Granta MIST

Selwyn College, Cambridge
5-7 April 2005

Abstracts

Session 1 – Tuesday 1400 – 1535
Planetary magnetospheres and ionospheres: the Cassini era
Chair – A. J. Smith

1400 – 1405 Welcome and Announcements.
A. J. Smith[(1)]
(1) British Antarctic Survey.

1405 – 1420 CAPS results at Saturn and Titan.
A. J. Coates[(1)] representing the CAPS team
(1) Mullard Space Science Laboratory, University College London.
Cassini-Huygens has been in Saturn orbit since 1 July 2004. The Cassini Plasma Spectrometer (CAPS) consists of two ion spectrometers and an electron spectrometer. Results from these so far include the dominance of the solar wind pressure in the control of the aurora; Saturn's inner magnetosphere is mainly composed of water ions from the icy satellites providing some comet-like features; the ionosphere near the rings is dominated by molecular oxygen; the rings can be seen using electrons; the inner magnetosphere has dispersion events possibly related to local sources; the interaction with Titan includes species of positive and negative ions and ionospheric photoelectrons. Here we will review the CAPS observations mentioning particularly the work of UK scientists as part of the team.

1420 – 1435 Cassini-CAPS observations of injected and drift dispersed hot plasma in Saturn's magnetosphere.
A. M. Rymer[(1)], T. W. Hill[(2)], A. J. Coates[(1)], H. J. McAndrews[(1)], L. K. Gilbert[(1)], G. R. Lewis[(1)], N. Andre[(3)], J. L. Burch[(4)] and M. K. Dougherty[(5)]
(1) Mullard Space Science Laboratory.
(2) Physics and Astronomy Department, Rice University.
(3) Centre d'Etude Spatiale des Rayonnements.
(4) Space Science and Engineering Division, Southwest Research Institute.
(5) Department of Space and Atmospheric Physics, Imperial College London.
The Cassini spacecraft has, at the time of writing, completed 4 orbits at Saturn. Measurements by the Cassini Plasma Spectrometer (CAPS) reveal classical signatures of hot (multi-keV) ions and electrons undergoing adiabatic drift dispersion in Saturn's inner magnetosphere ($L \sim 5 – 10$). These injection signatures are superimposed on cooler, denser background plasma. The signatures are evident on a linear energy-time plot as a "V"- type shape with ions comprising the right half and electrons the left. The time and location of injection can be approximated by measuring the gradient and intercept of this "V". We find that the inferred time since injection is usually less than one Saturn rotation (< 10.8 hours) and the inferred injection points are basically randomly distributed in local time. A complementary study has shown that CAPS observations of remote and local injection signatures are consistent with the occurrence of centrifugal interchange throughout the middle magnetosphere of Saturn (5 – 10 RS). These dispersions have been evident as a regular feature of Saturn's plasma sheet, with hundreds observed during the four orbits so far. In this presentation we will discuss these observations in the context of current studies and global versus local dynamics at Saturn.

1435 – 1450 Estimation the current density in Saturn's equatorial current sheet.

C. S. Arridge[1], K. K. Khurana[2] and M. K. Dougherty[1]
(1) Space and Atmospheric Physics, Imperial College London.
(2) Institute of Geophysics and Planetary Physics, University of California.
The plasma sheet in the jovian magnetosphere passes over the spacecraft approximately twice every 10 hours due to the dipole tilt and the rapid rotation of the magnetosphere. This provides the opportunity to sample plasma sheet properties very quickly over a spacecraft orbit. Estimations of equatorial radial and azimuthal current density in the jovian and terrestrial magnetospheres use measurements near the magnetic equatorial plane to compute the current density across the sheet [Iijima et al., 1990; Khurana, 2001]. Such an approach is limited in the kronian magnetosphere because of the absence of a significant dipole tilt [Giampieri and Dougherty, 2004] which implies that the exploration of such current sheets is restricted by the spacecraft trajectory.

We assume that the plasma sheet consists of a planar equatorial current sheet which warps away from the magnetic equator, becoming parallel to the Saturn-Sun line, after a given hinging distance. Under this assumption we analyse Pioneer, Voyager, and Cassini magnetometer data with respect to this shape and use the field structure to infer the currents flowing in the sheet using a Harris neutral sheet model.

We compare the estimated current density with previous empirical estimations of the current density profile [Mauk et al. 1985], models of the current sheet [Connerney et al. 1983; Bunce and Cowley, 2003; Giampieri and Dougherty, 2004], and present a search for a significant local time asymmetry, as suggested by modelling studies [Giampieri and Dougherty, 2004].

1450 – 1505 Saturn’s icy satellites Dione and Enceladus: initial results from the Cassini Plasma Spectrometer.

H. J. McAndrews[1], A. J. Coates[1] , C. J. Owen[1], M. F. Thomsen[2], F. J. Crary[3] and the CAPS Team
(1) Mullard Space Science Laboratory, University College London.
(2) Los Alamos National Laboratory.
(3) Southwest Research Institute.
The Cassini spacecraft, in orbit about Saturn since July 2004, has already had a number of encounters with the wakes of some of Saturn’ s icy satellites. The Cassini Plasma Spectrometer (CAPS) which is designed to measure electrons of energy 0.6 – 28 keV and ions from 0.6 – 50keV was able to detect the microsignature of Dione when the spacecraft was magnetically connected to the same L-shell as the moon. An increase in the energy density of the electrons downstream, with respect to the plasma corotation, of the moon was observed indicating that material in Dione’s wake may be a source of low energy electrons for the magnetosphere. The interaction with Enceladus, however, was markedly different as the moon orbits within the radiation belts of Saturn. This results in the moon carving out a “hole” region in the trapped high energy particles. This time the signature is seen upstream compared with corotation of the plasma, but downstream for the westward drifting energetic electrons. Here we present expectations based on data from the Voyager and Pioneer flybys of the icy moons and the theory behind such interactions. We then present initial results from the CAPS plasma instruments for the moon encounters seen to date.

1505 – 1520 Investigating Titan's magnetic wake.

A. L. Law (1), M.K. Dougherty (1) and I.C.F. Mueller-Wodarg (1)
(1) Space and Atmospheric Physics, Imperial College London.
Saturn's largest moon, Titan, is the only moon in the solar system to have a substantial atmosphere and thus ionosphere. Since Titan's orbit is usually within the Kronian magnetosphere, the moon poses an obstruction to the rapidly rotating magnetospheric plasma. This causes the magnetic field lines to drape around Titan, giving rise to a magnetic "wake". The first three targeted flybys of Titan made by the Cassini spacecraft were all at very similar Saturnian local time, so the response of the magnetosphere around Titan to changes in the solar wind can be examined. The magnetic environment around Titan and the wake geometry will be discussed, with a comparison made to the data from the Voyager flyby, which occurred at a different Saturnian local time.

1520 – 1535 Magnetospheric energy inputs into the upper atmospheres of the giant planets.

C. G. A. Smith(1), S. Miller(1) and A. D. Aylward(1)
(1) Atmospheric Physics Laboratory, University College London.
We revisit the effects of Joule heating upon the upper atmospheres of Jupiter and Saturn. We show that in addition to direct Joule heating there is an additional input of kinetic energy --- ion drag energy ---which we quantify relative to the Joule heating. We also show that fluctuations about the mean electric field, as observed in the Earth's ionosphere, may significantly increase the Joule heating itself.

For physically plausible parameters these effects may increase previous estimates of the upper atmospheric energy input at Saturn from ~10TW to ~40TW. Using a general circulation model we examine the consequences for the global thermospheric energy and momentum budget.

Session 2 – Tuesday 1605 – 1705
Atmospheric waves, winds, tides and temperatures
Chair – G. Millward

1605 – 1620 Dynamics and temperature of the Antarctic mesosphere & lower thermosphere over Rothera (68S).
N. J. Mitchell[1], P. T. Younger[1] and P. J. Espy[2]
(1) University of Bath.
(2) British Antarctic Survey.
In February 2005, a meteor radar was installed at Rothera (68@S, 68@W) in the Antarctic. The radar is able to measure horizontal winds in the mesosphere and lower thermosphere (MLT) region at heights of ~ 80 – 100 km with a time resolution of ~ 1 hour. The radar can also make estimates of atmospheric temperature with a time resolution of ~ 1 day. The Rothera site was chosen so as to be at a conjugate geographical latitude to an identical system operated at Esrange (68@N, 21@E) in Arctic Sweden. Measurements from the two radars can thus be used to reveal and investigate asymmetries between the Arctic and Antarctic MLT regions, free from the instrument biases that seriously hamper attempts to measure such asymmetries using dissimilar techniques (such as meteor-radar/MF-radar comparisons). Preliminary results from the Antarctic radar are presented describing the mean flow, planetary waves and daily-mean temperatures measured in the late-summer MLT over Rothera and comparisons are made with similar observations made over Esrange.

1620 – 1635 CMAT2 - Developing the UCL upper atmosphere model.
A. D. Aylward[1], M. J. Harris[1] and G. Millward[1]
(1) Atmospheric Physics Laboratory, University College London.
CMAT2 - the Coupled Mesosphere and Thermosphere Model version 2 - is the latest of the terrestrial atmosphere models to be developed at UCL. It represents a "new start" in atmospheric modelling, building on the many years of experience of modelling at UCL, Sheffield and Leicester, but built from first principles using modern programming techniques and standards of documentation. Although the code is new, the proof of its "added" usefulness will be in the science it can perform. We describe the current "state" of the model, demonstrate what it can do and discuss the development programme we have embarked upon. George Millward, in a separate session, will describe the APEX magnetic coordinate system that will be part of this programme. Here we concentrate on what is otherwise new about this model, its approach and capabilities.

1635 – 1650 Storming the Bastille: Storm-enhanced densities in the F2-layer.
H. Rishbeth[1] and S. Basu[2]
(1) School of Physics & Astronomy, University of Southampton.
(2) Center for Space Physics, Boston University.
The Bastille Day storm of July 2000 and other large geomagnetic storms show examples of large increases of F2-layer electron density in low and middle latitudes. This paper discusses the physics of storm-enhanced electron densities (SED), in particular the suggestion that plasma originating in equatorial latitudes may be transported to the polar cap, and raises questions that need study.

1650 – 1705 Thermospheric temperature comparisons: combining incoherent scatter and optically determined neutral temperatures.

E. M. Griffin(1), A. Aruliah(1), I. McWhirter(1), D. M. Gabriel(1), E. A. K. Ford(1) and N. P. Meredith(2)

(1) Atmospheric Physics Lab, University College London.

(2) Physical Sciences Division, British Antarctic Survey.

The climatological behaviour of the upper thermospheric neutral temperature at high latitudes is not well understood due to a lack of direct measurements. Fabry–Perot Interferometers (FPI) have been used in satellite and ground-based deployments to provide these direct measurements, by sampling the 630 nm atomic oxygen emission, but the coverage provided by these datasets has been limited. Not all FPI measurements have been calibrated to allow absolute temperatures to be determined from recorded profiles, however we demonstrate how these measurements may be calibrated by using derived temperatures from incoherent scatter radar (ISR) data in certain conditions. Estimates of thermospheric neutral temperatures have been made using ISRs from several locations in the past, but their applicability at high latitudes are restricted to relatively quiet geomagnetic conditions. In this paper we show that when compared to neutral temperatures measured by Fabry-Perot Interferometers discrepancies occur at all but the lowest geomagnetic activity level at 2 high latitude sites, one within the polar cap and one at the edge of the auroral oval. Using the local magnetometer data allows identification of conditions necessary for reliable agreement between the FPI and ISR techniques. This then leads to the possibility of providing normalisation for FPI temperatures from datasets without absolute calibration, an important result which will help expand the measured thermospheric temperature database and hence provide a means to correct the empirical models. The ultimate goal will be to provide an accurate climatology of upper thermospheric neutral temperatures by combining the polar cap and auroral zone results.

Session 3 – Wednesday 0900 – 1040
General Session - 1
Chair – N. J. Mitchell

0900 – 0915 Beyond the dipole: Global ionospheric modelling using the Earth's real magnetic field.

G. H. Millward[(1)], A. D. Aylward[(1)], A. D. Richmond[(2)], N. Maruyama[(2)] and A. Maute[(2)]
(1) Atmospheric Physics Lab., University College London.
(2) National Center for Atmospheric Research.

Whilst undoubtedly powerful for a range of global studies, for reasons of mathematical simplicity, present 'flux-tube' based ionospheric models are limited by their adherence to a dipole structure for the magnetic field. This leads to global ionospheric results which are best considered 'Earth-like', rather than mapped accurately at all locations. Certain regions, such as the equatorial American sector (where the field deviates strongly from a dipole) are particularly poorly served: Key features, such as the equatorial Appleton Anomaly, are simply 'in the wrong place'.

In an attempt to improve on this situation, a collaborative project has been undertaken between the Atmospheric Physics Lab., UCL, and the National Center for Atmospheric Research (NCAR). Our technique has been to restructure the Coupled Thermosphere-Ionosphere-Plasmasphere model (CTIP) using algorithms developed at NCAR to trace along an actual magnetic field-line, as defined by the International Geomagnetic Reference Field (IGRF).

Details of the technique will be outlined and results shown for the new model. The next stage of the project, in which the new ionosphere is fully coupled to a global model of thermospheric electrodynamics (again, correctly mapped to the IGRF) will also be discussed.

0915 – 0930 Evidence for the Tongue-of-Ionisation in the European evening sector.

A. Wood[(1)], H. R. Middleton[(1)], S. E. Pryse[(1)] and I. W. McCrea[(2)]
(1) Institute of Mathematical and Physical Sciences, University of Wales Aberystwyth.
(2) Department of Space Science, Rutherford Appleton Laboratory.

The tongue-of-ionisation (TOI), comprising dayside plasma entrained in the high-latitude convection, is believed to be responsible for density enhancements in the polar ionosphere. If the lifetime of the convecting plasma is sufficiently long then the large-scale structure may be transported through the polar cap and into the nightside region. Modelling studies have indicated that the TOI has an UT dependence, with the feature in the nightside being most prominent in the European sector. Observations are presented from a sequence of satellite passes monitored by the UWA radio tomography chain, which infer the presence of the TOI in the evening sector. The interpretation is supported by measurements of plasma electron density and temperature by the EISCAT incoherent scatter radars, and plasma flow by the SuperDarn coherent scatter radars.

0930 – 1945 A statistical study of artificial plasma irregularities produced by RF heating.

H. Shergill[(1)] and T. Robinson[(1)]
(1) University of Leicester.

The production of small-scale plasma irregularities in experiments undertaken at the EISCAT heating facility in Tromso have been observed using the CUTLASS Finland radar. Presented here are some results examining the moments of the distributions of backscatter intensities from patches of artificial irregularities. Statistical moments are able to resolve the geometry of the patches and can be used to determine quantitatively the distribution of power within the patch. The effect on these moments for power stepping and beam sweeping experiments is shown and a tentative explanation given.

0945 – 1000 SPEAR: Latest results, operational status and future opportunities.

T. Robinson[(1)], T. Yeoman[(1)], R. Dhillon[(1)] and M. Lester[(1)]
(1) Department of Physics and Astronomy, University of Leicester.

The new SPEAR (Space Plasma Exploration by Active Radar) facility on Svalbard has been operational for almost a year. Attention has been focussed, during this period, on performance of the high power beam. The first observations of artificially stimulated ion and plasma line scatter with the ESR have been recorded, as well as those of CUTLASS backscatter from artificially generated field aligned plasma density irregularities. These first observations were all at F-region altitudes. In the most recent campaign in December 2004, stimulated E-region ion line scatter was observed for the first time. There is also evidence of SPEAR excitation mHz magnetic pulsations through electrojet modulation. A summary of SPEAR observations so far, together with an update on current operational status and future experimental opportunities will be presented.

1000 – 1015 Current-voltage relationship in the downward field-aligned current region.

A. Cran-McGreehin[(1)] and Dr A. N. Wright[(1)]
(1) University of St Andrews.

Field-aligned electrons accelerated upwards from the ionosphere to the magnetosphere are the principal charge-carriers in the auroral downward field-aligned current region. Current densities, typically of the order of a few micro-amps per square metre, are sustained by potential drops of several 100 eV up to a few keV. This analytical work, based on a model presented last year at MIST, derives a non-linear current-voltage relationship for the downward current region, which is complementary to the well-known linear current-voltage relationship for the upward current region (Knight [1973]). We find that the B/n peak plays a crucial role in determining Ohm's Law. We also consider the extension of this to two-dimensional downward current systems.

1015 – 1030 Solar-terrestrial physics dataset access and science workflows with a virtual observatory: AstroGrid developments.

S. Dalla[(1)], and N.A. Walton[(2)] on behalf of the AstroGrid Consortium
(1) School of Physics and Astronomy, University of Manchester. (2) Institute of Astronomy, University of Cambridge. Virtual Observatories (VOs) are being developed all over the world to enable seamless access to a diverse range of astronomical datasets. AstroGrid (www.astrogrid.org) is the UK's Virtual Observatory and one of the main partners in the Euro-VO and the International Virtual Observatory Alliance (IVOA). AstroGrid integrates both night-time astronomy and solar system datasets. In this presentation we will describe the AstroGrid V1.0 release, and show how a user can define complex sets of operations on a variety of datasets, to be submitted for remote execution to the AstroGrid Common Execution Architecture. We will focus on developments in the STP area. These include making the datasets part of the UKSSDC centre at RAL available to AstroGrid users. Also, a science case aimed at studying the geoeffectiveness of Coronal Mass Ejections is being developed with input from the STP community. This demonstrates usage of the AstroGrid workflow environment to link measurements of solar activity with interplanetary and magnetospheric data.

1030 – 1040 PPARC national facilities and AstroGrid.

M. Pinnock[(1)]
(1) British Antarctic Survey.

Session 4 – Wednesday 1115 - 1230
General Session - 2
Chair – A. M. Rymer

1115 – 1130 The International Heliophysical Year.
A. R. Breen(1), B. J. I. Bromage(2) and R. A. Harrison(3)
(1) University of Wales, Aberystwyth
(2) University of Central Lancashire.
(3) Rutherford-Appleton Laboratory.
Marking the 50th anniversary of the highly successful International Geophysical Year (IGY), in 1957, groups world-wide are making plans for multidisciplinary and multinational campaigns, mainly as part of an International Polar Year (IPY). As part of this, it is proposed that there be an International Heliophysical Year (IHY) in which we provide some co-ordination of the many solar, heliospheric and near-Earth spacecraft and ground-based observatories, for specific scientific campaigns.

IHY is NOT designed to be another red-tape activity. It is being set up as an enabling activity for the grass-roots scientist to drive co-ordinated observations.

We are in the process of setting up arrangements for the running of the IHY project and for this we need the community to say what it wants. The aim is for IHY to be science-driven and user-driven via a system of science proposals (analogous to the Joint Observing Programme approach adopted for the SoHO spacecraft and to the Special Programme approach used by EISCAT). IHY will act as a link between these programmes and as a means of bringing together groups studying related phenomena in different regions of the Sun-Earth energy train.

In this presentation we discuss the proposed IHY frameword and invite discussion and participation by the MIST community

1130 – 1145 Reconstruction of solar images.
R. Henwood(1) and D. Willis(1)
(1) Rutherford Appleton Laboratory.
This paper describes a study that has been undertaken using the Greenwich Sunspot Group Reports (1874 – 1976). A specially designed visualisation tool, which displays reconstructed solar images, has been developed. Using this visualisation tool, it has been found that there are anomalies in certain fields of the electronic sunspot database. These anomalies are apparent if sunspot positions are calculated using radial distance and ‘clock angle’. Sunspot positions calculated using heliographic latitude and central meridian distance appear to be free from such anomalies but in this case zero heliographic latitude and central meridian distance does not coincide with the centre of the Sun’s apparent disk. The power and utility of the visualisation tool is demonstrated by showing that large sunspots usually exist on the solar disk at the times of great geomagnetic storms recorded by the Royal Greenwich Observatory (RGO) during the interval AD 1840 – 1954. Indeed, a sunspot large enough to be seen by the unaided eye (under favourable atmospheric viewing conditions) existed at approximately the same time as a great geomagnetic storm for more than 90% of the great geomagnetic storms listed by the RGO. This result substantiates a technique used to identify possible intense historical geomagnetic storms during the interval 165 BC – AD 1911, which depends on the existence of approximately coincident sunspot and auroral observations from East Asia.

1145 – 1200 Ulysses observations of the heliospheric current sheet at solar maximum.

S. Child[(1)] and R. Forsyth[(1)]
(1) Imperial College London.

Since 1990, the Ulysses mission has studied the previously unexplored third dimension of the heliosphere from an elliptical orbit tilted at approximately 80@ to the solar equatorial plane. Here we present an ongoing attempt to understand the topology of the heliospheric magnetic field through solar maximum by studying spacecraft observations of the heliospheric current sheet (HCS). The dataset covers the entire second Ulysses orbit (December 1997 @ Feb 2004). Encounters with the HCS by Ulysses are observed at all latitudes in the southern hemisphere and up to 67º in the north. We find the Ulysses observations to be consistent with a single highly tilted HCS at solar maximum, but that there is also substantial local structure within individual sector boundary crossings.

1200 – 1215 Compressibility and the role of passive scalars in solar wind plasma turbulence.

S. C. Chapman[(1)], B. Hnat[(1)] and G. Rowlands[(1)]
(1) Space and Astrophysics Group, University of Warwick.

Incompressible Magnetohydrodynamics is often assumed to describe solar wind turbulence. We use extended self similarity to reveal scaling in the structure functions of density fluctuations in the solar wind. The obtained scaling is then compared with that found in the inertial range of the magnetic field magnitude in the solar wind, and in quantities identified as passive scalars in other turbulent systems. We find that these are not coincident. This implies that either solar wind turbulence is compressible, or that straightforward comparison of structure functions does not adequately capture its inertial range properties.

1215 – 1230 Trajectories of ions specularly reflected from non-planar collisionless shocks.

P. Newman[(1)], W. Wilkinson[(1)] and S. Ellacott [(1)]
(1) School of Computing, Mathematical, and Information Sciences, University of Brighton.

An important contribution to the thermalization of the solar wind ions at the Earth's bow shock for high Mach numbers comes from the reflection of a fraction of these ions from the surface of the shock. Previous studies have examined the trajectories of the reflected ions assuming the shock to be an infinite plane. In this paper a model is developed to describe the trajectories of particles after reflection for a variety of shock surface geometries. Of particular interest are the initial conditions which allow the particle to return to the shock with a greater normal velocity than at first encounter, or to return to the shock at all. Results on the effect of the magnetic field direction and the curvature of the shock are discussed for cylindrical and spherical shock geometries and compared to those for a planar shock.

Session 5 – Wednesday 1400 – 1500
The impact of Cluster in magnetospheric boundary layer science - 1
Chair – J. A. Wild

1400 – 1415 Dawn-dusk asymmetries and sub-Alfvenic flow in the high and low latitude magnetosheath.

M. Longmore[(1)], S. J. Schwartz[(2)], J. Geach[(3)], B. M. A. Cooling[(4)], I. Dandouras[(5)], E. A. Luce [(2)] and A. N. Fazakerley[(6)]
(1) Astronomy Unit, Queen Mary, University of London.
(2) Blackett Laboratory, Imperial College London.
(3) Department of Physics, University of Durham.
(4) Formerly at Queen Mary, University of London.
(5) CESR-CNRS.
(6) Mullard Space Science Laboratory, University College London.
We present the results of a statistical survey of the magnetosheath using four years of Cluster orbital coverage. Moments of the plasma distribution obtained from the electron and ion instruments together with magnetic field data are used to characterise the flow and density in the magnetosheath. We note two important differences between our survey and the gas-dynamic model predictions: a deceleration of the flow at higher latitudes close to the magnetopause, resulting in sub-Alfvenic flow near the cusp, and a dawn-dusk asymmetry with higher velocity magnitudes and lower densities measured on the dusk side of the magnetosheath in the Northern hemisphere. The latter observation is in agreement with studies carried out by Paularena et al. (2001), Nemcek et al. (2000), and Safrankova et al. (2004). In additon to this we observe a reverse of this asymmetry for the southern hemisphere. High-latitude sub-Alfvenic flow is thought to be a necessary condition for steady state reconnection pole-ward of the cusp.

1415 – 1430 The problem of estimating wave energy transfer functions from cluster data.

I. Bates[(1)] and H. St. C. K. Alleyne[(1)]
Space System Group, ACSE Department, University of Sheffield. Energy Transfer is an important mechanism for redistributing the energy input by the Solar Wind around the magnetospheric regions. We concern ourselves in this study with the problem of energy redistribution by waves.

An exchange of energy between the plasma particles and the wavefield is an example of a linear energy transfer. The dynamics of the magnetosphere however are complex and it is possible that higher-order energy transfer modes involving wave-wave interactions are also effective mechanisms for energy transfer, in certain regions under certain conditions. Transfer Functions are a qualitative measure of the energy transfer processes that occur in the plasma. It is the estimation of these quantities that we are interested in.

Previous studies of transfer function estimation in space plasmas have used two-point measurements, e.g. data from the AMPTE UKS/IRM satellites in the magnetosheath, and it was shown to be possible to extract information about the wave energy transfer occurring between the two spacecraft. In particular linear and quadratic processes were shown to be significant. However the 'simple' two-point geometry limited the spatial generalisation of the result.

The energy transfer problem becomes a little more involved when extended to include the CLUSTER data set, however the potential of increased spatial coverage is strong motivation to develop this technique for a multi-point data set. Preliminary results presented here, using data from the DWP/WEC instruments, show that it is possible to gain meaningful energy transfer estimates (when interpreted carefully) from the four-point CLUSTER data set.

1430 – 1445 Cluster observations of the electron-dominated boundary layer in the mid-altitude cleft/cusp.

Y. V. Bogdanova(1), C. J. Owen(1), A. N. Fazakerley(1), B. Klecker(2), M. Dunlop(3), M. Andre(4), N. Cornilleau-Wehrlin(5), H. Reme(6) and A. Balogh(7)
(1) Mullard Space Science Laboratory, University College London.
(2) Max-Planck Institute fur Extraterrestrische Physik.
(3) Rutherford Appleton Laboratory.
(4) Swedish Institute of Space Physics.
(5) Centre d'Etude des Environnements Terrestre et Planetaires.
(6) Centre d'Etude Spatiale des Rayonnements.
(7) Space and Atmospheric Physics Group, Imperial College London.

The nature of the particle precipitations at dayside mid-altitudes can be interpreted in terms of evolution of reconnected field lines. Due to the difference between electron and ion parallel velocities, two distinctive boundary layers should be observed at mid-altitudes between the open-closed boundary and the injections in the cusp proper. The first layer, the electron-dominated boundary layer, consists of soft magnetosheath electrons and high-energy boundary plasma sheet ions [Lockwood, 1997]. The second layer is a mixture of both ions and electrons with magnetostheath energies [Newell and Meng, 1991]. The Cluster spacecraft frequently observe these boundary layers. In this paper we discuss plasma properties inside the electron-dominated boundary layer. This layer contains parallel and/or anti-parallel electron beams and is co-located with sharp enhancements of the wave activity and with transverse heating and outflow of ionospheric ions. We present and discuss two examples of electron-dominated boundary layers, and present results of a statistical study showing how the size of this region depends on solar wind and IMF conditions.

1445 – 1500 CLUSTER observations of waves in and around a possible reconnection diffusion region in the Earth's magnetotail current sheet.

P. Petkaki(1), A. Walsh(1), M. Freeman(1), A. Buckley(2), C. Owen(3), E. Lucek(4), R. Horne(1) and N. Cornilleau – Wehrlin(5)
(1) British Antarctic Survey.
(2) Space Science Centre, School of Science and Technology, The University of Sussex.
(3) Mullard Space Science Laboratory.
(4) SPAT, Blackett Laboratory, Imperial College London.
(5) CETP/UVSQ.

We present an analysis of electric and magnetic waves from 8 to 4000 Hz measured by STAFF instruments on the Cluster spacecraft during several current sheet crossings on 11/10/2001. Plasma flows of order of the local Alfvén speed reversed from tailward to earthward, suggesting that a possible reconnection site moved over spacecraft. Strong broadband electric and magnetic wave activity was seen during the interval with little evidence of discrete linear wave modes.
We ordered the observed wave spectrum by the position within the current using the magnitude of the magnetic field. We found that the electric and magnetic wave power decreased considerably at all frequencies when the magnetic field strength approached zero, indicating that electrostatic and electromagnetic waves might be efficiently suppressed within the current sheet. The implications of these results for reconnection from wave-particle interactions are discussed.

Session 6 – Wednesday 1530 - 1630
The impact of Cluster in magnetospheric boundary layer science - 2
Chair – C. J. Owen

1530 – 1545 EFW analysis of boundary layer structures and FTEs observed by Cluster.

H. Khan[(1)], H. Laakso[(1)], C. Escoubet[(1)], M. Dunlop [(2)], H. Opgenoorth[(1)] and A. Masson[(1)],
(1) European Space and Technology Centre, Solar and Solar Terrestrial Mission Division.
(2) Rutherford Appleton Laboratory.
We present observations from the Electric Field and Waves (EFW) instrument on Cluster during an outbound pass on 6th April 2004, as the satellite traverses the high-latitude cusp and magnetopause boundary. Here we concentrate on the substructures and plasma drifts in the thin magnetospheric boundaries adjacent to the cusp and as the satellites cross the magnetopause. The EFW experiment provides very high time resolution data and as a result we are able to investigate the boundary layer structures in far greater detail than with any other instrument. The time interval used for this study is one of steady southward and dawnward IMF conditions, allowing a direct source of energy into the magnetosphere via reconnection at the dayside magnetopause. Several flux transfer events resulting from reconnection are observed on either side of the magnetopause boundary, and we present an analysis of these events with reference to electric field and density variations. We also indicate the differences observed between the Cluster satellites, separated at this time by ~300km, thus allowing us to gain an understanding of the spatial and temporal evolution of the structures encountered in these regions.

1545 – 1600 A survey of high-latitude flux transfer events observed by Cluster: northward IMF.

R. C. Fear[(1)], A. N. Fazakerley[(1)], C. J. Owen[(1)] and A. Balogh[(2)],
(1) Mullard Space Science Laboratory, University College London.
(2) Imperial College of Science, Technology and Medicine.
During Cluster's dayside magnetopause crossing season (November - June) the four spacecraft cross the magnetopause at higher latitudes near local noon, and further along the flanks, than previous missions. This provides high-latitude and flank observations of Flux Transfer Events (FTEs), a signature of transient magnetopause reconnection. We present the results of a statistical study of FTEs observed by Cluster in the 2002/3 dayside season. Some statistical results are consistent with the results of earlier surveys at lower latitudes. For example, the majority of FTEs occur under southward IMF; those observed under southward IMF in the northern hemisphere tend to have a standard polarity (positive-negative) bipolar signature in the component of the magnetic field normal to the magnetopause, whilst those in the southern hemisphere generally exhibit a reverse signature (negative-positive). However, a significant number of FTEs were observed under strongly northward IMF. These events are mostly standard polarity irrespective of the hemisphere in which they are observed. Furthermore, FTEs occurring under northward and dawnward IMF were predominantly observed on the dusk flank, and vice versa. These two observations are consistent with the northward IMF FTEs being generated by lobe reconnection. When magnetosheath and magnetospheric magnetic field lines reconnect, two FTEs are generated, which propagate away from each other due to magnetic tension. Cluster crosses the northern hemisphere magnetopause at lower latitudes than in the southern hemisphere. This orbital bias implies that Cluster generally passes equatorward of any northern hemisphere reconnection site, but tailward of any southern hemisphere site. Hence, the southernmost FTE of the pair is more likely to be observed in whichever hemisphere Cluster is located. This orbital effect causes the bias towards standard polarity in both hemispheres.

1600 – 1615 Simultaneous Cluster-Double Star observations at the high and low latitude magnetopause.

A.N. Fazakerley(1), M. W. Dunlop(2), M.G.G.T. Taylor(1), J.A. Davies(2), C.J. Owen(1), F. Pitout(3), Z. Pu(4), H. Laakso(5), Q.-G. Zong(6), Y.Bogdanova(1), C. Shen(7), K. Nykyri(8), P. Cargill(8), C. Carr(8), P. Escoubet(5), B. Lavraud(9), M. Lockwood(2), S.E. Milan(10), T.D. Phan(11), H. Reme(12) and B. Sonnerup(13).

(1) MSSL-UCL.
(2)RAL.
(3)MPE.
(4)PKU.
(5)ESTEC.
(6)Boston University.
(7)CSSAR.
(8)ICSTM.
(9)LANL.
(10)Leicester University.
(11)UC-Berkeley.
(12)CESR.
(13)Dartmouth College.

The recent launch of the equatorial spacecraft of the Double Star mission (TC-1) has provided an unprecedented opportunity to monitor the low-latitude dayside magnetosphere boundary layer in conjunction with simultaneous observations of the high-latitude boundary layer by the quartet of Cluster spacecraft. During 2004, the Cluster orbit preferentially sampled the equatorward edge of the cusp region in the northern hemisphere and crossed the adjacent mantle region in the southern hemisphere. At the same time, on a number of occasions, the TC-1 spacecraft sampled both the subsolar region of the magnetopause and, often, low southerly latitudes. The aim of this talk is to focus on CLUSTER-Double Star conjunctions and in particular we attempt to track the evolution of reconnection signatures, such as FTEs. We present preliminary results of one such situation in which, on 6 April 2004, both Cluster and the Double Star TC-1 spacecraft were on outbound transits through the dawnside magnetosphere. The observations are consistent with ongoing reconnection on the dayside magnetopause, resulting in a series of FTEs seen at both Cluster and TC-1, which appear to lie north and south of the reconnection line, respectively. In fact, the observed polarity and motion of each flux transfer event (FTE) signature advocates the existence of an active reconnection region consistently located between the positions of Cluster and TC-1. Cluster observes consistently northward moving FTEs with +/- polarity, whereas TC-1 sees FTEs of -/+ polarity. This assertion is further supported by the application of a model designed to track flux tube motion for the observed plasma parameters and prevailing interplanetary conditions. The results from this model show, in addition, that the low-latitude, FTE dynamics are sensitive to changes in convected upstream (i.e. magnetosheath) conditions, particularly the IMF clock angle. Changes in the latter suggest that TC-1 should miss the resulting FTEs more often than Cluster and this model prediction is supported by the observations.

1615 – 1630 Double Star, Cluster, and ground-based observations of magnetic reconnection during an interval of duskward oriented IMF.

J. A. Wild(1), S. E. Milan(1), J. A. Davies(2), S. W. H. Cowley(1), C. M. Carr(3), A. Balogh(3), J. M. Bosqued(4), H. Reme(4), A. N. Fazakerley(5), A. Marchudon(5), P. W. Daly(6), H. Laakso(7) and S. Buchert(8)
(1) Dept. of Physics & Astronomy, University of Leicester.
(2) Rutherford Appleton Laboratory.
(3) Blackett Laboratory, Imperial College London.
(4) CESR/CNRS.
(5) Mullard Space Science Laboratory, University College London.
(6) Max Planck Institute for Solar System Research.
(7) Space Science Department, ESTEC.
(8) Swedish Institute of Space Physics.

We present the first space- and ground-based study exploiting data from the coordinated Cluster and Double Star missions, in order to investigate dayside magnetic reconnection under By+ dominated IMF conditions. In-situ observations of magnetosheath flux transfer events combined with measurements of pulsed poleward and dawnward directed flows in the pre-noon sector high-latitude northern hemisphere ionosphere are interpreted as indications of pulsed magnetic reconnection during an interval in which the IMF remained relatively steady. Observations of newly-reconnected magnetic flux tubes both at mid-latitudes and in the vicinity of the subsolar point suggests that during By+ dominated IMF, reconnection is not, as proposed previously, limited to the high-latitude magnetopause.

Session 7 – Thursday 0900 - 1030
Signatures of magnetic reconnection in the ionosphere
Chair – G. Chisham

0900 – 0915 Simultaneous observations of ionospheric flow and tail reconnection signatures during the substorm expansion phase.

M. Lester(1), M. Parkinson(2), J.A. Wild(1), S.E. Milan(1), T. Nagai(3), K.A. McWilliams(4), P. Dyson(2), H.J. Singer(5) and H. Frey(6)
(1) Department of Physics and Astronomy, University of Leicester.
(2) School of Physics, La Trobe University.
(3) Tokyo Institute of Technology.
(4) Department of Physics and Engineering Physics, University of Saskatchewan.
(5) NOAA Space Environment Center.
(6) Space Science Laboratory, University of California.

We report observations of ionospheric flow by the Tasman International Geospace Environment Radar (TIGER) during a substorm expansion phase made in conjunction with Geotail observations at approximately 20 Re downtail from Earth. A travelling compression region (TCR) moving tailward was observed by Geotail in the outer layers of the plasma sheet immediately following expansion phase onset. Flows in the ionosphere were also enhanced briefly at this time, although TIGER only observed the sunward (westward) flow. Later in the expansion phase, enhanced earthward flow was observed by Geotail coincident with a localized, vortical like flow region observed by TIGER which was superposed upon the larger scale twin cell convection pattern. Subsequent intensifications of the substorm were also related to further enhancements in the ionospheric flow. Geotail exited the PSBL into the tail lobe only when the auroral activity reached the location of the estimated ionospheric footprint. The existence of the TCR indicates that reconnection took place earthward of Geotail at or following the expansion phase onset and resulted in the brief enhancement in the flow. Subsequently reconnection at a site tailward of Geotail was responsible for enhanced Earthward flow. In this case the response in the ionosphere was a vortex like flow pattern similar to previous observations associated with a flow burst in the central plasma sheet. We also conclude that reconnection of open flux in the tail lobe did not finally occur until just before the second intensification in the local time sector of Geotail almost one hour after expansion phase onset, and 24 minutes after the IMF turned northward at the magnetopause. The observations therefore imply that although reconnection of closed magnetic flux within the plasma sheet took place at the time of the expansion phase onset, it is not necessary for reconnection of open flux of the tail lobe to take place at expansion phase onset.

0915 – 0930 Modulation of dayside reconnection by solar wind pressure pulses during Northward IMF.

G. Provan(1), M. Lester(1), S. W. H. Cowley(1), A. Grocott(1), S.E.Milan(1) and B. Hubert(2),
(1) Department of Physics and Astronomy, University of Leicester.
(2) Laboratories de Physique Atmosphèrique et Planètaire, Universitè de Liège.

On 17 September 2000 the IMF was directed continuously northward for more than three hours. Density fluctuations in the solar wind resulted in quasi-periodic variations in the solar wind dynamic pressure, and correlated fluctuations in the IMF Bz component. The Northern hemisphere SuperDARN radars observed bursts of high-latitude high-velocity plasma flow during this northward IMF interval, both when ionospheric signatures consistent with low-latitude merging were observed, and when lobe merging was occurring. On average the recurrence period of these flow bursts was ~22 min. During this time the SI-12 spectrographic imager channel on the IMAGE spacecraft observed the dayside proton auroral spot continuously. The brightness of the auroral spot varied over time. Here we find a direct correlation between the occurrence of bursts of plasma flow and periodic fluctuations in the brightness of the proton aurora spot. Interestingly, the bright region of the auroral spot is often associated with a lack of radar baskcatter and possible flow avoidance region, with the plasma flow bursts being deflected around this region. The solar wind pressure pulses were directly correlated with the periodic fluctuations of the ionospheric plasma velocity and the brightness of the proton auroral spot, suggesting that the ionospheric precipitation and dayside reconnection were modulated by pressure pulses in the solar wind, resulting in fluctuations in the brightness of the proton auroral spot and periodic variations in the dayside high-latitude plasma flow.

0930 – 0945 Dayside flow bursts and high latitude reconnection when the IMF is strongly northward.

H.Hu(1,2), T.Yeoman(1) and M.Lester(1)
(1) University of Leicester.
(2) Polar Research Institute of China.

The dayside ionospheric convection characteristics are studied using Northern Hemispheric SuperDARN radars data and DMSP particle and flow observations when the IMF was strongly northward during 1300-1500UT on 2 March 2002. Although IMF Bx was positive which is believed to favour Southern Hemisphere high latitude reconnection at equinox, a four-cell convection pattern was observed and lasted for more than 2 hours in the Northern Hemisphere. The reconnection rate derived from the northern hemisphere potential map analysis illustrates that the high latitude reconnection was quasi-periodic, with period between 2-15 min and amplitude of 10 kV on the background of steady reconnection of 11 kV. A sawtooth-like and reverse dispersed ion signature was observed by DMSP-F14 at the sunward flowing cusp at around 1441UT, confirming the high latitude reconnection was pulsed. Accompanying the pulsed reconnection, poleward moving radar aurora and antisunward ionospheric flow bursts were observed in the postnoon LLBL /BPS region. DMSP flow data show that the similar flow pattern and particle precipitation occurred at the conjugate hemisphere.

0945 – 1000 Interhemispheric study of ionospheric flow at the dayside.

A. Goudarzi(1), M. Lester(1) and S. E. Milan(1)
(1) Radio and Space Plasma Physics, Department of Physics & Astronomy, University of Leicester.

We analyse the ionospheric flow response to reconnection during different interplanetary magnetic field conditions, utilising the SuperDARN radars in both hemispheres. Analysing data from the SuperDARN radars, which cover a large fraction of the polar cap in both hemispheres, gives us an opportunity to study the asymmetries which are caused by the By component of the IMF over a wide local time extend. In order to characterize the upstream IMF conditions we use the ACE spacecraft and, in addition, particle precipitation data is provided by the DMSP satellites to determine the location of the boundary between open and closed field lines.

1000 – 1015 Ionospheric plasma near the adiaroic boundary under small clock angle IMF.

S E Pryse(1), R W Sims(1), J Moen(2) and K Oksavik(2)
(1)University of Wales, Aberystwyth.
(2)University of Oslo.
The open/closed field-line boundary (OCB) of the polar cap under conditions of Bz>0 and small clock angle is identified from the adiaroic boundary inferred from ion drift measurements by the EISCAT Svalbard Radar. Coincident particle flux observations by the NOAA-12 satellite reveal energetic (>30 keV) electrons characteristic of closed field lines at the boundary, together with a population of softer precipitating magnetosheath particles. This particle energy-distribution was distinct from that of the central plasma sheet (CPS) observed at lower latitudes. The plasma near the adiaroic boundary is discussed in light of these observations.

1015 – 1030 Characteristics of night time spike events.

A.Aminaei(1) and F.Honary(1)
(1) Lancaster University.
In this paper we present the morphology of absorption spike events which are linked with magnetic reconnection. More than 450 night time spike events during 1994 -2003 as observed by IRIS (imaging riometer for ionospheric studies) are analysed for this study. Four different classes of absorption spike events are identified based on their temporal structure and variation of AL index. The relation of each class of absorption spike event with substorm development, pseudobreakups and Bursty Bulk Flows (BBF) is discussed. Also, seasonal and yearly occurrences of each class of spike events and their dependency to the Kp index and IMF (interplanetary magnetic fields) are presented.

Session 8 – Thursday 1100 - 1225
General Session - 3
Chair – H. Khan

1100 – 1115 Cluster and ground-based observations of the effects of strong solar winds during geomagnetic storms.

N. Balan[1], H. Alleyne[1], S. Walker[1], H. Reme[2], A. Balogh[3], N. Cornilleau[4], S.-R. Zhang[5], T. van Eyken[6], A. N. Fazakerley[7] and P. M. E. Decreau[8]
(1)Control and Systems Engineering, University of Sheffield.
(2)CNRS, CESR.
(3)Blackett Laboratory, Imperial College.
(4)CETP/CNRS.
(5)MIT Haystack Observatory.
(6)EISCAT.
(7)Uni. College, London.
(8)LPCE/CNRS.

The effects on the magnetosphere, ionosphere and ground magnetic field of the strong solar winds that passed through the Earth during the early main phases of the geomagnetic storms on 24 and 29 October 2003 are presented using data from ACE, Geotail, Cluster (FGM, CIS, PEACE, STAFF, WHISPER and EFW), and ground-based instruments like EISCAT radars and Tromso magnetometer chain (60-79N). During the early main phase of the moderate storm on 24 October, a strong solar wind (speed about 600 km/s, density up to 75 cm^-3, temperature up to 0.5 MK and dynamic pressure over 10 nPa) reached ACE at 14:47:15 UT, and IMF Bz turned strongly northward slightly afterwards. About 38 min later when the solar wind reached magnetopause, the Cluster spacecrafts, which were entering the southern magnetosheath, started detecting sudden increases in ion densities (nearly 400 times in H(+), He(++) and hot ions) and ion temperatures (over 10 times), with strong southward turning of the ion velocity (-300 km/s) for about 2.5 hours (15:25-18:02 UT) until the spacecrafts existed the cusp. The EISCAT VHF radar (field of view at about 74N) and Tromso magnetometer chain detected large and sudden changes in the ionosphere and ground magnetic field for about an hour during the early stages of the event. The data seem to indicate that the observed changes in the magnetosphere, ionosphere and ground magnetic field are caused mainly the direct effects of the strong solar winds, which are also modulated by the changes in IMF Bz and solar wind azimuthally flow. A similar event happened during the early main phase of a severe geomagnetic storm on 29 October when an extremely strong solar wind (speed exceeding 1500 km/s, density and pressure not available) reached ACE at 05:58:28 UT and IMF Bz fluctuated around zero. The events at Cluster started about 13.5 min later when the wind reached the spacecrafts which were again entering the magnetosheath.

1115 – 1130 Energetic electron decay timescales in the Earth's outer radiation belt.

N. P. Meredith[1], R. B. Horne[1] and R. R. Anderson[2]
(1) British Antarctic Survey.

The flux of energetic electrons in the Earth's outer radiation belt is highly variable during enhanced magnetic activity. This variability is caused by an imbalance between source and loss processes both of which tend to be enhanced during magnetically disturbed periods. Subsequently, in the absence of further enhanced magnetic activity, the fluxes of energetic electrons gradually decay to quiet time levels. We use 15 months of data from the CRRES satellite to estimate the timescales for decay and to identify the principle loss mechanism. Gradual loss of energetic electrons in the region 3 < L < 5 is observed to occur during quiet periods (kp < 2.5) following enhanced magnetic activity on timescales ranging from 2 – 3 days for 200 keV electrons to 5 – 6 days for ~ MeV electrons. The intervals of decay are associated with large average values of the ratio fpe/fce (> 7) indicating that the decay takes place in the plasmasphere. We suggest that plasmaspheric hiss, a whistler mode emission that is observed inside the plasmapause and which may resonate with electrons in the appropriate energy range, is responsible for much of this loss.

1130 – 1145 A Critical test of electron acceleration in the Van Allen radiation belts.

R. B. Horne[1], R. M. Thorne[2], N. P. Meredith[1], A. J. Smith[1], S. A. Glauert[1], M. Engebretson[3], J. Posch[3], Y. Shprits[2], S. Kanekal[4], D. Baker[4], J. Pickett[5] and D. A. Gurnett[5]
(1) British Antarctic Survey.
(2) U. of California, Los Angeles.
(3) Augsburg College.
(4) Laboratory for Atmospheric and Space Physics, U. of Colorado.
(5) U. of Iowa.

During the 2003 "Haloween storm", the outer radiation belt was depleted and then reformed near L ~ 2.5 inside the slot region, which is usually devoid of energetic particles. This rare event provided a unique set of conditions to test the leading theories of electron acceleration. We show that the depletion of the outer belt, and the initial injection to L = 2.5, corresponded to an increase in ULF wave power, consistent with inward radial diffusion and acceleration. However, the major increase in the radiation belt flux occurred over a period of 2-3 days, during which ULF wave power decreased rapidly and could not inject electrons below L ~ 4. During the flux increase, IMAGE data shows that the plasmapause was compressed to as low as L=2.5 and intense whistler mode chorus waves were observed by CLUSTER at L ~ 4, and on the ground at Halley (L = 4.3) and Palmer (L = 2.6). The ground data suggest that strong whistler mode waves were present outside the plasmapause in space. Using model to solve the Fokker-Planck equation, we find the timescale for electron acceleration by the whistler mode chorus waves in the slot region was about 1-2 days. The results suggest that wave acceleration was primarily responsible for the MeV electrons observed in the slot region. The results suggest that wave acceleration may be an important process in accelerating electrons in the radiation belts of other magnetised planets, such as Jupiter, Saturn, Uranus, and Neptune.

1145 – 1200 The association of Substorm Chorus Events with drift echoes of substorm injected electrons.

G. A. Abel[1], M. P. Freeman[1], A. J. Smith[1] and G. D. Reeves[2]
(1) British Antarctic Survey.
(2) Los Alamos National Laboratory.

Over recent years Substorm Chorus Events (SCEs) have been proposed as a useful indicator of substorm onset. The events are regularly seen in the data from the VELOX (VLF/ELF Logger Experiment) instrument at Halley, Antarctica, which has provided over a decade of near continuous observations. SCEs are generally thought to be excited by the injection of electrons near midnight as they gradient-curvature drift towards dawn. On close one-to-one inspection SCEs seen at Halley and energetic electron signatures seen with the LANL geostationary spacecraft we have found that many events are associated with the drift echo of the injected electrons rather than the initial injection. In this paper we present some example events as well as the relative statistics. We also present an argument that drift echoes may in fact present more favourable conditions for the generation of the whistler mode chorus seen on the ground as SCEs.

1200 – 1215 Electron precipitation during sawtooth Injections.

A. J. Kavanagh[1], A. Aasnes[2], G. Lu[3] and F. Honary[1]
(1) Lancaster University.
(2) University of Bergen.
(3) High Altitude Observatory.

Sawtooth events (saw tooth-like profiles in particle-flux time series) have been identified at geostationary orbit as quasi-periodic (2-4 hr) injections of energetic electrons and ions, and geomagnetic field depolarisations that occur during geomagnetic storms. Our understanding of what drives Sawtooth events is far from complete as indeed is our knowledge of the processes that occur during these energetic events. Recently it has been suggested that Sawtooth injections are a signature of periodic substorms and in fact studies of substorms in the past have now been identified as sawtooth events. Here we present both ground and space based observations of energetic electron precipitation during Sawtooth events (including the large storm of April 2002) and compare them with established patterns from individual substorms. We show that for the cases studied there is little difference between precipitation patterns during isolated substorms and during Sawtooth events, consistent with the view that Sawtooth events are periodic substorms.

1215 – 1230 Cluster observations of flux rope structures in the near tail.

P. Henderson[1], C. J. Owen[1], A. N. Fazakerley[1], A. Balogh[2] and J. Slavin[3]
(1) Mullard Space Science Laboratory, University College London.
(2) Imperial College London.
(3) NASA Goddard Space Flight Centre.

We present a preliminary analysis of flux rope like structures in Earth's near tail observed by Cluster during the 2003 tail season. Properties of the ropes are investigated using multi spacecraft techniques in a time of small spacecraft separation. This allows a good determination of currents through the Cluster tetrahedron using the 'curlometer' technique, as well as multi spacecraft timings. The currents produced from the 'curlometer' technique are compared to electron currents from the PEACE instrument. It is found that the variance direction that best describes the axis of the ropes is not always the intermediate direction, as is seen in more developed 'force free' flux ropes further down-tail, and that possible nested current signatures are observed.

POSTERS – Wednesday 1630 - 1830

P1 - A statistical test of the assumptions used to form a minimal substorm model and the complications of the intrinsic correlations in the solar wind.

G. A. Abel(1), M. P. Freeman(1), A. J. Smith(1) and E. I. Tanskanen(2)
(1) British Antarctic Survey.
(2) NASA, Goddard Space Flight Center.

A minimal model for the evolution of the global dynamical state of the magnetotail during the substorm, involving only three simple rules has been developed. The model considers the general state of the magnetospheric system rather than concentrate on the physical nature of the substorm instability. When driven by a real solar wind power input, the minimal substorm model produces a probability distribution of times between substorm onsets that compares favourably with the distribution of 1001 inter-substorm intervals found by Borovsky et al. from observation. In this paper we examine the validity of the assumptions behind the model, specifically that the integrated solar wind input between two contiguous substorm onsets is proportional to the solar wind input at the time of the first substorm. We do this by comparing the integrated solar wind input between pairs of substorm onsets with the solar wind input at the time of the first substorm onset for a set of observed substorm pairs. The significance of the correlations found in our tests are considered in the context of the intrinsic correlations in the solar wind.

P2 - Global modelling of the Kronian magnetospheric magnetic field.

C. S. Arridge(1), K. K. Khurana(2) and M. K. Dougherty(1)
(1) Space and Atmospheric Physics, Imperial College London.
(2) Institute of Geophysics and Planetary Physics, University of California.

Understanding data from spacecraft fields and particles instruments requires an understanding of the magnetospheric magnetic field which has a central role in the dynamics of magnetospheric plasma. However, magnetometers only provide a measurement of the local field-line geometry and so models are required to extrapolate these local measurements to the global field structure and bridge the gap between observations and theoretical understanding.

In modelling the observed magnetospheric field at Saturn, much work has been done in the so-called "internal field plus disc" approach, where models of the planetary internal field and azimuthal magnetodisc are superposed. However, because magnetopause currents are not considered, these models are restricted to the low latitude inner and middle magnetosphere thus limiting their applicability. Global magnetospheric magnetic field models, such as are available for the terrestrial [Tsyganenko 1989,1995,2001], jovian [Khurana et al. 2003], and hermean [Scuffham and Balogh, 2004] magnetospheres, take into account magnetopause currents and generate model fields which are valid throughout the magnetosphere. Previous global modelling work at Saturn uses methods which are inflexible and computationally expensive, and which do not take into account Saturn's seasonally varying magnetosphere which render them difficult to use for magnetospheric science particularly at the current epoch.

We present the development of a flexible global magnetospheric model aimed at being our "best pre-Cassini guess" of the topology of the magnetospheric field. We find fields due to magnetopause currents which are based on scalar potential functions and which confine the internal and magnetodisc magnetic fields inside a model magnetopause boundary. Our model is dependent on the seasonally varying tilt between the magnetic dipole axis and the solar wind flow, and extends the domain of internal field plus disc models to the whole of the dayside magnetosphere, and also to around -15 Rs on the nightside. The model can also be parameterised with respect to upstream pressure. The resulting field topology is examined and we compare magnetic fields, obtained from the model, with those obtained by Pioneer 11, Voyager 1/2 and also data from Cassini.

P3 - PMSE overshoot: recent EISCAT results.

A. D. Aylward[1], G. O. L. Jones[1], O. Havnes[2], C. La Hoz[2] and others
(1) Atmospheric Physics Lab, University College London.
(2) Dept of Physics, University of Tromso.

When the Tromso heater is cycled in the presence of PMSE (Polar Mesospheric Summer Echoes) an overshoot effect can be created whereby a cycle of short heating time (c 20s) followed by a long relaxation time (c 160s) can produce an abrupt increase in PMSE power as the heater is switched off. A campaign in June 2004 tried different cycles and heater strengths under different ambient conditions to see how the overshoot effect varied with the different parameters. We describe preliminary results from the campaign and demonstrate what we believe they show about electron bite-outs ans other parameters in the plasma.

P4 – First simultaneous MLT and themospheric F-region observations.

N. Balan[1], S. Kawamura[2], T. Nakamura[3], M. Yamamoto[3], S. Fukao[3] and H. Alleyne[1]
(1) Control and Systems Engineering, University of Sheffield.
(2) NITC, Tokyo.
(3) RISH Kyoto Unisversity.

Simultaneous zonal and meridional wind velocities at MLT altitudes (80-95 km), meridional wind velocity in the upper thermosphere (220-450 km), and electron density (150-600 km) and peak height in the ionosphere obtained by operating the MU radar (35N, 136E) in alternate meteor and incoherent scatter modes, for the first time, are presented for the four seasons in 2000-01 when solar activity varied from medium to high. The amplitude spectra of the data are presented. The mean winds, and tides and waves at different altitudes through which the upper atmospheric regions could be dynamically coupled are compared. At MLT altitudes, the resultant horizontal mean wind flows eastward with slight northward turning in all seasons. In the upper thermosphere, the meridional mean wind flows equatorward during spring-summer and poleward during fall-winter. Diurnal tide is found to be dominant at all altitudes and in all seasons except in summer when semi-diurnal tide becomes strong at MLT altitudes. Waves of period near 16-20, 36-48, and 66 hours are also present in general in all regions. A major geomagnetic storm with Dst reaching -358 nT and a moderate storm with Dst reaching -112 nT occurred during an MTEC-S observation at March equinox (2001). The effects of the storms on the different regions are presented

P5 - Correlation dimension analysis of current reversal models.

I. Bates[1], M. Balikhin[1], M. Gedalin[2], G. Consolini[3] and R. A. Treumann[4]
(1) Space Systems Group, ACSE Department, University of Sheffield.
(2) Ben-Gurion University.
(3) Istituto di Fisica dello Spazio Interplanetario.
(4) Max-Planck-Institute for Extraterrestrial Physics.

Some features of the magnetospheric activity seem to possess low dimensional dynamics. Self-organised criticality (SOC) is often referred to as the statistical behaviour responsible for the observed distribution of the electrojet indices. One of the models extensively used for this objective is the field-reversal model.

We apply the correlation dimension analysis to an implementation of the field reversal model to show that, although the field reversal model does exhibit low dimensional dynamics, quantitatively the dimension of the dynamics does not agree with that calculated from the dataset of electrojet indices. Thus, the electrojet indices statistics cannot be explained directly by this model.

P6 – Geomagnetic Effects of the 28th October 2003 Solar Flare

M. Beharrell[(1)], P. Verronen[(2)], F. Honary[(1)] and E. Turunen[(2)]
(1) Lancaster University.
(2) Sodankylä Geophysical Observatory.

The geomagnetic solar flare effect (GSFE) of the X17.2 Solar flare of 28th Oct 2003 has been studied, employing SAMNET and satellite data. Although the usual GSFE and SQ current systems in the northern hemisphere are anticlockwise, a clockwise current vortex is seen over Scandinavia at the beginning of the flare, the possible causes and validity of which are discussed. Also, we report the first results from the Sodankylä Ion Chemistry modelling of the electron density profile during the flare.

P7 - The terdiurnal and quartdiurnal tides in the mesosphere and lower thermosphere over the UK.

C. L. Beldon[(1)] and N. J. Mitchell [(1)]
(1)Department of Electronic & Electrical Engineering, University of Bath.

Horizontal winds in the mesosphere and lower thermosphere have been measured by a VHF meteor radar based in Castle Eaton, UK (52.6@N, 2.2@W) over the 16-year interval from January 1988 to January 2004. The complete data set has been used to investigate the terdiurnal (8-hr) and quartdiurnal (6-hr) tides. Previous studies of these tides have typically used much shorter datasets. The length of the dataset considered here allows the study of tidal inter-annual variability over an interval of approximately one and half solar cycles. The terdiurnal tide monthly-mean amplitudes are in the range of 1 to 5 m/s, and there is a clear seasonal behaviour with maximum amplitudes occurring in autumn and winter. The quartdiurnal tide has mean amplitudes of up to 4 m/s and also maximises during winter months. Both the tides show large day-to-day variability with the terdiurnal amplitudes reaching values as high as 30 m/s and quartdiurnal amplitudes reaching 20 m/s. Spectral analysis is used to investigate the role of planetary waves in the variability of the terdiurnal and quartdiurnal tides.

P8 - Extremely long-baseline interplanetary scintillation measurements of solar wind speed and direction.

A. R. Breen[(1)], R. A. Fallows[(1)], M. M. Bisi[(1)], P. Thomasson[(2)] and R. A. Jones[(1)]
(1) University of Wales, Aberystwyth.
(2) Jodrell Bank Observatory, University of Manchester.

Measurements of interplanetary scintillation provide a valuable method for probing the solar wind throughout the inner heliosphere. The long baselines of up to 390km available at EISCAT have been used for many years to provide increased velocity resolution in the line of sight and an indication as to the true direction of flow of the solar wind. The upgrade of EISCAT to provide measurements at 1400MHz has allowed simultaneous observations to be made between EISCAT and MERLIN in the UK with baselines of more than 2000km. These observations show a further improved velocity resolution and demonstrate that density variations in the slow solar wind remain correlated for at least 8s. The direction of flow can be determined with much greater accuracy than previously: Initial results suggest that this changes according to the solar wind configuration in the line of sight, with deviation from radial of up to 4 degrees seen. These are the first direct observations of differential meridional velocities on the solar wind.

P9 - Preliminary visualisation of wave particle interactions detected by the cluster dwp/correlator.

E. C. Chambers(1), T. D. Carozzi(1), M. P. Gough(1) and A. M. Buckley(1)
(1) Space Science Centre, University of Sussex.

The DWP/correlator produces autocorrelation functions (ACF) of electron counts supplied from PEACE. One of the tasks of the Cluster mission for the DWP/correlator is to cope with the large amount of data produced by the four spacecraft once it has been received on the ground.

We assume that particles within the plasma are randomly distributed when no wave or turbulence is present, and that the counts can be described using a Poisson distribution in such a state. We have found ACF's whose significance indicates that they are likely to be non-poissonic. It was also found that these are thinly distributed in the time domain over short time scales ranging from 1 hour to 1 day and therefore no spatial structuring could be seen.

We present preliminary visualisation techniques applied to show the 'large scale' temporal and spatial distribution of these non-Poissonic ACF's and look for any general or specific structure in the global morphology of wave particle interactions in the data when viewed over wide time periods of months to years.

P10 - Identifying the open-closed field line boundary in the ionosphere using the SuperDARN HF radar network.

G. Chisham(1), M. P. Freeman(1) and T. Sotirelis(2)
(1) British Antarctic Survey.
(2) Applied Physics Laboratory, Johns Hopkins University.

Continuous and extensive spatio-temporal measurements of the open-closed magnetic field line boundary (OCB) are best made at the foot points of the boundary in the Earth's ionosphere. Routine identification of the OCB is crucial if accurate global measurements of energy transfer processes occurring at the boundary, such as magnetic reconnection, are to become a reality. The spectral width boundary (SWB) measured by the Super Dual Auroral Radar Network (SuperDARN) is proving to be a reliable ionospheric proxy for the OCB across a wide range of magnetic local times (MLTs). In this paper we present the results of a statistical comparison of the latitudinal locations of SWBs measured by SuperDARN and particle precipitation boundaries (PPBs) measured by the Defense Meterological Satellite Program (DMSP) spacecraft, concentrating on the correlation with the PPB which best describes the location of the OCB. The results show that the SWB is most accurate as an OCB proxy in the pre-midnight sector (~1800-0200 MLT) and the pre-noon sector (~0800-1200 MLT). In the early morning sector (~0200-0800 MLT) the SWB is located ~2-4 degrees equatorward of the OCB. In the afternoon sector (~1200-1800 MLT) only higher latitude SWBs (poleward of ~74 degrees) can be relied upon as an accurate proxy. The observations have also led to the suggestion that the spectral width observed by the SuperDARN radars is inversely correlated with the energy flux of precipitating electrons.

P11 - Neutral temperature from auroral spectroscopy.

O. Jokiaho(1), B. Lanchester(1), N. Ivchenko(2), G. Daniell(1) and L. Miller(1)
(1) University of Southampton.
(2) Alfvén Laboratory KTH.

The project utilises data from the High Throughput Imaging Echelle Spectrograph (HiTIES). This forms part of the Spectrographic Imaging Facility (SIF), which also consists of four photometers and a narrow field auroral imager, all pointed towards the magnetic zenith, located at Longyearbyen, Svalbard in Norway. It is a joint University of Southampton and University College London platform. The process of extracting the neutral temperature and the altitude variation of the aurora from molecular nitrogen ion "0-2" vibrational transition necessitates the use of quantum molecular spectroscopy. It involves modeling, convolving and fitting the rotational transition lines as a function of temperature and instrument function with the observed spectral profile. Background subtraction remains the most significant issue in this process. Supporting observations are conducted in the oxygen contaminated molecular nitrogen ion "1-3" transition and the Svalbard Eiscat Radar electron density profiles. Their results and relevant issues will be discussed.

P12 - Introducing CMAT2 - Geomagnetic influences on the terrestrial atmosphere.

A. Lyons(1), M. Harris(1) and N. Arnold(1)
Department of Physics and Astronomy, University of Leicester.

P13 - Modelling the response of the F-region to SAPS.

B. Pinter(1), S. D. Thom(1), R. L. Balthazor(1) and H. Vo(2)
(1) Department of Applied Mathematics, University of Sheffield.
(2) The University of Wales, Aberystwyth.

We examine the effects of Sub-Auroral Polarisation Streams (SAPS) on the mid-latitude ionosphere. SAPS modify the density of the F-region significantly, and these density changes have significant impact on TEC measurements, GPS ray paths, and over-the-horizon (OTH) radar. We model the effects of SAPS with the Coupled Thermosphere Ionosphere Plasmasphere model (CTIP), comparing the results with the Utah State University TDIM model.

P14 - Observations of Lunar tides in the mesosphere and lower thermosphere at arctic and middle latitudes.

D. J. Sandford(1) and N. J. Mitchell(1)
(1) Department of Electronic and Electrical Engineering, University of Bath.

Meteor radars have been used to measure the horizontal winds in the mesosphere and lower thermosphere over Castle Eaton (52N) in the UK and over Esrange (68N) in Arctic Sweden. The signature of the lunar (M2) tide has been identified at both locations and can reach amplitudes as large as 11m/s. For the UK, a 16-year data set covering the interval 1988 – 2004 and for the Arctic, a 5-year data set covering the interval 1999 – 2004 have been considered. The Arctic radar has an interferometer and so allows investigation of vertical structure of the lunar tide. At both locations the tide has maximum amplitudes in winter and the amplitude is found to increase with height over the 80 – 100 km height range observed. Vertical wavelengths are very variable, ranging from about 15 km in summer to more than 70km in winter. The role of the “12-hour” M2 lunar tide in contributing to the apparent variability of the 12-hour, S2, semi-diurnal solar tide is considered and the decadal scale variability of the mid-latitude lunar tide is quantified.

P15 - Naturally enhanced ESR spectra and their relation to observed auroral features.

J. Sullivan[(1)], B. Lanchester[(1)], M. Lockwood[(1)] and N. Ivchenko[(2)]
(1) University of Southampton.
(2) Alfvén Laboratory KTH.

Presented here are the beginnings of a project to look at the recent phenomena of NEIALs (Naturally Enhanced Ion-Acoustic Lines) observed in power density spectra recorded at the EISCAT Svalbard Radar (ESR). The current theory of NEIALs is reviewed, including their appearance in the radar spectra, observed statistical properties and the evidence put forward to differentiate between the dominant proposed generation mechanisms.
The instruments being used in this project are summarised, namely; the ESR, the University of Tromso ODIN imager and the Spectroscopic Imaging Facility (SIF) :- a joint Southampton/UCL platform consisting of a spectrograph, photometers and a narrow view camera. The increased sensitivity and co-ordination of these instruments enable us to explore the relationship between optical auroral phenomena and the occurrence of NEIALs in greater detail than previously achieved. Preliminary results are presented of an event in which there was a high incidence of NEIALs measured by the ESR, and supporting optical data from two sites.

P16 - Magnetospheric and ionospheric magnetic field modelling within the GEOSPACE consortium.

E. E. Woodfield[(1)] and R. Holme[(1)]
(1) Dept. Earth and Ocean Sciences, University of Liverpool.

Models of the Earth's magnetic field are of great interest to many in the solar-terrestrial physics community, not least those who wish to combine space and ground-based measurements. A summary of the current progress of magnetic field modelling in the magnetosphere and ionosphere will be presented. We then go on to describe improvements that are planned as part of the GEOSPACE consortium. This is a five year NERC funded project to exploit vector magnetic data from satellites with the aim of improving our understanding and modelling capability for the Earth's entire magnetic field from the core to the magnetosphere. Current plans for the external magnetic field include the synergy of magnetic data from low orbiting satellites and the Cluster spacecraft. This presentation is also a perfect opportunity for members of the MIST community to comment on the current state of magnetic field modelling and influence its future direction.

P17 - Electron density dynamics of the storm-time ionosphere over Europe and the USA.

P. Yin(1) and C. Mitchell(1)
(1) Department of Electronic and Electric Engineering, University of Bath.

GPS dual-frequency observations are used to produce electron density distribution with a 4-D tomography inversion technique (Multi-instrumentation Data Analysis System—MIDAS [1]). Recent work [2] has shown that GPS imaging can be used to study storm-time disturbances in the ionosphere. The advantage of GPS imaging for physical studies of the ionosphere is that the data are available all of the time during and since the recent solar maximum – all storms can be studied and compared.

In this paper we present the dramatic uplifts of F2 layer heights at mid-latitudes during the November 2003 storm. This event took place at 16-17UT on 20th November in the European sector, and an hour later in the USA sector accompanied with the enhancement of electron densities and TEC.

Several storms from the current solar maximum are case-studied and the uplifts in the peak height are discussed from the point of view of Interplanetary Magnetic Field (IMF) changes and in particular the southward turning (Bz component). The magnitudes of these sudden changes in height, density and TEC are compared between Europe and the USA.

References:
[1] Mitchell, C.N. and P.S. Spencer, A three dimensional time-dependent algorithm for ionospheric imaging, Ann. Geophysics-ITALY, 46, 4, 687, 2003.
[2] Yin, P., C.N. Mitchell, P.S. Spencer and J.C. Foster, Ionosperic electron concentration imaging using GPS over the USA during the storm of July 2000, Geophys. Res. Lett., 31:L12806, doi:10.1029/2004GL19899, 2004.