Gravity Wave identification using GPS Total Electron Content in South East Asia

Sarthak Srivastava and Amal Chandran
Satellite Research Center, School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore
(sarthak002@e.ntu.edu.sg)

Ionospheric Total Electron Content (TEC) data from ground-based Global Positioning System (GPS) receiver networks have been used previously to detect Travelling Ionospheric Disturbances (TIDs). The TIDs have been shown to arise through coupling of lower atmosphere with the ionosphere with Gravity Waves as the coupling mechanism. Gravity Waves generated by earthquakes, tsunamis, volcanoes, topography, convection and even solar eclipses have been detected using GPS TEC data. In this study, we identify Gravity Wave signatures in GPS TEC data derived from the Sumatran GPS Array (SuGAr) network. SuGAr is a network of 49 ground-based GPS stations along the convergent plate boundary between Indo-Australian and Asian tectonic plates in western Sumatra, Indonesia. Since initiation in 2002, data from SuGAr has primarily been used to study earthquakes and plate-tectonics in south-east Asia. Due to its location along the seismically-active region, SuGAr can provide valuable data for studying co-seismic Gravity Waves triggered by terrestrial-atmosphere coupling. Frequent occurrence of deep convective clouds in tropical region implies that SuGAr data also provides a unique opportunity to study atmospheric waves generated by convection.

We have identified Gravity Waves across a wide spectrum corresponding to seismic and tropical convection events in Sumatran region. Upon identifying the wave signatures, we characterized the wave parameters and identified the wave sources through suitable ray tracing calculations. In this paper we show acoustic-gravity waves generated by the 2012 Sumatra great earthquake sequence consisting of 2 largest strike slip earthquakes ever recorded. Spectral analysis indicates the presence of fundamental resonant frequencies for solid Earth-atmosphere coupling. Using a geometric ray tracing method, we also trace the waves very close to the reported epicentres of the double earthquake sequence. We also discuss inertia-gravity waves generated due to convection in South-East Asia using SuGAr TEC data for 2018. Indication of deep convective clouds is confirmed through satellite-based cloud top brightness temperature data. Ray tracing is performed to further trace the observed waves to the convective system location.