

Variations of minor constituents in the tropo-stratosphere studied with multi-station balloon and lidar observations

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1. Introduction

We have conducted water-vapor and ozonesonde, and lidar observations at the stations located over the Pacific, Indonesia and the Indochina Peninsula for the purpose to understand the dehydration and mass exchange processes in the Tropical Tropopause Layer (TTL) as an activity of the Soundings of Ozone and Water in the Equatorial Region (SOWER) project. In this paper, we introduce our recent results obtained from the observations.

2. Long-term variation in water vapor

Using SOWER campaign data during 1998-2010 together with data from other tropical campaigns during 1993-2009, water vapor variations in the tropical lower stratosphere at interannual and decadal time scales are investigated. Significant variations associated with the quasibiennial oscillation and decadal-scale variations with a drop around the year 2000 and gradual increases in the late 2000s were confirmed for the first time using in situ data.

3. Multi-station observation of dehydration process

SOWER campaigns have made several tens of successful water vapor observations in the western tropical Pacific. Variations of the observed water vapor mixing ratio in the TTL are examined in terms of the origin of the air parcels and by the minimum saturation mixing ratio of the air parcels being exposed during horizontal advection inferred by a bundle of isentropic trajectories. A preliminary analysis suggests occurrences of dehydration process consistent with the 'cold trap' hypothesis.

4. Dehydration and cirrus clouds formation

Cirrus clouds were observed by lidar at Bandung in 2003 and 2004 and Biak in 2006 or later as part of SOWER campaign. Cirrus clouds were simultaneously observed with water vapor by CFH near tropopause height for 17 balloon launches. In most cases, a few ten % (max. ~90%) of super saturation over ice was observed at the height where cirrus clouds were observed.

5. Ozone variation in sub-tropics

We have accumulated the ozonesonde data since September 2004 in Hanoi, Vietnam located on the base of the Indochina Peninsula. These data showed a clear seasonal variation of ozone mixing ratio with larger values in summer and smaller in winter in the upper troposphere and lower stratosphere (UTLS) region. This variation was caused by a seasonal difference in the origin and

transportation path of the air parcel observed at Hanoi.

Keywords: Stratosphere Troposphere Exchange, Tropical Tropopause Layer, Dehydration, SOWER, Water vapor and ozonesonde