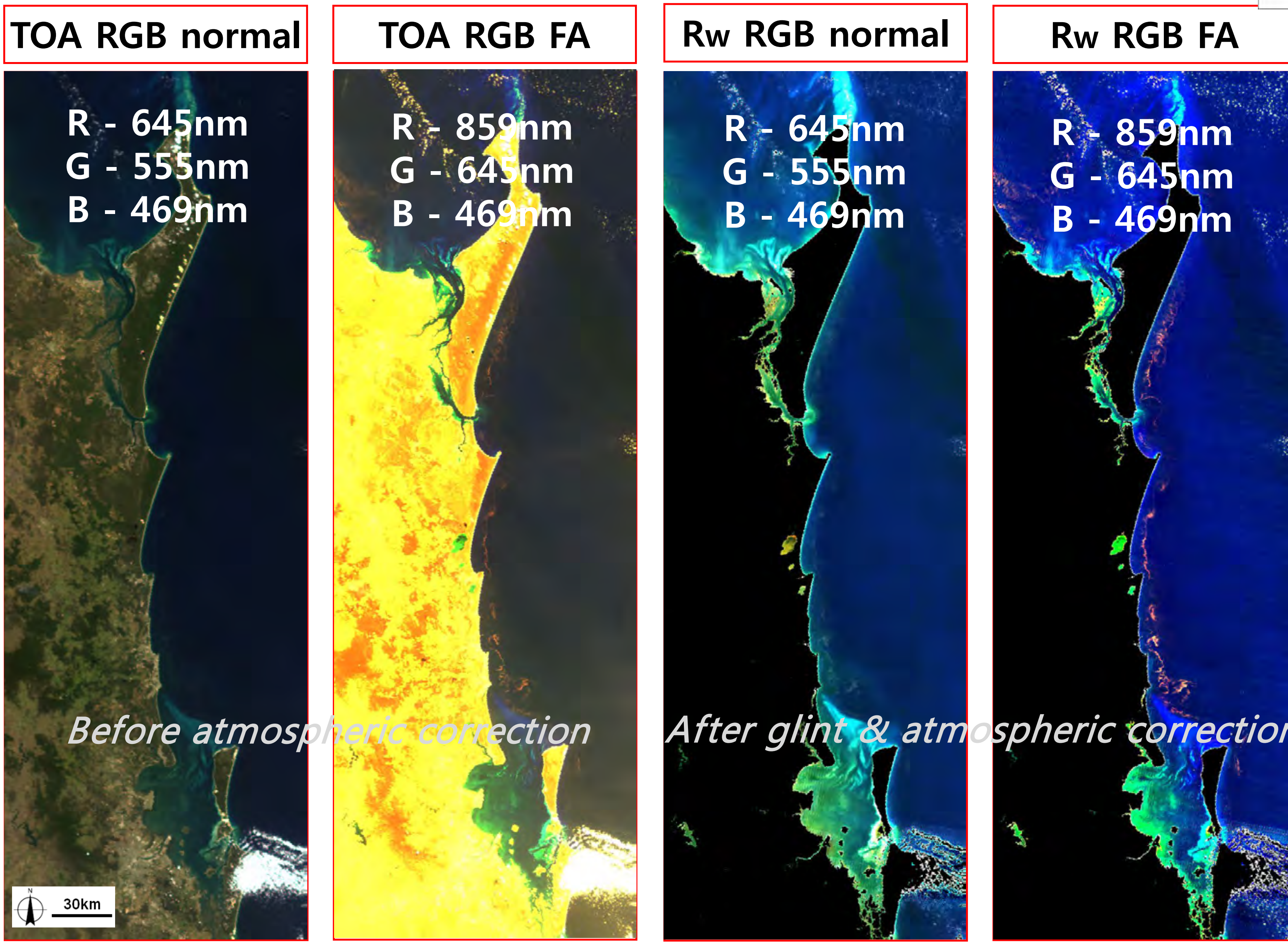


ISRD in GOCI-II

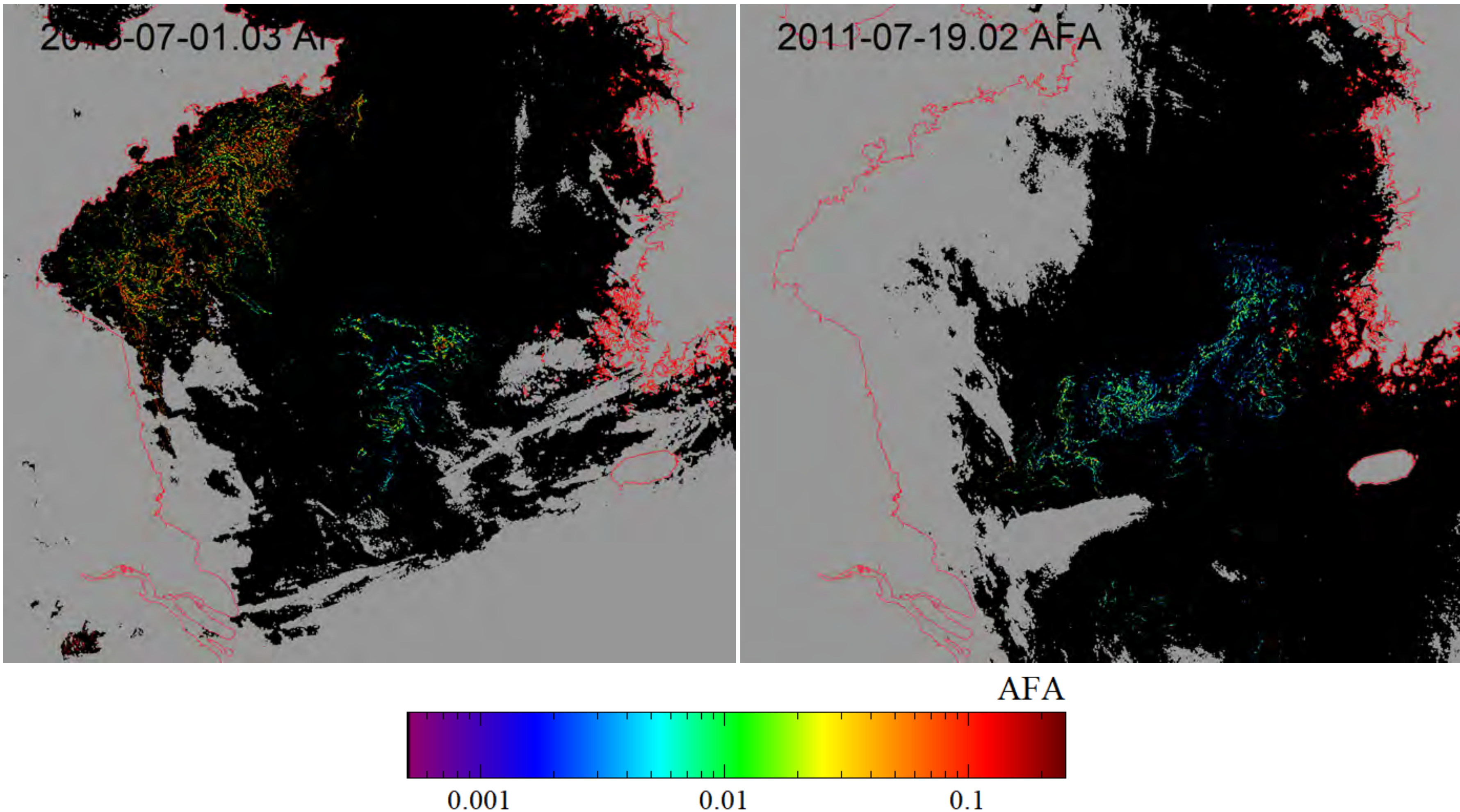
- GOCI-II instrument include a baffle to limit intrusion of the undesired straylight.
- ISRD has been better characterized in GOCI-II. ISRD effects will be further corrected if needed.
- We are now better prepared for the ISRD issue

MODIS-Terra 2006 Oct 3 (275) 9:50



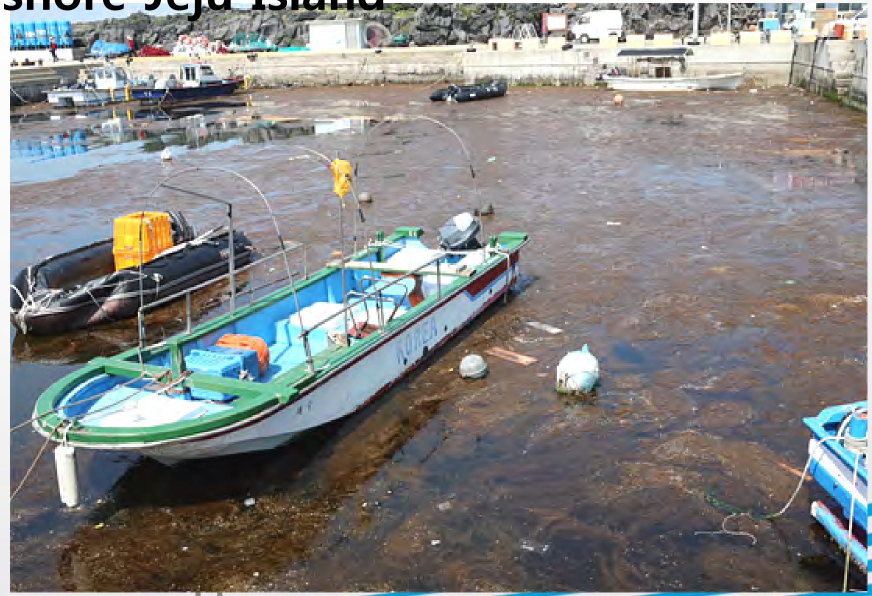


Ulva prolifera blooms in YS every year since 2008



Brown algae (Sargassum honeri) bloom in 2015

In early 2015, a large amount of floating brown seaweed accumulated along the southwest coast of the Korean Peninsula and along the coast of Jeju Island, located in the northern East China Sea (ECS) (Hwang etal. 2016). The seaweed was identified as Sargassum horneri (Turner) C. Agardh, a species of brown algae. The bloom event in the ECS resulted in significant economic loss to local aquaculture industry for Porphyra and Saccharina as well as abalone. About $800,000 USD were spent to clear out over 10,000 tons of seaweed washed ashore Jeju Island



Floating algae detection: Background

There are simple indices :NDVI, aFAI (or MCI-type) can be used for Sargassum detection thanks to pioneering works. But,

- In the highly dynamic environment in both aerosol loading and water turbidity, difficult to use a scene-wide threshold(discussed in Garcia et al., 2013)

- An algorithm to cope with spatially varying background

- Algae covered area is required to compute the algal biomass.

- Need to detect small variability without false detection

Formula for algae-covered fractional(subpixel) area

Satellite measured reflectance (α: fractional area)

$$\rho(\lambda) = (1-\alpha)\rho_W(\lambda) + \alpha\rho_A(\lambda) + \rho_{path}(\lambda)$$

Red-edge Reflectance Difference (RERD):

$$\Delta\rho = \rho(\lambda_n) - \rho(\lambda_r)$$

$$\Delta\rho = \Delta\rho_W + \Delta\rho_{path} + \alpha(\Delta\rho_A - \Delta\rho_W)$$

Finally,

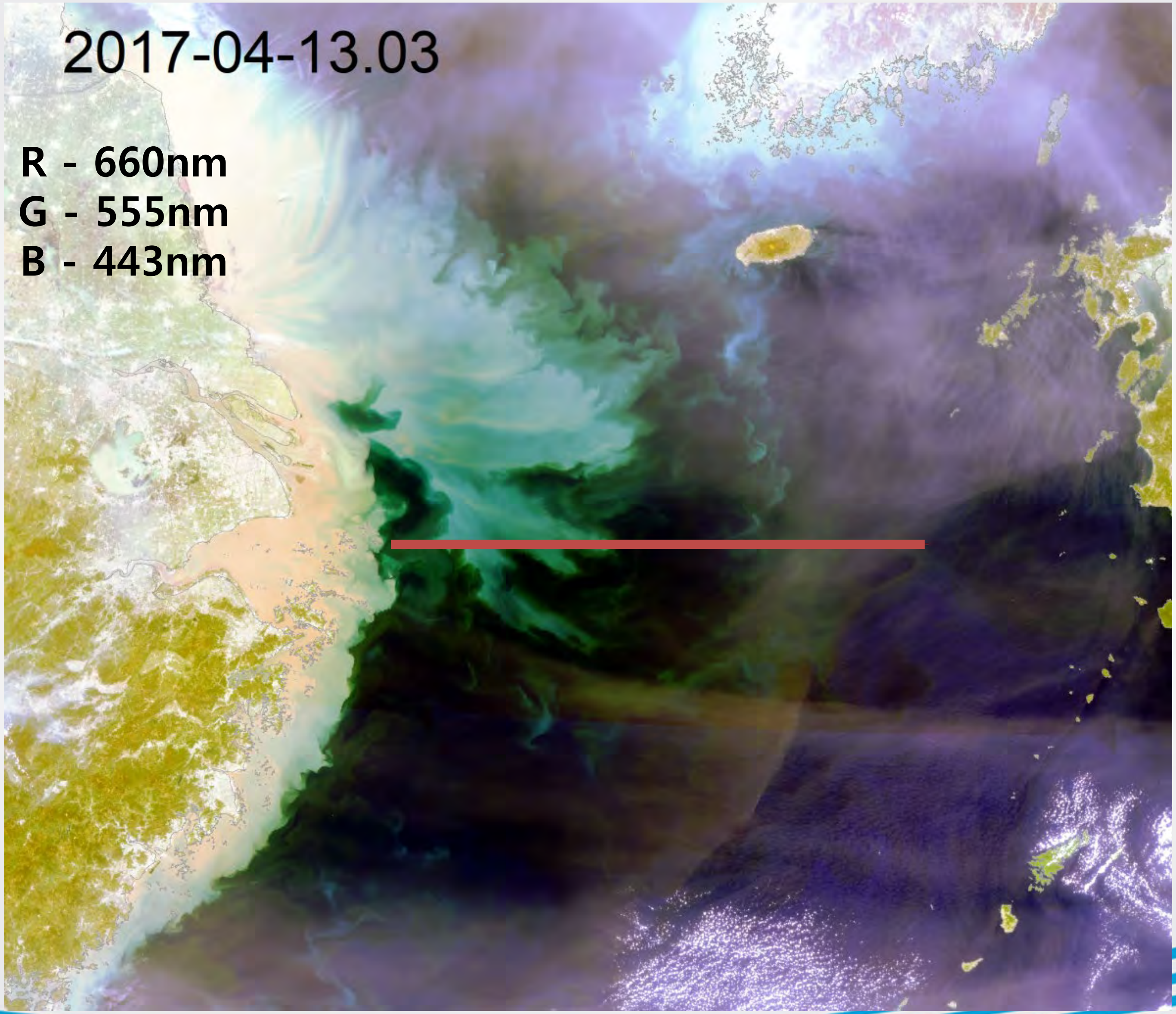
$$\alpha = \frac{\Delta\rho - (\Delta\rho_W + \Delta\rho_{path})}{\Delta\rho_A - \Delta\rho_W}$$

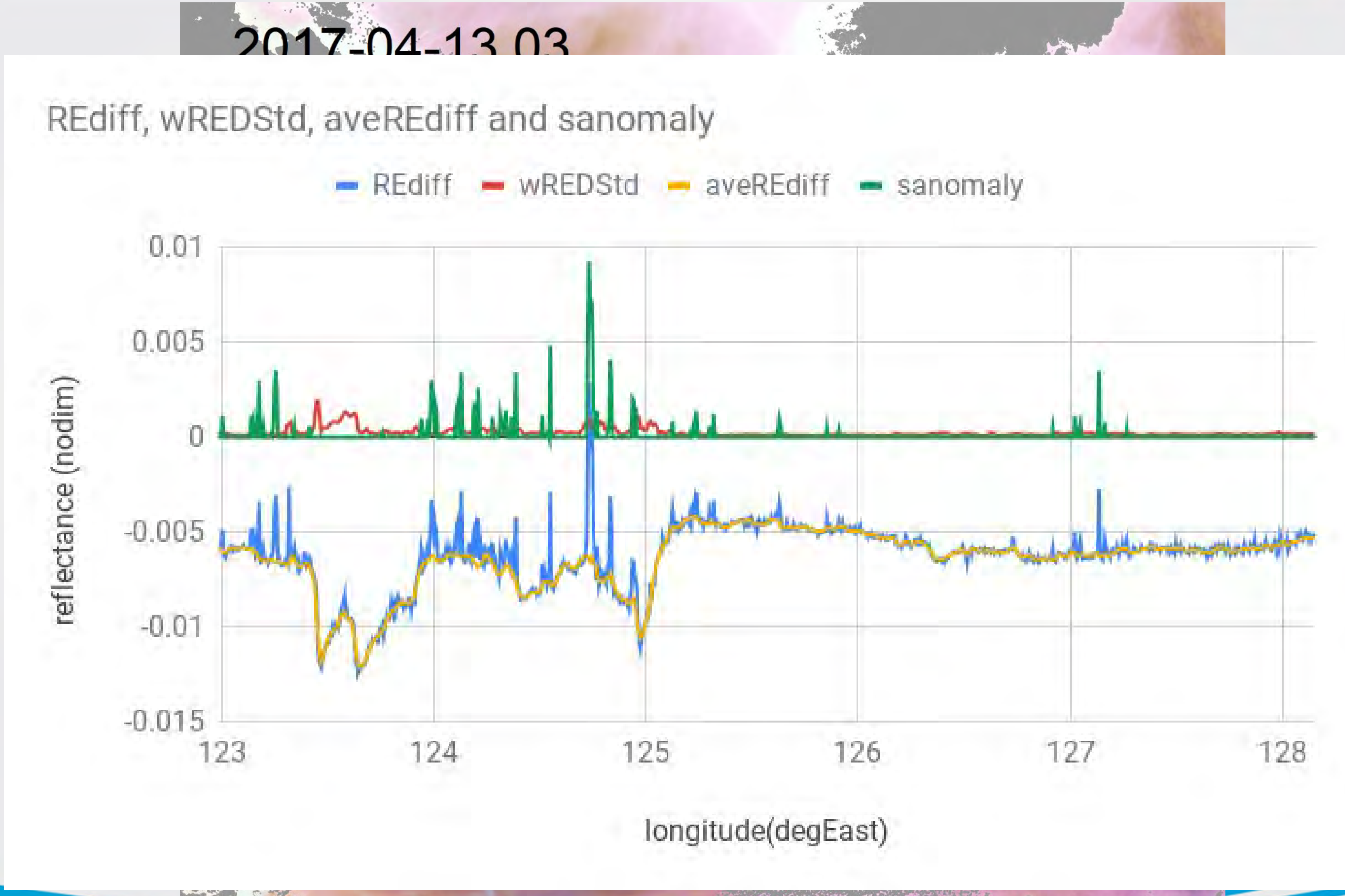
Background term varys depending on turbidity, sunglint and aerosol.

where

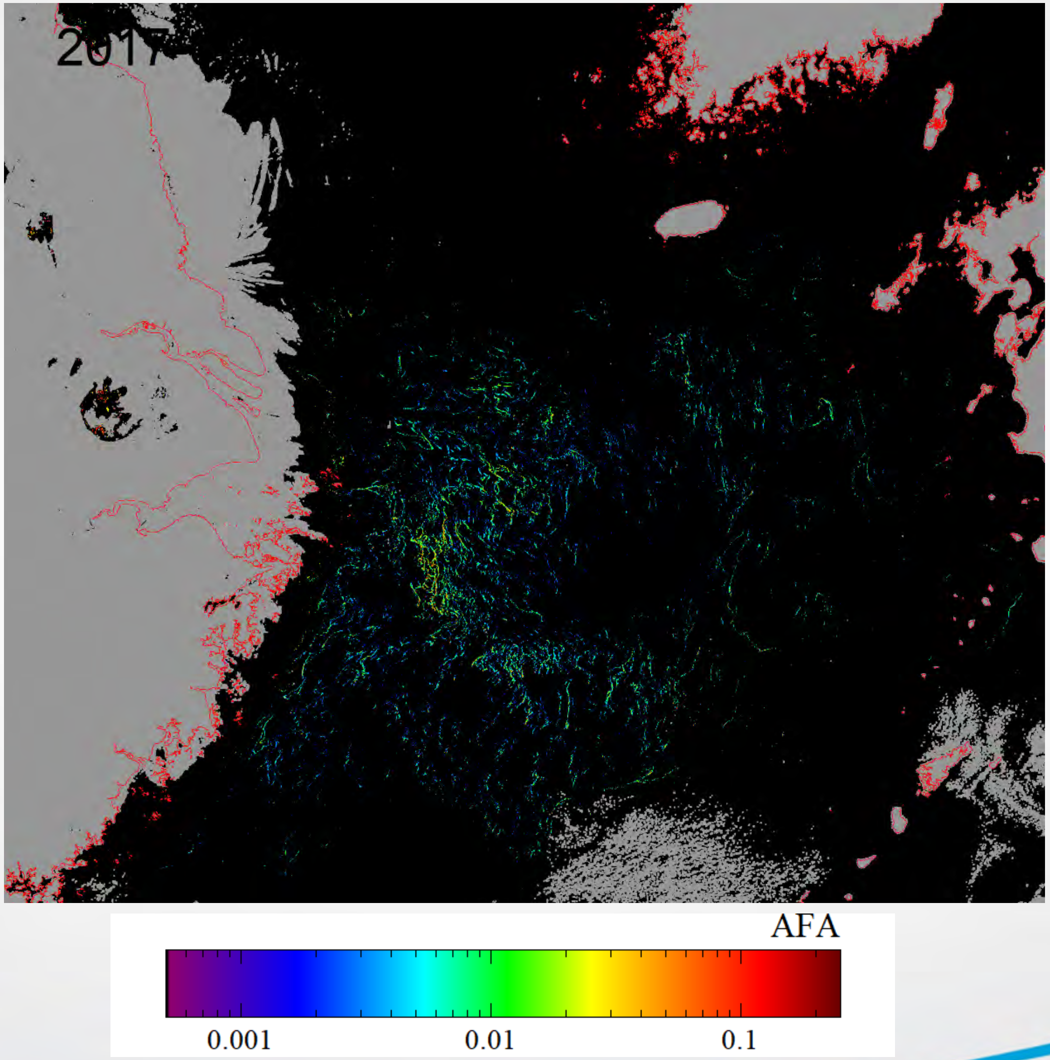
$$\Delta\rho_A = T(\lambda_n)\widetilde{\rho_A}(\lambda_n) - T(\lambda_r)\widetilde{\rho_A}(\lambda_r)$$

Example: Image of 12hr 13. April 2017




2017-04-13 03
REdiff, wREDStd, aveREdiff and sanomaly
REdiff
wREDStd
aveREdiff
sanomaly
0.01
0.005
0
-0.005
-0.01
-0.015
reflectance (nodim)
123
124
125
126
127
128
longitude(degEast)

Algae covered fractional area for the 12hr 13. April 2017 image



In reality: tricky points

- How to determine 'algae-free' & 'cloud-free' water pixels for computing background term

- Spatial anomaly for a pixel can be high for various reasons e.g. due to boat, cloud edge, turbidity variation. A post selection step is required.

- These points determine success or failure of the process

Retrieval of spectrum for algae reflectance

Satellite measured reflectance (α: fractional area)

$$\rho(\lambda) = (1-\alpha)\rho_W(\lambda) + \alpha\rho_A(\lambda) + \rho_{path}(\lambda)$$

Subtracting the reflectance of algae-fee background,

$$\rho(\lambda)|_{\alpha=0} = \rho_W(\lambda) + \rho_{path}(\lambda)$$

We get spatial anomaly reflectance:

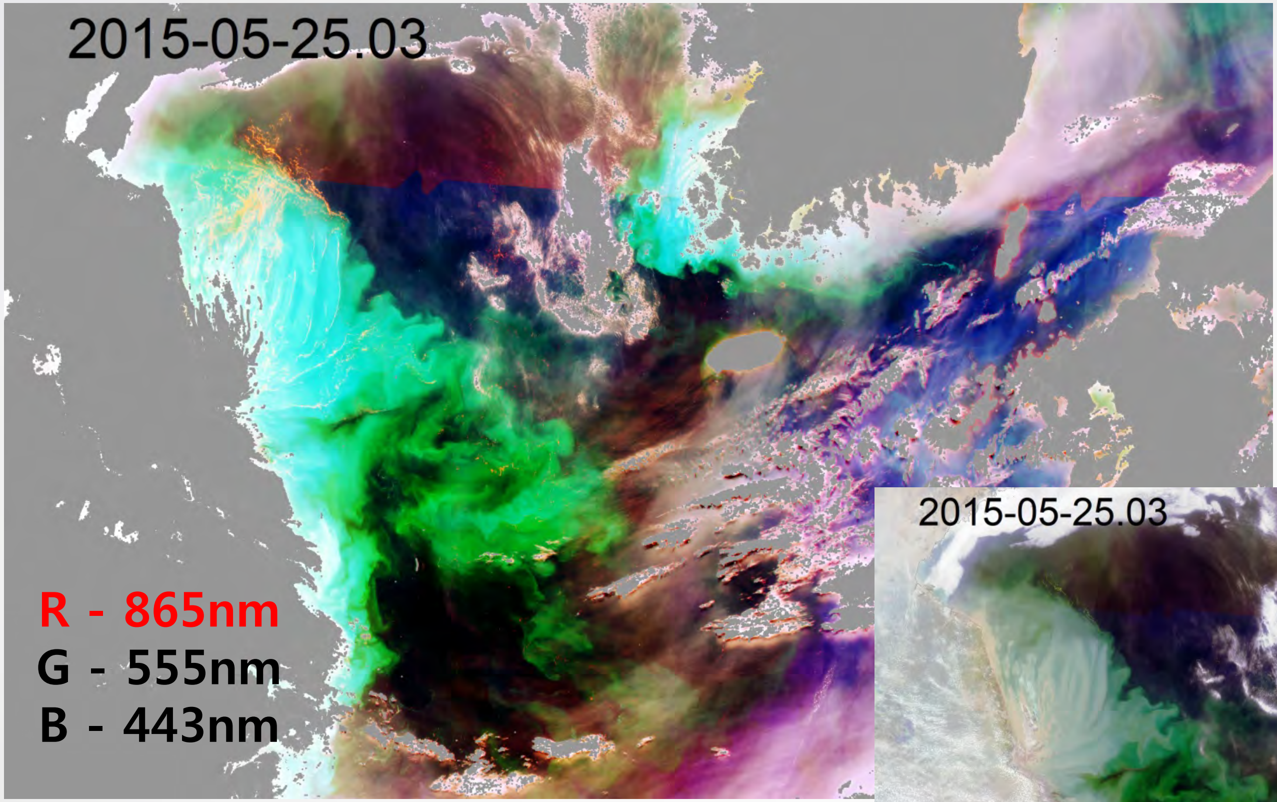
$$[\Delta\rho(\lambda)]_S \equiv \rho(\lambda) - \rho(\lambda)|_{\alpha=0} = \alpha(\rho_A(\lambda) - \rho_W(\lambda))$$

Finally, algal reflectance in a pixel:

$$\alpha\rho_A(\lambda) = [\Delta\rho(\lambda)]_S + \alpha\rho_W(\lambda))$$

Water reflectance can be obtained by atm corr for algae-free pixels

Image of 25. May 2015: RGB



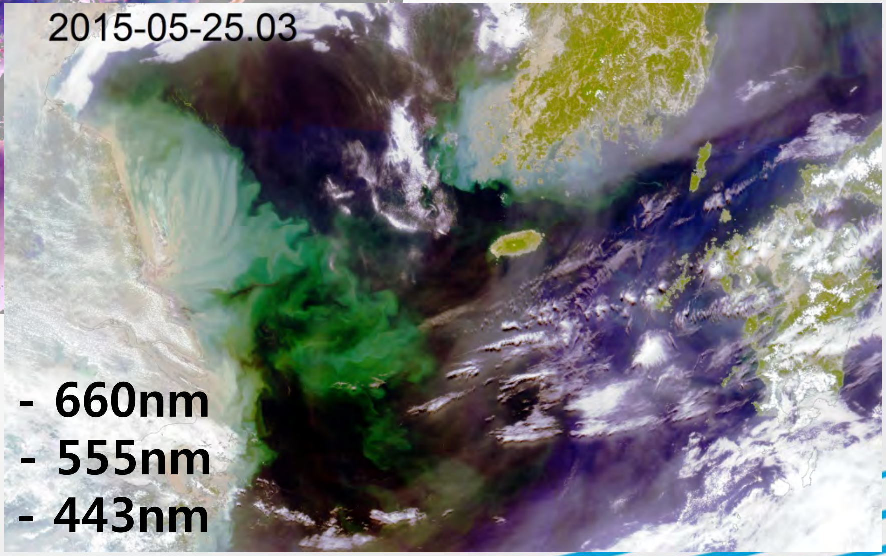
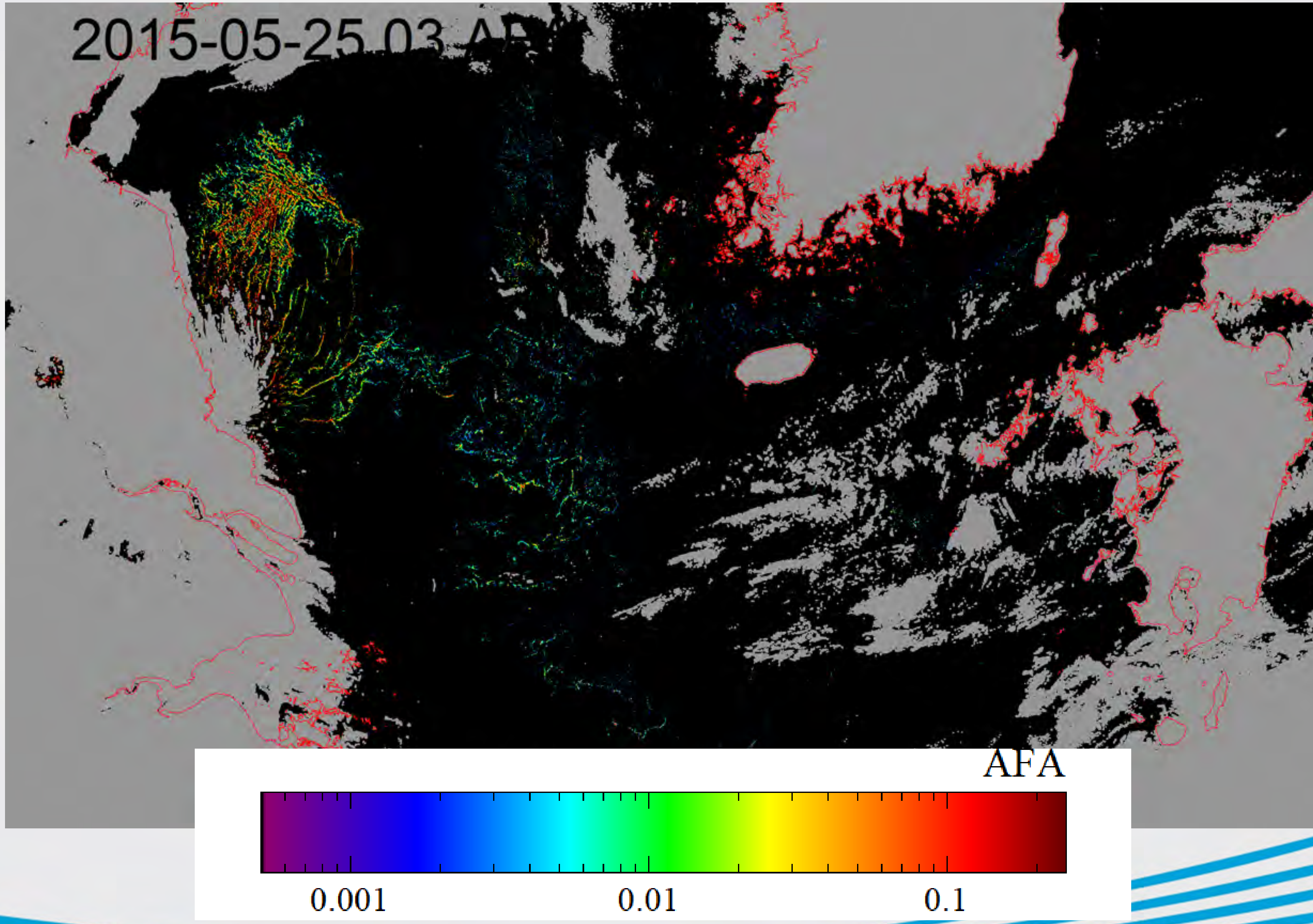
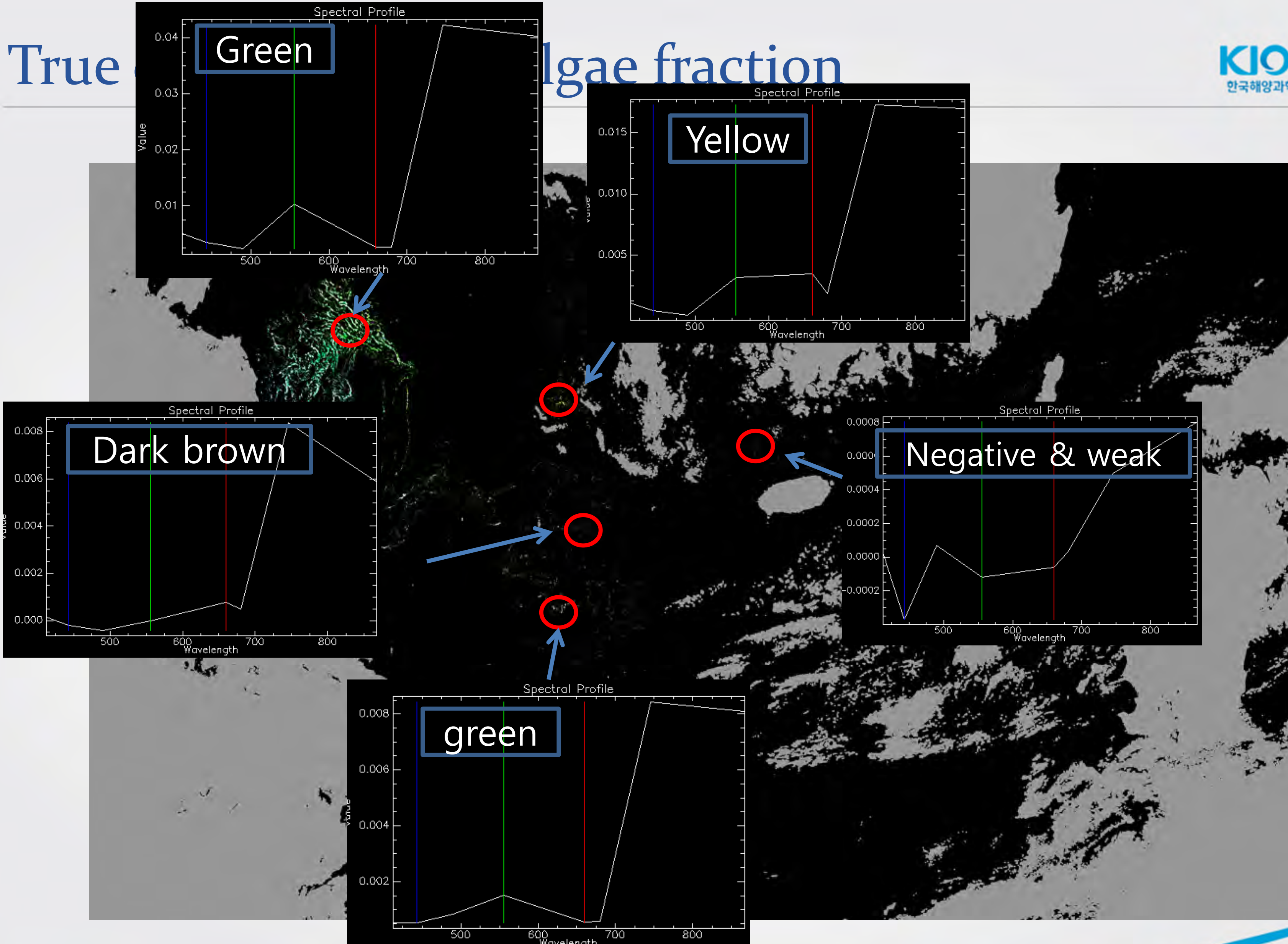


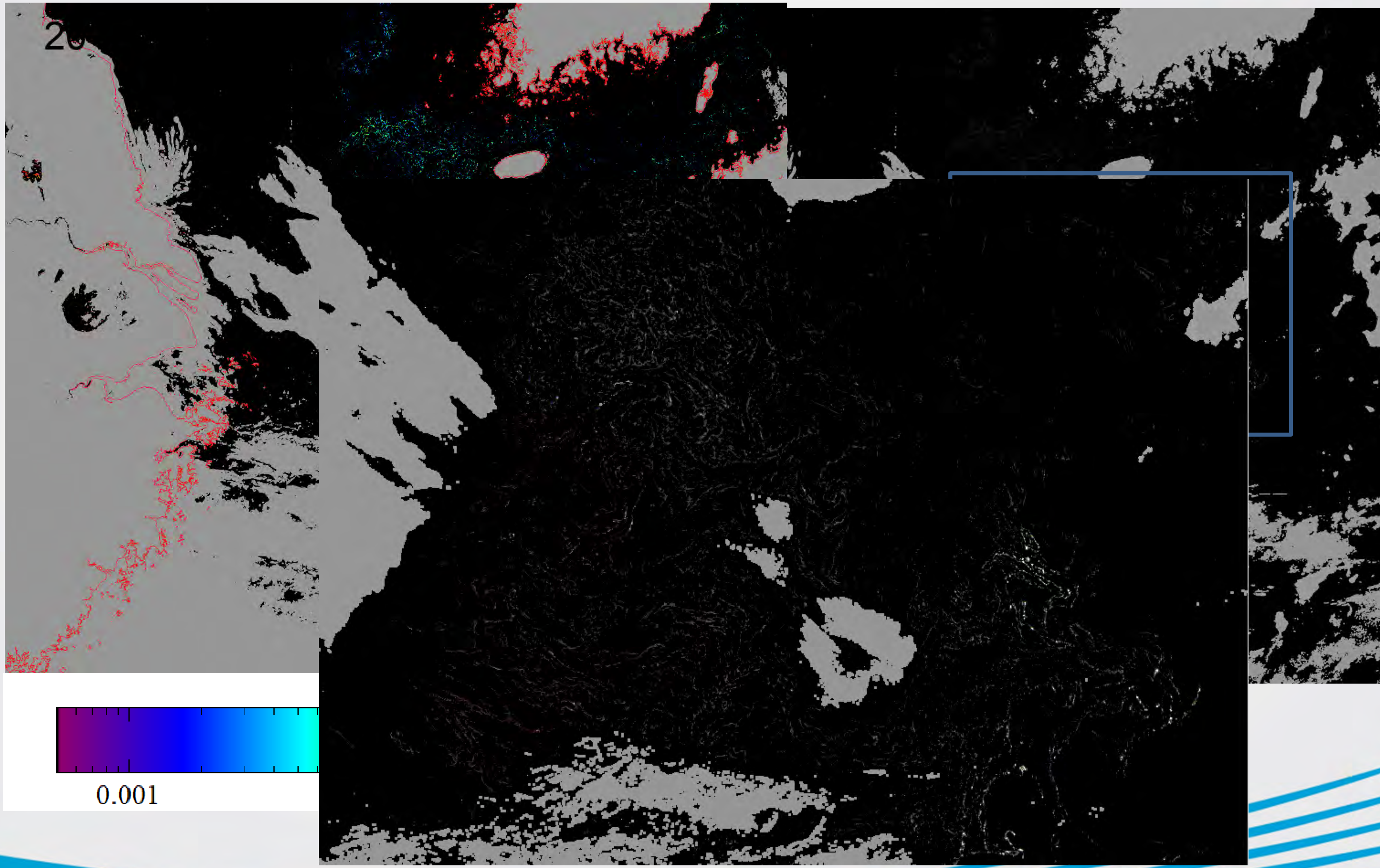
Image of 25. May 2015: algal cover fraction



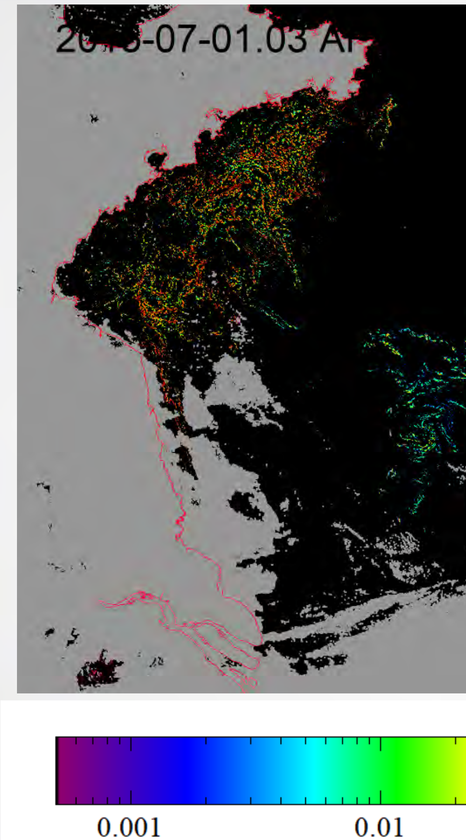
True lgae fraction

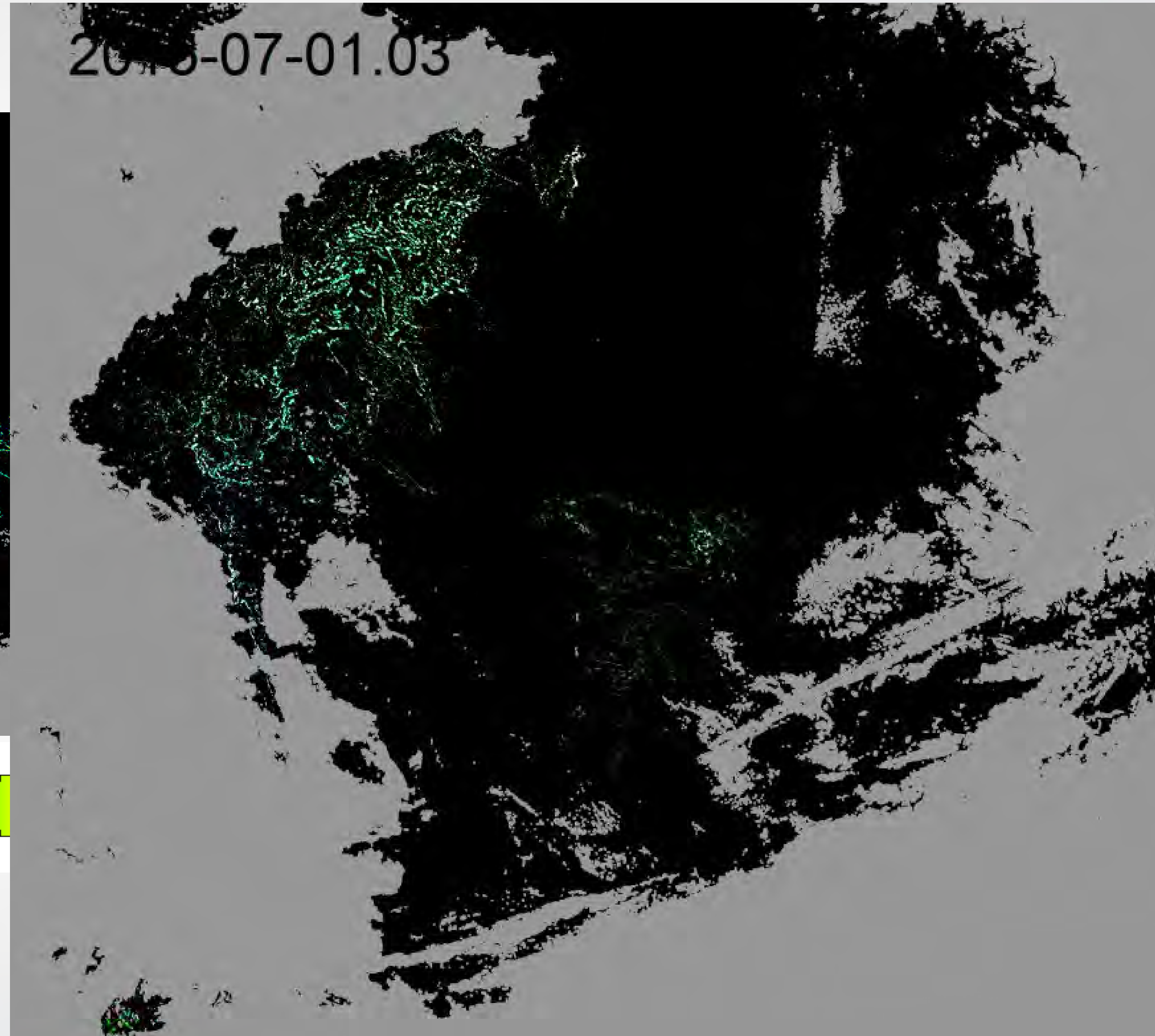


month earlier 25 April 2015 (L: AFA, R: true color image for algae)



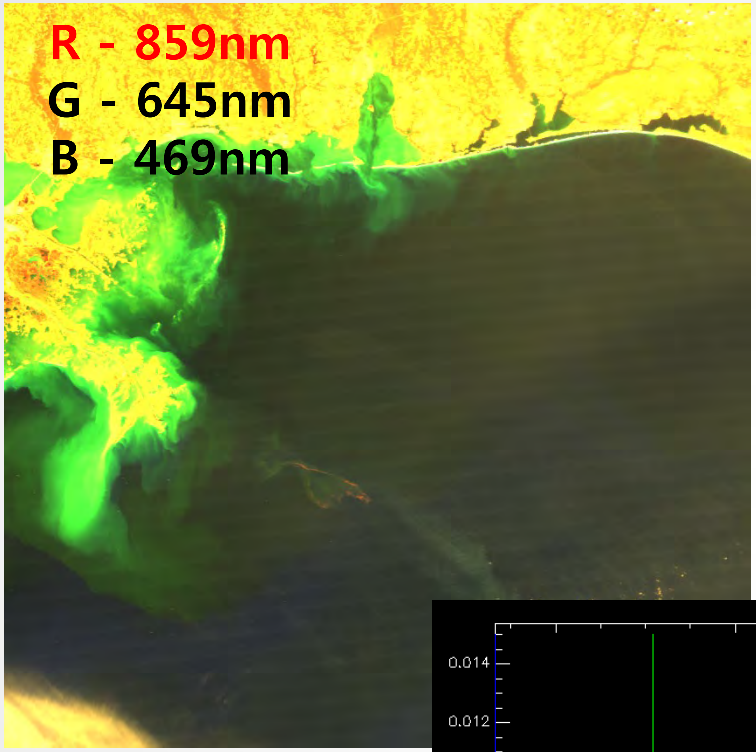
month later 01 July 2015 (L: AFA, R: true color image for algae)

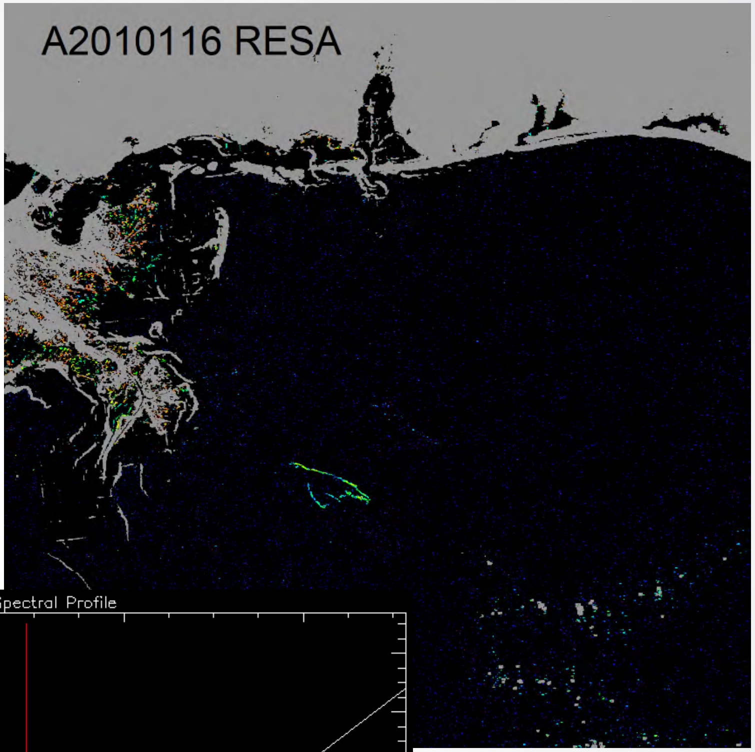


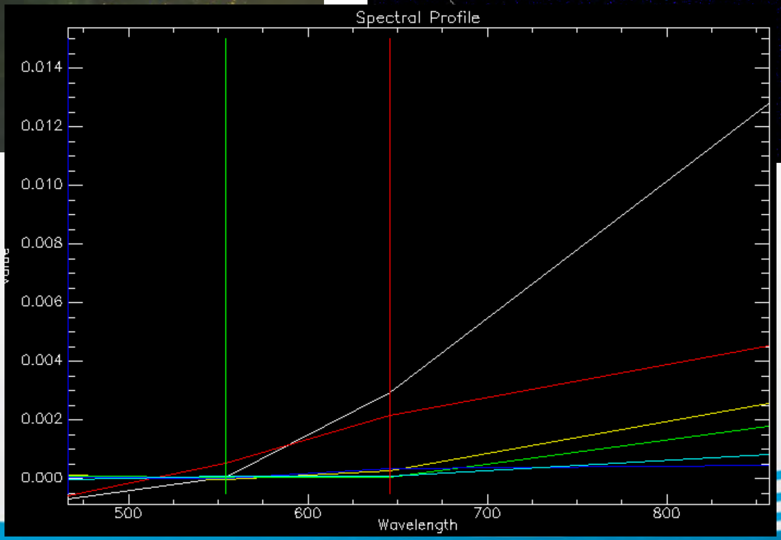


Will this spatial anomaly algorithm work for detection of other floating mater?

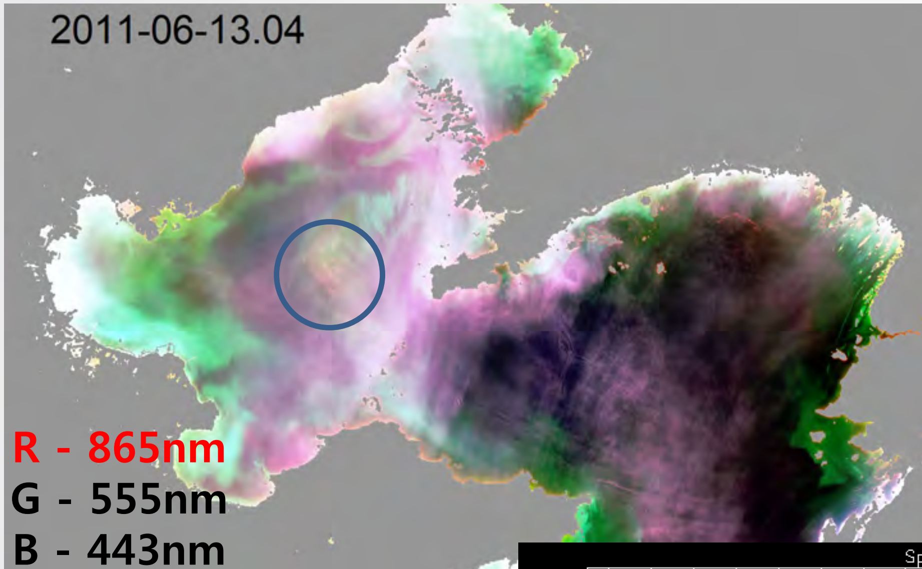
DWH Oil Spill MOD/Aqua image 26 April 2010

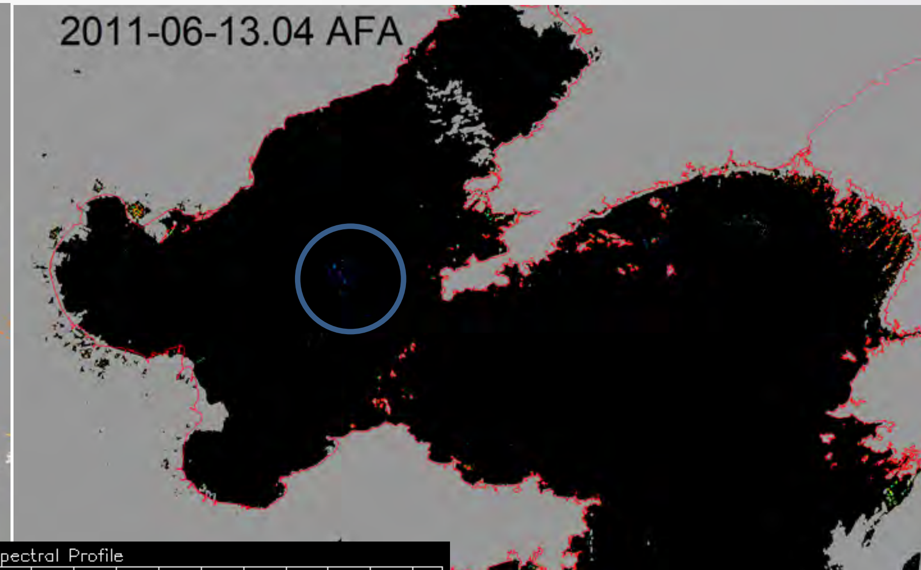


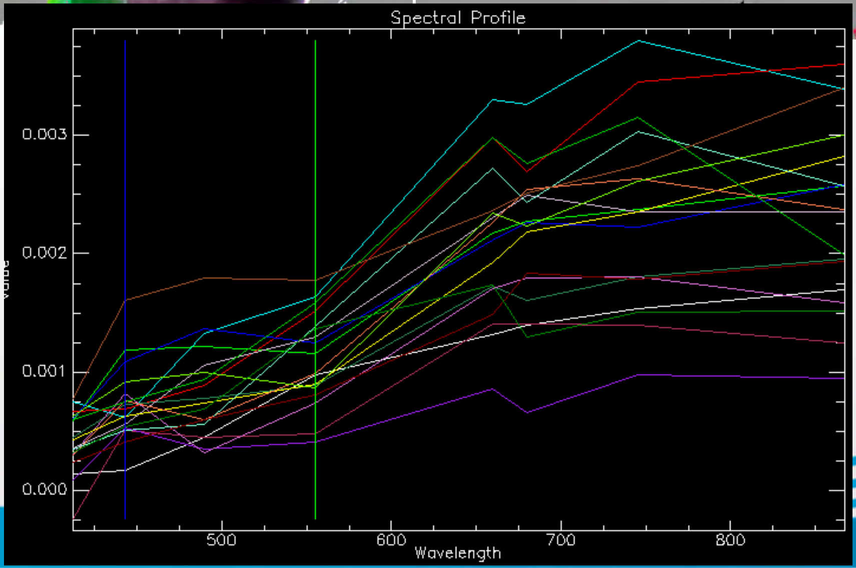




2011 Bohai Bay Oil Spill:
GOCI 13 June 2011 (false RGB, R: fractional area)







Drifting debris detection?

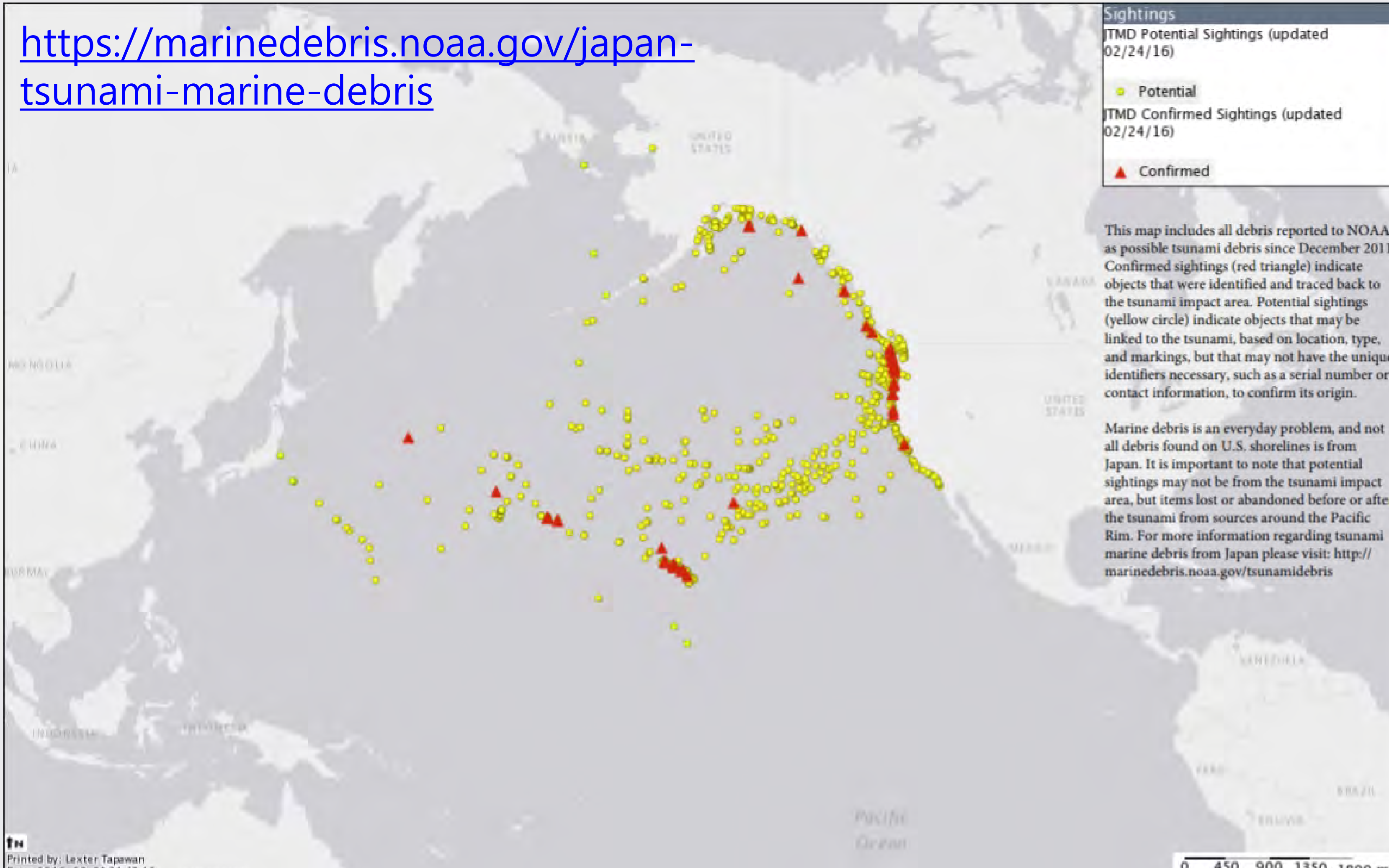
Floating debris detection: North Korea Dooman River flooding end of August 2016

Debris found on Oct. 2 in Uljin, South Korea

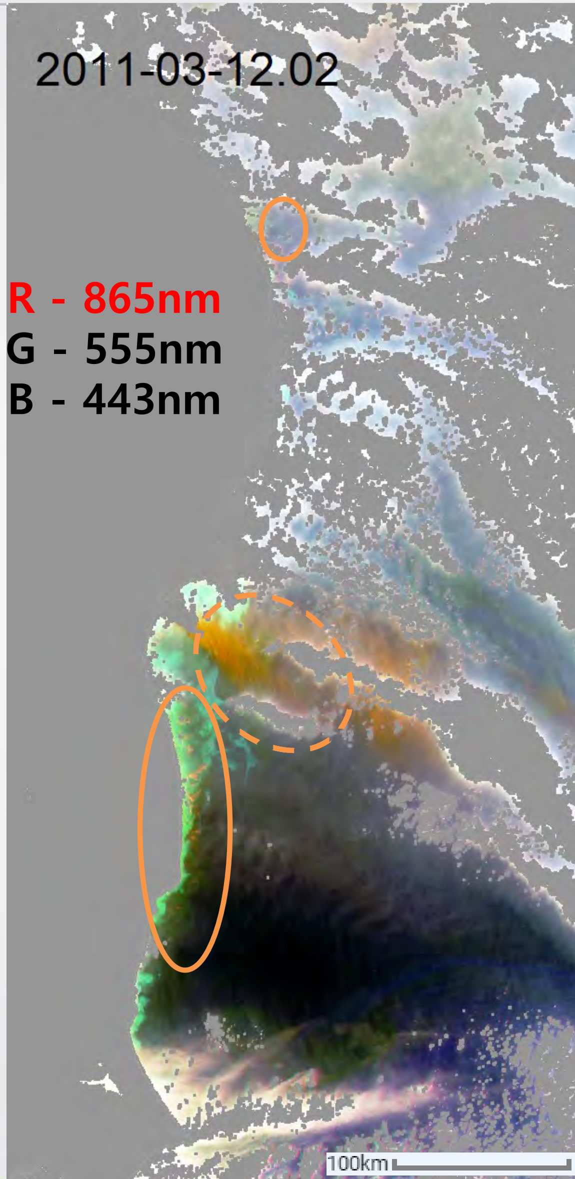
Landsat8/OLI image of Sep 01, 2006

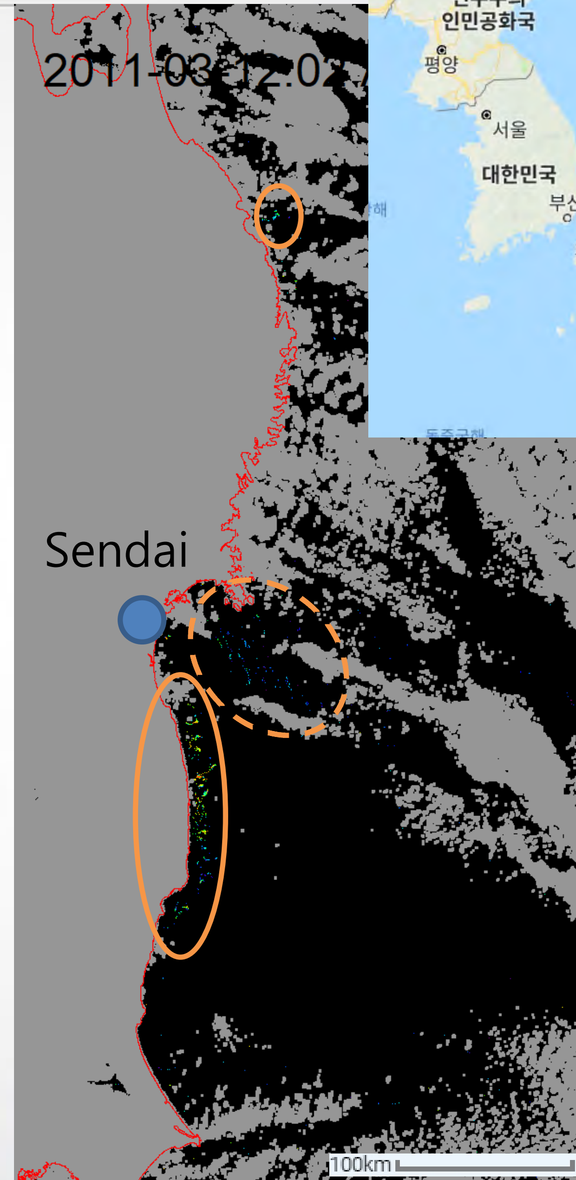
Marine Debris from 2011 East Japan Tsunami

https://marinedebris.noaa.gov/japan-tsunami-marine-debris

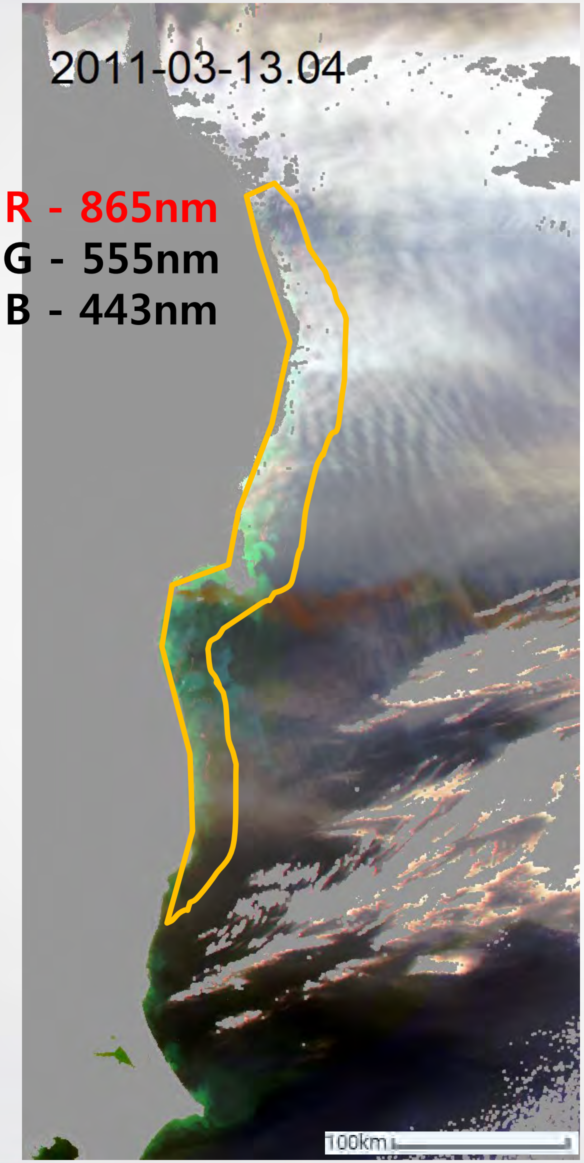


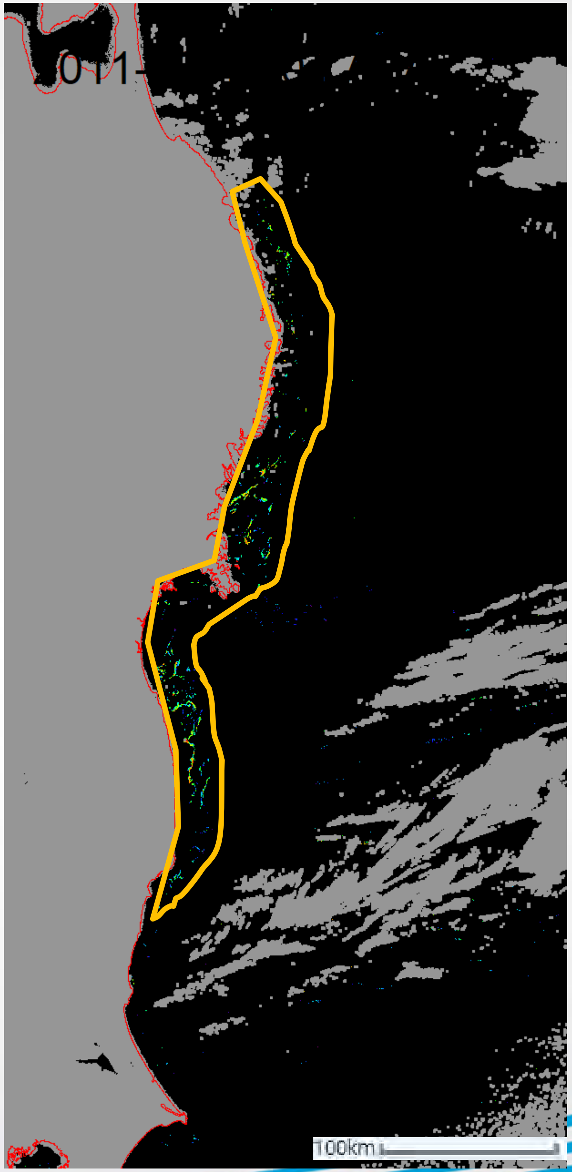
+1 day from the Earthquake Mar. 11 (R: a



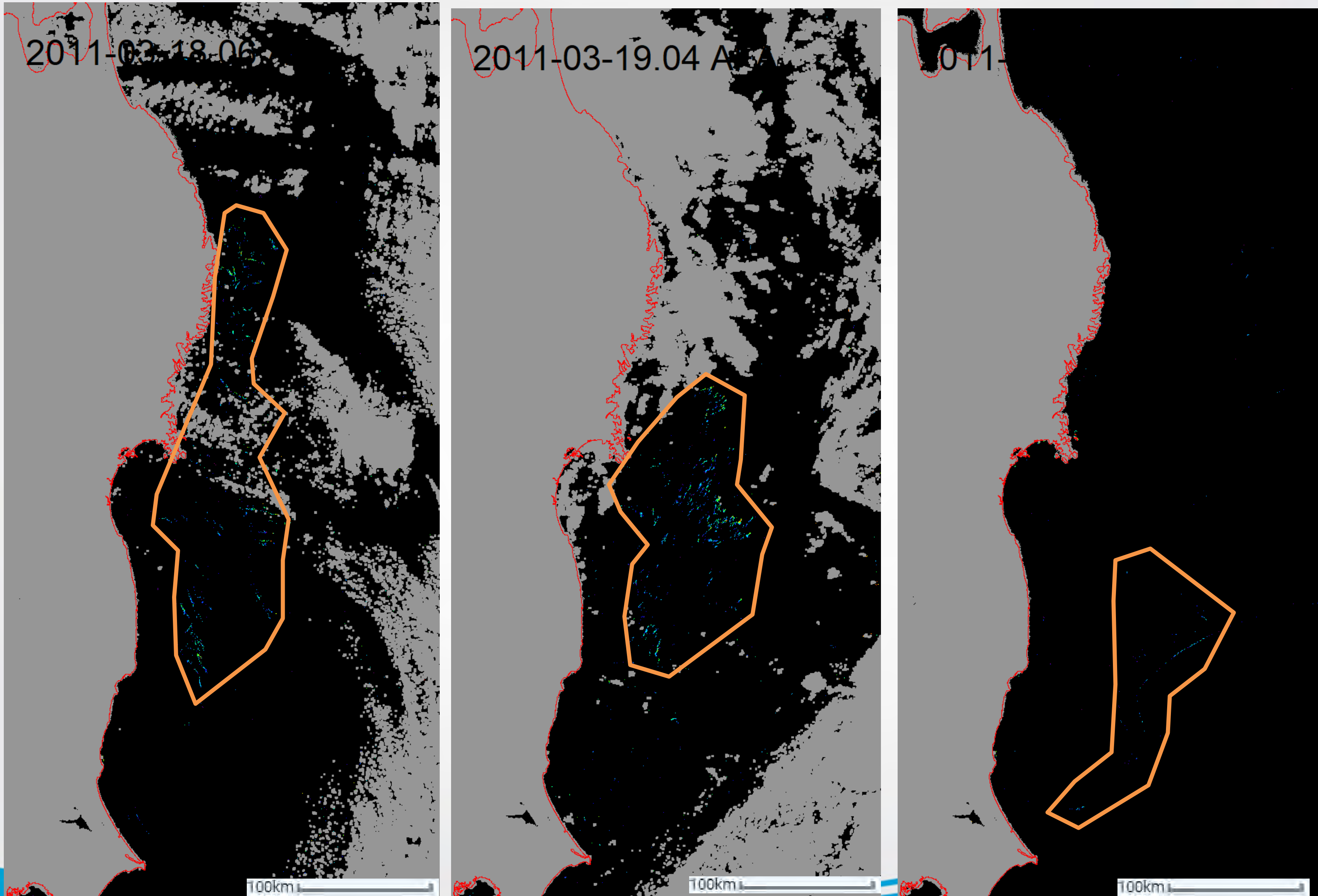


+2 days from 2011 Japan Earthquake





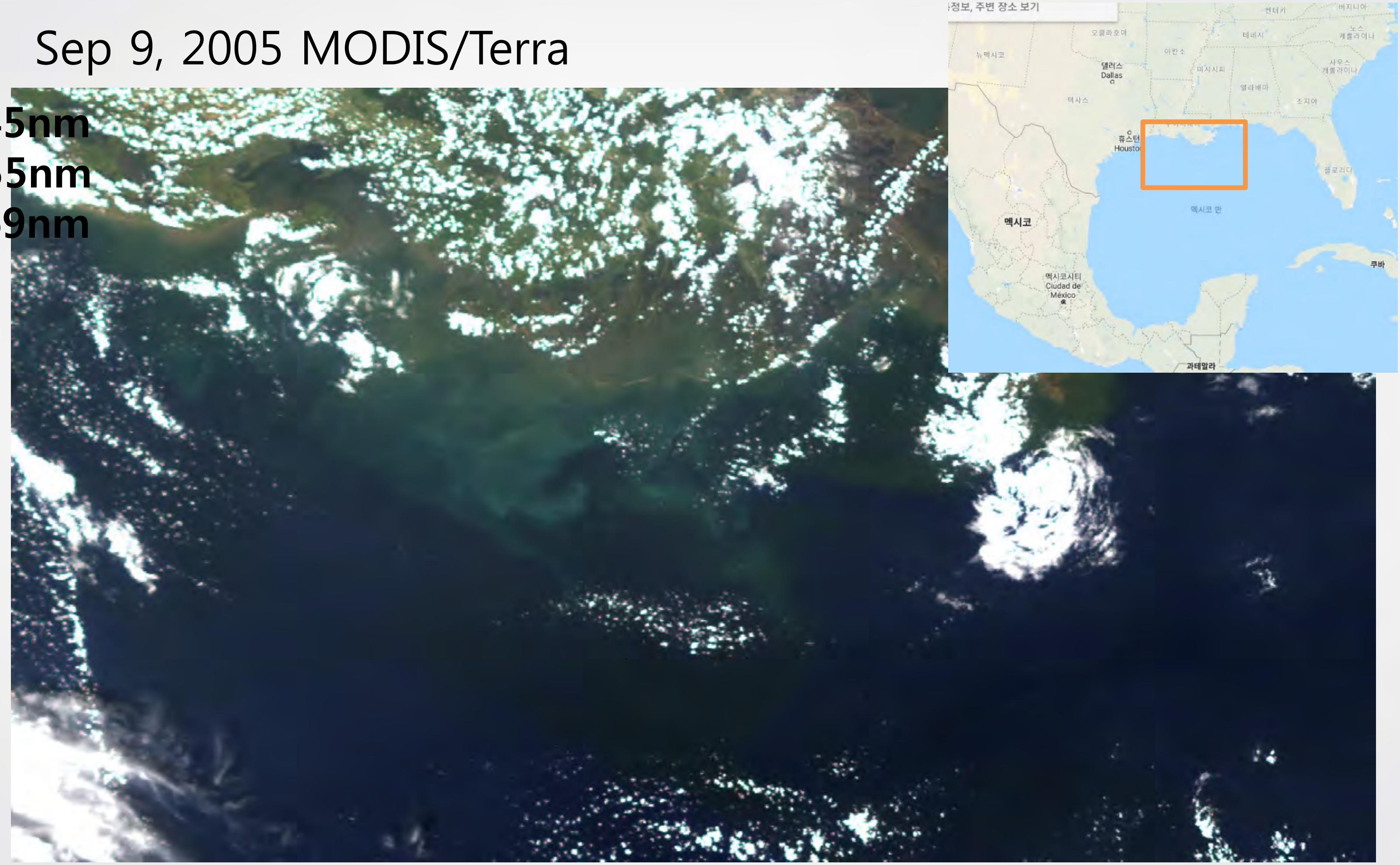
Mar 18, 19, .. up to Apr 6



Hurricane Katrina aftermath

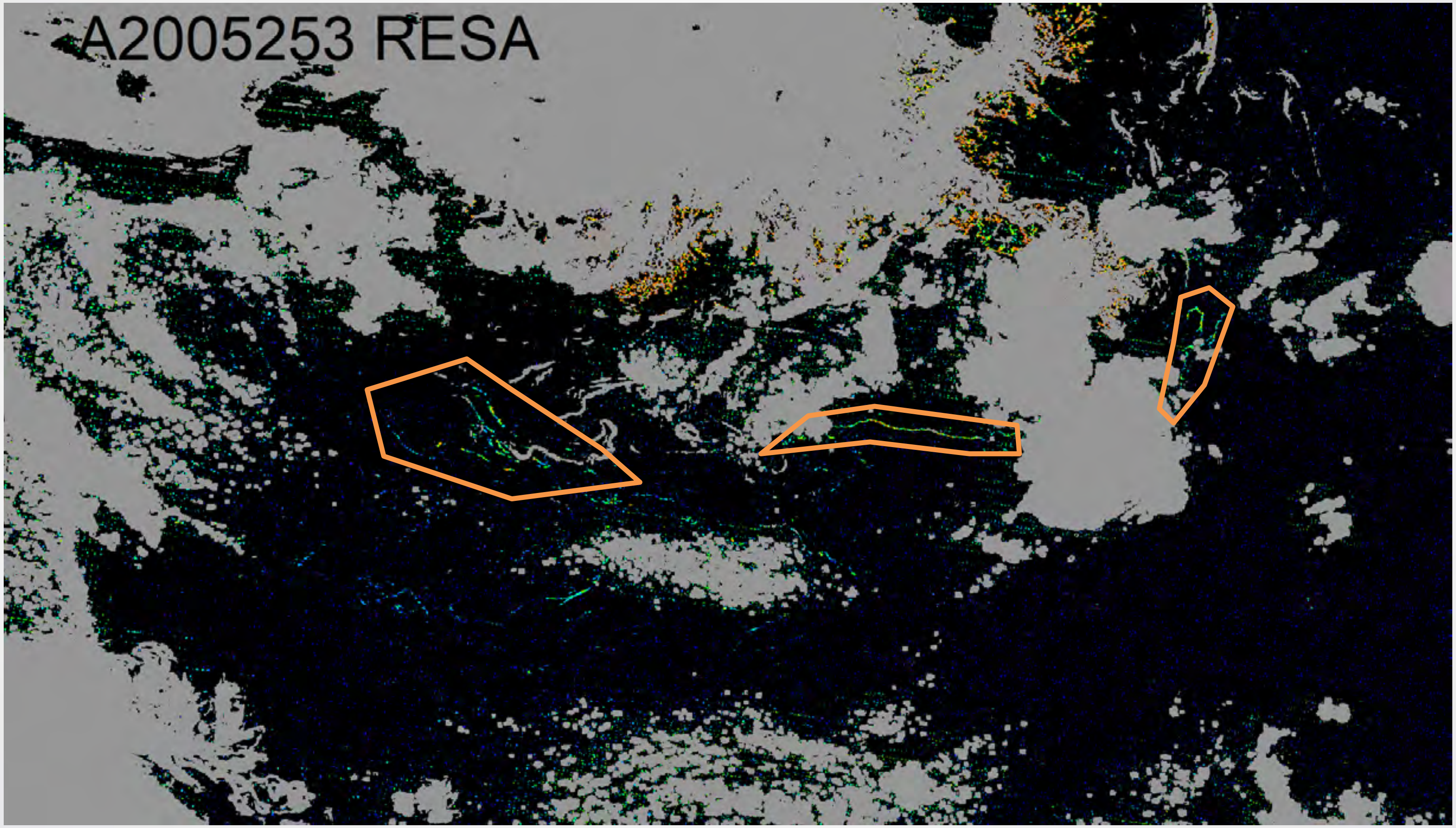
Sep 9, 2005 MODIS/Terra

R - 645nm
G - 555nm
B - 469nm



Hurricane Katrina debris?

Sep 9, 2005 MODIS/Terra



Discussion

- High density floating materials after disasters can be detected. How can we further go to detect the garbage patches in the Pacific gyre?

- GOCI and GOCI-II is one of the best satellite sensors for monitoring coastal waters and atmosphere in northeast Asia. But its spatial resolution (and spectral resolution) is not good enough to deal with complexity of coastal waters. Do we need much higher spatial resolution(20~50 meters) sensor in geo orbit?