Global inverse analysis of CH_4 fluxes using NICAM-TM 4D-Var

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Atmospheric methane (CH_4) is the most important greenhouse gas after carbon dioxide. Because CH_4 has a relatively short lifetime due to chemical losses in the atmosphere, it is expected that reducing CH_4 emissions would mitigate global warming in a relatively short timeframe. However, sources of atmospheric CH_4 are associated with a wide variety of processes such as fossil fuel production and consumption, agriculture, natural wetlands, and biomass burning, and our understanding of the full CH_4 budget is limited. To better understand CH_4 sources, an inverse analysis is one prominent methodology that estimates spatiotemporal variations of CH_4 sources consistent with their prior estimates and atmospheric observations within specified uncertainties. In this study, we performed a long-term inverse analysis of CH_4 fluxes with an inversion system named NICAM-TM 4D-Var (Niwa et al., 2017a,b). The inversion system is based on the atmospheric transport model NICAM-TM (Niwa et al., 2011), which has a homogeneous icosahedral grid system and mass conserving property. The horizontal model grid resolution was set to 223 km and the CH_4 flux estimation was performed at the same resolution, though some spatial error correlations were introduced. The prior flux dataset includes wetland/rice cultivation emission and soil uptake estimated by the terrestrial ecosystem model VISIT (Ito and Inatomi, 2012). The other emission categories are provided from the ongoing Global Carbon Project (GCP)–CH_4. In the inversion, several emission categories are separately estimated according to their seasonal and interannual variabilities. Compared with the prior estimates, the inverse analysis with ground-based station data estimated smaller emissions from East Asia and Europe, larger and smaller northern summer emissions from West Siberia and Hudson Bay Lowlands, respectively, and larger emissions from Bengal and Indochina areas. These changes estimated by the inversion are attributed to emissions from anthropogenic categories (mainly fossil fuel related), natural wetlands, and rice cultivation, respectively. The presentation will also address the reliability of the inversion estimates using independent aircraft data and examine the independence of each category emission estimate.

References

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