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Severe weather in the context of solar wind coupling to the magnetosphere-ionosphere-atmosphere system

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Tropical and extratropical cyclones can intensify into the most destructive weather systems that have significant societal and economic impacts. Rapid intensification of such weather systems has been examined in the context of solar wind coupling to the magnetosphere-ionosphere-atmosphere (MIA) system. It has been shown [1,2] that explosive extratropical cyclones and rapid intensification of tropical cyclones tend to follow arrivals of high-speed solar wind when the MIA coupling is strongest. The coupling generates atmospheric gravity waves (AGWs) that propagate from the high-latitude lower thermosphere both upward and downward [3,4]. In the upper atmosphere, AGWs are observed as traveling ionospheric disturbances. In the lower atmosphere, they can reach the troposphere and be ducted [4] to low latitudes. Despite significantly reduced wave amplitude, but subject to amplification upon over-reflection in the upper troposphere, these AGWs can trigger/release moist instabilities leading to convection and latent heat release, which is the energy driving the storms. The release of conditional symmetric instability is known to initiate slantwise convection producing rain/snow bands in extratropical cyclones. Severe weather, including severe winter storms, heavy snowfall and rainfall events, have been examined in the context of MIA coupling [5]. The results indicate a tendency of significant weather events, particularly if caused by low pressure systems in winter, to follow arrivals of solar wind high-speed streams from coronal holes. In the present paper we review the published results and provide further evidence to support them. This includes the occurrence of heavy rainfall events and flash floods, as well as the rapid intensification of recent hurricanes and typhoons, with the goal to identify sources of AGWs at high latitudes that may play a role in triggering convective bursts potentially leading to such events.

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