

## **Astronomical (Milankovitch) Theory of Climate Change**

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The theory of astronomical climate change begins with Joseph Adhemar, A French mathematician from 1797-1862, who, to explain past ice ages, noted the precession of equinoxes, which occurs throughout 22,000 years. This is the change in the timing of the Perihelion, which is the closest approach of the earth to the sun annually. Thus, 11,000 years ago the sun was the closest to earth in July... creating hotter summers and colder winters. Today, the Perihelion is in January, creating warmer winters and cooler summers.

In 1867, James Croll, a Scottish scientist from 1821-1890, proved that the eccentricity, how circular the earth's orbit is, varies between 1% (more circular) and 6% (more elliptical) throughout orbit cycles of 100,000-400,000 years. Eccentricity affects climate because it affects the intensity of radiation taken in seasonally. Besides an effect in eccentricity, the earth's tilt also was affected. This was proven by James Croll in 1875. It was shown that the tilt of the earth's axis varies between 22 degrees and 25 degrees. It affects climate because the more vertical the tilt, the more likely there is to be an ice age because the polar regions receive less heat. Also, a greater tilt means more severe seasons.

From here, James Croll reasoned five things about climate change:

1. A decrease in sunlight radiation in winter favors the accumulation of snow, which results in additional loss of heat by reflecting more sunlight back into space ("positive feedback" mechanism).
2. If winter occurs when earth is closer to the sun, then temperatures are warmer and vice versa.

3. If the polar area of one hemisphere becomes colder, then trade winds will strengthen. This will force equatorial currents, currents drifting outward from the equator, in the ocean to move to the other hemisphere... losing more heat.
4. If the eccentricity was circular, precession of equinoxes would not affect the climate at all because each season would occur at an equal distance from the sun.
5. An ice age is most likely to occur if the two conditions of there being an elongated orbit and a winter solstice occurring far from the sun were to happen together.

Finally, Milutin Milankovitch, a Serbian civil engineer and geophysicist, discovered that the amount of the earth's sunlight intake is more prominent in the summer than the winter because in the winter Arctic temperatures are cold enough to form ice even today while in the summer, any decrease in the intensity of the sunlight on earth could lead to greater snow and ice. Milankovitch also created a formula that modeled the relationship between summer radiation and the altitude of the snow line.