Climatology of Spatiotemporal Variations of Tropospheric CO_2 Observed by CONTRAIL-CME

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CONTRAIL (Comprehensive Observation Network for Trace Gases by Airliner) is the ongoing project that measures atmospheric trace gases during intercontinental flights of Japan Airlines. Atmospheric carbon dioxide (CO_2) concentration is analyzed using Continuous CO_2 Measuring Equipment (CME) onboard the aircraft. From >10 thousands of measurement flights since 2005, extensive number of CO_2 data (~7 millions) along level-flight and ascent/descent tracks have been obtained, enabling us to well characterize spatiotemporal distributions of atmospheric CO_2 covering large part of the globe especially the Asia-Pacific regions. The CONTRAIL CO_2 data are available in ObsPack (partly) and by contacting PIs of the CONTRAIL project (complete dataset).

In this study, we define ΔCO_2 as a deviation from the long-term trend observed at a northern hemispheric baseline station Mauna Loa, Hawaii (data provided by NOAA's flask-based measurements), to illustrate climatological CO_2 distributions including seasonal and shorter-term variations. For instance, over the Tokyo Narita International Airport (NRT), Japan, ΔCO_2 reaches seasonal maximum at late April to early May with higher values near the surface. In this season, high ΔCO_2 spreads east of the Asian continent in the upper troposphere over the northern Pacific. In contrast, seasonal minimum of ΔCO_2 occurs in September. The summertime low ΔCO_2 appears to be more pronounced over the Asian continent than over the Pacific, and the summer seasonal minimum tends to be lower in the upper troposphere than the lower troposphere over areas in the continental outflow such as NRT. Likewise, we highlight different seasonal variations/vertical profiles of tropospheric ΔCO_2 over various airports in different regions and spatial distributions in the upper troposphere in large-scale perspective, to discuss them from viewpoints of seasonally varying continental sources/sinks and atmospheric transport.

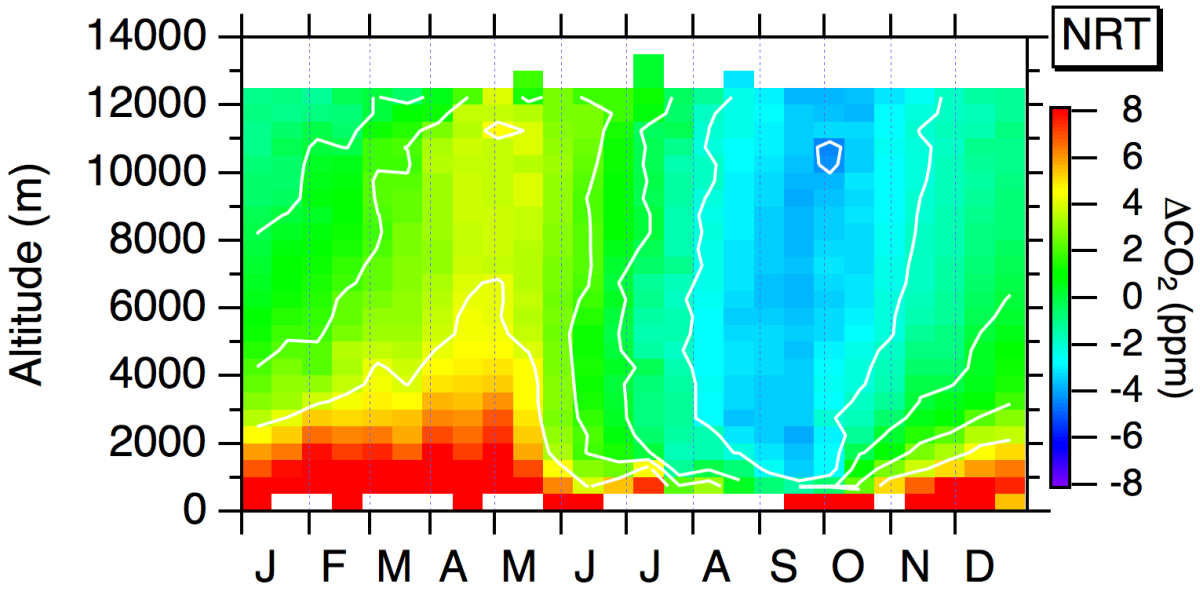

Figure 1. An altitude-time cross section of ΔCO_2 (deviation from the long-term trend at Mauna Loa) over the Tokyo Narita International Airport (NRT).