論文の内容の要旨

論文題目　：Numerical Study on Multi-scale Diffusion of CO_2 Purposely Injected in the Deep Ocean

（和訳　深海に隔離された二酸化炭素のマルチスケール拡散に関する数値的研究）

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The direct injection of carbon dioxide CO_2 into the deep ocean is one of the feasible ways for the mitigation of the global warming. On the other hand, there is a concern about its environmental impact near the injection point. To minimize its biological impact, it is necessary to make CO_2 disperse as fast as possible and it is thought that injection with a pipe towed by a moving ship is effective for this purpose.

Although field experiments are desirable to assess the method, such experiments are expensive, and, therefore, various numerical model studies have been conducted to predict the dilution process in small scale (O(1 km)) or large scale (O(104 km)), respectively. Because the injection ships are planned to move in the site with O(102 km), a mesoscale model is required to build a bridge between the small-scale and a large-scale regional model.

To numerically investigate the time change of CO_2 concentration by turbulence diffusion in both small- and mesoscales, a moving and nesting grid technique was developed and used in combination with the double low-wavenumber forcing technique to generate proper ocean fluctuating flow field, which is important for the dispersion process of CO_2 concentration. The nested small-scale grid system moves in the mesoscale grid system along the trajectory of a moving ship injecting CO_2 in the deep ocean.

Moreover, to overcome the artificial diffusion of concentration at the interfaces of two different grid systems, a new diffusion model, called particle Laplacian method (PLM) based on Lagrangian mesh-free method, was developed for anisotropic diffusion in the ocean.

From the results of numerical simulations, the developed techniques demonstrated its efficiencies and applicable to the future studies to give an outline for the optimization of the CO_2 ocean sequestration system, by which biological impacts should be minimized and insignificant.