

Data DOI Task Force Report on “Present Status of Data Publication and Data Citation of Geomagnetic Data/Indices”

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Denmark (by Anna Willer (anna@space.dtu.dk))

Data Publication

DTU Space has mint a DOI for the definitive PCN index on July 5, 2019 (doi:10.11581/DTU:00000057). The metadata include for example the creator, the license for the index, the geolocation, abstract and subjects. DTU Space is planning to mint a doi for quality controlled data sets from magnetometer stations (variometer stations and observatories) in Greenland, Faroe islands and Denmark.

France (by Vincent Lesur (lesur@ipgp.fr))

Data Publication

The “Bureau Central de Magnétisme terrestre” (BCMT) has mint a Digital Object Identifier (DOI) and set a licence (Creative Commons BY NC) for the definitive and variometer data it generates. One single DOI (doi:10.18715/BCMT.MAG.DEF) has been set for all definitive data derived from the BCMT observatories where agreement of partner institutions contributing to the data collection has been granted. In the same way a single DOI has been set for variometer data (DOI 10.18715/BCMT.MAG.VAR). The landing page describing the involved observatories and giving access to the data is hosted by the data centre of the “Institut de Physique du Globe de Paris” (IPGP).

Germany (by Jürgen Matzka (jmat@gfz-potsdam.de))

Data Publication and Citation

At GFZ, DOI is given to a clearly defined dataset that is used in a publication. There exists support through experts and software tools that allow the scientists to get this done in a very easy way. Here are examples where you can find data publications with DOI and data citation to it in a publication.

Name of Database	Aurhor of Database	Data DOI	Article DOI Citing Data DOI	Author
Preliminary minute means Geomagnetic Observatory Tatuoca (TTB), 2008 to 2017	Soares, et al. [2018]	10.5880/GFZ.2.3.2018.005	10.1029/2018JA025968	Soares et al. [2018, J. Geophys. Res.]
Preliminary minute mean values of geomagnetic observatory Villa Remedios, Bolivia, for January 2013	Matzka et al. [2018]	10.5880/GFZ.2.3.2018.001	10.1029/2017JA025165	Yamazaki et al. [2018, J. Geophys. Res.]
Hourly mean values of the horizontal	Matzka et al. [2018]	10.5880/GFZ.2.3.2018.003	10.1029/2018GL077510	Siddiqui et al. 2018, J.

component at the geomagnetic observatory Huancayo (HUA), 1958 to 2013				Geophys. Res.]
Preliminary minute mean values of geomagnetic observatory Villa Remedios, Bolivia, August 2010	Matzka et al. [2018]	10.5880/GFZ.2.3.2018.004	10.1029/2018JA025365	Yamazaki et al. [2018, J. Geophys. Res.]
Hourly mean values geomagnetic observatory Huancayo (HUA), 1935 to 1985	Matzka et al. [2017]	10.5880/GFZ.2.3.2017.001	10.1016/j.jastp.2017.04.014	Matzka et al. [2017, J. Atmos. Solar-Terr. Phys.]
Geomagnetic Observatory St. Helena, preliminary hourly mean values 2010, XYZ components	Matzka [2016]	10.5880/GFZ.2.3.2016.001	10.1002/2016JA023211	Crossen and Matzka [2016, J. Geophys. Res.]

We have plans to give a DOI for Kp index in the near future and also for GFZ Observatory data. This would be very rewarding, but it is a bit more complex, since data sets are growing, potentially the data has to be changed in the future if errors are detected.

INTERMAGNET (by Simon Flower (smf@bgs.ac.uk))

Data Publication

INTERMAGNET published a DOI for the 2013 definitive data set (doi:10.5880/INTERMAGNET.2013) on June 27, 2019. INTERMAGNET will publish a DOI for 2014 data quite soon, as this is now not much work to prepare. The 2015 publication will contain all 24 years of data that INTERMAGNET previously published (1991–2014) plus data for 2015. This is about to be published on USB. It will take a bit of time to arrange the DOI for this publication because of the need to gather metadata for the contributions made between 1991 and 2013. However, once this is done, it will hopefully be easier to publish 'historic' DOIs for the INTERMAGNET DVDs and CDs from 1991 to 2013. Kirsten Elger and Damian Ulbricht from GFZ have been instrumental in the work so far. The DOI landing page is hosted at GFZ and the data is available through a GFZ ftp server.

INTERMAGNET already announced that 2015 will be the last 'physical' publication (CD, DVD or USB) that it makes containing definitive data. From the 2016 data set onwards INTERMAGNET will publish online only, and it will come with a DOI.

Japan (by Masahito Nosé (nose.masahito@isee.nagoya-u.ac.jp))

Data Publication

Recognizing the importance of data publication and data citation, solar-terrestrial physics (STP) data centers in Japan have been working to mint DOI to their database. We participated from October 2014 in a 1-year pilot program for DOI-minting to science data launched by Japan Link Center, which is one of the DOI registration agencies. In the pilot program, a procedure of the DOI-minting for STP data was established. As a result of close collaboration with Japan Link Center, the first case of data-DOI in Japan (doi:10.17591/55838dbd6c0ad) was created in June 2015. As of July 2019, there are 18 data-DOIs for the STP data in Japan. (Unfortunately, there have been no addition

of data DOI in these 2 years.) This includes DOIs for the geomagnetic indices indicated in bold: the Dst index (doi:10.17593/14515-74000), the AE index (doi:10.17593/15031-54800), and the Wp index (doi:10.17593/13437-46800), as well as geomagnetic field data measured with induction magnetometer (doi:10.17593/13882-05900).

Name of Database	DOI	Date of Minting
Profiles of neutral atmosphere winds 30min average with MF radar at Poker Flat, Alaska	10.17591/55838dbd6c0ad	2015/06/19
Dst Index	10.17593/14515-74000	2015/12/30
Ionogram at Kokubunji, Japan	10.17594/567ce8e9d3a52	2016/04/01
Manually scaled parameters of Ionogram at Kokugunji, Japan	10.17594/567ced454d15b	2016/04/04
Automatically scaled parameters of Ionogram at Kokugunji, Japan	10.17594/567ced0bbccf9	2016/04/04
Ionogram at Wakkanai, Japan	10.17594/5704b5259137a	2016/04/06
Manually scaled parameters of Ionogram at Wakkanai, Japan	10.17594/5704641f8b11d	2016/04/06
Automatically scaled parameters of Ionogram at Wakkanai, Japan	10.17594/5704b5444c661	2016/04/06
Ionogram at Yamagawa, Japan	10.17594/5704b78099ac0	2016/04/06
Manually scaled parameters of Ionogram at Yamagawa, Japan	10.17594/5704b7b16d387	2016/04/06
Automatically scaled parameters of Ionogram at Yamagawa, Japan	10.17594/5704b79d253fd	2016/04/06
Ionogram at Okinawa, Japan	10.17594/5704b8b1d8dbc	2016/04/06
Manually scaled parameters of Ionogram at Okinawa, Japan	10.17594/5704b8e3a7ffa	2016/04/06
Automatically scaled parameters of Ionogram at Okinawa, Japan	10.17594/5704b8ce63d3b	2016/04/06
Wp index	10.17593/13437-46800	2016/08/10
Wind Profiler at NICT Tokyo (1993-2003)	10.17591/14791-10297	2017/01/25
Magnetotelluric Data at Muroto, Japan	10.17593/13882-05900	2017/02/14
AE index	10.17593/15031-54800	2017/08/20

Data Citation

Data citation has just started in international journals. The following table shows examples of data citation in recent publications.

Name of Database	Data DOI	Article DOI Citing Data DOI	Author
Magnetotelluric Data at Muroto	10.17593/13882-05900	10.1002/2017JA024204	Nosé et al. [2017, J. Geophys. Res.]
Dst index	10.17593/14515-74000	10.1029/2018GL078825	Nosé et al. [2018, Geophys. Res. Lett.]
Dst index	10.17593/14515-74000	10.1007/s11207-018-1278-5	Bocchialini et al. [2018, Solar Phys.]

Russia (by Anatoly Soloviev (a.soloviev@gcras.ru))

Data Publication

“Earth Science DataBase” (ESDB) project was initiated by the Geophysical Center RAS in 2014 on the basis of the World Data Center for Solar-Terrestrial Physics (WDC for STP), a regular member of ICSU-WDS. The focus is on creation of the modern system of geophysical data registration, publication and DOI assignment through Crossref system, used for unique identification of

intellectual property. Since 2014, the following data sets have been registered in the ESDB system: database including 6 catalogues of Solar proton events over 1970-2008, database on historical recordings from 22 geomagnetic observatories in USSR/Russia over 1983-2009, database on continuous recordings from “Klimovskaya” geomagnetic observatory and “Saint-Petersburg” INTERMAGNET observatory since 2012, and seismotectonics map of Eastern Siberia. It also includes 26 individual data sets, including 2015 definitive data from INTERMAGNET observatory “Saint-Petersburg”.

Since August 2017, the following data sets have been registered in the ESDB system: 5 catalogues of solar proton events included in the database of Solar Proton Events (1970–2008) registered earlier in 2016, database of ULF wave power index (new geomagnetic index) and 17 data sets included in this database, database of virtual magnetograms 1994–2017, database and 2 data sets of solar flare events, database of magnetic storms and magnetic storm families 1908-2010 with 7 data sets, dataset of quality flag varies from 0 for doubtful to 2 for high quality events, uranium isotope composition of kimberlites, the enclosing and overburden deposits of the Zolotitskoye ore field, geomagnetic data recorded at geomagnetic observatory “White Sea” (IAGA code: WSE), and seismic activity and syzygies data.

Each data set, catalogue and database is accompanied with individual response page, located in the central repository of ESDB: <http://esdb.gcras.ru/>. Russian-Ukrainian Geomagnetic Data Center (RUGDC) is also registered in re3data (<http://www.re3data.org/>) with doi:10.17616/R39344. World Data Center for Solar-Terrestrial Physics in Moscow (WDC for STP) is also registered in re3data with doi: <http://doi.org/10.17616/R3DC7Z>.

For the time since 2017 several data sets registered with DOI have been cited, as well as the articles with DOI referring to data sets. This is indicated in the table below.

Title of Database	DOI
Geomagnetic data recorded at Geomagnetic Observatory Vostok (VOS) – Variational Minute Values (1993-2000)	10.2205/Mag-VOS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Tixie Bay (TIK) – Variational Minute Values (1984-1998)	10.2205/Mag-TIK-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Seykha (SEY) – Variational Minute Values (1988-1993)	10.2205/Mag-SEY-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Sabetta (SBT) – Variational Minute Values (1987-1990)	10.2205/Mag-SBT-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Salekhard (SAL) – Variational Minute Values (1987-1990)	10.2205/Mag-SAL-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Moscow (MSK) – Variational Minute Values (1997-1999)	10.2205/Mag-MSK-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Moscow (MOS) – Variational Minute Values (1985-2009)	10.2205/Mag-MOS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Mirny (MIR) – Variational Minute Values (1987-1998)	10.2205/Mag-MIR-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Lovozero (LOZ) – Variational Minute Values (1997-2000)	10.2205/Mag-LOZ-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Loparskaya (LOP) – Variational Minute Values (1993-1998)	10.2205/Mag-LOP-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Komsomolskaya (KMS) – Variational Minute Values (1990)	10.2205/Mag-KMS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Kharasavey (KHS) – Variational Minute Values (1986)	10.2205/Mag-KHS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Yugorsky Shar (JSH) – Variational Minute Values (1983-1984)	10.2205/Mag-JSH-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Irkutsk (IRT) – Variational Minute Values (1997-2003)	10.2205/Mag-IRT-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Dixon Island (DIK)	10.2205/Mag-DIK-minute-values

– Variational Minute Values (1983-1998)	
Geomagnetic data recorded at Geomagnetic Observatory Cape Schmidt (CPS) – Variational Minute Values (1984-2000)	10.2205/Mag-CPS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Cape Kamenniy (CKA) – Variational Minute Values (1988-1998)	10.2205/Mag-CKA-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Cape Chelyuskin (CCS) – Variational Minute Values (1997-1998)	10.2205/Mag-CCS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Belyi Island (BEY) – Variational Minute Values (1988-1990)	10.2205/Mag-BEY-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Arti (ARS) – Variational Minute Values (1994-1996)	10.2205/Mag-ARS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Amderma (AMD) – Variational Minute Values (1984-1998)	10.2205/Mag-AMD-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Heiss Island (HIS) – Variational Minute Values (1997-1998)	10.2205/Mag-HIS-minute-values
Geomagnetic data recorded at Geomagnetic Observatory Klimovskaya (IAGA code: KLI)	10.2205/KLI2011
Geomagnetic data recorded at Geomagnetic Observatory Saint Petersburg (IAGA code: SPG)	10.2205/SPG2012
Geomagnetic data recorded at Geomagnetic Observatory Saint Petersburg (SPG) - Minute Definitive Values (2015)	10.2205/SPG2015min-def
Seismotectonics map of Eastern Siberia	10.2205/ESDB-VONZ-125-map
Geomagnetic data recorded at Geomagnetic Observatory Klimovskaya (KLI) - Minute Values	10.2205/KLI2011min
Geomagnetic data recorded at Geomagnetic Observatory Saint Petersburg (SPG) - Minute Values (2012)	10.2205/SPG2012min
The Earth's Magnetic Field Variations Database (the Database of the Russian magnetic observatories for the variational minute values of E, H, Z elements of the Earth's magnetic field, 1983-2009)	10.2205/Mag-Variations-Database
Database of Solar Proton Events (1970–2008)	10.2205/ESDB-SAD-P
Catalog of Solar Proton Events in the 23rd Cycle of Solar Activity (1996–2008)	10.2205/ESDB-SAD-P-001
Catalog of Solar Proton Events in the 23rd Cycle of Solar Activity (1996–2008) (in Russian)	10.2205/ESDB-SAD-P-001-RU
Registered after August 2017	
Catalog of Solar Proton Events (1970-1979)	10.2205/ESDB-SAD-P-002
Catalog of Energy Spectra of Solar Proton Events (1970-1979)	10.2205/ESDB-SAD-P-003
Solar Proton Events Catalogue (1980-1986). Plots of the time profiles and energetic spectra of protons, ...	10.2205/ESDB-SAD-P-004
Solar Proton Events Catalogue (1980-1986). Data on particles and electromagnetic emissions.	10.2205/ESDB-SAD-P-005
Catalogue of Solar Proton Events (1987-1996)	10.2205/ESDB-SAD-P-006
Geomagnetic data recorded at Geomagnetic Observatory Saint Petersburg (SPG) - Minute Definitive Values (2016)	10.2205/SPG2016min-def
ULF wave index database	10.2205/ULF-index
ULF wave index 1991 dataset	10.2205/ULF-index-1991
ULF wave index 1992 dataset	10.2205/ULF-index-1992
ULF wave power index 1993 dataset	10.2205/ULF-index-1993
ULF wave power index 1994 dataset	10.2205/ULF-index-1994
ULF wave power index 1995 dataset	10.2205/ULF-index-1995
ULF wave power index 1996 dataset	10.2205/ULF-index-1996
ULF wave power index 1997 dataset	10.2205/ULF-index-1997

ULF wave power index 1998 dataset	10.2205/ULF-index-1998
ULF wave power index 1999 dataset	10.2205/ULF-index-1999
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ULF wave power index 2002 dataset	10.2205/ULF-index-2002
ULF wave power index 2003 dataset	10.2205/ULF-index-2003
ULF wave power index 2004 dataset	10.2205/ULF-index-2004
ULF wave power index 2005 dataset	10.2205/ULF-index-2005
ULF wave power index 2006 dataset	10.2205/ULF-index-2006
ULF wave power index 2007 dataset	10.2205/ULF-index-2007
Dataset of quality flag varies from 0 for doubtful to 2 for high quality events	10.2205/RJES-data-646
Virtual Magnetograms Database	10.2205/vm-database
Database of Solar Flare Events	10.2205/ESDB-SAD-FE
Catalog of Solar Flare Events with X-ray Class M1 - X>17.5. XXIII cycle of Solar Activity (1996-2008)	10.2205/ESDB-SAD-FE-01
Preliminary Current Catalog of Solar Flare Events with X-ray Classes M1 - X>17.5. XXIV Cycle of Solar Activity (2009-2017)	10.2205/ESDB-SAD-FE-02
Database of Magnetic Storms and Magnetic Storm Families 1908-2010	10.2205/Mag-St
Combined Catalogue of Magnetic Storms for 1938-1948	10.2205/Mag-St-01
Combined Catalogue of Magnetic Storms for 1949-1958	10.2205/Mag-St-02
Catalogue of Magnetic Storm Families for the period of 1957-1964	10.2205/Mag-St-03
Catalogue of Geomagnetic Storm Families for the Period of 1965-1975 and Statistical Regularities of Geomagnetic Activity	10.2205/Mag-St-04
Catalogue of Magnetic Storms	10.2205/Mag-St-05
Magnetic Storms from the Observations in Irkutsk for 1908-1959	10.2205/Mag-St-06
Catalogue of Magnetic Storms of the Ulan-Bator Observatory for 1966-1984	10.2205/Mag-St-07
Uranium isotope composition of kimberlites, the enclosing and overburden deposits of the Zolotitskoye ore field	10.2205/RJES-data-622
Geomagnetic data recorded at Geomagnetic Observatory White Sea (IAGA code: WSE)	10.2205/WSE-database
Seismic Activity and Syzygies Data	10.2205/rjes-data-650

Data Citation

The table below shows which of the registered DOI data has been cited, as well as the DOI of the articles referring to them.

DOI	Citation
10.2205/kli2011	https://doi.org/10.2139/ssrn.1731828
10.2205/ESDB-SAD-P-001-RU	https://doi.org/10.1134/S0010952519010106
10.2205/ESDB-SAD-P	https://doi.org/10.1134/S0016793217060044
10.2205/SPG2012	https://doi.org/10.5194/gi-6-473-2017
10.2205/SPG2015min-def	https://doi.org/10.5194/gi-6-473-2017 ; https://doi.org/10.1186/s40623-018-0786-8
10.2205/SPG2012min	https://doi.org/10.5194/gi-6-473-2017
10.2205/RJES-data-646	https://doi.org/10.2205/2018ES000646

10.2205/RJES-data-622	https://doi.org/10.2205/2018ES000622
10.2205/RJES-data-650	https://doi.org/10.2205/2019ES000650

United States (by Brian Meyer (brian.meyer@noaa.gov))

Data Publication

The National Centers for Environmental Information (NCEI) mints Digital Object Identifiers (DOI) for definitive data products, technical reports, and data collections. Since 2013, all products produced at NCEI for public consumption has an associated DOI, including the Enhanced Magnetic Model 2010, which at the time was the publicly available version of this model. A single DOI was minted for the out-of-cycle update to the World Magnetic Model 2015-2020 Technical report and the associated spherical harmonic coefficients. This was done in order to more closely relate the report and the data with the original release of the World Magnetic Model 2015-2020, because the processing steps for both were identical with slight variations in the date ranges in source data used. We have minted a DOI to represent the entire airborne magnetic and the marine trackline data holdings of NCEI. This is due to the nature of the data collection, where NCEI does not own these data, so it would be inappropriate for NCEI to mint survey level DOI, but we do control the distribution system. Collection level DOI were minted so that users are able to cite the source of these diverse source data.

Product/Database Title	DOI
EMAG2: A 2–arc min resolution Earth Magnetic Anomaly Grid compiled from satellite, airborne, and marine magnetic measurements	10.1029/2009GC002471
EMAG2: Earth Magnetic Anomaly Grid (2-arc-minute resolution) Version 3	10.7289/V5H70CVX
Enhanced Magnetic Model 2010	10.7289/V5HH6H0D
The Enhanced Magnetic Model 2015-2020	10.7289/V56971HV
The US/UK World Magnetic Model for 2015-2020	10.7289/V5TH8JNW
The US/UK World Magnetic Model for 2015-2020: Technical Report	10.7289/V5TB14V7
Out-of-Cycle Update of the US/UK World Magnetic Model for 2015-2020: Technical Note	10.25921/xhr3-0t19
Airborne Magnetic Trackline Database	10.7289/V5862DPB
Marine Trackline Geophysical Database	10.7289/V5CZ35DR