Ecologically-Relevant Changes in Temperature Variability

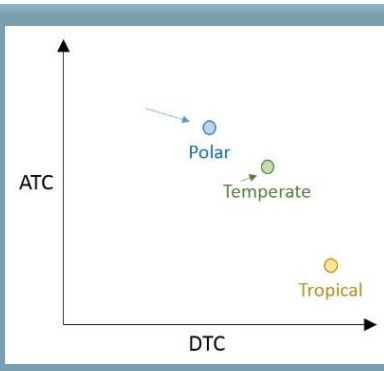
Bulletin Synopsis *December 2014*

For many organisms, the daily and annual temperature *range* is more ecologically-relevant than the change in *average* temperature, in terms of biological processes, phenology, and other ecological interactions. This bulletin highlights a recent global analysis of temperature range shifts between 1975 and 2013.

Temperature Variation

Annual – The range of temperatures experienced over a given year, or the annual temperature cycle (ATC), is generally larger at higher latitudes because winters are so much colder in those areas, compared to the tropics – *ATC increases as you move from the equator to the poles*.

Daily – In contrast, the daily temperature cycle (DTC) is typically much larger in tropical regions than higher latitudes because there is more intense solar heating during the day in the tropics – *DTC generally decreases as you move from the equator toward the poles*.



The combination of DTC and ATC gives each latitude a unique temperature cycle profile – arrows indicate the profile shifts observed by the researchers.

Study Overview

In a study published in the journal Nature Climate Change (Wang and Dillon 2014), researchers estimated the diurnal (i.e., daily) and annual temperature cycles (DTC and ATC) from 1975 to 2013 by analyzing 1.4 billion hourly temperature measurements from over 7,900 weather stations around the globe. These were the key findings:

1. There has been a global increase in DTC since 1975, and this effect was stronger at higher latitudes.

2. There has been a change in the magnitude of the ATC since 1975, but the direction and magnitude of the change varied by latitude: (1) decreased ATC in polar regions, (2) increased ATC in temperate regions, (3) no change in tropical areas – this effect was also stronger at higher latitudes.

3. Altogether, these changes indicate that the temperature cycles of high latitude climates are becoming more like the tropics (a phenomenon the researchers call a 'flattening' of the global temperature profile).

What's New?

These results differ from previous research – the last global analysis (~10 years ago) and subsequent regional studies actually suggested that the daily range has decreased or remained constant. However, this study is data-rich, global in scope, and it employs a new statistical approach.

The Implications

For forest managers, the impact of these changes on forest pests (life cycle and population dynamics) are the most immediate concern, but there will be important consequences for many species, for example:

- populations of short-lived organisms, e.g. mountain pine beetle, may increase during warmer winters
- organisms adapted to a larger range of temperatures may fare better than more specialized organisms
- where the daily and annual temperature ranges are becoming more similar (as they are in the tropics), we may see seasonal organisms that can now persist throughout the year

Putting Things in Context

This study focused on *what* has happened with temperature cycles, rather than *why* they may have changed. Other studies suggest that pollution in the atmosphere and cloud patterns may affect DTC by changing the amount of solar radiation reaching earth's surface. In fact, clouds have a large influence on daytime temperatures, but cloud patterns are difficult to model and there is currently no consensus on whether or how DTC may change in the future.

Click on the sub-headings above to go directly to the corresponding section of the full bulletin, or read the full bulletin online:
http://climatesmartnetwork.org/2014/12/ecologically-relevant-changes-in-temperature-variability/