

## Concentric gravity waves observed with IMAP/VISI on the international space station

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We report the recent results of IMAP/VISI, focusing on concentric gravity waves (CGWs) since CGWs is useful to examine causal relationship between the source in the lower-atmosphere and atmospheric gravity waves (AGWs) in the thermosphere. IMAP/VISI is a visible imaging spectrometer which measures nightglow emissions at O<sub>2</sub> (762nm, alt.=95km), OH (730nm, alt.=85km) and O (630nm, alt.=300km) from the international space station (~400 km alt.) covering +/-51 deg. in geographical latitude. Since the successful launch in August 2012, VISI continuously operates more than ten paths a day. VISI has two field-of-views (+/-45 deg. to nadir), and each field-of-view is 90 deg. width faced perpendicular to the orbital plane, which is mapped to ~600 km width at 95 km altitude and ~300 km width at 250 km altitude. Successive exposures with typical interval of 1.9 sec bring us line-scanning of airglow emissions with typical spatial resolution of 14 km.

We found more than 170 CGW events in O<sub>2</sub> 762 nm data obtained in 2013. The CGW events showed clear seasonal dependence maximized in spring and autumn, when the background winds are weak in the middle atmosphere. Prominent small-scale CGWs were seen around 0434 UT on June 1, 2013, about several hours after the Oklahoma tornado, which suggest the coupling between strong convection related with the tornado and the thermosphere. Another distinct CGW event seen in O<sub>2</sub> emission happened in the southeastern area of Australia around 13-15 UT for successive 3 days on 6-8 November 2013. We estimated the center of CGW by fitting a circle to CGW pattern, but there is no convective activity there. Thus, we discuss the possibility of ducted long-range propagation of AGW of which source is probably the strong Haiyan Typhoon close to Philippine. We also talk on the AGWs observed by IMAP/VISI and the Hokkaido SuperDARN HF radar.