Comparison of wind frequency spectra between the ERA5 reanalysis and the PANSY radar

*Lihito Yoshida[1], Yoshihiro Tomikawa[2,1], Mitsumu K. Ejiri[2,1], Masashi Kohma[3], Kaoru Sato[3]

1. Department of Polar Science, School of Multidisciplinary Sciences, The Graduate University for Advanced Studies, SOKENDAI, 2. National Institute of Polar Research, 3. Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

Gravity waves (GWs) are generated by mountains, jet streams, etc., and propagate into the mesosphere. GWs do not only decelerate the mesospheric jet stream, but also affect the horizontal wind in the lower stratosphere, and the global meridional circulation. These effects are important for numerical weather forecast and climate prediction, but difficult to be reproduced in current climate models because spatial scales of GWs are smaller than the climate model grid. In order to reproduce the GW effects in climate models, it needs to be implemented into the models through GW drag parameterization. However, it is still incomplete because of no horizontal propagation in the GW drag parameterization scheme and lack of observational constraint in the Antarctic region.

The latest objective and reanalysis data can partially resolve GWs and estimate their momentum flux and energy, because their horizontal resolution significantly increased in the last decade. A recent study reported that the European Centre for Medium-Range Weather Forecasts (ECMWF) operational analysis reproduced a realistic horizontal distribution of momentum flux due to GWs but its magnitude was smaller than the observations by a factor of 3-5.

In this research, we evaluate how much GWs over Syowa Station (39.6E, 69.0S) are reproduced in the ERA5 reanalysis data by comparison with the PANSY radar observation. The ERA5 reanalysis is the latest meteorological reanalysis dataset provided by the ECMWF. The ERA5 data is distributed at 137 vertical levels from the surface to 0.01 hPa with a horizontal spacing of 0.25 degree every 1 hour. The PANSY radar is the only Mesosphere-Stratosphere-Troposphere (MST)/Incoherent Scatter (IS) radar in the Antarctic and was installed at Syowa Station in 2011. It can measure three-dimensional winds between 1.5 and about 22 km altitudes with a vertical resolution of 150 m and a time resolution of about 200 s. Thus, it can observe GWs in all frequency bands and estimate their momentum flux in the troposphere and lower stratosphere.

We compared frequency spectra of three-dimensional winds between the ERA5 reanalysis and the PANSY radar from January to March 2016. As a result, we found that the frequency spectra of horizontal winds in the ERA5 reanalysis coincided well with those of the PANSY radar in a frequency range lower than the inertial frequency. On the other hand, those in the ERA5 reanalysis were smaller than those of the PANSY radar in a frequency range higher than the inertial frequency. Also, we found that the frequency spectra of vertical wind in the ERA5 reanalysis were smaller than those of the PANSY radar in all frequency bands.

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