A statistical analysis of gravity waves over the Antarctic observed by the PANSY radar

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Gravity waves are atmospheric waves with small temporal and spatial scales, whose restoring force is buoyancy. They transport momentum in the vertical direction and are known to play significant roles to drive the stratospheric and mesospheric meridional circulation and equatorial large-scale oscillations including QBO. In the winter hemisphere, gravity waves are focused on the polar night jet, resulting in modulation of the position and strength and the jet (e.g., Sato et al., 2009). The purpose of this study is to clarify the seasonal changes in the dynamical properties of gravity waves at high latitudes in the Southern Hemisphere. We conducted a statistical analysis of gravity waves using the observational data from the PANSY radar at Syowa Station, Antarctic (69.0˚S, 39.6˚E; Sato et al., 2014) for 7 years (October 2015-September 2022). The radar can estimate 3-dimensional wind disturbances and momentum fluxes associated with gravity waves.
In this study, gravity waves are defined in two types of disturbances: disturbances with a vertical wavelength shorter than 6 km and those with a period shorter than 1 day. Climatology of kinetic energy and momentum flux at an altitude of 1.5-20 km was calculated for each disturbance.
The vertical flux of zonal momentum tends to be negative at an altitude of 1.5-3 km throughout the year, while at an altitude above 3 km, the sign of the zonal momentum flux depends on the background zonal wind. It is notable that strongly negative zonal momentum fluxes are observed at an altitude of 15-20 km from fall to spring. The vertical flux of meridional momentum tends to be negative at an altitude of 1.5-5 km throughout the year, and it is positive (negative) when the background wind is southward (northward) at an altitude above 5 km.
Since the PANSY radar can directly observe vertical wind, the intrinsic frequency can be statistically estimated from the ratio of the horizontal kinetic energy to the vertical kinetic energy. It has a local maximum at the tropopause and slightly below the tropopause (at an altitude of 6-9 km), and has a local maximum at an altitude of 15-20 km in summer. The value of the short-period disturbances was smaller than that of the short vertical wavelength disturbances, which indicates that the intrinsic frequency of the short-period disturbances was larger than that of the short vertical wavelength disturbances.

Keywords: large atmospheric radar, gravity waves, troposphere-lower stratosphere, Antarctic

