Seasonal and Interannual Variations in Water Optical and Biogeochemical Properties Measured by the Geostationary Ocean Color Imager (GOCI)

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ABSTRACT

The first geostationary ocean color satellite sensor, Geostationary Ocean Color Imager (GOCI), which is onboard South Korean Communication, Ocean, and Meteorological Satellite (COMS), was launched in June 2010 and has 8 spectral bands covering 412-865 nm. GOCI can monitor and measure ocean phenomenon over a local area of the western Pacific region.

In collaboration with Korean scientists, the NOAA team has produced improved GOCI ocean color products. The GOCI-derived ocean color data can be used to effectively monitor ocean phenomenon in the region such as tide-induced re-suspension of sediments, diurnal variation of ocean optical and biogeochemical properties, and horizontal advection of river discharge.

In this presentation, we use four-year GOCI ocean color data to characterize seasonal and interannual variations in water optical and biogeochemical properties in the western Pacific region. In addition, some extensive results of GOCI-measured ocean diurnal variations are shown in various coastal regions of the Bohai Sea, Yellow Sea, and East China Sea. With possibly eight-time measurements daily, GOCI provides a unique capability to monitor the ocean environments in near-real-time, and GOCI data can be used to address the diurnal variability in the ecosystem of the GOCI coverage region. The GOCI results demonstrate that GOCI can effectively provide real-time monitoring of water optical, biological, and biogeochemical variability of the ocean ecosystem in the region.

DATA & METHODS

- NOAA Multi-Sensor Level-1 to Level-2 (NOAA-MSL12) data processing has been used for the 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).
- GOCI Level-1B data (March 2011– November 2014) were obtained from the Korea Ocean Satellite Center and processed to derive Level-2 ocean color products using the new atmospheric correction algorithm (*Wang et al*., 2013).

GOCI Climatology Images

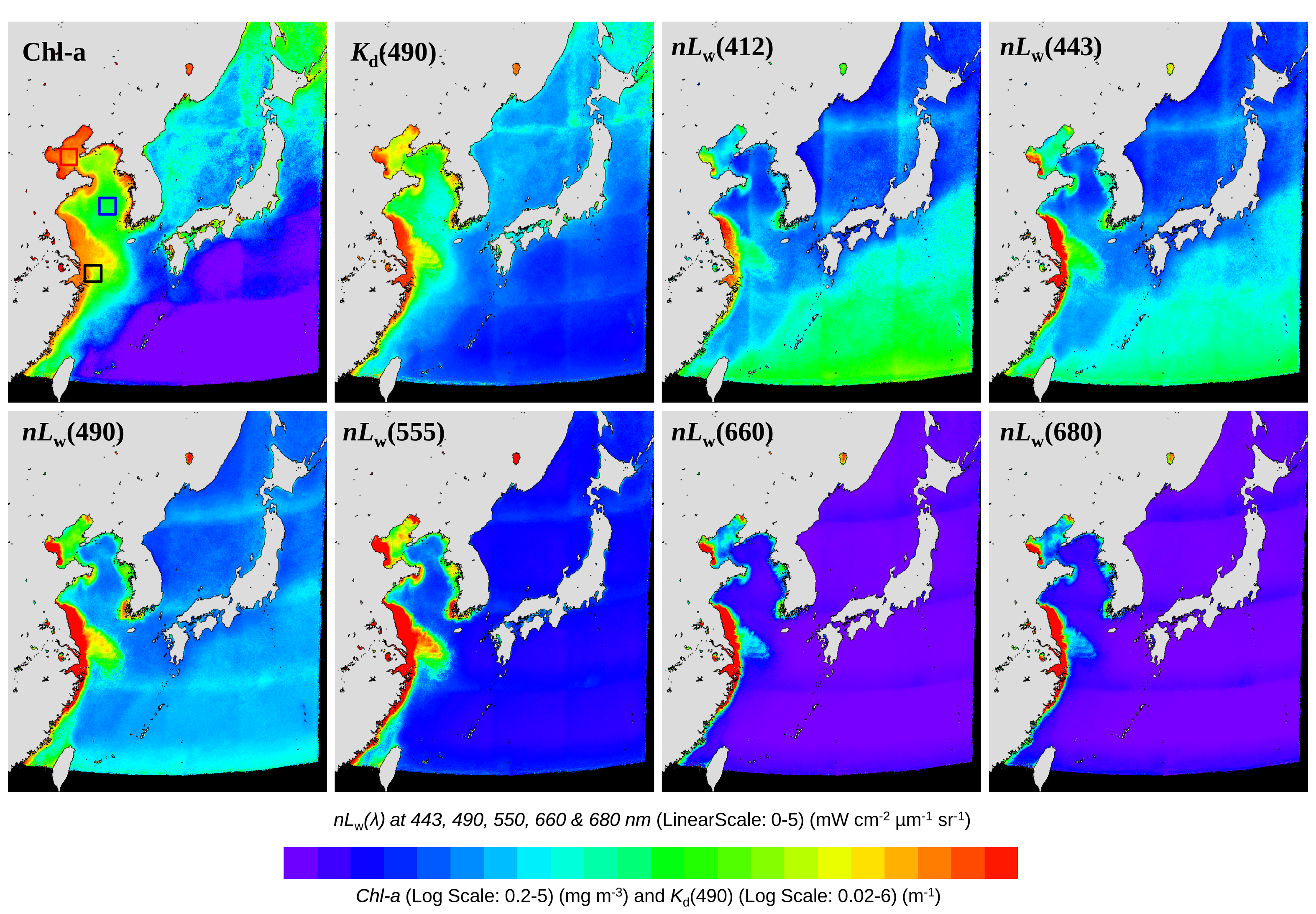

Fig. 1. Composite images of GOCI-measured ocean color products at the local noon derived from March 2011 to November 2014 (45 months).

- Waters are featured with low *Chl-a*, low $K_d(490)$, and high $nL_w(443)$ (blue band) in the Japan Sea and east of East China and South China Seas.
- Significantly enhanced $nL_w(555)$ and $nL_w(660)$ are located in the Bohai Sea, Yangtze River estuary, and coastal waters in the Yellow Sea.
- However, the boundary effect of different GOCI observation slots is still an ongoing issue and being resolved with the effort at KIOST.

GOCI Seasonal Images and Monthly Time Series

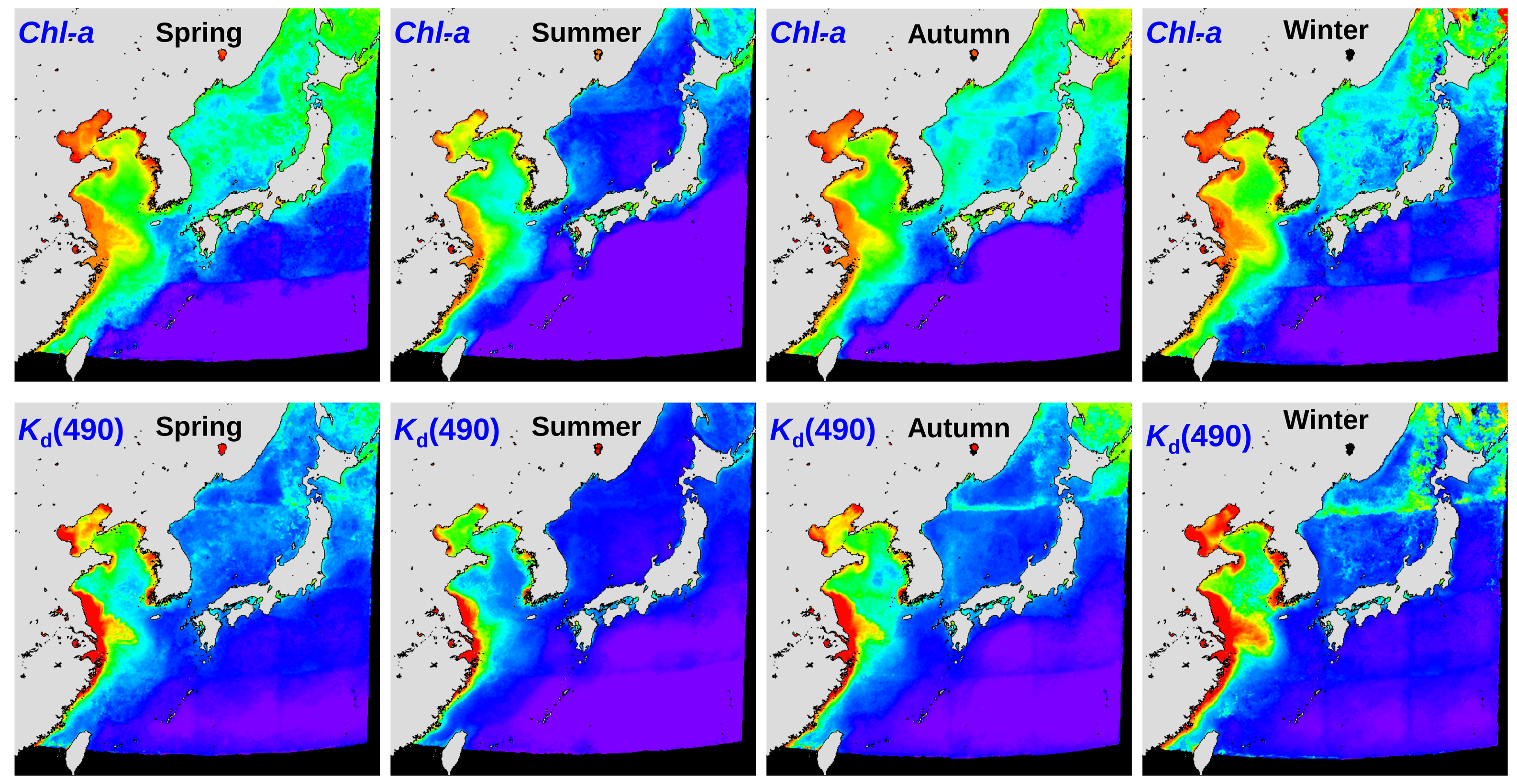

Fig. 2. Climatology seasonal images of GOCI-measured Chl-a and $K_d(490)$ at the local noon derived from March 2011 to November 2014 for Spring (March–May), Summer (June–August), Autumn (September–November), and Winter (December–February).

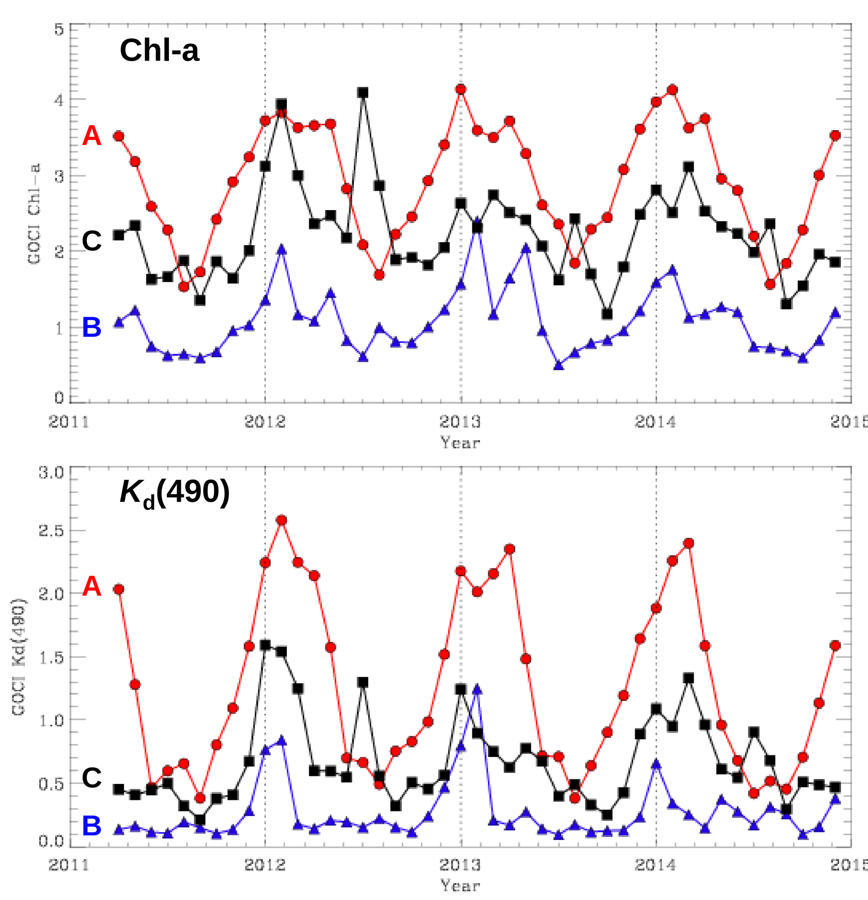

Fig. 3. Time series of GOCI-derived mean monthly Chl-a (top row) and $K_d(490)$ (bottom row) in the Bohai Sea (A), Mid-Yellow Sea (B), and Yangtze River Estuary (C) (marked in Chl-a image of Fig. 1 as red, blue, and black boxes, respectively).

- GOCI seasonal *Chl-a* and $K_d(490)$ images show seasonal spatial distributions over the Northwestern Pacific Ocean. In general, *Chl-a* and $K_d(490)$ values are higher in spring and lower in summer in the most waters.
- Time series of GOCI-measured *Chl-a* and $K_d(490)$ data show a strong seasonal variation (e.g., high values in winter and lower values in summer) and interannual variation (e.g., high *Chl-a* and $K_d(490)$ values near the Yangtze River Mouth in June 2012, possibly due to the strong river runoff).

Diurnal Variation of $K_d(490)$ in the East China Sea

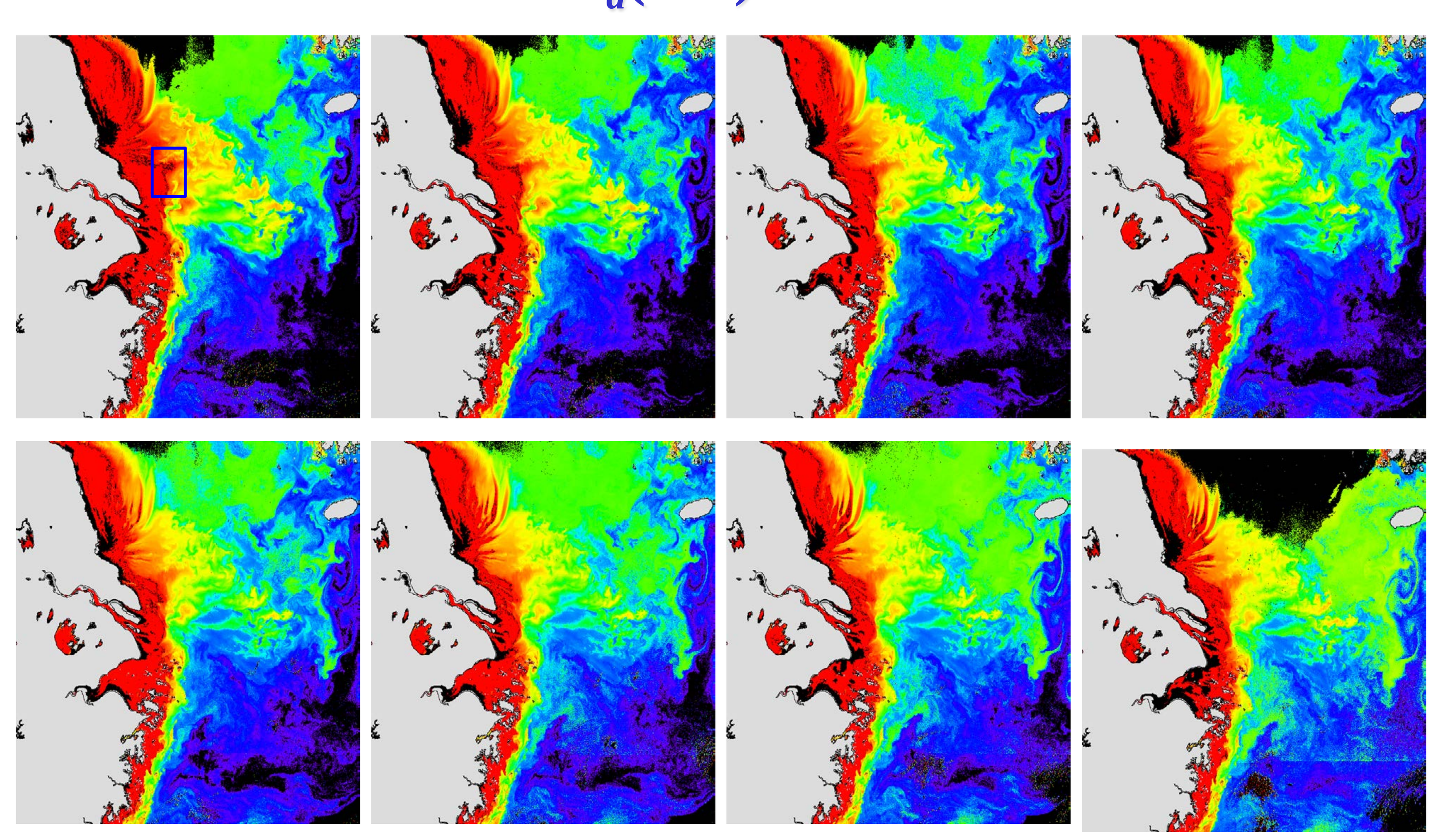

Fig. 4. Maps of GOCI-derived $K_d(490)$ in the East China Sea region on October 12, 2013 at the local time of 9:00, 10:00, 11:00, 12:00, 13:00, 14:00, 15:00, and 16:00. Region for further data analysis and quantification (**Fig. 5**) is marked with the blue box in the 9:00 o'clock plot.

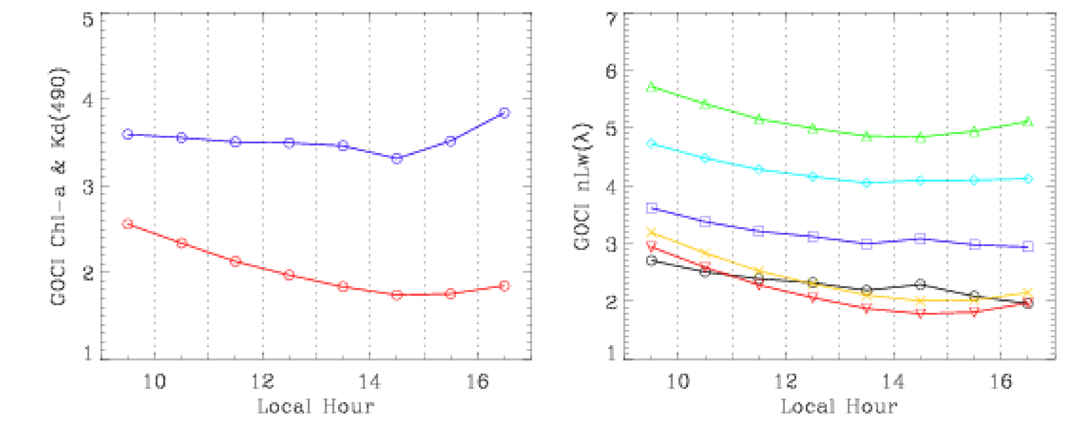

Fig. 5. Diurnal variability of GOCI-derived Chl-a, $K_d(490)$, and $nL_w(\lambda)$ on October 12, 2013 in the location of East China Sea (blue box in **Fig. 4**).

Diurnal Variation of $K_d(490)$ in the Bohai Sea

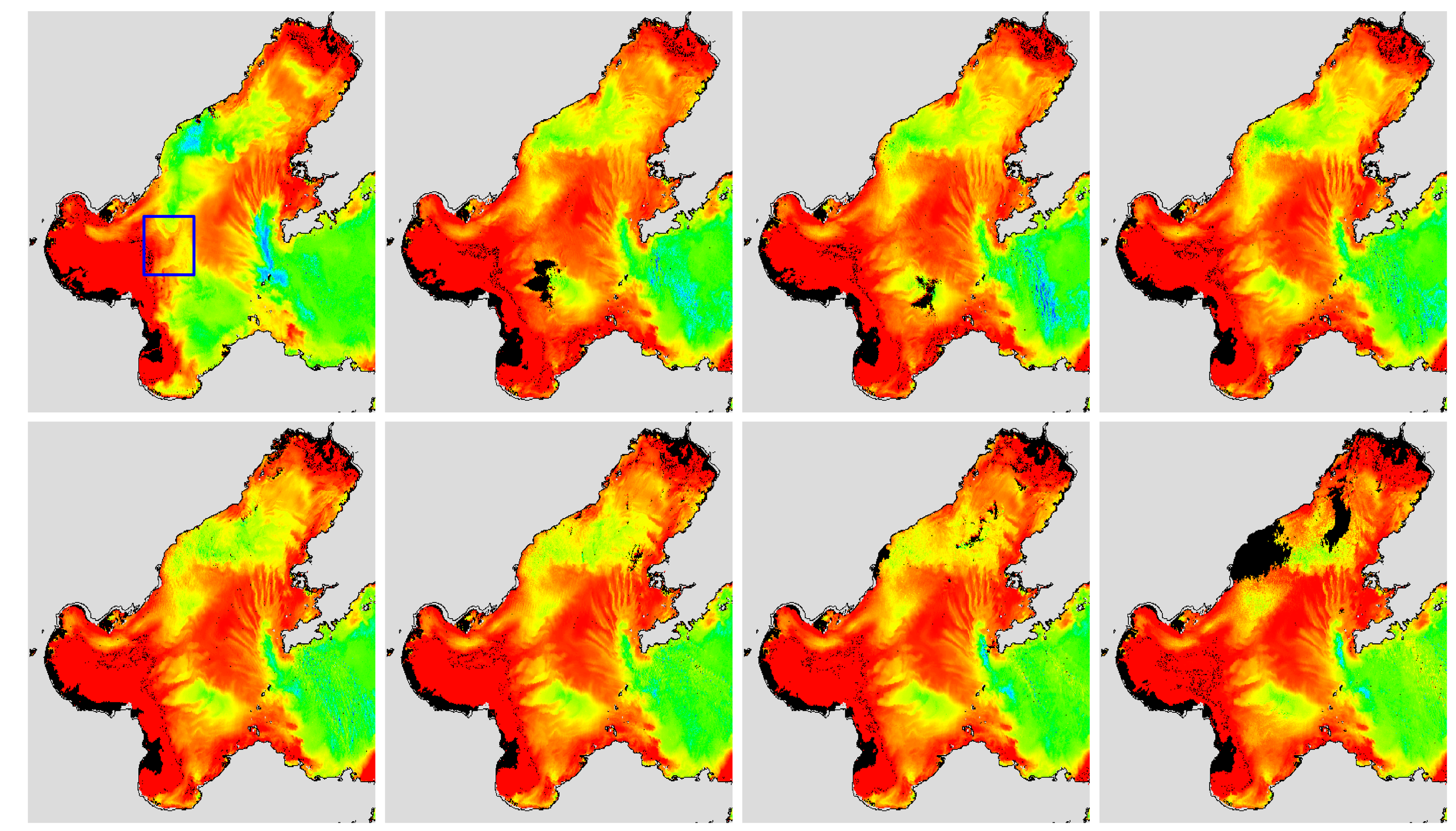

Fig. 6. Maps of GOCI-derived $K_d(490)$ in the East China Sea region on April 11, 2013 at the local time of 9:00, 10:00, 11:00, 12:00, 13:00, 14:00, 15:00, and 16:00.

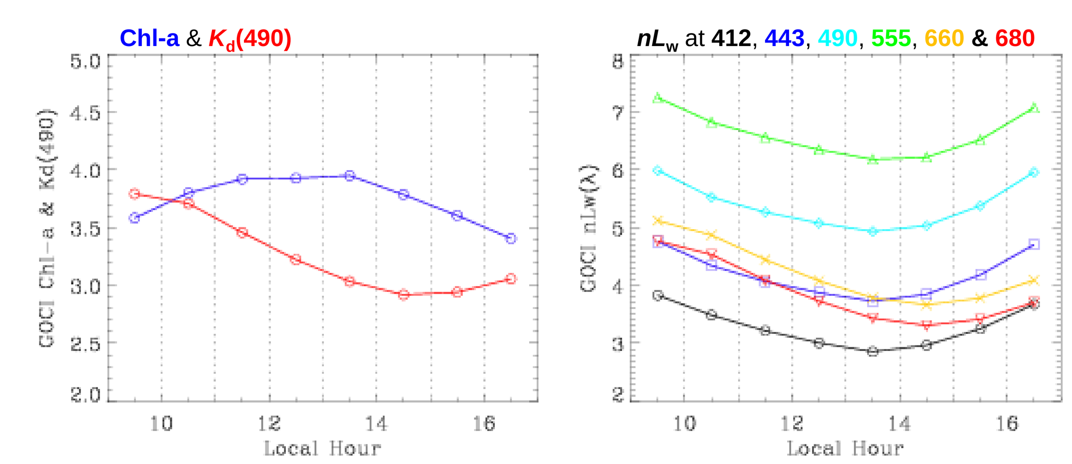

Fig. 7. Diurnal variability of GOCI-derived $K_d(490)$ and $nL_w(\lambda)$ on April 11, 2013 in the location of the Bohai Sea (blue box in **Fig. 6**).

- In the East China Sea and Bohai Sea as well as Yellow Sea, semidiurnal tide plays a significant role on the dynamics of the ocean environments, which can be monitored from daily 8-times GOCI measurements.
- Progressive diurnal changes in patterns and magnitudes of water properties (e.g., $K_d(490)$ and $nL_w(\lambda)$) from local 9:00 to 16:00 are clearly shown in the East China Sea and Bohai Sea.
- The Bohai Sea is dominated with turbid waters with $K_d(490)$ over ~3.0 m^{-1} for most part of the region between local time 9:00 to 16:00 o'clock.

CONCLUSIONS

- ➢The GOCI ocean color products for the GOCI coverage region have been derived using an iterative NIR-corrected atmospheric correction algorithm.
- ➢Validation results show a reasonably good agreement between GOCI retrievals and in situ measurements.
- ➢This study demonstrates that GOCI ocean color products can be confidently used to characterize and quantify the ocean environments as well as the diurnal variability of the marine ecosystem in the western Pacific.
- ➢This unique capability from geostationary satellite sensor can complement the ocean color observations of other polar-orbiting satellites such as MODIS and VIIRS, which have a global coverage but lack the temporal resolution to monitor the dynamics of marine environments on an hourly basis.

Reference:

Wang, M., W. Shi and L. Jiang (2012), Atmospheric correction using near-infrared bands for satellite ocean color data processing in the turbid western Pacific region, Opt. Express, 20(2), 741-753.

Wang, M., J. Ahn, J. Jiang, W. Shi, S. Son, Y. Park, and J. Ryu (2013), Ocean color products from the Korean Geostationary Ocean Color Imager (GOCI), Opt. Express, 21(3), 3835-3849.

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