High-resolution observation of a river plume by using the geostationary ocean color satellite

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Sea-surface salinity (SSS) is a direct indicator of a freshwater plume associated with river discharge. The river plume spreading from the estuary can determines the water density structure and circulation system in coastal oceans. The riverine materials provided to the coastal oceans are a crucial contributor and often yield significant fishery resources and may often be associated with eutrophication transporting the deposition, resuspension, and dissolved materials such as nutrients from land-derived sources. However, to date, satellite-derived SSS maps based on microwave measurements (L-band radiometers) such as the Aquarius/SAC-D was not designed to resolve the river plume at temporal and spatial resolutions sufficient because the SSS associated with a riverine plume vary highly in time and space in coastal oceans. It has been known that the relationship between the SSS and optical absorption coefficient of colored dissolved organic matter (aCDOM) has a significant negative correlation, leading to the successful estimation of the SSS in the marginal and coastal oceans based on ocean color satellite products. Recently, the geostationary satellite, the Korean Communication, Ocean and Meteorological Satellite (COMS) mounts the world's first geostationary ocean color sensor, the Geostationary Ocean Color Imager (GOCI) to obtain hourly ocean color images with visible and near-infrared band at eight times during the daytime around Japanese Islands and Korean peninsula with a spatial resolution of approximately 500 m. This paper presents the high-resolution and hourly SSS maps in the coastal oceans, Osaka Bay, Harima-nada, and Kii Straight to sufficiently analyze the river plume based on the observational data of ocean color sensor mounted on the geostationary satellite (GOCI-COMS). Using the spatiotemporally high-resolution SSS datasets, we examine the dynamics of river plume induced by the extreme typhoon. As a result of the field surveys in the study area during the period of the larger riverine runoff from summer to autumn, the regression between satellite-derived and in-situ CDOM shows a good correlation coefficients (R=0.88) and highly negative correlation between in-situ CDOM and SSS (R=-0.92). These results indicate that the satellite-derived CDOM can be useful to derive the estimated SSS map for our analysis. As an example of SSS data analysis, we exhibited the episodic changes of the SSS induced by the Category 4 typhoon that attacked Kinki-region during the pre-typhoon period in 15 July to post-typhoon period in 24 July, 2015 along with the time-series of the river runoff and precipitation in the watershed of the Yodo River (Figure 1). After the heavy precipitation and increased runoff induced by the typhoon, the river plume formed in the bay head enlarged to offshore, and largely extended to the whole eastern part of the bay. The narrow-width plume formed along the northern coast of the Harima-nada enlarged to offshore several kilometers in post-typhoon. The salinity of the saline Kuroshio water intruded in Kii Straight in 15 July decreased by the large river runoff in 20 July. Thus, the characteristics of the river plume can be qualitatively and quantitatively detected by using the satellite-derived SSS map based on GOCI. The SSS maps products has been started to be used for the initial condition and verification data of high-resolution coastal ocean simulation. An accurate determination of the SSS maps is essential to a better estimation of ocean environment and ecosystems relevant to coastal fisheries, aquaculture, and marine harvesting, and to measures for disaster reduction against the typhoon and tsunami.

Keywords: Colored dissolved organic matter, Sea surface salinity, River plume, Coastal oceans, Geostationary ocean color satellite