Earth's orbit creates more than a leap year

February 8 2008

Earth's orbit creates more than leap years. Image courtesy of NASA

The Earth's orbital behaviors are responsible for more than just presenting us with a leap year every four years. According to Michael E. Wysession, Ph.D., associate professor of earth and planetary sciences in Arts & Sciences at Washington University in St. Louis, parameters such as planetary gravitational attractions, the Earth's elliptical orbit around the sun and the degree of tilt of our planet's axis with respect to its path around the sun, have implications for climate change and the advent of ice ages.

People often think of orbits as circular, but they're not that smooth and simple. They are often a less-than-perfect eccentric circle.

"All planets travel in an ellipse around the sun, but the shape of that ellipse oscillates," he explains. "When the Earth's orbit is more elliptical, the planet spends more time farther away from the sun, and the Earth gets less sunlight over the course of the year. These periods of more-elliptical orbits are separated by about 100,000 years. Ice ages occur about every 100,000 years, and they line up exactly with this change in the Earth's elliptical shape."

The purpose of the leap year is to keep our artificial calendars aligned with what the Earth actually does in its orbit around the sun and to ensure that roughly at noon on the winter solstice (Dec. 21) each year, the same point on the Earth is tilted toward the sun.

As in much of nature, the process is both neat and messy.

Wandering solstice

While we are accustomed to thinking that the Earth takes 365 days to go around the sun, it actually takes about 365.25 days. Thus, every four years the quarter days add up to one whole day. If the quarter days were unaccounted for, the solstice would wander away from its Dec. 21 date over time.

"Earth's 24 hour day is a transient thing," Wysession says. "It actually takes 23 hours, 56 minutes and four seconds to make one revolution around its axis — that is, to go all the way around so that the stars will appear in the same point in the sky day after day.

"However, during that time, the Earth also has moved one more day along its orbit around the sun, so it actually has to spin a little bit more for the sun to arrive back in the same place in the sky. This amount of time is three minutes and 56 seconds, which makes the 24 hours."

However, Wysession notes that our time units — 60 seconds, 60 minutes, 24 hours — would mean nothing had humans evolved 100 million years earlier or later because the Earth spun much faster then, and today, like aging baby boomers, it is slowing down.

Extreme seasons in the future

Despite what many people believe, seasons on Earth are not determined by the nearness of the northern and summer hemispheres to the sun.

"Seasons occur because in January, for instance, the North Pole points away from the sun, so the southern hemisphere gets more direct sunlight," Wysession says. "Six months later, that will be reversed. In terms of climate change, this has an impact because land heats up much more quickly than water, five times more quickly. The northern hemisphere has most of the land on Earth; the southern has most of the water. On January 3 or 4 (it varies) the Earth is at its closest point to the sun (the perihelion), but because water heats up so slowly, it doesn't make as much difference in temperature in the southern hemisphere as it otherwise might.

"In the northern hemisphere summer, despite the Earth being farther away from the sun, land heats up much more quickly than the southern hemisphere's water, and heats up about the same amount consistently. The two hemispheres end up buffering the climate swing, producing less severe winters than we would have otherwise."

Stick around, though, if you like extremes. Wysession says that in the future, the Earth will be farther away from the sun in winter and closer to it in the summer, causing more severe temperature swings in these two seasons. This will happen about 12,000 years from now.

"Orbital parameters of Earth, the sun and moon and the planets have

great effects on ice ages and other climatic changes," he says. "Those major events are driven by very small changes in the planetary orbital functions."

Source: Washington University in St. Louis