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GOSAT observations of anthropogenic emission of carbon dioxide and methane

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Carbon dioxide (CO_2) and methane (CH_4) are the most important greenhouse gases in terms of radiative forcing. Human activities such as combustion of fossil fuel (for CO_2), and gas leakage, animal agriculture, rice cultivation and landfill emissions (for CH_4), are considered to be major sources of their emissions. Global emissions datasets usually depend on emission estimates reported by countries, which are seldom evaluated in an objective way. Here we present a method for delineating anthropogenic contributions to global atmospheric CO_2 and CH_4 (2009-2014) concentration fields using GOSAT observations of column-average dry air mole fractions (XCO_2 and XCH_4) and atmospheric transport model simulations using high-resolution emissions datasets (ODIAC for CO_2 and EDGAR for CH_4). The XCO_2 and XCH_4 concentration enhancements due to anthropogenic emissions are estimated at all GOSAT observation locations using the transport model simulation. We calculated threshold values to classify GOSAT observations into two categories: (1) data influenced by the anthropogenic sources and (2) those not influenced. We defined a clean background (averaged concentrations of GOSAT data that are free from contamination) in $10^{\circ}\times10^{\circ}$ regions over the globe and subtracted the background values from individual GOSAT observations. The anomalies (GOSAT observed values minus background values) were binned and compared to model-based anomalies over continental regions and selected countries. For CO_2, we have found global and regional linear relationships between model and observed anomalies especially for Eurasia and North America. The analysis for East Asian region showed a systematic bias that is somewhat comparable in magnitude to the uncertainties in emission inventories in that region, which were reported by recent studies. In the case of CH_4, we found a good match between inventory-based estimates and GOSAT observations for continental regions and large countries. The inventory-based estimate over North American region is biased which is in agreement with recent studies. Currently, our method is limited by the numbers of GOSAT observations available. If sufficient numbers of satellite observations are available from a instrument like GOSAT, our method could be a useful tool for monitoring greenhouse gas emissions using the regression slope between modeled and observed anomalies as a correction factor for nationally reported emissions.