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SOWER (Soundings of Ozone and Water in the Equatorial Region): LIDAR observed TTL cirrus clouds and aerosols at Biak, Indonesia in January 2011

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Cirrus clouds and aerosols were observed by Mie scattering depolarization lidar at Biak, Indonesia through SOWER campaign period from 6th to13th in January 2011. We used two lidar wavelengths at 1064 nm and 532 nm to observe Mie backscattering coefficient by cirrus clouds and aerosols. Depolarization ratio is also observed at 532 nm. Enhanced aerosol was observed just above the tropical cold point tropopause by the observations of this campaign. The aerosols have one or two layers structure during the campaign period. The width of the layer was 1-2 km. The depolarization ratio of the layer was very small (or nearly zero), and the backscattering Angstrom exponent is ~1. These results are suggesting that the aerosol layer was mainly composed of sulfuric acid droplet particles. This suggestion was supported by the observation by balloon borne OPC (optical particle counter) with heated inlet launched in the same SOWER campaign. It was observed that the most of the enhanced aerosol particles in this layer evaporated at the temperature 200C. The backscattering coefficient of the layer was about five times larger than the background aerosols. This enhancement is much larger than the usually observed variation in the background aerosols, and is further suggesting that the aerosols probably originated from some volcanic eruption. There were two relatively large scale volcanic eruptions in Java Island in late October (Merapi) and in late November (Tengger Caldera), 2010. The volcanic clouds from these eruptions are candidates for the origin of the aerosol layers. We observed a case that a cirrus cloud layer was formed within this enhanced aerosol layer. The number concentration and ice water content (iwc) of the cirrus cloud particles were estimated by assuming that the mode radius of the particles is ~10 micro-meter, and the shape of the particles are spherical. The estimated number concentration of the cloud particles is ~1000 /m^3. The estimated iwc is less than 10% of the saturation water vapor concentration of the same height level of the cloud. If we assume that all the ice particles were formed from vapor phase at the same height level (or in situ), this estimation implies that relative humidity over ice before the ice formation is less than 110%, if the humidity over ice is ~100% at the height of the cirrus cloud. Balloon borne humidity sensors (CU-CFH and FLASH) were launched in the campaign. The observed maximum humidity over ice within the aerosol layer was almost around this assumed value. The estimated number concentration is three orders smaller than the number concentration of OPC observed evaporating aerosols. The estimated relative humidity over ice is much less than the critical humidity for the homogeneous ice formation in the solution droplet aerosol particles. These results are indicating that cirrus cloud particles did not form within the observed evaporating (liquid solution) aerosols homogeneously.