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(POS-9) Occurrence of tornado outbreaks in the context of solar wind coupling to magnetosphere-ionosphere-atmosphere

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The National Oceanic and Atmospheric Administration National Weather Service database of tornadoes provided by the Storm Prediction Center is used to investigate the occurrence of tornado outbreaks in the United States from 1963 to 2023 in the context of solar wind that impacts the Earth's magnetosphere. The superposed epoch analysis of daily occurrence of tornadoes reveals a peak in the cumulative number of tornadoes near the interplanetary magnetic field sector boundary (heliospheric current sheet) crossings. Most of the large tornado outbreaks (20 or more tornadoes in 24 hours) are associated with high-density plasma adjacent to the heliospheric current sheet and with co-rotating interaction regions at the leading edge of solar wind high-speed streams. Large tornado outbreaks also followed impacts of interplanetary coronal mass ejections or occurred in the declining phase of major high-speed streams. We consider the role of aurorally generated atmospheric gravity waves in severe weather development leading to tornado outbreaks. While these gravity waves reach the troposphere with attenuated amplitudes, they can contribute to conditional symmetric instability release in frontal zones of extratropical cyclones [1, 2, 3] leading to synoptic-scale weather conditions favouring formation of supercells in the low-level southerly winds and strong wind shear environment. The ERA5 meteorological re-analysis is used to evaluate slantwise convective available potential energy (SCAPE) to assess conditional symmetric instability and slantwise convection in cases of large tornado outbreaks.

[1] Prikryl P., et al., Ann. Geophys., 27, 31–57, 2009.
[2] Prikryl, P., et al., J. Atmos. Sol.-Terr. Phys. 171, 94–110, 2018.
[3] Prikryl, P., Adv. Sci. Res., 21, 1–17, 2024.

Keyword-1

tornado outbreaks

Keyword-2

solar wind

Keyword-3

atmospheric gravity waves

Author: PRIKRYL, Paul (University of New Brunswick)

Co-author: Dr RUŠIN, Vojto (Astronomical Institute, Slovak Academy of Sciences)

Presenter: PRIKRYL, Paul (University of New Brunswick)

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