Influence of Fossil Fuel Emissions on CO_2 Flux Estimates by Atmospheric Inversions

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Top-down approaches (or atmospheric inversions), using atmospheric transport models with CO_2 observations, are an effective way to estimate regional carbon fluxes. CO_2 flux estimates by Bayesian inversions require a priori knowledge of terrestrial biosphere exchanges, oceanic fluxes, and fossil fuel and cement production (FFC) CO_2 emissions. In most inversion frameworks, global and regional FFC CO_2 emissions are assumed to be a known quantity because FFC CO_2 based on world statistics are thought to be more reliable than natural CO_2 fluxes. However different databases of FFC CO_2 emissions may have different temporal and spatial variations especially at locations where statistics are not so accurate. In this study, we use 3 datasets of FFC emissions in inversion estimations and evaluate the sensitivity of the optimized CO_2 fluxes to FFC emissions with JAMSTEC's ACTM (an AGCM-based atmospheric chemistry-transport model) for the period of 2001–2011. Interannually varying a priori FF CO_2 emissions were based on 1) CDIAC database, 2) EDGARv4.2 database, and 3) IEA database, with some modifications. Biosphere and oceanic fluxes were optimized. Except for FF emissions, other conditions were kept the same in our inverse experiments. The three a priori FF emissions showed ~5% (~0.3GtC/yr) difference in their global total emissions in the early 2000's and the difference reached ~9% (~0.9 GtC/yr) in 2010. This resulted in 0.5–1 GtC/yr (average 2001–2011) difference in the estimated global total emissions for the ACTM inversions. Regional differences in the FFC emissions were relatively large in East Asia (~0.5 GtC/yr) and Europe (~0.4 GtC/yr). These a priori flux differences caused differences in the estimated biosphere fluxes in East Asia and Europe. Boreal North America and North Africa had less difference in FFC emissions but showed larger difference in estimated fluxes which might be affected by their neighboring regions.
Forward simulation results with the prior and posterior fluxes were compared with aircraft measurements over Japan by Tohoku University to validate the flux amplitudes and trends.
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