Solar wind influence on tropical cyclones mediated by atmospheric gravity waves

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Solar wind coupling to the magnetosphere-ionosphere-atmosphere (MIA) system generates medium- and large-scale atmospheric gravity waves (AGWs) propagating globally from sources in the lower thermosphere at high latitudes. The AGWs propagate globally [1,2] upward and downward, are observed in the ionosphere as traveling ionospheric disturbances [3], can be ducted in lower atmosphere over long distances and reach troposphere. At the reflection point in the troposphere they can trigger moist instabilities to initiate convective bursts, with the latent heat release leading to intensification of storms [4]. In the follow-up studies [5,6,7] it was shown that explosive extratropical cyclones and rapid intensification of tropical cyclones tend to follow arrivals of solar wind high-speed streams (HSS) and/or interplanetary coronal mass ejections (ICMEs). The coupling of solar wind to MIA is most intense during the arrivals of co-rotating interaction regions (CIRs) and/or interplanetary shocks at the leading edges of HSSs and ICMEs when the amplitudes of aurorally-generated AGWs are largest. Ray tracing of AGWs in a model atmosphere show that they can reach tropical cyclones. Spiral gravity waves in typhoons were observed and simulated to propagate radially outward from the typhoon core [8]. The spectra of waves in surface pressure and surface wind measured by the Impacts of Typhoons on the Ocean in the Pacific (ITOP) buoy during the nearby passages of intense typhoons are similar to those of incoming aurorally-generated AGWs. It is suggested that the interaction of aurorally-generated gravity waves with the tropical cyclone vortex and the inner primary eyewall plays a role in the intensification process.

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