

Rapid intensification of extratropical and tropical cyclones in the context of solar wind-magnetosphere-ionosphere-atmosphere coupling

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The Wilcox effect, a relation between solar wind magnetic sector boundary structure and mid-latitude upper tropospheric vorticity [1], was confirmed [2] pointing to a possibility that coupling between the solar wind and the Earth's magnetosphere, and ultimately the ionized and neutral atmosphere, can influence development of tropospheric weather. Recent results [3,4] that support such link are summarized and corroborated to show further evidence that explosive extratropical cyclones, and rapid intensification of tropical cyclones, tend to follow arrivals of high-speed solar wind streams from coronal holes or coronal mass ejections. Large amplitude magneto-hydrodynamic waves couple to the magnetosphere-ionosphere-atmosphere (MIA) system generating sources of medium-scale atmospheric gravity waves in the lower thermosphere at high latitudes. These gravity waves propagate upward and downward, and can be ducted in the lower atmosphere over long distances. Simulations of gravity wave propagation in a model atmosphere using the Transfer Function Model [5] show that propagating waves originating in the thermosphere can excite a spectrum of gravity waves in the lower atmosphere. In spite of significantly reduced amplitudes but subject to amplification upon reflection in the upper troposphere, these gravity waves can trigger/release instabilities present in the troposphere to initiate convective bursts. Convective bursts have been linked to intensification of tropical cyclones. The latent heat release leads to intensification of storms. Explosive extratropical cyclones identified from storm tracks in the meteorological reanalysis datasets, and rapid intensification of tropical storms from the best-track databases, are investigated in the context of solar wind coupling to the MIA system using the superposed epoch analysis. Cases of tropical cyclones are shown to illustrate, sometimes very close, correlation between the intensification of tropical storms and the solar wind structure. These results suggest that vertical coupling in the atmosphere exerts downward control from solar wind to the lower atmospheric levels influencing development of extratropical and tropical cyclones.

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(a) 1995–2016 WPac RI=50+ kt/24h

