Water Quality and Bio-optical Properties Measured from the Geostationary and Polar-orbiting Satellite Sensors in the Northwestern Pacific Region

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INTRODUCTION

The first geostationary ocean color satellite (GOCI) has the unique capability with hourly measurements during daytime to provide short-/long-term environmental monitoring in the marine ecosystem over the western Pacific region. In this presentation, we show results of GOCI-derived ocean color products from 2012 to 2019 using the Multi-Sensor Level-1 to Level-2 (MSL12) ocean color data processing system to characterize diurnal, seasonal, and interannual variations in water property. In addition, water quality and bio-optical products from the polar-orbiting ocean color satellite sensors, e.g., the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (SNPP) and the Ocean and Land Colour Instrument (OLCI) on the Sentinel-3A, derived using the MSL12 are compared with those from GOCI. Comparison results with the in-situ measurements from the two AERONET-OC sites located in the Yellow Sea show that over open oceans ocean color products are quite accurate and highly stable, and reasonable water property data can be derived over turbid coastal and inland waters. Furthermore, we show that GOCI measurements provide important diurnal information, while the polar-orbiting satellites provide large scale spatial coverages. Thus, measurements from the geo and polar-orbiting satellites are complementary to provide more complete picture/information of water optical, biological, and biogeochemical variations over the open ocean and coastal/inland waters.

DATA & METHODS

- The Multi-Sensor Level-1 to Level-2 (**MSL12**) ocean color data processing system has been used for VIIRS, OLCI, and GOCI data processing.
- Various parameters and lookup tables are generated, and a new atmospheric correction algorithm has been developed and implemented in MSL12 for GOCI data processing in the region (*Wang et al.*, 2012, 2013).
- GOCI and OLCI Level-1B data were processed to derive Level-2 ocean color products using the new atmospheric correction algorithm (*Jiang & Wang*, 2014).
- VIIRS ocean color Environmental Data Records (EDR or Level-2 data) were processed from the VIIRS science quality Sensor Data Records (SDR or Level-1B data) routinely using MSL12 with the NIR-SWIR combined atmospheric correction algorithm (*Wang & Shi*, 2007).

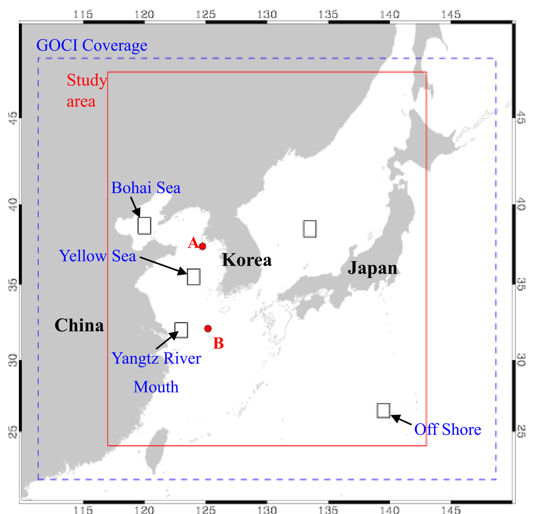

Fig. 1. Study map with two AERONET-OC sites (A-Ieodo, B-Socheongcho).

Performance of GOCI Ocean Color Products

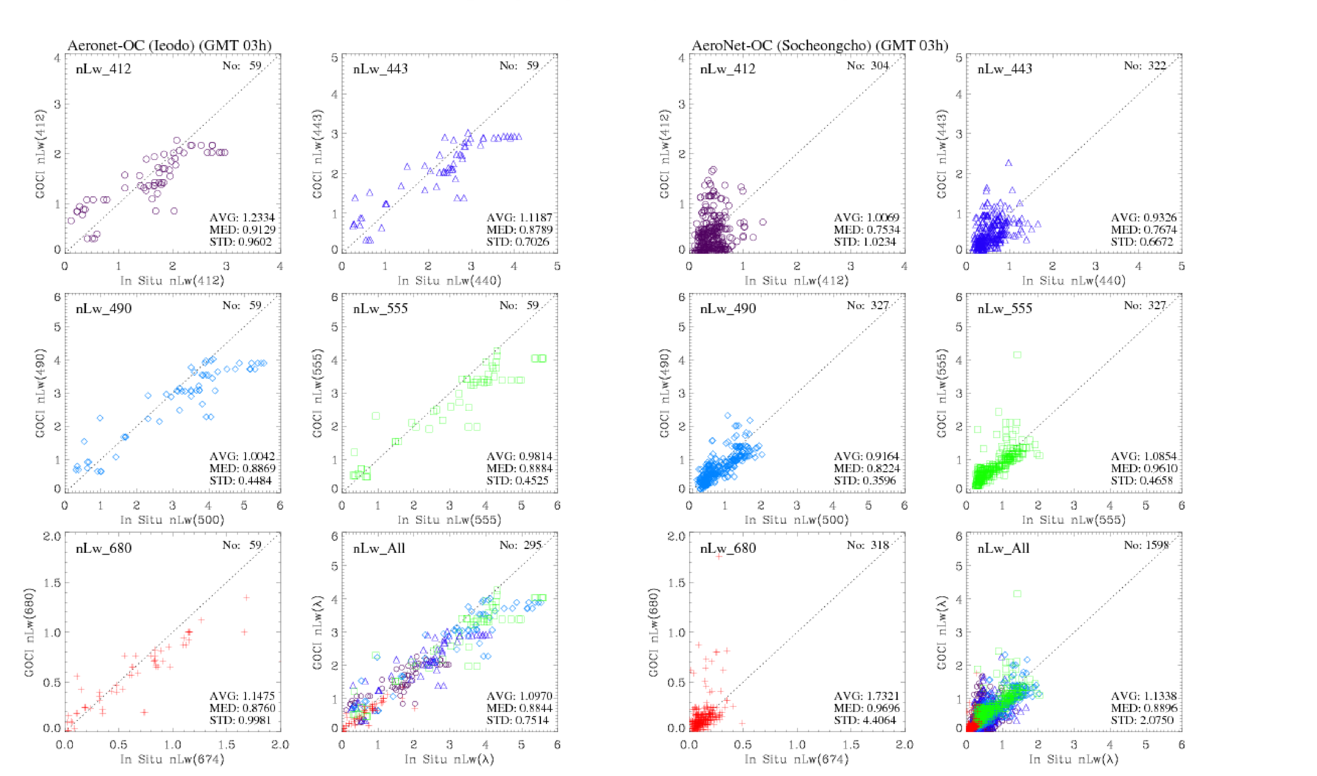

Fig. 2. Comparison of GOCI-derived $nL_w(\lambda)$ with *in situ* measurements.

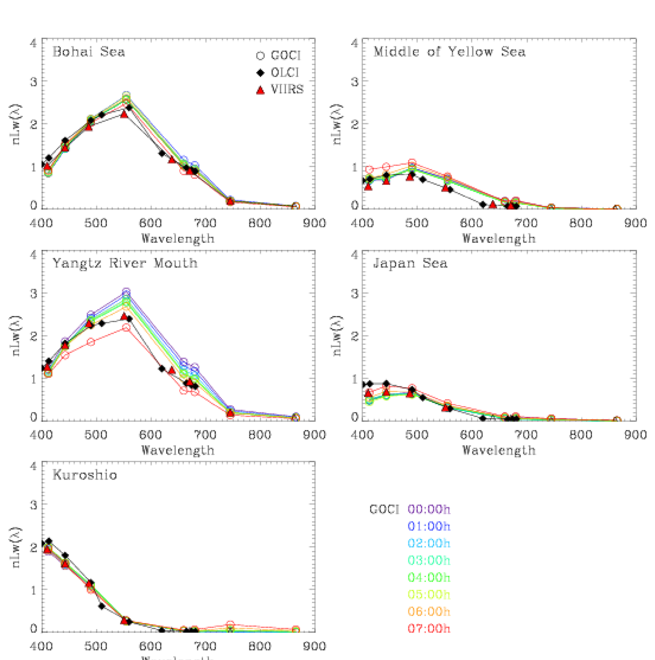

Fig. 3. $nL_w(\lambda)$ spectra from GOCI & VIIRS (Jan. 2012–Dec 2019), & OLCI (May 2016–Dec 2019) climatology composites in the five boxes shown in Fig. 1.

- Comparison results show that the GOCI-derived $nL_w(\lambda)$ data are reasonably well corresponding to the in situ measurements in the optically complex waters (Fig. 2), which are similar to those with VIIRS data.
- $nL_w(\lambda)$ spectra from GOCI (at noon), VIIRS, and OLCI climatology composites are similar in the five areas (Bohai Sea, middle of Yellow Sea, Yangtze river mouth, Japan/East Sea, and off shore waters) (Fig. 3).

GOCI, VIIRS, and OLCI Climatology Images

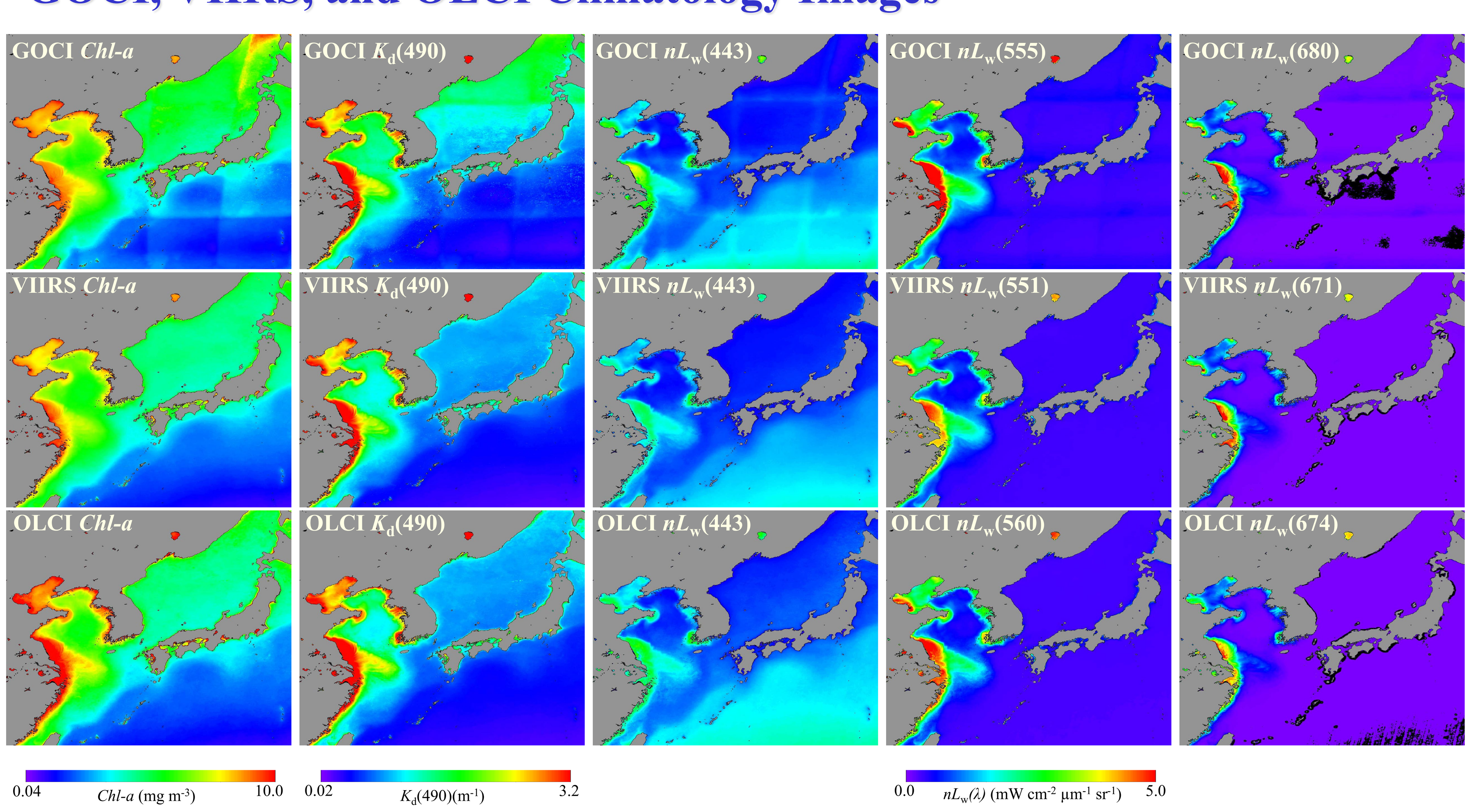

Fig. 4. Climatology Chl-a, $K_d(490)$, & $nL_w(\lambda)$ images of GOCI at noon & VIIRS (Jan 2012-Dec 2019), & OLCI (May 2016-Dec 2019).

- Overall, the GOCI-derived ocean color images are generally very similar to those from VIIRS and OLCI.
- However, there is still the boundary issue between slots in GOCI data, and significantly high values appear in the northern area in the GOCI-derived Chl-a images.

GOCI-, VIIRS-, and OLCI-derived Chl-a Seasonal Images

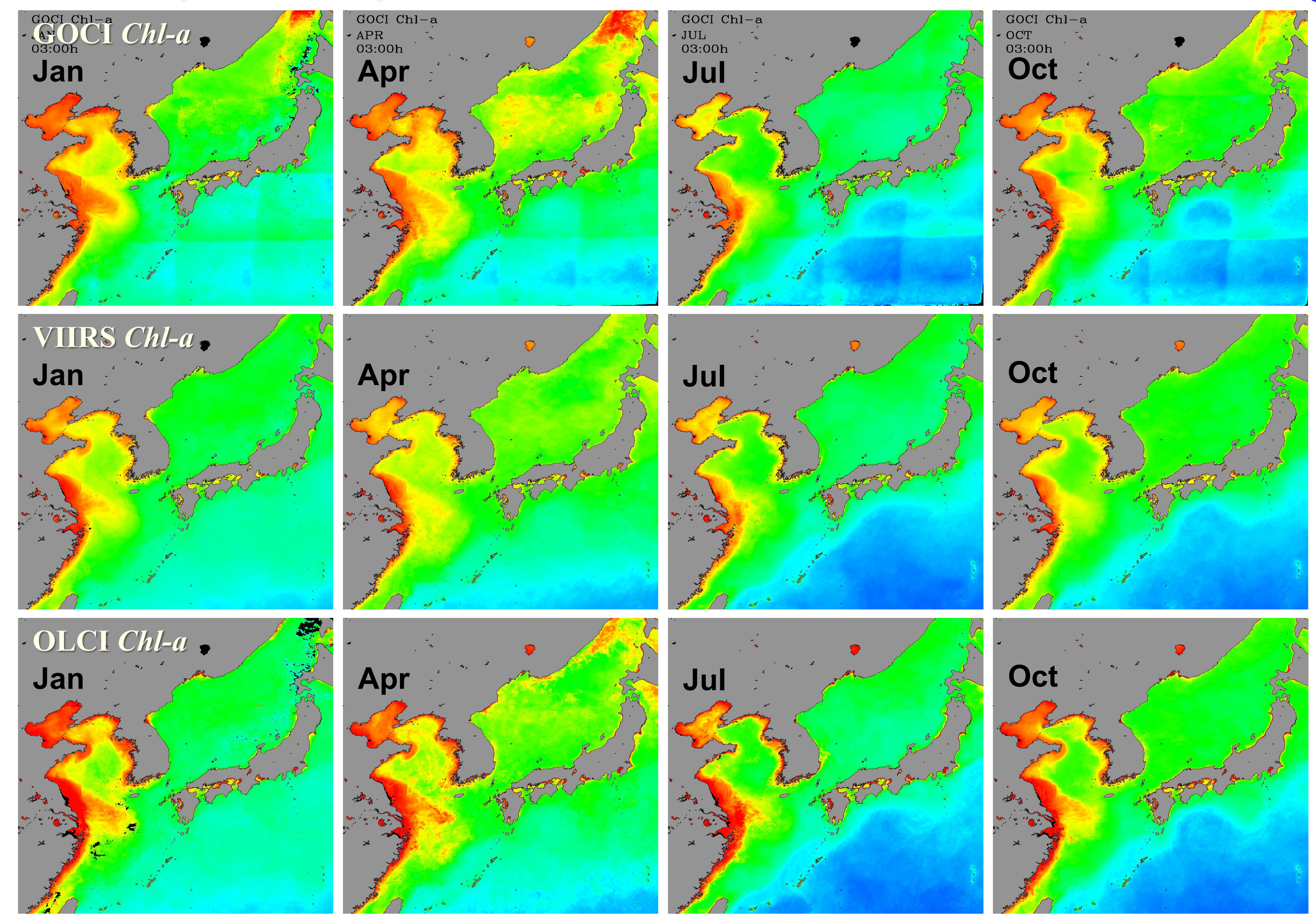

Fig. 5. Climatology monthly images of GOCI- & VIIRS- (Jan. 2012–Dec. 2019) and OLCI-derived (May 2016–Dec. 2019) Chl-a. GOCI images are at the local noon.

- GOCI-, VIIRS-, and OLCI-derived Chl-a images show similar seasonal and spatial distributions over the Northwestern Pacific Ocean.
- In general, Chl-a values are high in spring and low in summer in most waters.

Interannual Variation of GOCI-, VIIRS-, and OLCI-derived Products

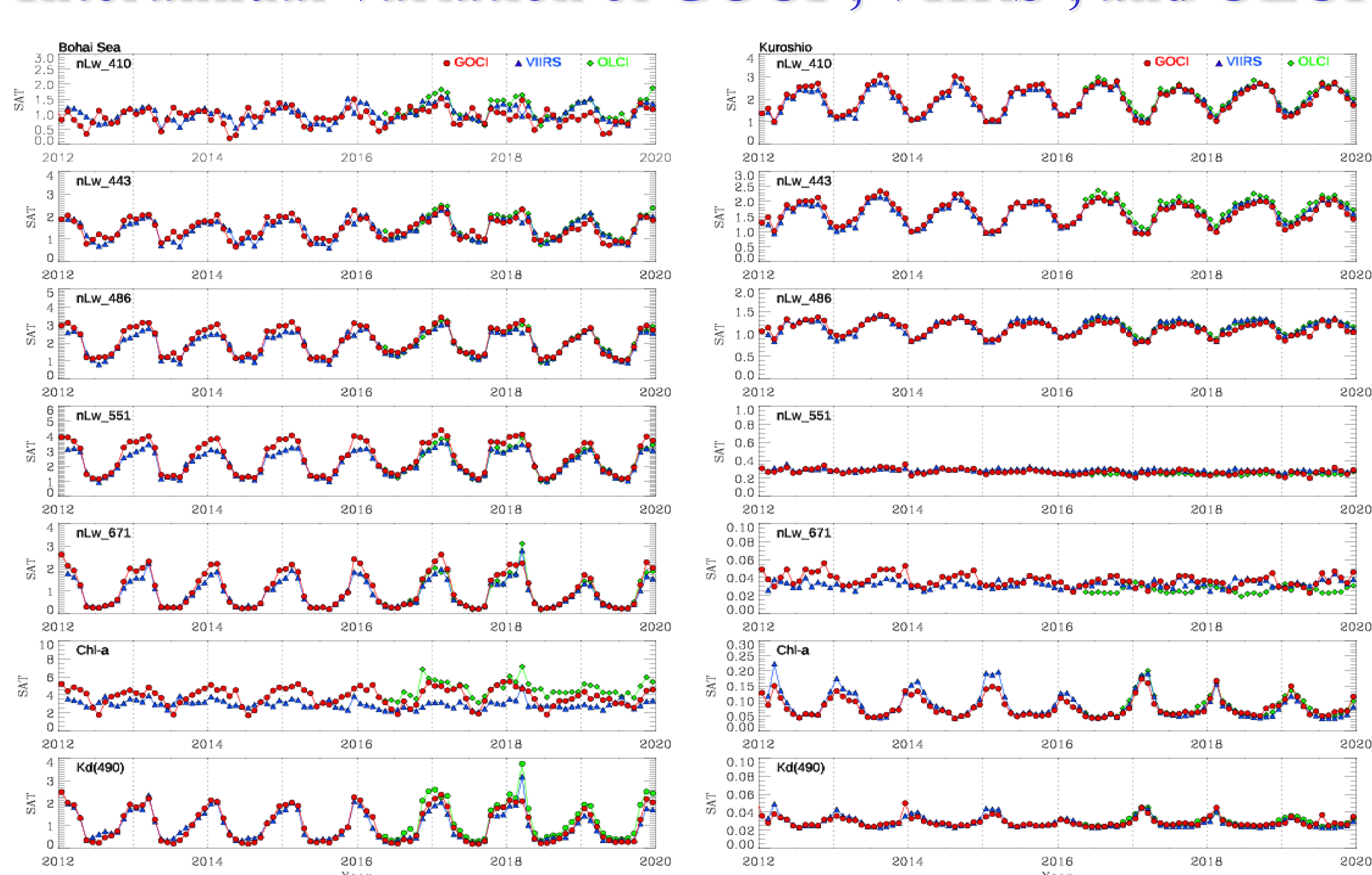

Fig. 6. Time series of GOCI-, VIIRS-, & OLCI-derived mean monthly ocean color products in highly turbid waters (Bohai Sea, left column) and the clear open ocean water (off coasts, right column).

- GOCI-, VIIRS-, and OLCI-derived ocean color products show the strong interannual variability in both highly turbid and clear open ocean waters.
- The monthly mean values are quite consistent in most of the ocean color products from the three sensors. However, there are still some discrepancies in $nL_w(\lambda)$ at blue bands and Chl-a data from GOCI, VIIRS, and OLCI data.

SUMMARY

- The GOCI ocean color products for the GOCI coverage region have been derived using an iterative NIR-water reflectance corrected atmospheric correction algorithm (i.e., the BMW algorithm from *Jiang and Wang* (2014)). Time series of the monthly composite images were produced for the entire GOCI region.
- VIIRS and OLCI ocean color products were also generated using MSL12 with the NIR-SWIR combined and NIR atmospheric correction algorithms, respectively. The VIIRS and OLCI ocean color data over the entire GOCI coverage region were compared with the GOCI ocean color data.
- Matchup results show that GOCI ocean color data are reasonably well correlated to the in situ optical measurements in the Korean coastal waters.
- In general, the temporal and spatial patterns of the GOCI-derived ocean color products are comparable to those from VIIRS and OLCI although there are still some differences. More efforts are required to improve the VIIRS, OLCI, and GOCI ocean color data quality over highly turbid coastal/inland waters.

Reference:

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Acknowledgments: The GOCI Level-1B data study were provided by Korea Institute of Ocean Science & Technology (KIOST) and in situ data were obtained from the NASA AERONET-OC sites. This study was supported by the NOAA Product Development, Readiness, and Application (PDRA)/Ocean Remote Sensing (ORS) Program funding and JPSS funding.