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Constraints on CO2 fux 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?Aos 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 ¥times 10^{-7} to $3.45 ¥times 10^{-7} $kg_{¥mathrm{chem}\{CO_2\}}$ 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.