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Volatility and conposition of aerosol in tropical stratosphere and TTL

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1. Introduction

Global circulation of atmosphere transports ozone, water vapor, methane and other constituents. Air flow from Tropical Tropopause Layer (TTL) to stratosphere passes cold tropopause. Water vapor condenses on ice nucleus and form large scale cirrus in the TTL because of cold conditions, and dehydrated air flows into the stratosphere. On the other hand, super saturation over ice was sometimes observed in TTL. Then, it is important to know aerosol compositions and their ability as ice nuclei in the TTL to understand the budget of water vapor in the atmosphere. So, we performed balloon borne observations at Biak, Indonesia in January 2011, 2012, and 2013 in order to understand aerosol size distribution and constituents in the stratosphere and TTL over western Pacific region.

2. Observation

We planned to estimate aerosol compositions from volatility observations, using dual OPCs. One of OPCs observes size distributions under ambient condition, and other one observes size distributions under heated condition through thermo denuder. OPC have ten size thresholds, 0.3, 0.4, 0.5, 0.66, 0.8, 1.2, 2.0, 3.4, 7.0, and 11.4 um in diameter for spherical particle with refractive index of 1.40. Air sampling rate is 3.0 liter/minute. Thermo denuder was constructed with a stainless steel pipe with diameter of 5 or 8 mm and a mantle heater with heating length of 50cm. Temperature of the mantle heater was controlled at 100 to 300 degree Celsius with step of 50 degrees. Laboratory experiments for test particles under 1 atm were examined and volatile temperature under TTL and stratosphere were estimated to be 100 degree Celsius for sulfuric acid, 150 or 200 degrees for ammonium sulfate and/or ammonium bi-sulfate, and more than 300 degrees for sea salt.

Dual OPCs were launched from the observatory of LAPAN in Biak Indonesia (1^o10'S ,133^o6'E) on Jan 10th, 2011 (200^oC), on Jan. 10th (200^oC), 11th (150^oC), 12th (100^oC) in 2012, and on Jan. 9th (200^oC), 10th (300^oC),,11th (250^oC)in 2013.

3. Results

a) Volcanic aerosols

An enhanced aerosol layer with concentrations of several 10s thousands particles/g-air for 0.3 um diameter was found around cold point tropopause and also found non-volatile particles with about 1 um in 2011. These layers are inferred to be volcanic layer by eruption of Mt. Merapi in November 2010. Aerosol layers with enhanced sub-micrometer aerosol concentration were also observed in the stratosphere, around 20 km, in 2012. The enhancement may be caused by eruption of Mt. Nebro in June 2011.

b) Composition of aerosols in TTL and stratosphere inferred from volatility

Major constituent of aerosol in TTL was inferred to be partially neutralized sulfuric acid, and non-volatile constituent was also included about 5 % in number concentration with 0.3-0.8 um. Cloud layers associated with convective clouds include more non-volatile constituent than in normal TTL. It is inferred that major components of stratospheric aerosol layer was sulfuric acid and also includes non-volatile constituents less than 5 % in number concentration of sub-micron particles. These results suggest that non-volatile constituent, sea salt, transported into TTL by convective clouds and transported to stratosphere through TTL.

Keywords: Tropical Tropopause Layer, aerosol, volatility, cirrus