

A numerical model for calculating the behavior of leaked CO₂ in the sea for assessing the potential impacts on the marine environment

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To mitigate global warming, the reduction of carbon dioxide (CO₂) in the atmosphere is indispensable. We should make every endeavor to do it. Among options for it, CO₂ capture and storage (CCS) is thought to be one of the most important ones. Captured CO₂ in major CO₂ emission sources, such as power plants, is transported into deep geological formations and stored there. In Japan, mainly off shore areas will be selected as the storage sites. There is still concern that stored CO₂ may leak out into the sea and that leaked CO₂ may impact the marine organisms. To diminish the risk of CO₂ leakage, it goes without saying that it is necessary to select the storage sites and the formations where CO₂ will be stored stably and safely. In addition, we should enhance scientific knowledge and develop methods to assess the potential marine environmental impacts in case the stored CO₂ should leak out. How much the marine environment or organisms will be impacted depends on the rise in the CO₂ concentration in seawater consequent on the leakage.

Aiming at calculating dispersion of leaked CO₂ in the sea, we are developing a numerical model. In JpGU 2015 meeting, we presented a model where the leaked CO₂ dissolved into seawater (Δ DIC) is represented as a passive tracer. In the model, CO₂ bubbles were not calculated. However, it is considered that CO₂ would leak out from the seafloor mainly as bubbles. CO₂ bubbles from the seabed rise in the water column, dissolving into seawater. These processes may affect the distribution of Δ DIC because the dissolution rate and the movement of CO₂ bubbles depend on the size of the bubbles, and temperature and salinity of ambient water. Therefore, we have incorporated CO₂ bubbles into the model. The model is based on a non-hydrostatic ocean model, named kinaco, which has a Lagrangian particle tracking scheme. To represent CO₂ bubbles in the model, we apply properties of CO₂ bubbles, such as the mass and volume, to the particles. Based on the size of bubbles, and temperature and salinity of the cells that the bubbles exist in, the buoyancy and the dissolution rates are calculated. According to them, the movements and the sizes of CO₂ bubbles are computed. CO₂ dissolved into seawater is dispersed as Δ DIC, which is calculated as a passive tracer in the model. In our presentation, details of the model and examples of the calculation with the model will be presented.

Keywords: potential marine environmental impacts, carbon dioxide capture and storage, numerical model