Abstract

Atmospheric carbon dioxide (CO_2) is an important greenhouse gas in the climate system due to its infrared properties. It is necessary to predict the future global warming induced by the CO_2 increase in the atmosphere, but there are large uncertainties in estimating global sources and sinks deduced from atmospheric CO_2 variations with time and space due to a sparse monitoring network. To better understand the global carbon cycle, more observations based on long-term measurements have been encouraged under the Global Atmosphere Watch (GAW) program being implemented by the World Meteorological Organization (WMO).

CO_2 mixing ratios measured using a nondispersive infrared analyzer are determined based on standard gases. Thus, a common standard gas scale is essential for developing a compatible data set of CO_2 measurements collected from different groups around the world. The World Calibration Center (WCC) was established in the WMO/GAW to reduce differences of measurements among the monitoring stations due to different standard scales. International round-robin experiments of CO_2 standard gas cylinders were also initiated as a WMO/GAW activity to improve the measurement quality at GAW monitoring stations.

Since the 1980s, many standard gases have been used for long-term observation programs of atmospheric and oceanic CO_2 in the Japan Meteorological Agency (JMA) and the Meteorological Research Institute (MRI). In 1986, JMA established a calibration system with primary standard gases to propagate the CO_2 scale to secondary and working standards used for the JMA and MRI observation programs. The JMA primary standards were calibrated based on the WMO scale maintained at the WCC to compare with other GAW stations under the international standard scale.

A long record of calibration data for the standard gases is valuable for evaluating the quality of CO_2 measurements in JMA and MRI, but its history was not analyzed in detail before the present report. Thus, an aim of this report is to re-evaluate the scale and stability of CO_2 standard gases using the data set from the JMA calibration system. In the first part of this report, we primarily describe the CO_2 observation programs in JMA and MRI and the purposes of this study relating to the standard gases in detail. In the second part, we present several inconsistencies of the JMA primary standards based on the calibration records of MRI standard gas cylinders, internal comparison results, and international round-robin experiments. The third part reports the results from the detailed data analyses to discuss the CO_2 scale and its stability of the JMA standards. In the fourth part, we describe a new database for recording calibration measurements from 1987 to 2002; the database will be available for further data analysis in the future.