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Constraints on CO_2 flux emissions: reconstructions of in-situ measurements from Lagrangian stochastic inversion

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In order to use high resolution in-situ measurements to constrain regional emissions of carbon dioxide ($\mathbf{CO_2}$) we use a Lagrangian methodology based on diffusive backward trajectory tracer reconstructions. We use aircraft, ground and tower sites for $\mathbf{CO_2}$ data, collected during the CONTRAIL campaign, from the MRI/JMA Tsukuba tall tower, nearby the $\mathbf{CO_2}$ emission hot spot of the Tokyo Bay area and from the World Data Centre for Greenhouse Gases (WDCGG). Advective transport based on ECMWF analyzed meteorological winds and the WRF mesoscale model is characterized by the sensitivity/transition probability (Green's function) allowing direct comparison with observations via the reconstruction of the volume mixing ratio of $\mathbf{CO_2}$. Sensitivity to simplified boundary layer representations, turbulent mixing representations and meteorological fields was studied and applied to the assessment of publicly available inventory data. Longer time series in remote sites (e.g. the Yonagunijima island) are used to constrain the influence of far field/continental East Asia emissions. Estimated fluxes for the Tokyo Bay Area for the analyzed period in 2007 range between 4.8×10^{-7} to 3.45×10^{-7} $\mathrm{kg}_{CO_2} m^{-2} s^{-1}$ with significant time variations. We assess the uncertainties in terms of errors associated with the transport and mixing processes in the vicinity of the emission sources.