Example Case Studies in the Use of SPDF Data Services

A cluster of 11 AGU publications surveyed, mostly in 2003-2004, yielded an impressive array of new results about the outer magnetosphere of Earth, all of which depended critically on input solar wind observations obtained through CDAWeb.

Pressure-pulse interactions were shown by Sibeck et al. to depend on a new linkage with kinetics of the foreshock region. Dayside magnetopause position was shown by Yang et al. to have a saturation effect in IMF Bz influence. In three important papers on magnetospheric periodicities associated with solar wind input,

Huang et al. (2003a,b,c) (1) suggest the existence of intrinsic 1-hour oscillations during quiet times as initiated by solar wind impulses but carrying on beyond the initial impulse event, (2) show that important details of substorm periodicities are directly controlled by periodicities in solar wind input, and (3) demonstrate that quasi-periodic, sawtooth-like variations of energetic plasma fluxes (measured at geosynchronous orbit during magnetic storms with periods of ~2.7 hours) represent true particle injections from the tail to the inner magnetosphere.

Later, another three-paper group by Lee and Lyons expands on the Huang et al. results by showing that (1) the nightside magnetosphere is highly sensitive to small solar wind dynamic pressure enhancements during strong southward IMF, (2) sawtooth oscillations can be reasonably associated in timing with corresponding solar wind pressure enhancements, and (3) nightside depolarization and magnetic compression/depression intervals are very sensitive to a combination of IMF and solar wind pressure conditions.

Cluster observations of convection patterns in the high-altitude cusp were shown by Vontrat-Reberac et al. to respond rapidly (3-5 min) to abrupt changes in IMF orientation, and Stubbs et al. demonstrated that extended cusp-like regions are more common during northward IMF, and especially with high solar wind pressure.

Finally, 3D MHD simulations by Slinker et al. of magnetopause oscillations, using the Kelvin-Helmholtz instability, succeeded in reproducing both the amplitude and frequency of induced oscillations using input solar wind and IMF data.

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Two magnetospheric oscillation papers (Huang et al, 2003a and 2003b) both make extensive use of CDAWeb data correlated to other sources for investigation of global magnetospheric response to solar wind pressure impulses.

They suggest existence of intrinsic 1-hour oscillations during quiet times as initiated by solar wind impulses but carrying on beyond the initial impulse event. The well-known saw-tooth oscillation with a period of about 2.7 hours in their data is studied with ground-based and satellite data during two magnetic storm events. The saw-tooth paper provides a broader view with IMAGE neutral atom observations and Geotail data.

The CDAWeb data are integral to determination of the upstream solar wind and geosynchronous magnetic field environments for correlation to the LANL energetic particle data for the saw-tooth and hourly oscillation events.

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SPDF's services are acknowledged as playing an important role in developing geospace models as well as in helping the science community with the use of these models.

Richards (2002) of NASA HQ uses the empirical models IRI and MSIS in conjunction with satellite data from SPDF's ATMOweb system for testing his theoretical FLIP model. LeVine and Abraham (2002) of GSFC rely on the IRI model to estimate the effects of the ionosphere on the remote sensing signals of future Sea Surface Salinity satellite missions (Aquarius, Hydros, SMOS). Milikh and Dimant (2003) of U. Maryland use IRI and MSIS to represent some of the input parameters for their theoretical simulation of the E-region ionosphere. Minow (2004) of MSFC developed an empirical plasma variability model based on ATMOweb satellite data and IRI. He reported about this effort in an invited talk during the recent LWS modeling workshop. A team from APL and U. Maryland (Ukhorskiy et al., 2004) acknowledged the use of OMNIWeb in their development of a forecasting tool for relativistic electrons at geostationary altitudes.

The LWS Geospace Mission Definition Team (Kintner et al., 2002) used the IRI and MSIS models to illustrate current limitations of our understanding of ionospheric and thermospheric processes as represented by theoretical and empirical models. N. Tsyganenko (USRA/GSFC) has used CDAWeb magnetic field data from Wind, ACE, IMP-8 and Geotail for the development of his Magnetospheric Magnetic Field model (Tsyganenko and Mukai, 2003; Tsyganenko et al., 2003; Tsyganenko and Fairfield, 2004), a model that supports a wide range of research projects as illustrated by the large number of citations. In addition N. Tsyganenko has also relied on the SPDF services for providing easy community access to his model software. The Center for Integrated Space Weather Modeling (CISM) and CCMS use the IRI model as benchmark against which the skill level of physics-based forecast models is measured (Siscoe et al., 2004; Eccles et a.l, 2004).

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