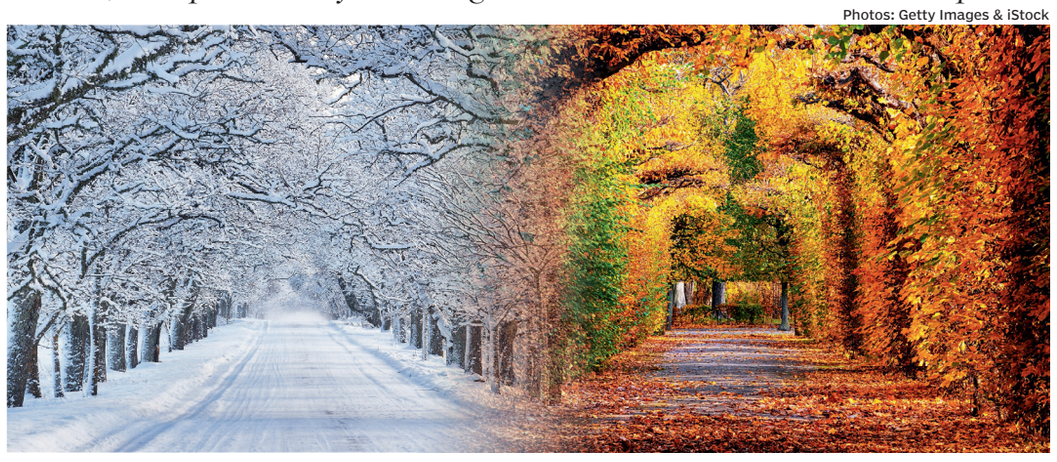
‘Earth’s axis and orbit shape its seasons — other planets have winter and summer too’

John Chiang *is Professor of Geography at the University of California, Berkeley. Speaking to* ***Srijana Mitra Das*** *at* ***Times Evoke****, he explains how frost changes to warmth on Earth — and other places:*

Photos: Getty Images & iStock



HOW THE WORLD TURNS... Seasons change as Earth tilts towards and orbits the sun in an ellipse — owing to both the influences, winter and summer take place at different times of the year in the Northern and Southern Hemispheres

What is the core of your research?

■ I’m interested in how Earth’s global climate works and how it brings about changes from seasonal timescales all the way to climates of the distant past. I use a combination of theory, observational analyses, data from satellites and meteorological stations and model simulations to understand how climate works and changes.

Can you tell us about how Earth’s axis and tilt shape its seasons?

■ Earth rotates on its axis — this has an angle which determines the plane of our planet’s orbit around the sun. In one configuration, when the Northern Hemisphere is more face-up towards the sun, we experience summer here. When the opposite happens and the Southern Hemisphere — which includes Australia, Antarctica and parts of Asia, Africa and South America — faces the sun more, it experiences summer.

Why is Earth’s elliptical orbit also a factor in influencing its climate?

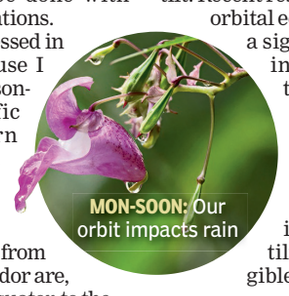
■ In principle, Earth has two sources of its seasons — the first is its axial tilt. The other is Earth’s orbital eccentricity — this is basically the fact that our planet’s orbit around the sun is not in a perfect circle but a shape where there is a point when we are closer to the sun and then farther away from it. That variation in Earth’s distance from the sun over the course of a year also changes the amount of sunlight we see — this can affect Earth’s temperature. Earth’s eccentricity, or how far away it is from being a circle, is not very large though — hence, the common understanding is that Earth’s tilt dominates seasons. That said, my research makes an argument for Earth’s orbital eccentricity being under-appreciated in determining our seasons.

THERE’S A CHILL: The Pacific rims tropical Peru but a part of it is cold

How can you distinguish between the two factors?

■ You cannot do so by observing climate because both these influences change over the course of the year but this can be done with climate model simulations.

My research progressed in this direction because I was studying the seasonal cycle of a specific region in the eastern equatorial Pacific called the ‘Pacific cold tongue’ — this encompasses a portion of the Pacific sea, from where Peru and Ecuador are, along the line of the equator, to the central Pacific. Now, given the location of the tropical Pacific, you would think its surface temperature would be warm throughout — but it is not so. This part is actually colder than the surrounding waters — hence, it is called the ‘cold tongue’.



MON-SOON: Our orbit impacts rain

This area is climatically very important for several reasons, including being the epicentre of the El Nino-Southern Oscillation (ENSO). That changes from year to year and it occurs because of the interaction of the tropical Pacific Ocean and the atmosphere. The expression of El Nino taking place is that the ocean surface temperature of the cold tongue warms up by about five degrees — this releases heat into Earth’s atmosphere and causes changes in global weather patterns, including India having droughts.

This region also has a seasonal cycle — previously, it was thought this was driven by Earth’s axial tilt. Recent research shows Earth’s orbital eccentricity also plays a significant role in driving these changes in the Pacific cold tongue. In fact, the amplitude of the cycle from Earth’s orbital eccentricity is about a third of what is driven by Earth’s tilt — that is not negligible at all.

How is orbital eccentricity an influence on the monsoon as well?

■ It’s not directly linked but some climate scientists are studying how the Indian monsoon changed in the distant past — it turns out the monsoon is quite sensitive to orbital changes which includes eccentricity. Also, the timing of when Earth’s orbit is closest to the sun relative to the seasons matters.

Currently, Earth is closest to the sun when it’s winter in the Northern Hemisphere and farthest during summer — that mutes the seasonal cycle and creates warmer winters and cooler summers.

Yet, 11,000 years ago, it was the opposite — Earth was closest to the sun during summer in the Northern Hemisphere and furthest away in its winters. So, there were hotter summers and colder winters — and the monsoon was tied to that. When the Northern Hemisphere’s sun is hotter, monsoons are stronger — so, 11,000 years ago, the monsoon was stronger than it is today.

Other planets also orbit the sun — do they have seasons as well?

■ Yes — Mars, for instance, has an orbital configuration which is quite similar to Earth’s. Its axis is also tilted, so it gets summers and winters too. Mars doesn’t have oceans though, which is the biggest difference between its climate and Earth. Also, Mars doesn’t have much greenhouse gases — hence, it is much colder.

AS CLIMES CHANGE: The godwit migrates from Alaska to Australia

READERS WRITE

Dear Times Evoke,

Thank you for a very informative edition on ‘A Pollutical Choice’ (4th February). Sunita Narain’s ‘Shaping The Air’ responses to TE were extremely useful for readers. Her suggestions on reducing air pollution must be considered by governments. The authorities can also redesign traffic plans to alter rush hours when vehicle density grows huge and both accidents and harmful emissions rise.

— **Dr D. Lakshmanan**, former Principal Scientist, CLRI, Kazhipattur

Chad Montrie on corporations versus workers approaching nature was brilliant. Pollution, landslides and toxic poisoning affecting workers and residents in industrial areas is heart-breaking. Such articles make us think about how governance must drive the economy while keeping public well-being in mind. My thanks to TE’s team for getting us such experts and presenting complex phenomena in simple words.

— **Jayashree J.**, Sarjapura

I love TE for its most unusual takes on the world. This time, the beautiful TE page had ‘Political Animals’ which caught my eye right away. It was so well-written and I learnt of Oscar Wilde’s comment on fox hunting and how Norway and Japan claim ‘tradition’ and ‘scientific research’ for whale-hunting. It’s eye-opening to see ‘brutality dressed-up’, as TE wrote.

— **Kavitha C. Deshmukh**, Pune

I am 11 years old and I read TE regularly. I found all its articles on air pollution very interesting. I want to ask TE’s global experts — doesn’t smoking also impact air quality? Such smoke and ash also go into the atmosphere. Smoking should be strictly stopped, so the AQI does not become worse.

— **Aman Singh**, Delhi

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