THE EVOLUTION OF THE GEOMAGNETIC FIELD ON THE ROMANIAN TERRITORY. MEASUREMENTS IN THE SECULAR VARIATION NATIONAL NETWORK BETWEEN 2010 AND 2014

RĂZVAN GRECULEASA[1], VENERA DOBRICĂ[1], ANCA ISAC[2]

[1] *"Sabba S. Ştefănescu" Institute of Geodynamics of the Romanian Academy, 19-21, Jean-Louis Calderon St., 020032 Bucharest, Romania*
[2] *Geological Institute of Romania, 1, Caransebeş St., Bucharest, Romania*

The paper reports the results obtained in the last five years (2010–2014) regarding the geomagnetic measurements at the 26 repeat stations of the Romanian secular variation network. Based on recordings provided by the Surlari Geomagnetic Observatory, the values obtained for the geomagnetic elements H, D, Z, and F were reduced to the middle of the year in which the measurements were taken (geomagnetic epoch year.5). Also, we compare the secular variation on the Romanian territory obtained from the geomagnetic measurements with the secular variation based on IGRF model. The local secular variation in the study interval seems to be marked by lateral variations in the magnetic properties of the crust.

Key words: geomagnetic measurements, repeat station, secular variation, Romanian territory.

1. INTRODUCTION

At present, the monitoring of the geomagnetic field is achieved by continuous measurements at geomagnetic observatories, by measurements at repeat stations and by satellite measurements. In Romania, the geomagnetic field evolution is monitored both by continuous measurements at the Geomagnetic Observatory Surlari, established in 1942, and by geomagnetic measurements at repeat stations. The latter are taken within a program that started in 1964, implying measurements repeated as much as possible each year in a network of 26 stations, the so-called Secular Variation National Network (Atanasiu *et al.*, 1965; Atanasiu *et al.*, 1967; Atanasiu *et al.*, 1970; Atanasiu *et al.*, 1974; Atanasiu *et al.*, 1976; Demetrescu *et al.*, 1985; Demetrescu *et al.*, 2011). The geographical distribution of the repeat stations and the location of the Surlari geomagnetic observatory (SUA) are shown in Fig. 1.

2. EQUIPMENT AND DATA

The aquisition of necessary data for the present study has been done between 2010 and 2014. During the annual field campaigns of geomagnetic measurements at repeat stations of the Secular Variation National Network, the following equipment has been used:

– for absolute measurements of the geomagnetic elements at discrete times: a DI-Flux theodolite (Lemi 204) for declination (D), and inclination (I), a recording proton precession magnetometer (Geometrics 856) for the total intensity (F) and two quartz horizontal magnetometers (QHM-1004 and QHM-1005) for the horizontal component (H). Though the latter is derived from D, I, and F, the QHMs have been considered, in order to keep continuity with older determinations at network stations;

– for continuous relative measurements: a recording fluxgate magnetometer (Lemi-18) for variations of the geomagnetic elements X, Y, and Z.

Data recorded by the proton magnetometer are stored in the memory of the G-856, with a capacity of 12,000 measurements. They can be downloaded by means of the *MagMap2000* software of the instrument. Data recorded by the Lemi-18 magnetometer are stored on an external memory, a 2 Gb card flash; they are downloaded by means of the *Lemi18.exe*. All recorded data have been processed to the sampling cadence of the geomagnetic observatory recordings (10 sec.).

In Fig. 2 we show, as an example, recordings of X, Y, and Z at one repeat station (Mizil) when the geomagnetic activity is a calm one, and the recordings at the Lipova station in a magnetically disturbed day are presented in Fig. 3, as compared to the geomagnetic recordings at the geomagnetic observatory. One can notice the similitude of variations, validating the field recordings.

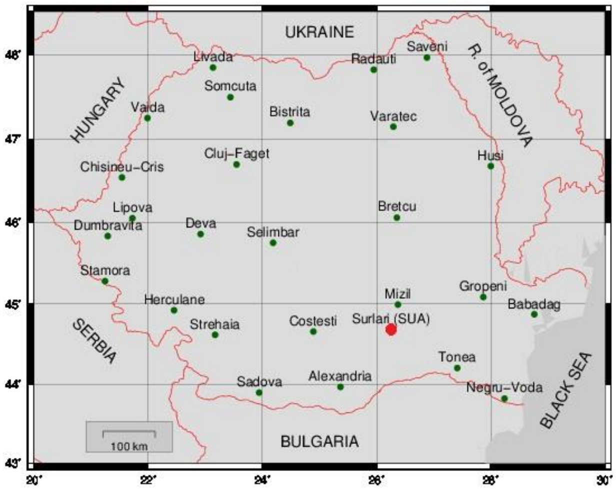


Fig. 1 – Geographical distribution of repeat stations and the location of the geomagnetic observatory (SUA).

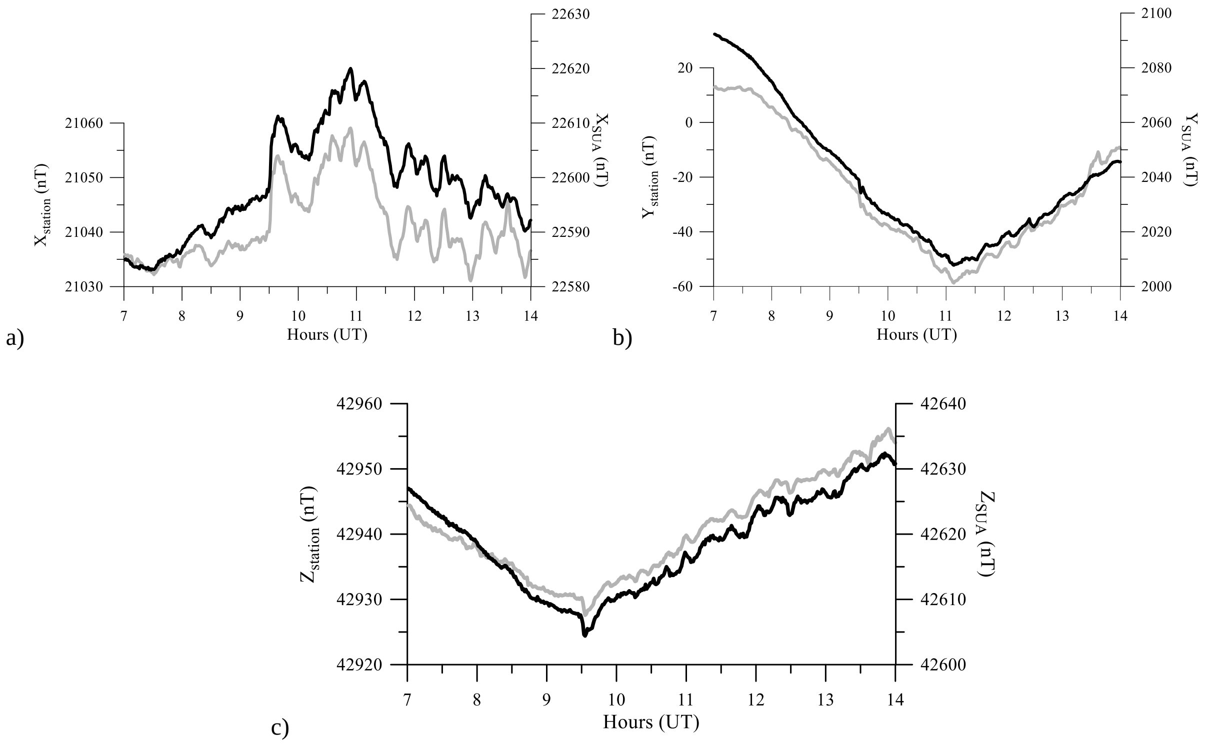


Fig. 2 – Recordings of geomagnetic elements at Mizil station (grey) and at the geomagnetic observatory (black), on 29.05.2014: a) – X component, b) – Y component, c) – Z component.

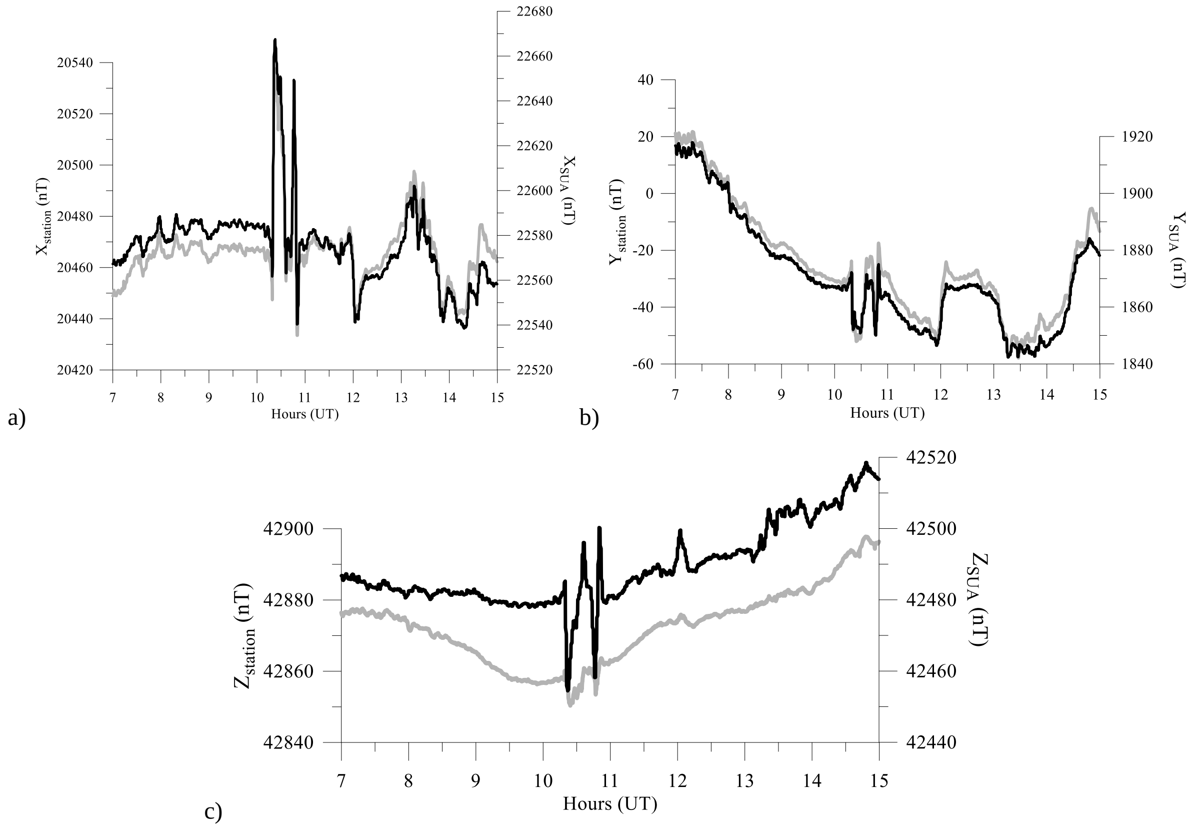


Fig. 3 – Recordings of geomagnetic elements at Lipova station (grey) and at the geomagnetic observatory (black), on 4.08.2010: a) – X component, b) – Y component, c) – Z component.

3. RESULTS AND DISCUSSION

3.1. THE GEOGRAPHICAL DISTRIBUTION OF GEOMAGNETIC ELEMENTS IN THE STUDY INTERVAL

In a first stage, the values of the geomagnetic elements, obtained by absolute measurements, were corrected for the diurnal variation based on time series recorded at the station and at the geomagnetic observatory. Then they were reduced to the middle of the year the measurements were done (geomagnetic epoch yyyy.5) using the annual averages provided by the observatory. The annual values at stations were used to derive maps for the various geomagnetic elements by means of the SURFER code, with Kriging interpolation option.

In Fig. 4 we compare the values for the geomagnetic elements indicated, for the 26 repeat stations, in the consecutive five years of the study. On the Romanian territory the geomagnetic elements take values of 20790 nT ÷ 23330 nT, in case of H, 3.73° ÷ 6.25°, in case of D, 41890 nT ÷ 44977 nT, in case of Z, and 47857 nT ÷ 49557 nT, in case of F. As one can see in the figure, differences from year to year (secular variation) are small in comparison to the plotted values, with the result that maps with these values would be very similar. Consequently, we shall show only the distribution at 2014.5, as an example (Fig. 5).

3.2 THE SECULAR VARIATION OF THE GEOMAGNETIC FIELD

The evolution of the geomagnetic elements during the five years of the present study, at each of the repeat stations, can be considered, in a first instance, as linear. In Fig. 6 is given, as an example, the evolution of the four geomagnetic elements at the Surlari observatory, in terms of annual averages, and, at one of the repeat stations

(Cluj), in terms of the values for the middle of the year when the measurements were taken. The shape of that evolution indicates the possibility of describing the secular variation in the study time-interval as being given by the slope of the straight line through the five points. The corresponding isopore maps are shown in Fig. 7. The secular variation on the Romanian territory is of 0.2 – 9.3 nT/year in case of the horizontal component, between 20.4 and 44.9 nT/year in case of the vertical component, between 23.9 and 38.3 nT/year in case of the total intensity, and between -1.81 and 10.9 minutes/year in case of declination.

Maps of Fig. 7 show a regional pattern, which probably is due to lateral variations of the magnetic properties of crustal rocks, since global models of the main field (for instance IGRF, Fig. 8) indicate a clear uniformity on the Romanian territory. It is evident at this time that the analysed time segment 2010–2014, is too short to allow approaching the internationally debated problem of the time-dependent magnetization of crustal rocks (Hulot *et al.*, 2009; Thébault *et al.*, 2009). The data presented in this paper should for sure be regarded in the context of long-term variations of the geomagnetic field (Demetrescu and Dobrică, 2014).

4. CONCLUSION

Geomagnetic measurements performed at the repeat stations of the Secular Variation National Network between 2010 and 2014 allowed a look at the space and temporal evolution of the geomagnetic field on the Romanian territory. Based on annualy repeated measurements, maps of the geomagnetic elements H, D, Z and F, as well as maps of the secular variation distribution, for the mentioned time interval, were constructed. The latter indicates a regional pattern which probably is due to lateral variations of the magnetic properties of crustal rocks.

Acknowledgements: The authors thank Crişan Demetrescu (Institute of Geodynamics) for useful discussions and suggestions. The research was done within the frame of the project UEFISCDI PN-II-IDEI 93/2011.

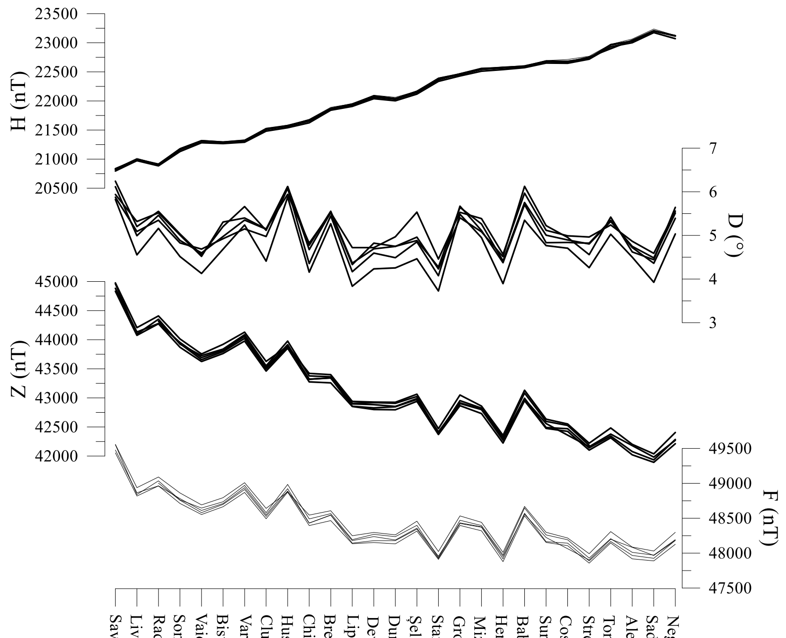


Fig. 4 – Lateral variation of geomagnetic elements from station to station in the five years of data. From top to bottom: H, D, Z, and F.

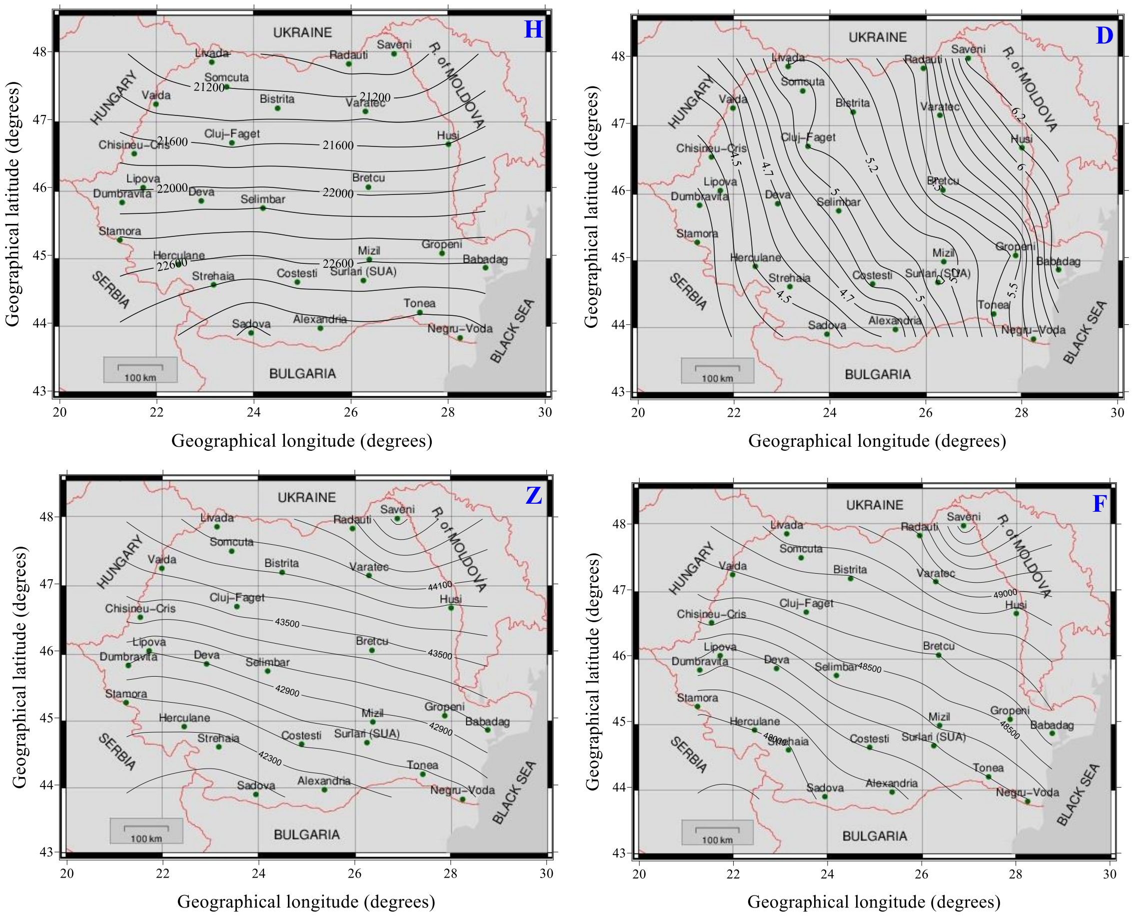


Fig. 5 – The geographical distribution of geomagnetic elements H, D, Z, and F at the geomagnetic epoch 2014.5.

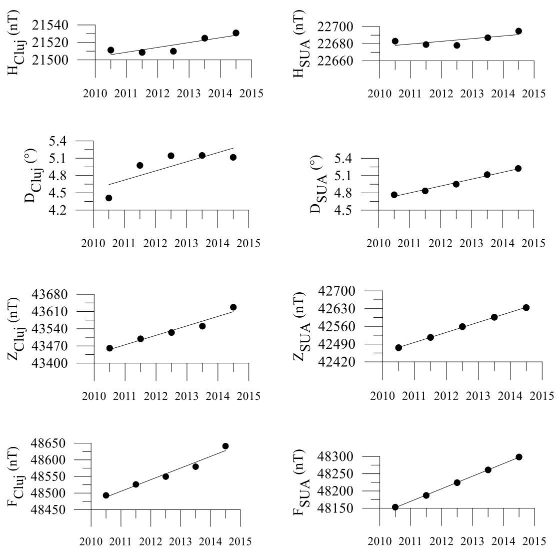
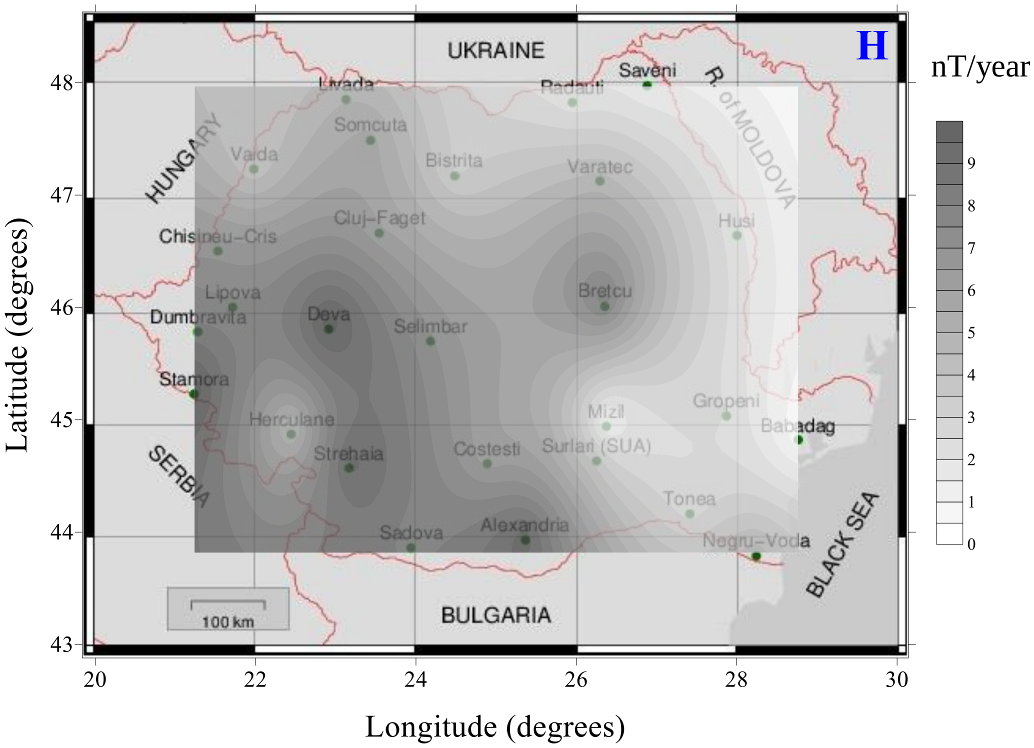


Fig. 6 – Annual values at the repeat Cluj station as compared to annual averages at the geomagnetic observatory (H, D, Z, F).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Somcuta
Vaida
Bistrita
Varatec
Cluj-Faget
Chisineu-Cris
Husi
Lipova
Dumbravita
Deva
Selimbar
Bretcu
Stamora
Herculane
Strehaia
Costesti
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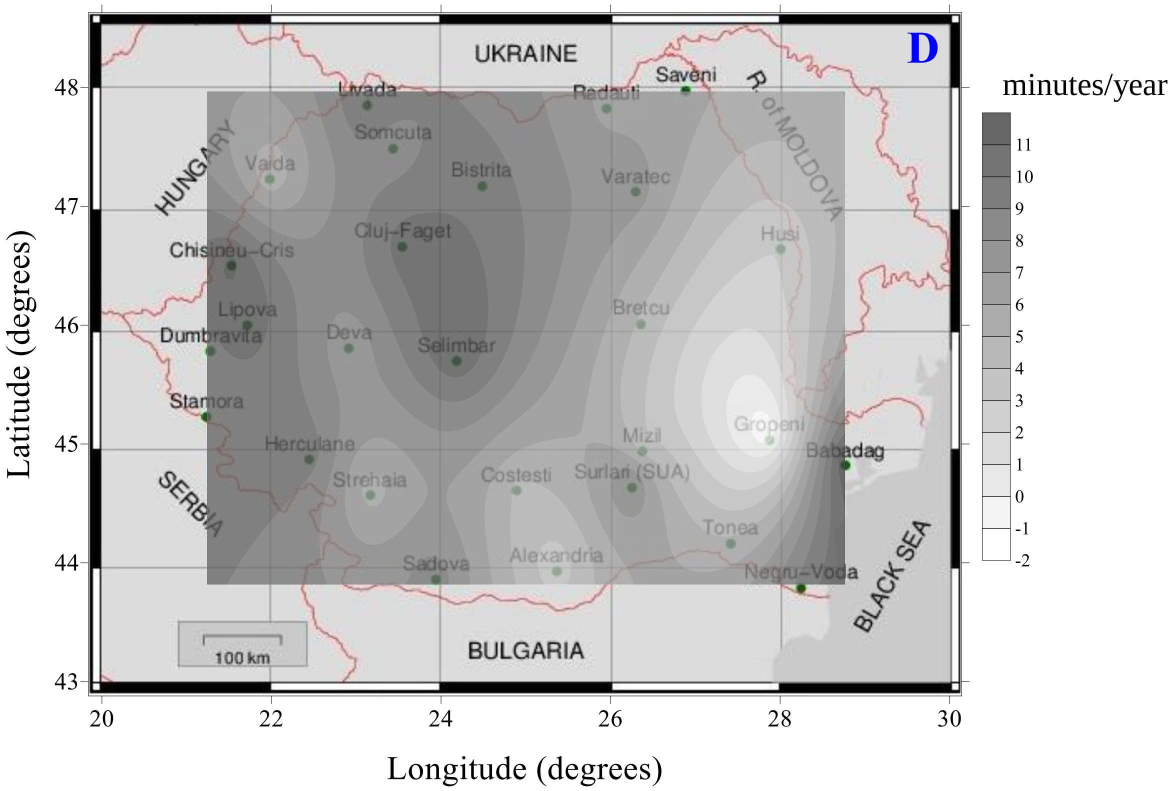
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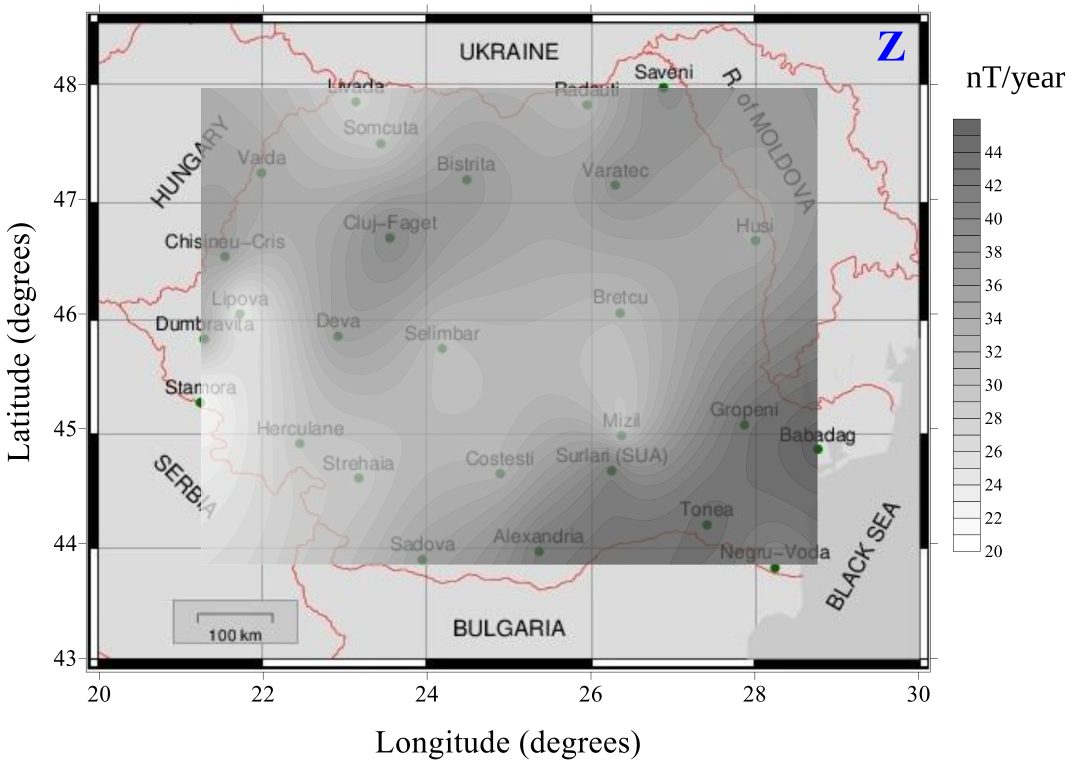

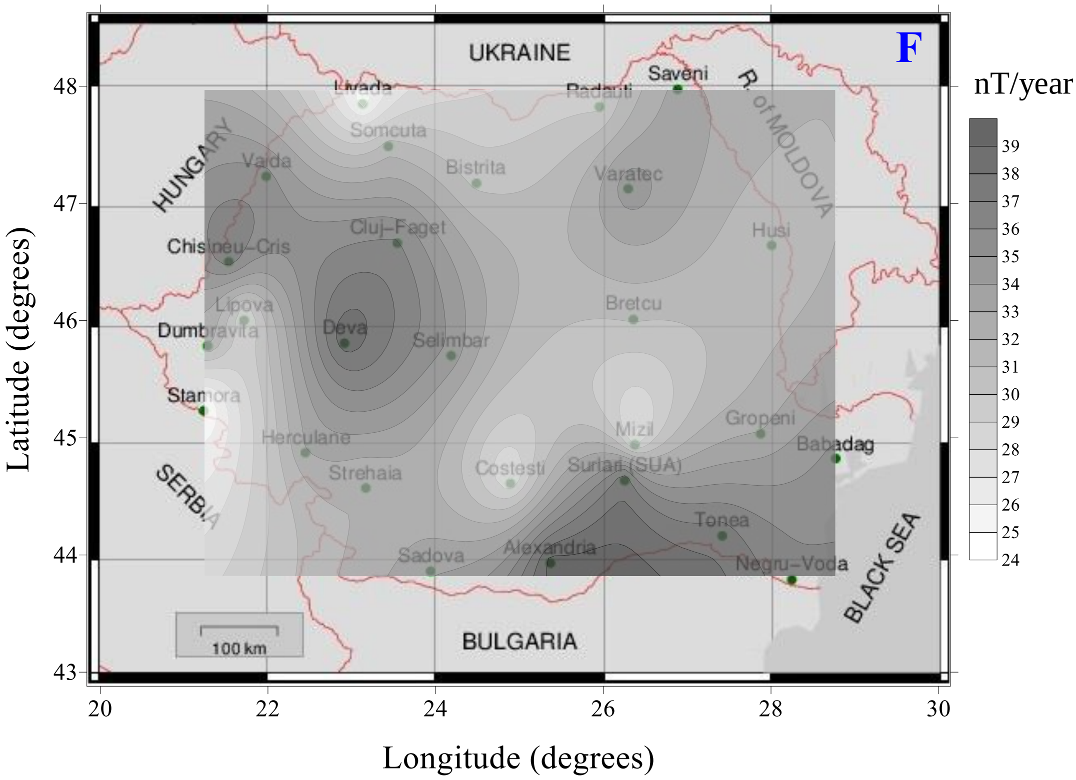

Fig. 7 – The geographical distribution of the average secular variation in the interval 2010.5 – 2014.5 of the geomagnetic field elements (H, D, Z and F).

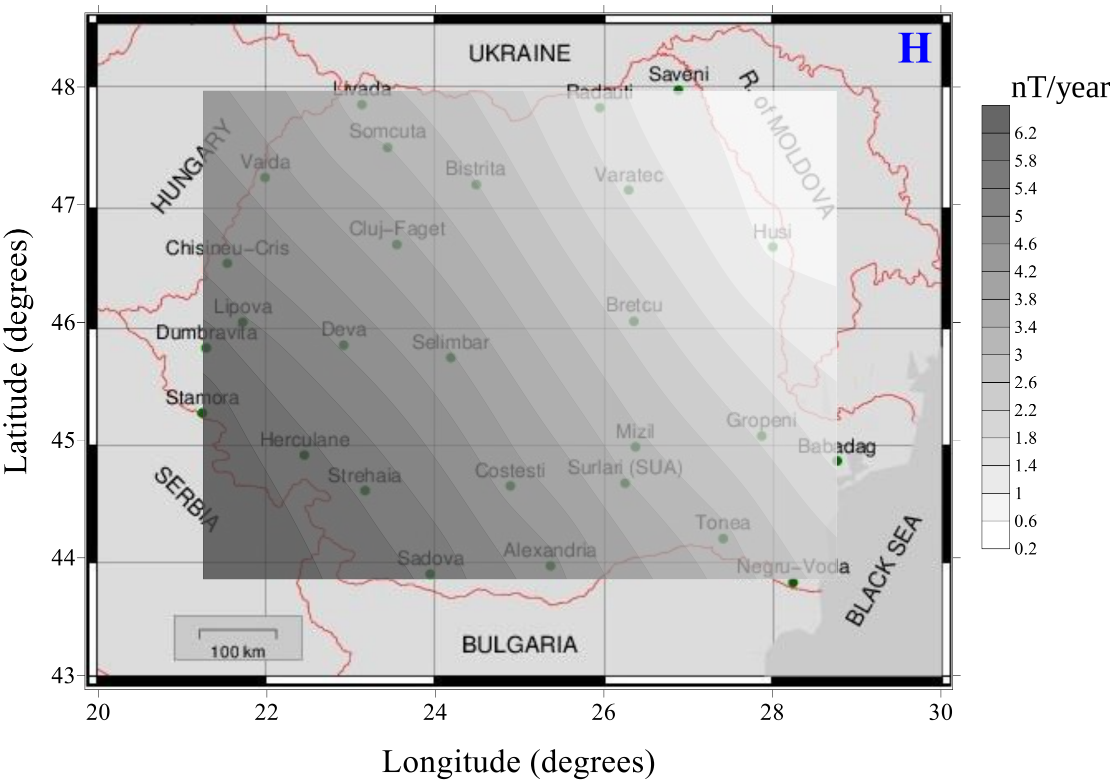

Fig. 8 – The geographic distribution of the average secular variation in the interval 2010.5 – 2014.5 of the geomagnetic horizontal component (H), based on the IGRF model.

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Received: November 12, 2015
Accepted for publication: December 14, 2015