

## Report of the Scientific Council of the Bureau Central de Magnétisme Terrestre

November 9, 2018

**Executive Summary:** The Scientific Council (SC) of the Bureau Central de Magnétisme Terrestre (BCMT) recognizes the extremely high importance of the magnetic observatory data time series and related services provided by the BCMT. In light of identified priorities for improving the operation of BCMT magnetic observatories, and to more promptly transmit, process, and disseminate accurate data, the SC (1) urges that two staff persons (an engineer and a scientist) be hired to support BCMT work at the École et Observatoire des Sciences de la Terre (EOST), (2) urges that a high degree of standardization be brought to the systems, software, and operational procedures used by the Institut de Physique du Globe de Paris (IPGP) and the EOST, (3) the SC supports IPGP development and deployment of magnetometer systems providing time series with improved accuracy (baseline stability), (4) supports IPGP efforts to find a new site for the M' Bour and Pamatai observatories, (5) encourages IPGP pursuit of local support for replacement of the Addis Ababa observatory.

**Meeting:** The executive leadership of the BCMT, Vincent Lesur, Aude Chambodut, and Pierdavid Coisson, provided the SC with a strategic plan. They hosted an SC meeting at the IPGP on October 12, 2018 where presentations were given. During parts of this meeting, Marc Chaussidon and Anne Le Friant were present as head of BCMT and as representatives of the IPGP. After the meeting, the SC developed this report and provided it to the BCMT.

**Priority:** The SC regards (1) the acquisition of high-fidelity magnetometer data time series from magnetic observatories, (2) the transmission, processing, management, and dissemination of observatory data (and metadata), and (3) the development and the dissemination of products (various averages and indices) that are derived from observatory data to be (together) services of great value for the pure and applied French-domestic scientific communities, as well as for related international scientific communities.

This priority is established in light of the numerous geophysical domains affecting signals recorded in magnetic observatory data, including the Earth's geodynamo, mantle, and the lithosphere; ocean currents; the ionosphere and magnetosphere; and solar-terrestrial interaction, as well as the broad utility of observatory data for individuals and agencies across the academic, commercial, and governmental sectors, including for the pursuit of fundamental scientific understanding, geomagnetic mapping and geophysical modeling, natural resource assessment and development, and space-weather monitoring and the assessment and mitigation of related geomagnetic hazards.

**Details:** •The SC recognizes that standard observatory data types include preliminary (raw), quasi-definitive (relatively accurate, lightly calibrated and processed), and definitive data (very accurate, fully calibrated and processed). •The SC recognizes that some of these data types are reported with resolutions ranging from 1-second to 1-year. •The SC recognizes that preliminary data are reported from some observatories in near-real-time, and the production of quasi-definitive and definitive data should be reported as soon as possible and on a schedule that is largely determined by INTERMAGNET (an international consortium of magnetic observatory institutes).

**Commendations:** •The SC commends the BCMT for its operation of magnetic observatories with broad geographic distribution and under a wide range of different conditions. •The SC commends the BCMT for its operation of magnetic observatories for long durations of time and with high levels of temporal continuity. •The SC commends the IGP for reporting preliminary magnetometer time series in near-real-time from many of its observatories. •The SC commends the BCMT for the production of quasi-definitive and definitive geomagnetic time series. •The SC commends the IGP for the development of accurate (stable-baseline) magnetometer systems. •The SC commends the IGP for the opening of the Edéa observatory in Cameroon. •The SC commends the EOST for the opening of the new Antananarivo observatory in Madagascar. •The SC commends on-going cooperation between IGP and EOST in support of BCMT observatories, data, and services.

**Challenge 1:** The SC recognizes the challenges in operating EOST observatories; their remote location imposes unusual logistical demands on EOST personnel. The SC also recognizes that the BCMT (in particular, the EOST) is struggling to promptly transmit and disseminate preliminary data, promptly process and disseminate quasi-definitive data. In particular, preliminary data are reported for EOST observatories with up to 1-day delay; in contrast, some INTERMAGNET institutes report preliminary data within 15 minutes of acquisition; preliminary data are reported from some IGP observatories within 15 minutes of acquisition. Quasi-definitive are reported from EOST observatories after unusually long delays (in some cases, after years); in contrast, some INTERMAGNET institutes report quasi-definitive data within months of acquisition.

**Action 1:** As soon as practically possible, the SC urges the Institut National des Sciences de l'Univers (INSU) to ensure the hiring of two staff for EOST (an additional engineer and an additional scientist). The SC notes that its 2016 report has already “strongly recommended” the hiring of an additional engineer at the EOST.

**Action 2:** Over the next 5 years, the SC urges that a high degree of standardization to be brought to the systems, software, and operational procedures used by the IPGP and the EOST. In particular, identical fluxgate magnetometers can be used at all BCMT observatories, identical or nearly identical acquisition systems can be employed at all BCMT observatories (with variations accommodated according to local needs), and identical data processing software and procedures can be applied to all BCMT observatory data. The SC perceives that, in many (if not all) cases, standardization would sensibly amount to the EOST using systems, software, and procedures used by the IPGP. The SC supports the IPGP in addressing short-term software development needs of the BCMT and perceives that this development might be focused on standardization of IPGP and EOST data management and processing.

**Benefit:** The SC anticipates that actions 1 and 2 will result in reporting of BCMT (and especially EOST) data with improved timeliness, thereby increasing the widespread usage of EOST data across the scientific community.

**Challenge 2:** The SC recognizes that the operation of each observatory requires labor-intensive attention to produce accurate (stable-baseline) magnetometer data. Calibrated observatory data are produced through data processing, where fluxgate time series are combined with occasional person-made absolute measurements. A large part of the problem, here, is related to the drifting response of fluxgate magnetometer systems.

**Action 3:** The SC supports IPGP plans to make operational new magnetometers (DVM18) at Chambon-la-Forêt once they are fully tested. In accomplishing this work, the SC encourages publication (or open presentation available to the public) of details of the tests. Subsequently, the SC would strongly support the installation of new magnetometers at all IPGP and all EOST observatories, as per the standardization already advocated above.

**Benefit:** The SC anticipates that action 3 will result in improved preliminary data accuracy, which will require less labor-intensity processing to produce quasi-definitive and definitive data products. This will amount to an improvement in the data service provided to the scientific community.

**Challenge 3:** The SC recognizes the importance of maintaining and improving magnetic observatory operations in Africa and in the South Pacific.

**Action 4:** The SC supports IPGP efforts to find a new site for the M'Bour observatory in Senegal and the Pamatai observatory in Tahiti.

**Action 5:** The SC encourages additional IGP pursuit of local support for replacement of the Addis Ababa observatory in Ethiopia. One possible avenue that might be explored is an alliance with other (non-Ethiopian) geophysical institutes maintaining operations in Ethiopia.

**Benefit:** The SC anticipates that these actions will result in maintenance of the geomagnetic monitoring that is unique to the BCMT, and that this will amount to the continuation of an important data service for the scientific community.

**Other issues:**

The SC generally supports BCMT projects for repeat surveys, geoelectric monitoring, high-frequency monitoring, and variometer deployments. However, effort expended by staff on these projects should not adversely affect needed work on maintaining and improving existing operations at the magnetic observatories. Proposed high-frequency monitoring projects, such as by search-coil sensors and variometer deployments, are entirely new dimensions for the BCMT, which the SC considers to be of low priority in comparison to work devoted to the present observatory network and their data.

The SC supports work within the International Service for Geomagnetic Indices (ISGI) for developing software to detect magnetic-storm sudden commencements. The SC encourages this work to be pursued in collaboration with other institutes pursuing similar work (such as by the Ebro observatory) so as to avoid duplication of effort.

The SC commends the BCMT for cataloging, organizing, and digitizing historical geomagnetic records. Since this work is time consuming, the SC suggests that it might be done on a need-to-do basis as requests are received to support specific research projects.

The SC commends BCMT work for developing data licenses and digital object identifiers for its data and products. The SC encourages this work to be pursued in coordination with INTERMAGNET and the World Data System.

The SC commends and encourages continued BCMT leadership and cooperation with international partners within INTERMAGNET and IAGA, as well as cooperation with allied ground (e.g. SuperMag) and satellite communities (e.g. SWARM).

The SC appreciates that proposed BCMT registration with the Astronomy and Astrophysics observational services of the CNRS-INSU. Such registration is consistent with the diversity of

applications for BCMT data and services. The SC encourages BCMT leadership to consider whether this additional registration comes with unanticipated costs.

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