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# Visualization of Earth main magnetic field maps on a spherical display

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**Abstract.** Thematic maps of the Earth Main Magnetic Field (EMMF) components compiled on various magnetic epochs and based on historical and instrumental observations are an effective tool for representation and analysis of EMMF and its temporal evolution. Such maps are published both as separate cartographic documents and selected map collections – atlases. The main disadvantage of cartographic editions published in the form of paper maps is their lack of visual representation. Modern GIS representation technologies are highly efficient for the visual analysis of cartographic documents. GIS-technologies are common in demonstration systems based on up-to-date visualization means. One of the most advanced instruments for visualization and representation of georeferenced data are digital projection systems with a spherical display.

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# Introduction

The creation of the Atlas of the Main Magnetic Field of the Earth for 1500–2010 is one of the key projects, carried out in the Geophysical Center of RAS. Thematic maps of the Earth Main Magnetic Field (EMMF) components compiled on various magnetic epochs and based on historical and instrumental observations are an effective tool for representation and analysis of EMMF and its temporal evolution. Such maps are published both as separate cartographic documents and selected map collections – atlases.

The main disadvantage of cartographic editions published in the form of paper maps is their lack of visual representation. Modern GIS representation technologies are highly efficient for the visual analysis of cartographic documents. GIS-technologies are common in demonstration systems based on up-to-date visualization means.

One of the most advanced approaches for visualization and representation of georeferenced data is the implementation of digital projection systems with a sphere shaped screen. Projection devices of this type are based on a revolutionary technology, which allows visualization of raster images, animation or video, converting

them for projection on a spherical display in a real time mode [*Beriozko,* 2011].

## Technical details and operation principle

The demonstration complex consists of a spherical display, a tabletop digital projector in a metal chassis with a complicated catadioptric optical system (lens block and mirror), and a PC workstation with special software. The spherical display itself is a hollow rigid acrylic sphere with a special inner covering for projection screens and antiglare outer coating. The sphere is mounted on the lens block with a special "fish-eye" lens with variable focal length. The lens block is installed into the metal chassis housing the projector and the mirror. The optical axis of the projector is perpendicular to the axis of the lens block. A metal mirror with a high reflection power, installed at an angle of 45° to the projector axis, deflects the beams at a right angle and directs them to the lens block. The metal chassis is made of steel covered with a protective powder coating.

The projection complex is connected to a PC workstation. A special software package, installed on the PC, converts any rectangular imagery with a 2:1 aspect

ratio into a spherical format. Converted imagery is projected on the mirror and then through the lens block on the inner surface of the spherical display. The software package allows visualizing separate raster images and video files giving a full control over the demonstration process (play, pause, rotation clockwise/counter clockwise, flipping, tilting, etc.).

Additionally the software allows showing consecutively a series of raster images with a specified speed (up to 30 fps) considering them as a set of frames of an animated sequence. Using this approach the complex was used for animated visualization of temporal evolution of EMMF components.

## Visualization of EMMF maps

The creation of the Atlas of the Earth's Magnetic Field for 1500–2010 implies compilation of digital maps of the EMMF components showing temporal variations of the Field for the specified time interval. Using ESRI ArcGIS software package these digital maps were converted into separate raster images with 2:1 aspect ratio and 2048×1024 300dpi resolution (Figure 1. Raster maps were compiled for each of the EMMF component, represented with colored isolines or gradient color rasters.

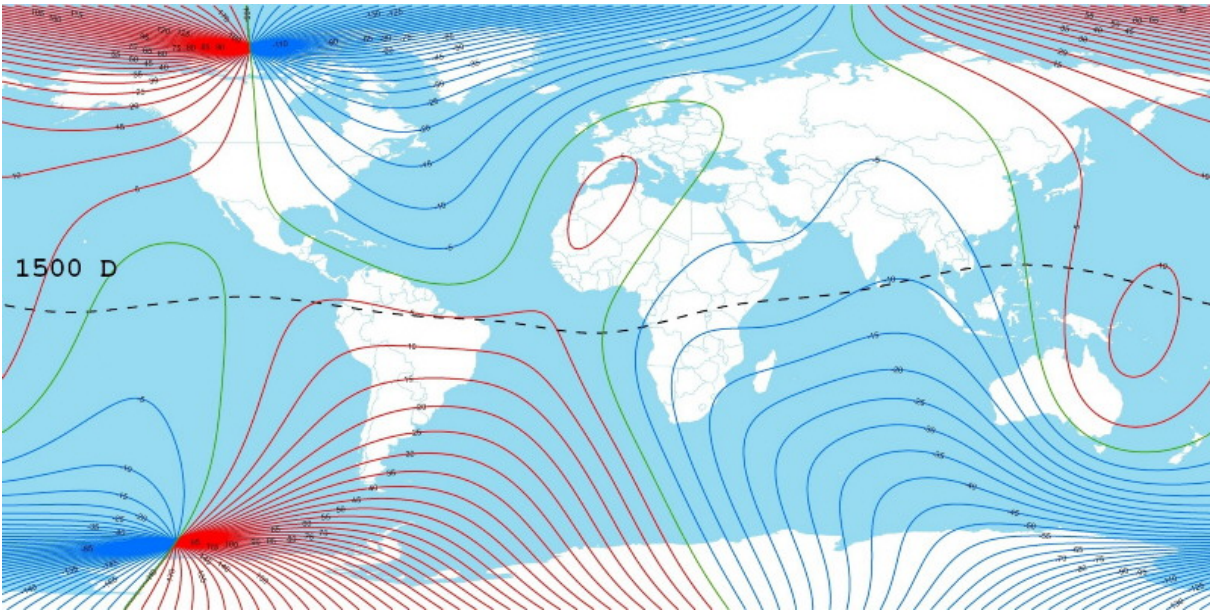


**Figure 1.** Digital maps of EMMF components, converted into raster images: **a)** declination, isolines.

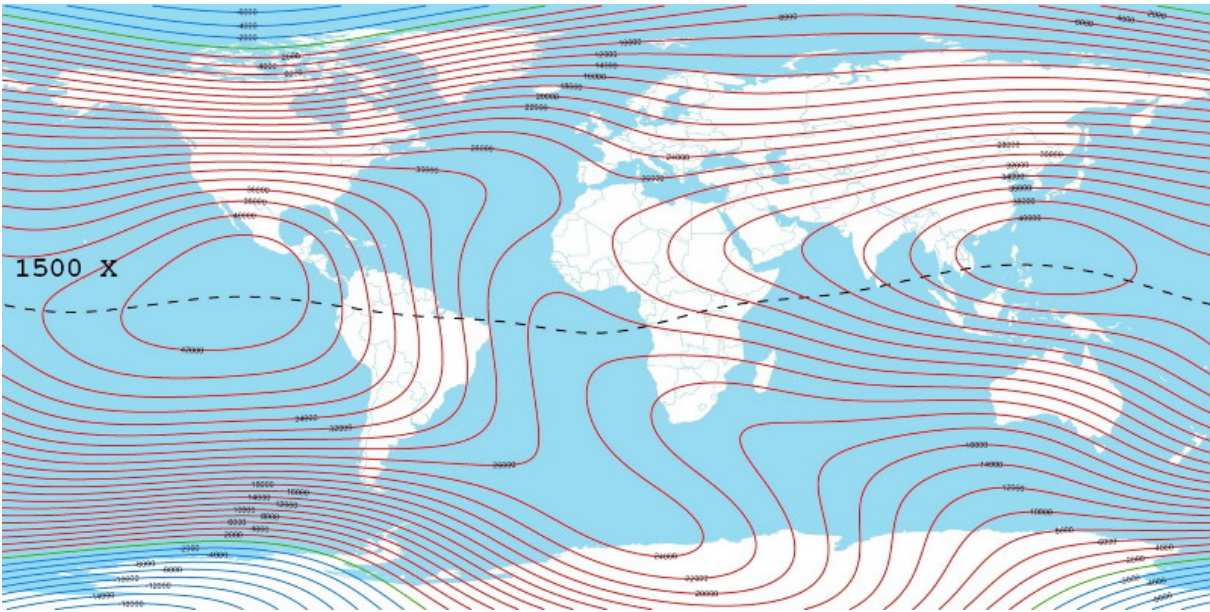


**Figure 1.** Digital maps of EMMF components, converted into raster images: **b)** north component, isolines.

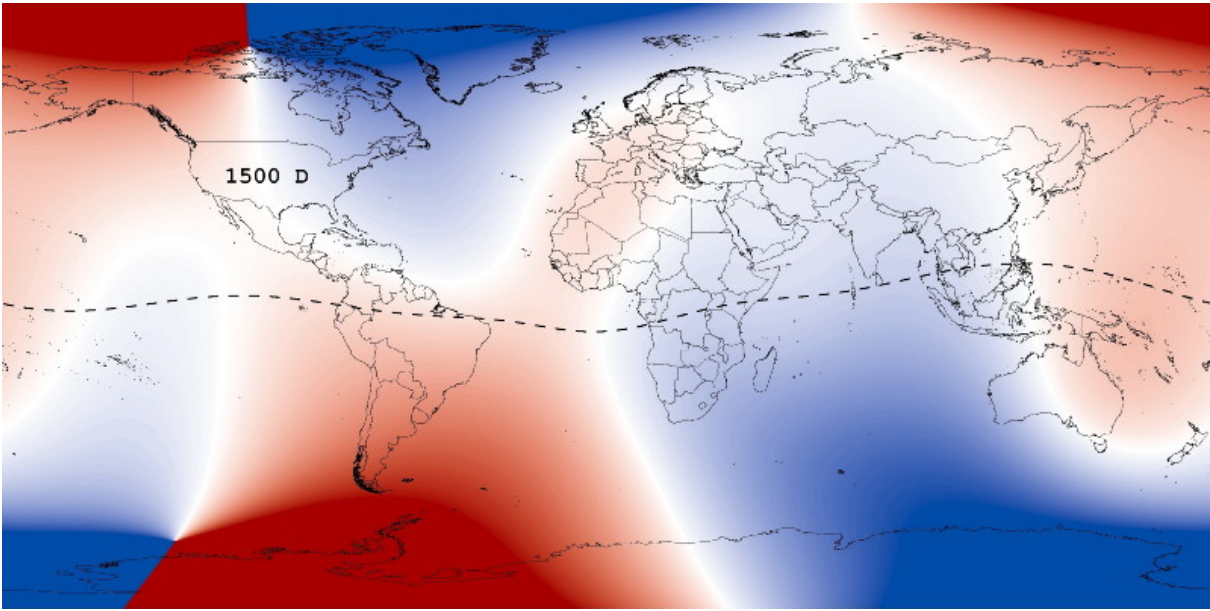


**Figure 1.** Digital maps of EMMF components, converted into raster images: **c)** declination, colored gradient.

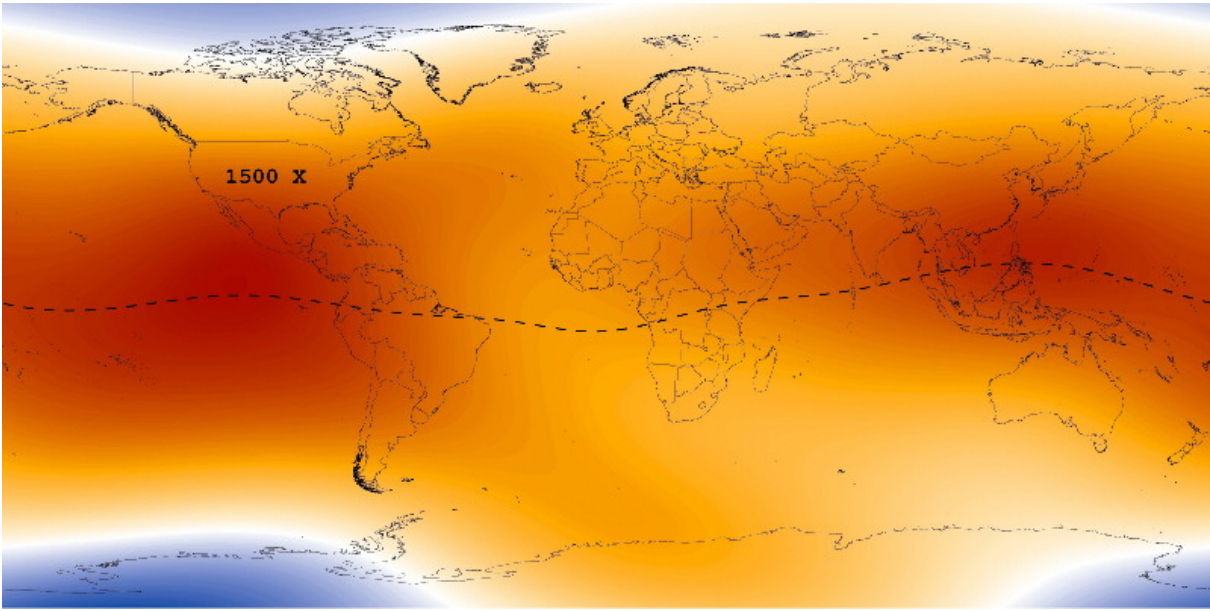


**Figure 1.** Digital maps of EMMF components, converted into raster images: **d)** north component, colored gradient.

Prepared raster maps were combined in separate sets and visualized as animated sequences by means of the demonstration complex available at the GC RAS (Figure 2).

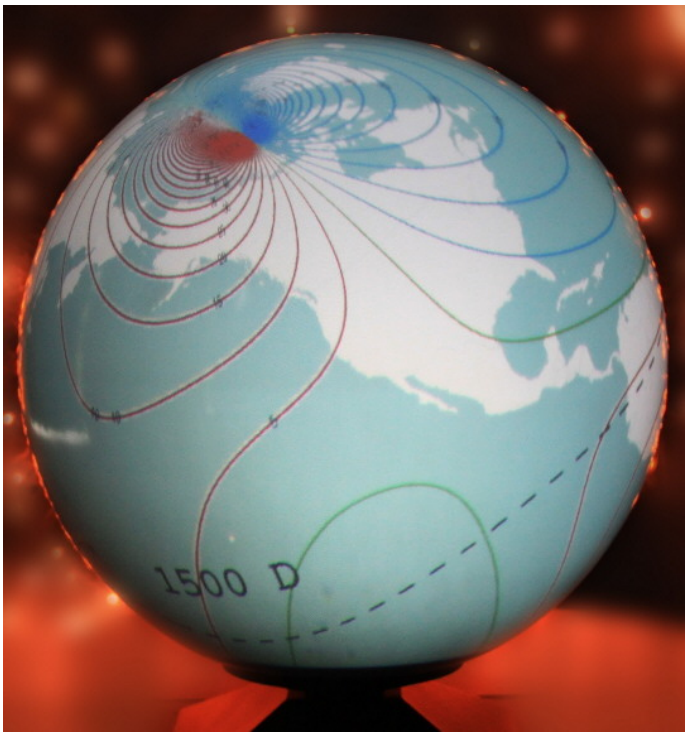


**Figure 2.** Visualization of digital maps of EMMF components by means of a digital projection system with a spherical display: **a)** declination, isolines.

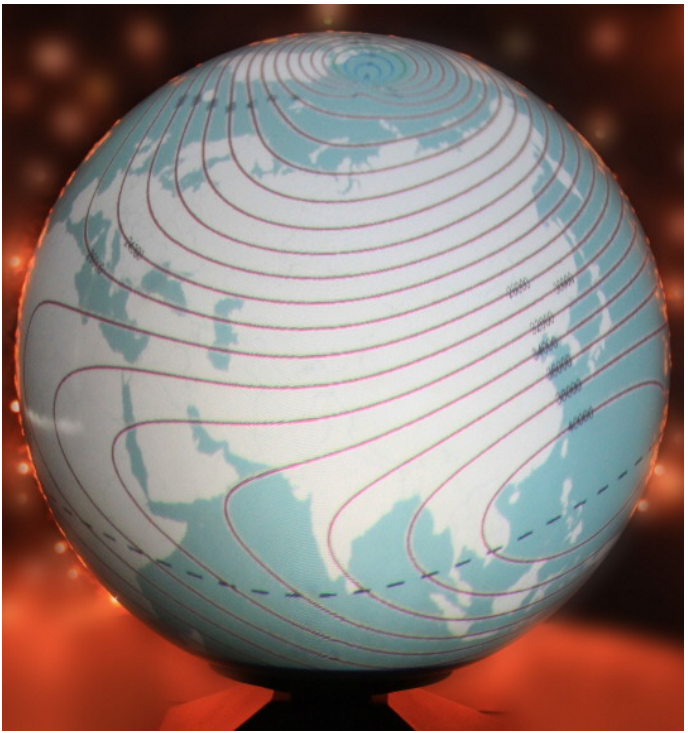

**Figure 2.** Visualization of digital maps of EMMF components by means of a digital projection system with a spherical display: **b)** north component, isolines.

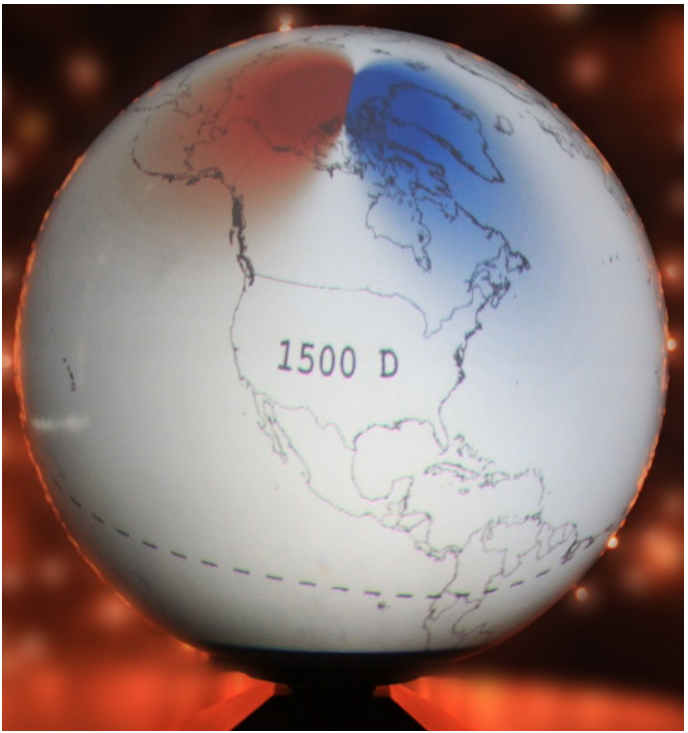


**Figure 2.** Visualization of digital maps of EMMF components by means of a digital projection system with a spherical display: **c)** declination, colored gradient.

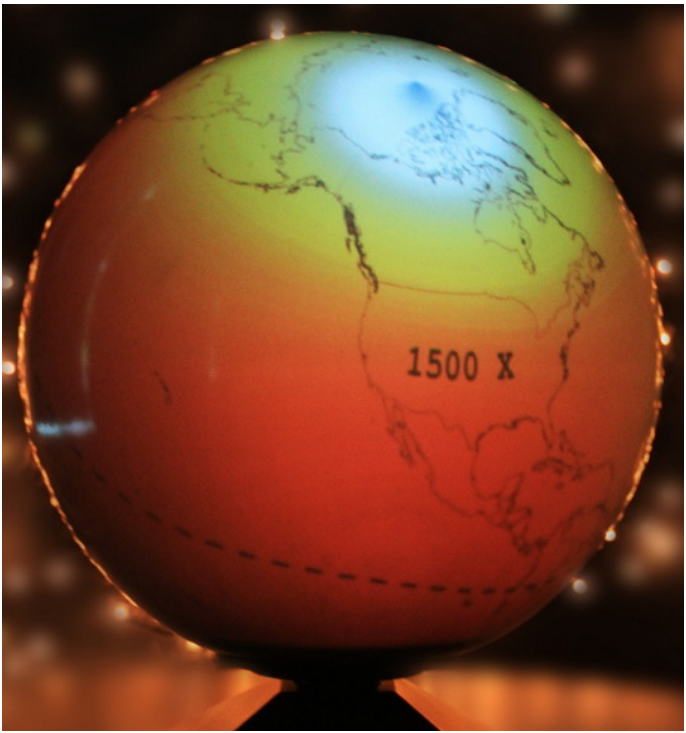


**Figure 2.** Visualization of digital maps of EMMF components by means of a digital projection system with a spherical display: **d)** north component, colored gradient.

# Conclusion

Implementation of modern representation means, based on GIS technologies, provides a significant increase in efficiency of cartographic data analysis. The presented digital projection system with a spherical display is a highly versatile tool for the visualization of georeferenced data.

# References

Beriozko, Alexander, Alexei Lebedev, Anatoly Soloviev, Roman Krasnoperov, and Alena Rybkina (2011), Geoinformation system with algorithmic shell as a new tool for Earth sciences, *Russ. J. Earth. Sci., 12*, ES1001, doi:10.2205/2011ES000501.