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Vertical profiles of atmospheric temperature between upper troposphere and mesosphere obtained from Rayleigh/Raman lidar

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Atmospheric gravity waves (AGWs) propagating upward from lower atmospheric sources play a dominant role in transportating and depositing energy and momentum from upper troposphere (UT) to lower mesosphere (LM). Particularly, in polar region, these effects of AGWs are well-known to strongly decelerate the polar night jet and drive large scale meridional circulation from the summer pole towards the winter pole. In addtion, it is suggested that considerations of the realistic propagation property of AGWs may largely improve a significant bias of climate model. Therefore, investigation of the activity of AGWs between UT and LM based on continuous observational studies can be regarded as one of important isuues.

The National Institute of Polar Research (NIPR) is leading a six year prioritized project of the Antarctic research observations since 2010. One of the sub-projects is entitled 'the global environmental change revealed through the Antarctic middle and upper atmosphere'. As a part of the sub-project, a Rayleigh/Raman lidar (RR lidar) was installed at Syowa, Antarctica (69S, 39E) in January, 2011. The operation has been conducted since February 2011 and the RR lidar has kept measuring temperature profiles continuously between approximately 10 and 80 km for almost 3 years.

The RR lidar system in Syowa can obtain photon count data for 4 channels simultaneously, and each data is recorded separately in binnary format. The data from 3 channeles, i.e., Raman (10-30km), Rayleigh-Low (20-65km), Rayleigh-High (30-80km), corresponding to differenet height ranges are used for estimations of temperature profiles from UT to LM. In oreder to estimate height continuous profiles of atmospheric temperature based on the 3 different channeles, we are examing the following analysis methods. (1) The temperature for Rayleigh-High and Rayleigh-Low channels estimated by solving the lidar equation can be assigned to temperature at an initial height for the lidar equation in Rayleigh-Low and Raman channels, respectively. (2) The initial heights for the lidar equation can be determined automatically taking into account time and height dependent shot noises due to background luminosity. (3) The error propagations from the initial height to lower heights are evaluated by assigning artificial temperature offset ranging from -50 to 50 K.

The height continuous temperature profiles between UT and LM obtained from improved analysis methods would allows us to investigate important scientific issues such as temporal and height variabilities of potential energy per unit mass of AGWs and the relationship between occurrence of Polar Stratospheric Clouds and background atmospheric temperature. In this presentation, we will report the detail of the analysis methods and future perspectives including open data base of temperature profiles.

Keywords: Rayleigh/Raman lidar, Atmospheric temperature, Mesosphere, Stratosphere, Atmospheric Gravity Waves, Polar Stratospheric Clouds