

Variations of tropospheric methane over Japan during 1988-2010

UMEZAWA, Taku^{1*} ; GOTO, Daisuke¹ ; AOKI, Shuji¹ ; ISHIJIMA, Kentaro² ; PATRA, Prabir² ; SUGAWARA, Satoshi³ ; MORIMOTO, Shinji¹ ; NAKAZAWA, Takakiyo¹

¹Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University, ²Research Institute for Global Change, JAMSTEC, Yokohama, Japan, ³Miyaigi University of Education, Sendai, Japan

Mixing ratios of greenhouse gases and related trace gases have been measured using chartered and commercial aircraft in the lower to upper troposphere (LT and UT) over Japan by Tohoku University. We present variations of CH₄ during 1988-2010. The analysis is aided by simulation results using an atmospheric chemistry transport model (i.e. ACTM). Tropospheric CH₄ over Japan shows altitude-dependent interannual and seasonal variations, reflecting differences in air mass origins at different altitudes. The long-term trend and interannual variation of CH₄ in the LT are consistent with previous reports of measurements at surface baseline stations in the northern hemisphere. However, those in the UT show excursions from those in the LT. In the UT, CH₄ mixing ratios show seasonal maximum in August due to efficient transport of air masses influenced by continental CH₄ sources, while LT CH₄ reaches its seasonal minimum during summer due to seasonally maximum chemical loss. Vertical profiles of the CH₄ mixing ratios also vary with season, reflecting the altitude-dependent seasonal cycles. In summer, transport of CH₄-rich air from Asian regions elevates UT CH₄ levels, forming the uniform vertical profile above the mid troposphere. On the other hand, CH₄ decreases nearly monotonically with altitude in winter-spring. The ACTM simulations with different emission scenarios reproduce general features of the tropospheric CH₄ variations over Japan. Tagged tracer simulations using the ACTM indicate substantial contributions of CH₄ sources in South Asia and East Asia to the summertime high CH₄ values observed in the UT. This suggests that our observation data over Japan are highly valuable for capturing CH₄ emission signals, particularly from the Asian continent.

Keywords: aircraft observation, methane, troposphere, over Japan