Large-Scale Geomagnetic Disturbances Driven by Solar-Wind Discontinuities

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Solar wind discontinuities can lead to important large-scale disturbances that significantly affect the space environment, including energetic particle fluxes, the aurora, and magnetospheric and ionospheric current systems. General correlations between solar wind parameters and overall geomagnetic activity are well known and well studied. However most large-scale disturbances are related to specific solar wind changes, and the relation of the resulting disturbance to solar-wind discontinuity characteristics has received much less attention. Two distinct types of discontinuity driven disturbance have now been identified: substorms resulting from northward interplanetary magnetic field (IMF) turnings and dynamic pressure (P) disturbances that result from enhancements of solar wind dynamic pressure. During typical substorms, enhanced auroral activity initiates near the equatorward boundary of the auroral oval within a ~1-2 hr MLT sector within the Harang electric-field reversal region and then expands to cover a few hours in MLT. Within the inner plasma sheet, particle injections and magnetic field dipolarization occur within what is referred to as the "substorm current wedge", which is within the same local time region as is the enhanced auroral activity. Typical P disturbances show rapid global enhancement of auroral emissions as well as a significant poleward motion of the poleward boundary of the aurora, but auroral enhancement related to the Harang reversal is not evident and substorm current wedge formation is not observed within the inner plasma sheet. We have recently found strong evidence that disturbances that occur following or during periods of strongly southward IMF are significantly different from typical disturbances. Under such conditions, substorms expand to a significantly broader MLT range than do typical substorms, and, in addition to a global auroral enhancement, P disturbances exhibit a substrom-like auroral enhancement within the Harang reversal that expands over a board MLT range. Thus for strongly southward IMF, both IMf and P changes can cause Harang region activation and current wedge formation. Because of this, it is reasonable to expect that IMF and P interplay effects may be important for solar

wind discontinuities having both a significant IMF change and a significant P change. Evidence will be presented that such interplay effects can indeed be important. In particular, discontinuities having a significant IMF northward turning and a significant decrease in P or having a significant increase in P and significant southward turning of the IMF are found to not lead to a substorm-like aurora disturbance within the Harang reversal region. We refer to such events as "null events", since the IMF northward turning or P increase for each would, by themselves, be expected to cause a large substorm disturbance, but the effects of these appear to be nullified by the simultaneous changes in the other quantity.