Climatological characteristics of atmospheric gravity waves in the polar regions analyzed by using GPS radio occultation data

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By using GPS RO data with CHAMP, we have studied the climatological behavior of the atmospheric gravity waves in the stratosphere in both the Arctic and Antarctic regions. In this study we used level-3 version 004 GPS RO data obtained by the CHAMP satellite from May 2001 to December 2005, which are processed at GFZ Potsdam.

In order to know the spatial and temporal variation of mean wind, surface wind (at 10 m above the surface), geopotential height, we referred to the ERA-40 and objective analysis at ECMWF.

From the GPS RO temperature profiles, we have calculated the background mean temperature, and temperature fluctuations with vertical wave lengths shorter than 7 km, then, we have determined Ep at 12-19 km, 19-26 km and 26-33 km.

The Ep values are estimated every one month in a cell with 20x10 degrees in longitude and latitude.

In the Arctic region, Ep shows a clear annual variation with a maximum in winter (December-February), which is consistent with the annual variation of Fz (E-P flux).

The large Fz value indicates the planetary waves are active, then, the planetary waves could waves distort the polar vortex.

Unbalanced flow due to the distortion of polar vortex can excite gravity waves through geostrophic adjustment.

Near the polar night jet, planetary waves are active, which excites the gravity wave, therefore, the Ep enhancement can be localized along the polar night jet.

Our study has confirmed similarity in the distribution of Ep and the polar night jet.

We also found a good correlation between Ep and DF, which suggests that the active planetary wave breaking is also effective in generating gravity waves.

To summarize, in the Arctic region the planetary wave breaking and/or geostrophic adjustment are important in understanding the enhancement of Ep.

In the Antarcic region, Ep gradually increases from July to September, and reaches the maximum in spring (September-October) before decreasing rapidly.

This seasonal variation is largely different from the Arctic result.

Time derivative of V in term of month coincides with the peak of Ep, and moreover, the horizontal distribution of Ep shows a very similar structure with V and the geopotential height.

These results suggest that the Ep enhancement is related to the decay of the polar vortex.

Because DF correlates well with the Ep enhancement, the planetary wave breaking seems to be related to the generation of gravity waves.

In winter months, we can recognize a good correlation between Ep and Fz.

They not only coincide but also have a quantitative consistency.

Like in the northern hemisphere, we can assume that planetary wave activity generates gravity waves via planetary wave breaking and/or geostrophic adjustment in winter months.