Geospace: Geomagnetic Environment

Ground-level magnetic perturbations, dB/dt (D. Welling)

Magnetopause Location and Geosynchronous Orbit Crossings (Y. Collado Vega)

Geomagnetic Indices (M. Liemohn)

Ground-level magnetic perturbations dB/dt validation

Improved validation suite to include:

- 6 events from SWPC study
  — increase length of Halloween storm (second day),
  — add time before each event to precondition models (can compare
  — with old runs without long preconditioning)
- have more magnetometer stations
  — cover isolated spikes (signal seen at single station),
  — regional assessments, sensitivity discussion,
  — 10-second cadence reasonable
  — dBx/dt, dBy/dt, dB_H/dt or dB/dt_H declination or X/Y or H/D components
  — compare latitude of peak dB/dt or southern edge of auroral oval
  — 2D image processing: auroral images vs. DeltaB maps, FAC
  — integrated quantities?
  — threshold selection: hit or false-positive

Challenges Before Geoelectric Field Validation

- **Need quality thresholds:**
  — model and observations need to agree to some degree (amplitude, location within 1000 km?) before incorporating ground conductivities
- **Observations of Geomagnetic Electric Field (GEF) are local:**
  — lack of long-term stations - large baseline (>10 km) measurements
  — need locally observed magnetic fields to model electric fields
- S**eparation of magnetic observation into induced field and external source**
  — Frequency-dependent ground conductances,
  — [electric power] network impedance - network geometry influences (lines ending at coasts)
  — Earthscope project to get high-resolution continental United States coverage within next two years
  — Coast effects - Baltic sea not negligible

dB/dt validation

Add new events - overlap with Geomagnetic indices group

— Nov. 6-11, 2004

monthly time period with 3 storms:

first 2/3 (two storms) as preconditioning phase,

last 1/3 (one storm) for validation?

Keep Halloween storm with caveats:

- magnetic field variations observed
- solar wind plasma velocity/density poorly known
- event may give poorer skills for models

dB/dt validation - long-term goals

- Work towards longer time periods —> accumulate years from operational models
- More extreme events -
  - stress test with synthetic extreme event
  - derive bounds of possible activity (spatial, amplitude)
- Advanced event breakdown by processes (sudden commencement, main phase, recovery, substorm,…)
- Bin by solar wind driver (Bx,By,Bz,Pram,N,Vx)
  - Advanced Metrics
  - Correlation Coefficient
  - Error quantifcation
  - Bias

All of this will be prepared in a White Paper

Magnetopause Location and Geosync. Orbit Crossings team

Issues

- Ionospheric conductance effects on magnetopause location under-investigated.
- MP compression events should be well reproduced by MHD models, but are not.
- MHD models give different standoff positions of the dayside magnetopause for the same solar wind conditions.
- Effects from the ring current should be taken into consideration.
- Check sensitivity of subsolar and flank magnetopause to changes in model parameters.
- Analysis of differences in solar wind propagation algorithms.
- Uncertainty in upstream conditions. Comparison of observations by multiple solar wind monitors.
- Understanding physical processes causing the magnetopause motion change.

User Needs: Magnetopause crossings at geosynchronous orbit immerse satellites in the magnetosheath in a field and plasma environment that is different from normal operations

Magnetopause

Long term collaboration with other teams:

- Ionospheric conductances effects on the magnetopause erosion
- Radiation belt electron losses from magnetopause
- Magnetopause location for determining the last-closed-drift-shell

Metrics and Analysis quasi-developed and to be:

- RMS, Prediction Efficiency, Cross Correlation, Event-based studies with probability detection
- Database of magnetopause crossings from different missions and Geosync. Orbit crossings
- Quantify speed of changing inward and outward motion of the boundary

Magnetopause

What to do next:

- Publish results already obtained
- Correlate magnetopause position with those observed by different missions.
- Models used will determine how the magnetopause is localized
- Metrics needed will be different for operational users than science users
- Try to understand these differences better and what metrics are useful
- Study what inner parameters make a difference in the different models
- Run the same models with the input of different solar wind monitors and find the error bars
- Important factors to be considered for Geosync. Orbit crossings tool: orbit location, solar wind input, and the inner parameters of the models
- Compile plans into White Paper

Geomagnetic Indices Team

- **Event selection:** we have a bunch on our list
  - We'd like for this list to overlap with those from the dB/dt crew and auroral precipitation crew
  - Some models, especially big first-principles codes, do all three of these elements in a single run
  - Our list will probably be long and then we'll trim it down
- **Month-long interval:** we want to choose a month with an intensity distribution of several key indices that matches the solar-cycle-level distribution
  - Several good candidates, but we need analysis
  - This will probably be completed after the meeting

Geomagnetic indices - Event list

- **6 SWPC events**
- **Additional events:**

  April 6-7, 2000,

  March 31, 2001,

  July 22-27, 2004,

  November 9-10, 2004,

  May 14, 2005,

  March 1, 2011,

  September 17, 2011,

  March 9, 2012,

  March 17, 2013,

  March 17, 2015.

- We're close…
  - We're picking half a dozen storm events
  - We're picking a month-long interval
  - We're picking metrics: the big three for us are trend, goodness, and event capture.

Geomagnetic Indices

- **Ultimate goal:** white paper on generally-applicable metrics for models predicting geomagnetic indices
  - A report that serves as a community reference for benchmarking a new or updated index predictor
- **Metric/skill scores:**
  - Pearson Correlation Coefficient
  - Mean Error, Mean Absolute Error
  - Root Mean Square Error
  - Prediction Efficiency (normalized comparison relative to mean of data)
  - Contingency tables: 2-4 threshold levels, to be determined based on analysis of intensity distributions of several key indices