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Data Assimilation and the Thermosphere Ionosphere System

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Modern technological systems like GPS and Galileo, HF communications, and radar ranging are affected by geomagnetic storms and can become unreliable during large events. Geomagnetic storms are caused by large increases, often associated with changes in the spatial distribution, of the high-latitude energy deposition from the magnetosphere. Wave surges, driven by impulsive energy inputs, propagate and interact globally, and are dependent on Universal Time (UT) and the time history of the source. Equatorward wind surges drive F-region plasma upwards and can initiate a positive ionospheric change. Expansion of high-latitude electrodynamic features into the mid-latitudes can also drive an initial positive response. The divergent nature of the wind field causes upwelling and changes to the neutral composition, that can be transported by the storm and background wind fields. Negative ionospheric phases result from increased molecular species. At low latitudes electrodynamic changes are initiated by penetration of magnetospheric fields followed by neutral wind dynamo effects. The changes in energy input have global consequences with undesirable effects on technological systems and they cannot be adequately modeled at the present time. For operational purposes these changes can only be specified and perhaps modeled using data assimilation schemes.