GP14A CC: 519 B Monday 1530h

Satellite Magnetic Missions Since Magsat: Recent and Proposed II

(joint with P, SA, T, SM)

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

GP14A-01 1530h INVITED

External Field and its Stormtime Dynamics as Inferred From Empirical Magnetospheric Models.

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This paper surveys recent results of the modeling of the external geomagnetic field, based on multi-spacecraft data from the inner and near magnetosphere ($R < 15R_E$), supported by concurrent observations in the upstream solar wind. At quiet times, the magnetic field of external origin does not exceed a few tenths of percent of the total geomagnetic field at the Earth's surface. During large storms, the contribution from ionospheric and magnetospheric sources dramatically increases and can reach a few percent of the main field. At low latitudes, most of the large-scale external disturbance comes from the symmetric and partial components of the ring current; a significant effect is also due to the near-Earth part of the tail current. At higher latitudes, the largest contribution is made by Birkeland currents and the auroral electrojet. The external field is largely variable on a wide range of time scales, reflecting incessant variations in the incoming solar wind and the IMF. It also responds to diurnal and seasonal periodic changes of the tilt angle of the Earth's dipole. Early empirical models used a primitive parameterization, in which the data were simply binned into a few intervals of the Kp index. Subsequent studies were aimed at the development of more accurate models, parameterized by the observed geoeffective characteristics of the interplanetary medium. In our most recent work, a new approach has been developed, making it possible to represent the actual dynamics of the magnetospheric currents during interplanetary disturbances. In contrast with earlier efforts, the new model takes into account the entire history of the external solar wind driving of the magnetosphere during a storm. In doing so, we used spacecraft data taken during 37 storms in 1996–2000 [*Tsyganenko et al.*, JGRA, v.108(A5), SMP-18, 2003] and employed the idea that each major source of the magnetospheric field evolves in time according to its individual solar-wind/IMF driving function, has its own decay timescale and a nonlinear saturation threshold. A strikingly good agreement was found between the Dst field at Earth and that calculated from the model field, in spite of the fact that we did not include any ground-based data in the modeling dataset. An important corollary of this modeling effort is that it provides an accurate estimate of contributions to the ground Dst field from major magnetospheric currents, and their variation during the entire cycle of a storm. The obtained results can be viewed as a significant milestone in the pursuit of a realistic field model, based on spacecraft observations. Empirical magnetosphere models are sometimes dismissively termed as "static", "synoptic", or "climatology" models, to contrast them with dynamic MHD simulations. In that regard, our results clearly demonstrate that, once large sets of nearly continuous and accurate interplanetary and magnetospheric data become available, it is possible to develop a truly dynamical external geomagnetic field model and use it to reproduce (and forecast) the entire process of a magnetospheric storm, as it unfolds in time.

URL: http://nssdc.gsfc.nasa.gov/space/model/magnetos/data-based/modeling.html

GP14A-02 1545h

Torque Balances on the Taylor Cylinders in the Geomagnetic Data Assimilation

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In this presentation we report on our continuing effort in geomagnetic data assimilation, aiming at understanding and predicting geomagnetic secular variation on decadal time scales. In particular, we focus on the effect of the torque balances on the cylindrical surfaces in the core co-axial with the Earth's rotation axis (the Taylor cylinders) on the time evolution of assimilated solutions. We use our MoSST core dynamics model and observed geomagnetic field at the Earth's surface derived via Comprehensive Field Model (CFM) for the geomagnetic data assimilation. In our earlier studies, a model solution is selected randomly from our numerical database. It is then assimilated with the observations such that the poloidal field possesses the same field tomography on the core-mantel boundary (CMB) continued downward from surface observations. This tomography change is assumed to be effective through out the outer core. While this approach allows rapid convergence between model solutions and the observations, it also generates sever numerical instabilities: the delicate balance between weak fluid inertia and the magnetic torques on the Taylor cylinders are completely altered. Consequently, the assimilated solution diverges quickly (in approximately 10% of the magnetic free-decay time in the core). To improve the assimilation, we propose a partial penetration of the assimilation from the CMB: The full-scale modification at the CMB decreases linearly and vanish at an interior radius ra. We shall examine from our assimilation tests possible relationships between the convergence rate of the model solutions to observations and the cut-off radius ra. A better assimilation shall serve our nudging tests in near future.

GP14A-03 1600h INVITED

Modeling and Interpretation of Magnetic Fields at Low-Earth-Orbit Altitudes Associated with Ionospheric and Geomagnetic-Field-Aligned Currents

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Ionospheric currents and their associated geomagnetic-field-aligned currents produce a variety of signatures in the geomagnetic field measured at low-Earth-orbit (LEO) altitudes. Analysis of these signatures with the aid of simulation models can provide a wealth of information about ionospheric electric fields, currents, and conductivities; about thermospheric winds; about magnetospheric processes; and about magnetosphere-ionosphere-thermosphere interactions. We survey the observations and simulations of LEO magnetic fields associated with ionospheric and geomagnetic-field-aligned currents, and discuss what they tell us about the ionosphere, thermosphere, and magnetosphere.

GP14A-04 1615h

Magnetic Field Anomalies Recorded Prior to the M=7.6 Chi-Chi Earthquake in Taiwan, Inferred Ground Currents, and the Electrical Conductivity of Rocks

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During seven weeks before the M=7.6 Chi-Chi earthquake in Taiwan on Sept. 21, 1999 and during the month-long aftershock sequence, strong magnetic field anomalies were recorded by two ground stations LY and TT close to the 100 km long, N-S trending fault line that broke during the Chi-Chi event. The magnetic anomalies occurred in hour-long pulses and reached total field intensities of 200 nT (above a 5 nT background). They imply powerful E-W trending ground currents of the order of 500,000 Amp. Assuming the magnetic anomaly to arise from a linear source, the signal strength at satellite altitudes of 300-700 km is estimated to be of the order of 3.3 - 1.5 pT, respectively. Modeling the ground conductor we find current densities of the order of 0.1 mAmp per square meter. We report on a laboratory study to measure the electrical conductivity of igneous rocks placed under stress. We find that the increase in conductivity is due to electronic charge carriers, which are positive holes (p-holes), e.g. defect electrons in the valence band of the otherwise insulating minerals. The current densities obtained from the rock deformation experiments are of the same order of magnitude as those inferred from modeling the Chi-Chi ground conductor.

GP14A-05 1630h

Large Magnetic Anomalies over Russia revealed by Balloon Data

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A stratospheric balloon flight at 30 km altitude measured the geomagnetic field intensity along a 6000 km track extending from Kamchatka to near the Ural Mountains. When the Comprehensive Model based on satellite and ground data (Sabaka et al.,2003) was used to remove the main and external fields from the observed data, magnetic anomalies of several 100 nT amplitude and 250 to 750 km wavelength are observed. They have not been observed before because the wavelength of these anomalies is too short for them to be revealed in geomagnetic field models. Also they do not appear in Russian aeromagnetic data where the balloon track and the aeromagnetic coverage overlap. Two dimensional (2D) magnetic models show that balloon anomalies may be caused by very magnetic, sometimes deep geologic bodies, although such bodies do not correspond to recognized geologic features. In the eastern part of the track these anomalies appear to be due to the bodies of up to 5 km depth and magnetizations of 0.12 SI (0.01 cgs). Magnetizations required for 2D magnetic modeling were compared with measured rock samples data from Magnetic Petrology Database and attempt was made to estimate how well the sample magnetization can represent the average magnetization for the source bodies for the balloon magnetic models. The locations of magnetic petrology data close to balloon track are related to the Urals Mountains (South Mougodjar area, basalts), Mongolia and Tuva ophiolites (serpentinites), Central Siberian Platform (dunites), and Kamchatka (basalts).

URL: http://core2.gsfc.nasa.gov/research/terr_mag/php/MPDB/frames.html

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GP21A CC: 220 C-E Tuesday 0830h

Satellite Magnetic Missions Since Magsat: Recent and Proposed III Posters *(joint with P, SA, T, SM)*

Presiding: **P T Taylor,** NASA Goddard Space Flight Center

GP21A-01 0830h POSTER

Newly developed maps of Moho and Curie discontinuities for Levant as a basis for innovative models of the Earth's crust in Cyprus and southern Israel

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A new map of Moho discontinuity for Levant (Israel, Jordan, Syria, Lebanon and eastern part of the Mediterranean Sea (including Cyprus and Eratosthenes)) has been constructed using integrated analysis