

The New BCMT Magnetic Database

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A b s t r a c t

The “Bureau Central de Magnétisme Terrestre” (BCMT) is a French organization in charge of the processing and distribution of magnetic data from 16 observatories (AAE, AMS, BNG, BOX, CLF, CZT, DRV, KOU, LZH, MBO, PAF, PHU, PPT, QSB, TAM, TAN), including those run in cooperation with foreign countries. The goal of this project is to carefully check all BCMT data and make them available on a public website in IAGA-2002 format. Data include hourly, daily, monthly and annual means as well as minute values when available. This task is quite simple for data dating from the INTERMAGNET era data, since occasional errors and discontinuities are known and well documented on CD-ROMs. However, some difficulties arise for older data, such as: missing or hard-to-find information on sampling rate, instruments and centering of hourly values; discrepancies between data in numerical format, data printed in year-books and data currently available in World Data Centers; spikes; undocumented data corrections. Such problems are occasional, but ought to be consistently tackled prior to scientific usage of old magnetic data.

1. Introduction

Long data series from magnetic observatories are widely used to investigate long-term variations of both the internal and external fields. Series of observatory monthly and annual means have revealed the occurrence of so-called geomagnetic jerks (Courtillot *et al.* 1978), originating within the Earth’s liquid core. In recent years, there has been a renewed interest in the long-term evolution of rapid variations of external origin (e.g., Le Mouél *et al.* 2004, Chulliat *et al.* 2005). This evolution can partly be attributed to the coupling between the main field and electrical currents in the ionosphere and magnetosphere.

Unfortunately, the number of magnetic observatories quickly decreases when going back in time. Few observatories throughout the world have data series extending for more than 50 years. Old magnetic observatory data are rare and therefore should be made available to all users. They should also be carefully checked, because the quality of instruments and data processing necessarily varied over time. Although a tedious task, checking old data is less expensive and time-consuming than building a new observatory and operating it for several decades.

The “Bureau Central de Magnétisme Terrestre” (BCMT), founded in 1921, coordinates the management of French magnetic observatories from different institutions (IPGP, EOST and IRD). It is currently in charge of the processing and distribution of magnetic data from seven French observatories (AMS, CLF, CZT, DRV, KOU, PAF, PPT) and nine observatories installed and run in cooperation with foreign institutions (AAE, BNG, BOX, LZH, MBO, PHU, QSB, TAM, TAN) (Fig. 1). All observatories belong to the INTERMAGNET network.

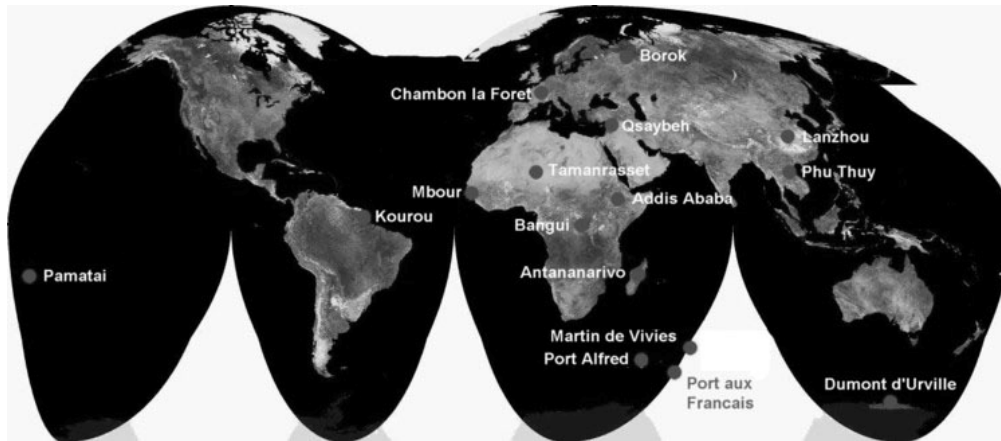


Fig. 1. Magnetic observatories having their data processed and distributed by the BCMT.

As shown in Fig. 2, several BCMT data series are very long. The combined PSM-VLJ-CLF series is exceptionally long, with a total length of 123 years in 2006. Four observatories (BNG, DRV, MBO and PAF) have series longer than 50 years. Also it should be noted that several foreign observatories (AAE, BOX, LZH, PHU, TAM and TAN) joined BCMT after their opening, thus having longer series in reality than indicated in Fig. 2.

A few years ago, a reevaluation of data discontinuities (jumps) in all BCMT observatories was undertaken. Reassessed jump values and associated documentation were recently published in the BCMT yearbook (Bitterly *et al.* 2005; an English translation of that paper will be published in 2007). Thanks to this effort, monthly means and annual means series of enhanced quality are now available for internal field studies.

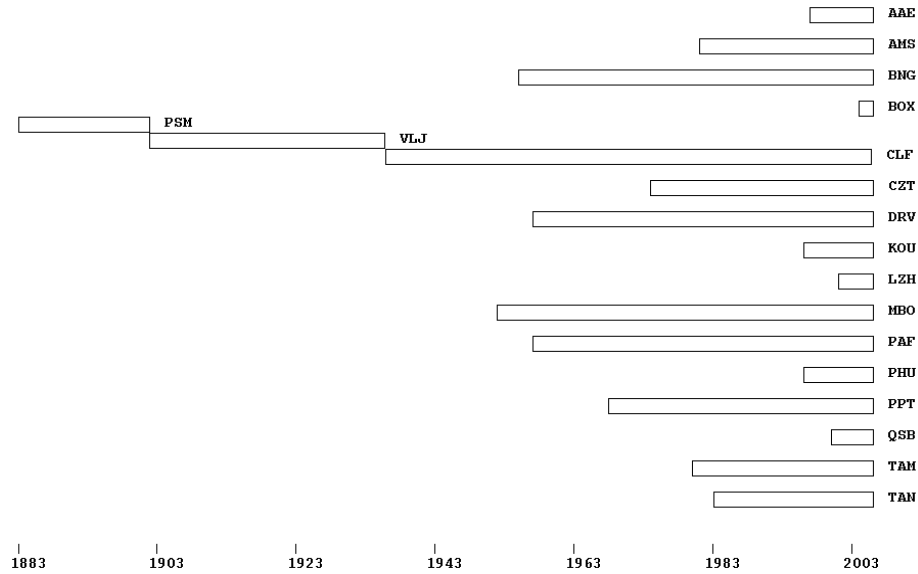


Fig. 2. Lengths of the BCMT data series.

The present project aims at completing the overall verification of old BCMT data, focusing on hourly values which are of interest for external field studies. All historical BCMT data will then be made available on a public website in IAGA-2002 format and sent to WDCs.

2. Database Structure

We chose to store minute values as well as hourly, daily and monthly means in IAGA-2002 format. As a general rule, data files contain the recorded components of the field (for example HDZF or XYZF), not the recalculated ones. In particular, the field modulus (F component) is the one recorded by an independent scalar magnetometer (when available), not the one calculated from the vector components. However, there are two exceptions:

- Minute values from the INTERMAGNET era are always given in XYZ.
- The F component of annual means is always recalculated from the vector components, in order to be consistent with INTERMAGNET file format.

The IAGA-2002 format includes a detailed header with precise information on sensor orientation, sampling rate and data interval type. This information is not so easy to find in old yearbooks (at least for some observatories), which lead us to do extensive research in BCMT archives; in a few cases, this information is missing. Taking advantage of the IAGA-2002 expendable header, we also added comments describing how means were calculated.

Annual means are stored using the INTERMAGNET file format. Jump values are not integrated but listed within the data series, at round dates (for example, a jump occurring between 1982 and 1983 is dated 1983.0). Footnotes documenting jumps are added whenever possible.

3. Data Checking

Checking old magnetic data is not a straightforward task. Past observers have done an impressive job by manipulating complicated instruments and manually processing a very large quantity of analog data. As their measurement and processing methods are not in use anymore, we should be extremely cautious when modifying old data. Therefore our motto during this project was: understand as much as possible, change as less as possible.

We systematically analyzed hourly values from all BCMT data series, and occasionally analyzed minute values. The checking method involved several tests complementing each other:

- Visual control from graphics (spikes, jumps, etc);
- Control of data listings;
- Inter-comparison of BCMT digital data and yearbooks;
- Inter-comparison of BCMT digital data and WDC data.

It is assumed that the most reliable data source is the yearbooks, since digital data were obtained by digitalizing yearbooks and WDC data were sent by BCMT. However, we found several anomalies in yearbooks. Some of them were corrected in digital data at an unknown date, without any note in subsequent yearbooks; some others were corrected by WDC staff.

Very different sorts of problems were found in hourly values, with various degrees of seriousness. Typical problems can be categorized as follows:

- Errors in old yearbooks (where hourly values are listed):
 - Misprint values
 - Spikes
 - Incorrect data block (one month of BNG declination having an offset of about 5')
- Errors originating in the digitalization of old yearbooks:
 - Wrong coding at data capture (lasting up to several days)
 - Incorrect data rejection (for example, at CLF on 12 October 1927 and 11 September 1930)
- Errors originating in the post-processing of digital data (means, etc):
 - Unnoticed effects of software bugs

- o Loss of one data block
- o Shifted date stamps (for example in a bissextile year)
- o Hourly means computed from too small a number of minute values or spiked minute values
- o Corrected errors in yearbooks left uncorrected in digital data

An example of isolated digitalization error is shown in Fig. 3. In that case, the data in the yearbook is $4^{\circ}58.8'$, while that in the computer is $4^{\circ}38.8'$. A more spectacular example is shown in Fig. 4, where wrong data capture lasted for a month. The reason for this is unknown.

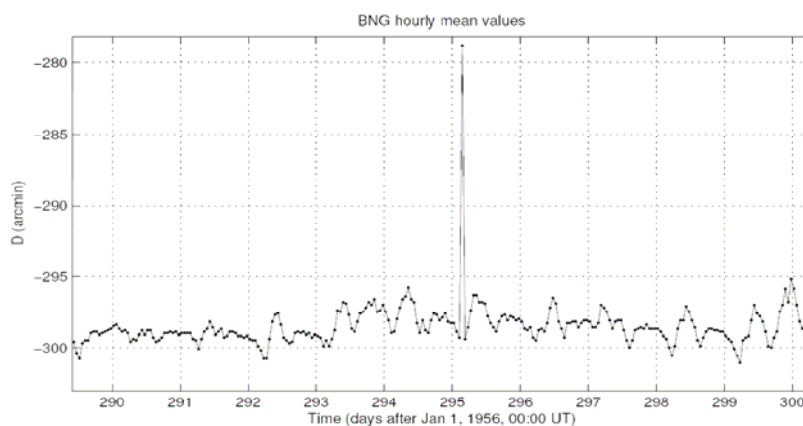


Fig. 3. Example of an isolated digitalization error in BNG data (D component, October 1956).

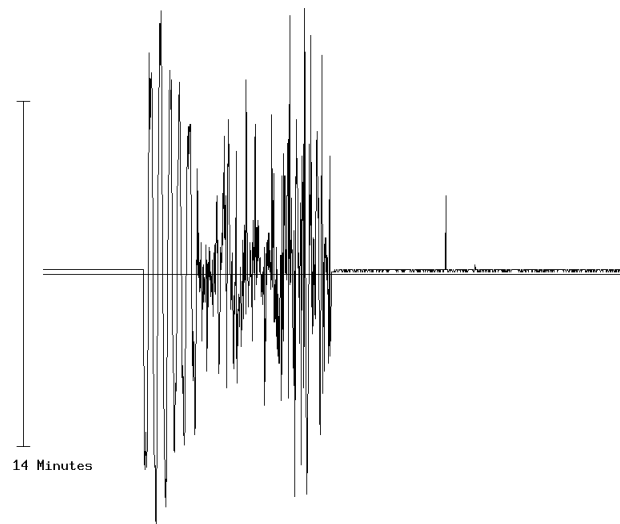


Fig. 4. Example of digitalization errors lasting several weeks in CLF data. The figure shows the difference between the original D component and the corrected one, from 1/6/1960 to 31/7/1960.

Once they have been detected, digitalization errors can be readily corrected by coming back to the original yearbooks. This is not the case for instrumental spikes, such as the ones shown in Fig. 5. For most spikes, it was decided to remove the data without interpolating. When minute values are available, spikes in hourly means usually come from spikes in minute values and can be corrected by removing the wrong minute values.

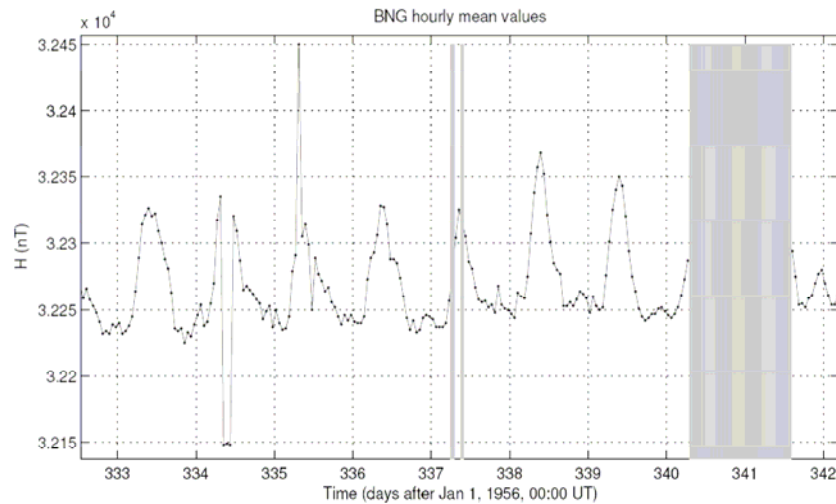


Fig. 5. Example of spikes in BNG data (December 1956).

4. Conclusion

The database is now technically ready and the data checking has been completed in all observatories, except for hourly values at PSM (1883-1900) and VLJ (1901-1922) which still need to be digitalized. In the coming months, the database will be made publicly available on the BCMT website (<http://obsmag.ipgp.jussieu.fr>) and all BCMT data will be updated in WDCs.

It has been a tedious work to construct this database and to check all data. However, significant data errors have been corrected and useful data information previously scattered in different archives is now available to users within the IAGA-2002 format.

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