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Energetic coupling of the solar wind-magnetosphere-ionosphere system

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Solar wind structures such as corotating high-speed streams, coronal mass ejections, and interplanetary shocks are common causes of geomagnetic storms in Earth's magnetosphere and ionosphere. This paper presents an epoch analysis of events associated with three types of interplanetary structures during the period of 1995-2003, including 17 events of high-speed streams (HSSs), 18 events of interplanetary shocks followed by complex ejecta, and 18 events of shocks followed by magnetic clouds. It is found that, on average, the HHS events resemble a weak geomagnetic storm with a minimum Dst value of -40 nT. The average behavior of the shock/ejecta and shock/cloud events possess the characteristics of a two-step main phase storm, showing the first dip in the sheath region and the second dip in the following cloud or ejecta. Amongst the 53 events studied there are 8 superstorms with the minimum Dst $<$ -250 nT. Four of them are associated with the sheath region and 4 are associated with either clouds or ejecta, which makes the sheath region as geoeffective as magnetic clouds or ejecta in producing superstorms.