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# Estimation of Atmosphere-Ocean $CO_2$ Flux in the East Sea using Geostationary Ocean Color Imager Data

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The ocean plays an important role in controlling the Earth's climate by regulating the concentration of $CO_2$ through air-sea carbon cycle while storing more than 50 times as much $CO_2$ as the atmosphere. With the on-going climate change, as the atmospheric $CO_2$ increases, the ocean $CO_2$ also increases. Oceanic acidification dissolves the shells which consist of calcium carbonate to increase $CO_2$. Thus, the monitoring of $CO_2$ and the flux between the atmosphere and ocean are important to analyze regional/global carbon cycle and climate change. In situ observations are difficult to monitor spatiotemporal changes because of weather, equipment, and budget problems. But satellite data can be used to cover vast areas at high temporal resolution.

The purpose of this study is to first estimate surface seawater fugacity of $CO_2$ ($fCO_2$) in the East Sea of Korea and then to determine the $CO_2$ fluxes between the atmosphere and ocean. To estimate $fCO_2$, we used random forest (RF) and support vector regression (SVR) machine learning approaches. Geostationary Ocean Color Imager (GOCI) and Hybrid Coordinate Ocean Model (HYCOM) reanalysis data were used as main input data in this study. GOCI is the world first geostationary ocean color observation sensor, and it collects 8 images hourly per day from 9 am to 4 pm in local time with 8 bands from visible to near-infrared regions at 500 m resolution. Five ocean related parameters—sea surface temperature (SST), sea surface salinity (SSS), mixed layer depth (MLD), chlorophyll-a (Chl-a), and colored dissolved organic matter (CDOM)—and 4 band reflectance (400 – 565 nm) and their ratios were used as input variables to the machine learning models. RF performed better than SVR, and SST, SSS, and MLD were most contributing parameters to estimate surface seawater $fCO_2$ in the East Sea. It might be related with an environment of the East Sea, an active deep convection and various currents that bring warm and salty water. We also calculated and analyzed sea-air $CO_2$ flux in the East Sea using analytical equations and the estimated surface seawater $fCO_2$ based on the RF model. The results showed that the East Sea absorbs $CO_2$ from the atmosphere throughout the whole region, acts as a sink for atmospheric $CO_2$.