[Research Title]

GHG estimation for effectiveness assessment of emission reduction and validation of Earth system model

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[Abstract]

Theme 2 conducted global scale modeling, observational data utilization, and data analysis, including climatecarbon cycle simulations, to support the steady implementation of the global stocktake from a scientific perspective. To achieve the global warming mitigation targets in the Paris Agreement, it is necessary to better understand the anthropogenic emissions of the major greenhouse gases (CO₂, CH₄, N₂O, hereafter GHGs), and their natural sinks/sources distributions on land and ocean, and concentration distribution in the atmosphere. We have achieved development of a system for estimation of regional sources and sinks of all three species by top-down/inverse modeling of atmospheric data. The system allowed these three gases to be compared and discussed in the CO₂-equivalent unit, and further contribute to the international research involving multiple data streams and reconciliation of top-down and bottom-up estimations. We have contributed and co-led various GHG budget activities of the Global Carbon Project (GCP), under the auspices of Future Earth, and the Regional Carbon Cycle Assessment and Processes, phase 2 (RECCAP2). The budgets of CO₂, CH₄, and N₂O on a global scale were used to validate and improve the performance of the Earth system model, in comparison with those obtained from inverse modeling. The improved model was used to perform simulations in which future anthropogenic CO_2 emission reduction is assumed. This study focused on the period when the atmospheric CO_2 concentration and global mean temperature start to decrease after anthropogenic emissions are mitigated. The results suggest stronger emphasis on both the pace of emission reductions and early intervention are necessary not only to maintain the global temperature well below the 1.5/2.0°C target but also to achieve earlier the effectiveness of mitigation measures. The Theme 2 activities have directly or indirectly contributed to the recently concluded IPCC 6th assessment report through the submission of inversion and earth system model results, and to the 1st global stocktake by the UNFCCC.

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