

Seasonal variations of greenhouse gases observed in the free-troposphere using a C-130H cargo aircraft

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Atmospheric measurements of greenhouse gases (GHGs) are conducted mostly at ground-based stations. Therefore, spatial and temporal variations of GHGs in the free-troposphere are not fully understood. Since February 2011, Japan Meteorological Agency has operated air flask sampling measurements of carbon dioxide (CO₂), carbon monoxide (CO), methane (CH₄), and nitrous oxide (N₂O) using a C-130H cargo aircraft in cooperation with the Ministry of Defense. The aircraft flies from Kanagawa to Minamitori-shima over the western North Pacific once a month, collecting about 20 and 4 air samples during cruising and descending sections respectively. The cruising altitude is about 6 km, where all the measurements represent free-tropospheric concentrations. It was well captured that the seasonal cycle of the observed CO₂ concentration shows a maximum during April-May and a minimum in September. However, detailed seasonal patterns are apparently different in vertical from the surface to 6 km altitude. Especially, the steep vertical gradients of CO₂ are prominent during winter and spring seasons. It was also found that high-concentration events of CO appeared in the mid free-troposphere during the spring season. These characteristic features strongly suggest a large impact of Asian continental outflow on the greenhouse gases distributions in the free-troposphere. By comparing three-dimensional simulation results with the aircraft measurements, the East Asian emissions and structures of the Asian continental outflow are examined.

Keywords: greenhouse gases, aircraft observation, free-troposphere