# Researchers use 'global thermometer' to track temperature extremes, droughts

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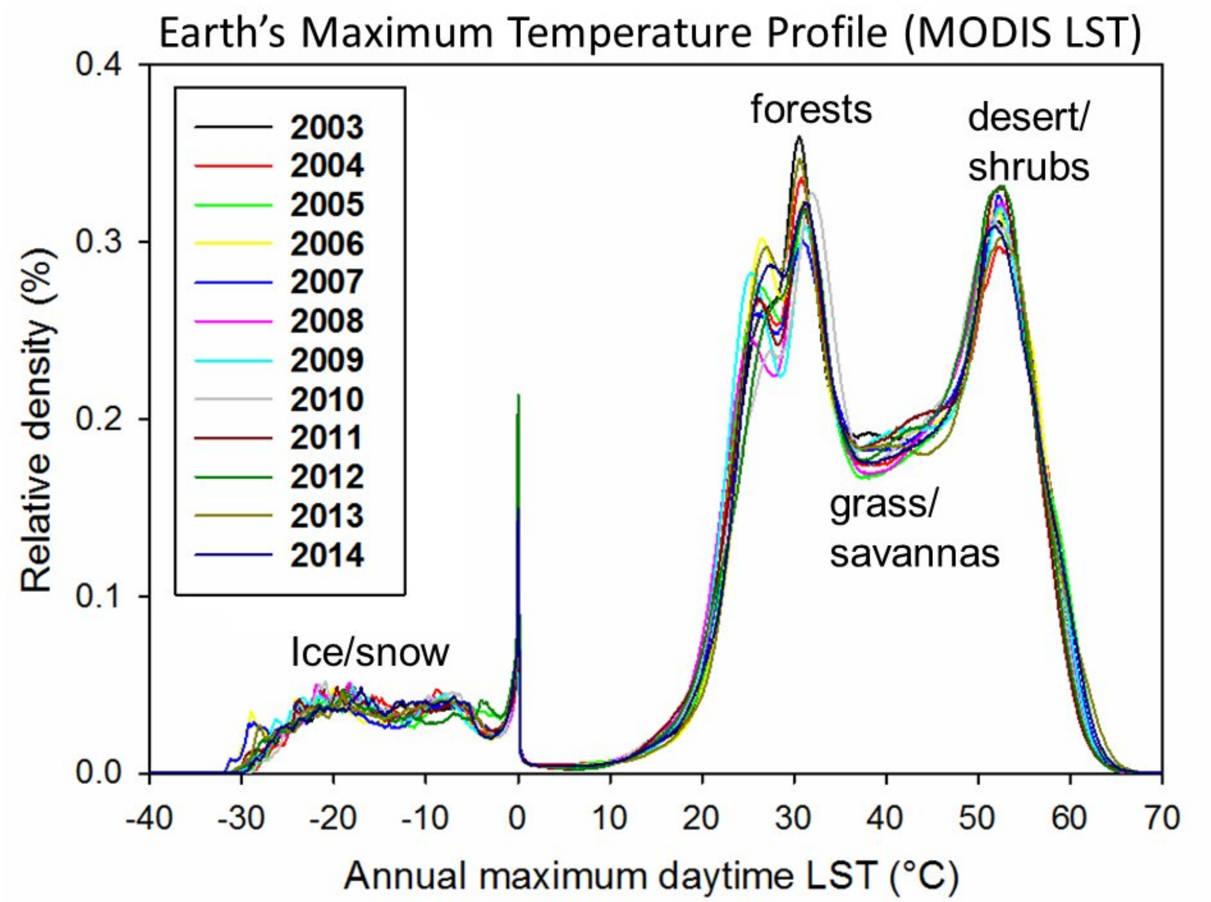


Earth's Maximum Temperature Profile: Histograms of global annual maximum land-surface temperature capture the unique influence of different land-cover types on the expression of maximum land-surface temperatures. Tracking shifts in the distribution of these annual histograms provides a new integrated measure of energy balance components and land-cover change, and a different means to monitor biospheric change. Credit: David Mildrexler, Oregon State University

Large areas of the Earth's surface are experiencing rising maximum temperatures, which affect virtually every ecosystem on the planet, including ice sheets and tropical forests that play major roles in regulating the biosphere, scientists have reported.

An analysis of records from NASA's Aqua satellite between 2003 and 2014 shows that spikes in maximum surface temperatures occurred in the tropical forests of Africa and South America and across much of Europe and Asia in 2010 and in Greenland in 2012. The higher temperature extremes coincided with disruptions that affected millions of people: severe droughts in the tropics and heat waves across much of the northern hemisphere. Maximum temperature extremes were also associated with widespread melting of the Greenland ice sheet.

The satellite-based record of land surface maximum temperatures, scientists have found, provides a sensitive global thermometer that links bulk shifts in maximum temperatures with ecosystem change and human well-being.

Those are among the conclusions reported in the *Journal of Applied Meteorology and Climatology* by a team of scientists from Oregon State University, the University of Maryland, the University of Montana and the Pacific Northwest Research Station of the U.S. Forest Service.

Land surface temperature measures the heat radiated by land and vegetation. While weather stations typically measure air temperatures just above the surface, satellites record the thermal energy emitted by soil, rock, pavement, grass, trees and other features of the landscape. Over forests, for example, the satellite measures the temperature of the leaves and branches of the tree canopy.

"Imagine the difference between the temperature of the sand and the air at the beach on a hot, summer day," said David Mildrexler, the lead author who received his Ph.D. from the College of Forestry at Oregon State last June. "The air might be warm, but if you walk barefoot across the sand, it's the searing hot surface temperature that's burning your feet. That's what the satellites are measuring."

The researchers looked at annual maximum land surface temperatures averaged across 8-day periods throughout the year for every 1-square kilometer (247 acres) pixel on Earth. NASA collects surface temperature measurements with an instrument known as MODIS (Moderate Resolution Imaging Spectroradiometer) on two satellites (Aqua and Terra), which orbit the Earth from north to south every day. Mildrexler and his team focused on the annual maximum for each year as recorded by the Aqua satellite, which crosses the equator in the early afternoon as temperatures approach their daily peak. Aqua began recording temperature data in the summer of 2002.

"As anyone who pays attention to the weather knows, the Earth's temperature has incredible variability," said Mildrexler. But across the globe and over time, the planet's profile of high temperatures tends to be fairly stable from year to year. In fact, he said, the Earth has a maximum temperature profile that is unique, since it is strongly influenced by the presence of life and the overall frequency and distribution of the world's biomes. It was the discovery of a consistent year-to-year profile that allowed the researchers to move beyond a previous analysis, in which they identified the hottest spots on Earth, to the development of a new global-change indicator that uses the entire planet's maximum land surface temperatures.

In their analysis, the scientists mapped major changes in 8-day maximum land surface temperatures over the course of the year and examined the ability of such changes to detect heat waves and droughts, melting ice sheets and tropical forest disturbance. In each case, they found significant temperature deviations during years in which disturbances occurred. For example, heat waves were particularly severe, droughts were extensive in tropical forests, and melting of the Greenland ice sheet accelerated in association with shifts in the 8-day maximum temperature.

In 2010, for example, one-fifth of the global land area experienced extreme maximum temperature anomalies that coincided with heat waves and droughts in Canada, the United States, Northern Europe, Russia, Kazakhstan, Mongolia and China and unprecedented droughts in tropical rainforests. These events were accompanied by reductions in ecosystem productivity, the researchers wrote, in addition to wildfires, air pollution and agricultural losses.

"The maximum surface temperature profile is a fundamental characteristic of the Earth system, and these temperatures can tell us a lot about changes to the globe," said Mildrexler. "It's clear that the bulk shifts we're seeing in these maximum temperatures are correlated with major changes to the biosphere. With global temperatures projected to continue rising, tracking shifts in maximum temperature patterns and the consequences to Earth's ecosystems every year globally is potentially an important new means of monitoring biospheric change."

The researchers focused on satellite records for land surfaces in daylight. NASA also produces satellite-based temperature records for the oceans and for nighttime portions of the globe.

Provided by Oregon State University

temperature-extremes.html