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## Comparison of Regional Simulation of Biospheric CO<sub>2</sub> Flux from the Updated Version of CarbonTracker Asia with FLUXCOM and Other Inversions over Asia

**Samuel Takele Kenea**, Lev Labzovskii, Tae-Young Goo, Shanlan Li, Young-Suk Oh, and Young-Hwa Byun

National Institute of Meteorological Sciences (NIMS), Jeju-do, Korea, Climate Research Division, Korea, Republic of (samueltake@yahoo.ca)

There are still large uncertainties in the estimates of net ecosystem exchange of CO<sub>2</sub> (NEE) with atmosphere in Asia, particularly in the boreal and eastern part of temperate Asia. To understand these uncertainties, we assessed the CarbonTracker Asia (CTA2017) estimates of the spatial and temporal distributions of NEE through a comparison with FLUXCOM and the global inversion models from the Copernicus Atmospheric Monitoring Service (CAMS), Monitoring Atmospheric Composition and Climate (MACC), and Jena CarboScope in Asia, as well as examining the impact of the nesting approach on the optimized NEE flux during the 2001–2013 period. The long-term mean carbon uptake is reduced in Asia, which is  $-0.32 \pm 0.22 \text{ PgC yr}^{-1}$ , whereas  $-0.58 \pm 0.26 \text{ PgC yr}^{-1}$  is shown from CT2017 (CarbonTracker global). The domain aggregated mean carbon uptake from CTA2017 is found to be lower by 23.8%, 44.8%, and 60.5% than CAMS, MACC, and Jena CarboScope, respectively. For example, both CTA2017 and CT2017 models captured the interannual variability (IAV) of the NEE flux with a different magnitude and this leads to divergent annual aggregated results. Differences in the estimated interannual variability of NEE in response to El Niño–Southern Oscillation (ENSO) may result from differences in the transport model resolutions. These inverse models' results have a substantial difference compared to FLUXCOM, which was found to be  $-5.54 \text{ PgC yr}^{-1}$ . On the one hand, we showed that the large NEE discrepancies between both inversion models and FLUXCOM stem mostly from the tropical forests. On the other hand, CTA2017 exhibits a slightly better correlation with FLUXCOM over grass/shrub, fields/woods/savanna, and mixed forest than CT2017. The land cover inconsistency between CTA2017 and FLUXCOM is therefore one driver of the discrepancy in the NEE estimates. The diurnal averaged NEE flux between CTA2017 and FLUXCOM exhibits better agreement during the carbon uptake period than the carbon release period. Both CTA2017 and CT2017 revealed that the overall spatial patterns of the carbon sink and source are similar, but the magnitude varied with seasons and ecosystem types, which is mainly attributed to differences in the transport model resolutions. Our findings indicate that substantial inconsistencies in the inversions and FLUXCOM mainly emerge during the carbon uptake period and over tropical forests. The main problems are underrepresentation of FLUXCOM NEE estimates by limited eddy

covariance flux measurements, the role of CO<sub>2</sub> emissions from land use change not accounted for by FLUXCOM, sparseness of surface observations of CO<sub>2</sub> concentrations used by the assimilation systems, and land cover inconsistency. This suggested that further scrutiny on the FLUXCOM and inverse estimates is most likely required. Such efforts will reduce inconsistencies across various NEE estimates over Asia, thus mitigating ecosystem-driven errors that propagate the global carbon budget. Moreover, this work also recommends further investigation on how the changes/updates made in CarbonTracker affect the interannual variability of the aggregate and spatial pattern of NEE flux in response to the ENSO effect over the region of interest.