

A method for assessing the impacts of leaked CO₂ on the marine environment

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Carbon dioxide (CO₂) capture and storage (CCS) is promising technology that mitigates the global warming. Captured CO₂ from industrial processes is transported to a reservoir in the deep geological formations. Storage sites are selected so deliberately that CO₂ is believed to be stably stored in the reservoir. However, in case of a worst-case scenario, we should assess the impacts of leakage. In Japan, CO₂ will be stored under the seabed, so that CO₂ would leak out into the sea if unexpected leakage should occur. Therefore, we should assess the potential impacts on the marine environment. In this talk, we will introduce a method of the assessment that we have been developing. The method consists of two tools; a numerical model and a database of marine biological impacts. A numerical model predicts dispersion, i.e. distribution and concentration, of leaked CO₂ in the sea. Since leaked CO₂ is advected and diffused by ocean flow, the model should properly represent flow, temperature, and salinity fields in the sea. In addition, seasonal variation in the sea could be important for the simulation. Stratification in the sea strengthens in summer and weakens in winter, so that leaked CO₂ would be more likely to be mixed vertically in winter than in summer. We have been developing an ocean model for simulating leaked CO₂, taking consideration of those factors above. The model is based on a non-hydrostatic ocean model, called *kinaco*, developed by Matsumura and Hasumi (2008). In general, numerical cost of a non-hydrostatic model is very expensive. In *kinaco*, numerical cost is improved greatly, which enables a simulation in a relatively large area and of a relatively long period, as a simulation with a non-hydrostatic model. With this model, we conducted a numerical simulation in a gulf-like topography. A passive tracer, which is regarded as TCO₂ (total dissolved inorganic carbon) originating from leaked CO₂, is injected near the bottom. In order to represent seasonal variation, sea surface temperature (SST) is restored to temporally variable temperature from observational data, and temperature and salinity on a lateral boundary are also restored to observational data. Wind velocity data given at the sea surface, which are converted to wind stress in the model and drive the model ocean, are daily mean observational data. In order to assess the potential impacts of leaked CO₂ on the marine organisms, we make use of a database of marine biological impacts of CO₂ concentration that RITE has been compiling. The biological impacts of CO₂ in the ocean are referred to not TCO₂ but partial pressure of CO₂ (pCO₂), and so the calculated TCO₂ in the simulation should be converted to pCO₂. With the resulting pCO₂ values and the database, we can estimate the potential area where marine organisms might be impacted.

Keywords: marine environmental impacts, Carbon dioxide Capture and Storage, numerical model, database of marine biological impacts