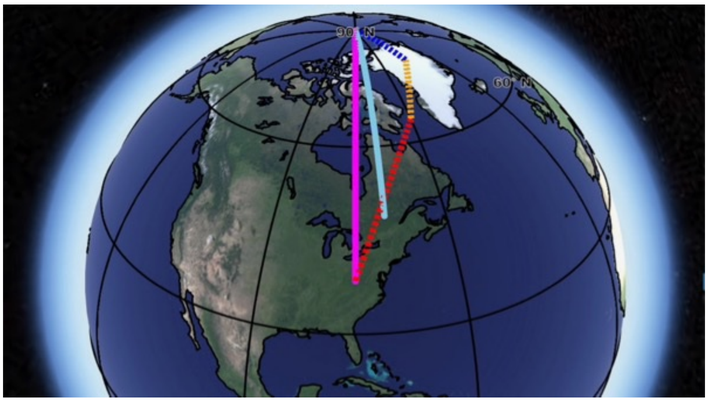
WHY IS EARTH'S SPIN AXIS DRIFTING?



As Earth rotates, its spin axis — an imaginary line that passes through the North and South Poles — drifts and wobbles. Scientists now have, for the 1st time, identified 3 reasons why. ⟶
The light blue line shows the observed direction of "polar motion" – the drift of Earth's spin axis. The pink line represents the sum of the influence of Greenland ice loss (blue), postglacial rebound (yellow) and the highly uncertain contribution of deep mantle convection (red). **These lines represent the direction of drift, not the amount. Over the 20th century, the amount of drift was 10 metres.**

Unlike a plastic globe of Earth you may have in your office, the real planet Earth isn't perfectly round and doesn't spin smoothly. A typical desk globe is designed to be a geometric sphere and to rotate smoothly when you spin it. Our actual planet is far less perfect -- in both shape and in rotation. The imaginary line around which Earth spins – passing through the North and South Poles – is called its spin axis. Scientists have known for a long time that Earth's spin axis drifts and wobbles. Measurements over the 20th century show that Earth's spin axis drifts by about 10 cm per year. Over the course of a century, that's more than 10 metres. This week (September 19, 2018), NASA scientists announced they've used observational and model-based data spanning the 20th century in order to identify – for the first time – three processes primarily responsible for this drift.

The three processes are mass loss due to melting ice (mostly in Greenland), the lifting of land masses as glaciers have melted since the last ice age (aka glacial rebound), and the slow creeping motion of rocky material in Earth's interior mantle, caused by convection currents carrying heat from our planet's interior to its surface (this third process is called mantle convection).

Scientists call the drift of Earth's spin-axis its polar motion. **Surendra Adhikari** of NASA's Jet Propulsion Laboratory in Pasadena, California is first author on the new paper describing the causes for the drift. He said:

> *The traditional explanation is that one process, glacial rebound, is responsible for this motion of Earth's spin axis. But recently, many researchers have speculated that other processes could have potentially large effects on it as well.*
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> *We assembled models for a suite of processes that are thought to be important for driving the motion of the spin axis. We identified not one but three sets of processes that are crucial – and melting of the global cryosphere (especially Greenland) over the course of the 20th century is one of them.*

His team's statement said:

> *In general, the redistribution of mass on and within Earth – like changes to land, ice sheets, oceans and mantle flow – affects the planet's rotation. As temperatures increased throughout the 20th century, Greenland's ice mass decreased. In fact, a total of about 7,500 gigatons – the weight of more than 20 million Empire State Buildings – of Greenland's ice melted into the ocean during this time period. This makes Greenland one of the top contributors of mass being transferred to the oceans, causing sea level to rise and, consequently, a drift in Earth's spin axis.*
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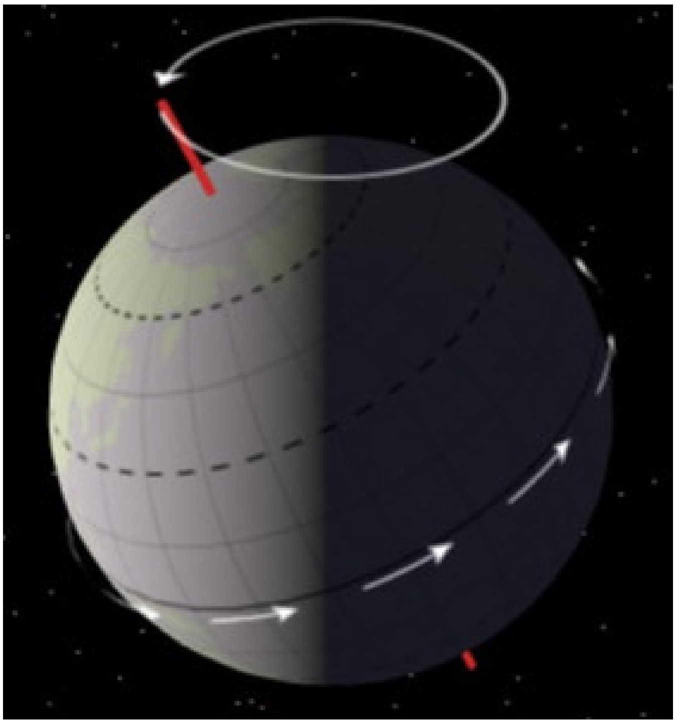
> *While ice melt is occurring in other places (like Antarctica), Greenland's location makes it a more significant contributor to polar motion.*

Coauthor **Erik Ivins**, also of JPL, explained:

> *There is a geometrical effect that if you have a mass that is 45 degrees from the North Pole — which Greenland is — or from the South Pole (like Patagonian glaciers), it will have a bigger impact on shifting Earth's spin axis than a mass that is right near the Pole.*
>
> *Previous studies identified glacial rebound as the key contributor to long-term polar motion. In the new study, which relied heavily on a statistical analysis of such rebound, scientists figured out that glacial rebound is likely to be responsible for only about a third of the polar drift in the 20th century.*

Their paper in Earth and Planetary Science Letters is titled "What drives 20th century polar motion?"



Apart from these “Little Wobbles” of the Earth, there is of course the long term spin of the Earth Axis, better known through the expression “Precession of the Equinox”. It is a gradual drift of the point above the poles in the stars, describing a circle in the sky over a period of about 26,000 years. Known in antiquity as the position of the Sun in the Circle of the Zodiac, it has drifted from the then position in the constellation Aries backwards through Pisces into Aquarius.
The spin axis currently points close to Polaris, but in 13,000 years it will be pointing towards Vega, about 47 degrees away from Polaris since the tilt of the spin axis is about 23.5 degrees. **Some references jokingly point out that by then we may be celebrating Christmas in July, which of course won’t happen, because our calendar is tied to the Equinox and will change with it.**

The torque which causes the Earth to precess comes from the gravitational pulls of the Sun and the Moon which try to pull the Earth's rotation axis toward the perpendicular to its orbital plane (the ecliptic plane). If the Earth were a perfect uniform sphere, there would be no precessional torque. The equatorial bulge of less than 1% plus any departures from spherical symmetry in density distribution are the only things which give the Sun and Moon any "handle" with which to exert torque on the Earth. It is not known why the tilt of the Earth axis is 23.5 degrees from the orbital plane.
AXIAL PRECESSION
In astronomy, axial precession is a gravity-induced, slow, and continuous change in the orientation of an astronomical body's rotational axis. In particular, it can refer to the gradual shift in the orientation of Earth's axis of rotation in a cycle of approximately 25,772 years. This is similar to the precession of a spinning-top, with the axis tracing out a pair of cones joined at their apices. The term "precession" typically refers only to this largest part of the motion; other changes in the alignment of Earth's axis—nutation and polar motion—are much smaller in magnitude.
Although there is no written testimony of a recognition of precession before the Greeks, it is clear from Greek testimony (such as from Aristotle), that Egyptian and Babylonian sciences were shrouded in mystery and only available to the 'initiated'. However, this lack of written evidence by no means precludes such knowledge from being understood, as the numbers that represent the precessionary cycle can be found in the dimensions of 'sacred' structures and mythologies from around the ancient world as the following examples illustrate.
TURKEY - First recorded division of the sky into 12 equal parts. Metsamor was identified by **Livvio Stecchini** as an ancient oracle centre. It lies at the foot of Mount Ararat, and archaeology has shown that the area was home to a sophisticated culture that was present in Anatolia from c. 6,000 BC.
SUMERIA - **Gudea**, a ruler of ‘Lagash’, of Sumeria, recorded that he was given instructions in a vision. “A wise man that shone like the heaven,“ by whose side stood “a divine bird,” “commanded me to build this temple”. Gudea employed a male ‘diviner, maker of decisions’, and a female ‘searcher of secrets’ to locate the site. He then recruited 216,000 people for the job.
BABYLON - The Babylonian historian **Berossus** (third century BC) ascribed a total reign of 432,000 years (120 shar’s of 3,600 yrs each), to the mythical Kings who ruled the land of Sumer before the flood. We can be fairly sure that the Sumerians were aware of the cycle, as it offers a natural division of both time and space into 360°, from units of 6 and 10. The Sumerians are the earliest culture to measure both time and space in units of 6 and 10. A system called the Hexi-decimal system. Remarkably, time and space are still measured today by the same units of measurement.
THE PLATONIC YEAR
The first recorded recognition of precession in Greece was by the astronomer **Hipparchus** who noticed that the positions of the stars had shifted in a systematic way from earlier Babylonian.
The Platonic Year was named after **Plato** (427 - 347 BC) because of his conviction of the intimate relationship between space and time. AK, with EarthSky and Wikipedia Notes