

## D13.4 Report on Use Cases, Requirements, Metadata and Interoperability of WP 13

### Document information Summary

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## SUMMARY

### 1. Introduction

Work Package 13 will bring geomagnetic data, derived geomagnetic data products and geomagnetic services (models of the geomagnetic field) to the EPOS platform. To achieve this the ‘Geomagnetic Observations’ TCS has three main technical tasks, in respect of building:

Task 13.4: EGMODA (European Geomagnetic Model and Data Archive).

Leader: British Geological Survey (Natural Environment Research Council), UK;

Participants: German Research Centre for Geosciences (GFZ), Germany; Finnish Meteorological Institute, Finland.

Based on existing distributed infrastructures, including INTERMAGNET, the World Data Centre for Geomagnetism (Edinburgh) and the IMAGE magnetometer network

- Will provide open academic access to geomagnetic data [INTERMAGNET, WDC; magnetic surveys, auroral zone variometer networks, i.e. non-absolute-level magnetic time series data, held by IMAGE]
- Will provide open academic access to geomagnetic models [the academic International Geomagnetic Reference Field (IGRF), the international model for navigation the World Magnetic Model (WMM), and the World Digital Magnetic Anomaly Map (WDMAM)]
- Will provide comprehensive data and metadata through a web interface and web services and through direct access (ftp) to databases
- The benefit of EGMODA will be direct and easy access to all relevant magnetic field data and models

Task 13.5: ESGI (European Service of Geomagnetic Indices).

Leader: École et Observatoire des Sciences de la Terre (EOST, Centre National de la Recherche Scientifique / University of Strasbourg);

Participants: Observatori de l'Ebre, Spain; German Research Centre for Geosciences (GFZ), Germany; Finnish Meteorological Institute, Finland.

Based on existing distributed infrastructures [ISGI, the Service on Rapid Magnetic Variations and the Service of Kp planetary Index]

- Will provide tools (discrimination of quiet or disturbed magnetic periods) & proxies with clear common data formats and data archiving/dissemination
- Will allow characterisation of geomagnetic activity and space weather conditions (past and in quasi real-time) with comprehensive metadata, through Web interface/services and direct access to databases.
- Will provide access to geomagnetic indices, including lists of significant events

Task 13.6: EMTDAMO (European Service of Magnetotelluric Data and Models).

Leader: Lulea University of Technology, Sweden;

Participants: Institute of Geophysics of the CAS, Czech Republic

- Magnetotelluric data have not yet been collected on the European level. EMTDAMO is thus a service in implementation.
- The inventory of existing data will be done jointly with the definition of metadata (survey and instrument information) before any software development.
- The final aim and benefits will be an evolving website and database that, with metadata, will enable access to magnetotelluric time series (magnetic, electric field), magnetotelluric transfer functions and crustal/lithospheric conductivity models in time (last 30 years) and space (Europe).
- The task will also provide a computational platform to compile several local conductivity models into a single regional model

In the main, the data, products and services provided through this work package will come from existing international collaborations, hosted by an individual institute (but the product of many institutes around the world). In all cases these collaborations are decades old and have proved their sustainability. They are not dependent on the continued participation of any one institute and have shown in the past their ability to transfer provision of service from one institute to another at times when an institute is no longer able to continue operating in this area of work.

Table of international collaboration organisations contributing data, products or services to EPOS:

Collaboration	Host organisation and country	Contact	Contribution to EPOS	Reference
INTERMAGNET	Geological Survey of Canada	BGS: Alan Thomson or Simon Flower	Global real-time observatory data	<a href="http://www.intermagnet.org">www.intermagnet.org</a>
World Data Centre (Edinburgh)	British Geological Survey (NERC), UK	BGS: Simon Flower or Peter Stevenson	Global observatory data archive	<a href="http://www.wdc.bgs.ac.uk">www.wdc.bgs.ac.uk</a>
International Geomagnetic Reference Field (IGRF)	National Geophysical Data Center (USA)	BGS: Alan Thomson or Simon Flower	Global geomagnetic model	<a href="http://www.ngdc.noaa.gov/IAGA/vmod/igrf.html">www.ngdc.noaa.gov/IAGA/vmod/igrf.html</a>
World Magnetic Model (WMM)	Jointly by the National Geophysical Data Center (USA) and NERC-BGS (UK)	BGS: Alan Thomson or Simon Flower	Global geomagnetic model	<a href="http://www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml">www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml</a> <a href="http://www.geomag.bgs.ac.uk">www.geomag.bgs.ac.uk</a>
International Monitor for Auroral Geomagnetic Effects	Finnish Meteorological Institute	FMI: Liisa Juusola, Ari Viljanen, Kirsti Kauristie	Auroral variometer data	<a href="http://space.fmi.fi/image/">space.fmi.fi/image/</a>

International Service of Geomagnetic Indices	École et Observatoire des Sciences de la Terre (CNRS-Unistra), France	CNRS: Aude Chambodut; Observatori de l'Ebre (OE): Juan-Jose Curto	IGA endorsed geomagnetic indices & lists of remarkable events	isgi.unistra.fr
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Table of national institutes contributing data, products or services to EPOS:

Institute	Country	Contact	Contribution to EPOS	Reference
Lulea University of Technology	Sweden	Toivo Korja & Maxim Smirnov	Coordination of magneto-telluric data and products submission	Not yet available

## 2. Priority List of DDSS elements

WP13 has declared seven priority DDSS (Data, Data products, Service and Software) elements (for implementation by month 24), and eight others for inclusion in the “roadmap” of services to be implemented after month 24. The seven priority elements are:

DDSS Number	DDSS Name
WP13-DDSS-001	Geomagnetic observatory data (WDC & INTERMAGNET)
WP13-DDSS-002	Variometer data IMAGE + Baltic extensions
WP13-DDSS-006	Geomagnetic indices (ISGI)
WP13-DDSS-007	Geomagnetic events (OE, ISGI)
WP13-DDSS-008	IMAGE electrojet indices
WP13-DDSS-009	Substorm events
WP13-DDSS-012	IGRF and WMM (global magnetic models)

Full details of each of these DDSS elements is given in Annex 1. These elements all have an associated web service at or near completion. One of the main risks to these elements being available to the EPOS ICS by month 24 is the lack of clarity on how metadata can be exchanged between the TCSs and the ICS. The ICS have defined a schema for the required metadata, but there is less clarity on what formats and protocols to use to exchange metadata. The ICS has been able to accept metadata from those TCSs able to provide it in the ISO 19139 standard, but for those DDSS elements where metadata cannot be provided to this standard there is little clarity on how to proceed.

There follows a short description of progress against each element.

### Geomagnetic observatory data (WDC & INTERMAGNET)

Observatory data will be provided to EPOS by the World Data Centre (WDC) for Geomagnetism in Edinburgh and by INTERMAGNET. The WDC has a working web service ready for integration into EPOS. INTERMAGNET has a web service on test and is working towards releasing this publicly. Institutes providing data to INTERMAGNET and the WDC need to be consulted about

the default data licensing systems conditions recommended by EPOS (Creative Commons). Since this license gives data providers better protection than the existing license regime, it is hoped that this will be a straightforward process.

A significant piece of ongoing work has been the creation of a community metadata system for observatory data. A schema for this system has been designed and presented to the community. Tools for working with the metadata are starting to be designed.

It is anticipated that these data will be ready for connection to the EPOS ICS systems by 3<sup>rd</sup> quarter of 2017, though some parts of the system (particularly the metadata) will need further work to make them fully operational.

### **Variometer data IMAGE + Baltic extensions**

IMAGE data will be provided to EPOS by the Finnish Meteorological Institute. FMI has a working web service whose integration into EPOS should be technically straightforward.

We note that IMAGE is not a legal entity. Institutes providing data to IMAGE need to be consulted about the default data licensing systems conditions recommended by EPOS (Creative Commons). Since this license gives data providers better protection than the presently applied “open access for scientific use”, it is hoped that this will be a smooth process. FMI’s own data are readily available owing to the institute’s open data policy.

It is anticipated that FMI’s data will be ready for connection to the EPOS ICS systems by 3<sup>rd</sup> quarter of 2017, though some parts of the system (particularly the metadata) may need further work to make them fully operational. Concerning data by other IMAGE contributors, we need to wait for mutual acceptance of licensing terms, and provide their data into EPOS as soon as possible.

### **Geomagnetic indices (ISGI)**

IAGA endorsed geomagnetic Indices will be provided to EPOS by the International Service of Geomagnetic Indices. ISGI has a working web service on test and is working towards releasing this publicly. The five ISGI-Collaborating-Institutes (ISGI-CI), responsible for the derivation of geomagnetic indices, have to be consulted in order to carefully take into account their data licensing systems and their Digital Object Identifier for each time series. If no license or DOI are already defined, then the ISGI-CI will be encouraged to adopt, for each index, a license and to get a DOI if possible. Since these elements give data providers better protection and recognition than the existing self-defined regime, it is hoped that this will be a straightforward process.

The creation of metadata system for geomagnetic indices relies on the ISGI Web pages that have already gathered all the information regarding each geomagnetic index in a synthetic but complete way. Although, some local Web pages are much more exhaustive on the derivation of a specific index (e.g.: Kp web pages at GFZ). A schema for this system has been designed and is currently presented to the ISGI-CI.

### **Geomagnetic events (OE, ISGI)**

As for Geomagnetic Indices, IAGA endorsed geomagnetic events will be provided to EPOS, in a first step, by the International Service of Geomagnetic Indices (ISGI), then, directly by the ISGI-Collaborating-Institute in charge of the establishment of the list of geomagnetic events: the Service of Rapid Magnetic Variations, Ebro. Observatory (OE), Spain.



ISGI has a working web service on test and is working towards releasing this publically. Creative Commons licenses and DOIs will be chosen and defined for each type of geomagnetic events, following EPOS recommendation.

The draft of metadata system has been designed and is currently under review.

### IMAGE electrojet indices

Electrojet indices are a simple product derived from IMAGE magnetometer data. FMI has a working web service whose integration into EPOS should be straightforward.

### IGRF and WMM (global magnetic models)

Web services have been created to allow access to the International Geomagnetic Reference Field (IGRF) and the World Magnetic Model (WMM). Metadata describing these web services has been created. These models are available now for connection to the EPOS ICS systems.

## 3. TCS roadmap

This is a list of the non-priority DDSS items for WP13, that is, those items that WP13 intends to implement after month 24 of the project. These divide into two groups, those that are likely to be available before the end of the implementation phase (month 48 of the project) and those that are likely to be ready after that time.

DDSS Number	DDSS Name	Ready date
WP13-DDSS-003	Magnetic survey data (e.g. WDC)	Month 36
WP13-DDSS-004	Magnetotelluric time-series (TS)	Month 48
WP13-DDSS-005	Historical data (e.g. Helsinki and SMA network )	Month 36
WP13-DDSS-010	Magnetotelluric transfer functions (TF)	Month 48
WP13-DDSS-011	Ground variations	Month 48
WP13-DDSS-013	Lithospheric conductivity models	Month 48
WP13-DDSS-014	European regional magnetic model (MagNetE)	Month 48
WP13-DDSS-015	World Digital Magnetic Anomaly Map (WDMAM)	Month 48

Work to date has focused on the priority elements, and little progress has been made in implementing the non-priority elements apart from the magnetotelluric data, where there is not an existing community and so there is much to do in order to get the necessary technical and legal systems in place.

### Magnetotelluric time-series (TS)

Magnetotelluric time series data will be provided to EPOS by different data suppliers. LTU has come to an agreement with Swedish National Infrastructure for Computing centre to run a feasibility study to store all the Magnetotelluric data including time series, transfer functions and conductivity models. Technical requirements and interoperability will be defined in cooperation with WP6&7 of EPOS and SNIC. GFZ has also offered assistance to host magnetotelluric data. Major efforts are being made to establish community approved magnetotelluric data exchange

formats. A special google group for MT data formats is established and discussions with community are initiated based on LTU proposals. New data formats will be as closely as possible adopted to match EPOS metadata structure (which is also currently under development).

MT user feedback group will continue to discuss data licensing systems conditions and most likely will follow the recommendation by EPOS (Creative Commons). We plan to run a test access to magnetotelluric time series and transfer functions by the end of 2017.

## 4. Data Management Plan (DMP)

The EPOS project is developing, both in terms of what DDSS elements each TCS would like to make available (and how complex these elements may be for the ICS to access) and the interface the ICS will make available to the TCSs. The geomagnetism TCS prefers that the ICS connects directly to service providers (such as INTERMAGNET, the WDC, ISGI ...). In this way it hopes to avoid having a functional layer between the ICS and the individual service providers, and only create this layer if it is shown to be the only possible way to proceed. There are a couple of reasons why we may yet need to create a functional layer:

- 1.) Where there is no current service provider, e.g. with Magnetotelluric data. It may be that the Geomagnetism TCS then becomes the service provider. However it may also be that the Magnetotelluric community want to perform this function themselves. This will be clarified by the EMTDAMO task team.
- 2.) Where there is an incompatibility between the service provided and the ICS ability to consume the service. It may be that we need some form of 'translation' service in these cases.

At present (March 2017) the Geomagnetism TCS is not intending to operate computer processing systems or data stores. As a facilitation body, rather than as a data centre, the data management plan for this TCS is necessarily generic.

At the TCS level we propose to base our data management plan around the data sharing principles of the WDS (<https://www.icsu-wds.org/services/data-sharing-principles>). Individual DDSS elements have data management plans which go into detail on sustainability issues such as

- Data Access Policy
- Data storage and maintenance responsibility
- Data curation responsibility
- Data management and governance structure
- Financial commitment securing the operational costs

These individual DDSS element data management plans are referenced in the descriptions of each DDSS element, in Annex 1.



## 5. Use cases

Use cases that are representative of the communities needs are important to allow the ICS to understand whether the systems it is creating are fit for purpose. Use cases describing needs within the community are relatively simple to create and two such cases have been included in this document (use case 1 and 2 in Annex 2). A further 3 use cases describe multi-disciplinary examples that are more in line with the aims of the overall EPOS project, in that they are examples of where data from more than one science discipline is required.

Multi-disciplinary use cases are difficult to create, since few researchers have cross-disciplinary experience. This is one area where the ICS may need to lead in creating systems that allow interoperability. Once that interoperability is available, new uses (and users) for cross-disciplinary data will be easier to create, in turn making clearer the use cases for such inter-disciplinary systems.

## 6. CONCLUSION

WP13 has a number of different DDSS elements to offer at a mixture of maturity levels in terms of their ability to interface with the EPOS Integrated Core Services. A number of services are ready to interface now, others will require adaptation. We have some DDSS elements that, though well organized, do not yet have the web service interface required for interfacing to EPOS, or do not have the metadata that EPOS will require to make the data ‘visible’ to users. Lack of clarity on the precise way that metadata can be exchanged within EPOS is slowing progress. The Magnetotelluric data and data products are not yet organised into a data collection and distribution service.

A high level analysis shows these items of technical work to be done within WP13 by month 24:

Item	Status
Create web services for geomagnetic models (IGRF and WMM)	Complete
Create a Metadata store for Geomagnetism. Interface the metadata store to the ICS.	In progress. Presented to feedback group.
Complete the web service for Geomagnetic Index data	In progress. Under test
Complete the web service for Geomagnetic Event data	In progress
Interface web services of ESGI to the ICS.	Not started
Create a web service for IMAGE variometer data and indices and interface this to the ICS	Established web services exist, integration to ICS to be implemented.
Work with the Magnetotelluric community to define a data centre for Magnetotelluric data.	In progress. Presented to user community.
Liaise with the WDMAM authors. Provide access to the WDMAM model via EPOS	Not started
Continue to refine DDSS element descriptions and Use Cases	In progress

Propose initial DDSS elements to ICS. Work with ICS to resolve problems on interfacing initial DDSS elements: <ul style="list-style-type: none"> <li>• WP13-DDSS-001: Geomagnetism observatory data (WDC &amp; INTERMAGNET)</li> <li>• WP13-DDSS-002: Variometer data IMAGE + Baltic extensions</li> <li>• WP13-DDSS-006: Geomagnetic indices (ISGI)</li> <li>• WP13-DDSS-012: IGRF and WMM (global magnetic models)</li> </ul>	Complete
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An important consideration in all this work will be to ensure that data distributed via EPOS is strongly ‘branded’ with the institute that created the data, data product or service. There is already some concern in the community that data delivered via the EPOS portal will appear to originate with EPOS. If we are to be successful, we need to make it very clear to users of the EPOS services who the originators are for the data they are using. Persistent Identifiers may be one way to do this, in which case WP13 will need to make more rapid progress in this area than the community has made to date.

We believe that we have a highly sustainable model for the continued delivery of these services into the future, having shown over a number of decades that we are able to build, develop and, importantly, maintain these services. We look forward to working with the EPOS members responsible for legal, governance and financial issues to share, refine and validate our vision of how these services will benefit the community for many years to come.

## Annex 1 – DDSS Detailed Descriptions

### WP13-DDSS-001: Geomagnetic observatory data (WDC & INTERMAGNET)

<b>Information provided by Simon Flower, BGS (NERC)</b>
<b>DDSS type and name</b> Geomagnetism observatory data (WDC & INTERMAGNET)
<b>Priority</b> High
<b>Format(s) of the data / data products (if applicable)</b> Format information not needed as access is via a web service
<b>Metadata standard used</b> The Metadata is currently disparate and non-structured. A component of the work for WP-13 is to create and populate a metadata store and define access mechanisms to this store. Design work has started on the store, for which EPOS access will be one user (there will be others). Help will be sought from WP6/7 to define the access mechanism (and metadata standard) for the ICS to access the metadata store.

### APIs used to provide discovery and access to the DDSS

INTERMAGNET has a restful web service under design. The consultation phase has just finished (end of Feb) and implementation should follow soon, though this has been slowed by the need to transfer the web service from the Geological Survey of Canada (the current host) to another institute (yet to be decided). The web service is described in an INTERMAGNET Discussion Document (number 28) which is being finalised. A draft of this discussion document is available. A test version of the web service is available at [www.intermagnet.org/test/ws](http://www.intermagnet.org/test/ws) though this may not always be available.

The World Data Centre (WDC) has a restful web service implemented and a new service in design. The existing service is described here:

Resources available from the WDC web service at <http://app.geomag.bgs.ac.uk/wdc>:

**/stations** - Retrieve a list of all stations known to the WDC

**/stations/{code}** - Retrieve basic metadata for the station with the given IAGA code

**/catalogue/search** - Query the WDC data catalogue. Results are filtered using the query parameters *minLatitude*, *maxLatitude*, *minLongitude*, *maxLongitude*, *minYear*, *maxYear*, *stations* and *frequencyTypes*.

So for example, the request

**<http://app.geomag.bgs.ac.uk/wdc/catalogue/search?minYear=2000&maxYear=2013&stations=LER,ESK&frequencyTypes=MINUTE>** would retrieve a list of links to all 1-minute datasets from Lerwick and Eskdalemuir observatories between the years 2000 and 2013.

**/datasets/{frequency}/{id}** - Retrieve a particular dataset, for example

**/datasets/hour/esk1985** is the path for the dataset of hourly mean values recorded at Eskdalemuir in 1985.

**/datasets/download** - Making a GET request to this resource retrieves an HTML form that then allows the client to make a POST request to download a large number of datasets in bulk. The server responds with a ZIP file containing the requested datasets in the requested format.

Further documentation will need to be created for the WDC web service.

Both the web services described give access to data, but only very limited access to metadata. A separate web service will be created to access Metadata.

Whilst the WDC makes available data that INTERMAGNET does not (and vice-versa) there is considerable overlap in the data sets available from these sites. Rules will need to be defined to describe which service is used for any search criteria that the user uses.

Web service descriptions and catalogue entries for these services are not available. It is anticipated that these will be required to allow the ICS to access these services.

### Authentication, Authorization, Accounting Infrastructure (AAAI)

Data from INTERMAGNET and the World Data Centre is openly available for non-commercial use. Commercial use of the data requires an agreement to be reached with the institute responsible for the data. There is no authentication or authorisation used to access data from these organisations. There is a logging system in place to allow INTERMAGNET and the WDC to provide the institutes responsible for each individual observatory with a detailed monthly list of who has downloaded data. This list is based on the IP details of the user, not on any registration process.

### Data policy

Both INTERMAGNET and the WDC are members of the World Data System and conform to its data policy. INTERMAGNET's data policy is described here:

<http://www.intermagnet.org/term-eng.php>, the WDC data policy is here:

<http://www.wdc.bgs.ac.uk/>. Both INTERMAGNET and the WDC make data available on demand.

INTERMAGNET is gradually reducing the 'lag-time' between data being recorded and available, with a target of 2 minutes lag time for its 1-minute data product and a 30 second lag time for its 1-second data product. Current best available lag-time is around 20 minutes and there is considerable variation in real-time performance across the community (many observatories still send single daily updates). INTERMAGNET allows individual observatories to embargo their data for a period. Typically this would not be longer than 1 to 2 weeks for observatories that are commercially sensitive. Real-time data is also 'provisional' in the sense that it will be corrected after a period of time has passed. INTERMAGNET is also responsible for collecting and distributing final data from observatories.

The WDC is only concerned with the distribution of final data products, which are typically produced annually, often some months after the end of a calendar year. The WDC does not collect real-time data. The WDC collects data from a larger set of observatories than INTERMAGNET – membership of INTERMAGNET requires an observatory to adhere to certain standards, whereas the WDC will distribute data on behalf of any observatory.

INTERMAGNET and the WDC have an overlap in the sample rates of the data series that they collect, but each also collects data at sample rates that the other does not – for example INTERMAGNET collects 1-second data, the WDC does not. The WDC provides hourly and annual means of magnetic data, INTERMAGNET does not.

Contributors to INTERMAGNET and the WDC are being consulted about the use of Creative Commons licensing with their data.

### Other technical details

INTERMAGNET and the WDC keep copies of all data that they receive in a small number of community formats. Data can be traced back to the observatory and institute that produced them. Because of the simplicity of the data set, these are not complex things to achieve and no software or standards are used to achieve them.

Neither INTERMAGNET nor the WDC provide user access to processing services. They are both data collection and dissemination providers.

### Roadmap for implementation

M9 – API standards agreed with ICS (provided this can be achieved with ICS in this time)

M21 – first version of metadata store implemented

M21 – API access to data implemented at INTERMAGNET and WDC to standards agreed with ICS

M21 – API access to metadata made available to ICS

M24 – metadata population complete

## Data Management Plan

Data access policy is covered earlier in this document. Storage of data at both INTERMAGNET and the WDC uses disk space made available by host institutes (Geological Survey of Canada for INTERMAGNET, British Geological Survey for WDC) on resilient modern servers that are regularly backed up. Responsibility for funding the continuity of this service and ongoing curation of data currently rests with these institutes; however this is a genuine community venture. In the event that an institute is no longer able to fulfil its responsibilities, another institute will step in to take up the work, because it is recognised that the services provided by these organisations are needed for global study of the Earth's magnetic field. An event like this occurred in 2007 when the Danish Technical University was no longer able to host a World Data Centre and the data and distribution systems were moved to the British Geological Survey. The World Data Centres for Geomagnetism have been operating since the late 1950s. The WDC in Edinburgh has been distributing digital data since the late 1970s. INTERMAGNET has been distributing real-time data since the early 1990s. There is a long history of successful operation of these data centres which does not depend on the financial viability of any single institute.

INTERMAGNET is governed by an Executive Council and an operations committee:

<http://www.intermagnet.org/structops-eng.php>

The WDC in Edinburgh is one of a number of World Data Centres for Geomagnetism (others are in the USA, India, Japan and Russia), all under the auspices of the World Data System. The WDC in Edinburgh is controlled by BGS staff and does not have a separate governing body.

## Testing and validation

Technical testing and validation:

A set of queries with known responses can be devised such that testing can possibly be automated (download data for a given observatory between a given set of dates and compare to a previously downloaded data set). Similar queries could be devised for the metadata.

Sustainability testing and validation:

The case for sustainability of the INTERMAGNET and WDC model has been made in the section on the data management plan. The main mechanism for testing sustainability is to investigate more fully the details of how these organisations have performed in the past.

## IT contact person

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WDC: Peter Stevenson, [petes@bgs.ac.uk](mailto:petes@bgs.ac.uk)

## Persistent Identifiers (PID)

The Geomagnetism community has made slow progress understanding how to apply DOIs to its time series data products. Both INTERMAGNET and IAGA (the International Association of Geomagnetism and Aeronomy) have projects to look into creation and use of DOIs. This will be a focus of work at the IAGA meeting in 2017. Individual institutes may have published DOIs for their data, but there is not a consistent approach across the community.

## User feedback groups

A user feedback group has been created following scientific meetings in September 2016. The group has around 40 members and is active.



## WP13-DDSS-002: Variometer data IMAGE plus Baltic extensions

<b>Information provided by</b> Liisa Juusola, Ari Viljanen & Kirsti Kauristie
<b>DDSS type and name</b> Name: Variometer data IMAGE plus Baltic extensions (including SUW, BRZ and TAR stations) Type: Magnetic variation field in nT in 10 s resolution. Geographic north, east and downward components of the geomagnetic field.
<b>Priority</b> High
<b>Format(s) of the data / data products (if applicable)</b> Presently available on-line formats ( <a href="http://space.fmi.fi/image/datainfo.html">http://space.fmi.fi/image/datainfo.html</a> ): ASCII/old IAGA format (also used internally at FMI for permanent data storage) ASCII/simple column files (most popular among users) ASCII/WDC (1993 format) Binary/GADF Graphics/PostScript, jpg
<b>Metadata standard used</b> The metadata is currently disparate and non-structured. Preferably, the same format will be used as for WP13-DDSS-001 (geomagnetic observatory data).
<b>APIs used to provide discovery and access to the DDSS</b> No API exists currently for data discovery from metadata. API for downloading data for EPOS has yet to be designed.  Presently, there are several ways to download data using web forms: Short events up to 48 hours: <a href="http://space.fmi.fi/image/reqform/dataform.html">http://space.fmi.fi/image/reqform/dataform.html</a> Monthly files in the IAGA format: <a href="http://space.fmi.fi/image/reqform/dataform_month.html">http://space.fmi.fi/image/reqform/dataform_month.html</a> Daily magnetograms: <a href="http://space.fmi.fi/image/beta/?page=online">http://space.fmi.fi/image/beta/?page=online</a> User-defined magnetograms; <a href="http://space.fmi.fi/image/beta/?page=user_defined">http://space.fmi.fi/image/beta/?page=user_defined</a>
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b> There is no authentication or authorisation used to access data for scientific purposes. A simple log file is automatically collected of numeric data file requests.
<b>Data policy</b> "Open access" policy is applied, i.e. data are freely available for scientific use. <a href="http://space.fmi.fi/image/rulesofroad.html">http://space.fmi.fi/image/rulesofroad.html</a>  For EPOS, we foresee that more explicit licensing terms must be defined with institutes providing data to IMAGE.  Concerning FMI's magnetometer data, the license is Creative Commons Attribution 4.0 International License (CC BY 4.0).
<b>Other technical details</b> None.



<b>Roadmap for implementation</b> M21 – first version of metadata store implemented M21 – API access to data implemented to standards agreed with ICS M21 – API access to metadata made available to ICS M24 – metadata population complete
<b>Data Management Plan</b> FMI has maintained a central data server for IMAGE, and we foresee that this will continue. Archiving uses a simple directory structure based on daily ASCII files of relatively small sizes (presently about 500 MB per year). Institutes providing data to IMAGE are responsible to check the quality of their own data before submission to the common data server.
<b>Testing and validation</b> Technical testing and validation for EPOS service: A set of queries with known responses can be devised such that testing can possibly be automated (download data for a given set of locations between a given set of dates and compare to a previously downloaded data set). Similar queries could be devised for the metadata.
<b>IT contact person</b> Lasse Häkkinen (lasse.hakkinen@fmi.fi)
<b>Persistent Identifiers (PID)</b> Not available. To be discussed with institutes providing data to IMAGE. There should obviously be a coordinated effort within a wider geomagnetism community.
<b>User feedback groups</b> No specific group planned for EPOS. The wide solar-terrestrial and geomagnetism community having used on-line data for more than 20 years provides feedback when noticing data deficiencies.

### WP13-DDSS-003: Magnetic survey data (WDC)

<b>Information provided by</b> Simon Flower, BGS (NERC)
<b>DDSS type and name</b> Magnetic survey data from the WDC
<b>Priority</b> Medium
<b>Format(s) of the data / data products (if applicable)</b> Format information not needed as access will be via a web service

**Metadata standard used**

This data set is extremely simple (it is kept in two structured text files). These can be seen here:

[http://geomag.bgs.ac.uk/data\\_service/data/surveydata.shtml](http://geomag.bgs.ac.uk/data_service/data/surveydata.shtml)

(check the options “aeromagnetic data” or “repeat station data”). Some extra Metadata may be needed, if so it will be made available via the web service that delivers the data. Help will be sought from WP6/7 to define the access mechanism (and metadata standard) for the ICS to access the metadata store.

**APIs used to provide discovery and access to the DDSS**

These have yet to be designed. Help will be sought from WP6/7 to ensure compatibility with EPOS core IT.

**Authentication, Authorization, Accounting Infrastructure (AAAI)**

This data is part of the World Data Centre for Geomagnetism. Data from the World Data Centre is openly available for non-commercial use. Commercial use of the data requires an agreement to be reached with the institute responsible for the data. There is no authentication or authorisation used to access data from these organisations. We would like to see a logging system in place to allow the WDC to provide the relevant institutes with a detailed monthly list of who has downloaded data. The list can be based on the IP details of the user, not on any registration process.

**Data policy**

The WDC is a member of the World Data System and conforms to its data policy. The WDC data policy is here: <http://www.wdc.bgs.ac.uk/>. The WDC makes data available on demand.

**Other technical details**

The WDC keeps copies of all magnetic survey data in a simple text format (data are reformatted to correspond to the format when they are received). Data can be traced back to the institute that produced them. Because of the simplicity of the data set, these are not complex things to achieve and no software or standards are used to achieve them. The WDC does not provide user access to processing services. It is a collector and disseminator of data.

**Roadmap for implementation**

M30 – agreement of description of API for data and metadata access

M36 – implementation of API for access to data

### Data Management Plan

Data access policy is covered earlier in this document. Storage of data at the WDC uses disk space made available by host institutes (British Geological Survey) on resilient servers with tape backup. Responsibility for funding the continuity of this service and ongoing curation of data currently rests with these institutes; however this is a genuine community venture. In the event that an institute is no longer able to fulfil its responsibilities, another institute will step in to take up the work, because it is recognised that the services provided by these organisations are needed for global study of the Earth's magnetic field. An event like this occurred in 2007 when the Danish Technical University was no longer able to host a World Data Centre and the data and distribution systems were moved to the British Geological Survey. The World Data Centres for Geomagnetism have been operating since the late 1950s. The WDC in Edinburgh has been distributing digital data since the late 1970s. There is a long history of successful operation of these data centres which does not depend on the financial viability of any single institute.

The WDC in Edinburgh is one of a number of World Data Centres for Geomagnetism (others are in the USA, India, Japan and Russia), all under the auspices of the World Data System. The WDC in Edinburgh is controlled by BGS staff and does not have a separate governing body.

### Testing and validation

Technical testing and validation:

A set of queries with known responses can be devised such that testing can possibly be automated (download data for a given set of locations between a given set of dates and compare to a previously downloaded data set). Similar queries could be devised for the metadata.

Sustainability testing and validation:

The case for sustainability of the WDC model has been made in the section on the data management plan. The main mechanism for testing sustainability is to investigate more fully the details of how these organisations have performed in the past.

### IT contact person

Simon Flower, [smf@bgs.ac.uk](mailto:smf@bgs.ac.uk)

Peter Stevenson, [petes@bgs.ac.uk](mailto:petes@bgs.ac.uk)

### Persistent Identifiers (PID)

The Geomagnetism community has made slow progress understanding how to apply DOIs to its time series data products. Both INTERMAGNET and IAGA (the International Association of Geomagnetism and Aeronomy) have projects to look into creation and use of DOIs. Individual institutes may have published DOIs for their data, but there is not a consistent approach across the community. The use of PIDs with this data set is a low priority in comparison with other geomagnetic data sets.

### User feedback groups

Members of this workgroup have strong links to the geomagnetic modelling community who use this data. This community will be asked to form a user group.

## WP13-DDSS-004: Magnetotelluric time-series (TS)

**Information provided by** Toivo Korja & Maxim Smirnov

**DDSS type and name**

Magnetotelluric time-series

<b>Priority</b> Medium
<b>Format(s) of the data / data products</b> The building of the magnetotelluric time-series data service and repository is a new project and there is no such centralized service in Europe. Moreover there is no community approved data exchange format for magnetotelluric time-series. A user feedback google group was established to discuss a new data format. The format proposal is based on different formats developed by various MT groups.
<b>Metadata standard used</b> The proposed data format consists of XML metadata file and binary data itself. The format of XML file will be adopted to match metadata structure developed within EPOS.
<b>APIs used to provide discovery and access to the DDSS</b> There is no APIs developed within the EPOS project at the moment to access magnetotelluric data. Data formats and API to access MT data are being discussed between WP6&7 and WP13.
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b> AAAI policy for magnetotelluric data will follow suggestions by EPOS. Individual requirements from user community will be taken into account.
<b>Data policy</b> Data policy will follow Creative Commons licensing recommended by EPOS.
<b>Other technical details</b>
<b>Roadmap for implementation</b> M36 – finalizing data exchange formats for time series, transfer functions and conductivity models. M36 – pilot project to host magnetotelluric data at SNIC M48 – implemented data services
<b>Data Management Plan</b> Under development
<b>Testing and validation</b> Under development
<b>IT contact person</b> Maxim Smirnov: maxim.smirnov@ltu.se
<b>Persistent Identifiers (PID)</b> Open
<b>User feedback groups</b> User feedback group was agreed during IAGA DIV VI meeting in Thailand 2016. Additionally user google group “EM data formats” is created to discuss data exchange format and other issues related to data sharing.

## WP13-DDSS-005: Historical data (e.g. Helsinki and SMA network)

<b>Information provided by</b> Ari Viljanen & Kirsti Kauristie
<b>DDSS type and name</b> Historical data (e.g. Helsinki data in 1844-1897)

<b>Priority</b>
Low
<b>Format(s) of the data / data products (if applicable)</b>
Simple ASCII files.
<b>Metadata standard used</b>
None.
<b>APIs used to provide discovery and access to the DDSS</b>
No API exists currently for data discovery from metadata. API for downloading data for EPOS has yet to be designed.
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b>
None.
<b>Data policy</b>
Open access.
<b>Other technical details</b>
None.
<b>Roadmap for implementation</b>
M33 – first version of metadata store implemented M33 – API access to data implemented to standards agreed with ICS M33 – API access to metadata made available to ICS M36 – metadata population complete
<b>Data Management Plan</b>
Data consist of historical recordings converted from year books and other written material to numeric files. No special actions are expected for maintenance.
<b>Testing and validation</b>
To be defined following the methods applied within WP13-DDSS-002.
<b>IT contact person</b>
Lasse Häkkinen (lasse.hakkinen@fmi.fi)
<b>Persistent Identifiers (PID)</b>
None.
<b>User feedback groups</b>
None.

### WP13-DDSS-006: Geomagnetic indices (ISGI)

<b>Information provided by</b> Aude Chambodut
<b>DDSS type and name</b>
Geomagnetic indices (ISGI)
<b>Priority</b>
High
<b>Format(s) of the data / data products (if applicable)</b>
Format information not needed as access is via a web service.
<b>Metadata standard used</b>
The Metadata is currently well defined, however, it is not yet searchable metadata catalogue interoperable with others specific or generic registries of resources (as EPOS system). Help will be sought from WP6/7 to define the access mechanism (and metadata standard) for the ICS to access the metadata store.

### APIs used to provide discovery and access to the DDSS

APIs exist currently for data discovery from Metadata. They are currently under test:

/IAGAindices – Retrieve a list of all geomagnetic indices

/IAGAindices/{code} – Retrieve basic metadata for the considered index

2 APIs for download that will provide access to the geomagnetic indices still need some adjustments for an operational running.

- The first API is using 3 fields: “IndexName” (6 to 10 characters), “BeginDate” beginning of time range and “EndDate” end of time range. The downloaded data are, for each geomagnetic index, the most successfully completed data on the period requested (definitive data are primarily taken into account, then the provisional and to finish the quicklook ones). This leads to a clear indication of the type of data uploaded for each index at time t.

- The second API is using the same 3 fields and two limit values in nT (“MinValue” or “MaxValue”) that allows to retrieve only part of geomagnetic indices.

### Authentication, Authorization, Accounting Infrastructure (AAAI)

Data from ISGI and ISGI Collaborating Institutes (ISGI-CI) are openly available for non-commercial use. Commercial use of the data requires an agreement to be reached with the institute responsible for the data. There is no authentication or authorisation used to access data from these organisations. There is a logging system in place to allow ISGI to provide ISGI Collaborating Institutes responsible for each individual index (data product) with a detailed list of who has downloaded data. This list is based on the IP details of the user, not on any registration process.



### Data policy

ISGI is a regular member of the World Data System and conform to its data policy (<http://www.icsu-wds.org/organization/data-policy>). The ISGI Data Policy recognizing the benefits and importance of contributing to the growing international efforts of data sharing, has adopted the following general principles:

- Full and open exchange of data, metadata and products shared, recognizing relevant international instruments and national policies and legislation;
- All shared data, metadata and products are made available with minimum time delay and at minimum cost;
- All shared data, metadata and products are free of charge or no more than cost of reproduction for only research and education.

ISGI's data policy is described here: <http://isgi.unistra.fr/policy.php>

ISGI make data available on demand. ISGI is getting a "lag-time" which depends on:

- (i) the data interval of each index (e.g.: considered data product over 3-hour period are available 30 minutes after the end of the considered 3-hour interval) and
- (ii) on the "lag-time" given by each ISGI Collaborating Institute. ISGI allows individual provider of geomagnetic index to embargo their data for a period (mainly for security purposes of the data during maintenance period, etc).

The real-time or **quick-look data** (also named *preliminary data*) are raw, automatically processed data that have not passed through any review by ISGI and/or ISGI collaborating Institutes scientists. They are intended for applications where gaps and glitches in the data are expected and accepted, for example, assimilation by forecast models. Near-real-time data should not be used in lieu of final, "clean", regularly reported data, and the data providers expressly deny permission for users to publish near-real-time data.

The **provisional data** are first step towards definitive data and have passed through routine-review by ISGI and/or ISGI collaborating Institutes scientists. They are intended for applications when definitive data are not still available.

The **definitive data** contained on ISGI Web site are available free of charge for non-commercial and scientific use. Definitive Geomagnetic Indices are available with open access and without login.

### Other technical details

ISGI keeps copies of all data that they receive in a small number of community formats (mainly ASCII). The workflows from ingest to dissemination is designed and defined according to the frame of the IAGA policy in matter of derivation of the IAGA endorsed geomagnetic indices.

The institution in charge of a geomagnetic index (the considered ISGI-CI) is committed to provide assurances in regard of availability/access of the index and of the time-lag in producing the index in future.

Indices are then formatted at minima to get an homogeneous data format compliant with the ISGI database and to acknowledge properly the ISGI-CI in the metadata. No major changes in data formats are made even for archival purposes. Thus Data can be traced back to the institute that produced them. Then, as soon as data are integrated to the ISGI server, customers are free to find data available on-line on ISGI Website.

ISGI is not providing user access to processing services. It is a data collection and dissemination provider.

**Roadmap for implementation**

M20 – first version of metadata store implemented

M20 – API access to metadata made available to ICS (provided this can be achieved with ICS in this time)

M21 – API access to data implemented at ISGI (provided this can be achieved with ICS in this time)

**Data Management Plan**

**Data access policy** is covered earlier in this document.

**Data storage**

ISGI remains a small database. The archiving and storage procedures are organised, by geomagnetic index, by quality-type and then by date, in simple directories architecture. That allows an easy handling and a great flexibility. Alternative operational facilities are designed. The main Web server is getting a mirror site synchronised every hour, the two being at two different geographical locations. Weekly incremented backups and synchronisations are performed onto two additional different network disks. Hardware system obsolescence is taken into account by a regular renewal of NAS (Network-Attached Storage) storage media. The future growing of the database size (and consequently of the corresponding database's backups) is taking into account by an overestimation of 400% of the need storage/backup space.

**Data maintenance responsibility**

In the frame of the IAGA policy in matter of derivation of the IAGA endorsed geomagnetic indices, the Institution in charge of a geomagnetic index is committed to provide assurances in regard of availability of the index and of the time-lag in producing the index in future and in archiving and access to archived data (see the "Criteria for endorsement of indices by IAGA" document: [http://isgi.unistra.fr/index\\_criteria.php](http://isgi.unistra.fr/index_criteria.php)).

IAGA, through ISGI Advisory Board and IAGA Working Group V-DAT, regularly assesses the adequateness, quality and sustainability of ISGI activities.

In case of minor problem with any aspect of the service, the advisory board will provide advices and guidance to overcome the difficulties. In case of major problem that leads to the impossibility to maintain the service in its current organizational structure (location, host institution ...), IAGA will issue an announcement of opportunity to appoint a new host organisation for ISGI.

It has already been the case in 1987 at the IUGG XIX General Assembly (Vancouver, Canada) where IAGA appointed CETP (now named LATMOS) as host organisation instead of the Koninklijk Nederlands Meteorologisch Instituut (De Bilt, the Netherlands).

It has already been the case in 2015 at the IUGG XXVI General Assembly (Prague, Czech Republic) where IAGA appointed EOST as host organisation instead of LATMOS because of the retirement of its Director and shortage of Manpower.

**Data curation responsibility**

Data integrity and authenticity are insured by the fact that through a simple procedure that directly follows the fact that ISGI is an official IAGA service.

Indeed, natively, each index derivation, calculation and management is under the responsibility of the corresponding ISGI-CI (total of 19 IAGA resolutions regarding the geomagnetic indices: 1963 #3, 4 & 5; 1967 #12 & 13; 1969 # 2, 3 & 15; 1975 #3; 1979 #15; 1983 #1, 1989 #7, 1995 #6 & 7; 1997 # 4 & 5; 2003 #5; 2005 #4; 2013 #3; [http://www.iugg.org/IAGA/iaga\\_pages/Resolutions/Resolutions.htm](http://www.iugg.org/IAGA/iaga_pages/Resolutions/Resolutions.htm)). Each index derivation is extensively detailed and explained in reference papers published in peer reviewed scientific journals.

**Governance structure**

The ISGI International Advisory Board, appointed by the Executive Committee of IAGA, cover a broad range of experts that use the geomagnetic indices.

**Financial commitment securing the operating costs**

ISGI is funded through various institutions (CNRS-INSU –French National Research Institute for Sciences of the Universe, CNES - French Space Agency-).

ISGI is also sustained by its host laboratory, EOST, through routine needs (informatics

software and hardware; data dissemination - web servers, web pages design and maintenance; backup facilities - on various systems at two different geographical locations; communication facilities - phone, Internet and mails; informatics - consumables; power supply, missions).

### Testing and validation

Technical testing and validation:

The authentication of geomagnetic indices is an on-going procedure that is currently one major concern among the community. It has to be noted that a task force was appointed on this subject in the frame of IAGA. The aim is to get consistent Digital Object Identifier (DOI) within the community of geomagnetic observatories, data and products, as geomagnetic indices.

ISGI goes through formal, periodic review and assessment to ensure responsiveness to scientific and technological developments and evolving requirements, in the frame of French organizations in charge of geomagnetic observatory activities (CNRS/INSU), and of the relevant International Scientific Society (IAGA).

In the same way, at each IAGA or IUGG meeting (every two years), ISGI is doing a report of the current status of Magnetic Indices and of ISGI Service. The ad hoc IAGA Working group is consequently giving feedback and advice. The 6 ISGI-CI are also giving, on a regular basis, feedbacks and advices at each stage of any change onto the ISGI Website.

Customers are always welcomed to send email to ISGI ([http://isgi.unistra.fr/locate\\_us.php](http://isgi.unistra.fr/locate_us.php)) regarding any aspect of the service itself, the associated Website or concerning the data.

Sustainability testing and validation:

See the section 'data' maintenance responsibility' in the data management plan.

### IT contact person

Aude Chambodut, [aude.chambodut@unistra.fr](mailto:aude.chambodut@unistra.fr)

### Persistent Identifiers (PID)

The identification of geomagnetic indices is an on-going procedure that is currently one major concern among the community. It has to be noted that a task force was appointed on this subject in the frame of IAGA. The aim is to get consistent Digital Object Identifier (DOI) within the community of geomagnetic observatories, data and products, as geomagnetic indices.

### User feedback groups

ISGI has links to the user community that can be used to create a user feedback group consisting of scientists with a regular requirement for access to this data.

## WP13-DDSS-007: Geomagnetic Events (OE, ISGI)

**Information provided by** Juan-Jose Curto & Aude Chambodut

### DDSS type and name

Geomagnetic events (OE, ISGI)

### Priority

High

### Format(s) of the data / data products (if applicable)

Format information not needed as access is via a web service.

**Metadata standard used**

The Metadata is currently well defined, however, it is not yet searchable metadata catalogue interoperable with others specific or generic registries of resources (as EPOS system).

Help will be sought from WP6/7 to define the access mechanism (and metadata standard) for the ICS to access the metadata store.

**APIs used to provide discovery and access to the DDSS**

APIs exist currently for data discovery from Metadata. They are currently under test:

/IAGAevents – Retrieve a list of all geomagnetic events

/IAGAevents/{code} – Retrieve basic metadata for the considered event type

An API for download that provides access to the geomagnetic event lists still need some adjustments for an operational running.

It is using 3 fields: “EventName” (6 to 10 characters), “BeginDate” beginning of time range and “EndDate” end of time range. The downloaded data are, for each geomagnetic index, the most successfully completed data on the period requested (definitive data are primarily taken into account, then the provisional and to finish the quicklook ones). This leads to a clear indication of the type of data uploaded for each index at time t.

**Authentication, Authorization, Accounting Infrastructure (AAAI)**

Data from ISGI and ISGI Collaborating Institutes are openly available for non-commercial use. Commercial use of the data requires an agreement to be reached with the institute responsible for the data. There is no authentication or authorisation used to access data from these organisations. There is a logging system in place to allow ISGI to provide ISGI Collaborating Institutes responsible for each individual data product (list of events) with a detailed list of who has downloaded data. This list is based on the IP details of the user, not on any registration process.

### Data policy

ISGI is a regular member of the World Data System and conform to its data policy (<http://www.icsu-wds.org/organization/data-policy>). The ISGI Data Policy recognizing the benefits and importance of contributing to the growing international efforts of data sharing, has adopted the following general principles:

- Full and open exchange of data, metadata and products shared, recognizing relevant international instruments and national policies and legislation;
- All shared data, metadata and products are made available with minimum time delay and at minimum cost;
- All shared data, metadata and products are free of charge or no more than cost of reproduction for only research and education.

ISGI's data policy is described here: <http://isgi.unistra.fr/policy.php> ISGI makes data available on demand.

List of remarkable geomagnetic events is updated with a "lag-time" which depends on the data type:

- The provisional data are first step towards definitive data and have passed through routine-review by ISGI and/or ISGI collaborating Institutes scientists. They are intended for applications when definitive data are not still available.
- The definitive data contained on ISGI Web site are available free of charge for non-commercial and scientific use. Definitive Geomagnetic lists are available with open access and without login.

### Other technical details

ISGI keeps copies of all data that they receive in a small number of community formats (mainly plain ASCII). The workflows from ingest to dissemination is designed and defined according to the frame of the IAGA policy in matter of determination of the IAGA endorsed lists of remarkable geomagnetic events.

The institution in charge of list of remarkable geomagnetic events (the Ebro Observatory) is committed to provide assurances in regard of availability/access of the events 'list and of the time-lag in producing the list of events in future. List are then formatted at minima to get a homogeneous data format compliant with the ISGI database and to acknowledge properly the ISGI-CI in the metadata. No major changes in data formats are made even for archival purposes. Thus Data can be traced back to the institute that produced them. Then, as soon as data are integrated to the ISGI server, customers are free to find data available on-line on ISGI Website. ISGI is not providing user access to processing services. It is a data collection and dissemination provider.

### Roadmap for implementation

M20 – first version of metadata store implemented

M21 – API access to metadata made available to ICS (provided this can be achieved with ICS in this time)

M22 – API access to data implemented at ISGI (provided this can be achieved with ICS in this time)



**Data Management Plan**

**Data access policy** is covered earlier in this document.

**Data storage**

ISGI remains a small database. The archiving and storage procedures are organised, by type of geomagnetic event, by quality-type and then by date, in simple directories architecture. That allows an easy handling and a great flexibility. Alternative operational facilities are designed. The main Web server is getting a mirror site synchronised every hour, the two being at two different geographical locations. Weekly incremented backups and synchronisations are performed onto two additional different network disks. Hardware system obsolescence is taken into account by a regular renewal of NAS (Network-Attached Storage) storage media.

The future growing of the database size (and consequently of the corresponding database's backups) is taking into account by an overestimation of 400% of the need storage/backup space.

**Data maintenance responsibility**

In the frame of the IAGA policy in matter of derivation of the IAGA endorsed list of remarkable events, the Institution in charge (Ebro Observatory -EO) is committed to provide assurances in regard of availability of the list and of the time-lag in producing the list in future and in archiving and access to archived data (see the "Criteria for endorsement of indices by IAGA" document: [http://isgi.unistra.fr/index\\_criteria.php](http://isgi.unistra.fr/index_criteria.php)).

IAGA, through ISGI Advisory Board and IAGA Working Group V-DAT, regularly assesses the adequateness, quality and sustainability of ISGI activities.

In case of minor problem with any aspect of the service, the advisory board will provide advices and guidance to overcome the difficulties. In case of major problem that leads to the impossibility to maintain the service in its current organizational structure (location, host institution ...), IAGA will issue an announcement of opportunity to appoint a new host organisation for ISGI.

It has already been the case in 1987 at the IUGG XIX General Assembly (Vancouver, Canada) where IAGA appointed CETP (now named LATMOS) as host organisation instead of the Koninklijk Nederlands Meteorologisch Instituut (De Bilt, the Netherlands).

It has already been the case in 2015 at the IUGG XXVI General Assembly (Prague, Czech Republic) where IAGA appointed EOST as host organisation instead of LATMOS because of the retirement of its Director and shortage of Manpower.

**Data curation responsibility**

Data integrity and authenticity are insured by the fact that through a simple procedure that directly follows the fact that ISGI is an official IAGA service.

Indeed, natively, each list of remarkable geomagnetic event determination and management is under the responsibility of the Ebro observatory. There are 3 IAGA resolutions regarding the Service of Rapid Magnetic Variations: 1975 #5 & 6; 2009 #6 (<http://www.iaga-aiga.org/resolutions/>). Each list of remarkable geomagnetic event determination is extensively detailed and explained in reference papers published in peer reviewed scientific journals.

**Governance structure**

The ISGI International Advisory Board, appointed by the Executive Committee of IAGA, cover a broad range of experts that use the geomagnetic indices and list of remarkable geomagnetic events.

### Financial commitment securing the operating costs

ISGI is funded through various institutions (CNRS-INSU – French National Research Institute for Sciences of the Universe, CNES - French Space Agency-). ISGI is also sustained by its host laboratory, EOST, through routine needs (informatics software and hardware; data dissemination - web servers, web pages design and maintenance; backup facilities - on various systems at two different geographical locations; communication facilities - phone, Internet and mails; informatics - consumables; power supply, missions). The ISGI-Collaborating Institute in charge of list of remarkable geomagnetic Events is Ebro Observatory. EO is governed by a Non Profit Foundation composed, by nine institutions, taking care of its financial support. Part of the needed infrastructures are funded by research projects and competitive public calls for grants.

### Testing and validation

Technical testing and validation:

ISGI goes through formal, periodic review and assessment to ensure responsiveness to scientific and technological developments and evolving requirements, in the frame of French organizations in charge of geomagnetic observatory activities (CNRS/INSU), and of the relevant International Scientific Society (IAGA).

At each IAGA or IUGG meeting (every two years), ISGI is doing a report of the current status of Magnetic Indices, list of remarkable geomagnetic events and of ISGI Service. The ad hoc IAGA Working group is consequently giving feedback and advice. The 6 ISGI-CI are also giving, on a regular basis, feedbacks and advices at each stage of any change onto the ISGI Website.

Customers are always welcomed to send email:

- to ISGI ([http://isgi.unistra.fr/locate\\_us.php](http://isgi.unistra.fr/locate_us.php)) regarding any aspect of the service itself, the associated Website or concerning the data;
- to Observatori de l'Ebre (<http://www.obsebre.es/en/contact>) regarding any aspect of the data.

Sustainability testing and validation:

See the heading 'Data maintenance responsibility' in the data management plan.

### IT contact person

Juan José Curto, [jjcurto@obsebre.es](mailto:jjcurto@obsebre.es)

Aude Chambodut, [aude.chambodut@unistra.fr](mailto:aude.chambodut@unistra.fr)

### Persistent Identifiers (PID)

The identification of list of remarkable geomagnetic events is an on-going procedure that is currently one major concern among the community. It has to be noted that a task force was appointed on this subject in the frame of IAGA. The aim is to get consistent Digital Object Identifier (DOI) within the community of geomagnetic observatories, data and products, as geomagnetic events.

### User feedback groups

ISGI has links to the user community that can be used to create a user feedback group consisting of scientists with a regular requirement for access to this data.

## WP13-DDSS-008: IMAGE electrojet indices (IE/IL/IU)

Information provided by Liisa Juusola, Ari Viljanen & Kirsti Kauristie

<b>DDSS type and name</b>
IMAGE electrojet indices (IE/IL/IU)
<b>Priority</b>
High
<b>Format(s) of the data / data products (if applicable)</b>
ASCII/simple column format
Graphics/jpg
<b>Metadata standard used</b>
To be defined adapting appropriate parts of the metadata format for IMAGE.
<b>APIs used to provide discovery and access to the DDSS</b>
No API exists currently for data discovery from metadata. API for downloading data for EPOS has yet to be designed.
Presently, data can be plotted and saved as numeric files using a web form: <a href="http://space.fmi.fi/image/il_index/">http://space.fmi.fi/image/il_index/</a>
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b>
None.
<b>Data policy</b>
"Open access" policy, i.e. the IE/IL/IU indices are freely available for scientific use. <a href="http://space.fmi.fi/image/rulesofroad.html">http://space.fmi.fi/image/rulesofroad.html</a>
<b>Other technical details</b>
IE/IL/IU indices are created interactively using a web form. This is a preferred method, since it automatically guarantees that the most recent magnetometer data are used for computing the indices.
<b>Roadmap for implementation</b>
M21 – first version of metadata store implemented M21 – API access to data implemented to standards agreed with ICS M21 – API access to metadata made available to ICS M24 – metadata population complete
<b>Data Management Plan</b>
No separate plan for IE/IL/IU is needed, since they are calculated from IMAGE magnetometer data (WP13-DDSS-002).
<b>Testing and validation</b>
To be defined following the methods applied within WP13-DDSS-002.
<b>IT contact person</b>
Lasse Häkkinen ( <a href="mailto:lasse.hakkinen@fmi.fi">lasse.hakkinen@fmi.fi</a> )
<b>Persistent Identifiers (PID)</b>
None.
<b>User feedback groups</b>
None.

## WP13-DDSS-009: Substorm Events

Information provided by Liisa Juusola, Ari Viljanen & Kirsti Kauristie

<b>DDSS type and name</b>
Substorm events, a subproduct derived from IL indices (WP13-DDSS-008).
<b>Priority</b>
Medium
<b>Format(s) of the data / data products (if applicable)</b>
ASCII column files
<b>Metadata standard used</b>
None.
<b>APIs used to provide discovery and access to the DDSS</b>
No API exists currently for data discovery from metadata. API for downloading data for EPOS has yet to be designed.
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b>
None.
<b>Data policy</b>
"Open access" policy is applied, i.e. data are freely available for scientific use. <a href="http://space.fmi.fi/image/rulesofroad.html">http://space.fmi.fi/image/rulesofroad.html</a>
<b>Other technical details</b>
None.
<b>Roadmap for implementation</b>
M21 – first version of metadata store implemented M21 – API access to data implemented to standards agreed with ICS M24 – API access to metadata made available to ICS M24 – metadata population complete
<b>Data Management Plan</b>
No separate plan for the substorm list is needed, since it can always be reproduced from IMAGE magnetometer data (WP13-DDSS-002).
<b>Testing and validation</b>
To be defined following the methods applied within WP13-DDSS-002.
<b>IT contact person</b>
Liisa Juusola (liisa.juusola@fmi.fi)
<b>Persistent Identifiers (PID)</b>
None.
<b>User feedback groups</b>
None.

### WP13-DDSS-010: Magnetotelluric transfer functions (TF)

<b>Information provided by</b> Toivo Korja & Maxim Smirnov
<b>DDSS type and name</b>
Magnetotelluric transfer functions
<b>Priority</b>
Low

<b>Format(s) of the data / data products</b> Data formats are discussed with connection to time-series data format.
<b>Metadata standard used</b> The building of the magnetotelluric transfer functions data service and repository is a new project and there is no such centralized service in Europe. Moreover there is no community approved data exchange format for magnetotelluric transfer functions. A user feedback google group was established to discuss a new data format. The format proposal is based on different formats developed by various MT groups.
<b>APIs used to provide discovery and access to the DDSS</b> There is no APIs developed within the EPOS project at the moment to access magnetotelluric data. Data formats and API to access MT data are being discussed between WP6&7 and WP13.
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b> AAAI policy for magnetotelluric data will follow suggestions by EPOS. Individual requirements from user community will be taken into account.
<b>Data policy</b> Data policy will follow Creative Commons licensing recommended by EPOS.
<b>Other technical details</b>
<b>Roadmap for implementation</b> M36 – finalizing data exchange formats for time series, transfer functions and conductivity models. M36 – pilot project to host magnetotelluric data at SNIC M48 – implemented data services
<b>Data Management Plan</b> Under development
<b>Testing and validation</b> Under development
<b>IT contact person</b> Maxim Smirnov: <a href="mailto:maxim.smirnov@ltu.se">maxim.smirnov@ltu.se</a>
<b>Persistent Identifiers (PID)</b> Open
<b>User feedback groups</b> User feedback group was agreed during IAGA DIV VI meeting in Thailand 2016. Additionally user google group “EM data formats” is created to discuss data exchange format and other issues related to data sharing.

## WP13-DDSS-011: Ground Variations

Information provided by Simon Flower and Alan Thomson

<b>DDSS type and name</b> Ground variations: this DDSS element will provide maps of local geomagnetic activity. This is envisaged to be data that allows plotting of the type of activity maps that are presently on the INTERMAGNET web site:  <a href="http://www.intermagnet.org/activitymap/activitymap-eng.php">http://www.intermagnet.org/activitymap/activitymap-eng.php</a>
<b>Priority</b> Medium
<b>Format(s) of the data / data products (if applicable)</b>
<b>Metadata standard used</b>
<b>APIs used to provide discovery and access to the DDSS</b>
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b>
<b>Data policy</b>
<b>Other technical details</b>
<b>Roadmap for implementation</b>  M36 – requirements described and agreed with community M42 – system designed to fulfill requirements, including web service and metadata M48 – DDSS element available via ICS
<b>Data Management Plan</b>
<b>Testing and validation</b>
<b>IT contact person</b>
<b>Persistent Identifiers (PID)</b>
<b>User feedback groups</b>

## WP13-DDSS-012: IGRF and WMM (global magnetic models)

<b>Information provided by</b> Simon Flower, BGS (NERC)
<b>DDSS type and name</b> IGRF and WMM (global magnetic models)
<b>Priority</b> High
<b>Format(s) of the data / data products (if applicable)</b> N/A (these are computer models)



<b>Metadata standard used</b> N/A (these are computer models)
<b>APIs used to provide discovery and access to the DDSS</b> The WMM (version 2015) and the IGRF (version 12) have a web service. Input to the web service is position + date, as in these examples:  <a href="http://www.geomag.bgs.ac.uk/web_service/GMMModels/wmm/2015?latitude=10&amp;longitude=20&amp;altitude=1&amp;year=2020.0&amp;format=xml">http://www.geomag.bgs.ac.uk/web_service/GMMModels/wmm/2015?latitude=10&amp;longitude=20&amp;altitude=1&amp;year=2020.0&amp;format=xml</a>  <a href="http://www.geomag.bgs.ac.uk/web_service/GMMModels/igrf/12?latitude=10&amp;longitude=20&amp;altitude=1&amp;year=2020.0&amp;format=xml">http://www.geomag.bgs.ac.uk/web_service/GMMModels/igrf/12?latitude=10&amp;longitude=20&amp;altitude=1&amp;year=2020.0&amp;format=xml</a>  Help is available here:  <a href="http://www.geomag.bgs.ac.uk/web_service/GMMModels/help/general">http://www.geomag.bgs.ac.uk/web_service/GMMModels/help/general</a>  Web service descriptions and catalogue entries for these services are available through BGS discovery metadata, though it is not yet clear whether this satisfies the needs of the ICS. Relevant metadata catalogue entries are: <ul style="list-style-type: none"> <li>• Global Geomagnetic field models web service [13607104]</li> <li>• International Geomagnetic Reference Field [13607111]</li> <li>• International Geomagnetic Reference Field service layer [13607112]</li> <li>• World Magnetic Model [13607110]</li> <li>• World Magnetic Model service layer [13607108]</li> </ul>
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b> The IGRF and WMM are open access models. It would be useful to have a record of the values that users have obtained from the models, for auditing purposes.
<b>Data policy</b> There is open access to both models. Software and the coefficient data files needed to run the software are freely available and can be found in a number of navigation products (mobile phones, GPS receivers, ...).
<b>Other technical details</b> Given the nature of the uses of these models (e.g. navigation of ships and aircraft) quality control and traceability are key elements to both the WMM and IGRF. A discussion of this for the IGRF is here: <a href="http://www.ngdc.noaa.gov/IAGA/vmod/igrfhw.html">http://www.ngdc.noaa.gov/IAGA/vmod/igrfhw.html</a> and for the WMM here: <a href="https://www.ngdc.noaa.gov/geomag/WMM/limit.shtml">https://www.ngdc.noaa.gov/geomag/WMM/limit.shtml</a> and in the associated technical report: <a href="https://www.ngdc.noaa.gov/geomag/WMM/data/WMM2015/WMM2015_Report.pdf">https://www.ngdc.noaa.gov/geomag/WMM/data/WMM2015/WMM2015_Report.pdf</a>
<b>Roadmap for implementation</b> M9 – API standards agreed with ICS (provided this can be achieved with ICS in this time) M15 – API access to WMM and IGRF made available to ICS

<p><b>Data Management Plan</b></p> <p>The WMM is sponsored by the U.S. National Geospatial-Intelligence Agency (NGA) and the U.K. Defence Geographic Centre (DGC) and is developed jointly by the National Geophysical Data Centre in the USA and the British Geological Survey – it is commissioned by defence and navigation agencies and widely used in these fields as well as in civilian navigation products. The origins of the model pre-date computer systems, going back to the 18<sup>th</sup> century World Chart Model and World Chart. There is a 5 year revision cycle. New models are available immediately for public use.</p> <p>The IGRF is released through the International Association for Geomagnetism and Aeronomy (IAGA), aimed at academic studies of the Earth’s magnetic field, but also used in many other areas. The first release was in 1968, the most recent release (the 12<sup>th</sup>) was in 2014. Candidate models are proposed by groups working in geomagnetism and a single model is agreed through an IAGA task group. Once the model is agreed, it is immediately available for use.</p> <p>Geomagnetic models are mentioned and required in international standards and laws, e.g. <a href="https://www.iso.org/obp/ui/#iso:std:iso:16695:ed-1:v1:en">https://www.iso.org/obp/ui/#iso:std:iso:16695:ed-1:v1:en</a>. BGS (and its predecessor organisations) have been involved in the compilation of these models since their inception.</p>
<p><b>Testing and validation</b></p> <p>Technical testing and validation:</p> <p>Test values (a set of input values with a corresponding known set of outputs) are available for the WMM and published in the technical manual: <a href="https://www.ngdc.noaa.gov/geomag/WMM/data/WMM2015/WMM2015_Report.pdf">https://www.ngdc.noaa.gov/geomag/WMM/data/WMM2015/WMM2015_Report.pdf</a>. A similar set of values can be generated for the IGRF if required.</p> <p>Sustainability testing and validation:</p> <p>The case for sustainability of the WMM and IGRF models has been made in the section on the data management plan. The main mechanism for testing sustainability is to investigate more fully the details of how these organisations have performed in the past.</p>
<p><b>IT contact person</b></p> <p>Simon Flower, <a href="mailto:smf@bgs.ac.uk">smf@bgs.ac.uk</a></p>
<p><b>Persistent Identifiers (PID)</b></p> <p>Models are identified by their revision number (IGRF) or year of distribution (WMM).</p>
<p><b>User feedback groups</b></p> <p>BGS has links to the user community that can be used to create a user feedback group consisting of users with a regular requirement for access to this data.</p>

## WP13-DDSS-013: Lithospheric conductivity models

<b>Information provided by</b> Toivo Korja & Maxim Smirnov
<b>DDSS type and name</b> Lithospheric conductivity models
<b>Priority</b> Low

<p><b>Format(s) of the data / data products (if applicable)</b></p> <p>The building of the conductivity models data service and repository is a new project and there is no such centralized service in Europe. Moreover there is no community approved data exchange model format. A user feedback google group was established to discuss a new data format. The format proposal is based on different formats developed by various MT groups.</p>
<p><b>Metadata standard used</b></p> <p>The proposed data format is XDMF which consist of metadata XML file and HDF5 file with conductivity model itself. The format can accommodate general 3D (including 1D/2D as special cases) models defined on various types of meshes: structured rectilinear, tetrahedral, hexahedral and non-conforming (sometimes called octree). The format uses HDF5 data model and optional XDMF as an XML scheme description, which allows external general-purpose visualization packages (such as Paraview and VisIt) to render models. The format of XML file will be adopted to match metadata structure developed within EPOS.</p>
<p><b>APIs used to provide discovery and access to the DDSS</b></p> <p>There is no APIs developed within the EPOS project at the moment to access magnetotelluric data. Data formats and API to access MT data are being discussed between WP6&amp;7 and WP13.</p>
<p><b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b></p> <p>AAAI policy for magnetotelluric data will follow suggestions by EPOS. Individual requirements from user community will be taken into account.</p>
<p><b>Data policy</b></p> <p>Data policy will follow Creative Commons licensing recommended by EPOS.</p>
<p><b>Other technical details</b></p>
<p><b>Roadmap for implementation</b></p> <p>M36 – finalizing data exchange formats for time series, transfer functions and conductivity models.</p> <p>M36 – pilot project to host magnetotelluric data at SNIC</p> <p>M48 – implemented data services</p>
<p><b>Data Management Plan</b></p> <p>Under development</p>
<p><b>Testing and validation</b></p> <p>Under development</p>
<p><b>IT contact person</b></p> <p>Maxim Smirnov: maxim.smirnov@ltu.se</p>
<p><b>Persistent Identifiers (PID)</b></p> <p>Open</p>
<p><b>User feedback groups</b></p> <p>User feedback group was agreed during IAGA DIV VI meeting in Thailand 2016. Additionally user google group “EM data formats” is created to discuss data exchange format and other issues related to data sharing.</p>

## WP13-DDSS-014: European regional magnetic model (MagNetE)

<b>Information provided by</b> Simon Flower and Alan Thomson
<b>DDSS type and name</b> European regional magnetic model (MagnetE)
<b>Priority</b> Medium
<b>Format(s) of the data / data products (if applicable)</b>
<b>Metadata standard used</b>
<b>APIs used to provide discovery and access to the DDSS</b>
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b>
<b>Data policy</b>
<b>Other technical details</b>
<b>Roadmap for implementation</b>  M30 – discuss feasibility of a MagNetE type model being made available to EPOS M36 – model available M42 – web service for model available M48 – web service connected to EPOS ICS
<b>Data Management Plan</b>
<b>Testing and validation</b>
<b>IT contact person</b>
<b>Persistent Identifiers (PID)</b>
<b>User feedback groups</b>

## WP13-DDSS-015: World Digital Magnetic Anomaly Map (WDMAM)

<b>Information provided by</b> Simon Flower and Jérôme Dymant
<b>DDSS type and name</b> World Digital Magnetic Anomaly Map (WDMAM)
<b>Priority</b> Medium
<b>Format(s) of the data / data products (if applicable)</b> A single grid data file. See <a href="http://geomag.org/models/wdmam.html">http://geomag.org/models/wdmam.html</a> (though there may be other formats / resolutions available - we will liaise with the current IAGA working group chair - Dymant).

<b>Metadata standard used</b>
<b>APIs used to provide discovery and access to the DDSS</b>
<b>Authentication, Authorization, Accounting Infrastructure (AAAI)</b>
<b>Data policy</b>
<b>Other technical details</b>
<b>Roadmap for implementation</b>  M36 – agreement reached with producers of WDMAM on the type of service that could be offered M42 – WDMAM available as a web service M48 – WDMAM web service integrated into EPOS ICS
<b>Data Management Plan</b>
<b>Testing and validation</b>
<b>IT contact person</b>
<b>Persistent Identifiers (PID)</b>
<b>User feedback groups</b>

## Annex 2 – Detailed Use Case Descriptions

### Use case 1: Downloading and viewing geomagnetic variometer and observatory data

<b>Use case name/topic:</b> Downloading and viewing geomagnetic variometer and observatory data
<b>Use case domain</b> This use case is: <ul style="list-style-type: none"> <li>o discipline-oriented, namely focusing on the discipline of Geophysics</li> </ul>
<b>Use case description</b> In this section the use cases will be outlined. This section may require iterative refinements.  <i>As a &lt;geophysical researcher&gt; I want to &lt;access geomagnetic data for one or more geomagnetic observatories or variometers, perhaps in some geographic region and for some time period&gt; so that I can &lt;view these data&gt; and &lt;download these data for my own research if visually acceptable&gt;</i>

<b>Actors involved in the use case</b> A list of the actors who communicate with this use case. <ul style="list-style-type: none"> <li>• <i>System user – researcher</i></li> <li>• <i>Geophysical researcher</i></li> </ul>
<b>Priority</b> How important is this Use Case to the TCS? (considering the degree of use: unavoidable/ frequent/occasionally/rare) <ul style="list-style-type: none"> <li>○ <i>High (frequent)</i></li> </ul>
<b>Pre-conditions</b> <i>User must have logged in</i>
<b>Flow of events – user</b> Basic sequences and needed steps (user view) <ol style="list-style-type: none"> <li>1. <i>&lt;geophysical researcher&gt; chooses observatory/variometer locations and times based on criteria such as regional information and/or observatory name and data sampling interval</i></li> <li>2. <i>&lt;geophysical researcher&gt; visualises the seven components (X,Y,Z,D,H,I,F) of the vector geomagnetic field for each observatory/variometer, time span and sampling interval selected to assess data quality</i></li> <li>3. <i>&lt;geophysical researcher&gt; requests data download for each acceptable observatory/variometer data record, or the acceptable parts of complete data record</i></li> </ol>
<b>System workflow - system view</b> <ol style="list-style-type: none"> <li>1. <i>The user interfaces receives the input: location(s), (optional) observatory/variometer name(s), time start and end, sampling interval(s)</i></li> <li>2. <i>System connects to the database and searches, for each location, for records that match the required criteria.</i> <ol style="list-style-type: none"> <li>a. <i>If data exist, system provides a 7-row stackplot of data for each named observatory/variometer for the time span requested (for variometer data not all components may be available)</i></li> <li>b. <i>If data do not exist system reports this to user (web access), with request to change location and time criteria (span and sampling interval), or end.</i></li> </ol> </li> <li>3. <i>System</i> <ol style="list-style-type: none"> <li>a. <i>Queries user (web access) for data acceptability (i.e. are data visually acceptable?)</i></li> <li>b. <i>Reminder sent if no response. Stop if no further response.</i></li> <li>c. <i>If data acceptable to user, prepares data for download/delivery, for each variometer/observatory requested</i></li> </ol> </li> </ol>
<b>Post-conditions</b> <i>All observatory/variometer data records are visualised and accepted/rejected by user, as appropriate</i>
<b>Extension Points</b> <i>User may request additional observatory/variometer data records and/or different time spans of data, and data sampling intervals</i>



# « Used » Use Cases

No other use cases used.

## Other Requirements

Download of data to commercial users is subject to each geomagnetic observatory/variometer data provider's commercial use policy

**(to be filled in by WP7) After the interview:** create class and sequence diagram for each use case. Class diagram and sequence diagram.

## Use case 2: Geomagnetic data for global and regional magnetic field modelling

**Use case name/topic:** Geomagnetic data for global and regional magnetic field modelling

**Use case domain** This use case is:

- o discipline-oriented, namely focusing on the discipline of Geomagnetism

**Use case description** In this section the use cases will be outlined. This section may require iterative refinements.

*As a <geomagnetic researcher> I want to <assemble a global or regional set of geomagnetic data from magnetic observatories, during magnetically quiet times as identified by small values of magnetic indices> so that I can <perform an off-line geophysical inversion of these data to recover a global magnetic field model and its time-rate-of-change at the epoch centred on the time span of geomagnetic data selected>*

**Actors involved in the use case** A list of the actors who communicate with this use case.

- <System user - researcher>
  - <Geomagnetism researcher>

**Priority** How important is this Use Case to the TCS? (considering the degree of use: unavoidable/ frequent/occasionally/rare)

- o Medium (occasional use)

**Pre-conditions** A list of conditions that must be true before the Use Case starts (e.g. user must have logged in)

*User must have logged in*

## Flow of events – user view

Basic sequences and needed steps (user view)

1. <geomagnetism researcher> chooses observatory locations, time spans and sampling interval to undertake analysis based on criteria: low values of geomagnetic indices (user chosen)
2. <geomagnetism researcher> accepts or rejects observatory data for analysis
3. <geomagnetism researcher> receives download of data for offline analysis

<p><b>System workflow - system view</b></p> <ol style="list-style-type: none"> <li>1. The user interfaces receives the input: location (spot, regional or global), time span, sampling interval, magnetic index type and maximum value</li> <li>2. System connects to the database and searches, for each location, for records that match the required criteria <ol style="list-style-type: none"> <li>a. If data exist, system provides an optional 4-row (X,Y,Z,F) stackplot of data for each named observatory for the time span requested</li> <li>b. If data do not exist system reports this to user, with request to change location(s), time criteria (span and sampling interval) and magnetic index type and value</li> <li>c. One reminder sent, on no reply - stop</li> </ol> </li> <li>4. System <ol style="list-style-type: none"> <li>a. Queries user (web access) for data acceptability (are data visually acceptable?) for each observatory data record</li> <li>b. One reminder sent if necessary. No reply=stop.</li> <li>c. If data are acceptable to user (as validator of data), prepares data for download/delivery, for each observatory requested</li> </ol> </li> </ol>
<p><b>Post-conditions</b> A database/file of geomagnetic data is prepared for delivery, according to the geomagnetic index criteria supplied by the user. Data available to user within 24 hours of request.</p> <p>A list of conditions that must be true when the use case ends, no matter which scenario is executed.</p>
<p><b>Extension Points</b></p> <p>No extension points</p>
<p><b>« Used » Use Cases</b></p> <p>May repeatedly use the use case &lt; Downloading and viewing geomagnetic variometer and observatory data &gt; (TBC – but probably)</p>
<p><b>Other Requirements</b></p> <p>None</p> <p>This can include non-functional requirements related to the Use Case.</p>
<p><b>(to be filled in by WP7) After the interview:</b> create class and sequence diagram for each use case. Class diagram and sequence diagram.</p>

### Use case 3: Geomagnetic model calculator

<p><b>Use case name/topic:</b> Geomagnetic model calculator</p>
<p><b>Use case domain</b> This use case is:</p> <ul style="list-style-type: none"> <li>o multidisciplinary, namely focusing on the disciplines of geomagnetism and geophysics</li> </ul>
<p><b>Use case description</b> In this section the use cases will be outlined. This section may require iterative refinements.</p> <p>As a &lt;geoscientist&gt; or &lt;public or non-scientific user&gt; I want to &lt;know the magnitude and/or direction of the Earth's magnetic field at a point and a time, or perhaps in a region, e.g. specified on a grid&gt; so that I can &lt;use this in my research&gt;</p>

<p><b>Actors involved in the use case</b> A list of the actors who communicate with this use case.</p> <ul style="list-style-type: none"> <li>• &lt;Public or non-scientific user&gt; <ul style="list-style-type: none"> <li>• &lt;Member of public&gt;</li> <li>• &lt;Other non-specialist user&gt;</li> </ul> </li> <li>• &lt;Geoscientist&gt; <ul style="list-style-type: none"> <li>• &lt;Academic Geomagnetic researcher&gt;</li> <li>• &lt;Geoscientific researcher&gt;</li> <li>• &lt;Commercial researcher&gt;</li> </ul> </li> </ul>
<p><b>Priority</b> How important is this Use Case to the TCS? (considering the degree of use: unavoidable/ frequent/occasionally/rare)</p> <ul style="list-style-type: none"> <li>o High (frequent)</li> </ul>
<p><b>Pre-conditions</b>  <i>User must have logged in</i></p>
<p><b>Flow of events – user view</b>  Basic sequences and needed steps (user view)</p> <p>&lt;User&gt; means either of &lt;Public or non-scientific user&gt; or &lt;Geoscientist&gt;</p> <ol style="list-style-type: none"> <li>1. &lt;User&gt; chooses locations and times to undertake analysis based on criteria: model spatial resolution (lower resolution=IGRF, or higher resolution=WMM)</li> <li>2. &lt;User&gt; accepts model output as table of spot values or grid of values for region of interest and time of interest</li> </ol>
<p><b>System workflow - system view</b></p> <ol style="list-style-type: none"> <li>1. The user interface (web access) receives the input: location (or range in latitude and longitude), time and field model resolution (low=IGRF or high=WMM) <ol style="list-style-type: none"> <li>a. One reminder is sent (web access) on no or incomplete input. No reply=stop.</li> </ol> </li> <li>2. The system <ol style="list-style-type: none"> <li>a. connects to the database and computes, for each location, the 7 components of magnetic field from the requested model</li> <li>b. provides a tabular or gridded report (as appropriate to request) of model output data for each location and time requested. Report supplied through web access and optional email</li> </ol> </li> </ol>
<p><b>Post-conditions</b>  <i>User request is fulfilled and data are available (web access) in tabular or other form</i></p>
<p><b>Extension Points</b>  <i>No extension points</i></p>
<p><b>« Used » Use Cases</b>  <i>No other use cases (? But perhaps other use cases may use this use case?)</i></p>
<p><b>Other Requirements</b>  <i>Commercial use must respect magnetic model calculator developers commercial use policy</i></p>

(to be filled in by WP7) After the interview: create class and sequence diagram for each use case. Class diagram and sequence diagram.

#### Use case 4: Microseismic activity in geomagnetic data

<b>Use case name/topic:</b> Microseismic activity in geomagnetic data
<b>Use case domain</b> This use case is: <ul style="list-style-type: none"> <li>o multidisciplinary, namely focusing on the disciplines of seismology and geomagnetism</li> </ul>
<b>Use case description</b> In this section the use cases will be outlined. This section may require iterative refinements. <i>As a &lt;geophysicist&gt; I want to &lt;identify time intervals in geomagnetic data affected by seismic activity&gt; so that I can &lt;quantify the seismic noise level in geomagnetic data and distinguish this from genuine geomagnetic activity&gt;.</i> ...
<b>Actors involved in the use case</b> A list of the actors who communicate with this use case. <ul style="list-style-type: none"> <li>• &lt;geophysicist&gt; <ul style="list-style-type: none"> <li>• &lt;geomagnetism researcher&gt;</li> </ul> </li> </ul>
<b>Priority</b> How important is this Use Case to the TCS? (considering the degree of use: unavoidable/ frequent/occasionally/rare) <ul style="list-style-type: none"> <li>o Low (occasional)</li> </ul>
<b>Pre-conditions</b> <i>User must have logged in</i>
<b>Flow of events – user view</b> Basic sequences and needed steps (user view) <ol style="list-style-type: none"> <li>1. &lt;geophysicist&gt; chooses magnetic observatory locations, time spans and data sampling interval to undertake analysis</li> <li>2. &lt;geophysicist&gt; receives plot of geomagnetic data labelled by intervals indicating reported seismic activity</li> <li>3. &lt;geophysicist&gt; chooses to compute noise level during seismic intervals and during non-seismic intervals</li> </ol>

<b>System workflow - system view</b>	
1.	<i>The user interfaces receives the input: location, time span, sampling interval</i>
2.	<i>System connects to the database and searches, for each location, for records that match the required criteria</i>
	<ul style="list-style-type: none"> <li>a. <i>If data exist, system provides an optional 7-row (X,Y,Z,D,H,I,F) stackplot of data for each named observatory for the time span requested, annotated by intervals of known seismic activity, as identified by seismic records</i></li> <li>b. <i>If data do not exist system reports this to user, with request to change location(s), time criteria (span and sampling interval) and magnetic index type and value</i></li> <li>c. <i>One reminder sent, on no reply - stop</i></li> </ul>
3	<i>System</i>
	<ul style="list-style-type: none"> <li>d. <i>Queries user (web access) for data acceptability (are data visually acceptable?) for each observatory data record</i></li> <li>e. <i>One reminder sent if necessary. No reply=stop.</i></li> <li>f. <i>If data are acceptable to user (as the validator of data), computes RMS level for each geomagnetic component during the identified periods of seismic activity and separately for non-seismic intervals, for each observatory requested</i></li> <li>g. <i>Reports results to user (web access) with optional email</i></li> </ul>
<b>Post-conditions</b>	
<b>Extension Points</b>	
None	
<b>« Used » Use Cases</b>	
<i>May repeatedly use the use case &lt; Downloading and viewing geomagnetic variometer and observatory data &gt; (TBC – but probably)</i>	
<b>Other Requirements</b>	
None	
<b>(to be filled in by WP7) After the interview:</b> create class and sequence diagram for each use case. Class diagram and sequence diagram.	

### Use case 5: GNSS position accuracy and geomagnetic activity (TBC)

<b>Use case name/topic:</b> GNSS position accuracy and geomagnetic activity
<b>Use case domain</b>
This use case is:
multidisciplinary, namely focusing on the disciplines of GNSS and geomagnetism
<b>Use case description</b>
<i>As a &lt;geophysicist&gt; I want to &lt;identify time intervals in GNSS data affected by solar/geomagnetic activity&gt; so that I can &lt;quantify the accuracy level in the GNSS &gt;.</i>

<b>Actors involved in the use case</b> <ul style="list-style-type: none"> <li>• &lt;geophysicist&gt;</li> <li>• &lt;geomagnetism researcher&gt;</li> </ul>
<b>Priority</b> Low
<b>Pre-conditions</b> <i>User must have logged in</i>
<b>Flow of events – user view</b> Basic sequences and needed steps (user view) <ol style="list-style-type: none"> <li>1. &lt;geophysicist&gt; chooses GNSS data over a specific time interval to undertake analysis</li> <li>2. &lt;geophysicist&gt; chooses geomagnetic index</li> <li>3. &lt;geophysicist&gt; receives labelled GNSS data over chosen intervals indicating geomagnetic activity</li> <li>4. &lt;geophysicist&gt; chooses level of geomagnetic activity (value of geomagnetic index to discriminate geomagnetically active and non-active intervals) to select GNSS data (acceptable, not acceptable).</li> </ol>
<b>System workflow - system view</b> <ol style="list-style-type: none"> <li>1. GNSS data are already selected. The user is asking for geomagnetic activity level and choosing a single or multiple geomagnetic indices.  The user interfaces for geomagnetic indices is receiving the following inputs:  period (begin time, end time), indice(s) names</li> <li>2. System connects to the database and searches, for records that match the required criteria <ol style="list-style-type: none"> <li>a. If data exist, system provides an optional stackplot (in nT or in mV/m) for each named index for the time span requested giving the data type information with colors (definitive/preliminary/quicklook).</li> <li>b. If data do not exist, system reports this to user, with request to new period criteria (time begin and end), magnetic index type and /or limit value</li> <li>c. One reminder sent, on no reply - stop</li> </ol> </li> <li>3. System <ol style="list-style-type: none"> <li>a. Queries user (web access) for data acceptability (are data visually acceptable?) for each index data record</li> <li>b. One reminder sent if necessary. No reply=stop.</li> <li>c. If data are acceptable to user (as the validator of data), tags GNSS data according to the identified periods of geomagnetic activity and underline quiet periods common to each geomagnetic index</li> <li>d. Reports results to user (web access) with optional email</li> </ol> </li> </ol>
<b>Post-conditions</b>
<b>Extension Points</b>
<b>« Used » Use Cases</b>
<b>Other Requirements</b>



**(to be filled in by WP7) After the interview:** create class and sequence diagram for each use case. Class diagram and sequence diagram.