Continuous measurements of atmospheric CO₂ and its δ¹³C and δ¹⁸O at Minamitorishima Island

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The Minamitorishima (MNM; 24°17’ N, 153°59’ E) station is uniquely located to monitor background air at northern mid latitudes; the site is located on a remote coral island in the western North Pacific, about 1,950 km southeast of Tokyo. The Japan Meteorological Agency has been making long-term continuous observations of atmospheric concentrations of major greenhouse gases at MNM. For a better understanding of mechanisms governing the observed CO₂ variation, systematic measurements of atmospheric CO₂ and its δ¹³C and δ¹⁸O have been carried out at MNM by analyzing discrete flask air samples taken at the site since 2011. The existing measurement program was enhanced by initiating continuous measurements of CO₂ and its δ¹³C and δ¹⁸O using a laser spectroscopy (Off-Axis Integrated-Cavity Output Spectroscopy) in March 2018.

Sample air is drawn from an air intake mounted on a tower at 20-m height above the ground surface, and introduced into a continuous isotope analyzer (Model CCIA-48, Los Gatos Research) after removing water vapor and aerosol particles. The analyzer is calibrated hourly for the concentrations of each CO₂ isotopologue, using 3 air-based CO₂ standard gases with isotopic ratios of industrial CO₂ and different total CO₂ concentrations. The isotopic ratios of these standards were determined by a mass spectrometer, and the concentrations of each CO₂ isotopologue of the standards were obtained from the isotopic ratios. The total CO₂ concentration and its δ¹³C and δ¹⁸O of sample air are calculated from the measured concentrations of each isotopologue.

The obtained CO₂ isotopic data are scattered, and the precisions of the δ¹³C and δ¹⁸O values measured by this analyzer estimated from hourly measurements of a target gas, which is dried natural air compressed into a 48-L gas cylinder, are about 10 times and 5 times worse than those achieved by our mass spectrometer, respectively. However, the daily mean values of atmospheric δ¹³C and δ¹⁸O show day-to-day variations in concert with those of the total CO₂ concentration and prominent seasonal variations. The daily mean δ¹³C and δ¹⁸O show systematic difference from the isotopic values obtained from flask sampling on the same day. However, since the differences are almost constant, the nature of the variations are very similar in both cases.

In this presentation, results of the preliminary analyses of the daily mean CO₂, δ¹³C and δ¹⁸O data obtained from the continuous measurement will be presented. From comparison with the flask sampling results, the effectiveness of the continuous measurement will also be discussed.
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