

Topics over the Last 10 Years

4.1 Mountain-top Atmospheric Monitoring: Long-term Observation of CO₂ Concentration at the Summit of Mt. Fuji

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1. Introduction

The atmospheric temperature at present is approximately 1 °C higher than in 1880 and results from an increased concentration of atmospheric greenhouse gases (mostly CO₂). This increase in concentration was found by measuring CO₂ concentration at Mauna Loa Observatory (MLO) and the South Pole, where observations were started in 1958. Today, such measurements are made all around the world. Measurements are typically made at the summit of mountains or on isolated islands or capes, locations that are not affected by anthropogenic emissions or plant respiration. Observations made on mountain summits have the advantage that the atmosphere there is representative of CO₂ concentration over a wide area, unlike the atmosphere on isolated islands and capes. However, due to difficulties in transporting equipment and securing power on mountain tops, most observation sites are established and operated on isolated islands or capes.

2. History of CO₂ observation at the summit of Mt. Fuji

We installed the CO₂ measurement system in Mt. Fuji Weather Station at the summit in 2009. In fact, observation of CO₂ concentration was carried out at the summit in 1980-1981 and 2002-2004 by Tohoku University and the Japan Meteorological Research Institute, respectively. They reported that diurnal variation of CO₂ concentration was not observed and CO₂ concentrations observed on Mt. Fuji were in close agreement with several vertical profiles of CO₂ concentration derived from aircraft measurements over Japan. Therefore, it was suggested that observations obtained at the summit of Mt. Fuji could be considered representative of the tropospheric CO₂ concentration in the mid-latitude Asian region. However, observation at the summit was interrupted with the shutdown of manual operations at the station by Japan Meteorological Agency because it became difficult to maintain year-round observation at the station without a power supply and air conditioning.

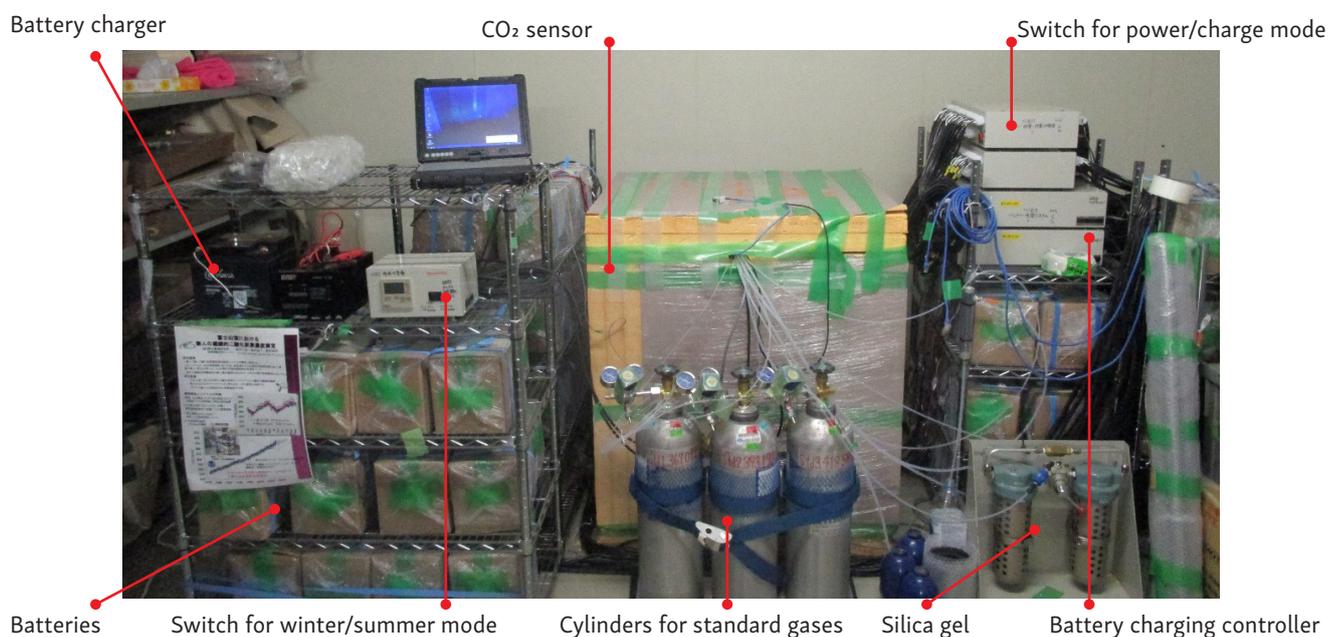


Fig. 4.1-1: CO₂ measurement system at Mt. Fuji Weather Station

3. Observation results of atmospheric CO₂ concentration

We developed a battery-operated CO₂ measurement system in 2009 and successfully observed atmospheric CO₂ concentrations at the summit of Mt. Fuji, despite the lack of a power supply and the severe low temperatures for 10 months of the year. The system consists of the main measurement component, power control devices for battery charging and power switching, and 100 batteries (Fig. 4.1-1). The main measurement component is covered with foam insulator and placed in a 100-L plastic insulated box to protect against temperatures below freezing. The 100 batteries are charged over a 3-week period in the summer (July-August) and the power stored by the batteries is used for observation in winter when power is not supplied to the station.

CO₂ concentration at the summit of Mt. Fuji was found to be lower in summer and higher in winter than at MLO (Fig. 4.1-2). The amplitude of variation at Mt. Fuji (18 ppm) was higher than that at MLO (8 ppm). In addition, ΔCO_2 (the difference in CO₂ concentration between Mt. Fuji and MLO) was found to be negative in summer and positive in winter (Fig. 4.1-3). The results suggest that CO₂ absorption and CO₂ emission were somewhat higher in summer and winter in Asia compared with other regions.

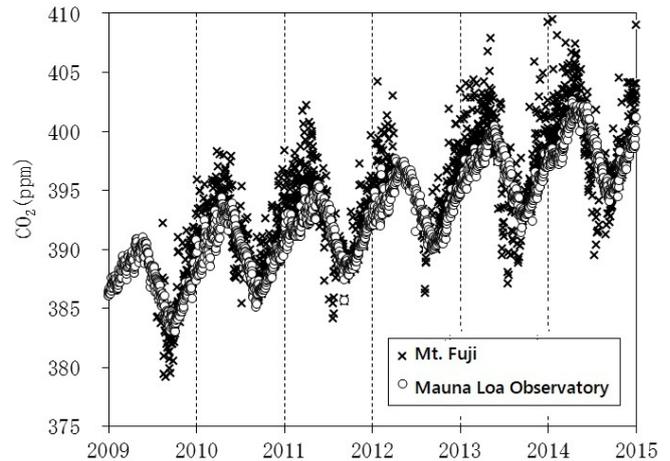


Fig. 4.1-2: CO₂ concentration at Mt. Fuji and Mauna Loa Observatory for the period 2009-2014

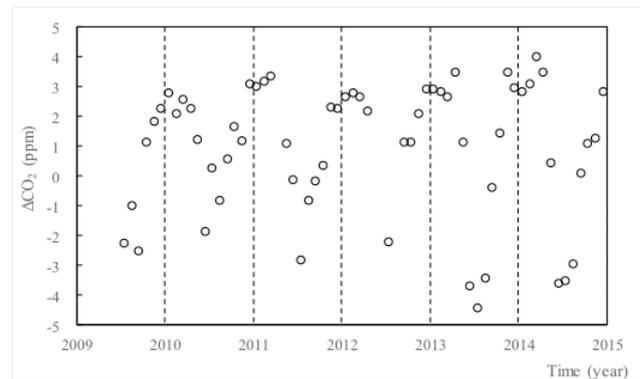


Fig. 4.1-3: ΔCO_2 concentration (difference in CO₂ concentration between Mt. Fuji and Mauna Loa Observatory)