Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AAS22-02 Room:301B Time:May 20 09:15-09:30

Propagation characteristics of gravity waves in the austral winter using the AIRS high resolution data

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Atmospheric Infrared Sounder (AIRS) on Aqua with horizontal resolution of 13.5 km at nadir has an ability to analyze gravity waves with a long vertical and short horizontal wavelength. Wave events from mountains (Eckermann et al., 2007) and convection (Grimsdell et al., 2010) with large amplitudes have been studied, although waves from jet-front system have not yet.

In the austral winter, it is expected that AIRS data can resolve (a) waves from the jet-front system, (b) waves travelling latitudinally (Sato et al., 2009), and (c) waves from small islands with a sharp mountain (Alexander et al., 2009). The momentum transport by waves of (b) and (c) that has not been included by gravity wave parameterizations so far is thought to play an essential role to improve the strength and seasonality of the polar night jet (McLandress et al., 2012).

In this study, the AIRS high resolution temperature data (Hoffmann and Alexander, 2009) from June to August 2004 was used. To reduce the noise, temperature anomalies at the height of 30 - 48 km were averaged. Then, the S-transform which is a one-dimensional wavelet transform was applied to data series cross (along) the satellite orbit. This procedure provides amplitudes, horizontal wavelengths, and wave vector directions of wave events with a direction up to 45 degrees from the cross (along) track direction. Finally, data that was considered from the noise is excluded.

A reanalysis data MERRA was used. To diagnose the occurrence of fronts at the lower troposphere, the frontogenesis function at 600 hPa was estimated.

The figure shows the amplitude of wave events averaged over the analyzed period. Large values are observed in regions of Andes, Antarctic Peninsula, islands, and over the Southern Ocean.

From the analysis of the frontogenesis function, two thirds of event grids with amplitude larger than 0.5 K are accompanied with fronts. It is thought that the jet-front system is a key for the generation of observed waves.

Grid numbers in the polar night jet were categorized with the wave vector direction and latitudinal westerly wind gradient at 30 hPa, U_y. Waves dominantly have a direction to the south in regions of $U_y < 0$, although grid numbers of waves directing northward are larger than southward where $U_y > 0$. It is consistent with the previous study that waves with no meridional wavenumber at initial propagate to the jet axis due to the latitudinal wind gradient (Sato et al., 2009).

Momentum flux with events near islands and that in the other regions will be quantitatively compared each other. To clarify the generation mechanism of observed waves, the relation to the tropospheric jet and to the development of synoptic-scale storms will be discussed.

Keywords: stratosphere, gravity waves, jet-front system, satellite data, S-Transform