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A link between high-speed solar wind streams and extratropical cyclones

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Databases of extratropical-cyclone tracks obtained from two meteorological reanalysis datasets are used in superposed epoch analysis of time series of solar wind plasma parameters and green coronal emission line intensity. The time series are keyed to times of maximum growth of explosively developing extratropical cyclones during northern and southern winters. The new statistical evidence corroborates the previously published results (Prikryl et al., Ann. Geophys., 27, 1-30, 2009). This evidence shows that explosive extratropical cyclones tend to occur after arrivals of solar wind disturbances such as high-speed solar wind streams from coronal holes when large amplitude magneto-hydrodynamic waves couple to the magnetosphere-ionosphere system. These MHD waves modulate Joule heating and/or Lorentz forcing of the high-latitude thermosphere generating medium-scale atmospheric gravity waves. Ray tracing of aurorally-generated gravity waves show that the gravity waves propagate upward and downward through the atmosphere. Simulations of gravity wave propagation in a model atmosphere using the Transfer Function Model (TFM) (Mayr et al., Space Sci. Rev., 54, 297–375, 1990) show that propagating waves originating in the thermosphere can excite a spectrum of gravity waves in the lower atmosphere. At the tropospheric level, in spite of significantly reduced amplitudes, they can provide a lift of unstable air to release the moist symmetric instability thus initiating slantwise convection and forming cloud/precipitation bands (Prikryl et al., Ann. Geophys., 27, 31-57, 2009). The release of latent heat is known to provide energy for rapid development and intensification of extratropical cyclones. It is observed that severe winter storms caused by low pressure systems tend to follow arrivals of high-speed solar wind.

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