Daily Accumulated Growing Degree Day and Spring Index Maps

The USA-NPN produces and distributes daily national maps of accumulated temperatures and spring onset dates as part of a growing suite of phenology map products.

Accumulated temperature is a strong driver of seasonal transitions in plants and animals, including leaf-out, flowering, fruit ripening, and migration. The timing of these seasonal transitions is known as phenology. The USA National Phenology Network (USA-NPN; usanpn.org) is a national-scale program that supports scientific advancement and decision-making by collecting, storing, and sharing phenology data and information. USA-NPN produces and delivers daily maps and short-term forecasts of accumulated growing degree days and spring onset dates at fine spatial scale for the conterminous United States. These data products have utility for a wide range of natural resource planning and management applications, including scheduling invasive species and pest detection and control activities, determining planting dates, anticipating allergy outbreaks and planning agricultural harvest dates.

The USA-NPN invites you to use freely available daily and short-term forecast maps of accumulated growing degree days and spring onset dates at fine spatial scale for the conterminous United States.

- Maps can be viewed independently or in conjunction with in-situ plant or animal phenology observation data using the online USA-NPN Visualization Tool (usanpn.org/data/visualizations)
- Map images (.png, .gif, .pdf) or WCS and WMS raster data files (GeoTiff, ArcGrid, NetCDF) are freely available and can be downloaded using the USA- NPN Geoserver Request Builder page (usanpn.org/ geoserver-request-builder)
- Web services are available via the USA-NPN Geoserver (geoserver.usanpn.org/ geoserver/wms? request=GetCapabilities)
- Interpretive material are available at usanpn.org/data/phenology_maps

Accumulated Temperature: A Driver of Phenology

Heat accumulation over the course of the year is commonly used to predict the timing of phenological transitions in plants and animals. This accumulation is typically reported in terms of growing degree days (GDDs), defined as the number of degrees the mean daily temperature exceeds a base temperature, below which an organism will remain developmentally inactive.

For many plants and animals, there is a specific amount of heat that must be accumulated to trigger a change in phenological status, e.g., leaf-out in plants or egg hatching in insects. These are referred to as growing degree thresholds. If the threshold for a phenological transition is known for a particular species, we can predict the timing of that transition if we know the seasonal accumulation of growing degree days (AGDDs) at a particular location. National-scale models and maps are needed to track AGDD–and AGDD threshold dates– at the fine temporal scales and spatial scales which best support natural resource management decision-making.

National Growing Degree Day Maps and Gridded Data

The USA-NPN generates and distributes daily AGDD maps using a January 1 start date and two base temperatures, 32°F and 50°F. Maps are constructed using PRISM[1] gridded temperature products and are available at 4 km spatial resolution. The figures on page 2 represent example maps. AGDD products available from USA-NPN at usanpn.org/data/agdd_maps include:
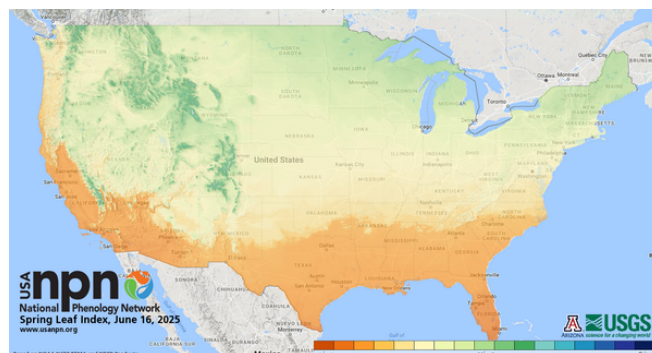
- Contemporary (daily, current year) maps of AGDD
- Daily anomaly maps of AGDD (current day compared to 30-year [1991-2020] mean for day)
- Daily 30-year mean temperature accumulations
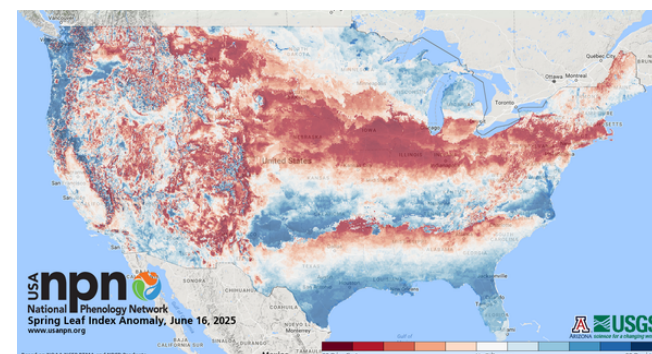- Daily minimum and maximum temperature values for current year
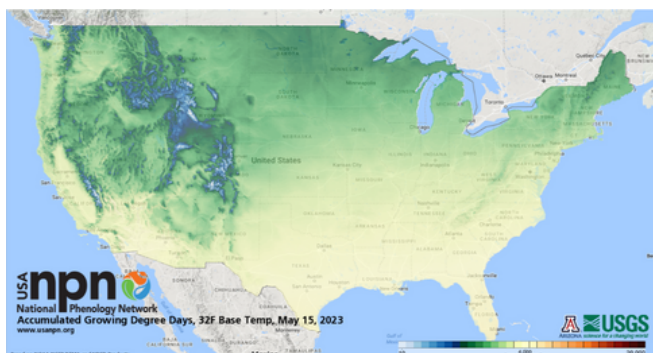
2023 AGDD for 15 May 2023 (32°F base)

2025 Spring Index First Leaf threshold dates as of 16 June
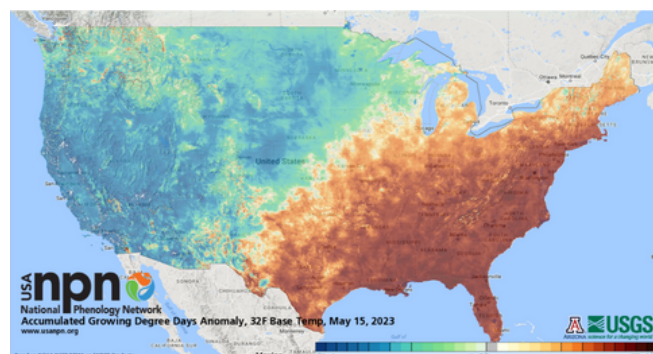
Anomaly for 15 May 2023 AGDD (32°F base) relative to 30-year (1991-2020) mean for 15 May

Anomaly for 2025 Spring Index First Leaf dates as of 16 June relative to 30-year (1991-2020) mean for 16 June

Spring Indices: Indicators of Phenological Activity

The Spring Indices are a form of AGDD model that predict the "start of spring" as a threshold event at any particular location, based on a model developed from early spring shrub leaf out and bloom events[2,3]. They are a powerful tool to track and forecast the progression of the onset of spring across the country.

The Spring Indices have value for applications where documenting the biological start of spring can help predict fire season or drought risk, growing season length, or inter-annual patterns of variability and change in the timing of spring, and have been included as national-scale indicators of climate change responses in the U.S. Environmental Protection Agency's Climate Change Indicators in the United States report[4] and the National Climate Indicators System, part of the U.S. National Climate Assessment[5]. In 2025, the USA-NPN's suite of Spring Indices was expanded to include the Late Bloom Index, an estimate of when conditions associated with the end of spring are reached[6].

National Spring Index Maps and Gridded Data

The USA-NPN generates and distributes Spring Index maps constructed using PRISM[1] gridded temperature products and are available at 4 km spatial resolution.

Spring Index products available from USA-NPN include:
- Current year maps of Spring Index First Leaf, First Bloom, and Late Bloom dates
- Current year anomaly maps of First Leaf, First Bloom, and Late Bloom dates (current year compared to 30-year [1991-2020] mean)
- Annual First Leaf and First Bloom date maps, 1981-2025
- Annual Late Bloom date maps, 1991-2020
- 30-year (1991-2020) mean maps for First Leaf, First Bloom, and Late Bloom dates
- Annual First Leaf and First Bloom date maps, 1880-2013

REFERENCES
[1] PRISM Climate group. www.prism.oregonstate.edu
[2] Ault, T. R., et. al. 2015. Trends and natural variability of North American spring onset as evaluated by a new gridded dataset of spring indices. *Journal of Climate*, 28, 8363-8378, 10.1175/JCLI-D-14-00736.1
[3] Schwartz, M.D., et. al. 2013. Spring onset variations and trends in the continental United States: past and regional assessment using temperature-based indices. *International Journal of Climatology*, 33, 2917–2922, 10.1002/joc.3625.
[4] EPA Climate Change Indicators. www.epa.gov/climatechange/science/indicators/index.html
[5] U.S. Global Change Research Program Indicators. www.globalchange.gov/browse/indicators
[6] Hatzis, J.J., et al. 2025. Building spring development indices for woody species in the conterminous United States. *Agricultural and Forest Meteorology,* 110443, 10.1016/j.agrformet.2025.110443