Investigating CO2 space-time variability in satellite - chemistry transport model differences using aircraft measurements

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Orbiting Carbon Observatory-2 (OCO-2) is providing global spatiotemporal distribution of column average dry-air mole fraction of CO2 (XCO2) at finer spatial resolution and covering the globe compared to the high precision surface network and aircraft measurements. This information offers a unique opportunity to the carbon cycle community to utilize satellite retrievals for policy-relevant source and sink estimations through top-down inversion. This study extensively examines CO2 variability from OCO-2 retrieval, aircraft measurements (Atmospheric Tomography Mission; ATom and Amazon aircraft program), and their representation in the MIROC4-ACTM chemistry transport model, aiming to understand CO2 difference (model-observation) across measurement platforms, tropospheric layers and regions.

Our results demonstrate the largest mismatch variability of aircraft (~-0.01 ± 0.4 ppm) and OCO-2 (~ -0.34 ± 1 ppm) against ACTM over land in North America and Amazon sites (SAN, ALF, RBA, TEF) likely due to uncertainty in prior land CO2 flux constrained at lower troposphere (lowest level- 2 km). Additionally, best match of aircraft and OCO-2 against ACTM (mismatch less than -0.04 ± 0.3 ppm; ATom and -0.27 ± 0.4 ppm; OCO-2) is observed over background remote troposphere in Pacific and Atlantic regions. However, in southern ocean ATom measurements showed better concurrency with ACTM (mismatch ~ 0.06 ± 0.15 ppm) as compared to OCO-2 XCO2 (mismatch ~ -0.06 ± 0.7 ppm). In all the regions, we observe that the aircraft tropospheric column (lowest level-8 km) and OCO-2 XCO2 pattern matches well with ACTM, but there is more systematic bias in OCO-2 as compared to aircraft in ACTM.

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