Abstract

[Research Title]

Multi-scale GHG budget evaluation based on atmospheric observations

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Theme 1 leveraged an observational network of GHGs across the Asia–Pacific region using a variety of platforms, such as ground-based stations, ships, aircraft, and satellites, to estimate GHG budgets on multiple spatial scales from a global to a city scale. The atmospheric transport model NICAM was employed to connect surface fluxes and atmospheric concentrations of GHGs. A global high-resolution (1° × 1°) inverse analysis system was developed using the NICAM-based Inverse Simulation for Monitoring CO_2/CH_4 (NISMON-CO_2/CH_4) for long-term inverse analysis (Niwa et al., 2022). Downscaling the optimized CO_2 fluxes of NISMON-CO_2, a further high-resolution (~14 km) atmospheric CO_2 transport simulation was performed, which involved the introduction of tagged CO_2 tracers to estimate CO_2 fluxes from the Greater Tokyo Region. Experimental analyses of NISMON-CO_2 and the high-resolution tagged tracer simulation proposed potential observations that can better constrain GHG flux estimates in the Asia–Pacific region and the Greater Tokyo Region, respectively. In fact, a new portable GHG measurement system was developed and installed at a building of Chiba University in 2023 to better constrain the flux estimate from the Great Tokyo area. Moreover, a new shipboard observation along the Pacific Belt Zone in Japan began in 2022 to efficiently capture GHG emission signals from other large cities. A near-real-time estimation method of CO_2 emission changes in China was developed using enhancement ratios between CO_2 and CH_4 observed at the Hateruma and Yonaguni Islands (Tohjima et al., 2022, 2023). Flask and in situ measurements of the stable isotope ratio ($\delta^{13}C$) of CH_4 were also conducted to evaluate the sectoral contributions of CH_4 emissions. For ocean fluxes, which are important to determine the background levels of atmospheric concentrations, Theme 1 produced a global sea–air CO_2 flux data product by integrating the newly produced data product for marginal seas in the northwestern North Pacific with the existing data product for open ocean. Measurements were conducted in the winter of 2022 and 2023 onboard the research vessel of the Japan Meteorological Agency to support the flux estimation for marginal seas. The globally integrated sea–air CO_2 flux data were provided to the international research project led by the Global Carbon Project and the inverse analysis of NISMON-CO_2. The abovementioned datasets related to GHG budgets are made publicly available to improve the transparency of the studies, and they are expected to support policymaking in terms of GHG emission reduction to achieve the goal of the Paris Agreement.

[References]

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