Intercomparisons of water vapor vertical column amount and vertical distribution observed by ground-based remote sensing techniques

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Water vapor plays a key role in determining the Earth's climate, accounting for about 60% of natural greenhouse effects. Ground-based remote sensing techniques are thought to be useful for regular continuous observations of water vapor vertical column amount (Precipitable Water Content; PWC) and vertical distribution in the troposphere. However, their quantitative evaluation is limited. Under such circumstances, simultaneous observations using three ground-based microwave radiometers (WVR1125, MP1502, MP1504) were conducted on December 22-31, 2015. In addition, simultaneous observations using a set of four Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) instruments directing toward different azimuth angles (called 4AZ-MAXDOAS) and a CIMEL sunphotometer of NASA AERONET were also conducted. First, we focused on seven days from December 25 to 31, when the weather was relatively stable, to estimate PWC differences using WVR1125 as a standard. Comparisons between the three microwave radiometers showed relatively large systematic differences by about 20%, due to uncertainty in calibration constant. On the other hand, the differences of CIMEL and 4AZ-MAXDOAS from WVR1125 were as small as below 10%. Based on these results, we analyzed data taken on December 22-24 and found that large differences, which cannot be explained by uncertainty in the calibration constant, occurred during and after the rain. This was thought to be due to interferences by raindrops in air and on a radome of the microwave radiometer. This effect lasted in 12 hours after rains stopped. In addition, we found that just before rainfall, MAX-DOAS PWCs were much smaller than those of microwave radiometer. This is suggested to be due to advection of water-rich air into heights (7-8 km), to which the sensitivity of MAX-DOAS observation is weak.

Keywords: Water vapor, microwave radiometer, MAX-DOAS, CIMEL

