CORRELATION BETWEEN SUNSPOT MAGNETIC FIELDS AND NEAR-GROUND TEMPERATURE

N. I. Lozitska

Astronomical Observatory, National Taras Shevchenko University of Kyiv
3 Observatorna Str., 04053 Kyiv, Ukraine
e-mail: nloz@observ.univ.kiev.ua

The data on measurements of sunspot magnetic fields B_{sp} and near-ground temperature T on the Earth from 1924 to 2004 are analysed. A reliable positive correlation between these parameters is found. The correlation is stronger at high geographical latitudes, for example, for latitudes of 65° N and 80° N the correlation coefficients r are 0.5 and 0.6, respectively ($p < 0.01$). It is significant that for the same time interval the correlation between the Wolf number W and T is weaker, $r = 0.2$, $p < 0.05$. These results indicate that global warming of the Earth's climate which has been observed since about 1965 can be connected with long-term changes of solar magnetism.

INTRODUCTION

Long-term changes of the near-ground temperature depend on many natural factors. One of them, not enough studied, is magnetic fields. There are empirical evidences for the statistical connection between near-ground temperature and geomagnetic fields. Wollin *et al.* [6] found the negative correlation between interannual variations of the temperature and geomagnetic field changes measured for the same regions on the Earth. Lozitska and Lozitsky [5] discovered a very strong negative correlation (up to correlation coefficient $r = -0.95$) between B_z component of the geomagnetic field and near-ground temperature measured in 5×15 degree squares along every geographical parallels from 30° N to 85° N, including both land and ocean places. So long as the solar and Earth's magnetism could have some physical connection, it is interesting to perform a comparative study of sunspot magnetic fields and near-ground temperature. This is the main purpose of the present work.

DATA OF MEASUREMENTS

The first parameter, the annual values of the sunspot magnetic fields from 1924 to 2004, was calculated in [4] using visual observations of the Zeeman splitting in the Fe I $\lambda\lambda$ 525.02 and 630.25 nm lines carried out at several astronomical observatories, including the Kyiv University Astronomical Observatory. The sunspots with a diameter of penumbra from 30 to 60 arcsec only were studied to exclude instrumental effects for small spots and irregularity of origin for larger spots. The magnetic field strengths B_{sp} averaged for each year were calculated on the basis of individual daily measurements. It was early pointed that such selected and calculated mean sunspot magnetic fields present a new actual heliomagnetic index [3]. About 20 000 individual measurements were averaged to obtain annual values of B_{sp}. Typical error bars for these annual values is ±(0.2–0.3) cT.

The second parameter, data on temperatures T for 1924–2004 averaged over months were taken from [2]. In addition, the data on annual latitudes and global anomalies of temperature indexes for land and ocean from the National Space Data Center [1] were used as well. The accuracy of both data is 0.01° C. In these publications, the temperature for north hemisphere reduced to the zero-level of the world ocean is presented.

RESULTS

Global temperature data, published in different sources and related to the time before the satellite epoch, have different trends. The best accuracy of such measurements was obtained for north hemisphere excluding equatorial zone. Therefore, for the period from 1924 to 2003, the correlation coefficients between B_{sp} and T are practically the same for different databases, $r = 0.30$–0.46 ($p < 0.01$). If we exclude the trends for both parameters, the correlation increases to 0.53–0.60. The close value, $r = 0.58$, was derived in case of the trend excluding from global temperature.

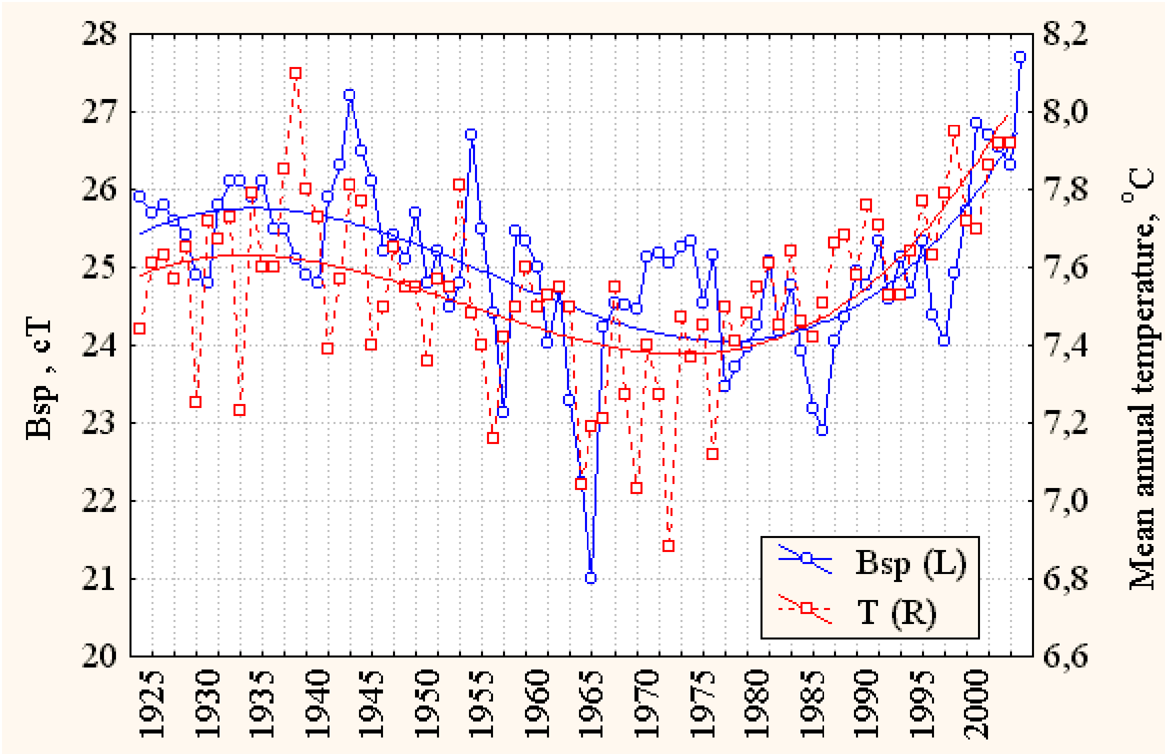

Figure 1. Comparison of the temporal variations for sunspot magnetic fields B_{sp} (solid lines) and near-ground temperatures T for latitudes of 30–85° N (dashed). Solid smooth lines present the long-term trends approximated by polynomials of the third degree. The correlation coefficient in this case is 0.46 (p $<$ 0.01)

Obtained results are partly illustrated in Fig. 1. One can see that changes of near-ground temperature and sunspot magnetic fields are very similar. As to correlation coefficient r, it depends on geographical latitudes, namely, the correlation is stronger at high geographical latitudes. For example, for latitudes of 65° N and 80° N the correlation coefficients r are 0.50 and 0.60, respectively (probability of zero-hypothesis, p, is less than 0.01 in both cases).

It is interesting to note that for the same time interval the correlation between the Wolf number W and T is weaker, $r = 0.1 - 0.2$ for different latitudes.

This means that global warming of the Earth's climate which has been observed since about 1965 can be connected with long-term changes of solar magnetism.

[1] Global meteorological data.–[http://www.giss.nasa.gov/data/update/gistemp/].

[2] *Gruza G. V., Ran'kova E. Ya.* Data on structure and changeability of climate. Temperature of air on see level. North hemisphere.–Obninsk: Goskom USSR of hidrometeorology and monitoring of the environment, 1979.–203 p.

[3] *Lozitska N. I.* Comparison of the new indexes of solar activity // Izv. Krim. Astrofiz. Obs.–2002.–**98**.–P. 187–188.

[4] *Lozitska N. I.* Annual variations of the sunspot magnetic fields during last 80 years // Astronomy in Ukraine – Past, Present and Future: Abstr. Book., Kyiv, Ukraine, July 15–17, 2004.–Kyiv, 2004.–P. 84.

[5] *Lozitska N. I., Lozitsky V. V.* The influence of cosmic rays on temperature in low Earth's atmosphere // Kinematics and Physics of Celestial Bodies. Suppl. Ser.–2000, N 3.–P. 508–509.

[6] *Wollin G., Ryan V. F., Ericson D. B.* Relationship between Annual Variations in the rate of Change of magnetic Intensity and those of surface air temperature // J. Geomagn. and Geoelec.–1981.–**33**.–P. 545–567.