PUBLS. INST. GEOPHYS. POL. ACAD. SC., C-99 (398), 2007

A Search for Users of Magnetic Observatory Data

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A b s t r a c t

Statistics on the use of magnetic observatory data are not easy to come by. However, over three hundred day-files per month for each observatory are downloaded from the INTERMAGNET web site. Observatory data and derived products such as indices are widely used by researchers. An examination of eight widely read journals indicates that over 80% of the articles that deal in some way with geomagnetism use either data or products. Use by industry also appears to be extremely large.

1. Introduction

My oral presentation at the XXII IAGA Workshop was a rather unstructured talk entitled *A Personalized Account of Geomagnetism in Canada*. The talk had three themes: (1) what we do today in geomagnetism is very much connected to past events; (2) the nature of our science is such that we have been forced to find new ways of measuring and surveying the magnetic field; (3) we produce data so that science and society will use them. Because of the restrictions on the length of papers, I have decided to restrict this written version to the third theme. Do people use observatory data? What type of data do they use? What are the uses of the data? These are some of the questions I had in mind when I began the investigation. Answering them proved to be harder than expected.

2. Statistics on Observatory Data Usage

2.1 Sources and types of data

Magnetic observatories specialize in producing data that represent the true value for the magnetic field with a high degree of accuracy. Because of this, their traditional products are those that require accurate or stable data – mean values from annual to

hourly, indices and so on. There is certainly a group of users that need and want these data and data products. But there is a large group of users that is more interested in the resolution and sampling rate of data than its stability or absolute accuracy. Observatory one-minute data and data at faster sampling rates are of interest to this group.

It became apparent early on that it was going to be extremely difficult to come up with a complete picture of magnetic observatory data usage. This is due both to the numerous ways in which a user or researcher can obtain observatory data and to the numerous types of data that observatories produce. These are summarized in Table 1.

Table 1

Sources and types of observatory data

Sources of observatory data	Types of observatory data	Derived products
INTERMAGNET web site	1-minute data (preliminary or definitive)	Magnetic indices
Observatory web site	Hourly mean values (definitive)	Reference field models
Yearbooks and compilations	Monthly mean values	Magnetic forecasts
World data centers	Annual mean values (definitive)	
Third party	Fast-sample data (1-sec, 5-sec)	

Third party refers to observatory data that are redistributed as part of another data set. The inclusion of some Canadian observatory data with the MACCS data set is an example. Preliminary data refer to data that have not had baseline corrections applied. After the application of baseline corrections the data are considered definitive. The table also lists three derived products. Reference field models and forecasts obviously use non-observatory data as well, but observatory data are an essential component.

2.2 Requests for INTEMAGNET data

Of the five sources listed in Table 1, reliable statistics are available for only one, the INTERMAGNET web site and then only for one type of data, 1-minute. I was also able to obtain comparable numbers for requests that came to the Geological Survey of Canada Geomagnetism web site; this is a single example of data distributed by an observatory site. Data are downloaded from the INTERMAGNET site in day-files. Table 2 shows the number of day-files loaded on a month-by-month basis from January 2005 to October 2006. I have also given the most-requested observatory for each month. The table also gives the number of Canadian data downloaded from the INTERMAGNET site for comparison with the Canadian data downloaded from our own web site.

Table 2

Number of day-files requested from INTERMAGNET site

Month	Preliminary data				Definitive data
	All observa-tories	Most-requested	Canadian observatories	Canadian web site	All observa-tories
Jan 2005	9903	STJ (650)	1651	745	7009
Feb 2005	6477	RES (413)	1280	56	6356
Mar 2005	7125	BMT (834)	75	739	8721
Apr 2005	11116	VSS (1086)	1242	60	45453
May 2005	2660	KAK (951)	75	117	1098
Jun 2005	4279	ASP (488)	243	180	17444
Jul 2005	14381	EYR (577)	1339	91	18524
Aug 2005	6407	STJ (919)	1134	23	11290
Sep 2005	3631	BOU (394)	914	2216	2702
Oct 2005	12963	BNG (296)	1546	50	29185
Nov 2005	2759	KOU (277)	149	50	2534
Dec 2005	2441	STJ (746)	809	58	1741
Jan 2006	4543	BNG (669)	509	276	9411
Feb 2006	8148	FUR (223)	493	105	24721
Mar 2006	3334	SPT (293)	257	162	77139
Apr 2006	5875	FRD (493)	464	346	136685
May 2006	2163	RES (256)	500	225	9689
Jun 2006	4333	CLF (744)	1012	263	–
Jul 2006	5514	QSB (468)	604	263	–
Aug 2006	11476	STJ (1277)	1768	1129	–
Sep 2006	1982	PHU (366)	339	261	–
Oct 2006	10620	AAE (1012)	1659	294	
Total	**142130**		**18062**	**7709**	**409702**

Data from approximately 100 observatories are available from the INTEMAGNET site. An average of approximately 65 day-files of preliminary data per observatory per month is downloaded. Data from the 12 Canadian observatories are obtained from the INTERMAGNET site at approximately the same rate. However, an additional 29 station-days per observatory per month are obtained from the GSC Geomagnetism web site. Canadian data are also supplied in quasi-real-time to the Ottawa Forecast Centre, adding another 30 day-files per observatory month.

The number of requests for definitive data is even larger – 241 day-files per observatory per year. Note that definitive data are also distributed as binary month files. To make comparisons easier I have converted these to dayflies. Combining requests for preliminary and definitive data gives an average of 306 day-files per observatory per month. This is a large amount of data but it is probably an extreme underestimate since it does not include data requested from the WDCs or any other institute. Nor does it include requests for anything other than one-minute data, such as annual, monthly and hourly means, or one-second and 5-second data.

Neither the INTERMAGNET web site nor the GSC site request identification from users beyond an e-mail address. Therefore, it is difficult to determine in detail who is requesting the data. However, through an examination of all e-mail addresses associated with downloads of Canadian data I was able to garner institutional information for about one half of the users. These were roughly divided among academia, industry and government/military.

2.3 Use of observatory data in journals

Observatory data can be used both operationally and for research purposes. Again, obtaining complete statistics on who uses the data and for what purposes is virtually impossible but I was able to obtain some information through limited studies. To start, I looked at the publications and reports produced by our own group, most of which are preserved in bound volumes as the Contributions from the Dominion Observatory and the Contributions from the Earth Physics Branch. These span the period from 1950 to 1982, the year the Earth Physics Branch became part of the Geological Survey of Canada. The compilation undoubtedly missed some publications, but it is fairly complete and should give a reasonable picture of our internal usage.

Table 3 shows the number of publications broken down by topic, and the percentage that actually used observatory data. The major research interest of the organization was paleomagnetism which does not depend on or even use observatory data. But nevertheless over that 30 year period an average eight papers were published per year, two of which made use of observatory data. The present situation is also reflected in the table in the four columns which give statistics on the number of reports, papers and presentations produced by the group during the period 2000 to 2005.

The shift in our research interests is obvious, the main topic of research now being geomagnetic hazards. It is also interesting that we still produce eight papers per year on average, but now 70% of them use observatory data. We also give a large number of presentations at conferences and elsewhere, most of which make use of our data.

2.4 Use of observatory data in publications

Papers using observatory data are published in numerous international journals and in numerous institutional publications. I chose to restrict my examination of the literature to 8 widely recognized journals. I further restricted the search to the time interval 2000 to 2005. I then used the search facility of SCOPUS™, an extensive database of research literature, to search for articles in these journals on the basis of

Table 3

Usage of observatory data by GSC

Category	1950 to 1982		2000 to 2005			
	Number pubs.	% using obs. data	Number pubs.	% using obs. data	Number present	% using obs. data
Variations	59	80	7	86	10	100
Induction/MT	40	20	0	0	0	0
Internal/Crustal/ main field	35	26	5	80	8	50
Instrumentation	22	0	0	0	0	0
Hazards	0	0	27	67	39	87
Forecasts	0	0	4	100	7	86
Paleomagnetism	85	0	0	0	0	0
Other	14	0	5	20	3	67
	255	**25**	**48**	**69**	**67**	**82**

Table 4

Number of articles retrieved by SCOPUS™ literature search

Search terms	GJI	GRL	AG	JGR (all)	EPS	PEPI	EPSL	Nature	
Magnetometer data	0	12 (2)	43 (3)	41 (3)	5	1	0	0	102
(Geo)magnetic indices	3	20 (2)	29 (3)	5	6	0	3	0	66
(Geo)magnetic (sub)storm	4	103 (8)	97 (8)	128 (10)	15 (1)	0	0	3	350
(Geo)magnetic field model	12 (1)	11 (1)	0	2 (10)	21	2	2	0	50
(Geo)magnetic secular varia-tion (change)	21 (2)	6	1	1	7	7	12	3	58
	40	152	170	177	54	10	17	6	626

GJI = Geophysical Journal International
EPS = Earth, Planets and Space
GRL = Geophysical Research Letters
PEPI = Physics of the Earth and Planetary Interiors
AG = Annales Geophysicae
EPSL = Earth and Planetary Science Letters
JGR = Journal of Geophysical Research (all editions)

several search terms that I had chosen. Table 4 shows the number of articles selected by SCOPUS for each set of search terms for each journal. In actual fact, the number of articles selected by SCOPUS was considerably larger than the number given in the table; I rejected many others (35%) as being off the topic on the basis of their titles. For example, using the search terms (geo)magnetic AND secular AND variation OR change retrieved numerous articles on paleosecular variation. Table 4 gives the number of articles retrieved for each journal and for each search term.

To determine whether these papers actually used observatory data, derived products or other forms of magnetic data would have required reading the abstract of each and possibly the entire article. Since there were 626 articles, this was too great a task. I therefore chose 50 articles semi-randomly; that is, the distribution of articles chosen roughly matched the distribution in the above table. The bracketed values in Table 4 indicate the number of articles chosen for that subject and for that journal. Table 5 gives the percentage of papers that use magnetic data or derived products (indices, reference field models). Although only 36% of papers use observatory data directly, a full 82% use either observatory data or derived products.

Table 5

Data usage in geomagnetism research papers

Type of data	Usage [%]
Magnetic observatory	36
Other ground magnetic data	30
Satellite data	42
Indices	50
Models	8
None	10

2.5 Derived products and other data

Table 5 indicates that researchers make great use of magnetic indices. In fact, indices are used in 50% of the papers. Researchers also make use of models for a variety of purposes. However, models, indices (to a lesser extent), and magnetic forecasts are widely used outside the research community. Again, with one exception, I have only draw on the statistics from the GSC Geomagnetism web site, which are given in Table 6 for various data products.

Two numbers are given under on-line declination calculator: the number of accesses for our own site and the number of accesses to the calculator on the WDC-A site, supplied by Susan McLean (private communication).

Table 6

Usage of derived products

Product	Daily access
Magnetic forecasts	3200
Forecast related products	250
On-line declination calculator (GSC) (WDC)	200 800
On-the-fly plots	80
Local indices and ranges	60

3. Discussion

Despite the very limited scope of this study it appears that magnetic observatory data and derived products are widely used. Of fifty papers selected for examination more than 80% use either data or derived products. If the same ratio applies to the whole sample of 626 papers then more than 100 papers per year that use data or products are published in the eight selected journals. The total usage of data or products by the academic research community is likely several times this number. Industry also uses data. My own experience indicates that major industrial users include the aeromagnetic survey community and the directional drilling community, among many others.

The use of derived products is also extremely large. Indices were used in fully half the research papers. We also know that indices, in particular Kp, are used by industries that are affected by disturbances, such as the GPS survey industry and electrical power industry. Accesses to our forecasts exceed 3000 per day. We do not track user profiles but experiential evidence indicates that the user base is extremely broad. Both our own statistics and those of WDC-A indicate the continued need for magnetic reference field models.

Despite the wide use of observatory data and products it is my opinion that the importance of our data is generally underappreciated. Better tracking and publication of user statistics by all institutes that disseminate data or derived products would enable a much more complete analysis to be carried out. This would be a valuable service to the magnetic observatory community.

Acknowledgements. I wish to acknowledge the following for their help in the research and preparation of this report. Jennifer Parmelee for supplying the INTERMAGNET and other statistics; the staff of the Earth Sciences Sector library for help with the journal searches; Susan McLean for supplying information on reference field model use at WDC-A.

Accepted February 15, 2007