A link between high-speed solar wind streams and rapid intensification of tropical cyclones

*Paul Prikryl[1,2], Lidia Nikitina[2], Vojto Rušin[3]

1. Physics Department, University of New Brunswick, Fredericton, NB, Canada, 2. Geomagnetic Laboratory, Natural Resources Canada, Ottawa, ON, Canada, 3. Astronomical Institute, Slovak Academy of Sciences, Tatranská Lomnica, Slovak Republic

Physical processes responsible for changes of tropical cyclone intensity are not well understood [1]. To improve the current understanding of tropical cyclone structure and intensity changes the future research needs to focus on response to all external forcing [2]. We examined rapid intensification of tropical storms in the context of solar wind coupling to the magnetosphere-ionosphere-atmosphere system. Tropical cyclone "best tracks" in the southern and northern hemispheres are used in the superposed epoch analysis of time series of solar wind parameters. The results indicate that rapid intensification of tropical storms tends to follow arrivals of high-speed solar wind from coronal holes and coronal mass ejections [3]. The ensuing auroral and polar cap activity including ionospheric currents and ionospheric convection generates atmospheric gravity waves that propagate from the high-latitude lower thermosphere both upward and downward [4,5,6]. If ducted in the lower atmosphere, they can reach tropical troposphere. Despite significantly reduced wave amplitude, but subject to amplification upon reflection in the upper troposphere, these gravity waves can trigger/release moist instabilities to initiate convective bursts, with the latent heat release leading to intensification of storms [7]. Convective bursts have been linked to rapid intensification of tropical cyclones. Tropical cyclone intensifications are preceded by atmospheric gravity waves generated by the solar wind magnetosphere-ionosphere-atmosphere coupling process. The gravity waves are observed in the ionosphere as traveling ionospheric disturbances. Their propagation in the lower atmosphere is examined by ray tracing in a model atmosphere to show that they can reach tropical cyclones. It is suggested that the interaction of aurorally-generated gravity waves with the tropical cyclone vortex and the inner primary eyewall could play a role in the intensification process. Assuming that quasi-periodic convective bursts lead to vortex waves, a two-dimensional barotropic approximation [8] is used to obtain asymptotic solutions representing propagation of vortex waves. The absorption of vortex waves by the mean flow in the critical layer leads to formation of the secondary eyewall and ultimately to a process of eyewall replacement cycle, one of the well-established paradigms of intensity changes in tropical cyclones [9].

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Keywords: Solar wind-magnetosphere-ionosphere-atmosphere coupling, High-speed solar wind stream, Atmospheric gravity wave, Extratropical and tropical cyclones

