

Temperature Influence over Magnetic Declination Measurements

Iliya CHOLAKOV and Bozhidar SREBROV

Geophysical Institute, Bulgarian Academy of Sciences
“Acad. G. Bonchev” str., block 3, 1113 Sofia, Bulgaria
e-mails: srebrov@geophys.bas.bg; geomagpag@abv.bg

A b s t r a c t

An investigation of temperature influence over magnetic declination measurements in geomagnetic observatory Panagyurishte is made. The examined period is from 1991 to 2005. A good correlation between the declination base values and the seasonal temperature variation is shown.

1. Introduction

The study of secular geomagnetic field variations is associated with the accumulation of long series of highly accurate, stable, and reliable observatory data. The data acquisition is going through two stages – registration, mainly digital and analog, and absolute measurements of the geomagnetic field elements. The application of modern measurement equipment enables to obtain observatory data of high precision of about 1 nT. Data stability for a long time period is an important requirement.

Data published by many authors (Rasmussen and Lauridsen 1990, Lauridsen 1991, Petiau 1996, Jankowski and Suckdorff 1996, Schulze 1998, Beblo 1998, Bitterly *et al.* 2001, Curto and Sanclement 2001) show that with existing high requirements for data precision, the following factors are important: temperature, humidity, variation difference between the points of registration and measurement, batter of the pillars, hydrological processes taking place under the variation and absolute houses.

Results of temperature influence on the absolute declination value are presented in the paper. A time period of 15 years (1991-2005) is taken. Since 1999 a seasonal temperature trend on the basic declination line is observed.

2. Observatory Activity

Measurements of the geomagnetic elements D, H, Z, and F have been carried out in Panagyurishte observatory (PAG) during the period 1991-2005 with two series of

Bobrov-type quartz variometers, with standard velocity of 20 mm/h and record sensibility of about 2 nT/mm. The variometers are installed in two rooms in the variometric house, and their walls are thermally insulated with air gaps (Fig. 1). This creates a good room's temperature stability. The annual room temperature change is about 4-5°C while the outside temperature varies in the range of 50°C. The absolute declination measurements are carried out in the absolute house on the pillar № 1 (Fig. 1). This pillar and the other five ones are concrete octahedrons of 2 m height and 25 cm face. Their stability is guaranteed by a common concrete basement of the dimensions: 4 m width, 6 m length, and 1.2 m thickness. Pillar №1 is basic for providing absolute measurements in the observatory. The normal magnetic theodolite "Matting und Wiesenberg – 164" is fixed on it. Besides declination measurements, the horizontal intensity by Gauss-Lamont methods is also measured. Two observers take measurements three times monthly, and the mean value is calculated. During the winter months the temperature in the absolute house is kept at about 19-20°C.

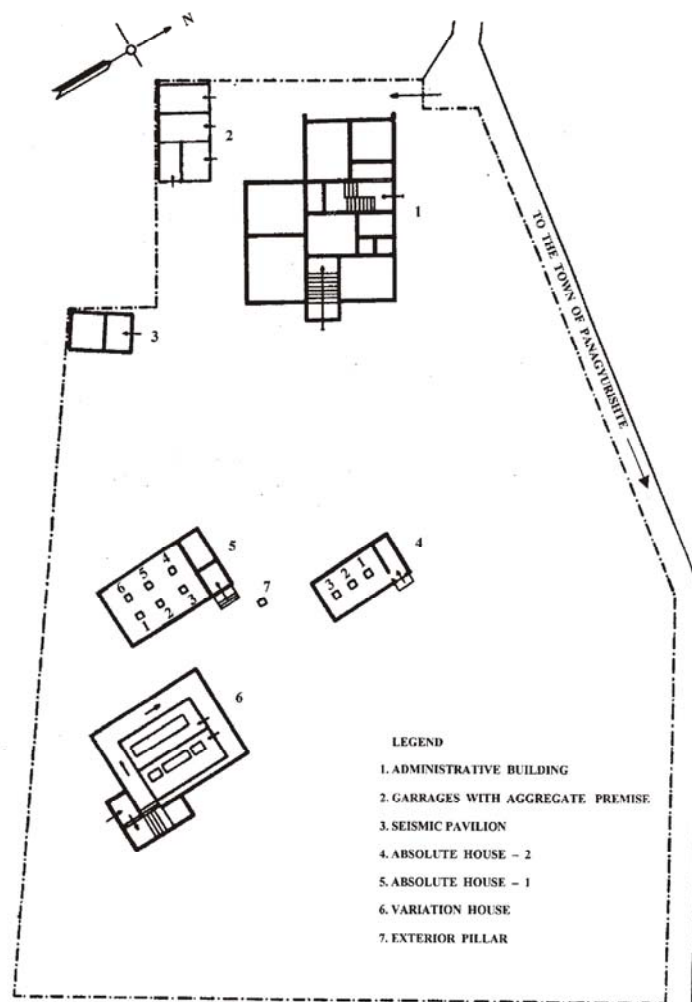


Fig. 1. Plan of Geomagnetic Observatory Panagyurishte.

3. Seasonal Trend Study of the Base Declination Line

In 1999 a significant part of the trees surrounding the absolute house were removed which influenced the solar radiation regime of the house. Till that year the base declination line stability has been very high (about 0.1 – 0.25 min. annually) which is in the range of measurement accuracy. For example, in 1992, temperature data in the absolute house varied by about 4-5 °C annually (from 19°C in the cold months up to 24°C in hot months, Fig. 2).

Since 1999 an increase in summer temperatures registered in absolute house has been observed and the temperature variation amplitude reached 7-8°C.

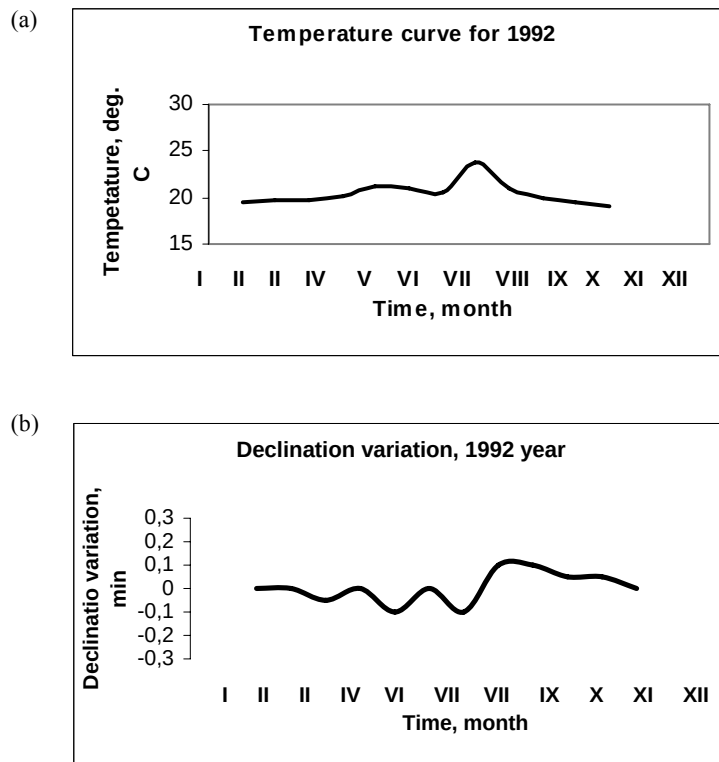


Fig. 2. Temperature and declination variations in the absolute house, 1992.

An annual trend of base declination values which correlates with the annual temperature trend has been established. Two temperature and declination graphs for 2003 are presented in Fig. 3. The seasonal base line declination and temperature trend for the whole 15 years period are shown in Fig. 4. The base line amplitude reaches up to 0.5 – 0.6 min. An analysis of possible reasons has been made. According to it, the most probable factors for the annual base declination line trend is the volumetric deformation of the pillar which serves as theodolite basement. This can be also seen in Fig. 4, where the base line declination maxima are slightly shifted from the temperature maxima. This is caused by the high thermal capacity of the pillar as its volume is very large.

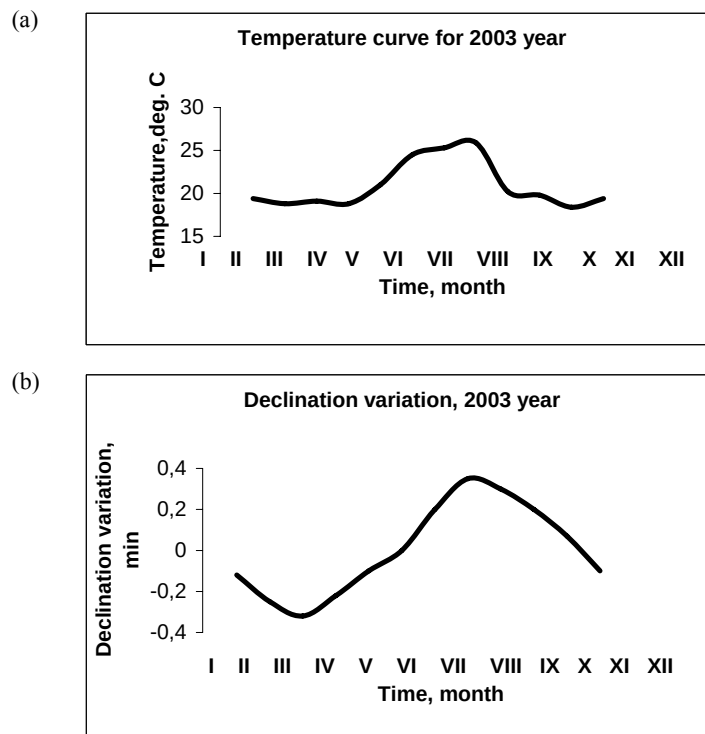


Fig. 3. Temperature and declination variations in the absolute house, 2003.

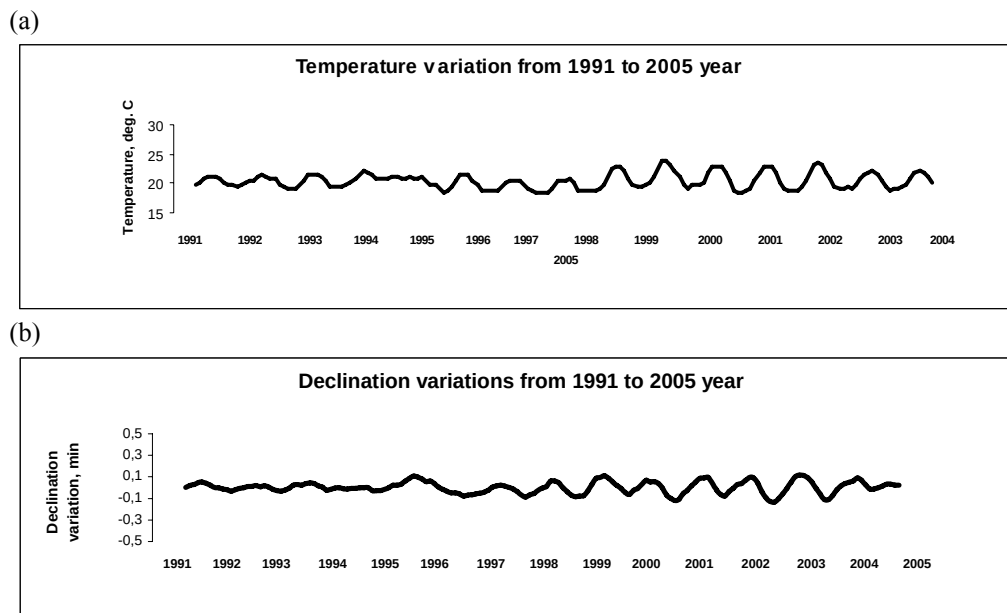


Fig. 4. Temperature and declination variations in the absolute house, 1991-2005.

References

- Bitterly, J., M. Bitterly and M. Manda, 2001, *Study of baseline values over long-time period at Chambon la Foret observatory*, Contrib. Geophysics and Geodesy **31**, 1, Geoph. Institute, Slovak Academy of Sciences.
- Beblo, M., 1998, *Some remarks on absolute measurements (in FUR)*. **In:** VII IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, Adolf Schmidt-Observatory for Geomagnetism Niemegk, September 8-15, 1996, 98/21.
- Curto, J.J., and E Sanclement, 2001, *Levelling Error corrections to D-Measurements in DI-flux magnetometers*, Contrib. Geophysics and Geology **31**, 1, 111-117, Geoph. Institute, Slovak Academy of Sciences.
- Jankowski, J., and C. Sucksdorff, 1996, *Guide for Magnetic Measurements and Observatory Practice*, International Association of Geomagnetism and Aeronomy, Warsaw, 235 pp.
- Lauridsen, E.K., 1991, *Review of Accuracy and Sources of error in Geomagnetic Measurements*, Münchner Geophysikalische Mitteilungen, München, Heft 5, 69-97.
- Petiau, G., 1996, *Temperature and tilt correction on Chambon la Forêt observatory magnetometers*. **In:** Proc. VI Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, J.L. Rasson (ed.), Publication scientifique et technique № 003, édité par l'Institut Royal Meteorologique de Belgique, 209-214.
- Rasmussen, O., and K. Lauridsen, 1990, *Improving baseline drift in fluxgate magnetometers caused by foundation movements, using band suspended fluxgate sensors*, Phys. Earth Planet. Int. **59**, 78-81.
- Schulz, G., 1998, *Long-term experience with digital variometer systems of different generations at Wingst observatory*. **In:** VII IAGA Workshop on Geomagnetic Observatory Instruments, Data Acquisition and Processing, Adolf Schmidt-Observatory for Geomagnetism Niemegk, September 8-15, 1996, str. 98/21.

Accepted February 7, 2007