URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Gravity Wave breaking at thermospheric altitude during tropical cyclone Amphan observed by GPS and GAGAN network

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The impact of various tropospheric extreme events has become a demanding area of scientific interest. Various low frequency atmospheric waves such as atmospheric gravity wave or acoustic wave are triggered by pushing convective plumes into the stratosphere. These waves with higher amplitude propagate upward direction with lower phase speed and dissipate and break into the mesosphere. A small part of these waves can somehow manage to reach the lower thermosphere containing very high vertical wavelength and low amplitude and propagates with a very high phase speed.

Here we have explored the properties of atmospheric gravity waves (GWs) which were generated by tropical cyclone Amphan during May 20 and 21, 2021. Fortunately, we found a very calm geomagnetic condition during the observation time. Conventional techniques for detection of gravity waves are extremely demanding in nature. Navigation-based methods can serve as an efficient and cost-effective alternative. The current study investigated a convective system generated gravity wave over Indian region based on the irregularities observed in GPS retrieved total electron content from Indian GAGAN and UNAVCO Bangladesh network.

We have detected the GWs propagating in a very high phase speed (greater than 200m/s) which indicates the possibility of propagation not below the thermospheric altitude or propagation by tunneling. A very high vertical wavelength greater than 150km which was modulated by neutral wind has also been detected. Generally secondary gravity wave forms when the momentum deposition occurs by the dissipation of primary gravity wave at the thermospheric altitude. We have used a ray tracing algorithm in varying background atmospheric parameters such as temperature, wind flow, neutral density to find the secondary source of the detected gravity wave. We have incorporated kinematic viscosity and thermal diffusivity in our ray tracing algorithm due to the very lower neutral density and high temperature in this medium. A secondary source above 100km altitude has been detected by reverse ray tracing on significant number of detected GWs. We also estimate the dissipation altitude by using momentum deposition calculation. This study explores a wide area of interest such as coupling mechanism between various atmospheric layers, wave propagation in high kinematic viscosity etc. in tropical region.