Forecasting the Impact of Equinoctial High-Speed Stream Structures on Thermospheric Responses and an Extension to Solstitial Events

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We examine thermospheric neutral density response to 172 solar wind high-speed streams (HSSs) and the associated stream interfaces during the equinox seasons of 2002-2008. We find responses to two drivers: 1) the equinoctial Russell-McPherron (R-M) effect, which allows the azimuthal component of the interplanetary magnetic field (IMF) to project onto Earth's vertical dipole component; and 2) coronal streamer structures, extensions of the Sun's meso-scale magnetic field into space. Events for which the IMF projection is antiparallel to the dipole field are classified as “Effective-E”; otherwise they are “Ineffective-I”. Effective orientations enhance energy deposition and subsequently thermospheric density variations. The IMF polarities preceding and following stream interfaces at Earth produce events that are: Effective-Effective-EE; Ineffective-Ineffective-II; Ineffective-Effective-IE; and Effective-Ineffective-EI. These categories are additionally organized according to their coronal source structure: helmet streamers (HS-EI and HS-IE) and pseudo-streamers (PS-EE and PS-II). The response to HS-IE structures is smoothly varying and long-lived, while the response to PS-EE structures is erratic, short-lived, and modulated by thermospheric preconditioning. We find significant distinguishable responses to these drivers in four geomagnetically sensitive observations: low-energy particle precipitation, proxied Joule heating, nitric oxide flux, and neutral density. Distinct signatures exist in neutral density response that can be anticipated days in advance based on knowledge of on-disk coronal holes. Further, we show that the HS-IE events produce the largest neutral density disturbances.

We extend this work to include 66 solstitial HSSs during 2002-2008. Though the R-M effect no longer dictates response, we find distinct signatures according to coronal streamer structure categorization.