PANSY レーダーで観測された昭和基地上空の対流圏・下部成層圏重力波の解析

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An Analysis of Gravity Waves in the Troposphere and Lower Stratosphere Observed by the PANSY Radar at Syowa Station in the Antarctic

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Gravity waves mainly generated in the troposphere propagate into the middle atmosphere, deposit momentum, and drive the material circulation in the middle atmosphere (e.g. Plumb, 2002). Due to their temporally and spatially fine structure, observations of gravity waves are not easy, especially in the polar region. However the necessity of a quantitative analysis of gravity waves in the polar region based on observations has been widely recognized.

The PANSY (Program of the Antarctic Syowa MST/IS) radar, the first MST radar in the Antarctic, started its continuous operation with a partial system in April 2012 at Syowa Station (39.59°E, 69.01°S). The PANSY radar is a powerful observational instrument providing vertical profiles of vertical and horizontal winds with high time and height resolutions and good accuracy. The time series with such a high time resolution over a long time period allow us to analyze a wide ω range including an entire range of internal gravity waves from the inertial frequency [2π/(13 h) at Syowa Station] to a typical tropospheric Brunt-Väisälä frequency [2π/(10 min)] in case of negligible Doppler shift by the background wind. From October 2015 to September 2016, the full system observations were conducted. And the vertical and horizontal winds were obtained in an extended height region of 1.5 - 22 km, which enable the analysis of gravity waves in the lower stratosphere. The purpose of this study is to examine statistical characteristics and seasonal variability of the gravity waves in the polar troposphere and lower stratosphere based on the full system PANSY radar continuous observation data over one year corresponding to the 157680 point data in the temporal direction.

First, we analyze the frequency spectra for horizontal and vertical wind fluctuations (Fig.1). The spectra have peaks around the period of a few days in the upper troposphere (z = 7-9 km) and the period of a half day in the lower stratosphere (z ≧ 13 km). The peak around the half day period in the lower stratosphere is obvious in January, while it is obscure in July. Second, we estimate the momentum fluxes and variances associated with gravity waves by the method provided by Vincent and Reid (1983). The seasonal variances of the momentum fluxes and variances in the lower stratosphere are clear. They are larger in winter in the lower stratosphere, and smaller in summer, which is consistent with the previous study based on the radiosonde observation (Yoshiki et al., 2004).

Thanks to huge number of time series of PANSY radar observation, the intermittency of momentum fluxes associated with the gravity waves were quantified. The intermittency is important because it affects strongly the vertical distribution of gravity waves forcing. We also examined the seasonal and vertical variation of the intermittency.

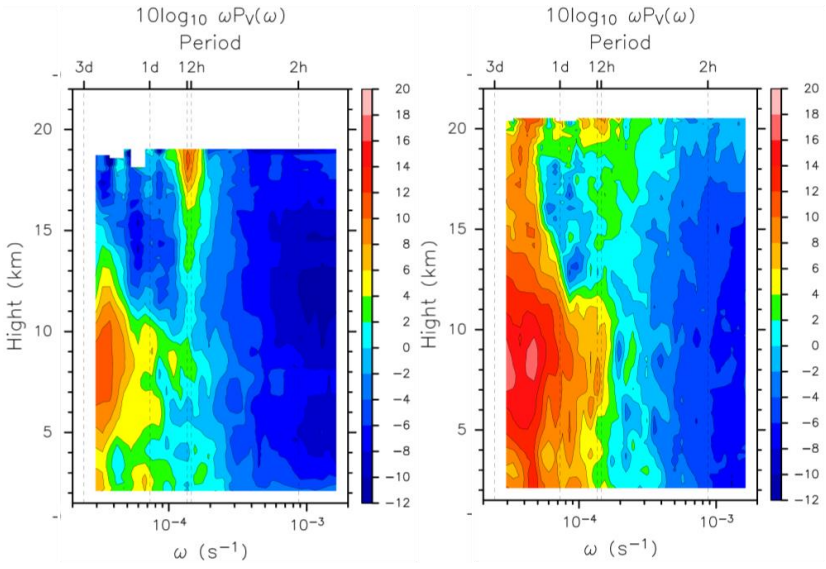

Fig1. Frequency spectra of meridional wind in January (left panel) and July (right panel) 2016