10 Years of Observation for Greenhouse Gases by Commercial Airlines in the CONTRAIL Project

Y. Sawa[1], T. Machida[2], H. Matsueda[1], Y. Niwa[1], T. Umezawa[3,2], K. Tsuboi[1], K. Katsumata[2], H. Eto[4], D. Goto[5], S. Morimoto[6] and S. Aoki[6]

[1]Meteorological Research Institute, Tsukuba, Japan; +81-29-853-8538, E-mail: ysawa@mri-jma.go.jp
[2]National Institute for Environmental Studies, Tsukuba-City, Ibaraki, Japan
[3]Max Planck Institute (MPI) for Chemistry, Mainz, Germany
[4]Japan Airlines, Tokyo, Japan
[5]National Institute of Polar Research (NIPR), Tokyo, Japan
[6]Tohoku University, Sendai, Japan

Since 2005, we have conducted an observational project for atmospheric greenhouse gases using passenger aircraft of the Japan Airlines (JAL) named Comprehensive Observation Network for TRace gases by AIrLiner (CONTRAIL). The CONTRAIL deploys three measurement programs. (1) Successful operation of Continuous CO_2 Measuring Equipment (CME) over the past 10 years has delivered more than 7 million *in situ* carbon dioxide (CO_2) data points from over 10,000 flights between Japan and Europe, Australia, North America, and Asia. (2) Automatic Air Sampling Equipment (ASE) has collected more than 5,000 air samples in the upper troposphere mainly over the Western Pacific (i.e. flight tracks between Australia and Japan) since 1993 when the previous JAL observation project was initiated. (3) In April 2012, we started monthly flask samplings in the upper troposphere or lower stratosphere at high latitudes over the Eurasian continent during flights between Europe and Japan. These air samples were analyzed for various greenhouse gases such as methane, nitrous oxide or sulfur hexaflouride.

The 10-year CME observations enabled us to well-characterize spatiotemporal variations of CO_2 in wide regions of the globe especially the Asia-Pacific regions, and we present some of such examples. We found enhanced CO_2 growth rates of about 3 ppm/year during 2012-2013, although we need to consider the influence of irregular observation density in flight routes and time. Another example of an inter-annual variation is that we observed vertical CO_2 profiles significantly different over Singapore between October 2014 and October 2015. The elevated CO_2 in the lower troposphere in 2015 is attributable to the massive burnings in Indonesia.

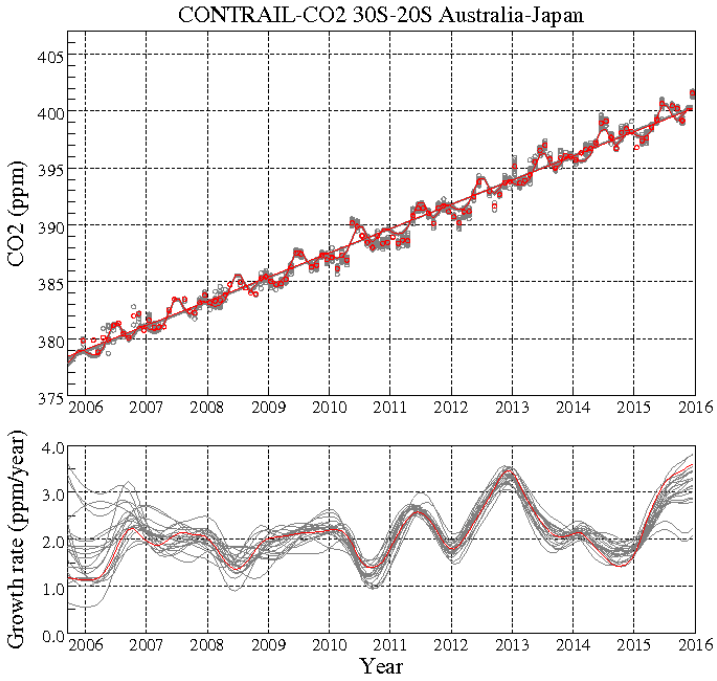

Figure 1. Observed CO_2 mixing ratios and growth rates at about 10 km for the latitude of 30S-20S during the flights between Australia and Japan. Red color shows mean values with all available data, while gray colors show those calculated from 20 cases with using only 30% of data by random collections.