Climatological variations of tropospheric CO_2 over the Asia-Pacific region observed by the CONTRAIL commercial airliner measurements

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We present spatial and temporal variations of tropospheric CO_2 over the Asia-Pacific region analyzed from 10 years of the CONTRAIL commercial airliner measurements. The CONTRAIL flights with the high-frequency CO_2 measurements have covered large part of the Asia-Pacific region. Here we address climatological variations of CO_2 from the boundary layer to the upper troposphere across the Asia-Pacific region toward comprehensive understanding of influence of Asian surface fluxes under the varying seasonal meteorology. Highlights of this study are summarized as follows. (1) Seasonally elevated and highly variable CO_2 is observed in East Asia to the North Pacific in spring. This is likely explained by active passage of eastward-tracking synoptic systems that sweeps the continental East Asia and uplifts the region’s CO_2 emissions up to the free troposphere. (2) The region-wide CO_2 decrease is obvious across the Asia-Pacific region and it is principally composed of CO_2 drawdowns originating in two distinct regions: boreal Eurasia and South Asia. We observed seasonally largest variability of CO_2 in the UT north of 40° N, likely due to heterogeneous spatial distributions of biospheric fluxes combined with sporadic convective vertical transport over the continent. Our observations also characterized distinct CO_2 depletion in the upper troposphere over South Asia as a result of strong South Asian biospheric uptakes and confinement in the Asian summer monsoon anticyclone. The development and decay of the anticyclone remarkably contributes to distributing CO_2 over the Asia-Pacific region. (3) As the cyclonic activity decays and the monsoon anticyclone develops from spring to summer, CONTRAIL measurements with highest data density over East Asia to the North Pacific serve as better constraints to CO_2 fluxes in East Asia in spring and those in South Asia in late summer.

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