

Abstract

[Research Title]

GHG budget evaluation using emission inventories, observational data, and biogeochemical models

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[Abstract]

Theme 3 developed a bottom-up approach to evaluate the surface GHG budget by aggregating individual sources and sinks. The SII-8 project employs a unique bottom-up approach to evaluate the surface GHG budget. This approach is necessary to compensate for the alternative top-down approach that derives the budget from atmospheric observational data and models. The bottom-up approach uses emission inventories, biogeochemical models, and land surface data to evaluate individual sources and sinks. This approach estimates the budget spatially explicitly and in the long-term and allows decomposing sectoral contributions. Moreover, it usually does not require expensive instruments. However, this approach has disadvantages in quick reporting and is susceptible to sector-specific errors and biases. The bottom-up GHG evaluation system developed by Subtheme 1 in 2023 uses the biogeochemical model VISIT to estimate natural sources (e.g., CH₄, N₂O, and CO₂ from wetlands, soils, and land use, respectively) and sinks (e.g., CO₂ and CH₄ by afforestation and soil oxidation, respectively). Most of the anthropogenic emissions, conventionally separated into five categories (fossil fuel mining, industry and urban sources, waste management, agriculture, and livestock), were derived from up-to-date emission inventories (EDGAR v8.0). Moreover, emissions from wildfires were derived from the Global Fire Emission Dataset. Spatial maps of annual fluxes at 0.25° latitude and 0.25° longitude were produced for all sources and sinks, which allowed spatial and temporal analyses for arbitrary areas. To improve the accuracy and integrity of the bottom-up estimation, original schemes were developed for paddy field and termite CH₄ emissions, and an alternative estimation method was developed for anthropogenic emissions using machine learning algorithms. The bottom-up system was successfully demonstrated for the CH₄ and N₂O budgets of Asia. Subtheme 2 developed an early warning system for the CO₂ budget of terrestrial ecosystems using time series data from geostationary satellites (Himawari), allowing the detection of the impacts of extreme events such as droughts and heatwaves. Moreover, Subtheme 2 attempts to optimize the VISIT model parameters using numerical algorithms to improve the accuracy of retrieving the observed terrestrial CO₂ budget. Many scientific papers have published the achievements of Theme 3, and the IPCC Assessment Reports cited some of these papers. In

conjunction with Themes 1 and 2, these outcomes were aggregated into the annual report and successfully submitted to the global stocktake.

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