SCIPP RESEARCH BRIEF:
TROPICALIZATION OF THE TEMPERATE ZONE: SPATIOTEMPORAL VARIABILITY OF WINTER WARMING AND DECLINING FREEZE DAYS ACROSS THE UNITED STATES

Vincent M. Brown[a], Derek T. Thompson[a], Buren B. DeFee II[a,b], Michael J. Osland[c], Barry D. Keim[d]

GOALS:

1. Quantify county-level annual and winter changes in daily minimum temperature (T_{min}) and maximum temperature (T_{max}) across America's tropical temperate transition zone (TTTz) and the Continental United States (CONUS) from 1951 to 2024, and examine spatial differences in these trends.
2. Assess whether the magnitude and timing of the coldest daily T_{min} and T_{max} at the county level have changed across and within cool seasons since 1952.
3. Quantify changes in the total count and temporal concentration of freeze days and evaluate the latitudinal movement of freeze-day occurrence during the cool season since 1952.

RESULTS:

ANNUAL MAXIMUM AND MINIMUM TEMPERATURES

99% of land area of both the CONUS and the TTTz experienced statistically significant warming. The observed average warming rates of both were 0.22°C per decade. During the winter, average T_{min} increased by 0.26°C a decade in the CONUS and 0.25°C a decade in the TTTz..

COOL SEASON COLDEST MINIMUM AND MAXIMUM TEMPERATURES

The average coldest T_{max} increased significantly in 111 counties and decreased significantly in 12 counties, with the counties exhibiting decreasing trends generally exhibiting weak or non-significant trends in the coldest daily T_{min}. Average coldest county-wide T_{min} significantly increased in 57% of land area at an average rate of 0.42°C per decade in the CONUS and increased in 779 counties at an average rate of 0.41°C per decade in the TTTz.

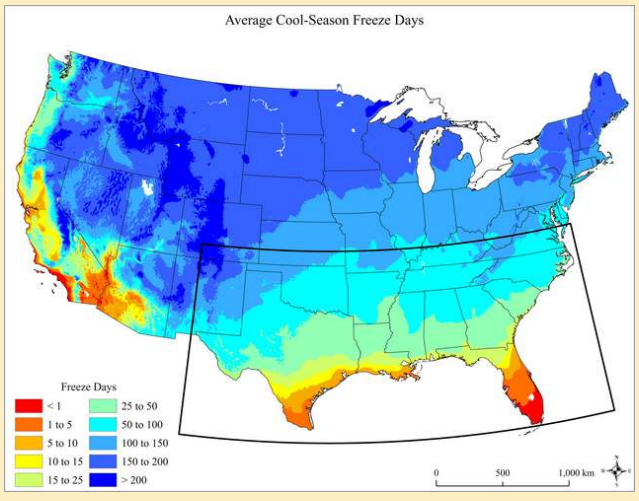

FIG. 2. Average cool-season freeze days from 1952 to 2024.

CHANGING FREQUENCY, CONCENTRATION, AND GEOGRAPHY OF FREEZE DAYS

In the CONUS, 85% of land area observed significant decreases in cool-season freeze days and 80% of counties with over 10 average freeze days exhibited significant trends in freeze day concentration, with all but one showing a contraction. 329 counties in CONUS exhibited significant trends in the start date of freeze-day concentration periods, with all but two counties shifting later. 739 counties exhibited significant trends in the end dates of freeze day concentration periods, with all but one shifting towards an earlier end date.

In the TTTZ, 94% of land area observed significant decreases in freeze days and 81% of counties with over 10 average freeze days exhibited significant trends of contraction in freeze day concentration. 212 of the 329 counties in CONUS that exhibited significant trends in the start date of freeze-day concentration periods were located in the TTTz. 260 counties in the TTTz exhibited significant end date trends all shifting earlier and generally located farther inland than counties with significant start date trends. Freeze day isopleths across two 20 year periods showed the mean latitude of freeze days has migrated poleward. The 30 freeze day isopleth was on average 122 km farther north in 2005-2024 than it was in 1952-1971.

ECOLOGICAL AND SOCIETAL IMPACTS OF WARMING WINTERS WITHIN THE TTTZ

The present trends can cause mass mortality of tropical, cold sensitive, taxa as they migrate northward or upslope in response to warming. Along the southeast coast of the TTTz, mangroves, which are coastal wetland plants that are sensitive to hard freezes, are expanding northward at the expense of salt marshes, altering key ecosystem services. On land, warming winters facilitate the northward spread of invasive species and in coastal waters, shifting species ranges are reshaping fisheries management. Some industries that are vulnerable to low temperatures, like Louisiana's crawfish aquaculture industry, may benefit from warmer winters.

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AFFILIATIONS

[a]Department of Geography & Anthropology, Louisiana State University, Baton Rouge, Louisiana, United States of America
[b]HNTB, Baton Rouge, Louisiana, USA
[c]U.S. Geological Survey, Lafayette, Louisiana, USA
[d]Louisiana State University Health Sciences Center, Environmental Health, Climate and Sustainability, New Orleans, Louisiana, USA

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