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Estimating anthropogenic methane emissions with GOSAT satellite retrievals and ground-based observations

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To estimate anthropogenic methane emissions localized around large cities, we use the Lagrangian particle dispersion model FLEXPART to model local tracer transport at 0.1˚ spatial resolution and compare the model simulations of local methane enhancements to GOSAT observations made in 2009-2015. The satellite-observed methane column enhancements are aggregated according to discrete simulated enhancement levels. The observed and simulated enhancements compare well for the global domain and show differences for several large regions such as the US and East Asia. To extend the analysis and account for large scale transport and influence of natural fluxes, we perform global high-resolution methaneflux inversion to estimate global methane emissions using atmospheric methane data collected at global in-situ network, which is archived at WDCGG, and GOSAT satellite retrievals. FLEXPART is coupled to a global atmospheric tracer transport model (NIES-TM). Prior fluxes at 0.1˚ resolution were prepared for anthropogenic emissions (EDGAR 4.3.2), biomass burning (GFAS), and wetlands (VISIT). The inverse model NIES-TM-FLEXPART-VAR (NTFVAR) applies variational optimization to two categories of fluxes: anthropogenic and natural (wetlands). Bi-weekly emissions are estimated for years 2009 to 2017. To reduce GOSAT retrieval biases, the monthly mean difference between GOSAT data and the inversion-optimized forward simulation is estimated for each 5º latitude band and then it is subtracted from GOSAT retrievals before including them in the inversion. The bias correction is designed to remove large scale biases in GOSAT retrievals, while retaining local scale variability that contains most information on anthropogenic emissions. Estimated anthropogenic emissions over large regions (US, China, India) are comparable to GCP-CH_4 top-down estimates. The sensitivity of the estimated emissions to prior fluxes is checked by making inverse modeling with prior emissions adjusted to match national reports to UNFCCC for selected large countries.