AVAILABILITY AND ACCESS TO DATA FROM KAKIOKA MAGNETIC OBSERVATORY, JAPAN

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ABSTRACT

The Japan Meteorological Agency (JMA) is operating four geomagnetic observatories in Japan. Kakioka Magnetic Observatory (KMO), commissioned in 1913, is the oldest. The hourly records at KMO cover over almost 100 years. KMO is JMA's headquarters for geomagnetic and geoelectric observations. Almost all data are available at the KMO website free of charge for researchers. KMO and two other observatories have been certified as INTERMAGNET observatories, and quasi-real-time geomagnetic data from them are available at the INTERMAGNET website.

Keywords: Magnetic observatory, Historical data, Available data

1 INTRODUCTION

The Japan Meteorological Agency (JMA) operates four geomagnetic observatories in Japan (Table 1, Fig. 1). Kakioka Magnetic Observatory (KMO) is JMA's headquarters for geomagnetic and geoelectric observations. KMO has made data from the three observatories on the main Japanese islands, covering geomagnetic latitudes from 20° to 35°, available to researchers. Three of these observatories are part of the INTERMAGNET global network. KMO was commissioned in 1913, 70 km northeast of Tokyo, to replace the Tokyo geomagnetic observatory, which suffered from severe noise after construction of the Tokyo train system. The hourly geomagnetic field data recorded at Kakioka cover almost 100 years.

Table 1. Geographic[1] and geomagnetic[2] coordinates and altitudes of magnetic observatories operated by JMA

	IAGA code	Latitude (N)	Longitude (E)	Magnetic latitude	Magnetic longitude	Altitude
Kakioka	KAK	36°13′56″	140°11′11″	27.47°	209.23°	36 m
Memambetsu	MMB	43°54′36″	144°11′19″	35.44°	211.77°	42 m
Kanoya	KNY	31°25′27″	130°52′48″	22.00°	201.21°	107 m
Chichijima	CBI	27°05′46″	142°11′06″	18.58°	212.10°	155 m

[1]Japanese Geodetic Datum 2000

[2]11th International Geomagnetic Reference Field (IGRF-11)

This paper describes the geomagnetic and geoelectric data available from JMA and provides information on how to access them.

2 A BRIEF HISTORY OF GEOMAGNETIC DATA RECORDED IN JAPAN

JMA has published geomagnetic data since 1896 (Kakioka Magnetic Observatory 1983). Until 1912, geomagnetic field observations were carried out at Edo-jo Castle in the very center of Tokyo. Because of its central city location, contamination of geomagnetic data by artificial noise became a problem. A plan to introduce a city tram service close to the site forced the observatory to be moved away from Tokyo (Toya et al., 2005).

The main reason for the choice of the new site was to avoid areas where electric train systems were likely to be commissioned. Consequently, the new observatory was located in the remote rural area of Kakioka. Because there was originally only one permanent staff member on location at the new site, officers from the Central Meteorological Observatory (CMO) in Tokyo were sent monthly to Kakioka to take absolute geomagnetic measurements. Data recorded on bromide paper and field notes were taken back to CMO.

The great Kanto earthquake struck the Kanto Plain on the Japanese main island of Honsyu on Saturday, 1 September 1923. The fire that followed devastated Tokyo and inflicted severe damage on the CMO buildings. Almost all of the data from Kakioka for the period from January 1917 to August 1923 were destroyed by the fire.

The earthquake caused severe damage to KMO. Though temporary repairs had been made by January 1924, the facilities remained inadequate. CMO rebuilt the KMO office and other buildings and installed new magnetic observation systems. All of the staff involved in geomagnetic observation were then stationed at Kakioka, allowing swift processing of data. Absolute measurements were routinely conducted at a higher frequency, changing from monthly to weekly. Geomagnetic data from KMO have provided a continuous record since 1913, even covering the period of World War II.

KMO branch observatories were established at Memambetsu (MMB) in 1952 and at Kanoya (KNY) in 1958 (Fig. 1), in response to the International Geophysical Year campaign. Geomagnetic data have been recorded at an automated station at Chichijima (CBI) in the Ogasawara Islands since 1973. Figure 2 shows the historical variations of the geomagnetic field recorded at these four observatories.

The Kakioka automatic standard magnetometer (KASMMER) was installed in 1976 (Yanagihara et al., 1972). The main components of this instrument are optical pumping magnetometers, a proton precession magnetometer, an angle measuring instrument, and a computer processor for making calculations. Operation of all of these components, except the angle measuring instrument, is automated. The installation of KASMMER allows KMO to provide data at one-minute resolution. KMO commenced recording one-second in 1983 (Tsunomura et al., 1994) and 0.1-second data in 1997 (Oowada et al., 2003), respectively. Similar systems with one-second and 0.1-second resolution have since been installed at MMB and KNY.

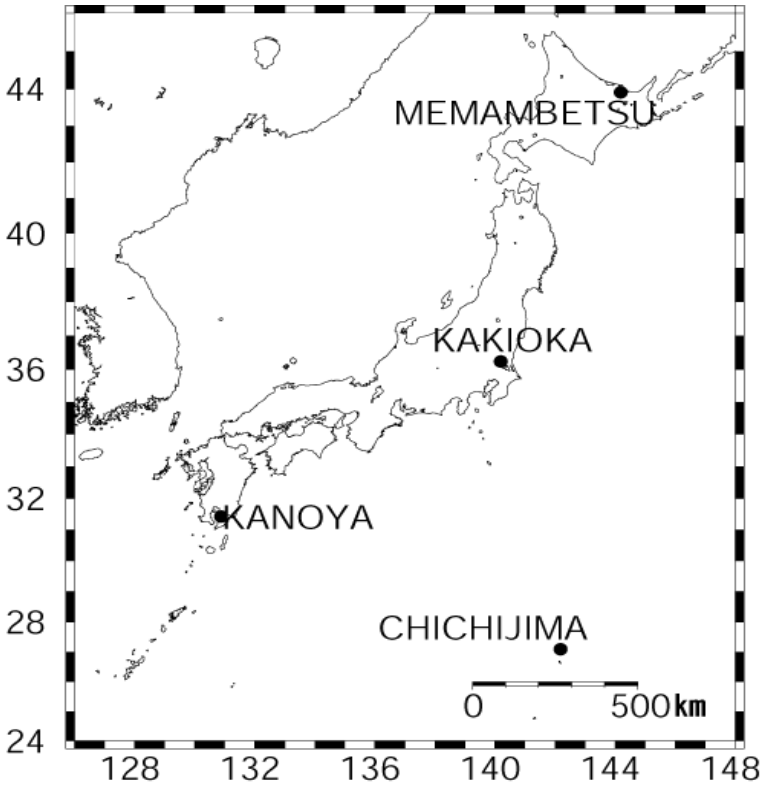

Figure 1. Locations of geomagnetic observatories operated by JMA

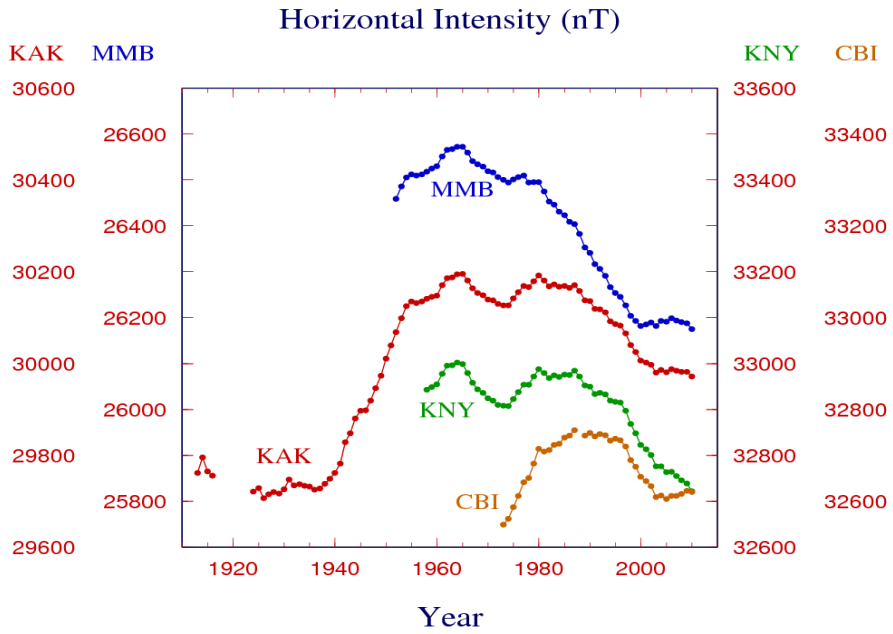

Figure 2. Annual mean geomagnetic fields (H component) recorded at geomagnetic observatories operated by JMA (after Kakioka Magnetic Observatory 2011)

KAK, MMB, KNY, and CBI indicate Kakioka, Memambetsu, Kanoya, and Chichijima observatories, respectively. Data from January 1917 to August 1923 at Kakioka were destroyed during the great Kanto earthquake of 1923. The four curves are offset for clarity.

JMA commenced recording geoelectric data at KMO in 1929, at KNY in 1948, and at MMB in 1949. Atmospheric electricity data has also been recorded at KAK and MMB, but these observations ceased at MMB in December 2010. No capabilities to record geoelectric or atmospheric electricity data have been installed at CBI.

3 DATA AVAILABILITY AND ACCESS

3.1 Reports of the Kakioka Magnetic Observatory

Reports on geomagnetic observations obtained by JMA have been published annually as the "Report of the Kakioka Magnetic Observatory". These reports have been provided on CD-ROM since 2001. The latest report includes:

- 1-minute and hourly geomagnetic and geoelectric field data
- Monthly and annual means of geomagnetic and geoelectric fields
- K-indices and a list of rapid variations
- Dynamic spectra for magnetic pulsations
- Remarks on observations
- Data viewing software

The CD-ROM can be purchased from the Japan Meteorological Business Support Center.

3.2 Kakioka Magnetic Observatory website

Almost all of the geomagnetic data obtained by JMA are available from the KMO website, free of charge for research purposes. KMO provides the data for the benefit of the international scientific community. Commercial use and redistribution are prohibited. If the data are used in publications, presentations, and other communications, Kakioka Magnetic Observatory, Japan Meteorological Agency, must be appropriately acknowledged.

Starting dates for availability of geomagnetic and geoelectric fields and for atmospheric electricity are provided in Tables 2, 3, and 4, respectively. KMO has joined the Inter-university Upper atmosphere Global Observation NETwork (IUGONET) project; KMO numerical data and metadata are registered in the IUGONET database.

Table 2. Starting dates for availability of geomagnetic fields for each observatory

	one-hour	one-minute	one-second	0.1-second
Kakioka	Jan 1924	Jan 1976	Apr 1993	Jun 1997
Memambetsu	Jan 1958	Jan 1985	Apr 1997	Apr 1997
Kanoya	Jan 1958	Jan 1985	Jun 1996	Jun 1996
Chichijima	Feb 1973	Feb 1989	Jan 1990	none

Table 3. Starting dates for availability of geoelectric fields for each observatory

	Geoelectric fields			
	one-hour	one-minute	one-second	0.1-second
Kakioka	Jan 1962	Jan 1987	Jan 2000	Apr 1997
Memambetsu	Jan 1962	Jan 1987	Jan 2000	Apr 1997
Kanoya	Jan 1962	Jan 1987	Jan 2001	Jun 1996
Chichijima	none	none	none	none

Table 4. Starting dates for availability of atmospheric electricity for each observatory

	Atmospheric electricity			
	one-hour	one-minute	one-second	0.1-second
Kakioka	Jan 1962	Jan 2004	none	none
Memambetsu*	Jan 1962	Jan 2001	none	none
Kanoya	none	none	none	none
Chichijima	none	none	none	none

*Atmospheric electricity observation at Memanbetsu was discontinued in Dec 2010.

Images of dynamic magnetic spectra from KMO since 2000 can be downloaded from the KMO website. These can be useful for identifying magnetic pulsations (e.g., Fig. 3).

Historical geomagnetic field data recorded by CMO in Tokyo from 1896 to 1912 are also available from the KMO website (Fig. 2).

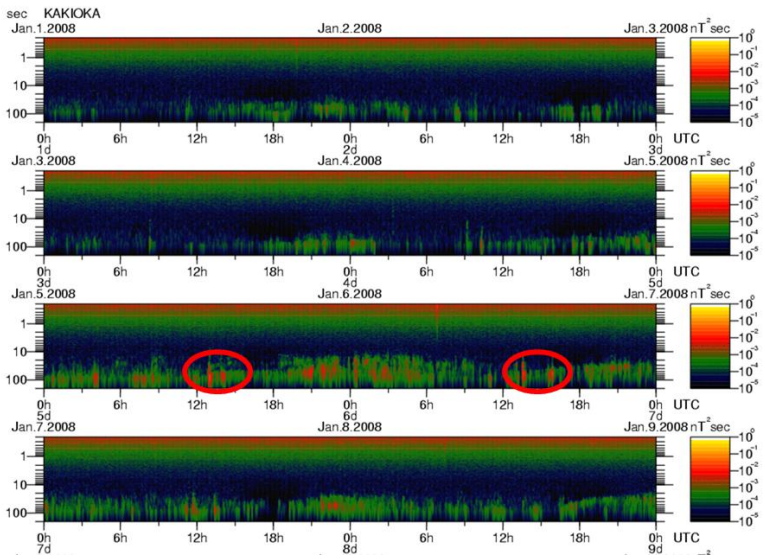

Figure 3. Sample images of dynamic spectra from Kakioka in January 2008. The red ellipses mark geomagnetic pulsations.

3.3 INTERMAGNET: International Real-time Magnetic Observatory Network

The INTERMAGNET program exists to establish a global network of cooperating digital magnetic observatories adopting modern standard specifications for measuring and recording equipment and also to facilitate data exchange and provision of geomagnetic products in close to real time. In particular, INTERMAGNET provides a useful means to obtain the latest data on the geomagnetic field around the world.

An INTERMAGNET Magnetic Observatory (IMO) is required to have full absolute control that provides one-minute magnetic field data measured by a vector magnetometer, and optionally by a scalar magnetometer, all with a resolution of 0.1 nT. Vector measurements using a magnetometer must include the best available baseline. In 1992, KMO was the first magnetic observatory in Japan to be recognized as an IMO. Two KMO branch observatories, MMB and KNY, were also certified as IMOs in 1994 and 2002, respectively.

Though to date only one-minute data have been exchanged in real time through INTERMAGNET, provisional one-second data have been sent in real time to the Geomagnetic Information Node of Kyoto since September 2012. The INTERMAGNET website provides a useful means to obtain quasi-real-time data from Kakioka, Memambetsu, and Kanoya observatories.

4 FUTURE PLAN: DIGITIZATION OF LEGACY DATA

Before the installation of KASMMER at KMO in 1976, only hourly geomagnetic data was published in digital form. However, the pre-1976 analogue records on bromide paper are of sufficient quality and resolution for digitization. To provide such legacy data in more convenient form, Mashiko et al. (in press) developed a method for conversion of geomagnetic bromide paper records into digital data with better than one-minute resolution. The digitization of analogue records at KMO is in progress with the cooperation of the Data Analysis Center for Geomagnetism and Space Magnetism, Kyoto University. The release of resultant digital geomagnetic field data via the KMO website will start in 2013.

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