Milankovitch Cycle

Introduction

- The Milankovitch or astronomical theory of climate change is an explanation for changes in the seasons which result from changes in the earth's orbit around the sun. The theory is named for Serbian astronomer Milutin Milankovitch

Natural causes of Milankovitch Cycle

- Eccentricity
- Obliquity
- Precession

Who was Milutin Milankovitch?

- Born May 28, 1879, Dalj, Austria-Hungary [now in Croatia]
- Died December 12, 1958, Belgrade, Yugoslavia [now in Serbia]
- Mathematician and geophysicist
- Best known for his work that linked long-term changes in climate to astronomical factors affecting the amount of solar energy received at Earth's surface.
- Published *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem* (1941; *Canon of Insolation and the Ice-Age Problem*).

- Earth experienced it's most recent ice ages during the Pleistocene epoch, which lasted from 2.6 million years ago to 11,700 years ago. For thousands of years at a time, even the more temperate regions of the globe were covered with glaciers and ice sheets, according to the University of California Museum of Paleontology.
- To determine how Earth could experience such vast changes in climate over time, Milankovitch incorporated data about the variations of Earth's position with the timeline of the ice ages during the Pleistocene. He studied Earth's variations for the last 600,000 years and calculated the varying amounts of solar radiation due to Earth's changing orbital parameters. In doing so, he was able to link lower amounts of solar radiation in the high northern latitudes to previous European ice ages, according to AMNH.
- Milankovitch's calculations and charts, which were published in the 1920s and are still used today to understand past and future climate, led him to conclude that there are three different positional cycles, each with its own cycle length, that influence the climate on Earth: the eccentricity of Earth's orbit, the planet's axial tilt and the wobble of its axis.

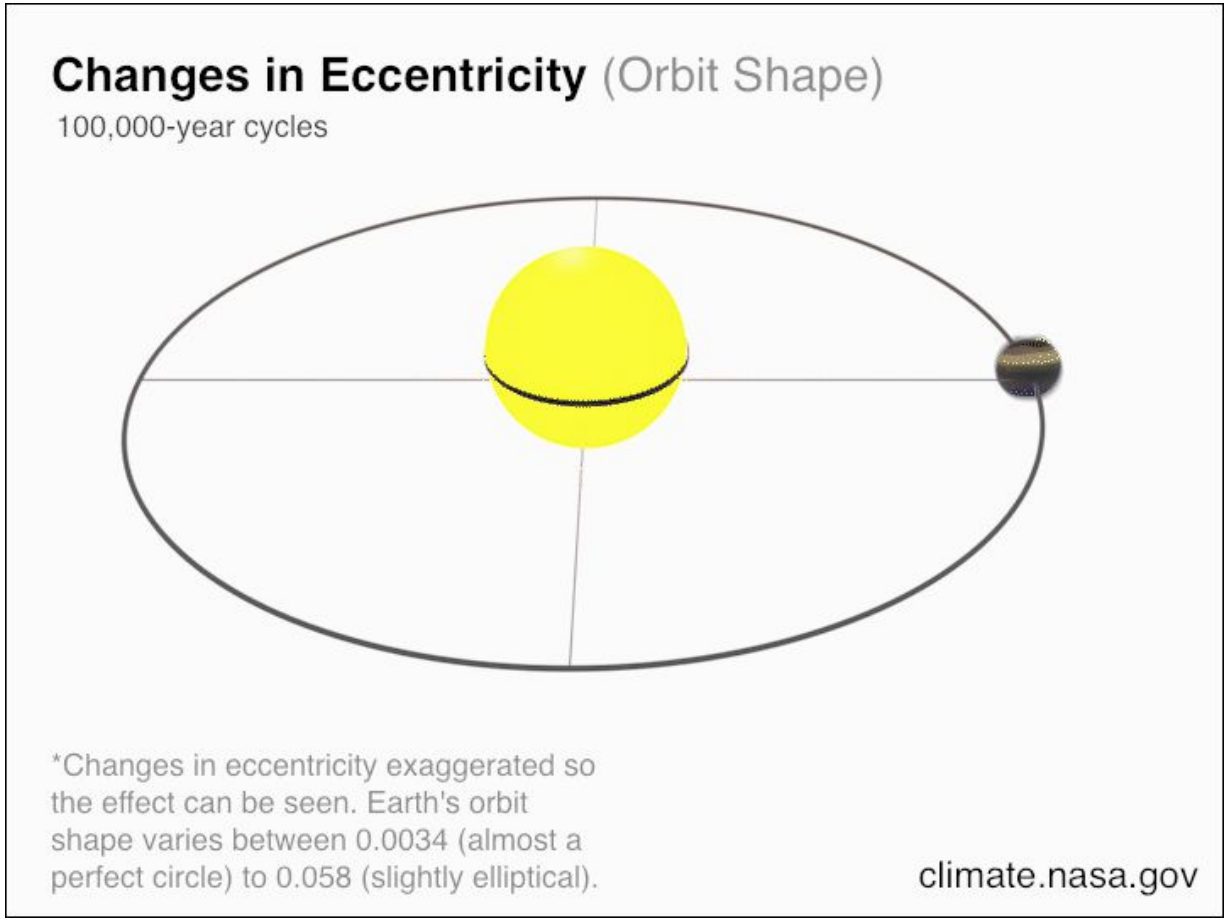
Eccentricity

Eccentricity is a term used to describe the shape of Earth's orbit around the sun. The variation of Earth's orbit around the sun ranges from an almost exact circle (eccentricity = 0.0005) to a slightly elongated shape (eccentricity = 0.0607). The impact of the variation is a change in the amount of solar energy from perihelion (around January 3) to aphelion (around July 4).

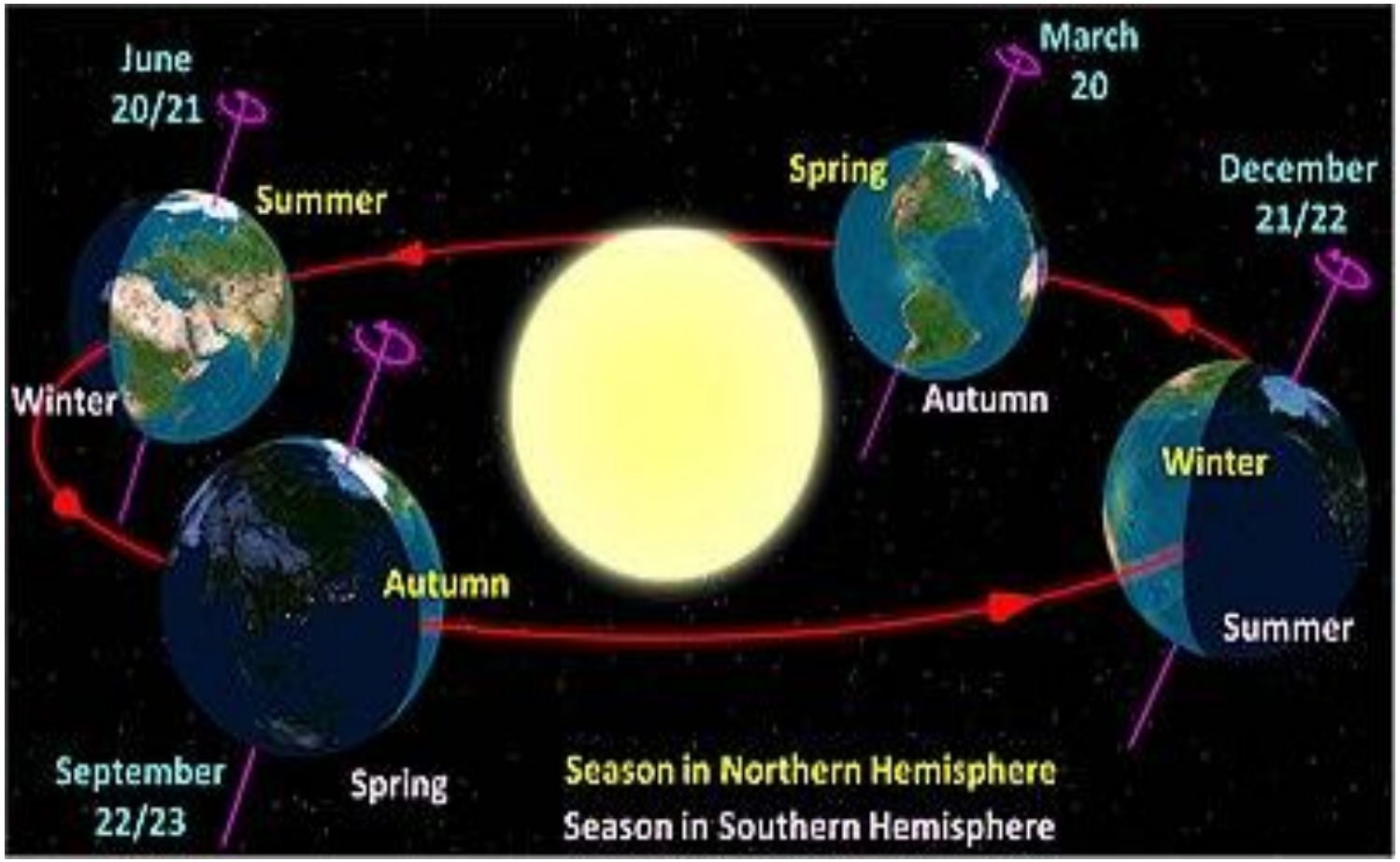
The Earth's orbit around the Sun, like other planet's orbits, is not a perfect circle. It is an ellipse. This means that the Earth is closer to and further away from the Sun at different times in the year.

- Perihelion - when the Earth is closest to the Sun (usually happens in January)
- Aphelion - when the Earth is furthest from the Sun (usually happens in June)

Changes in eccentricity



Season in Northern and southern hemisphere

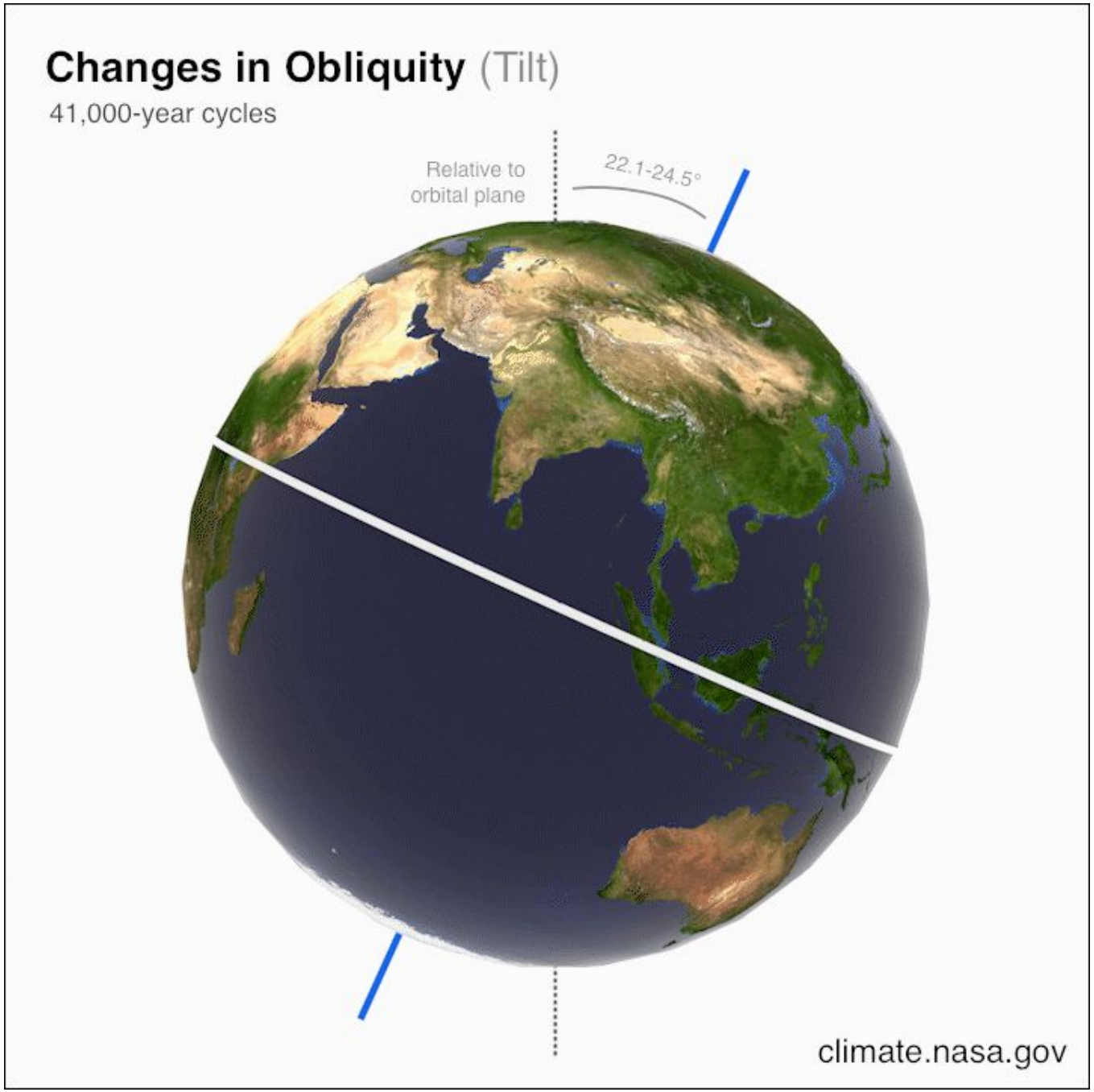


Obliquity

- Obliquity is the variation of the tilt of the earth's axis away from the orbital plane.
- The tilt varies between 22.1 º and 24.5 º and the average is 23.5 º
- The obliquity changes on a cycle taking approximately 40,000 years
- Currently, the axis of rotation for the earth is tilted at 23.5°

However, this value changes from a minimum of 22.5° to a maximum of 24.5° and takes 41,000 years to complete one cycle

The more tilt means more severe seasons - warmer summers and colder winters; less tilt means less severe seasons - cooler summers and milder winters



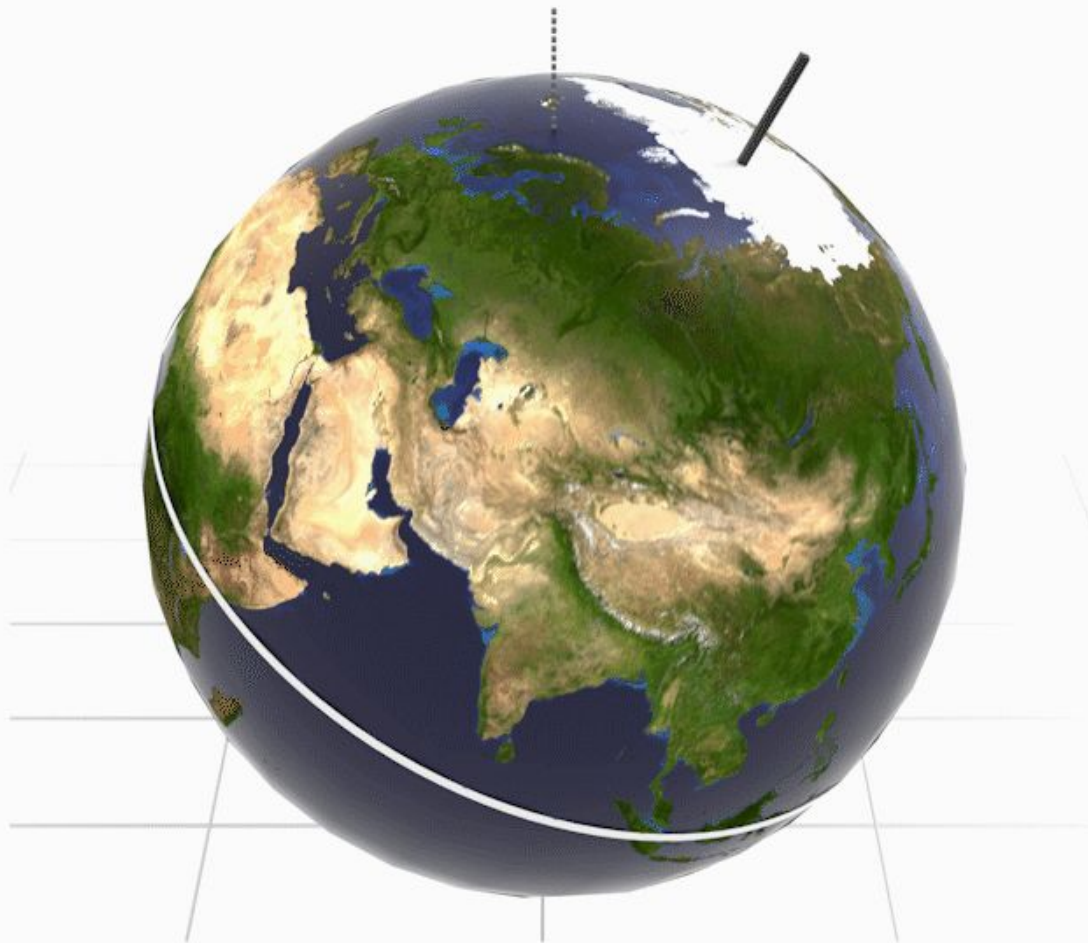
Precession

- Precession is the change in orientation of the Earth's rotational axis. The precession cycle takes about 19,000 - 23,000 years.
- Earth wobbles just slightly as it spins on its axis, similarly to when a spinning top begins to slow down. This wobble, known as precession, is primarily caused by the gravity of the sun and moon pulling on Earth's equatorial bulges. The wobble doesn't change the tilt of Earth's axis, but the orientation changes. Over about 26,000 years, Earth wobbles around in a complete circle, according to Washington State University.
- Now, and for the past several thousands of years, Earth's axis has been pointed north more or less toward Polaris, also known as the North Star. But Earth's gradual precessional wobble means that Polaris isn't always the North Star. About 5,000 years ago the Earth was pointed more toward another star, called Thubin. And, in approximately 12,000 years, the axis will have traveled a bit more around its precession circle and will point toward Vega, which will become the next North Star

- As the Earth completes a precession cycle, the orientation of the planet is altered with respect to perihelion and aphelion. If a hemisphere is pointed toward the sun during perihelion (shortest distance between Earth and sun), it will be pointed away during aphelion (largest distance between Earth and sun), and the opposite is true for the other hemisphere. The hemisphere that's pointed toward the sun during perihelion and away during aphelion experiences more extreme seasonal contrasts than the other hemisphere.
- Currently, the southern hemisphere's summer occurs near perihelion and winter near aphelion, which means the southern hemisphere experiences more extreme seasons than the northern hemisphere.

Axial Precession (Wobble)

26,000-year cycles



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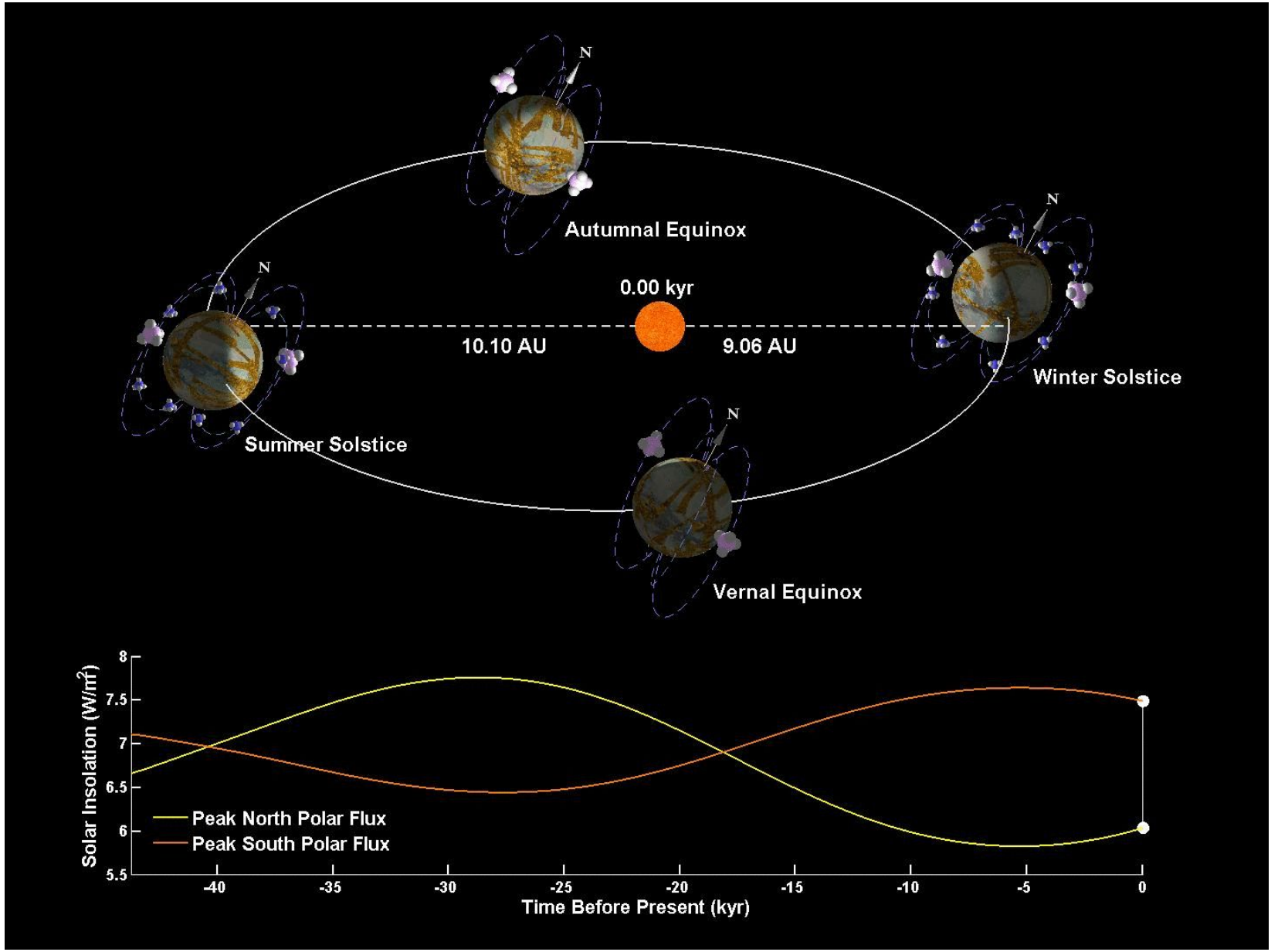

https://www.youtube.com/watch?v=wi-VEby3m9E