Reproducibility of gravity waves over the Antarctic in the ERA5 by comparison with PANSY

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Gravity waves are generated by mountains, jet streams, etc., and propagate into the mesosphere, which decelerate the mesospheric jet stream. Although this effect is essential in long-term forecast and climate change prediction, it needs to be implemented in models through gravity wave drag parameterization because of its smaller spatial scales than the model grid. However, it is still incomplete because of no horizontal propagation in the gravity wave drag parameterization scheme and lack of observations in the Antarctic region. Even the latest climate models cannot sufficiently reproduce the timing of polar vortex breakdown. Therefore, it is planned to perform meteorological observations of the Antarctic lower stratosphere with superpressure balloons, which can estimate the momentum transport by gravity waves. Since superpressure balloons move along with an air parcel on a constant density surface, this observation is the only way to obtain information of momentum flux and kinetic / potential energy for the entire period range (approximately 5 minutes to more than 10 hours) of gravity waves.

On the other hand, increasing resolution of the latest objective and reanalysis data encourages us to estimate the momentum flux and energy of gravity waves from them. It is reported that the European Centre for Medium-Range Weather Forecasts (ECMWF) operational analysis reproduced the horizontal distribution of momentum flux due to gravity waves, which was similar to but smaller than the observations by a factor of 3-5. It is probably because small-scale gravity waves cannot be represented in the ECMWF model. In addition, it is pointed out that the gravity wave drag due to small-scale gravity waves cannot be sufficiently reproduced in the WACCM model because the horizontal and vertical wind speeds do not follow the power law near the limit of the horizontal resolution of the model.

In this research, spectral features and gravity waves in the latest meteorological reanalysis data ERA5 are compared with various observations, and evaluated in their reproducibility (i.e., altitude and period dependence, and orographic and non-orographic difference). The primary purpose of this study is to carry out a preliminary survey of gravity wave features in ERA5 for comparison with the planned superpressure balloon observations in Antarctica around 2022.

We compared wind spectra and momentum flux spectra in the PANSY radar at Syowa Station, Antarctica, in Angular frequency band from 2π /7 [/d] to 2π /2 [/h]. As a result of comparison with PANSY, it was found that the horizontal wind spectra of ERA5 abruptly attenuates in a higher frequency region than the inertia frequency. It was also found that the vertical wind spectra do not match in almost all regions of the compared angular frequency bands.

Since the previous research compared superpressure balloon observations from September to December 2010 with the ECMWF operational analysis, we will investigate differences in gravity wave reproducibility using ERA5 during the same period. We also compare them with the data of brightness temperature disturbances obtained by AIRS onboard NASA's satellite Aqua.