Geomagnetic fields are generated in the Earth’s core by physical processes that give a typical yearly change of several tens of nano-Tesla (nT) in the strength of the magnetic field at the Earth’s surface. However these relatively small variations can be dominated by field changes caused by processes on the Sun, which lead to rapid hourly ranges in field strength of over 1000 nT in extreme cases. Changes caused by external sources, such as solar storms, in particular, are known as geomagnetic activity or storms.

Magnetic observatories provide data to study both processes (Figure 1). To do this we require, on the one hand, observatories to have high sampling rates and resolution and, on the other hand, we also require high instrument stability. We achieve this by combining automatic sampling by instruments known as variometers with absolute magnetic measurements made by human observers. The variometer data alone can be used for more detailed studies of...
geomagnetic activity, especially in the auroral zones of the planet. However, repeated short-term measurements on a dense network of observatory sites are needed for the study of the internal part of the geomagnetic field.

Data for these needs, together with global and regional magnetic field models, will be provided by the EGMODA (the European Geomagnetic Model and Data Archive) service. The ESGI service (European Service of Geomagnetic Indices) will then provide data and products related to geomagnetic activity. Finally, the magnetotelluric method uses natural time variations of the Earth's magnetic and electric fields to determine the electrical conductivity of the Earth's sub-surface. Therefore an entirely new geomagnetic service, EMTDAMO (European Service of Magnetotelluric Data and Models), will collect data from various sources to develop new conductivity models of the Earth.

EGMODA

EGMODA will be a portal to data from INTERMAGNET, the international network of geomagnetic observatories, and the World Data Centre for Geomagnetism (Figure 2), which provide a range of observatory and survey data and products. This same portal will also provide easy access to global geomagnetic model grids and calculators, such as the International Geomagnetic Reference Field (IGRF), the US/UK model initiative called the World Magnetic Model and the International World Digital Magnetic Anomaly Map (WDMAM). European regional data and models will also be available, including data from International Monitor for Auroral Geomagnetic Effects (IMAGE), a dense magnetometer network covering the Fennoscandian region (Figure 3), and maps of the magnetic field of the crust (MagNetE).

Users will therefore, for example, be able to:

- Request estimates of the magnetic field strength and direction at any location in the world for any time
- Display graphically the crustal magnetic field grid over an area of interest (Figure 4)
- Access actual measurements of data from nearby magnetometers

ESGI

The European Service of Geomagnetic Indices will provide users direct access to data and data products in the form of geomagnetic activity indices and lists of remarkable events. These data products are currently produced by internationally distributed institutes.

ESGI will be a portal to data products from the International Service of Geomagnetic Indices (ISGI), from Ebro Observatory and from IMAGE. ESGI will therefore provide a wide range of information related to different phenomena occurring in the magnetosphere,
ionosphere and deep in the Earth, with each product unique in its own way (Figure 5).

ESGI will make possible the use of geomagnetic activity indices in areas not yet fully explored until now, such as the systematic comparison of satellite sampled data with the level of geomagnetic activity, or the impacts of induced currents in technological infrastructures during severe geomagnetic storms.

EMTDAMO

The European Magnetotelluric Data and Models service is being developed in close contact with its user community to create a new service, which will be provided by EPOS. Until now there has been no central server for magnetotelluric data, therefore EMTDAMO will rely on existing data provider facilities. Currently the major efforts under EMTDAMO are in establishing community acceptable data formats for storing and exchanging electromagnetic data, including time series, transfer functions and models.

The EMTDAMO service, when up-and-running, will provide the opportunity for end-users to search all the available magnetotelluric data around Europe and to get open access to all data released under the CC license. Therefore, it will be possible to make use of previously acquired data in new projects that target more detailed surveys of particular areas. The EMTDAMO conductivity models (Figure 6) will be updated following the completion of current scientific projects, thus providing new models for the wider geophysical community concerned with integrated joint inversion and data analysis.

Captions

Figure 1: Magnetic observatories are built in areas free from industrial or urban magnetic noise. This picture shows the Geomagnetic observatory at Hartland, south-west UK. Copyright NERC BGS under the license CC:BY

Figure 2: Magnetic observatories in Europe, data from which are collected by the WDC for Geomagnetism (http://www.wdc.bgs.ac.uk/). The oldest record dates back to 1813. Currently operational observatories are indicated by green symbols. Copyright: WDC for Geomagnetism (NERC BGS, Edinburgh, UK) under the licence CC:BY

Figure 3: Locations of the 39 magnetometer stations of the IMAGE network (http://space.fmi.fi/image/beta/). Copyright: IMAGE (Finland) under the licence CC:BY

Figure 4: A Magnetic Anomaly Map for Europe, sampled from the World Digital Magnetic Anomaly Map, the result of an international collaboration (http://www.wdmam.org/). Copyright: “homemade” licence CC:BY

Figure 5: Evolution of three planetary sub-auroral geomagnetic
indices during the geomagnetic storm of 8-9 September 2017. From top to bottom: aa and am (derived by EOST- Strasbourg university, France- under the licence CC:BY-NC 4.0), and Kp (derived by GFZ Potsdam - Germany- under the licence CC:BY 4.0). Copyright: ISGI Web site (http://isgi.unistra.fr) licence CC:BY 4.0

Figure 6: An existing conductance map (conductivity integrated over depth) for Fennoscandia. A similar model will be available for the whole of Europe, under EPOS, and most importantly will be updated using newly completed project results, thus providing new, more accurate and detailed conductivity information. Copyright: BEAR WG licence CC:BY

Links
Ebro Observatory – Roquetes, Spain - Magnetic observatory in charge of the list of remarkable events collection for IAGA (through ISGI) - http://www.obsebre.es/en/rapid
IAGA - International Association of Geomagnetism and Aeronomy - www.iaga-aiga.org
IGRF - International Geomagnetic Reference field - Standard internal magnetic field model developed under the auspices of the IAGA - https://www.ngdc.noaa.gov/IAGA/vmod/igrf.html
IMAGE - International Monitor for Auroral Geomagnetic Effects - Network of variometer stations in Northern Europe (10 institutes over 7 countries) - http://space.fmi.fi/image/beta/
INTERMAGNET - International Real-time Magnetic Observatory Network - http://www.intermagnet.org/
MagNetE - Magnetic Network in Europe - Coordination of repeat station measurements across Europe - http://magnete-group.org/
WDC for Geomagnetism - World Data Center for Geomagnetism, Edinburgh - http://www.wdc.bgs.ac.uk/
WDMAM - World Digital Magnetic Anomaly Map - Crustal Magnetic field model developed under the guidance of the International Association of Geomagnetism and Aeronomy (IAGA) - http://www.wdmam.org/

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