Analysis of 13C and 18O isotope data of CO2 in CARIBIC aircraft samples as tracers of upper troposphere/lower stratosphere mixing and the global carbon cycle

http://www.firstlight.cn 2010-09-14

The project CARIBIC (http://caribic-atmospheric.com) aims to study atmospheric chemistry and transport by regularly measuring many compounds in the free troposphere and the upper troposphere/lowermost stratosphere (UT/LMS) by using passenger aircraft. Here we present CO2 concentrations and isotope results, and analyze the data together with supporting trace gas data. 509 CARIBIC-2 samples (highest precision and accuracy δ13C(CO2) and δ18O(CO2) data) from June 2007 until March 2009, together with CARIBIC-1 samples (flights between November 1999 and April 2002, 350 samples in total, 270 for NH, mostly δ13C(CO2) data) give a fairly extensive, unique data set for the NH free troposphere and the UT/LMS region. Total uncertainty of the data is the same as reported for the global monitoring program by NOAA-ESRL. To compare data from different years a de-trending is applied. In the UT/LMS region δ13C(CO2), δ18O(CO2) and CO2 are found to correlate well with stratospheric tracers, in particular N2O; δ18O(CO2) appears to be a useful, hitherto unused, tracer of atmospheric transport in the UT/LMS region and also inter-hemispheric mixing. By filtering out the LMS data (based on N2O distributions), the isotope variations for the free and upper troposphere are obtained. These variations have only small latitudinal gradients, if any, and are in good agreement with the data of selected NOAA stations in NH tropics. Correlations between δ13C(CO2) and CO2 are observed both within single flight(s) covering long distances and during certain seasons. The overall variability in de-trended δ13C(CO2) and CO2 for CARIBIC-1 and CARIBIC-2 are similar and are generally in agreement, which underscores agreement between high and low resolution sampling. Based on all correlations, we infer that the CO2 distribution in the NH troposphere along CARIBIC flight routes is chiefly regulated by uplift and pole-wards transport of tropical air up to approximately 50° N. The main reason for variability of signals in the troposphere (which is larger for the higher resolution sampling during CARIBIC-2) is mixing of different tropospheric air masses affected by different CO2 sources and sinks. The effect of stratospheric flux appears to be limited. All in all it is demonstrated that CARIBIC produced new important and reliable data sets for little explored regions of the atmosphere. A logical next step will be global scale modeling of 13C and especially 18O, which is linked to the hydrological cycle.

存档文本