SM53A-05 1330h POSTER

Modelling the Lower Boundary of the Upward Current Region as an Oblique Double Layer: Effects on the Evolution of the O+ Density of Ionospheric Origin

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Understanding the coupling between the plasma sheet dominated magnetosphere and the auroral ionosphere is a key problem in the auroral physics community. The region of space where this coupling occurs is known as the auroral cavity in the upward current region. Previous research has shown that two boundaries may exist: one between the ionosphere and auroral cavity and the other between the magnetosphere and auroral cavity. We present work that explores the boundary between the ionosphere and auroral cavity known as the lower boundary which we model as an oblique double layer (DL). This work shows how O^+ and H^+ populations of ionospheric origin evolve as they travel anti-earthward through an oblique DL. We inject distributions of O^+ ions, which are weakly magnetized, and H^+ ions, which are strongly magnetized compared to O^+ , and show that the O^+ distributions gain greater perpendicular energy than H^+ distribution. The O^+ distributions gain greater perpendicular energy than H^+ because the first adiabatic moment is weakly conserved for O^+ and strongly conserved for H^+. In addition, the amount of perpendicular heating of the O^+distribution is a function of the obliqueness angle, with the greatest perpendicular heating occurring at some angle between 45 and 60 degrees. To understand how this optimum heating of the O^+ ions feeds back into the DL solution, we first present O^+ density profiles as a function of the obliqueness angle of the DL. We then use the resulting O^+ density profiles in BGK solutions to examine how the perpendicular heating of the O^+distributions affects the self-consistent nature of the DL. This will help us understand how the obliqueness angle is chosen: whether there are micro-physical reasons or global external drivers that cause the obliqueness angle. An oblique DL at the lower boundary may partially explain why the O^+ion beams in the auroral cavity are wider than the H+ ions beams, something that has been observed by FAST, Freja, Polar, DE-1, and S3-3. The oblique DL model that we use here is a particle tracer with an externally imposed electric field that is based on FAST observations. Moreover, the altitude at which the DL is assumed to form is also based on observations and is much lower than previous work (Borovksy, JGR 1988, pg 5713 and references therein) on oblique DL's, which affects the amount of perpendicular heating that the O^+ions gain.

SM53A-06 1330h POSTER

High Resolution Measurement of Auroral "Hiss" and "Roar"

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In December 2002, a Versatile Electromagnetic Wave Receiver (VIEW) together with a new digitization system was deployed at South Pole station. The motivation was to measure three types of auroral radio emissions: Auroral Roar, a relatively narrowband ($\Delta f/f < 0.1$) emission near 2 and 3 times the F region ionospheric electron cyclotron frequency (f_{ce}); Auroral Hiss, a whistler mode wave emission with frequencies lower than 1MHz ; and Auroral medium frequency (MF) burst, broadband impulsive radio emissions observed at ground level during the breakup phase of auroral substorms. High resolution broad band structure of those three emissions are recorded automatically at South Pole, and are crucial to our understanding the mechanism and relations of auroral radio emissions. This experiment uses a 3x3 meter square magnetic dipole antenna, located 1.7 km away from the South Pole station. A pre-amplifier is buried right below the eastern pylon of the antenna, connected by a 1.7 km long coaxial cable to a LF-HF receiver in the station. The output of the receiver is fed into the Versatile Electromagnetic Wave Receiver (VIEW) and Windows system equipped with a digitization board. Software is written to digitize the selected signals at 1 or 2 MHz. This data acquisition system was designed so that researchers at Dartmouth College can review the data from South Pole weekly and save interesting parts according to instructions sent from Dartmouth. In the year of 2003, the experiment concentrated on the auroral roar frequency band. With 3 hours window per day, it captured more than 30 auroral roar events at South Pole station. The data show detailed structure of Auroral Roar, which is comprised of multiple narrow band features drifting in frequencies in a complicated pattern. (LaBelle et al., 1995; Shepherd et al., 1998) Starting in 2004, the experiment is concentrating on the auroral hiss frequency band. This mode promises to caputure the first detailed structure of auroral hiss at LF/MF (above 50 kHz). LaBelle, J., M.L. Trimpi, R. Brittain, and A.T. Weatherwax, Fine structure of auroral roar emissions, *J. Geophys. Res., 100*, 21953, 1995. Shepherd, S.G, J. LaBelle, and M.L. Trimpi, Further investigation of auroral roar fine structure *J. Geophys. Res., 103*, 2219, 1998.

SM53A-07 1330h POSTER

Analysis of Ionospheric Waves Observed with the SIERRA Sounding Rocket

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On January 14, 2002 at 8:23:05 UT the SIERRA sounding rocket was launched into active aurora from Poker Flat, Alaska. The launch occurred after a medium size substorm break up during the expansion phase. Apogee was 735 km and was reached at approximately 492 seconds. Instruments on board the main payload included particle and electric field detectors. The focus here is on the main payload high frequency wave experiment which detected waveforms continuously with a 5 MHz bandwidth. A wealth of waves was detected throughout the period of time when the electron instrument registered auroral electrons, from 200 to 690 seconds flight time. For example langmuir and upper hybrid waves, are observed on both the upleg and downleg, between 1100 and 2000 kHz, lasting about 350 seconds; unstructured whistler mode hiss is observed throughout the aurora and polar cap, between 200-850 seconds; and structured whistler mode signals occur between 100 and 1000 kHz during the downleg lasting for about 200 seconds. Many of these waves are structured and have dispersive features. Because the main payload was in cartwheel mode we can get polarization information for the observed waves, some of which are spin modulated and some not. We propose to use ray tracing in a model ionosphere based on the rocket observations to investigate the locations and motions of the sources producing the observed dispersed features. This investigation may constrain the mode identification even if the source locations and motions cannot be unambiguously inferred.

SM53A-08 1330h POSTER

Weak Double Layers in Space and Heliospheric Plasmas

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We report observations of weak double layers whose time domain signatures are isolated tripolar electric field pulses. The observations are from near-earth space by Cluster spacecraft and from the interplanetary medium up to 8 AU heliospheric distance from Cassini. The heliospheric observations show that these weak double layers are often associated with ion acoustic wave activity. However, their pulse shapes are different from the classical ion acoustic double layers which should appear as asymmetric bipolar pulses in the electric field. We will discuss the possibility that they are dynamically linked to ion acoustic fluctuations. A statistical survey on the interdependence between electric field amplitudes, time durations, and the background magnetic field strength suggests that the double layers are of kinetic nature rather than of fluid nature. Comparisons of our observational findings with existing theories on BGK waves will be made.

SM53B CC: 220 C-E Friday 1330h

What Controls the Degree of Conjugacy in Auroral Phenomena? III Posters *(joint with SA)*

Presiding: **J B Sigwarth,** University of Iowa**; N J Fox,** Applied Physics Laboratory, Johns Hopkins University

SM53B-01 1330h POSTER

On the Conjugacy of Auroral Afternoon Bright Spots

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Using global ultraviolet auroral images from both Polar and IMAGE satellites, we investigate the conjugacy of afternoon aurora. This study is limited to periods between the equinox and northern winter solstice when Polar UVI is imaging the southern auroral zone and IMAGE FUV provides coverage of the northern auroral region. Both instruments are sensitive to LBH emissions produced by electron impact. We find several intervals during which the dayside auroral morphology is not conjugate: multiple spots aligned in longitude in one hemisphere are absent in the other. Hence, the electron access or electron acceleration mechanisms responsible for the auroral emission are likewise not conjugate. The asymmetries in the auroral morphology are related to the direction of the y-component of the IMF. When IMF By is strongly negative (positive), the afternoon aurora is more structured and discrete in the northern (southern) hemisphere. The characteristics of the multiple spots are consistent with them being the result of a Kelvin-Helmholtz instability (KHI). This implies that the KHI may only be operating in one hemisphere.

URL: http://sprg.ssl.berkeley.edu/matt/AGUS2004/

SM53B-02 1330h POSTER

Simultaneous observations of the auroral oval in both hemispheres under various conditions

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Recently, it has been possible to observe the entire auroral oval in both the northern and southern hemispheres simultaneously with the IMAGE FUV imagers and Polar VIS Earth camera, respectively. These rare opportunities allow us to study conjugate and non-conjugate effects on a global scale under various interplanetary conditions; thus enabling us to better understand the transfer of mass and energy from the solar wind to the magnetosphere/ionosphere system. The events we study here are from late 2002 with periods of simultaneous observation lasting between about 30 and 50 minutes. Most events are associated with a steady IMF B_X component, where the IMF B_Y and B_Z components vary. The location of the "centroid" of the auroral ovals, which allow us to track their motion, are determined using a circle fitting routine. Initial results have shown the expected IMF B_Y-dependent asymmetry along the dawn-dusk meridian; however, in the event studied there was also an overall dawnward

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offset of the ovals in both hemispheres. Under conditions of strong IMF $B_X > 0$ and weak IMF $B_Z > 0$, we have observed the southern oval move equatorward relative to the northern oval, consistent with tail lobe reconnection occurring only in the southern hemisphere.

SM53B-03 1330h POSTER

Hemispheric Asymmetry in Auroral Boundaries

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Auroral boundaries observed simultaneously in both hemispheres are compared. Automatically determined boundaries identified in DMSP SSJ4 particle precipitation observations from both hemispheres observed within 5 minutes UT and 1 hour MLT of each other are assembled from 1983 to present. There are a little over a thousand such pairs for each type of boundary. Equatorward boundaries show a greater degree of interhemispheric consistency than do more poleward boundaries. The effects of season and IMF conditions on interhemispheric consistency are examined.

SM53B-04 1330h POSTER

Nonconjugate Aurora Regulated by Interhemispherical Asymmetry in Density Scale Height

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Newell et al. [1996] have proposed that the observed seasonal and diurnal dependence of the probability of intense electron precipitation is regulated by the ionospheric feedback instability. The numerical simulations of Pokhotelov et al. [2002] under solstice conditions subsequently verified that the MI feedback instability can produce electron energy fluxes that are signficantly greater in the low-conductivity winter ionosphere than in the high-conductivity summer ionosphere. The nonconjugacy reported by Pokhotelov et al. is due entirely to an imposed seasonal asymmetry in ionospheric conductivity. In this paper, using numerical simulation we show that interhemispherical asymmetry in the density scale height of the topside ionosphere and low-altitude magnetosphere, e.g. due to seasonal variation or sunlight exposure, can have an even greater effect on the production of parallel electric fields responsible for auroral electron precipitation – whether associated with feedback instability or quasistatic current systems. The study is based on a reduced two-fluid MHD model which includes active E-region dynamics together with 2D dispersive Alfven wave dynamics in the strongly inhomogeneous ionospheric and dipolar-magnetized magnetospheric plasmas. Newell, P.T., C.-I. Meng, and K.M Lyons, Supression of discrete auroral by sunlight, Nature 381, 766, 1996. Pokhotelov, D., W. Lotko, and A.V. Streltsov, Effects of the seasona asymmetry in ionospheric Pedersen conductance on the appearance of discrete aurora, Geophys. Res. Lett., 29(10), 1437, doi:10.1029/2001GL014010, 2002.

SM53B-05 1330h POSTER

A comparison of Antarctic Pi1 signatures and substorm onsets recorded by the WIC imager on the IMAGE satellite

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The accurate timing and location of substorm onsets continues to be a controversial issue. In this study we will show that Pi1 pulsations (1 - 40 sec period) can at times provide more information than the more widely used Pi2 pulsations (40 - 150 sec period). We have examined a set of substorm onsets during the months of June 2000 through June 2001 identified at UC Berkeley by inspection of global auroral images from the IMAGE Far Ultraviolet Imager (FUV) - Wideband Imaging Camera (WIC) and have compared these onset times and locations to Pi1 activity seen in search coil magnetometer data from numerous high latitude stations in Antarctica from 65° - 80° MLAT, including South Pole Station, McMurdo, and the U. S. and British AGO arrays. Our study focused on the 41 substorm onsets identified using IMAGE data between 20 and 6 UT (corresponding to ∼ 17 - 3 MLT on the ground). Our results indicate that Pi1 onset times most often agreed with those identified by IMAGE when the Antarctic ground stations were between 2200 and 2400 MLT. Unlike Pi2 pulsations, Pi1 weaken in amplitude as they propagate away from the footprint of the source region and at times are not evident at distant stations. The observations presented here will be used to attempt to determine whether Pi1 observations from a large network of ground stations could successfully infer the time and location of onsets even in the absence of satellite imager data.

SM53B-06 1330h POSTER

Field Line Resonances Driven by Broad-band Magnetotail Source

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In Earth's magnetosphere, latitudinally localized shear Alfven waves in Earth's magnetosphere are typically attributed to excitation by a monochromatic fast mode source. We demonstrate that standing wave field line resonances (FLRs) can also be excited by a broadband source. In a warm plasma, and in the absence of a broad-band driver, monochromatically driven FLRs rapidly propagate Earthward with respect to the equatorial plane. This results in small amplitude FLRs being excited due to the large frequency mismatch that exists between the monochromatic driver and the field lines where standing waves eventually form. Here, We investigate the role played by incoherent drivers for FLRs, and demonstrate that a broad-band magnetotail source preferentially excites monochromatic FLRs on field lines where thermal and inertial wave dispersion effects cancel. We discuss the roles of nonlinearity, time dependent conductivity and dispersion in the steepening and localization of FLR dynamics, and offer a potential explanaton as to why FLRs map to specific latitudes.

SM53BA-07 1330h POSTER

The Computation of FLR Eigenfrequencies in General Geometries

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Until recently, the calculation of field-line resonance (FLR) frequencies from magnetic field data, provided by magnetospheric models such as BATSRUS and Tsyganenko (T01), was restricted to orthogonal coordinate systems. With this restriction, only dipolar and axisymmetric configurations are admissible. The matter of addressing more general configurations such as non-axi-symmetric, stretched and twisted field topologies requires the use of a non-orthogonal coordinate system. The appropriate coordinate system can be constrained by defining the magnetic field as the product of matched Euler potentials, $\mathbf{B} = \nabla \alpha_i \times \nabla \alpha_j$, and imposing the condition, $\nabla \cdot \mathbf{B} = 0$, everywhere. As a consequence, the coordinates defining the plane perpendicular to $\mathbf{B}$, α_i and α_j, must both satisfy the partial differential equation, $\mathbf{B} \cdot \nabla \alpha_{i,j} = 0$. In other words, $\alpha_{i,j}$ must be constant along magnetic field lines. Upon solving this differential equation implicitly using known magnetic field intensities, the metric tensor for the resulting basis can be computed. The elements of this tensor can be substituted directly into the eigenvalue problem for general coordinate systems written in covariant notation. The equation for FLR modes has been developed for arbitrary incompressible magnetospheric conditions and has been specialized to the case where spatial variations are constrained along the magnetic field. The result is a coupled fourth-order system of ordinary differential equations, which can be evaluated numerically. The eigenvalue problem is solved at several latitudes for a broad range of magnetospheric conditions.

SM53B-08 1330h POSTER

Multi-Altitude Cusp Observations with Cluster and DMSP

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The comparison of particle spectrograms from different altitudes in the cusp is important to our understanding of magnetospheric entry processes. In practice, however, this remains a difficult task. Low altitude measurements detect a smaller cusp that is crossed relatively quickly, while at mid altitudes the extent of the cusp is larger and the traversals much slower, blurring the distinction between temporal and spatial features and complicating conjunction studies with low altitude data. The Cluster multi-satellite mission allows the opportunity to better understand the features at mid altitudes, facilitating direct comparisons with concomitant low altitude observations by one or more of the DMSP spacecraft. Orbit and particle data from both missions have been searched over a nine-month period for near-simultaneous cusp region crossings. Model magnetic field line footprints at 100 km altitude give an indication of the quality of the magnetic conjunctions in space and time. Examples of the conjunctions found will be presented, along with a discussion of the degree to which they can be related to each other and how these methods can be used to provide insight into the evolution of structures in the cusp.

SM53B-09 1330h POSTER

Storm Time Magnetospheric Convection: Substorms, SMC Events, and Sawtooth Events

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Sawtooth events are global dynamic magnetospheric phenomena that derive their name from the sawtooth' signatures in energetic electron and proton fluxes observed globally by the LANL geostationary satellites. The investigation of these events have raised issues regarding the dynamics of magnetospheric convection and energy dissipation during periods of strong magnetospheric forcing by the solar wind. One theory asserts that substorm disturbances may occur in increasing degrees and that sawtooth events are extreme examples of periodic substorm expansions. Another view suggests that the magnetosphere may develop a new mode of driven global oscillation in response to extreme solar wind driving. We examine several storms that include periods of substorm expansions, steady magnetospheric convection intervals and sawtooth intervals. We utilize global data sets to investigate the global magnetic disturbance pattern, deduced polar ionospheric potential and current distributions, polar cap flux inferred from Polar and IMAGE global auroral UV images, and geostationary satellite measurements of particles and fields to investigate these hypotheses.

SM53B-10 1330h POSTER

Electron Shear and Low-Frequency Oscillations in a Collisional Ionosphere

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A fluid-like dispersion relation including only electron velocity shears has been derived using a general kinetic dispersion relation of a current and shear driven ion acoustic instability developed by St-Maurice. A numerical analysis for both the the kinetic and fluid-like expressions was undertaken to determine the threshold currents and shears for different angles (of the wave vector) and frequencies. The fluid results have been compared to those obtained from the kinetic formulation. It has been found that an ion over electron temperature ratio smaller than 0.1 for large frequencies and smaller than 0.01 for small frequencies are needed to reproduce the fluid results in the collisionless case while a ratio smaller than 0.1 is required in the collisional case for all frequencies.

SM53C CC: 518 A Friday 1330h

Space Weather: Linking Research and User Needs III *(joint with SA, SH)*

Presiding: **D Boteler,** Geomagnetic Laboratory, Natural Resources Canada**;** **S Wing,** Applied Physics Laboratory, Johns Hopkins University

SM53C-01 1330h INVITED

Space Weather Effects on Spacecraft

An Eng

Satellite Company, 2617 Anderson Road

This paper will present on overview of spacecraft effects from an operators point of view. This will include a description of past effects and solutions found for them, plus an examination of user needs for future research.

SM53C-02 1350h

Radiation Belt Responses to the Solar Storms of October-November 2003

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The solar disturbances of October-November 2003 produced very large enhancements of the energetic particles in Earth's radiation belts. Most notably, there were flux increases very deep in the magnetosphere leading to a complete filling of the "slot" region around L∼ 2.5 which is usually devoid of relativistic electrons. The radiation belts were pumped up in intensity for more than a week and seemed to be related to a wide variety of spacecraft anomaly and other space weather effects. We report on the observed magnetospheric events in recent times and place these results into the context of the historical record. We particularly use data from the SAMPEX and POLAR spacecraft. We conclude that the solar and magnetospheric events are amongst the largest that have been recorded.

SM53C-03 1405h

3D Modeling of Shock-Induced Trapping of Solar Energetic Particles in the Earth's Magnetosphere

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The prompt trapping of Solar Energetic Particles (SEPs) in the inner magnetosphere around L=2-2.5 has been reported, including protons and heavier ions, in association with high speed interplanetary shocks and Storm Sudden Commencements (SSCs). These observations include the Bastille Day 2000 CME-driven storm as well as two in November 2001, which produced a long-lived new proton belt, as well as trapping of heavy ions up to Fe in all three cases. A survey of such events around the most recent solar maximum, including high altitude measurements from Polar and HEO satellites along with low altitude measurements from SAMPEX, indicates similarities to the well-studied March 24, 1991 SSC event. In this event, electrons and protons in drift resonance with a magnetosonic impulse were transported radially inward, requiring a source population which is multi-MeV at geosynchronous. A requirement for such shock-induced acceleration is a high-speed CME- shock at 1 AU, which launches a perturbation with comparable velocity inside the magnetosphere. Secondly, there must be a source population which is drift-resonant with the impulse. The CME-shock itself is a source of solar energetic particles, both protons and heavy ions, with higher fluxes and harder spectra associated with faster moving CMEs. A 3D Lorentz integration of SEP trajectories in electric and magnetic fields taken from the Lyon-Fedder-Mobarry (LFM) global MHD model, using solar wind input parameters from spacecraft measurements upstream from the bow shock, has been carried out for two November, 2001 SEP trapping events (see Kress et al., this meeting). The results indicate that an enhancement in solar wind dynamic pressure for these events plays a role in the observed injection of ions to low L-values, to form a new proton belt which lasted for more than a year. Improvements over current models for space weather forecasting of SEP access, and the trapped energetic proton and heavier ion environment which space systems are subject to, will be described briefly.

URL: http://www.dartmouth.edu/tilde physics/cism/publications/3d.modeling.pdf

SM53C-04 1420h

Essentials for In Situ Space Weather Monitoring in the Future

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Current space-weather monitoring techniques rely on two principles: (1) The observation of the disturbance itself, using the fact that any geomagnetically active solar wind structures encounters upstream monitoring spacecraft before it reaches the magnetosphere; and (2) information in the form of particles, typically ions above 30 keV, that propagate faster than the disturbance, or particle-generated plasma waves, and thus are observed far upstream of approaching shocks. We report new findings on the ultra-low (>6 keV) suprathermal ion population upstream of interplanetary shocks. A picture arises that connects the systematically observed spectral-, composition-, and flow features ahead of the shock with the in situ acceleration process. With an initial algorithm that uses these new foreshock ion characteristics we demonstrate that unprecedented reliability in long-term (hours-to-days) interplanetary shock forecasting can be achieved. Furthermore, we introduce a new and challenging concept for suprathermal ion instrumentation as an essential building-block for the future of space weather forecasting.

SM53C-05 1435h

Multi-Parameter Characterization of Magnetospheric States

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The Earth's magnetosphere is under continuous actions of the solar wind and interplanetary magnetic field (IMF). Magnetospheric dynamics thus results are largely due to the magnetospher's responses to the changing solar wind and IMF forcing and to its interaction with the underlying ionosphere. Therefore, it may be possible to statistically characterize the state of the magnetosphere in terms of the solar wind and IMF driver and corresponding magnetopsheric response parameters, as proposed by Fung [1996]. Recently, we set up a web-based Magnetosphere State Query System and opened the system to the community (accessible under Modeling from http://radbelts.gsfc.nasa.gov). In this paper, we present preliminary results from exercising the query system to investigate magnetospheric state characterizations in terms of the solar wind speed, IMF, and various geomagnetic activity indices. The Kp, Dst and auroral indices represent magnetospheric responses in different region and on multiple time scales. It should be noted that our purpose here is not to determine the inter-relationship or 'input-output' relationship between various driver and response parameters, but to see if specific combinations of parameters may be prevalent. Fung, S. F., Recent development in the NASA trapped radiation models, Radiation belts Models and Standards, Geophysical Monogr., 97, AGU, Washington, D. C., 79-91, 1996.

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Geospace Disturbances During a Solar Maximum : Spatio-Temporal Structure

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The geospace disturbances during the last Solar maximum have shown complex spatio-temporal structure due to the many physical processes during storms and substorms. The recent studies of magnetospheric dynamics using data-derived models have given a new understanding of the complex phenomena of magnetic storms and magnetospheric substorms, but many of these studies use data from periods with weak solar activity. For example, the widely used Bargatze et al. [1985] data set of the solar wind induced electric field and the corresponding AL index is for a declining phase of solar activity. The recent solar maximum is unique in that the data from an unprecedented number of ground-based and space-borne platforms are available for this period. The comprehensive spatio-temporal data, essential for developing an integrated model of geospace disturbances during storms and substorms, is compiled for this period. For the year 2002 the 1-min resolution data of the upstream solar wind from ACE spacecraft and the ground magnetic field variations from over 57 ground stations (13 CANOPUS and 26 IMAGE stations and 18 stations for which data is available from WDC-Kyoto) have been compiled. The magnetic field variations data have 1-min resolution, although most studies of interest to space weather may not require such a high resolution. As a representation of the spatio-temporal structure of the disturbances, the LT-UT plots are obtained and these are used along with spacecraft images from Polar, Fast and IMAGE, to develop a comprehensive picture of geospace disturbances. The key objective of the studies using this database is to develop models of the global and multi-scale features of geospace, and present these in forms suitable for research and forecasting.