

Ducted Concentric Gravity Wave Observed by IMAP/VISI Associated with Super Typhoon Haiyan

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Although the convection activity in the troposphere is generally accepted as one of important source of gravity waves in the mesosphere and lower thermosphere, however it is still uncertain how these waves can reach these regions and what types of waves are generated. For decades, the study of gravity waves has been classified into two categories; first is that the waves travel directly from the source and the second is that the waves are ducted or trapped. Many studies tried to explain both categories yet all studies focused on gravity waves produced by transient events. There were almost no observation reports of airglow emissions during a large storm and what type of gravity waves and typical wavelength can be produced from such event. To address this issue, a space-based observation is more preferable since it covers wider area. Until recently, IMAP/VISI is the only space-based instrument that capable of imaging gravity waves above the troposphere in the nadir direction. The Visible and near-Infrared Spectral Imager (VISI) of the IMAP mission was launched successfully on July 21, 2012 with H-IIB/HTV-3 and installed onto the International Space Station (ISS). IMAP/VISI is now operated in the night side hemisphere with a range of +/- 51 deg. GLAT. IMAP/VISI is measuring three different airglow emissions of OI at 630 nm, the OH Meinel band at 730 nm and the O₂ (762 nm) atmospheric band at 762 nm at an altitude of ~400 km with the typical spatial resolution of 16-50 km.

We found concentric gravity waves events in the southeastern part of Australia that was observed around 13-15 UT for 3 days from 6-8 November 2013 in O₂ (0-0) airglow emission by IMAP/VISI. The waves have horizontal wavelength vary from 80 – 210 km. By using the least squares method, the curvature of the waves was fitted to a perfect circle. The center of the wave was found to be around 155⁰E; -42⁰S with the radius varies from 400-1200 km. From the meteorological satellite, we cannot locate any convective source around the center of the wave. The nearby local convective source was located a few hundreds km to the south of the wave center and the rainfall rate was less than 10 mm/hr. Therefore, we rule out the possibility of local convective activity as the source of these waves. From the past studies, there were evidences that the gravity waves may be ducted and traveled a great distance away from a specific convective source (e.g. Nakamura et al., 1999; Walterscheid et al., 1999; Hecht et al., 2001). Their studies suggested that the gravity waves observed in Australia were originated from convective activity several thousands km north of Australia. During the observed events, the Typhoon Haiyan was underway. On November 6, the typhoon was categorized as 5 – equivalent of super typhoon and reached its peak on November 7 and then made a landfall in Philippine on November 8. In this study, we argue that the concentric gravity waves seen by IMAP/VISI could be generated by the intense convective activity associated with the Haiyan Typhoon event. Background wind data from TIDI (TIMED Doppler Interferometer) and MF Radar will be used to examine the plausibility for the formation of a ducted/trapped region that can explain the long distance propagation of these waves. The temperature profile from MSISE-90 model will also be used to examine the mesospheric inversion layer and if it's possible to get the data, we will also use the ground-based airglow imager data from Adelaide and Alice Spring.

Keywords: IMAP/VISI, O₂ (0-0), concentric gravity wave, ducted, typhoon Haiyan