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Numerical simulation of mountain air quality around Mt. Fuji during summer season

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Introduction

The atmospheric model research relating to the chemical observation at mountains in Japan is a few (e.g. Inomata et al., 2010; Osada et al., 2009). We have concerned atmospheric sulfate, which is a product of sulfur dioxide (SO_2) oxidations, among pollutants from the Asian continent, and have carried out the observational research by using Mt. Fuji (Igarashi et al . 2004; 2006; Igarashi et al., JAAST2008). It was confirmed, by the data analysis with a synoptic-scale transport model, that 1) the gaseous species observation at the summit of Mt. Fuji captures the free tropospheric nature through a year, 2) the summit is the best point to detect the Asian outflow of the pollution, and 3) the reproduction by the chemical transport model is effective and beneficial (Inomata et al., 2010). However, the conclusion obtained by simple meteorological analyses exhibited limitation for the observation results in Mt. Fuji during summer. The non-hydrostatic chemical transport model (WRF-chem) was applied to deepen the understanding of the interesting SO_2 variations observed at Mt. Fuji during summer (association with an oral presentation in the same session; Igarashi et al.), and the reproduction of the event was carried out in the present study.

Target events

There were two interesting phenomena in the summer of 2007. The first one is a diurnal variability of SO_2 in 7.8-gou (about 3200m asl). After August 5, 2007, the highest SO_2 concentration reached 1 ppbv for the period until the tenth August, and a remarkable diurnal variability was observed. The second one is SO_2 observation data at the summit of Mt. Fuji. The maximum concentration reached 5 ppbv during the end of August, 2007, and the recorded concentration level was comparable with those in winter that was brought by trans-boundary pollution event. It was found that the air parcel which reached the vicinity of the summit originated from the Asian continent by the backward trajectory analysis. There were other evidences that the air parcel responsible for the event was from the Asian continent. The high aerosols number concentration (Kobayashi et al., 2010) and high radon concentrations (Nagano, Kojima, KEK Proc. 2009-8) were observed at the same time, synchronizing with an early southward shift of the autumnal rain (Shurin) front in summer.

Reproduction and analysis by WRF-Chem model

In order to explain transportation and the variation of SO_x concentration level around Mt. Fuji during summer, which are influenced by mountain and valley winds that were not clarified by simple data analysis so far, the reproduction of the above-mentioned phenomenon was performed by using chemical transport model coupled online with the non-hydrostatic meteorological model (WRF-Chem). Taking the transport event from the Asian continent into considerations, the most outside domain was set to cover the East Asian area, and the inner area with Mt. Fuji as the central point was set by nesting procedure in the calculation. JCAP II emission inventory (Chatani et al., 2011) were used for a detailed domestic inventory. The REAS inventory data (Ohara et al., 2007; Kurokawa et al., 2009) were used for the Asian inventory. The model performance for the mountain air quality was examined by comparing the numerical results with the SO_2 concentration, etc. observed during the summer of 2007.

Keywords: Mountain air qual, Non-hydrostatic model, WRF-chem, Mt. Fuji