

## Distributions and temporal changes of greenhouse gases in upper atmosphere observed by aircraft

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More accurate prediction for future levels of atmospheric greenhouse gases such as carbon dioxide (CO<sub>2</sub>) requires the quantitative understanding of global cycles in these gases. Precise spatial and temporal variations of these gases can reduce the uncertainties of flux estimation at earth's surface. The atmospheric observations of greenhouse gases, however, are not enough in several areas in the world. Measurements in upper atmosphere are, especially, quite limited compared to surface ones. The observed data in upper atmosphere are free from local sources and sinks and thus have representativeness in wide area/region. These data are also useful for validating the vertical transport of global transport models.

Aircraft is one of the most reliable tools to observe the atmospheric compositions in troposphere and lower stratosphere. We will present some examples of aircraft measurements conducted by Tohoku University (TU), Meteorological Research Institute (MRI) and National Institute for Environmental Studies (NIES), Japan. One is the observations of CH<sub>4</sub> concentrations from the lower to upper troposphere over Japan during 1988-2010 based on aircraft measurements from the TU. Second one is the systematic measurements of the atmospheric O<sub>2</sub>/N<sub>2</sub> ratio using aircraft over Japan since 1999 by TU. Last one is the observation project for greenhouse gases using commercial airliner (CONTRAIL) conducted by MRI and NIES since 2005.

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