# Tracing simulation of effused organic carbon produced by coastal ecosystems

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Many of the organic carbon produced by coastal organisms such as seagrass, mangrove, corals, are flush out to offshore. The effused organic carbon may potentially important for the global carbon cycles, but the quantitative studies of the effused organic carbon and its fates are very limited due to the difficulty of the observation. In this study, for elucidating the fate of the effused organic carbon, a numerical simulation model for tracing the effused organic carbon was developed.

The model is composed of an ocean circulation model based on the Coupled-Ocean-Atmosphere-Wave-Sediment Transport (COAWST) Modeling System (Warner et al., 2010) coupled with a newly developed low-trophic ecosystem model (modified from Nakamura et al., 2018). The low-trophic ecosystem model has some compartments; dissolved inorganic carbon (DIC), total alkalinity (TA), dissolved oxygen (DO), ammonium ($NH_4$), nitrate ($NO_3$), phosphate ($PO_4$), labile dissolved organic carbon (LDOC), nitrogen (LDON), and phosphorous (LDOP), refractory organic carbon (RDOC), nitrogen (RDON), and phosphorous (RDOP), coarse particulate organic carbon (CPOC), nitrogen (CPON), and phosphorous (CPOP), detritus type particulate organic carbon (DPOC), nitrogen (DPON), and phosphorous (DPOP), 3 functional groups of phytoplankton (Dinoflagellate, Diatom, Coccolithophorids), 1 functional group of zooplankton, and particulate inorganic carbon (PIC; dead $CaCO_3$ shell of Coccolithophorids). In addition, for tracing the fate of the carbon, a carbon isotope module with carbon isotope compartments, such as DI$^{13}$C, RDO$^{13}$C, LDO$^{13}$C, CPO$^{13}$C, DPO$^{13}$C, and $^{13}$C of those groups of phytoplankton, $^{13}$C of zooplankton, and PI$^{13}$C, was incorporated into the model. Since carbon isotope is aimed to use as the carbon tracing, isotope fractionation by all physical and biological processes were deactivated.

This model applied the Yaeyama Islands region, especially focusing Nagura Bay, Ishigaki Island, for tracing organic carbon effused from the mangrove ecosystem around the Nagura river, and conducted carbon tracing simulation. In this simulation, completely 0% of carbon isotope is included in all the compartments, and 50% of the mangrove leaf carbon as the CPOC was marked as CPO$^{13}$C and released from the river mouth. Then the CPOC and CPO$^{13}$C were dispersed by advection and diffusion. Through the decomposition processes, some parts of the CPOC changed the form to detritus, then it was decomposed and was changed the form to DIC. And some other part of the CPOC was eaten by zooplankton and assimilated to the zooplankton body. Then the assimilated carbon was changed to other forms... Such kind of carbon propagation was able to be chased by carbon isotope. The model still needs proper parameter adjustment especially decomposition related parameters, but the model was well tracing and visualizing carbon and its fate.

Keywords: effused organic carbon, carbon tracing, numerical simulation, ocean circulation model, low-trophic ecosystem model

 