UNDERSTANDING THE GEOMAGNETIC FIELD: A PRECONDITION FOR BETTER LIVING

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Abstract. This paper examines the influence of the geomagnetic field on the living world and in particular, its effects on health. The paper also presents the causes of magnetic storms analyses of their impacts and calculation, and interpretation of the K-index

Keywords: Magnetic field; magnetogram; magnetic storms; K-index

1. Introduction

Certain reactions with the living world occur due to changes in the magnetic field. During the 1990's, because of the computerization of measuring instruments, access to satellite data, and the development of specially applied software, studies of the magnetic field have intensified.

2. Magnetic storms

Investigations of magnetic storms date from the early history of mankind. The earliest expeditions, organized to investigate and observe the geomagnetic field in sub-polar and polar zones, started in the 1920's.. At that time, magnetic storms were described as masterpieces of unknown forces hidden in space and were named after well-known women.

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Depending on how "beautiful" the magnetic storm was, scientists named the storms St Helena, Queen Elizabeth, St Mary, etc.

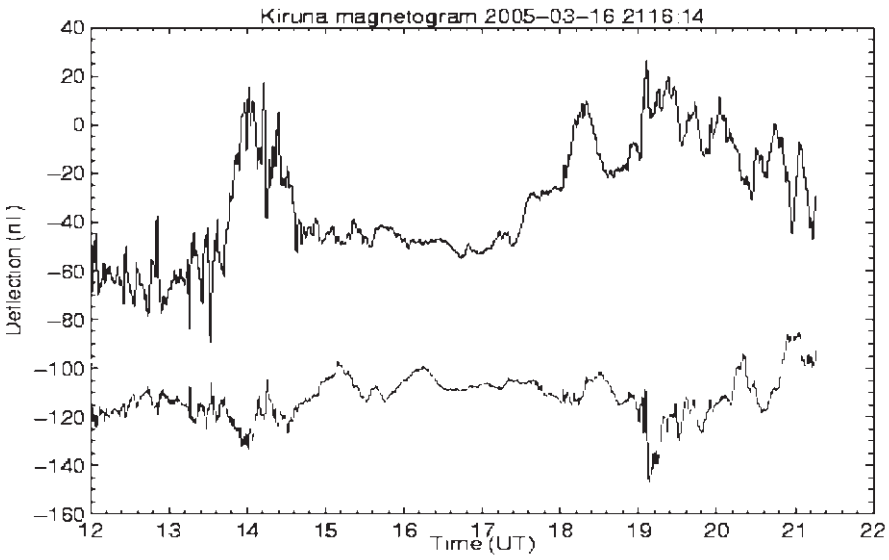

Figure 184. Magnetogram in real time.

During the 1958 International Geophysical Year, instruments in observatories across the world recorded magnetic field variations and pulsations of 0.2 to 30 minute. The study of the daily variation of the Earth's geomagnetic field indicated that the variations were the result of changes in the solar magnetic field, the magnetic fields of sunspots, and changes in the speed and density of solar wind.

Now, with satellite-borne instruments it is possible to carry out sizeable surveys of solar changes and observe the activity and its influence on the earth.

Magnetic storms are related to regular solar explosions. Explosions release strong plasma flow, elementary particles, and electromagnetic radiation. Electromagnetic radiation reaches the earth in 8 minutes, cosmic radiation in several hours, and solar wind in 24 hours. Short wave and cosmic radiation disappear in the atmosphere, but plasma flow is blocked by the Earth's magnetic field. Thus, the Earth's magnetic shield receives the shock, a process that results in disturbance of the Earth's magnetic field or its oscillation (Figure 184 - Figure 186).

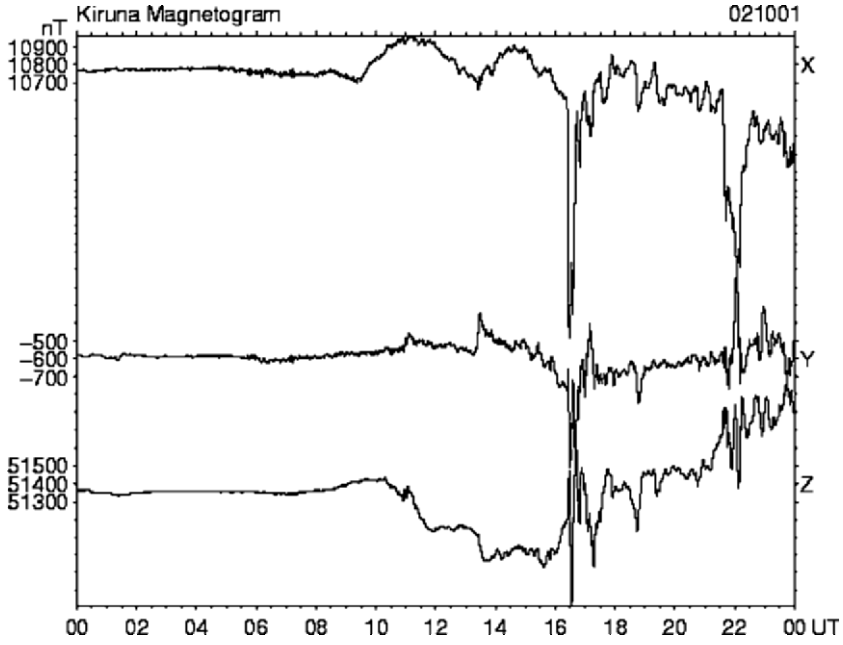

Figure 185. Magnetic storm recorded on October 2, 2001.

A magnetic storm can be mathematically defined as follows: If, over the time interval observed [t_0 , tn], which is divided into equal time intervals [t_i, t_{i+1}] = Δt = 3 hours, a change of the magnetic field value occurs Δm_i = [m_i, m_{i+1}], (where m_i and Δm are in [nT]) which is higher than some value given in advance Δm (Table 39), at that moment a magnetic storm occurs.

The K-index, introduced by Bartels in 1949, denotes irregular changes of the geomagnetic field over a three-hour time interval. It is calculated as the average value of deviation from normal for the two horizontal components of magnetic field observed by base stations all over the world. K-index values are scaled from 0 to 9. The magnitude of change that defines the maximum value of the K-index varies for each base station (Table 39).

Magnetic storms and solar activity, also called heliophysical fields, of 10,000 nT to 50,000 nT size have not been studied sufficiently. It is well known that during the occurrence of such activity, a large number of accidents take place, there is an increase in job absences, and higher rates of human mortality are reported.

Magnetic fields may have positive or negative effects on living organisms depending on their intensity, frequency, orientation, exposure time, and their origins.

Negative effects include disturbances of the central nervous system, cardiovascular system, and immunological system.

The magnetic field has a positive effect when used in magnetotherapy (used in treatment of the nervous system, etc).

Most of the processes in the human body are based on electromagnetic activity, changes in the speed of chemical reactions, and the speed of nerve impulses. A major question is why weak magnetic fields cause the strongest effects on humans when they are surrounded by strong magnetic fields such as the Earth's magnetic field or artificial electromagnets.

Table 39. The 13 geomagnetic observatories and appropriate values of changes in maximum K-index (K = 9).

Observatory					Geographic		Geomagnetic		
#	Code	Name	Location	Active	Lat.	Long.	Lat.*	Long.*	K = 9
1	LER	Lerwick	Scotland	1932-present	60°08'	358°49'	62.0°	89.2°	1000 nT
2	MEA	Meanook	Canada	1932-present	54°37'	246°40'	61.7°	305.7°	1500 nT
3	SIT	Sitka	Alaska (USA)	1932-present	57°03'	224°40'	60.4°	279.8°	1000 nT
4	ESK	Eskdalemuir	Scotland	1932-present	55°19'	356°48'	57.9°	83.9°	750 nT
5	LOV	Lovö	Sweden	1954-2004	59°21'	17°50'	57.9°	106.5°	600 nT
	UPS	Uppsala	Sweden	2004-present	59°54'	17°21'	58.5°	106.4°	600 nT
6	AGN	Agincourt	Canada	1932-1969	43°47'	280°44'	54.1°	350.5°	600 nT
6	OTT	Ottawa	Canada	1969-present	45°24'	284°27'	55.8°	355.0°	750 nT
7	RSV	Rude Skov	Denmark	1932-1984	55°51'	12°27'	55.5°	99.4°	600 nT
	BFE	Brorfelde	Denmark	1984-present	55°37'	11°40'	55.4°	98.6°	600 nT
8	ABN	Abinger	England	1932-1957	51°11'	359°37'	53.4°	84.5°	500 nT
	HAD	Hartland	England	1957-present	50°58'	355°31'	54.0°	80.2°	500 nT
9	WNG	Wingst	Germany	1938-present	53°45'	9°04'	54.1°	95.1°	500 nT
10	WIT	Witteveen	Netherland	1932-1988	52°49'	6°40'	53.7°	92.3°	500 nT

Observatory					Geographic		Geomagnetic		
#	Code	Name	Location	Active	Lat.	Long.	Lat.*	Long.*	K = 9
	NGK	Niemegk	Germany	1988-present	52°04'	12°41'	51.9°	97.7°	500 nT
11	CLH	Cheltenham	USA	1932-1957	38°42'	283°12'	49.1°	353.8°	500 nT
	FRD	Fredericksburg	USA	1957-present	38°12'	282°38'	48.6°	353.1°	500 nT
12	TOO	Toolangi	Australia	1972-1981	-37°32'	145°28'	-45.6°	223.0°	500 nT
	CNB	Canberra	Australia	1981-present	-35°18'	149°00'	-42.9°	226.8°	450 nT
13	AML	Amberley	New Zealand	1932-1978	-43°09'	172°43'	-46.9°	254.1°	500 nT
	EYR	Eyrewell	New Zealand	1978-present	-43°25'	172°21'	-47.2°	253.8°	500 nT

*) After IGRF model 'IGRF 2000', Earth Planets Space, Vol. 52 (No. 12)

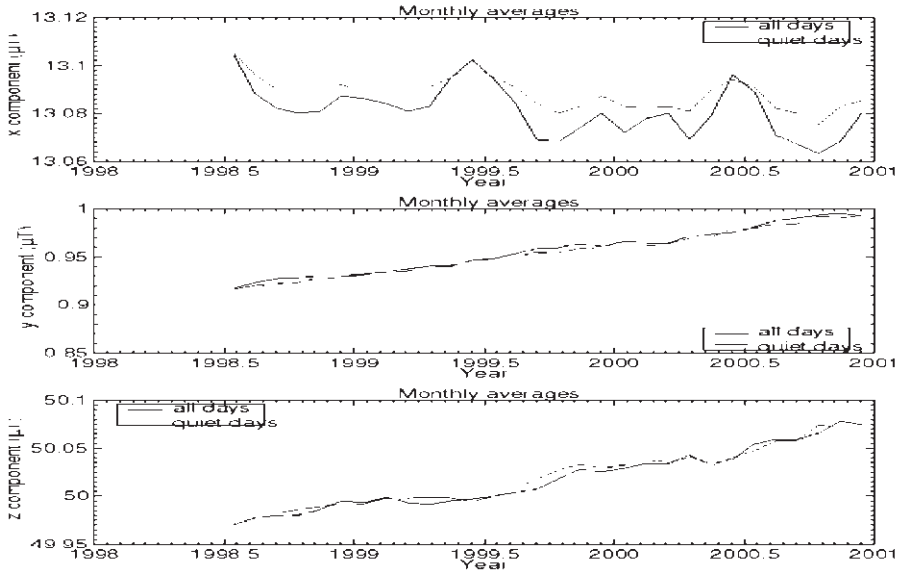

Figure 186. Magnetogram components from 1988 to 2001.

Table 40. Coordinates of Grocka, Serbia Geomagnetic Observatory.

Observatory					Geographic		Geomagnetic	
#	Code	Name	Location	Active	Lat.	Long.	Lat.*	Long.*
	GCK	Grocka	Serbia	1957- present	44°36' N	20°46' E	43.4°	102.3°

Table 41. K-index scale for the Grocka Geomagnetic Observatory.

K-index	0	1	2	3	4	5	6	7	8	9
Amplitude [nT]	0	3	7	15	27	48	80	140	230	350

According to some, a human's electromagnetic field is most active in the area of low frequencies from 0.01-100Hz. Brain activity is carried out at ultra low frequencies. Brain waves and magnetic storm waves can interfere with one another.

Russian scientists say men perceive magnetic storms only as information. The threshold of susceptibility of the human organism depends on its reaction. Some people have low thresholds and they perceive changes of the geomagnetic field that others do not feel.

Disturbed blood pressure in the cerebral system can have a negative impact on human health.

Human beings are sensitive to the Earth's magnetic field and its variations. But, with time and an enormous increase of iron they become less sensitive.

Oscillations of the geomagnetic field can be interpreted as a signal for coming danger, earthquake, tsunami, etc. The recent tsunami events in the Indian Ocean confirm this. It has been proven that a change in the Earth's magnetic field took place. On some islands inhabited by indigenous people, who avoided contact with civilization, there were no casualties; although those islands were the first to be affected by the tsunami waves. The people and the animals felt the field changes and moved to the hills in advance of the waves.

Laboratory tests have shown negative effects of rapid changes of the magnetic field. These rapid changes are the so-called pulsations and micropulsations in frequencies from 0.1 Hz to 10 Hz.

Periodic changes of the polarity of the magnetic field (a short time period geologically) have influenced the genetic system in terms of mutation and hereditary changes.

In is generally known that migrant birds navigate by the Earth's magnetic field. It is also known that pigeons maintain their direction of flight to within 0.3 degrees. Birds register changes in the magnitude of the magnetic field on the order of 1 nT and bees about 5 nT. Their nerve endings contain microscopic grains of magnetite (Fe_3O_4). During magnetic storms their mechanism for orientation is distorted, so that they behave in an unusual manner.

3. Conclusion

Measurements carried out in the Republic of Macedonia as part of the project to establish a geomagnetic observatory are not sufficient for the complex investigation on the effects of the geomagnetic field on the health of people and animals.

Permanent observation of the Earth's magnetic field would provide predictions of biological behavior which, if broadcast on the radio or other media, would be useful for the population of the Republic of Macedonia.

There is a need to finalize the project so that geomagnetic field data from Macedonia can be used, not only in a conventional manner, but be used to relate biology, medicine, ecology, and other disciplines.

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