Spatial and temporal variations of atmospheric methane concentration and its carbon and hydrogen isotopic ratios in the upper troposphere/lower stratosphere over the Eurasian continent observed by commercial airliner

*Ryo Fujita[1], Shinji Morimoto[1], Shuji Aoki[1], Toshinobu Machida[2], Yousuke Sawa[3], Hidekazu Matsueda[3], Yosuke Niwa[3], Kazuhiro Tsuboi[3], Keiich Katsumata[2], Takakiyo Nakazawa[1]

1.Center for Atmospheric and Oceanic Studies, Graduate School of Science, Tohoku University, 2.National Institute for Environmental Studies, 3.Meterological Research Institute

Aircraft observation campaigns over the northern high latitudes have been conducted to clarify the spatial and temporal variations of GHGs concentrations and their sources in the surfaces (Sugawara et al., 1996; Tohjima et al., 1997; Nakazawa et al., 1997; Paris et al., 2008); however, systematic time-series observations using aircrafts are still limited (Matsueda et al., 2002; Haszpra et al., 2012; Umezawa et al., 2012). In addition, there is no systematic and simultaneous observation for the atmospheric CH_4 concentrations and their isotopic ratios ($\delta^{13}C$, δD) in the upper troposphere/lower stratosphere over the northern high latitudes; except for a few studies using balloon flights and aircraft observation campaigns (Sugawara et al., 1997; Rice et al., 2003; Rö ckmann et al., 2011). In this study, we have conducted monthly air sampling on-board a commercial airliner between Europe and Japan from April 2012, and clarified the spatiotemporal variations of CH_4, $\delta^{13}C$ and δD in the upper troposphere/lower stratosphere over the Eurasian continent.
In the upper troposphere, CH_4 concentrations, $\delta^{13}C$ and δD showed no clear seasonal variations. In the lower stratosphere, on the other hand, CH_4 and $\delta^{13}C$, δD showed clear aniti-phase seasonal variations; seasonal maximum (minimum) of the CH_4 concentration ($\delta^{13}C$, δD) was found in November to January and seasonal minimum (maximum) was in spring. They can be explained by effective flushing of the lowermost stratospheric air with the tropospheric air in autumn and subsidence of the middle stratospheric air in spring (Sawa et al., 2015). Moreover, compact correlations of CH_4 with respect to $\delta^{13}C$ and δD were found in the lower stratosphere, suggesting the occurrence of reactions of CH_4 not only with OH, but also with Cl and $O(^1D)$.

Keywords: Methane, carbon and hydrogen isotopic ratios, upper troposphere/lower stratosphere, Eurasian continent

