

Thermal Calendars Maps and Tool

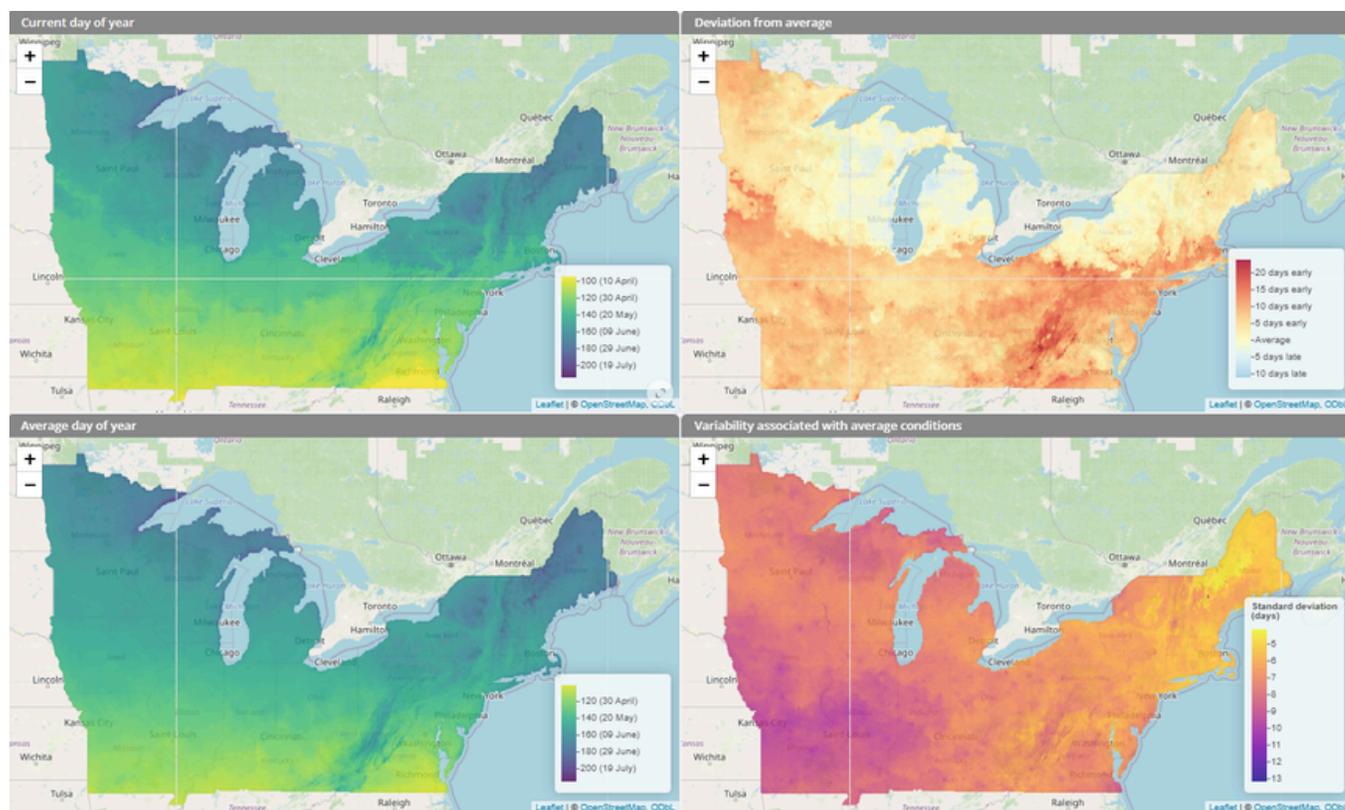
Many seasonal events in plants and insects are cued to occur after sufficient warmth has accumulated. This information can support planning, early detection and monitoring surveys, and response activities.

To support planning, survey, and management efforts, the USA National Phenology Network (USA-NPN) hosts an interactive tool providing high-resolution, real-time maps of thermal accumulation in the northeastern U.S.

The **Thermal Calendars Tool** offers maps indicating the date 50 distinct thresholds of accumulated warmth are reached in the northeastern U.S. Users can:

- View maps displaying information about the date a threshold has been reached in the current year or when it is typically reached.
- Zoom, pan, and extract values for specific locations.

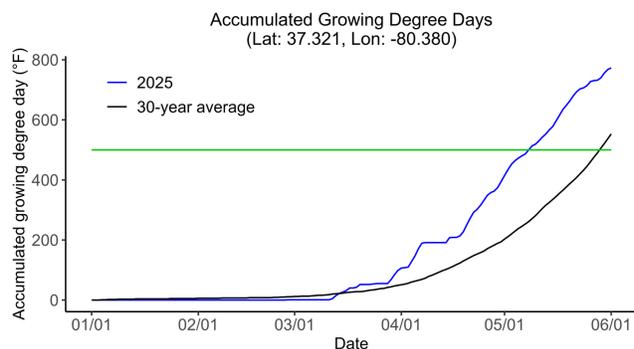
www.usanpn.org/data/maps/thermal_calendars



Maps displayed in the Thermal Calendars Tool for an accumulated growing degree day threshold of 400 °F in 2025. The map at the top left shows the dates on which the threshold was reached in 2025, and the map at the top right displays how many days earlier or later the 2025 date is relative to the average date between 1991 and 2020. The map at the bottom left displays the average date the threshold was reached between 1991 and 2020, and the map at the bottom right displays the variability, in days, around the long-term average date.

Accumulated Warmth: A Driver of Phenology

Accumulated warmth is typically measured in growing degree days (GDDs) and is commonly used to predict the timing of phenological transitions in plants and animals. For many species, seasonal life cycle transitions are triggered when a specific amount of heat has been accumulated after the start of the year. These are referred to as GDD thresholds. Thresholds can be especially useful in predicting when problematic insect pests will reach life stages during which they may cause the most damage or are most readily controlled.



Growing degree day accumulation for a location near Blacksburg, VA in 2025 (in blue) and a 30-year average accumulation curve (in black). In 2025, this location reached an accumulated growing degree day threshold of 500 (°F, in green) on May 9, twenty days earlier than the 30-year average.

Pest Insect Use Case: the Spongy Moth

Spongy moth (*Lymantria dispar*) caterpillars feed primarily on oak, birch, and poplar trees, causing defoliation which can lead to tree mortality. Control measures often target feeding caterpillars that are present after egg hatch (approx. 150 GDD) and before pupation (approx. 900 GDD).

Managers interested in determining when spongy moth caterpillars are expected to emerge from egg masses, for instance, can select a threshold value of 150 GDD in the Thermal Calendars tool and see whether their location has reached the threshold yet this year. If the location has not yet reached 150 GDD, users can view the date their location has reached the threshold historically and anticipate whether they are likely to reach the threshold earlier or later than normal based on anomalies for locations at lower latitudes or elevations.

Maps in the Thermal Calendars Tool

The tool provides maps that are updated daily, displaying the date on which GDD thresholds have been reached in the northeastern U.S. Maps indicate when thresholds were met in the current year as well as when thresholds are usually met. Maps are constructed for 50 distinct GDD thresholds, from 50 to 2500 GDD in 50-degree increments. Temperature data originate from PRISM¹ gridded temperature products at 4-km spatial resolution. GDD values are calculated using the Baskerville-Emin method² with a base temperature of 50 °F and a start date of January 1.

For a given threshold, the tool displays four maps:

- Date the threshold was reached in the current year.
- Average date the threshold was reached between 1991 and 2020.
- Variation among dates the threshold was reached, 1991-2020 (standard deviation).
- Number of days earlier or later the threshold was reached in the current year relative to the 30-year average.

Navigating in the Thermal Calendars Tool

When first accessing the tool, users have the option to select one of 50 GDD thresholds from a drop-down menu. After clicking the "Plot" button to display the maps, the user can zoom into a particular region. If the user clicks on a location in any of the four maps, values associated with that location will appear at the bottom left corner of each map. In addition to the full suite of GDD thresholds, two common insect pest examples are included to illustrate the utility of the tool and a link to a more extensive table of pest GDDs is provided.



Adult spongy moth with egg mass (left), first instar caterpillars (middle), and late instar caterpillar (right).

REFERENCES

¹PRISM Climate group. www.prism.oregonstate.edu

²Baskerville, G. L. & Emin, P. (1969). Rapid estimation of heat accumulation from maximum and minimum temperatures. *Ecology*, 50, 514-517. <https://doi.org/10.2307/1933912>

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