

Bureau Central de Magnétisme Terrestre

Report of the Scientific Council Meeting

14 November 2011

Foreword

This document is the report of the second meeting of the Scientific Council of the Bureau Central de Magnétisme Terrestre (BCMT) held on 11 November 2011 at the Institut de Physique du Globe de Paris. The Council is the main advisory body to the BCMT and works to Terms of Reference set by the Director of the BCMT.

The Scientific Council has provided a list of findings and recommendations for the consideration of the Director of the BCMT, based on consideration of the evidence of BCMT activities and plans provided by staff of the BCMT component institutes.

David Kerridge

Chair, BCMT Scientific Council

Membership of the BCMT Scientific Council

Jacques Hinderer	EOST
Gauthier Hulot	IPGP
Andrew Jackson	ETH Zürich
Dominique Jault	LGIT
David Kerridge	BGS
Jeffrey Love	USGS
Christophe Sotin	JPL
Erwan Thébault	IPGP
Susanne Vennerstrøm	DTU Space

(Jeffrey Love replaced Stefan Maus who resigned his membership of the Scientific Council following the inaugural meeting held on 6 April 2009.)

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Executive Summary

The second meeting of the Scientific Council of the Bureau Central de Magnétisme Terrestre (BCMT) took place at the Institut de Physique du Globe de Paris on 14 November 2011. After consideration of the evidence provided in a series of presentations on the work of the BCMT the Council produced a set of findings and recommendations. The principal findings and recommendations are listed below. (The number in parentheses after each item gives its position in the complete list of findings and recommendations which can be found in Sections 6.1 - 6.8.)

1. The Council noted that many of the recommendations made in the report of the 2009 meeting had been acted on, and was pleased to see positive results. For example, the Council believes the presentations demonstrated better integration between IPGP and EOST activities than was evident in 2009 and welcomes this. [2]
2. The Council welcomes the action taken to produce a BCMT Strategic Plan, and approves of its content. The plan was produced without direct reference to Council and it is recommended that the BCMT takes advantage of the expertise of Council in developing such documents. Council members are willing to be consulted between formal meetings. [4]
3. The Council commends the staff of the BCMT component institutes for their commitment and dedication in working to achieve world-leading standards of measurement and observation. [8]
4. The Council strongly supports the BCMT proposal to move Bangui observatory to Cameroon (Edea) and commends the efforts being made to re-establish Qsaybeh and Antananarivo observatories. [10]
5. The Council strongly recommends that IRD continues its support for BCMT observatories in Africa as there are very few good quality magnetic observatories on the continent. French efforts to secure such observations are extremely important, and are much appreciated by the international scientific community. [27]
6. The Council commends the BCMT for the rapid progress made in producing one-second values from its observatories and in the delivery of Quasi-Definitive data. [12]
7. The Council recommends that the BCMT considers how close a 'relative' ISGI is to the observatory operations within BCMT. Closer integration is thought to be important as part of succession planning for the eventual retirement of the current Director. [18]
8. The Council noted that the topic of space weather could provide a focus for joint work on data products and research by ISGI and BCMT staff and recommends that this avenue is explored. There is a wide range of customers for space weather data products and research funding opportunities, in the ESA Space Situational Awareness (SSA) Programme, for instance. [19]
9. The Council strongly recommends that BCMT implements and maintains a web site giving links to data and data products and information on the BCMT partners. [25]
10. The Council recognises the significant contributions Mr Decker has made in a relatively short time since his appointment to IPGP, including important contributions to INTERMAGET operations. The Council believes that every effort should be made to maintain the current momentum in software development and strongly recommends that, as Mr Decker is due to leave IPGP, a replacement post is approved as a matter of urgency. [30]

1. Introduction

The Scientific Council of the Bureau Central de Magnétisme Terrestre (BCMT) was established in April 2009 by the Director of the BCMT who set the Council's Terms of Reference. The Council's inaugural meeting took place at the Institut de Physique du Globe de Paris (IPGP) on 6 April 2009. This 2011 meeting was the second meeting of the Council.

The meeting consisted of a series of presentations in open session given by BCMT staff and by members of the Scientific Council, and two private sessions for the Council to meet. In the private sessions members of the Council discussed and agreed recommendations based on the information provided prior to the meeting and in the presentations describing progress since the last meeting and planned activities. These recommendations were presented by the Chair in open session at the conclusion of the meeting.

Summaries of the presentations describing the BCMT component institutes' activities and plans, and on more general aspects of geomagnetism, are given in Sections 3 and 4. Section 5 summarises a presentation given by Dr Love. The findings and recommendations of the Scientific Council appear in Section 6. The meeting Agenda is given in Appendix A. The membership of the Council is listed in Appendix A, along with the names of the members of the BCMT Management Committee and guests who attended the meeting. The Terms of Reference for the Scientific Council are given in Appendix B. Acronyms used in this report are listed in 6.8.1.1 Appendix C.

2. Opening and welcoming addresses

The meeting was opened by the Chair, David Kerridge who welcomed the members of the Scientific Council, members of the BCMT management committee, BCMT staff and guests. He said that at the first meeting of the Council on 6 April 2009 there had been frank and open discussions between Council members and BCMT staff and he encouraged the same approach for this meeting. It was important for the Council to hear about problems as well as successes so that it could be effective in its role and offer constructive advice. He said the Council was eager to hear of progress since 2009, plans for the coming years, and he hoped the discussions during the day would stimulate new ideas. He noted that funding agencies would look to the Council for reassurance on value for money.

Prof Vincent Courtillot was Director of the BCMT at the time of the first meeting of the Council and was attending this meeting representing Prof Jaupart, the current Director of BCMT who, unfortunately, had other engagements. Prof Courtillot said he had appreciated the quality of the Council's report on the first meeting and had instituted actions in response to the recommendations, and the outcomes would be described in the presentations by BCMT staff.

Prof Jean Virieaux, President of the Commission des Services Nationaux d'Observation (CSNO), said that the leadership of INSU (Institut National des Sciences de l'Univers) considers observatories (in various disciplines) to be critical to science, and that support for them, currently running at €950k per annum, was planned to be stable. He said that BCMT is an SNO for magnetism (Service National d'Observation Magnétisme) and it is BCMT as an entity that applies for funding support. (IPGP, EOST and ISGI as components of the BCMT are individually designated as Service d'Observation.)

David Kerridge said it would be useful to the Council to have a better understanding of the scientific organisational hierarchy in France, leading to where BCMT sits. Later in the meeting Prof Courtillot provided a diagram showing the links 'upwards' from BCMT to CSNO to CSST (Commission Spécialisée des Sciences de la Terre) to INSU and finally to CNRS (Centre National de la Recherche Scientifique).

The Agenda was reviewed and approved and the meeting moved to reports from BCMT staff.

3. Status of the BCMT

3.1 Overview

Dr Arnaud Chulliat gave the opening presentation, an overview of BCMT. He began by listing achievements made since the 2009 meeting in instrumentation, observatory operations and data products. More detail was given on instrumentation and observatory operations in subsequent talks by Xavier Lalanne and Aude Chambodut reported in Sections 3.2 and 3.3. Dr Chulliat gave details of progress on the production of Quasi-Definitive (QD) data and their planned distribution, through INTERMAGNET. The main motivation for the production of QD data is to have an observatory data product available for use alongside data from the Swarm satellites. He showed how QD data had been applied to validation of the 11th generation International Geomagnetic Reference Field. Progress on acquisition and distribution of real-time data from the BCMT observatories was described.

Dr Chulliat presented budgetary figures for the various contributors to the overall BCMT budget, with projections to 2012. In response to a question from Prof Sotin on why IRD funding in 2012 was shown as zero, Dr Chulliat said the situation is very uncertain and so he had (cautiously) indicated that no funding may be the eventual outcome. Prof Virieux said that a strong recommendation by the Council to IRD to continue supporting observatories in Africa was needed, noting that this issue was wider than geomagnetism.

The reason for the decrease in IPEV funding in 2011 was questioned by Prof Courtillot. Dr David-Beausire said this was because equipment was requested as part of the 2011 funding request, but IPEV cannot pay for equipment.

Dr Chulliat went on to describe the BCMT response to a selection of the recommendations made in the report of the 2009 meeting. A Strategic Plan had been produced; actions to secure the future of magnetic observatory operations in Africa were continuing; there was now better co-ordination between the BCMT member institutes on instruments, data acquisition systems, and software for data processing and data management; and progress had been made on recruitment.

3.2 Instrumentation

Xavier Lalanne began by describing the large -30°C/+50°C thermal chamber at Chambon La Forêt Observatory used for instrument testing. He went on to describe the VM391 vector magnetometer used in the French observatories, and upgrades to analogue circuitry and A/D converters. Figures on noise performance were presented and comparisons with similar figures for a selection of competitor magnetometers were favourable. Plans to make improvements by replacing some analogue circuitry by digital components, and by using a metal-glass alloy, Vitrovac 6025 X, in a new sensor promised to deliver a new low noise fluxgate magnetometer.

Mr Lalanne said that the French experience of the widely used GEM SM90 Overhauser magnetometers was disappointing, they had poor reliability, with two instruments requiring repairs in a typical year. He said that three BCMT observatories are equipped with IXSEA magnetometers but these are no longer manufactured. Consequently a decision had been made to develop a Helium scalar magnetometer, with the sensor cells produced 'in-house'. Following successful with a prototype device trials (performance data were shown) plans had been made to build two more magnetometers to establish reproducibility.

Prof Mandaia said it appeared that the Helium scalar magnetometer is very similar in design to the magnetometer developed by LETI for the Swarm mission. Mr Lalanne said although the physical principle is the same, there are differences as the LETI scalar magnetometer is designed for observation on a moving platform whereas the IPGP magnetometer is designed for static operations as at a magnetic observatory.

There was a general discussion about the distribution of instrumental expertise in different French bodies and the need to capture knowledge if a particular group was at risk and the role BCMT could play. This was thought to be an important issue, as the instrument developments described by Mr Lalanne are internationally competitive. At a minimum, the rate of production needed to keep pace with plans to upgrade the BCMT

observatories, otherwise procurement from other suppliers would be necessary. On the other hand, over-production could, in principle at least, be used to generate sales to re-invest in French observatory operations.

3.3 Observatories

Aude Chambodut described efforts to complete the BCMT contribution to the global magnetic observatory network. Easter Island (Isla de Pasqua - IPM - Chile) is now in full operation and Dr Chambodut showed an exciting and unexpected magnetic signal that had been recorded as the tsunami generated by the offshore Chile Mw 8.8 earthquake on 27 February 2010 passed the island. The fidelity of the records was excellent as a result of one-second sampling. The DomeC/Concordia observatory (DMC - Antarctica) is also in full operation and an example of the use of the observatory's data to produce a polar magnetic activity index was shown. Both IPM and DMC had been accepted as full INTERMAGNET observatories in October 2010. In addition, in April 2011, Dalat observatory (DLT - Vietnam) had been commissioned, and it was intended to submit a membership application to the September 2012 meeting of INTERMAGNET. As a result of these efforts BCMT is now running 19 observatories worldwide.

Dr Chambodut then described progress in upgrading equipment. Installation of data acquisition systems to collect one-second data samples had been completed at 15 observatories (8 since the 2009 meeting). It is intended that all (currently operational) BCMT observatories will be upgraded to this standard by the end of 2012.

Dr Chambodut then turned to the problem of observatories under threat. Because of severe difficulties with security IRD had decided to close Bangui Observatory (BNG – Central African Republic). The possibility of establishing a new observatory in Cameroon (at similar dip latitude to Bangui) was under active investigation. Qsaybeh Observatory (QSB - Lebanon) has stopped operations, but a complete re-installation is planned for 2012. A Lebanese observer will receive training at Chambon La Forêt. The location of Antananarivo Observatory (TAN – Madagascar) is no longer suitable and relocation to a site 60 km from the current location is planned to be completed by mid-2013. This project is made possible through collaboration with the Geophysical Institute and Observatory of Antananarivo (Institut et Observatoire Geophysique D'Antananarivo - IOGA).

In a discussion on the observatories in the French Austral and Antarctic territories the major importance of the contribution made by IPEV in terms of funding, logistical support and manpower was apparent.

3.4 Data processing

Luc Decker described the data flow from the BCMT observatories through the IPGP and EOST servers to the BCMT web site, INTERMAGNET and to partner organizations. Earthworm, a software package originally developed for real time seismic data acquisition, had been adapted for collection of geomagnetic one-second data and was implemented at seven BCMT observatories. USGS staff had assisted with this. An Earthworm reception system had been setup at the US Space Weather Prediction Center (NOAA) in Boulder. There is a growing customer base for the data, including space weather service providers, ISGI for computation of geomagnetic activity indices, the French army and some private sector companies.

Mr Decker described MagEdit, a web application to de-spike geomagnetic data, and showed the graphical interface used to display and correct data. It incorporates an automatic spike detection system developed in collaboration with Russian mathematicians. Mr Decker also described software developments, taking advantage of the work done on spike detection, to automatically detect geomagnetic events, such as storm sudden commencements (SSC) in real time. The aim is to automatically issue alerts, by email and via Twitter and SMS messages when an SSC is detected. Trials of a prototype system had started in July 2011, with promising results.

Members of the Scientific Council recommended that magnetograms based on the real-time (Earthworm) data are made available on the BCMT website. Magnetograms with highlighted SSC events could also be displayed. It was suggested that the BCMT team at IPGP consider distributing some of its in-house software to the scientific community, under an open-source scheme. For example, this would allow more observatories to use the SSC detection system providing a more extensive set of data on events than available at present.

3.5 ISGI

Michel Menvielle explained that ISGI is in charge of computation and dissemination of the geomagnetic indices endorsed by the International Association of Geomagnetism and Aeronomy (IAGA), and that it operates under the supervision of the International Union of Geodesy and Geophysics (IUGG) through IAGA. ISGI has been accepted as one of the first components of the newly instituted ICSU World Data System (WDS) and is recognised by INSU/CNRS as a "service d'observation" in both the solid earth and astronomy-astrophysics domains.

Prof Menvielle described the suite of indices, produced in France, Germany and Japan, that ISGI is responsible for, referring to the related physical processes in the magnetosphere. Good progress has been made in meeting the needs of users by providing 'quick-look' (near real time), provisional and definitive values of indices on the ISGI website, free of charge. Prof Menvielle believes that user requirements are being met quite well, though there is always room for improvement in the timeliness and quality of quick-look indices. Efforts are being made to improve the ISGI web site.

Prof Menvielle described research topics undertaken under the auspices of the ISGI Bureau since 2009. The availability of high time resolution digital data from observatories provides opportunities to better characterise geomagnetic activity in both time and space. Work on using root mean square values to estimate magnetic energy density over any time interval and based on geographical selections of observatory data was shown. There are applications of this work in the Advanced Thermosphere Modelling for Orbit Prediction (ATMOP) project funded under the European Union's Framework 7 programme, which aims to produce near real time thermospheric density estimates required for satellite drag calculations. Magnetic energy density estimates are being used to assess the geomagnetic forcing of the thermosphere (alongside solar forcing).

There was discussion of the closeness of the relationship between IPGP and EOST, the observatory operators in BCMT, and ISGI. The question of maintaining two separate web sites was raised, and it was suggested that combining the two might offer efficiencies. Prof Menvielle argued that ISGI and BCMT must continue to maintain two separate web sites, because ISGI is an international service and must have its own web site to ensure its visibility to international users. Nevertheless, Prof Menvielle agreed that the links between the web sites should be improved. He suggested, as an example, that it would be possible to send real-time preliminary values of indices derived by ISGI to the BCMT site in real time, and that the ISGI site could display real-time magnetograms from a selection of BCMT observatories. It was stated again that providing web access to real-time magnetograms would be effective in improving the profile of BCMT.

Members of the Scientific Council felt there is an opportunity to develop a coordinated strategy for the development and dissemination of space weather products, and joint research, taking advantage of the range of expertise within the BCMT. For example, presentations on development of new products for space weather applications, such the SSC alerts and magnetic energy density indices had been given independently during the meeting. There seemed to be potential for BCMT and ISGI to work together on SSC detection (it was noted that Ebro observatory collects SSC data on behalf of ISGI). Following Mr Decker's presentation there had been a comment on using one-second data to study the evolution of SSC events as a possible area of research

Space weather is a 'hot topic' and the ESA Space Situational Awareness programme could provide a focus for coordinated effort and it may be a source of future funding.

4. New Projects

4.1 New repeat stations

Arnaud Chulliat described the history of the French repeat station network of 32 stations (supplemented by Chambon la Forêt Observatory) which had been occupied every five years since 1947, the last re-occupation being in 2007. Customers for the information gained, in the form of a national map of magnetic declination include the French Civil Aviation (DGAC), the National Geographical Institute (IGN) and the general public. The

French repeat station data had contributed to the Magnetic Network in Europe (MagNetE) project which had published a declination map for Europe for 2006.

Problems in finding the reference marks for the stations and azimuth marks were described. Examples of observations from stations with several occupations were shown in comparison with secular variation calculated from a global geomagnetic field model derived independently of the repeat station data. Where the fit was good it was clear that the data added little information for global modelling. However, at a small number of stations (an example close to Nantes was shown) the data and the model differed significantly and there is interest in understanding the reasons for such apparently local effects.

Dr Chulliat presented a proposal to abandon the existing repeat station network and start again with a smaller network of 10-15 sites based at airports. Through agreement with DGAC, access to these sites over the long term was assured, and DGAC would be a beneficiary of the measurements. Practical testing to evaluate the use of GPS for azimuth determination had been carried out, with success, at Chambon la Forêt Observatory and at Orléans Airport. Dr Chulliat said the next step was to formalize the agreement with DGAC and then carry out a campaign of observations in 2012.

There was discussion on the arrangements with DGAC. Although there is no legal obligation, it is in the spirit of the BCMT mission to provide DGAC with up-to-date information on magnetic declination at airports in France. (After the meeting Dr Chulliat advised that IPGP has a cooperation agreement with IGN and the national declination map is provided to them.) The question of whether overlapping measurements should be made to connect the old and new networks was raised. Following discussion, it was agreed that the evidence on the good quality of fit of global secular variation models to data from the old network would make this an unnecessary (and expensive) exercise. The scientific value of the repeat station observations was questioned. Dr Chulliat agreed that the scientific value of the observations was not particularly high, but the measurements would gain greater significance if there was a gap in magnetic survey satellite missions.

4.2 Transfer of the Bangui observatory to Cameroon

Xavier Lalanne reported that the decision to move out of the Central African Republic and look for a safer location was taken on 16 June 2011 and that on 25 June 2011 all the equipment at Bangui Observatory had been stolen. The Institute of Geological and Mining Research in Cameroon had agreed to the principle of operating a magnetic observatory in co-operation with IPGP in the south-west of the country near the city of Edea, close to the coast. This is an attractive site as it has been a CTBTO radionuclide station for four years, has trained technicians, it is in a remote location, and has reliable power and Internet connections. Mr Lalanne noted that Edea is some way south of the Equatorial Electrojet (EEJ) and said that establishing an observatory at Edea might open up possibilities to make measurements in the north of Cameroon, close to the EEJ, supplementing observations made by the West African Magnetometer Network.

Members of the Scientific Council agreed that this was an excellent initiative and appreciated the positive efforts being made to overcome the problems resulting from the unstable situation at Bangui.

5. Future directions

Jeff Love of the USGS contributed a presentation on an aspect of his recent research.

5.1 *Geomagnetic detection of asymmetric solar dynamo modes*

Dr Love described an analysis of the geomagnetic activity aa-index, which is derived from ground-based observatories, from solar cycle 11 to the beginning of cycle 24 (1868-2010). Averages of autocorrelation show 27.0-day recurrent geomagnetic activity during solar cycle minima, which varies over time, and some solar cycle minima also exhibit a smaller amount of 13.5-day recurrence. The recent solar minimum 23-24 is unusual in that it exhibits geomagnetic activity recurrence with 9.0 and 6.7-day periods; these periods are not seen so prominently in any of the minima for cycles 11-22. Using solar wind data and spherical-harmonic models fitted to heliomagnetic data, an anomalous relative increase in non-axisymmetric ingredients, and especially sectorial ingredients, in the solar magnetic field as the cause of 9.0 and 6.7-day geomagnetic-activity recurrence was discovered. These results show that the recent minimum, which was of great depth and duration, was also an unusual period for the magnetic shape of the solar dynamo field. Dr Love pointed out:

- These results highlight the importance of maintaining long-term operational continuity of magnetic observatories – the data provide a record of the long-term history of solar-terrestrial interactions;
- This work makes use of the aa index, an important data-derived product of the BCMT (ISGI); and,
- There are abundant opportunities for BCMT scientists to expand their research work into the domain of space weather.

6. Findings and Recommendations of the Scientific Council

The Scientific Council met twice in closed session to discuss the information provided in the presentations and in discussions and the responses to questions in the open sessions. At the second closed session a set of findings and recommendations was drawn up and this formed the basis of the presentation made by David Kerridge at the meeting's final open session. Formally, this report was made to the BCMT Director. The following observations and recommendations are based on the material in that presentation.

6.1 *General remarks*

1. The Scientific Council **thanks** the representatives of the BCMT component institutes for the quality of their presentations and understands the effort involved in producing them. The willingness of all attending the meeting to participate openly in discussions and to give clear answers to questions is much appreciated by the Council.
2. The Council **noted** that many of the recommendations made in the report of the 2009 meeting had been acted on, and was pleased to see positive results. For example, the Council believes the presentations demonstrated better integration between IGP and EOST activities than was evident in 2009 and **welcomes** this.
3. The Council **welcomes** the commitment of INSU/CSNO to observations and to the maintenance of funding to support them.
4. The Council welcomes the action taken to produce a BCMT Strategic Plan, and **approves** of its content. The plan was produced without direct reference to Council and it is **recommended** that the BCMT takes advantage of the expertise of Council in developing such documents. Council members are willing to be consulted between formal meetings.

6.2 *Instrumentation*

5. The Council was **impressed** by the BCMT achievements in instrument development and noted the need to establish their quality of performance over the long term.

6. The Council **noted** the potential to produce instruments for commercial sale. Increasing the number of suppliers of observatory instrumentation would offer greater choice to purchasers in magnetic observatories. Although the market is relatively small some income to re-invest in French observatories could be generated. (The Council recognised that this suggestion might contravene regulations unknown to its members with which BCMT member institutions have to comply.)
7. From general discussions it appears that there is a danger of loss of knowledge and expertise in instrumentation in both the public and private sector in France. The Council **recommends** that the BCMT be proactive and take measures to preserve capability in danger of being lost.

6.3 Observatories

8. The Council **commends** the staff of the BCMT component institutes for their commitment and dedication in working to achieve world-leading standards of measurement and observation.
9. The Council **congratulates** the BCMT on extending its global network of observatories to the numbers planned at the 2009 meeting and notes the success in achieving INTERMAGNET operating standards. The new observatories in operation on Easter Island and in Antarctica are in scientifically valuable locations.
10. The Council **strongly supports** the BCMT proposal to move Bangui observatory to Cameroon (Edea) and **commends** the efforts being made to re-establish Qsaybeh and Antananarivo observatories.
11. The Council **endorses** BCMT proposals to acquire observations of the Equatorial Electrojet (EEJ) in Cameroon.

6.4 Data processing

12. The Council **commends** the BCMT for the rapid progress made in producing one-second values from its observatories and in the delivery of Quasi-Definitive data.
13. The Council was **impressed** by the progress reported in software development. The experience of Council members led them to advise keeping effort devoted to the difficult topic of automatic de-spiking of data to reasonable levels as this presents severe difficulties when, as in the case of geomagnetic data during magnetic disturbances, the signal has spiky characteristics.
14. The Council **recommended** that when software developments are planned the requirements of the wider global magnetic observatory network are kept in mind so there is the potential for wider benefit. (Geomagnetic research generally depends on collections of global data sets and so exporting good practice and helping others produce good quality data pays off widely.)
15. The Council **advised** the BCMT to consider collaboration on new software developments. The example of collaborative communities in software development in seismology, requiring an open source approach, and the success in implementing Earthworm with the assistance of USGS was noted.
16. The Council **noted** that because of the high level of achievement in both hardware and software the BCMT is in a position to offer leadership in the international magnetic observatory community and **encourages** it to do so.

6.5 ISGI

17. The Council **recognises** the important international role of ISGI, its status in the World Data System and endorsement of its activities by IAGA and IUGG.
18. The Council **recommends** that the BCMT considers how close a 'relative' ISGI is to the observatory operations within BCMT. Closer integration is thought to be important as part of succession planning for the eventual retirement of the current Director.
19. The Council noted that the topic of space weather could provide a focus for joint work on data products and research by ISGI and BCMT staff and **recommends** that this avenue is explored. There is a wide

range of customers for space weather data products and research funding opportunities, in the ESA Space Situational Awareness (SSA) Programme, for instance.

6.6 Repeat stations

20. The Council **suggests** that a clear rationale for the repeat station programme is documented justifying the density of stations and the frequency of their occupation. It is expected that this will include reference to requirements for national maps for strategic and public good reasons, and scientific benefits.
21. The Council recognises local user-driven requirements for measurements at airports and **endorses** the plan to use airports to establish a new repeat station network with a total of 10-15 sites.
22. During the meeting there was discussion of a possible new aeromagnetic survey of France to be conducted by BRGM. The Council **recommends** that BCMT seeks information about this and links the repeat station plans to the new aeromagnetic survey if possible.

6.7 BCMT visibility

23. The Council believes the BCMT has much to be proud of and **recommends** that BCMT should take advantage of this to raise its profile/visibility. For example the BCMT efforts to report data promptly and the work on Quasi Definitive and one-second data should continue to be publicised to the scientific community through conference presentations and journal publications.
24. The Council recognises the visibility BCMT gains through the leading role its staff play in the INTERMAGNET programme, which has policies to help to ensure that observatory-related work is valued and properly acknowledged. The Council **recommends** that BCMT continues to exercise leadership in INTERMAGNET.
25. The Council **strongly recommends** that BCMT implements and maintains a web site giving links to data and data products and information on the BCMT partners.
26. The Council believes there is the potential to create interest in non-academic customers who may be willing to sponsor some activities in return for customised data products. The Council **suggests** that this possibility is investigated, while recognising that BCMT partners may have remits which inhibit engagement with the private sector.

6.8 Resources

27. The Council **strongly recommends** that IRD continues its support for BCMT observatories in Africa as there are very few good quality magnetic observatories on the continent. French efforts to secure such observations are extremely important, and are much appreciated by the international scientific community.
28. The Council recognises and **appreciates** the value of the manpower and logistical support for the French Austral and Antarctic observatories given by IPEV.
29. The Council **suggests** that BCMT evaluate whether the level of software and databasing skills and resource available to ISGI is adequate for ISGI to deliver its mission.
30. The Council **recognises** the significant contributions Mr Decker has made in a relatively short time since his appointment to IPGP, including important contributions to INTERMAGNET operations. The Council believes that every effort should be made to maintain the current momentum in software development and **strongly recommends** that, as Mr Decker is due to leave IPGP, a replacement post is approved as a matter of urgency.

Appendix A : Agenda

Meeting of the BCMT Scientific Council 14 November 2011, IPGP, room 108

Morning session

- 9h00-9h30 Welcome coffee
- 9h30-9h45 **Opening and welcome addresses**
David Kerridge (Chair)
Vincent Courtillot
Jean Virieux: INSU and the BCMT
Approval of the agenda
- 9h45-10h45 **Status of the BCMT** (all reports 15 minutes and 5 minutes for questions)
Arnaud Chulliat: Overview
Xavier Lalanne: Instrumentation
Aude Chambodut: Observatories
- 10h45-11h00 Coffee break
- 11h00-11h40 **Status of the BCMT** (continued)
Luc Decker: Data processing
Michel Menvielle: ISGI
- 11h40-13h00 *Working meeting #1 – Council members only*
- 13h00-14h00 Lunch break

Afternoon session

- 14h00-15h00 **New Projects**
Arnaud Chulliat and Aline Peltier: New repeat stations
Xavier Lalanne: Transfer of the Bangui observatory to Cameroon
Discussion
- 15h00-15h30 **Future directions**
Secular changes of the Sun and space weather: Jeff Love
Open discussion
- 15h30-16h00 Coffee break
- 16h00-17h00 *Working meeting #2 – Council members only*
- 17h00-17h30 Preliminary report and recommendations of the Scientific Council

- Close of meeting -

Appendix A : List of participants

BCMT Scientific Council

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Appendix B : Scientific Council Terms of Reference

The following Terms of Reference are dated as 6 April 2009.

Purpose

The Scientific Council is the main *advisory* body of the BCMT.

The BCMT was created and attached to the Institut de Physique du Globe de Paris (then part of the Paris University) by a decree published in 1921 (attached). In 2008, the Institut National des Sciences de l'Univers (CNRS-INSU) set up an Observation Service in Magnetism, which was delegated to the BCMT.

Membership

The Council members are nominated by the BCMT Director, after consultations of the BCMT Management Committee and CNRS-INSU.

The Council elects its chair and secretary from among its members.

Roles and responsibilities

The Scientific Council shall:

- Receive reports from the Director and advise on the BCMT observational strategy.
- Make specific recommendations to the Director on:
 1. the start / stop of magnetic observatories and other ground observations;
 2. the status of existing and the development of new instruments and data acquisition systems;
 3. the status of existing and the development of new data products based on ground magnetic data.
- Advise the Director on the BCMT internal organization.
- Advise the Director on its funding strategy (requests to funding agencies for money and positions).
- Help the BCMT identify and anticipate future scientific and societal needs in terms of ground magnetic observations.
- Write reports with recommendations on the BCMT activity (typically every year) and forward it to institutions participating in the BCMT and to funding agencies, including CNRS-INSU.

Appendix C : Acronyms of organisations

BCMT:	Bureau Central de Magnétisme Terrestre
BGS:	British Geological Survey
BRGM:	Bureau de Recherches Géologiques et Minières
CEA:	Commissariat à l'Énergie Atomique
CNES:	Centre National d'Etudes Spaciales
CNRS:	Centre National de la Recherche Scientifique
CSNO:	Commission des Services Nationaux d'Observation
CSST:	Commission Spécialisée des Sciences de la Terre
DGAC:	Direction Générale de l'Aviation Civile
DTU:	Technical University of Denmark (Danmarks Tekniske Universitet)
EEJ:	Equatorial Electrojet
EOST:	Ecole et Observatoire des Sciences de la Terre
ESA SSA:	European Space Agency Space Situational Awareness (programme)
ETH:	Swiss Federal Institute of Technology (Eidgenössische Technische Hochschule)
IAGA:	International Association of Geomagnetism and Aeronomy
ICSU:	International Council for Science
IGN:	Institut National de l'Information Géographique et Forestière
INSU:	Institut National des Sciences de l'Univers
IOGA:	Institut et Observatoire Geophysique D'Antananarivo
IPSL:	Institut Pierre Simon Laplace
IPEV:	Institut Polaire Français, Paul-Emile Victor
IPGP:	Institut de Physique du Globe de Paris
IRD:	Institut de Recherché pour le Développement
ISGI:	International Service of Geomagnetic Indices
ISTerre:	Institut des Sciences de la Terre
IUGG:	International Union of Geodesy and Geophysics
LETI:	Laboratoire d'Electronique et de Technologie de l'Information
JPL:	Jet Propulsion Laboratory
NOAA:	National Oceanic and Atmospheric Administration
USGS:	United States Geological Survey
WDS:	World Data System

