【Grant-in-Aid for Scientific Research (S)】

Integrated Disciplines (Environmental Science)

Title of Project : Synthesis of Dynamical and Chemical Descriptions on the Atmospheric Processes in the Tropical Tropopause Layer

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Research Area : Environmental science
Keyword : Atmospheric transport processes

【Purpose and Background of the Research】

Atmospheric minor constituents are transported into the stratosphere (ST) through the Tropical Tropopause Layer (TTL) and return to the troposphere in high latitudes. Chemistry climate models simulate gross features of the general circulation. The dehydration processes taking place in the cold TTL environment and the stratospheric age of air, however, are not well reproduced due to the lack of knowledge on underlying mechanisms.

The stratospheric processes are characterized by interactions among radiation, dynamics and chemistry. It is thus necessary to attain a synthetic view in order to understand stratospheric changes on a global scale. The purpose of this study is to synthesize views on atmospheric dynamics and chemistry by conducting comprehensive observations, analyses and numerical simulations.

【Research Methods】

Our dynamics group (SOWER) has been carrying out campaign observations focusing on the TTL dehydration. Chemistry (cryogenic air sampling) group has been working on the long-term changes in the age of air by detailed analyses of air samples collected in the ST. A field campaign is scheduled at Biak (1.17° S, 136.06° E) as collaborations of these groups together with LAPAN, Indonesia. Intensive observations are planed with launches of cryogenic samplers and aerosol samplers on board thin-film high-altitude balloons under continued operation of a ground-based Mie lidar. Special sondes such as CO_2, ozone, frostpoint hygrometers, cloud particles, and Optical Particle Counters (OPCs) with the inlet-tube heating capability are launched to get comprehensive data on TTL dehydration.

Air samples are analyzed to derive mixing ratio, isotopic ratio, and isotopomers of varieties of minor constituents to study chemical changes taking place in the air ascending in the ST. The results are compared with those observed by US-lead aircraft project (ATTREX) having been conducted in February-March 2014. The aerosol samples are analyzed by an environmental electron microscope to study the function of aerosols on ice formation.

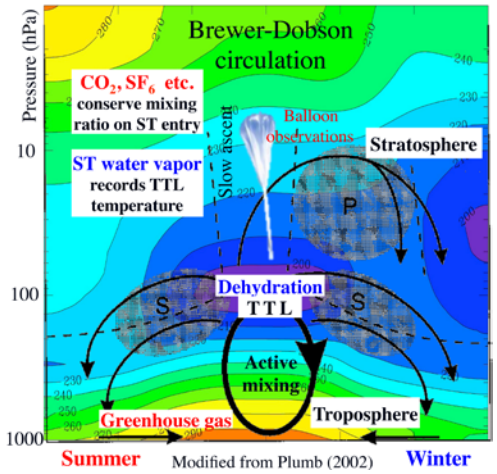

Figure 1　Scope of the study

【Expected Research Achievements and Scientific Significance】

Efficiencies of homogeneous and heterogeneous ice nucleation will be studied as a function of the degree of supersaturation and size distributions of aqueous and solid sulfate aerosols. Independent estimates of the age of air, one derived from CO_2 mixing ratio and the other from water vapor profile, will be compared to see mutual consistency and with diagnosis from chemistry climate models.

The results are brought into non-hydrostatic cloud-resolving models to improve knowledge of stratospheric change and the reliability of models.

【Publications Relevant to the Project】

Aoki *et al.*, 2003: *Tellus*, **55B**, 178-186.
Hasebe, 2012: *Tenki*, **59**(9), 788-796.
Shibata *et al.*, 2012: *J. Geophys. Res.*, **117**, D11209, doi:10.1029/2011JD017029.

【Term of Project】 FY2014-2018

【Budget Allocation】 138,400 Thousand Yen

【Homepage Address and Other Contact Information】

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