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Technical note: Joint database of sunspot magnetic fields

E. V. Miletsky, Ya. A. Nagovitsyn, and V. G. Ivanov

Main Astronomical Observatory, St. Petersburg, Russia

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[1] Preliminary results of the creation of the Pulkovo electron database of sunspot magnetic fields are presented. The database includes observations at seven observatories in the scope of the National Program of Solar Service for 40 years. In different periods of time, Crimea Astrophysical Observatory, Main Astronomical Observatory, Siberian Institute of the Terrestrial Magnetism and Radio wave Propagation (Irkutsk), Institute of Terrestrial Magnetism and Radio wave Propagation (Troitsk, Moscow Region), Shamakha Astrophysical Observatory, Observatory of the Ural State University, and Ussuriisk Astronomical Station participated in these observations; however, only two first observatories from this list conducted continuous observations in 1957–1997. A series of a new activity index, annual mean values of the magnitudes of sunspot magnetic fields in the Pulkovo system, is presented. *INDEX TERMS:* 7524 Solar Physics, Astrophysics, and Astronomy: Magnetic fields; 7594 Solar Physics, Astrophysics, and Astronomy: Instruments and techniques; 7536 Solar Physics, Astrophysics, and Astronomy: Solar activity cycle; *KEYWORDS:* Sunspots; magnetic fields; Pulkovo database.

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1. Introduction

[2] It is known that the processes of formation and evolution of many solar phenomena occur with participation of magnetic fields of sunspots. The usage of the data of durable observations of these fields is of a great importance while solving many important problems of solar physics. A many-year material of daily observations of sunspot magnetic fields is accumulated in some observatories.

[3] During three previous years we succeeded in creation of the Joint Database of Sunspot Magnetic Fields. It is based on the data of magnetic field observations during a long period of time in some observatories participated in the program Solar Service in the USSR. They are Crimea Astrophysical Observatory (CrAO), Main Astronomical Observatory (MAO), Siberian Institute of the Terrestrial Magnetism and Radio wave Propagation (Irkutsk) (IMIS), Institute of Terrestrial Magnetism and Radio wave Propagation (Troitsk, Moscow Region) (IZMIRAN), Shamakha Astrophysical Observatory (ShAO), Observatory of the Ural State University UrAO), and Ussuriisk Astronomical Observatory (UsAO) Currently. the longest period of time (1957–1997) is covered by the data obtained in Pulkovo observatory.

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2. Description of the Database

[4] The basis of the database contain the values of the maximum field strength and polarity of sunspot magnetic fields determined using the Zeeman splitting of some lines of the solar spectrum. Depending on the type of the information contained, the data in the database are located in structural sections. The information in each section is presented separately for each observatory. In the Statistics in Groups section the measurements of the magnetic field in separate sunspots are archived. Files of a standard text format (ASCII) are stored in this section. Each such file contains the data for one year. The Daily Statistics section contains files containing for every observational day total values of the magnetic field of the particular sign and number of sunspots used to calculate these values. The third section contains as files of the GIF format scanned images of the sun for a particular day. These images are drawings or photographs of sunspots together with the values of the magnetic field strength measured in these sunspots.

[5] A possibility is foreseen to approach the database information by two ways. One way provides a permanent survey of the data using a HTML interface. The other way realized in the form of CGI script provides an approach to the interactive search mechanism. This mechanism makes it possible using various criteria given by a customer to sam-

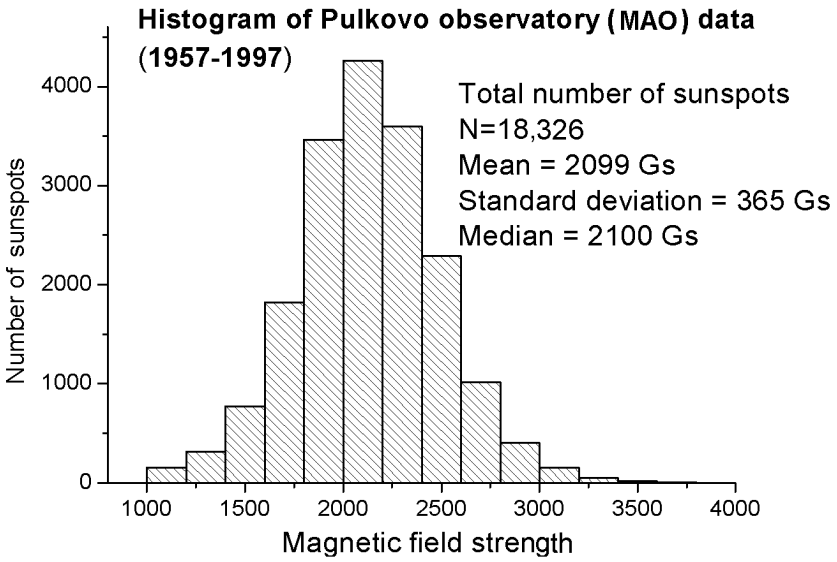

Figure 1. Histogram of statistical distribution for MAO data.

ple the data on sunspot magnetic fields. In particular, one is able to chose and/or give the options required: the name of the observatory, the dates of the beginning and end of the sampling, and also the magnetic field range of interest with indication of its polarity. Moreover, information may be obtained for particular sunspots as a summed daily, monthly mean, or annual mean values. Thus some abilities are realized usually typical only for relation databases. This fact increases considerable the efficiency of obtaining and further use of the information contained in the database [*Vyalyshin et al.*, 1990].

[6] A comparative analysis of the data of various observatories was performed. To do that using the magnetic field strength corresponding statistical characteristics (mean values, standard deviations, medians, and percentiles) were calculated separately for each observatory. The obtained results are presented in Table 1. The total number of sunspots is the total with measured values of the field strength. The remaining values are the mean values of the corresponding statistical characteristics. The comparison of the characteristics calculated for each observatory point to their insignificant differences. These values agree well with the *Miletsky and Nagovitsyn* [2000] results calculated on the basis of the MAO data as well as to the approximate evaluations of *Obridko* [1985].

[7] Frequency distributions according to the data of each observatory also were drawn. For the sake of example, Figure 1 shows a histogram of such distribution for MAO. Numerical check of the obtained distributions to their correspondence to the normal hypothesis points to their small but

Table 1. Comparative Analysis of the Data of Various Observatories

	Observatory							Total/ Mean
	MAO	CrAO	IMIS	IZMIRAN	ShAO	UrAO	UsAO	
Observation interval, years	1957–1997	1957–1995	1964–1971	1957–1966	1966–1976	1967–1995	1966–1989	
Number of sunspots	18,326	80,098	5252	2742	2602	13,560	12,059	134,639[a]
25% percentile, Gs	1900	1600	1300	1800	1600	1600	1900	1671[b]
75% percentile, Gs	2320	2200	2100	2400	2400	2200	2500	2302[b]
Mean, Gs	2099	1922	1773	2066	2012	1940	2200	2002[b]
SD, Gs	365	455	534	485	532	487	390	464[b]
Median, Gs	2100	1900	1700	2100	2000	1900	2200	1986[b]

[a] Total

[b] Mean

significant (99% significance level) deviation from the normal law. Partly that may be explained by the presence of a lower threshold of 1000 Gs for each sunspot. This threshold is evidently close to the minimum value at which sunspots are still able to be formed. Concluding one may state that the information contained in the Joint Base of Sunspot Magnetic Fields brings a great potential for further studies in the field of solar physics and solar-terrestrial relations.

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V. G. Ivanov, E. V. Miletsky, and Ya. A. Nagovitsyn, Main Astronomical Observatory, St. Petersburg, Russia.