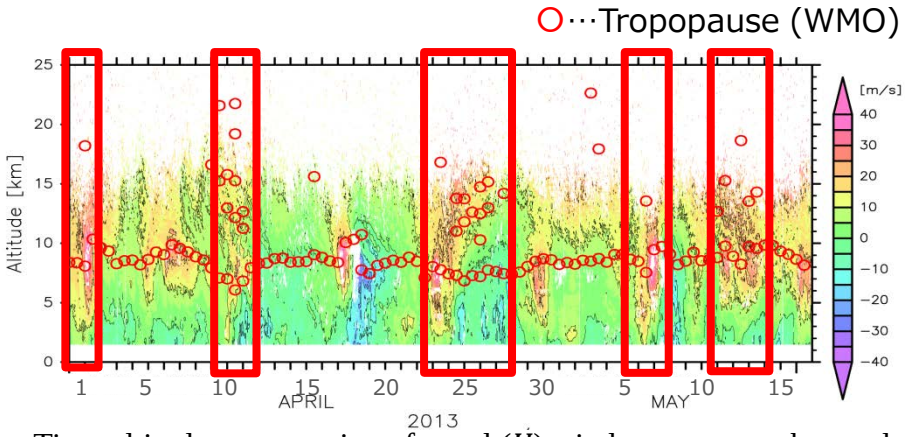
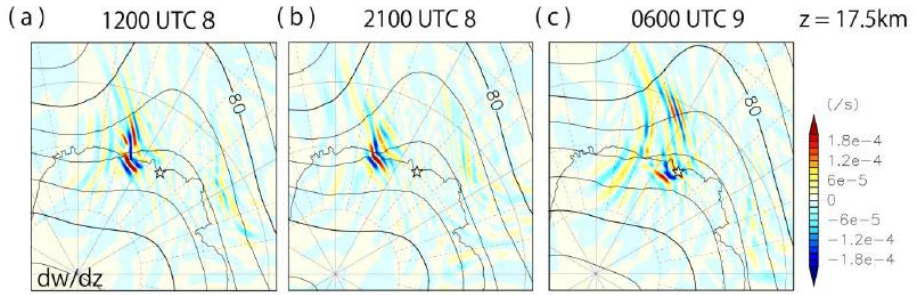
A study of multiple tropopause structures caused by inertia-gravity waves

- Multiple tropopauses (MT) defined by the World Meteorological Organization are frequently detected in autumn to spring at Syowa Station (69.0°S, 39.6°E). The dynamical mechanism of MT events was examined by observations of the PANSY radar, the first Mesosphere-Stratosphere-Troposphere radar in the Antarctic, and of radiosondes on 8–11 April 2013.
- By a detailed analysis of observational data, it is shown that the MT structure is composed of strong temperature fluctuations associated with linear inertia-gravity waves (IGWs).
- In the analysis using the numerical simulation data, these IGWs were likely radiated spontaneously from the upper tropospheric flow and were forced by strong southerly surface winds over steep coast.
- It is also shown that non-orographic IGWs associated with the tropopause folding event contribute to 40% of the momentum fluxes, as shown by a gravity-wave resolving general circulation model in the lower stratosphere around 65°S. This result indicates that they are one of the key components for solving the cold-bias problem found in most climate models.

(Shibuya et al., *Journal of the Atmos Sci*, accepted)



Time-altitude cross section of zonal ($\dot{U}$) wind component observed by the PANSY radar at Syowa Station (contour interval 10 m s^{-1}). The red circles denote the tropopause as determined by twice daily operational radiosonde observations.



Snapshots of horizontal maps of vertical gradient of vertical wind components and isobars at z =17.5 km at (a) 1200 UTC 8, (b) at 2100 UTC 8 and (c) at 0600 UTC 9 April 2013.. A star mark denotes the location of Syowa Station (69° S, 39.6° E). Contour intervals are 2 hPa in (a,b,c) and 8 hPa in (d,e,f). Note that gravity waves are characterized as atmospheric waves having significant *dw/dz*, which corresponds to the opposite of horizontal wind divergences.