MILANKOVITCH CYCLES, EIGHTY YEARS LATER

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Figure 1.

Milutin Milankovitch, Figure 1, published his influential research ”Canon of Insolation and the Ice-age Problem” in Belgrade, Serbia, 1941. His work is important nowadays in terms of studying climate. changes.

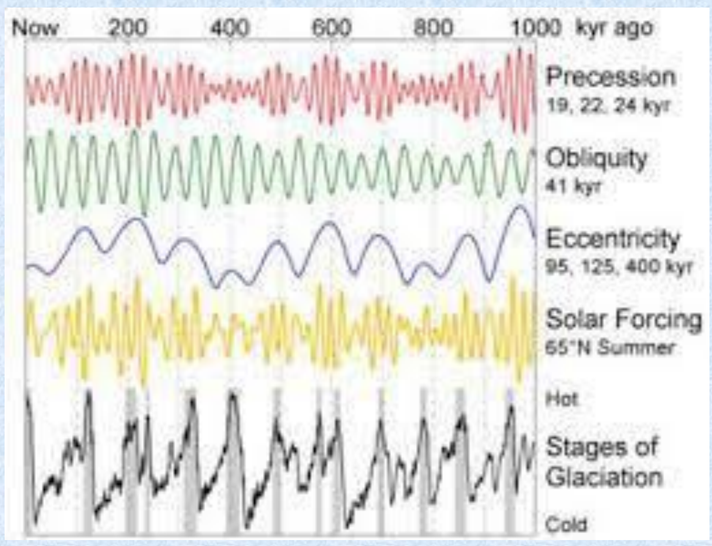

Figure 2.

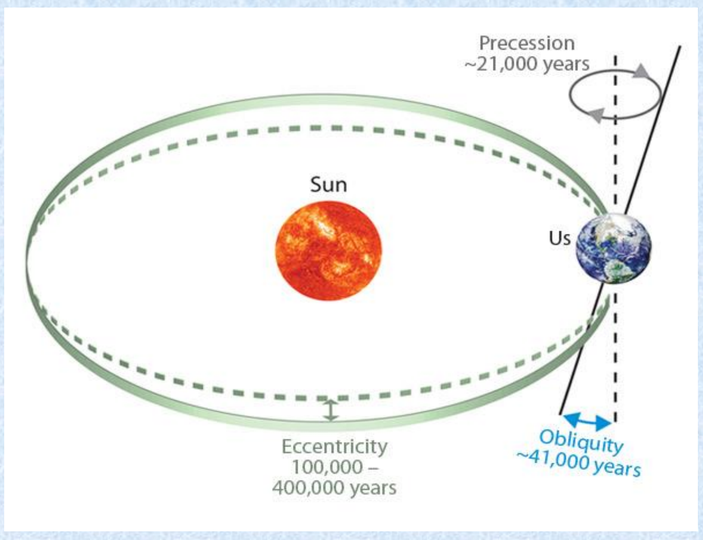

Figure 3.

In this research Milankovitch finds that the position of the Earth and the Sun is crucial for the Earth climate. These factors are astronomical and therefore they are not influenced by humans or their activity. The changes in these astronomical factors are long-term changes, so called secular changes. The degree to which the orbit differs from a circle is measured by its eccentricity- the smaller the value of the eccentricity the closer the orbit is to a circle. This eccentricity of the Earth's orbit around the Sun varies over time and has a maximum value of about 6% but is currently lower, at about 1.7%. This means that the Northern hemisphere receives about 7% less radiation in its summer, and 7% more in its winter, than the Southern in its equivalent seasons because the Earth is closer to the Sun in January than in July. The eccentricity varies with periods of around 100,000 and 413,000 years due to the gravitational influence of the Moon and other planets, primarily Jupiter and Saturn. The tilt (or obliquity) varies cyclically with a period of about 41,000 years, and the precession of the seasons varies with periods of up to about 26,000 years. These periodic changes are known as Milankovitch cycles, Figures 2 and 3. The astronomical Milankovitch cycles lead to long-term changes in the average annual energy radiated by the Sun that is absorbed by the whole planet by different region of the Earth. It should have in mind that there are uneven distribution of land vs ocean in the Northern (about 39%) and Southern (about 19%) hemisphere. Therefore, solar radiation is unequally absorbed in these hemispheres [8]. For the Earth's climate more important is the Northern hemisphere absorption scenario because of the larger land surfaces which are more important in the Earth's energetic budget (the difference between absorbed and emitted solar radiation) than the ocean surfaces. Long-term changes in total solar irradiance (TSI), the spatially and spectrally integrated radiant energy from the Sun at a distance of one astronomical unit, cause changes in the temperature. This change further cause long-term subsequent secondary feedback influences and together they are enough to cause climate change in glacial/interglacial cycles. This was the Milankovitch's answer to the riddle of the ice age.

Today, there is no consensus in the scientific community on the cause of climate change. There are opinions that human activities encourage climate change, but there are opposite approaches that natural factors primarily cause these changes. Future research should answer many open questions in this area. So, it is a matter of interdisciplinary connection and cooperation of many scientists from different fields. Accurate theory of climate change mechanisms will provide a good basis for numerical models that would provide reliable predictions of climate change in the future.

REFERENCES

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[2] Lockwood, M. (2012), "Solar influence on global and regional climates“, Surv. Geophys., 33:503-534.
[3] Zharkova, V. (2020), “Modern Grand Solar Minimum will lead to terrestrial cooling”, Temperature, 7:3, 217-222.