A39 Session Summary

- 20 Presentations, 1 withdrawn
- 19 Posters

- Observatories and Operations
- E-field monitoring and conductivity studies
- Data processing
Observatories and Operations

- Observatories
  - 2 – BGS
  - 4 – Russian
  - 1 – Indian
  - 1 - Czech

- Observatory Practices
Sable Island Observatory (SBL)
1999 – present

Geographic: 43º55'55.6"N 299º59'25.8"E
Geomagnetic: 53º18'36"N 015º19'41"E
5m above MSL.
Russian Observatories

Deployment of new INTERMAGNET observatories

Geomagnetic Data Center, GC RAS (Moscow)

Operational observatories
South American EMBRACE Network

- Measure variations with Induction Coils
- Data sent to HQ in real-time
- Equatorial Electrojet is present
- Are trying to remove QDC for SW purposes
- Computing $K_{SA}$, K style index for South America
- Estimate a Dst proxy
Setup of observatories

- Fluxgate theodolite (DI-flux)
- Declination D
- Inclination I
- Pillar differences $\Delta X, \Delta Y, \Delta Z, \Delta D, \Delta I, \Delta H, \Delta F$
- Absolute scalar (PPM)
- Variometer (here: FGE)
- Total field F

HEZ or XYZ
Adding pillar differences

constant pillar difference

\[ \Delta F \]

\[ \Delta X \]

\[ \Delta Y \]

\[ \Delta Z \]

time-varying main, external and induced field

\[ \Delta F \]

\[ \Delta X \]

\[ \Delta Y \]

\[ \Delta Z \]

here: for scalar difference
A new Method for D/I measurements!

Proceeding is as follows:

- Set vertical circle to 90° and do the $E_{up}$ and $W_{up}$ measurements like the usual first two D measurements (check leveling).

- Repeat that with vertical circle set to 70° and 110°.

- Set vertical circle to 270° and do the $E_{down}$ and $W_{down}$ measurements.

- Repeat that with vertical circle set to 250° and 290°.
Advantages of the new Method:

• No meridian need to be calculated

• Adjustment to zero always with the same wheel (horizontal).

• The slope of reading is small. Adjustment is easy.

• Only one single “flip over”.

• 12 measurements instead of 8 measurements. Improvement of accuracy due to statistics. Outliers can be identified.

• Allows to avoid very steep telescope position.
Automatic Baseline Controlling dIdD (ABCD) magnetometer basics

- Based on a dIdD magnetometer
- Suspended instrument
- Coils can be rotated around the sensor
- Recording instrument with autocalibration capability
- Calibration on regular intervals by program or on remote command
Known problems at the present stage

- Optical system moves relative to ABCD magnetometer
- Long initial drift
- Angle encoder has thermal sensitivity
- In case of external reference mark optical system works only during the night
CrowdMag (M. Nair)

- Uses magnetometer in a smart phone
- Has low sensitivity and subject to noise
- Downloadable App
- Potential for 1 billion data sources
CrowdMag apps are now available at Google play store and Apple iTunes. In addition to measuring magnetic data, these phones also comes with a World Magnetic Model (WMM2015) calculator.
E-Field and Conductivity Studies

- Thomson et al., BGS operations
- Finn et al., USGS operations
- Both papers had the ultimate goal of validating conductivity models for GIC’s

- Kusvhinov et al., Conductivity study near Hawaii, using offshore Total Field measurements and on shore vector measurements
A Rationale for Long Term Geo-Electric Field Monitoring

• Validating models of surface electric fields that cause geomagnetically induced currents in power grids
• Providing additional monitoring of space weather impact at ground level
  • E.g. Supporting WMO aims
• Long term monitoring to study space weather and space climate variability
  • How does E-field variability relate to solar wind driving and the magnetospheric response?
• Long term monitoring to study Earth structure
  • Classic magnetotellurics
Geo-Electric Observatory

Voltage is amplified by chosen gain factor

Digital data transmission to data logger

Data are scaled, normalised & filtered to 1 Hz

Signal digitised at 50 Hz & GPS time-stamped

Raw Differential Voltage between electrode pairs (high impedance)

Data telemetry to BGS office

ADC

‘SDAS’ PC

BGS Data Base

PREAMP

GPS
Conclusions

• Monitoring has been more or less continuous since 2012
  • Lerwick has probably been most problematic
• It’s been a learning curve
  • Hardware and filtering perhaps need (fine?) tuned, e.g.
    • Electrode degradation over time – how often to be replaced?
    • Relatively short lines (~100m) – limited scope for increase
    • High frequency noise, jumps and spikes
    • Rainfall and probably temperature variations too
• Comparisons with modelled E-field
  • Clear local differences w.r.t measured E-field (the ‘classic MT problem’)
    • Regional field (e.g. length of power line scale) not yet determined
  • Signal to noise issue: only seen a few storms to analyse
  • Not fully dealt with un-modelled periodic sources: tides and Sq
  • But some agreement with regional scale models gives support to modelling methodology
EarthScope and USGS MT + USGS observatories
Observation platform: Wave Glider (Liquid Robotics/Schlumberger)

- Autonomous
- Wave and sun powered
- Can be fixed at one location for days (weeks)
- Linked to Iridium satellites (thus allowing for data control and data retrieve in near real time)
- Can be remotely manipulated
Data Processing Operations

• Operational QC task shared between 4 staff on weekly rotation

• Point of contact for engineers and observatory staff

• Data quality checked and corrected in real-time or next-day basis (Monday-Friday)

• Real-time data processing systems checked for faults and managed during routine downtime
Baseline fitting – piecewise polynomials

Mandic, I

- Improved baseline fitting
- Employed Cubic Spline Interpolation
- Fitting is guided by the baseline values
“Efficiency” of WCSS

IMO 4

Average accuracy of random WCSS BL

- X: std.err. (WCSS)
- Y: std.err. (WCSS)
- Z: std.err. (old BL)
- X: std.err. (old BL)
- Y: std.err. (old BL)

Spline baseline
- GCK baseline

Original samples
- 10% observations

STD. ERR. / InT

0 0.5 1 1.5 2 2.5

percent of observations

Improving Absolute Measurement Errors

- Quality training and frequent retraining
- Eliminate poor observers
- Consider using residual method

- Improve total field mag (F)
- Keep DI-Flux in good calibration
- Automate computations
Data filtering

- Vik, used Teager Operator for real-time spike removal. Mainly lightning.
- Getmanov, Filtering to remove industrial noise. Linear piecewise approximation and cubic spline models were shown