Coordinated Observations between IMAP/VISI and Ground-based All-sky Imager on Concentric Gravity Wave in the Lower Thermosphere

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We report the first coordinated IMAP/VISI and ground-based all-sky imager observation of concentric gravity wave (CGW) in the mesosphere and lower thermosphere (MLT) region. The purpose is to clarify the causal relationship between the gravity wave in the MLT region and its source by examining the physical process of gravity waves, such as generation, propagation, and dissipation. The Visible and near-Infrared Spectral Imager (VISI) of the IMAP mission on the international space station (ISS) gives us a unique opportunity to investigate the distributions of airglow emissions at O_2 762 nm, OH 730 nm and OI 630 nm in a wide range along the ISS orbit with a resolution of 15 to 50 km. From the IMAP/VISI data, we found a CGW event in the O_2 762 nm emission data around ˜1200 UT on October 18, 2012 over northeastern part of Japan. The similar CGW patterns were also seen in the OH and OI 557.7 nm airglow image data taken with the all-sky image data at Rikubetsu (43.5N, 143.8E) during the period from ˜1100 to 1200 UT. From the successive images data at Rikubetsu, the horizontal wavelength, phase velocity and period of AGW in OH data are estimated to be ˜50 km, ˜105 m/s and 8.6 min., and those in OI 557.7 nm data are ˜51 km, ˜96 m/s and 9.2 min. On the other hand the horizontal wavelength in IMAP/VISI O_2 (762 nm) data is ˜67 km. In order to locate the source accurately, we fitted a round circle to the CGW pattern. The best fitted circle for O_2 762 nm data has a radius of ˜1400 km and the center is at [35N, 140E], and those for OH and OI 577.7 nm emissions are at [36N, 140E] and [35N, 140E] with the radius of ˜988 km and ˜1000 km, respectively. These results suggest that the CGW observed both with IMAP/VISI and Rikubetsu all-sky imager is generated by a same source. From the MTSAT and TRIMM data, the highly localized precipitation accompanied with deep convective activity happened around the center of CGW (up to 23.6 mm/h at 0300 UT), implying that this activity would generate the CGW.

In addition, the background wind profile in the lower atmosphere (0 to 31 km) was obtained from the National Centers for Atmospheric Prediction (NCEP) Reanalysis data and that in the MLT region (84 to 102 km) was obtained with the MF Radar at Wakkanai. The zonal wind velocity in the altitude range above the tropopause (12 to 31 km) varies between 5 to 33 m/s, much smaller than the apparent horizontal speed of CGW at the emission layers (˜96-105 m/s) estimated from the Rikubetsu all-sky data. Although there was no observation wind data in the altitude range of 32 to 83 km, it is likely that the background wind effect would be negligibly small considering the quite fast apparent speed of CGW (˜96 to 105 m/s). The background wind at OH layer (˜86 km) and O_2 emission layer (˜94 km) was dominated by southeastward wind direction with amplitude less than ˜50 m/s throughout the period of 1000 to 1300 UT. The relatively small background wind perpendicular to the propagation of CGW likely contributes to increase the CGW intensity from the dispersion theory. The arc-like shape may be distorted from the CGW pattern, which is caused by the interference between CGW and background wind.