WEATHER PATTERNS' INFLUENCE ON FROST TIMING

AIR CIRCULATION AFFECTS FROST MORE THAN GLOBAL WARMING — FOR NOW

May 23, 2017

Gardeners know the frustration of a false spring. Coaxed outside by warm weather, some people plant their gardens in the spring only to see a sudden late frost strike at the plants with a killer freezer burn. Grumbling green thumbs, along with farmers and water supply managers, would benefit from more accurate predictions of the first and last frosts of the season.

Such timing is in flux, however. The frost-free season in North America is approximately 10 days longer now than it was a century ago. In a new study, published today in Nature Communications, researchers from the University of Utah and the U.S. Geological Survey parse the factors contributing to the timing of frost in the United States. Atmospheric circulation patterns, they found, were the dominant influence on frost timing, although the trend of globally warming temperatures played a part as well.

"The frost-free season has been lengthening over the past century, and now we understand the changes in atmospheric circulation that are extremely strong in frost timing, even stronger than global warming," says University of Utah atmospheric sciences professor Court Strong.

Weather and climate are complex systems, with many factors affecting what the particular weather conditions might be in a certain place at a certain time. Previous research, says Gregory McCabe, of the USGS in Denver has focused on the role of large-scale phenomena like El Niño. "I don't think anyone has broken it down to look at the circulations patterns specific to the timing of frost," McCabe says.

Strong and McCabe set out to investigate the relative contributions of the global warming trend and local atmospheric circulation patterns to the century-long lengthening of the frost-free season.

"If you ask a U.S. forecaster what determines the first fall frost, they'll say a cold air mass coming down out of Canada, clearly due to circulation," Strong says. "There's a role for warming, but on the other hand forecasters will tell you there's clearly a role for circulation as well."

To more accurately capture regional, relatively small-scale circulation patterns, Strong and McCabe divided the United States into four regions, and examined separately how frost timing patterns varied in each region over 93 years of weather data.

The researchers found that atmospheric circulation patterns accounted for between 25 and 48 percent of the variation in frost timing. To put that in context, Strong says, remember that the frost-free season has lengthened by an average of 10 days over the past century. Three to five of those days can be accounted for by atmospheric circulation, while three days can be chalked up to global warming. Other factors, such as local cloud cover, may account for the remaining two to four days.

Although the results show that atmospheric circulation is the primary driver of frost timing, the warming trend exerts an influence over circulation beyond the general trend of warming temperatures. "We also found evidence that these circulation patterns themselves have been altered by global warming, especially in the Western U.S. and the Northwest," Strong says. "Warming is an important part of this narrative despite this finding that circulation is a stronger driver historically."

Next, Strong and McCabe will evaluate how well climate models capture the drivers of frost timing and look for ways the models can be improved. Better modeling of atmospheric patterns leads to more accurate forecast of future frost timing. "The year-to year variability in climate is controlled by these changes in atmospheric circulation," McCabe says. "On top of that you have the warming trend. If you don't get these patterns right then the simulations are going to have a lot of uncertainty in them."

This study was partially funded by a grant from the National Science Foundation (the iUTAH project; award EPS-1208732) Find the full study here (https://www.nature.com/articles/ncomms15307).

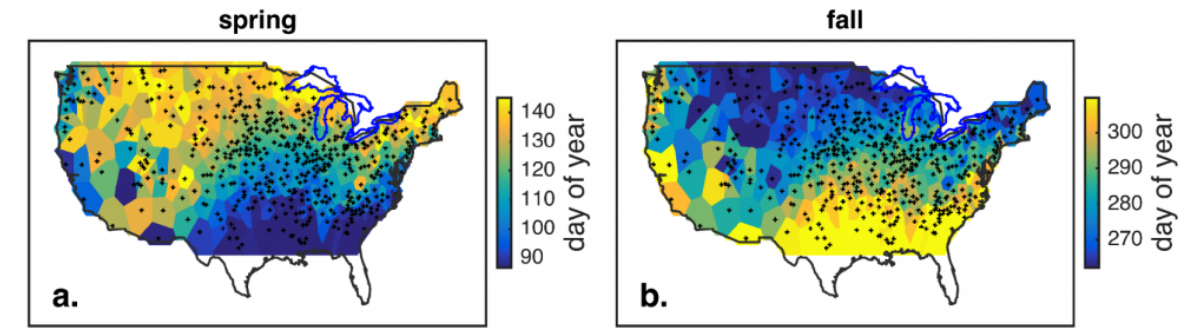

PHOTO CREDIT: Courtesy of Court Strong/University of Utah
Average day of the year with the last spring frost (left) and first fall frost (right). Cooler colors indicate an earlier day of the year.

Media Contacts

Court Strong | associate professor, Department of Atmospheric Sciences

Office: 801-585-0049 court.strong@utah.edu (mailto:court.strong@utah.edu)

Heidi Koontz | public affairs specialist, U.S. Geological Survey

Office: 303-202-4763 hkoontz@usgs.gov (mailto:hkoontz@usgs.gov)

Paul Gabrielsen | science writer, University Marketing & Communications

Office: 801-585-6861 Mobile: 801-505-8253 paul.gabrielsen@utah.edu (mailto:paul.gabrielsen@utah.edu)