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INFLUENCE OF VARIATIONS OF THE EARTH'S ORBIT AND SOLAR LUMINOSITY ON THE SEA LEVEL CHANGES – BULGARIAN CONTRIBUTION TO SEA & SPACE EVENT OF EXPO-98

Y.Y.SHOPOV, D. A. STOYKOVA, D.FORD*,
L.N.GEORGIEV, L.TSANKOV. D. GEORGIEVA
Faculty of Physics, University of Sofia, James Bouchier 5,
Sofia 1164, Bulgaria
**Geography Dept., McMaster Univ., Hamilton, Ontario, L8S 1K4, Canada*
E-Mail:YYShopov@Phys.Uni-Sofia.BG

Abstract. This paper is an overview of the Bulgarian participation in Sea & Space event of the European Commission, which is a part of the 1998 European Week for Scientific and Technological Culture. We emphasise on the original research presented in our newsletter, which was awarded with the first prize in Bulgarian Sea & Space contest.

Calcite speleothems luminescence depends exponentially upon the soil temperatures which are determined primarily by the solar visible and infrared radiation. So the microzonality of the luminescence of speleothems is used as an indirect Solar Insolation (SI) proxy index. We measured a luminescent SI proxy record in a speleothem. The record has been dated by 6 TIMS U/Th . It reveals determination of millennial and century cycles in the record. This record exhibits a very rapid increasing in SI at 139 kyrs +/- 5.5 responsible for the termination II (the end of the last glaciation). This increasing is preceding the one suggested by the orbital (Milankovitch) theory with about 10 kyrs and is due to the most powerful cycle of the solar luminosity with duration of 11,5 kyrs superposed on the orbital variations curve. The Devils Hole 18- O record suggests that the termination II happened at 140 +/- 3 kyrs. It follows precisely the shape of our experimental SI record. So the Devils Hole record approves the orbital theory, but suggests, that the solar luminosity contribution to the SI curves is severely underestimated. We demonstrate that the solar luminosity variations contribute to the Earth's heating almost as much as the variations of the Earth's orbit (Milankovitch cycles). Their most powerful cycle (with duration of 11 500 yrs) is responsible for the shifting of the timing of the last deglaciation. They are responsible for almost half of the variations in high resolution SI experimental records. So this millennial solar luminosity cycle can produce climatic variations with intensity comparable to these of the orbital variations. Solar luminosity and orbital variations both cause variations of the SI affecting the climate by the same mechanism.

1. Introduction

Sea & Space is an international contest of the European Commission which is a part of the 1998 European Week for Scientific and Technological Culture.

It has been set up jointly by the European Space Agency (ESA), the European Southern Observatory (ESO) and the European Association for Astronomical Education (EAAE). Sea & Space has strongly educational direction and is pointed mainly towards middle and high school students. Its subject are connections between Sea and Space in various natural ways and different levels.

11 registered groups participated in Sea & Space event in Bulgaria with total 39 student participants. Student astronomy club Urania at Sofia University participated with 4 high school and University students. Varna Astronomical Observatory and Planetarium took part with 9 groups, including children with different ages and interests. Bourgas Secondary School was presented by 4 students of "Bourgas" group.

Besides these groups there were also several active participants from Silistra and Smolyan city High Schools.

National Steering Committee decided to award the following individual participants:

1. First prize - Diana Stoykova, Student Astronomical Club Urania, at Sofia University, under the supervision of Dr. Yavor Shopov, for the paper "Influence of the Space Factors on the Sea" in the newsletter "Sea & Space- Bulgarian Overview".

2. Second prize - Svetlin Tassev, Group "Deep Space Voyagers" at the Public Astronomical Observatory - Varna, under the supervision of Veselka Radeva.

3. Third prize - Stanislava Stancheva, Group "Bourgas" under the supervision of Ognjana Stancheva.

The participation of our team in this event includes an original scientific research, which was done during the same year, concerning the influence of space factors on the sea level. The general aim of this study is to find possible influences of space forces on the glacial and interglacial periods of the Earth's climate. They produce dramatic changes in the sea level.

The newsletter "Sea & Space- Bulgarian Overview" contains several topics: the first is titled "Influence of Space Factors on the Sea". It contains mostly original research (Shopov et al.,1998, Stoykova et al., 1998) aimed to find possible space influences on the glaciations. The 2nd chapter "The Bible Flood - a Possible Result of Cosmic Catastrophe" contains an original explanation of the Bible flood as a result of falling of a giant asteroid over the Sun (Shopov et al.,1996b). The 3rd - "Water in the Space", and the last chapter "A Closer Look to the Space" contains an explanation of comets as celestial bodies and exhibits original photos of the comet Hale - Bopp and the deep sky.

2. Influence of Space Factors on the Sea

Long ago Croll (1864) and Milankovitch (1920) demonstrated that variations of the Earth's orbit cause significant variations of the amount of solar radiation received by the Earth's surface (Solar Insolation - SI). Since 1930 scientists have started to believe, that the glacial periods (ice ages) are result of such variations. There are 3 components of the orbital variations (Fig. 1) causing variations of SI:

1. Variations of the tilt (obliquity) or the Earth's axis regarding to the vertical to the plane of the ecliptic (plane of the Earth's orbit). It varies about 1.5° on either sides of its average angle of 23.5° with period about 41 000 years.

2. Precession - owing to the gravitational pull of the Sun and the Moon on the equatorial bulge of the Earth, its axis of rotation move slowly around a

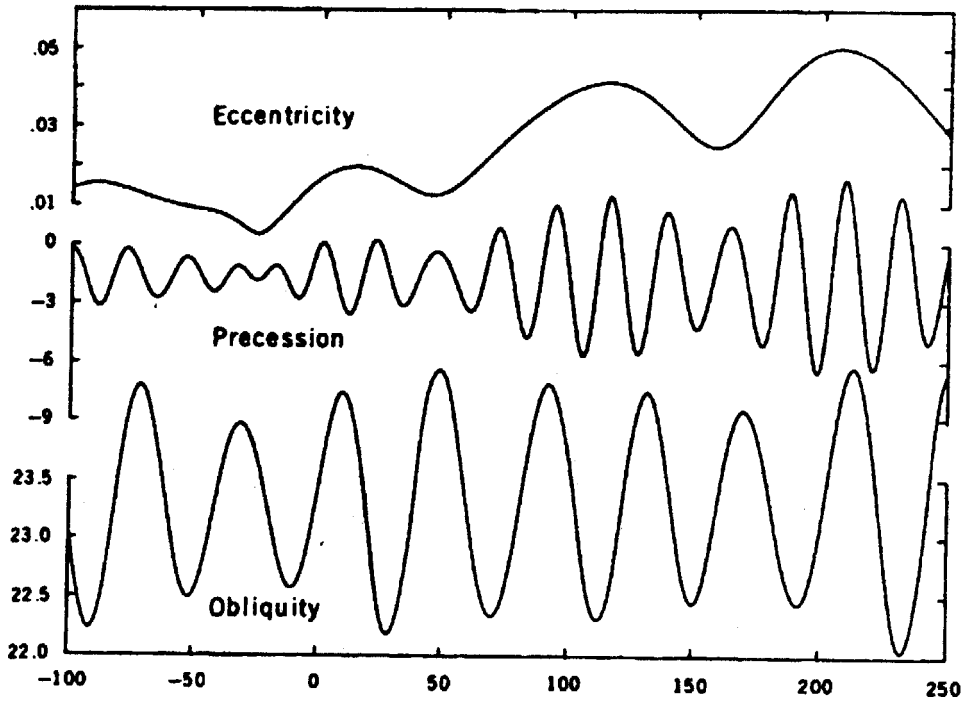

Fig.1. *Future (negative age) and past variations of the eccentricity, precession and tilt as function of time (K= 1000) according to calculations by Berger (1978).*

circular path and complete one turn every 23 000 years. It causes also precession of the equinoxes and solstices with the same period. Precessional motion is similar to rotation of the axis of a top.

3. Eccentricity is the ratio between the distance from the centre of the orbit to one of its focal points versus the semimajor axis of the Earth's orbit. It varies

with a number of the periods around 100 000 years. They cause small variations of the total Solar energy received by Earth.

Recent measurements (Winograd et al., 1988, 1992) of a cave deposit from Devils Hole (USA), which is the best dated paleoclimatic record, demonstrated that the end of the former period came 10 000 years before the one suggested by the orbital theory. This fact disapproves the theory because it demonstrates that the result appears far before the reason.

Orbital variations of the SI have been calculated theoretically by Berger (1978, 1992). His theoretical curves explain about half of the signal in the existing proxy paleotemperature records (Imbrie et al., 1992, 1993) derived from sea cores and polar ice. But the precise correlation demonstrates, that a significant part of it is not due to the orbital variations (Imbrie et al., 1992, 1993). The unexplained variation may be due to long-period self-variations of the solar emission (Solar Luminosity- SL).

The orbital theory has 2 presumptions:

1. That the SL is constant during the geological periods of time.

2. That Earth behaves as an absolute solid body independently of the orbital variations.

The recent studies demonstrated that both these presumptions are wrong. The direct satellite measurements of the solar constant demonstrated, that it varies with time as much as 0.4 % during the observation time span (Hickey et al., 1980), but it may vary much greater during the geological periods. Increasing of the ice volume and related sea level change during glaciations produce changes in the inertial moment of Earth and resulting changes of the speed of the Earth's rotation (Tenchov et al., 1993). These changes must affect in some degree the amplitude and maybe even the frequency of the orbital variations. The orbital variations cause also some deformation of solid Earth and redistribution of the ocean masses (Moerner, 1976, 1983). As a result the theoretical curves can be used only for qualitative reference. For quantitative correlation is necessary to use experimental records of the SI, because they contain also variations of the SL and number of others not covered by the orbital theory.

Till recently there were no quantitative proxy records able to demonstrate how big were the variations of the SL in geological time scale. In the last years Shopov et al. (1993, 1996a) measured the first such records covering a sufficiently long period in order to contain orbital variations.

The SL variations were estimated for the last 300 years from the observed sunspot numbers by Hoyt et al. (1993). A record of luminescence of a flowstone from the Duhlata cave (Bulgaria) has been used (Hoyt & Shopov, personal communication) to obtain a record of variations of Solar Irradiance ("Solar constant") in W/m2 for the last 10 000 years by calibration of the luminescence record with satellite measurements.

The calcite speleothems (stalagmites, etc.) usually display luminescence which is produced by calcium salts of humic and fulvic acids derived from soils above the cave (White & Brennan, 1989, Shopov, 1989). These acids are released by the decomposition of humic matter. The rates of decomposition depend

exponentially upon the soil surface temperatures that are determined primarily by the solar infrared radiation (Shopov et al., 1994). So the microzonality of luminescence of the speleothems can be used as an indirect Solar Activity (SA) index (Shopov et al., 1990). From a speleothem from the Cold Water cave, (Iowa USA) we obtained a high correlation coefficient of 0.9 between the luminescence record and SL Sunspot index measured since 1700 AD, and reconstructed sunspot numbers since 1000 AD with precision in the frames of experimental error of their measurements (Shopov et al., 1996a). The intensity of luminescence was independent on actual precipitation (zero correlation).

Time series of a SA index "Microzonality of Luminescence of Speleothems" are obtained by the Laser Luminescence Microzonal analysis (LLMZA) of cave flowstones described by Shopov (1987). The LLMZA allows measurement of luminescence time series with duration of hundreds of thousands years, but time step for short time series can be as small as 6 hours (Shopov et al., 1994) allowing resolution of 3 days (Shopov et al., 1988).

Striking correlation (with a correlation coefficient of 0.8) is demonstrated between the calibration residue delta 14-C record and a LLMZA speleothem record (Shopov et al.,1994). The Cosmic Rays Flux (CRF) and inverted sunspot numbers demonstrate the same correlation coefficient of 0.8 (Beer, 1991). The 14-C record represents the CRF and its modulation by the solar wind.

We measured a luminescent SI proxy record in a speleothem (JC11) from Jewel Cave (South Dakota USA) (Shopov et al.,1998, Stoykova et al., 1998). This record covers 89 300- 138 600 yrs B.P. with high resolution (34 years) and precision of measurements better than 1%. It reveals determination of millennial and century cycles in the record. This TIMS U/Th dated record exhibits a very rapid increasing in SI at 139 kyrs +/- 5.5 kyrs (2 sigma error) responsible for the termination II. This increasing is preceding the one suggested by the orbital theory with about 10 kyrs and is due to the most powerful cycle of the SL with duration of 11,5 kyrs superposed on the orbital variations curve. The Devils Hole 18- O record suggests that termination II happened at 140 +/- 3 kyrs. It follows precisely the shape of our experimental SI record. So the Devils Hole record approves the orbital theory. This result is confirmed by another U/Th dated luminescent SI proxy record in a speleothem from a Bulgarian cave 10 000 km far form the JC11 site.

Imbrie et al. (1985) demonstrated that orbital variations cause major changes of the global sea level, because of the melting of polar ice caps by the solar radiation. They even expressed units of orbital variations in resulting sea level changes in meters regarding the modern sea level. According to Fairbanks (1989) during the last glacial maximum (18 000 years ago) global sea level was 120 meters below the modern one. The reason for this is that water and ice adsorb strongly the infrared solar radiation, resulting in melting of the ice. Lower SI during glaciations allows higher ratio between ice precipitation and melting, resulting in increasing of ice accumulation and preservation, and also in advance of the ice shields in direction to the equator. The melting of this ice during interglacials cause rising of the sea level.

3. The Bible Flood - a Possible Result of a Cosmic Catastrophe?

A Bulgarian scientific team demonstrated, that the Bible Flood probably is with age equal to the beginning of the bible chronology (Creation of the World), i. e. 5 500 years B.C. Studies of Shopov et al. (1996b, 1997b) suggested, that around 7 500 B.C. precipitation over Bulgaria, averaged over 120 years exceeded tens times the recent values. Presuming that the excess precipitation had fallen only within 1 year, this means a never seen rainfall (flood). Such event is described in the Bible, Greek mythology and the Sumerian epic Gilgamesh (compiled during III millennium B.C. on the base of more ancient legends). Such immemorial precipitation probably would lead to some temporary rising of the Black Sea level. Such rising at 5 500 B.C. was recently suggested (see International Herald Tribune, December 19, 1996) by an international team of scientists lead by Dr. William Rayn and Walter Pittman from Columbia University, Palisades, New York. They demonstrated that the Black sea level rose with 150 meters in one year, flooding 160 000 square kilometres. Before this event Black sea was an isolated fresh water lake. The Black Sea level rising itself can not undoubtedly be related to the flood, but combined with the never seen (during the human civilisation) precipitation at that time definitely leads to the thought that this phenomenon is namely the Bible flood.

The Bulgarian result has been obtained by study of the variations of the growth rate of a stalagmite from Duhlata cave (Sofia district, Bulgaria). The cave flowstones, stalactites and stalagmites usually are built of calcium carbonate, obtained by partial dissolving of the bedrock over the cave. This solution precipitates a part of the dissolved carbonate in the form of cave speleothems (stalactites, stalagmites, etc.). They grow continuously hundreds thousand years. As bigger is precipitation, as higher is the amount of the bedrock dissolved and reprecipitated over the stalagmite and as faster is its growth. Therefore speleothem growth rate is linearly proportional to the amount of precipitation in the past. A curve of the stalagmite growth rate variations, representing past precipitation has beén obtained by dating of a sequence of points along the stalagmite growth axis. In this way it is demonstrated, that around 7 500 B.C. the averaged for 120 years stalagmite growth rate exceeds 50 times the recent value. The obtained result is confirmed also by independent dating of the same sample by radiocarbon dating and other modern dating methods.

The never seen precipitation at that time had contributed to the rising of the sea level. Moerner (1988) found a rapid rising of the sea level with 17 m between 8 000 and 7 500 B.P.) and maybe caused the final rising, which had turned the Mediterranean Sea over the edge to flood the Black Sea region. Such precipitation can not be produced by any known Earth force. It requires rapid increasing in evaporation of water, but there are no evidences of rapid warming during the flood. So the only possible reason for such evaporation is increasing of the SL with several percentages. Water absorbs strongly the infrared solar radiation, which causes melting of glaciers and evaporation of water. But the SL usually remains rather steady (Solar constant). Shopov et al. (1997b) believe that

such higher solar radiation can be produced by an extraordinary solar eruption or (perhaps more likely) by explosion of a comet or asteroid in the solar atmosphere. Such explosion (like Tungussian meteorite) can cause a major mixing of parts of Solar shells and appearance of warmer Solar matter from a depth to the Solar surface. Probably several years would be necessary for recovery of the Sun from such a catastrophic event.

4. Conclusions

The SL variations contribute to Earth's heating almost as much as the variations of the Earth's orbit (Milankovitch cycles). Their most powerful cycle (with duration of 11500 yrs) is responsible for the shifting of the timing of the last deglaciation. They are responsible for almost half of the variations in high resolution SI experimental records.

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