Characteristics of Atmospheric Gravity Wave Activity in the Polar Regions Revealed by GPS Radio Occultation Data

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Using GPS radio occultation (RO) temperature data, we have studied the climatological behavior of atmospheric gravity waves in the lower stratosphere in both the Arctic and Antarctic regions. We used level-3 version 004 GPS RO data obtained by the CHAMP satellite from May 2001 to December 2005, which are processed by GFZ Potsdam. From the temperature profiles, we have calculated the background mean temperature, T_0, Brunt-Väisälä frequency squared, N^2 and temperature fluctuations, T' with vertical wave length shorter than 7 km and then determined E_p at 12-19 km, 19-26 km and 26-33 km. The E_p values are estimated every one month in a cell with $20° \times 10°$ in longitude and latitude and we determined the monthly mean E_p as a function of longitude, latitude and time (month) between 12-33 km.

In the Arctic region, E_p shows a clear annual variation with maximum in winter (December-February), which is consistent with the annual variation of vertical component of E-P flux, F_z estimated from the global objective analysis data. The large F_z value indicates higher planetary wave activity, which results in distortion of the polar vortex. Then, the unbalanced flow due to the distortion of the polar vortex can excite gravity waves through geostrophic adjustment. Our study has confirmed similarity in the horizontal distribution of E_p and the polar night jet. A good correlation between E_p and the divergence of EP-flux, ∇F, suggests that the active planetary wave generates gravity waves through planetary wave transience and/or breaking.

In the Antarctic region, E_p gradually increases from July to August/September and reaches maximum in early spring (September-October) before decreasing rapidly. Time derivative of V in term of month coincides with the peak of E_p, and the horizontal distribution of E_p has a very similar structure with V. An example is shown in Figure 1. These results suggest that the E_p enhancement is closely related to the decay of the polar vortex. Because ∇F correlates well with the E_p enhancement, planetary wave transience and/or breaking seems to be related to the gravity wave generation. In winter, considering a good correlation between E_p and F_z similar to the Arctic result, we assume that gravity waves are also generated by the planetary wave activity via geostrophic adjustment.

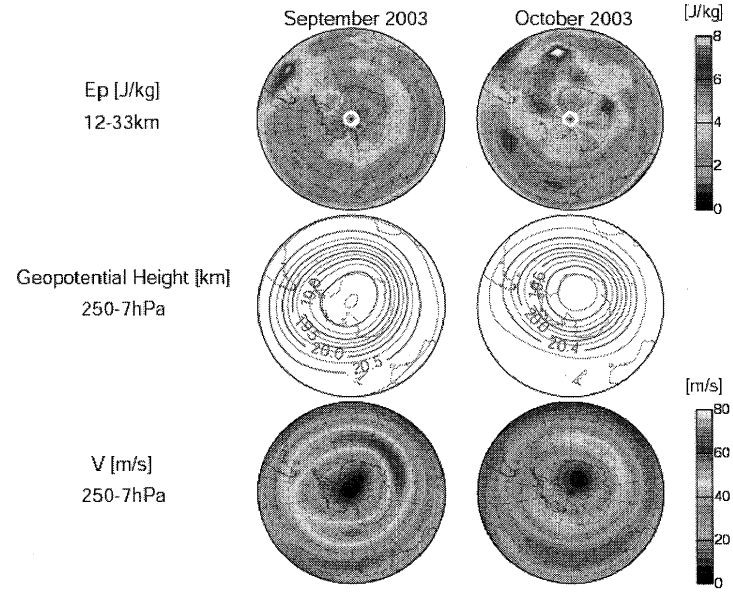

Figure 1. Distribution of E_p at 12-33 km (top), geopotential height at 250-7 hPa (middle) and V at 250-7 hPa. Right and left panels are the distribution in September 2003 and October 2003.