40th Anniversary of the Greenland Magnetometer Array

and

IMAGE 2013 Meeting

May 15-16 2013

DTU Campus
Kongens Lyngby, Denmark

Program committee

Claudia Stolle
Eija Tanskanen
Eigil Friis-Christensen

Local organizing committee

Jürgen Matzka
Lars W. Pedersen
Mille L. Nielsen
Anna Willer
Livia Kother
Nynne Lauritsen

Image from http://bild10.com/bilder/Nordlicht-46.jp

Attendees

1. Chivers, Hugh
   (University of California, San Diego (Retd) and La Jolla Science, Del Mar, California, USA)
2. Clauer, Bob (Virginia Tech, USA)
3. Dorrian, Gareth (University of Lancaster, UK)
4. Edvardsen, Inge (Baker Hughes, Norway)
5. Finlay, Chris (DTU Space, Denmark)
6. Friis-Christensen, Eigil (DTU Space, Denmark)
7. Genevey, Michel (former DMI, Denmark)
8. Gil, Carla (DTU Space, Denmark)
9. Gjerløv, Jesper (APL, USA)
10. Hansen, Truls Lynne (UIT, Norway)
11. Heinselman, Craig (EISCAT Kiruna, Sweden)
12. Janzhura, Alexander (AARI, Russia)
13. Johnsen, Magnar Gullikstad (UIT, Norway)
14. Katkalov, Juri (FMI, Finland)
15. Kotsiaros, Stavros (DTU Space, Denmark)
16. Kother, Livia (DTU Space, Denmark)
17. Lauritsen, Nynne (DTU Space)
18. Lukianova, Renata (AARI, Russia)
19. Lühr, Hermann (GFZ Potsdam, Germany)
20. Matzka, Jürgen (DTU Space, Denmark)
21. Nielsen, Mille (Copenhagen University, DTU Space)
22. Olsen, Nils (DTU Space, Denmark)
23. Overgaard, Søren (former DMI, Denmark)
24. Pajunpää, Kari (FMI, Finland)
25. Pedersen, Lars William (DTU Space, Denmark)
26. Primdahl, Fritz (DTU Space, Denmark)
27. Pulkkinen, Tuija (Aalto University, Finland)
28. Stauning, Peter (DMI, Denmark)
29. Stolle, Claudia (DTU Space, Denmark)
30. Schwarz, Gerhard (SGU, Uppsala, Sweden)
31. Tanskanen, Eija (FMI, Finland)
32. Turunen, Esa (SGO, Finland)
33. Vennerstrøm, Susanne (DTU Space, Denmark)
34. Viljanen, Ari (FMI, Finland)
35. Wilhjelm, Johannes (former DMI, Denmark)
36. Willer, Anna (DTU Space, Denmark)
37. Wintoft, Peter (IRF Lund, Sweden)

Program

All presentations will be held at the DTU Campus in room S16 (ground floor) building 101.

Poster viewing during coffee and lunch breaks.

Wednesday, May 15 2013

IMAGE – Science

09:00-09:05	Welcome
09:05-09:25	Eija Tanskanen: “Solar and solar wind forcing of geomagnetic activity”
09:25-09:45	Magnar Gullikstad Johnsen : “The Dayside Open/Closed Field-line Boundary - Ground-based determination and examination” (invited)
09:45-10:05	Hermann Lühr: ”Revisiting Travelling Convection Vortex events from the CHAMP perspective” (invited)
10:05 -10:25	Esa Turunen: “Geospace atmosphere interaction in 3D” (invited)

Coffee break

10:45-11:05	Ari Viljanen: ”Magnetometer networks and large-scale modelling of geomagnetically induced currents”
11:05-11:25	Juri Katkalov: “Web application for the visualisation of geomagnetic, geoelectric and GIC data”
11:25-11:45	Peter Stauning: "The Polar Cap (PC) Index - a critical review."

Lunch break: There is a table reserved in the DTU canteen (building 101) where participants can buy their own lunch.

GREENLAND – Science

13:15-13:35	Eigil Friis-Christensen: “The early days of the Greenland magnetometer array, installations and first scientific results”
13:35-13:55	Robert Clauer: “A Brief Look at the History and Future of Science and Discovery Enabled by Magnetometer Arrays in Greenland” (invited)
13:55-14:15	Tuija Pulkinen: “Significance of ground-based magnetic observations in the satellite era” (invited)
14:15-14:35	Craig Heinselman: “Incoherent Scatter Radars in Greenland and around the Arctic” (invited)

Coffee break

15:10-15:30 Jesper Gjerløv: "Why the Greenland chain is critical for SuperMAG and for our understanding of how the Earth interacts with the near space" (invited)
15:30-15:50 Renata Lukianova: "Response of the high latitude magnetic field intensity to the exceptionally high solar wind streams"
15:50-16:10 Claudia Stolle: "Results from recent scientific studies that include Greenland magnetometer data"
16:10-16:30 Hugh Chivers: "Collocating Riometers with magnetometers"

18:00 **DINNER**
Buffet incl. beverages will be served in building 328, first floor room 123+129

Posters

Peter Stauning:"A new approach to PC index calculations"

Peter Stauning:"Power Grid Disturbances and Polar Cap Index during Geomagnetic Storms"

J.M. Weygand: "Application and Validation of the Spherical Elementary Currents Systems Technique for Deriving Ionospheric Equivalent Currents with the North American and Greenland Ground Magnetometer Arrays"

Thursday, May 16 2013

Operations, techniques and time for AOB

09:00 – 09:45 Image Steering Committee (chair: Eija Tanskanen)

Coffee break

10:00 – 10:15 Kari Pajunpää: "Status and future of the magnetometer network in Finland"
10:15 – 10:30 Truls Hansen: "Status and future of the magnetometer network in Norway"
10:30 – 10:45 Jürgen Matzka: "Status and future of the magnetometer network at DTU"
10:45 – 11:00 A. Janzhura: "Advanced methods for real-time geomagnetic data acquisition"

12:00 **Tour to Brorfelde:** There will be arranged bus and car transfer from DTU. After arriving at Brorfelde, we will have the traditional Danish "smørrebrød" for lunch. Hereafter there will be possibilities for a guided tour to the DTU magnetometer setup.

16:00 **Retour to Lyngby, Copenhagen and/or Copenhagen Airport**

Abstracts

sorted by time of presentations

Wednesday, May 15 2013, Morning

The Dayside Open/Closed Field line Boundary - Ground-based determination and examination

Magnar Gullikstad Johnsen
UIT, Norway

The Open/Closed field line Boundary (OCB) is the most important boundary in the magnetospheric system. In the cusp, the OCB maps directly to the active reconnection site on the magnetopause. Several techniques exist for the determination of the OCB, including satellite based in-situ and remote sensing techniques as well as ground-based optical and radio techniques. In the cusp the equatorward boundary of the auroral 630 nm [OI] red line emission can be used as a proxy for the dayside OCB. Svalbard is a unique location for optical studies of the dayside aurora because of its high geographic latitude, statistical location beneath the cusp and relative friendly climate. Permanent optical observations of the dayside aurora has been performed from the Auroral Station in Longyearbyen, Svalbard, since 1978. Data from the meridian scanning photometer located in Longyearbyen (LYR MSP), covering the period from 1994 to present, has been used to identify and determine statistical location of the optical OCB. The resulting OCB location has been investigated in relation to the geomagnetic activity and solar wind parameters. Our results are compared to other statistical studies of the OCB latitude.
The DPY current is a well-known high latitude, dayside ionospheric current associated with the cusp and plasma in-flow region of the polar cap. It has been studied widely since the 1970s, especially using the Greenland Magnetometer Array. The relationship between the DPY current and the cusp aurora is examined and discussed using data from the northern part of the IMAGE magnetometer chain and LYR MSP. Challenges and possibilities of using the equatorward edge of the DPY current as a proxy for the cusp/dayside OCB are evaluated.

Revisiting Travelling Convection Vortex events from the CHAMP perspective

Hermann Lühr and Jaeheung Park
GFZ, German Research Centre for Geosciences, Potsdam, Germany

The term “Travelling Convection Vortex (TCV)“ was first coined by the authors of the pioneering study Friis-Christensen et al. (1988). Subsequent to that paper many more researchers were inspired by the phenomena. Pairs of field-aligned currents were assumed to drive plasma convection around the footprints of the FACs. These drift vortices propagate at high speed (several km/s) from pre-noon to the morning sector. TCVs, thought to be driven by transient pressure pulses of the solar wind, have been studied by many facilities, e.g. magnetometers, auroral radars, and auroral cameras. Still missing was a convincing observation of FACs associated with TCVs. Having a satellite that passes just in time over an active TCV is a very rare event. Because of the fast motion of the two systems, the chances for coincidences are small. The CHAMP mission with its 10 years of high-resolution magnetic field measurements provides a good opportunity to improve this situation.
We first searched for prominent TCV events in the IMAGE data set. Based on that selection CHAMP orbit data were scanned for close approaches with the TCVs. From the initially large number of candidates only a hand full of events turned out to be suitable for direct comparison. We are going to present two of these examples. They show a clear relation of the vortices with FACs. Opposed to intuition the vortices have an elongated shape rather than a circular. In our presentation we try to present a picture of the TCVs as complete as possible.

Magnetometer networks and large-scale modelling of geomagnetically induced currents

Ari Viljanen (1), Risto Pirjola (1,2), Magnus Wik (3), Antal Adam (4), Ernö Pracser (4), Yaroslav Sakharov (5) and Juri Katkalov (5)

1) Finnish Meteorological Institute, Finland
2) Natural Resource Canada, Canada
3) NeuroSpace, Sweden
4) Research Centre for Astronomy and Earth Sciences of the Hungarian Academy of Sciences, Hungary
5) Polar Geophysical Institute, Russia

Within the EURISGIC project (European Risk from Geomagnetically Induced Currents), we have derived statistics of geomagnetically induced currents (GIC) in the European high-voltage power grids. The basic data used in this work consist of European ground magnetometer recordings from 30-40 stations in 1996-2008 at 1-min resolution. Combined with the ground conductivity map of Europe, we have calculated the geoelectric field in the area of the power grids. When the electric field is applied to the prototype grid model, we finally obtain GIC. This presentation gives an overview of the occurrence of GIC in Europe.

Web application for the visualisation of geomagnetic, geoelectric and GIC data

Juri Katkalov(1), Magnus Wik (2) and Ari Viljanen (3)

1) Polar Geophysical Institute, Russia
2) NeuroSpace, Sweden
3) Finnish Meteorological Institute, Finland

As a part of the EU/FP7 EURISGIC project web services (www.eurisgic.eu), a web application for visualisation of geomagnetic, geoelectric and geomagnetically induced current (GIC) data has been created. During the EURISGIC project, this tool is used for demonstrating GIC in the European prototype power grid model for a set of geomagnetic storms. It is also used to demonstrate statistical results of the geoelectric field and GIC in Europe in 1996-2008. The tool can also be used for commercial or educational exploitation for power companies and universities.

The Polar Cap (PC) Index - a critical review

Peter Stauning
DMI, Denmark

The Polar Cap (PC) index introduced by Troshichev and Andrezen [1985] is derived from polar magnetic variations and is mainly a measure of the intensity of the transpolar ionospheric currents. These currents relate to the polar cap antisunward ionospheric plasma convection driven by the dawn-dusk electric field, which in turn is generated by the interaction of the solar wind with the Earth's magnetosphere. Coefficients to calculate PCN and PCS index values from polar magnetic variations recorded at Thule and Vostok, respectively, have been derived by several different procedures in the past. The PCN index is found in 7 different versions while the PCS index is found in 5 different versions in past publications. Recent publications (in 2011 and 2012) still convey 3 different PCN and 2 different PCS indices. The presentation here discusses the principal differences between the various PC index procedures and provides comparisons between coefficient and index values derived using the different procedures. Approval of a final PC index procedure is pending at the International Association for Geomagnetism and Aeronomy (IAGA) for a decision possibly at the General Assembly in 2013. It might be considered whether the use of PC indices in international science journals should be avoided until an IAGA-approved unified procedure has been established.

Wednesday, May 15 2013, Afternoon

The early days of the Greenland magnetometer array installations and first scientific results

Eigil Friis-Christensen
DTU Space, Denmark

The Greenland magnetometer chain was established in 1972 with a very specific science goal. The objective was to investigate the recently discovered dayside current at latitudes poleward of the auroral oval in contrast to the few existing magnetometer chains, which were focusing on the night side magnetic substorm phenomena. The presentation will describe the challenges, solutions, and initial results of the endeavour to get continuous observations throughout the year based on the available technical possibilities.

A Brief Look at the History and Future of Science and Discovery Enabled by Magnetometer Arrays In Greenland

Robert Clauer, Hyomin Kim, Dan Weimer and Xia Cai
Virginia Tech, Center For Space Science And Engineering Research, Blacksburg, VA , USA

The Greenland Magnetometers have played a key role in developing our understanding of the coupling between the solar wind magnetosphere and ionosphere. Particularly the west coast chain of magnetometers, which lie nearly along the 40-degree magnetic meridian and span, on the day side, from deep in the polar cap, across the polar cusp to the sub-auroral region. They span the ionospheric foot prints of the magnetic field lines that first interact with the solar wind and they measure the effects of the electric currents that couple the solar wind energy to the magnetosphere and ionosphere. Through the combined and coordinated analysis of the Greenland magnetometer data, Søndre Strømfjord incoherent scatter radar data, polar satellite measurements of fields and particle precipitation, and, of course, good satellite monitors of the solar wind driver, we have discovered and developed our present understanding of the various ways the solar wind affects our magnetic haven and produces space weather. Highlights of these discoveries will be discussed along with recent results and discussion of the next science frontier investigations of simultaneous measurements from the Greenland west coast chain and a conjugate chain along the 40-degree magnetic meridian in Antarctica.

Significance of ground-based magnetic observations in the satellite era

Tuija I. Pulkkinen
Aalto University, School of Electrical Engineering, Espoo, Finland

Terrestrial magnetic field measurements dating back more than a century provide together with sunspot observations an invaluable long-term record of the long-term solar activity and internal geomagnetic field variations as well as much faster solar wind-driven ionospheric currents and magnetospheric processes. Long time series from a chain of stations have allowed us to monitor the auroral electrojets and their changing response to the unusually long and quiet solar minimum period.
First comprehensive sets of coordinated measurements of the Sun, solar wind, magnetosphere, and ionosphere were obtained in the framework of the ISTP program. Even with multiple spacecraft, ground-based instruments were essential in separating temporal and spatial variations as well as giving a spatial coverage for the point measurements in space. Event studies have led to vast improvements of our understanding of the Sun-Earth connection physics; the ground magnetic observations played a key role in separating physical processes related to direct solar wind driving from those associated with magnetotail dynamics.
Modernized society heavily dependent on technology susceptible to space weather effects has brought a new need to operate magnetic networks both to understand the very rapid and small-scale processes leading to geomagnetically induced currents (GIC) and their effects in power transmission networks, natural gas pipelines and other systems as well as to monitor the larger-scale ionospheric currents that affect radio communications, satellite-based positioning accuracy or satellite operations in general. Magnetometer networks today continue to be a vital component of both space science as well as applications for the benefit of the society.

Incoherent Scatter Radars in the Greenland and Around the Arctic

Craig Heinselman
EISCAT Scientific Association, Kiruna, Sweden

The Søndrestrøm Incoherent Scatter Radar was established near Kangerlussuaq, Greenland in 1982 with operations starting in 1983. The radar itself was moved from Chatanika, Alaska to Kangerlussuaq, primarily to support measurements of the ionospheric footprint of the magnetospheric cusp region. Over the years, the radar has been used for a wide variety of research topics in collaboration with many other instruments in Greenland and the arctic regions.
Collaborations among different instruments have increased over the decades. There now exists a broad and expanding network of ISRs and other instruments in the polar regions. This expands the scope of investigations to a more global scale. In parallel with this expansion, the techniques available to ISRs have also allowed measurements to smaller and smaller scale sizes. Both of these thrusts have opened new areas of promising research for the future.

Why the Greenland chain is critical for SuperMAG and for our understanding of how the Earth interacts with the near space

Jesper Gjerløv
The Johns Hopkins University – Applied Physics Laboratory (APL), Maryland, USA

SuperMAG is a worldwide collaboration of organizations and national agencies that currently operate more than 300 ground based magnetometers. This vast data set is truly unique since it allows continuous and nearly global measurement of a fundamental parameter, the ground level magnetic field, thereby allowing studies of the global electric current system and its coupling to near-space. SuperMAG is currently funded by NASA, NSF and ESA. In this presentation we focus on two recent studies enabled by this global collaboration: 1) A generalization of the traditional 12-station auroral electrojet (AE) index to include more than 100 magnetometer stations, SME, was shown to be an excellent predictor of global auroral power and it was shown, contrary to common opinion, that substorms do not have a preferred recurrence rate but instead have two distinct dynamic regimes, each following a power law. 2) Earth's ring current studies revealing consistent local time asymmetries in the net current which suggest that part of the current closure takes place in other regions of space. Measurements from the Cluster spacecraft were found to indicate the role of magnetopause surface currents for ring current closure.

Response of the high latitude magnetic field intensity to the exceptionally high solar wind streams

Lukianova, R. (1,2); Mursula, K. (3); Kozlovsk, A. (4) and Holappa, L. (3)

1) Arctic and Antarctic Research Institute, St. Petersburg, Russia
2) Space Research Institute, Moscow, Russia
3) University of Oulu, Finland
4) Sodankyla Geophysical Observatory, Finland

The exceptionally high solar wind stream activity in 2003 caused a record intensity in the substorm westward auroral electrojet current (WEJ), leading to a major reduction of the horizontal field at auroral latitudes and to a notable strengthening of the vertical geomagnetic field in both polar caps. This strengthening is clearly visible in the polar observatory annual means as a significant deflection in the secular variation. The WEJ is enhanced also during the most quiet time of the strongest high speed stream years. We present and use a novel method to find the years with the largest amounts of fast solar wind streams at the Earth's orbit. The longest available time series from Godhavn and Sodankyla allows monitoring the WEJ intensity during the last 100 years, i.e., during most of the Modern Great Maximum (MGM) of solar activity. We show, for the first time, that the strongest solar wind speeds, comparable with those in 2003, occurred in the declining phase of solar cycle 18. Since high solar wind speeds indicate strong solar polar magnetic fields, we find that cycle 19, which formed the peak of sunspot solar activity (i.e. the strongest toroidal field) during MGM, was indeed preceded by a time with the strongest poloidal field of MGM, thus supporting the basic tenet of solar dynamo theory.

Results from recent scientific studies that include Greenland magnetometer data

Claudia Stolle, Jürgen Matzka, Stavros Kotsiaros, Eigil Friis-Christensen, Anna Willer, Lars Pedersen
DTU Space, Denmark

The exceptional location and the continuous and high quality data records from the Greenland magnetometer array have enabled many scientific investigations of the Earth magnetosphere, on local as well as global scale. For the latter, the Greenland data perfectly complement those from other magnetometer arrays and satellites. Recent investigations involving magnetic data from Greenland include global statistical maps of geomagnetic perturbations, evidence for Pc5 frequency range global modes, and traveling convection vortices with simultaneous observations of EMICS. This talk will present recent scientific results by the international community which have used Greenlandic observations.

Collocating Riometers with magnetometers

Hugh J A Chivers
University of California, San Diego (Retd) and La Jolla Sciences, USA

Riometers and magnetometers both register the effects of particle precipitation during geomagnetic substorms. Extensive past studies have intercompared the observed variations in both these and other instruments when collocated at sites across the Arctic and the Antarctic to investigate more fully the dynamic processes. With the availability of compact and reliable Riometer systems it is proposed that these arrangements continue at all magnetometer stations especially in northern Europe where data collection systems within the Polar Cap can be accessed routinely.

Posters

A new approach to PC index calculations

Peter Stauning
DMI, Denmark

The Polar Cap PCN (North) index is derived from magnetic variations recorded at Thule while a PCS (South) index is derived from Vostok data. The magnetic variations are generated by transpolar ionospheric currents that relate to the polar cap antisunward ionospheric plasma convection driven by the dawn-dusk electric fields, which in turn are generated by the interaction of the solar wind with the Earth's magnetosphere. The PC indices are particularly useful for monitoring Space Weather conditions to provide forecast of adverse events such as strong geomagnetic substorms that could endanger power grids. Coefficients to calculate PCN and PCS index values from polar magnetic variations have been derived by several different procedures in the past. Approval of a final PC index procedure is pending at the International Association for Geomagnetism and Aeronomy (IAGA) but a major problem is the complexity of present index procedures. A new approach to define simplified procedures for deriving PC index coefficients and values is presented. In addition to the simplification the suggested new procedure provides equalized handling of PCN and PCS index calculations such that actual index values would reflect real differences between the conditions in the northern and southern Polar Caps and not just differences in the calculation procedures.

Power Grid Disturbances and Polar Cap Index during Geomagnetic Storms

Peter Stauning
DMI, Denmark

The strong geomagnetic storm in the evening of 30 October 2003 caused high-voltage power grid disturbances in Sweden that expanded to produce hour-long power line outage in Malmö located in the southern part of the country. This was not a unique situation. The geomagnetic storm on 13 March 1989 caused extensive disruptions of high-voltage power circuits especially in the Province of Quebec, Canada, but also to a lesser degree in Scandinavia. Similar events have occurred earlier, among others, during the great storms of 13 - 14 July 1982 and 8 - 9 February 1986. The high-voltage power grid disturbances were related to impulsive magnetic variations accompanying extraordinarily intense substorm events. These events were preceded by lengthy intervals of unusually high values of the Polar Cap (PC) index caused by enhanced transpolar ionospheric convection. The transpolar convection transports magnetic flux from the dayside to night side which causes equatorward displacements of the region of auroral activity enabling the substorms to hit vital power grids. During the 30 October 2003 event the intense solar proton radiation disabled the ACE satellite observations widely used to provide forecast of magnetic storm events. Hence in this case the alarmingly high PC index could provide useful warning of the storm as a back-up of the missing ACE-based forecast. In further cases, monitoring the PC index level could provide supplementary storm warnings to the benefit of power grid operators.

Application and Validation of the Spherical Elementary Currents Systems Technique for Deriving Ionospheric Equivalent Currents with the North American and Greenland Ground Magnetometer Arrays

J.M. Weygand (1), O. Amm (2), A. Viljanen (2), V. Angelopoulos (3), A. Grocott (4), B. J. Anderson (5), D. Murr (6), M. J. Engebretson (7), H. Gleisner (8), I. Mann (9), C. Stolle (10), and K. Hayashi (11)

1) Institute of Geophysics and Planetary Physics, UCLA, Los Angeles, California, USA
2) Arctic Research Unit, Finnish Meteorological Institute, Helsinki, Finland
3) Department of Earth and Space Sciences, UCLA, Los Angeles, California, USA
4) Department of Physics and Astronomy, University of Leicester, Leicester, UK
5) The Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA
6) Center for Space Physics, Boston University, Boston, Massachusetts
7) Department of Physics, Augsburg College, Minneapolis, MN, USA
8) Atmosphere Space Research Division, Danish Meteorological Institute, Copenhagen, Denmark
9) Department of Physics, University of Alberta, Canada
10) Technical University of Denmark, DTU Space, Copenhagen, Denmark
11) Department of Earth and Planetary Physics, University of Tokyo, Tokyo, Japan

With data from the CANMOS, CARISMA, GIMA, DTU MGS, MACCs, STEP, and THEMIS ground magnetometer arrays we applied the state-of-art technique based on SECS (spherical elementary currents systems) developed by Amm and Viljanen [1999] in order to calculate maps of ionospheric equivalent currents over the whole North American auroral region. For this study we examine equivalent ionospheric currents (EICS) and spherical elementary current (SEC) amplitudes associated with a Harang discontinuity on January 9, 2008, a PBI and substorm on April 9, 2008, and the April 5, 2010 storm. Equivalent ionospheric current (EIC) maps inferred at the minimum temporal resolution of the database, in this case 10 sec, are analyzed further in conjunction with near simultaneous images of the THEMIS all sky imager mosaics, SuperDARN radar data, and AMPERE currents. The results show in detail the dynamic evolution of the currents along with the other data sets over the entire North American ground magnetometer network. The EIC maps can be used for contextual interpretation as well as help with our understanding of magnetosphere-ionosphere coupling mechanisms using the ground arrays and the GOES, AMPERE, and THEMIS spacecraft data.

Thursday, May 16 2013, Morning

Status and future of geomagnetic array at Tromsø University, Norway

Truls Lynne Hansen
UIT, Norway

Tromsø Geophysical Observatory, University of Tromsø, is operating a network of magnetometers covering the area from Svalbard to southern Norway. Three of the sites are geomagnetic observatory tracking the secular variation, the remaining 11 are equipped with stable variometers primary for monitoring magnetic disturbances. The chain constitutes a substantial part of the IMAGE network. Near real time data access and processing are essential features of the chain. Based on this services for wellbore navigation and geomagnetic surveying have become important applications of the chain, as has also services for the space weather program of ESA.

Status and future of geomagnetic array at DTU

Jürgen Matzka, Anna Willer, Lars W. Pedersen, Claudia Stolle
DTU Space, Denmark

Presently, 16 stations of the Greenland Magnetometer Array are operating; all except Station Nord (NRD) are sending 1 Hz recordings in near real time. One station, Daneborg (DNB), is not operational. The standard configuration for all stations is a FGE vector magnetometer with a 16 bit/1 Hz ADC and a laptop data logger. The data loggers are remotely controllable and send variation data, typically every 3 minutes, by ftp. The FGE sensor is aligned to the vertical and approximately aligned to local magnetic; the data has arbitrary offsets for the North and vertical component. The size of the East component is indicative for the misalignment between the instrument orientation and local magnetic. The arbitrary offsets in the North and vertical component as well as the local magnetic North direction are estimated from global main field models. Calibration constants (comparable to 'baselines' determined at geomagnetic observatories) can thus be determined and the variation measurements can be transformed into full vector data. Full vector data is available in near real time and distributed through Tromsø Geophysical Observatory. Visually checked variation data is available through FTP at DTU Space.
Future plans are to set up further magnetometer stations in Greenland and the Faroe Islands, to improve instrument stability by using temperature controlled boxes for the instruments, and to freely distribute visually checked full vector data with a delay of maximum two months. We are open to host other scientific instruments at our sites.

Advanced methods for real-time geomagnetic data acquisition

Alexander Janzhura
AARI, Russia

A real-time information on geomagnetic variations is very important for goals of the Space Weather monitoring. The modern communication systems and computer technology makes it possible to collect and process the data from remote sites without significant delays.
Two types of the transport protocols, the streaming and secure ones, are used over Internet to transmit data. The streaming protocols present a simple transmission model with a minimum of protocol mechanism. These protocols are not enough stable but they are very fast and light to transmit real-time data. The secure protocols ensure a reliable but relatively slow communication. Appropriate combination of streaming and secure protocols can considerably improve the real-time data transfer to the data centers and suppliers. The embedded computing platform should be used to ensure the communication and data logging at stations. This small and powerful platform is much more stable than ordinary computers and it can provide a full remote access.
The real-time transmitting and processing the 1-second geomagnetic data is the more difficult task, since the common procedure of the data collecting in form of the text files (for example, IAGA-2002 format) cannot provide the fast and multi-task access to the data. In the case of 1-second (or faster) data it is better to apply the software methods using the database management system. A method for asynchronous data exchange between browser and server could be applied for on-line distribution of magnetic data and their analysis on the WEB. We suggest to use these techniques in on-line derivation of the 1-minute PC and AE induces.
This paper demonstrates realization of the method for collecting, processing and presentation of the 1–second magnetic variations in real-time regime in case of two remote magnetic stations Mineyama (MNY) and Amderma (AMD).