Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PEM27-P23 Room:Convention Hall Time:May 26 18:15-19:30

New analysis of gravity wave in middle atmosphere by Rayleigh/Raman lidar at Syowa station in Antarctica

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The gravity waves are generated in lower atmosphere, propagate upward and transfer momentum to the middle atmosphere. It has been found that the gravity waves induce large scale meridional circulation and drive the middle atmosphere away from radiative equilibrium [Lindzen, 1981; Holton, 1982; Matsuno, 1982]. However, we has not completely known the quantification of gravity wave roles in the middle atmospheric circulation. In particular, it has not been found that the quantification of gravity waves generated from convection (e.g. polar night jet). A Rayleigh/Raman lidar was installed in January 2011 at Syowa station, Antarctica (69S, 40E). It has measured temperature profiled between approximately 8 and 70 km for more than 850 nights (before the end of October in 2014).

We have analyzed the lidar data based on Duck et al. (2001) and Alexander et al. (2011). However, their analysis has a problem. They estimated gravity waves' temperature amplitude to be the value (T') that is difference between background temperature and atmospheric temperature. Their analysis may underestimate the potential energy (Ep) due to not consider the phase. To solve the above problem, we calculated the value (T_h') delaying 90 degree from T' phase to perform Hilbert transformation on T′ weighted by the square root of density, and defined gravity waves' temperature amplitude as $((T')^2+(T_h')^2)^{1/2}$. In this presentation, our analysis will be explained in detail.

Keywords: Stratsphere, Mesosphere, Middle atmosphere, gravity wave, Antarctica, Lidar