

## Geomagnetism and Paleomagnetism

**GP13A CC: 519 B Monday 1330h**  
**Satellite Magnetic Missions Since Magsat: Recent and Proposed I** (*joint with P, SA, T, SM*)

**Presiding: P T Taylor, NASA**  
 Goddard Space Flight Center; **J C Cain, Florida State University**

**GP13A-01 1340h**

### Contributions of satellite magnetic observations in LEO

**Joseph C Cain** (850-644 4014; [cain@geomag.gfdl.fsu.edu](mailto:cain@geomag.gfdl.fsu.edu))

Geophysical Fluid Dynamics Institute, Florida State University, GFDI/FSU, Tallahassee, FL 32306-4360, United States

Prior to the data collection by Magsat nearly a quarter century ago, magnetic missions in Low Earth Orbit (LEO) had already achieved some success to improve the pre-space era knowledge of the spatial and temporal structure of the geomagnetic field. The relatively accurate vector observations of Magsat was a step upward in this comprehension. These data were extensively exploited to better understand the dynamics of the ionospheric current sources and the details of the small scale structure of the field, as well as obtaining a firm point in time useful for secular variation studies. This review explores the advances that have been made over this time span to the present more comprehensive set of observations by multiple spacecraft in LEO, and the uncertainties that remain that might be addressed by future missions. These present and future missions are seen to have the capability to better understand not only the classical geomagnetic field structure and sources of the observed variations, but also the dynamics of the interactions with the neutral atmosphere as it responds to input from the sun. While the solar-weather connection still seems elusive, a full understanding of the physics of these complex processes at LEO may eventually shed light on this issue. The increasing span of accurate global magnetic observations in time also furthers the possibility that we can better define the electrical structure of the deep earth as it responds to imposed magnetic variations. Finally, the added decades of observation should help sort out theories of the core dynamo generation of the main field.

**GP13A-02 1355h INVITED**

### Geomagnetism and the Age of Space Exploration

**John L. LaBrecque** (202 358 1373; [John.LaBrecque@nasa.gov](mailto:John.LaBrecque@nasa.gov))  
 NASA Headquarters, Code YS, Washington, DC 20546, United States

There can be little doubt that geomagnetic measurements have had an enormous impact on Earth science in the last four decades. The International Decade of Geopotential Field Research has encouraged the development of an international constellation of geomagnetic satellites providing the most detailed geomagnetic field measurements ever. The can look forward to New comprehensive models of the magnetic field are separating field sources with ever more accurate and complete models of the magnetosphere, ionosphere and ocean circulation and geodynamo. In the past geomagnetic field analysis have been constrained by incomplete global measurements. We now have the data and the modeling capability to perform combined analyses of space geodetic, time variable gravity field data in conjunction with these high resolution geomagnetic field models in pursuit of a better understanding the structure and dynamics of Earth's interior.

**GP13A-03 1415h INVITED**

### ESPERIA: an Equatorial Magnetic, Plasma and Particle Mission for Monitoring Perturbations in the Topause Ionosphere and for Defining the Near-Earth Magnetic Environment.

**Vittorio Sgrigna**<sup>1</sup> (+39 06 55177227; [sgrigna@fis.uniroma3.it](mailto:sgrigna@fis.uniroma3.it)); **Rodolfo Console**<sup>2</sup> (+39 06 51860417; [console@ingv.it](mailto:console@ingv.it)); **Aurora Buzzi**<sup>1</sup> (+39 06 55177090; [buzzi@fis.uniroma3.it](mailto:buzzi@fis.uniroma3.it)); **Livio Conti**<sup>1</sup> (+39 06 55177090; [contil@fis.uniroma3.it](mailto:contil@fis.uniroma3.it)); **Arkady Moiseev Galper**<sup>3</sup> (+7 095 3239194; [galper@incos.exp.mephi.ru](mailto:galper@incos.exp.mephi.ru)); **Valeria Malvezzi**<sup>1</sup> (+39 06 55177227; [malvezzi@fis.uniroma3.it](mailto:malvezzi@fis.uniroma3.it)); **Michel Parrot**<sup>4</sup> (+33 02 38 25 52 91; [mparrot@cnsr-orleans.fr](mailto:mparrot@cnsr-orleans.fr)); **Piergiorgio Picozza**<sup>5</sup> (39062022926; [piergiorgio.picozza@roma2.infn.it](mailto:piergiorgio.picozza@roma2.infn.it)); **Renato Scrimaglio**<sup>6</sup> (390862433066; [scrimaglio@aquila.infn.it](mailto:scrimaglio@aquila.infn.it)); **Piero Spillantini**<sup>7</sup> (+39 055 4572261; [spillantini@fi.infn.it](mailto:spillantini@fi.infn.it)); **David Zilpimiani**<sup>8</sup> (+995 32333506; [zilpi@stereo1.ge](mailto:zilpi@stereo1.ge))

<sup>1</sup>Dept. of Physics and INFN Sect., University Roma Tre, 84, Via della Vasca Navale, Rome I-00146, Italy

<sup>2</sup>Italian National Institute of Geophysics and Volcanology, 605, Via di Vigna Murata, Rome I-00143, Italy

<sup>3</sup>Institute of Cosmic Physics, MEPhI, 31, Kashirskoe Shosse, Moscow 115409, Russian Federation

<sup>4</sup>LPCE/CNRS, 3A, Avenue de la Recherche Scientifique, Orleans 45071, France

<sup>5</sup>Dept. of Physics and INFN Sect., University Tor Vergata, 1, Via della Ricerca Scientifica, Rome I-00133, Italy

<sup>6</sup>Dept. of Physics, University of L'Aquila, Via Vetoio, Coppito-L'Aquila, L'Aquila I-67010, Italy

<sup>7</sup>Dept. of Physics, University of Florence, 1, Via Sansone, Sesto Fiorentino-Fi I-50019, Italy

<sup>8</sup>Institute of Geophysics, Georgian Academy of Science, 1, Alexidze Street, Tbilisi 380093, Georgia

ESPERIA is an equatorial space mission planned with a LEO small-satellite and a multi-instrument payload. The project has been ideally conceived to define the near-Earth electromagnetic, plasma, and particle environment, both in steady-state and perturbed-state conditions. In recent times has been observed that either Earth's interior processes or near-Earth space phenomena have a privileged and sensitive zone of investigation constituted by the ionosphere-magnetosphere transition region, at altitudes ranging around 500 ÷ 1000 km. In fact, sun and cosmic rays as well as, seismic, anthropogenic and thunderstorm activities, influence the structure and dynamics of the zone. These external and internal contributions play an important role in defining the particle and electromagnetic field character of the region, both in steady-state and perturbed-state conditions. So, a suitable monitoring of the topside ionosphere may give an help in studying many important physical phenomena as pre-earthquake and anthropogenic electromagnetic emissions, solar wind and flares, as well as in mapping the geomagnetic field. Concerning the Earth's magnetic field mapping, ESPERIA can be seen as an equatorial coordinated and simultaneous complement to polar missions, like SWARM. The first step in realizing the project was an opportunity given by the Italian Space Agency (ASI) for a Phase A Study, concerned with detecting any tectonic and pre-seismic related signals, and studying seismo-associated perturbations and instabilities in the topside ionosphere. The study has been performed by an International Consortium lead by the University Roma Tre, and the ESPERIA Phase A report is now available. The ASI constrains restricted the scientific objectives of the above-mentioned ideally conceived project, but recent contacts with other missions and science teams give indications to reconcile the project to its original aims.

**GP13A-04 1435h**

### The Fine Structure of Field-aligned Currents: Initial FedSat Magnetometer Results

**Michael B Terkildsen**<sup>1</sup> (+612 4921 6653; [michael.terkildsen@newcastle.edu.au](mailto:michael.terkildsen@newcastle.edu.au))

**Brian J Fraser**<sup>1,2</sup> (+612 4921 5445; [brian.fraser@newcastle.edu.au](mailto:brian.fraser@newcastle.edu.au))

**Fred W Menk**<sup>1,2</sup> (+612 4921 5424; [fred.menk@newcastle.edu.au](mailto:fred.menk@newcastle.edu.au))

<sup>1</sup>CRC for Satellite Systems, University Drive University of Newcastle, Callaghan, NSW 2308, Australia

<sup>2</sup>School of Mathematical and Physical Sciences, University Drive University of Newcastle, Callaghan, NSW 2308, Australia

High precision vector magnetic field measurements using the Newmag magnetometer onboard the Australian research microsatellite FedSat, launched in December 2001, are being used to investigate the fine structure of polar field-aligned currents, FAC, including cusp currents, polar cap and substorm current systems during both geomagnetically quiet and storm-time conditions. FedSat is in a sun synchronous 90.7 degree inclination polar circular orbit at 800km, and NewMag has a survey sample rate of 10 vector samples/second and a burst mode sample rate of 100 vector samples/second. FedSat-NewMag is therefore capable of identifying spatial structures within FAC regions with scale sizes down to 75 m, and is thus ideally placed to investigate FAC fine structure. In addition to FedSat magnetometer data, Oersted magnetic field measurements, also with a burst mode sampling rate of 100Hz, are being studied at times of conjunction between the two satellites to resolve the ambiguity that arises in single-satellite magnetic field measurements when attempting to distinguish between spatial and temporal variations. This research aims to commence addressing a number of outstanding questions relating to properties including, how do we distinguish between temporal-spatial structures, what is the distribution of FAC intensity as a function of spatial scale and what determines where and when extremely thin and intense current structures occur, and how are they affected by geomagnetic storms. Initial results on these studies will be reported.

**GP13A-05 1450h**

### Progress in Measuring the Earth's Total Field Variation 2001-2003 using the Scalar Helium Magnetometer on SAC-C

**Carol A Raymond**<sup>1</sup> (818-354-8690; [Carol.A.Raymond@jpl.nasa.gov](mailto:Carol.A.Raymond@jpl.nasa.gov))

**Igor K Kulikov**<sup>1</sup> (818-393-5369; [Igor.K.Kulikov@jpl.nasa.gov](mailto:Igor.K.Kulikov@jpl.nasa.gov))

**Jeffrey B Jewell**<sup>1</sup> (818-354-6211; [Jeffrey.B.Jewell@jpl.nasa.gov](mailto:Jeffrey.B.Jewell@jpl.nasa.gov))

**Michael E Purucker**<sup>2</sup> (301-614-6473; [purucker@geomag.gsfc.nasa.gov](mailto:purucker@geomag.gsfc.nasa.gov))

**Edward J Smith**<sup>1</sup> (818-354-2248; [Edward.J.Smith@jpl.nasa.gov](mailto:Edward.J.Smith@jpl.nasa.gov))

<sup>1</sup>Jet Propulsion Laboratory, Caltech, 4800 Oak Grove Drive, Pasadena, Ca 91109, United States

<sup>2</sup>Raytheon ITSS at NASA/Goddard Space Flight Center, MC 921, Greenbelt, MD 20771, United States

A Scalar Helium Magnetometer (SHM) built at the Jet Propulsion Laboratory was included as part of the Danish Magnetic Mapping Payload on the Argentine/NASA Satellite Aplicaciones Cientificas-C (SAC-C) which launched in November, 2000. The SHM on SAC-C comprises two orthogonal sensors (gas cells) mounted at the end of an 8-meter boom. The SHM data must be corrected for biases termed "light shifts" that are an inherent characteristic of optically-pumped devices. Properly calibrated, the SHM is expected to achieve accuracy on the order of 1 nanotesla. The real light shift is a constant that adds to the measured magnitude, whereas the virtual light shift has a cosine dependency on the angle between the field direction and the sensor optical axis. There are also small offsets in the X, Y, and Z axes that are intrinsic to the sensors and also have a cosine dependency on field direction. SHM data processed using the correction parameters obtained in a pre-flight calibration produce poor agreement with field models and near-coincident passes of Ørsted and CHAMP; however, the uncalibrated data generally agree well. We have analyzed a selected SAC-C quiet day data set ( $K_p < 2$ ) spanning 2001-2003 to determine the optimal values of the instrument biases. An inversion was performed to derive the optimal correction parameters and to solve for the off-nominal, and poorly determined boom orientation about the Z-axis. The inversion minimized the fit to the Comprehensive Magnetic Field Model - 3 (CM3) predicted field, coincident passes of Ørsted and CHAMP when available, as well as internal crossovers of SHM tracks that were temporally proximal. The CM3 model was also used to provide the field direction relative to the SHM sensors for the corrections. The methods will be discussed, along with the resulting total field maps and their errors.