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The seasonal cycle of atmospheric CO₂ in the southern hemisphere over the last ten years seen by GOSAT

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In the southern hemisphere, the sparse coverage of in-situ CO₂ measurements prevents a robust determination of regional carbon fluxes and leads to large uncertainties in inverse model results. Therefore, the extensive spatial coverage afforded by satellite CO₂ measurements is especially valuable there. By analyzing satellite measurements, new insights on the carbon cycle can be derived and carbon cycle models can be validated for the southern hemisphere.

Here, we present a comparison of atmospheric CO₂ data in Australia provided by the Greenhouse gases Observing SATellite (GOSAT) and the CarbonTracker (CT2019) inverse model from 2009 to 2018. We find that the seasonality of GOSAT CO₂ is different from that of CarbonTracker across much of the southern hemisphere. This discrepancy follows a clear seasonal pattern with the largest difference of ~2ppm between October and December. We investigate the origin of the discrepancy by utilizing the CO₂ components provided by CarbonTracker and different fire CO₂ emission databases. Further, we conduct several sensitivity studies by assimilating GOSAT CO₂ in the TM5-4DVar data assimilation system, and by transporting different surface fluxes through the TM5 transport model. Our results suggest that the underestimation of local and transported wildfire CO₂ emissions could cause the observed discrepancy in the seasonality of column CO₂ between GOSAT and inverse models such as CarbonTracker in the southern hemisphere.