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Assimilation of GOSAT XCO₂ data to optimize surface CO₂ flux in East Asia

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Because East Asia is the third-largest source region of CO₂ after North America and Europe, there is a need to estimate surface CO₂ fluxes accurately over East Asia. Nevertheless, since the number of surface CO₂ observations in East Asia is relatively small compared to that in North America and Europe, the estimation of surface CO₂ fluxes in East Asia has relatively large uncertainties. To supplement sparse surface CO₂ observations, satellite observations can be used.

In this study, the column-averaged dry-air mole fraction (XCO₂) concentration data from the Greenhouse gas Observing SATellite (GOSAT) Project was used to estimate the surface CO₂ fluxes in East Asia. CarbonTracker developed by Earth System Research Laboratory was used as an inverse modeling system. To assimilate GOSAT XCO₂ data in CarbonTracker, the observation operator for GOSAT XCO₂ data was developed. To determine the appropriate Model-Data-Mismatch (MDM) for GOSAT XCO₂ data, a sensitivity test was conducted. The experiment assimilating GOSAT data showed lower BIAS and RMSE than that without assimilating GOSAT data. In addition, the experiment using 2 ppm MDM for GOSAT data showed lower BIAS and RMSE than that using 3 ppm MDM.

The surface CO₂ fluxes over East Asia from the experiments with and without GOSAT data were also compared. By assimilating GOSAT observations, the absorption of surface CO₂ fluxes in the ocean became strong and that in land became weaker. Especially, the absorption of surface CO₂ fluxes in the Eurasian Boreal region became much weaker than in other regions. The uncertainty reduction was also the largest in the Eurasian Boreal region where the surface CO₂ observations are sparse.

Therefore GOSAT XCO₂ data have a profound impact on estimating the surface CO₂ fluxes in East Asia where the surface observations are insufficient.

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