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# Does Solar Irradiance Caused the Time Shifting of Termination-II?

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Glaciations were attributed to variations of the Earth's orbit (Milankovitch cycles). But the best dated paleoclimatic record (from a Devils Hole, Nevada speleothem) demonstrated that the end of the last glacial period (Termination II) happened 10 000 years before the one suggested by the orbital variations (Winograd et al, 1992), i.e. the result appeared before the reason. This fact suggests that the theory do not completely reflect the real variation of the solar insolation.

The Orbital theory presumes that the solar irradiance was constant during geological periods of time. Recent studies demonstrated that this presumption is not precise. 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 there are experimental data suggesting that it varied much greater during geological periods. Stuiver & Braziunas (1989) demonstrated that longer solar cycles are more than one order of magnitude stronger, than the solar cycles covered by direct measurements. Increasing of the ice volume and the related sea level change during glaciations produces changes in the inertial moment of the Earth and resulting changes in the speed of Earth's rotation (Tenchov et al., 1993). Orbital variations cause also some deformation of the solid Earth and redistribution of the Ocean masses (Morner, 1983). In result theoretical Milankovich curves can be used only for qualitative reference. For quantitative correlation it is necessary to use experimental records of the solar insolation, because they contain also variations of the solar irradiance and number of others not covered by the Orbital theory.

Variations of the orbital parameters (precession and tilt of the Earth's axis) cause different variations of the solar insolation in the different geographic regions with different latitude, while solar irradiance cause the same variations of the solar insolation everywhere on Earth. In order to estimate the significance of the contribution of both these factors to the real solar insolation during the Termination- II and their influence over the North Atlantic region and it's climate we compare the available solar insolation and paleotemperature records in the region. All such records, which are precisely dated by U/Th dating suggest that Termination II happened about 10 000 years before the one suggested by the orbital theory.

In order to estimate intensity of the past variations of the solar irradiance we measured two experimental luminescent solar insolation proxy records from speleothems from Duhlata cave, Bulgaria and Jewel cave, South Dakota, US, 10 000 km apart. They both cover the period of 89- 139 kyrs BP with high resolution and exhibits a very rapid increasing in solar irradiance and insolation at 139 kyrs $\pm$5.5 kyrs BP (95% confidence level) responsible for the termination II. It is due to the most powerful cycle of the solar irradiance with period of 11.5 kyrs producing variations of $\pm$3.7 % from the solar constant. Such variation can be produced by variation of the effective temperature of the solar surface of $\pm$55 K from its average value of 5785 K. We demonstrated that the 11500-yrs cycle have intensity of several orders of magnitude higher, than the observed century and sub- century cycles. It appears to be a bit more powerful than the precession cycle and a bit less than the total orbital component of the solar insolation variations. It is superposed on the orbital variation curve to produce the real solar insolation variations. Solar irradiance and orbital variations both cause variations of solar insolation affecting the climate.

This cycle was found previously to be the most intensive one in the $\Delta^{14}$C calibration record and was interpreted to be of geomagnetic origin. Our studies suggest that this is a solar cycle modulating the geomagnetic field. The Devils Hole $^{18}$O record suggests that termination II had happened at 140$\pm$3 kyrs B.P. It follows precisely the shape of our experimental solar insolation records. These records suggest that the solar irradiance contribution to the solar insolation curves has been severely underestimated. Such conclusion is supported also by data of Spotl et.al, 2002 from Alps and Gallup et al (2002) from Barbados. These two locations with dramatically different latitude both exhibit rapid temperature rising thousands of years before the one suggested by Milankovich theory.

We obtained many other cycles, more intensive of them with duration of 6000, 4400, 3950, 3300, 2770, 2500, 2300, 1900, 1460, 1200, 900 and 160 years with amplitude ranging from 1.5 to 0.03 % of the Solar Constant.

In conclusion solar irradiance variations contribute to Earth's heating almost as much as the orbital variations of the Earth's orbit (Milankovitch cycles). Their most prominent cycle (with period of 11,500 yrs) must be also taken into account for a proper explanation of the timing of the last deglaciation. This solar luminosity cycle modulates the geomagnetic field and production of cosmogenic isotopes.

## 0.1 References


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