Tropical cyclone induced gravity wave perturbations in the upper atmosphere: GITM-R simulations

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The tropical cyclone induced concentric gravity waves (CGWs) are capable of propagating upward from convective sources in the troposphere to the upper atmosphere and creating concentric traveling ionosphere disturbances (CTIDs). To examine the CGWs propagation, we implement tropical cyclone induced CGWs into the lower boundary of Global Ionosphere–Thermosphere Model with local-grid refinement (GITM-R). GITM-R is a three-dimensional non-hydrostatic general circulation model for the upper atmosphere with the local-grid refinement module to enhance the resolution at the location of interest. In this study, we simulate CGWs induced by typhoon Meranti in 2016. Information of the TC shape and moving trails is obtained from the TC best-track dataset and the gravity wave patterns are specified at the lower boundary of GITM-R (100 km altitude). The horizontal wavelength and phase speed of wave perturbation at the lower boundary are specified to be consistent with the TEC observations. The simulation results reveal a clear evolution of CTIDs, which shows reasonable agreement with the GPS-TEC observations. To further examine the dependence of the CTIDs on the wavelength and frequency of the gravity wave perturbation at the lower boundary, different waveforms have been tested as well. The magnitude of CTIDs has a negative correlation with the period, but a positive correlation with the wavelength when the horizontal phase velocities are sufficiently fast against the critical-level absorption.