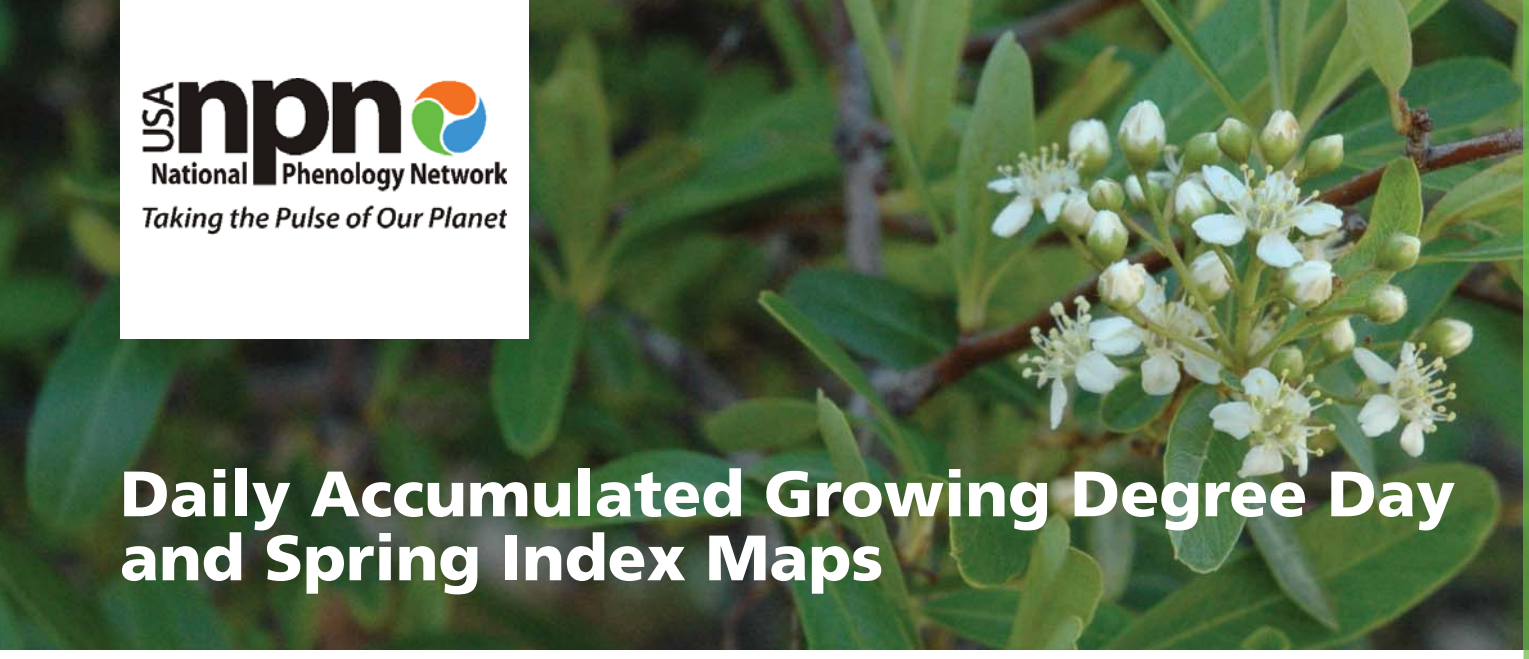


USA npn National Phenology Network
Taking the Pulse of Our Planet

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.

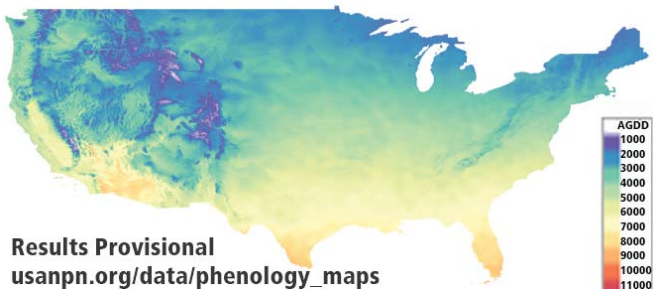
For many plants and animals, there is a specific amount of heat that must be accumulated to trigger a change in phenological status, e.g., leaf-out in plants or egg hatching in insects. These are referred to as growing degree thresholds. If the threshold for a phenological transition is known for a particular 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

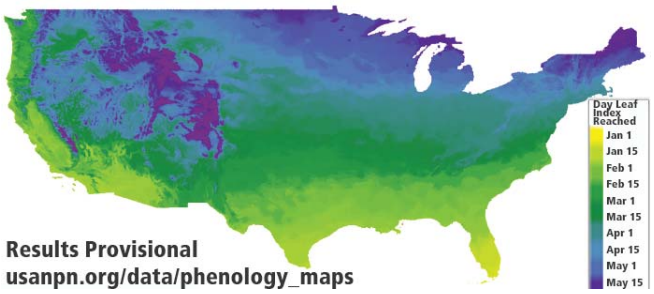
The USA-NPN generates and distributes daily AGDD maps using a January 1 start date and two base temperatures, 32°F and 50°F. Maps are constructed using NOAA National Centers for Environmental Prediction (NCEP) Real-Time Mesoscale Analysis (RTMA)[1], NOAA National Weather Service National Digital Forecast Database [2] and PRISM [3] gridded temperature products and are available at 2.5 km spatial resolution. The figures below represent example product output generated from the USA-NPN Geoserver Request Builder. AGDD products available from USA-NPN at usanpn.org/data/agdd_maps include:

- Contemporary (daily, current year) maps of AGDD
- 6-day forecast maps of AGDD
- Daily anomaly maps of AGDD (current day compared to 30-year [1981-2010] mean for day)
- Daily 30-year mean temperature accumulations
- Daily minimum and maximum temperature values for current year

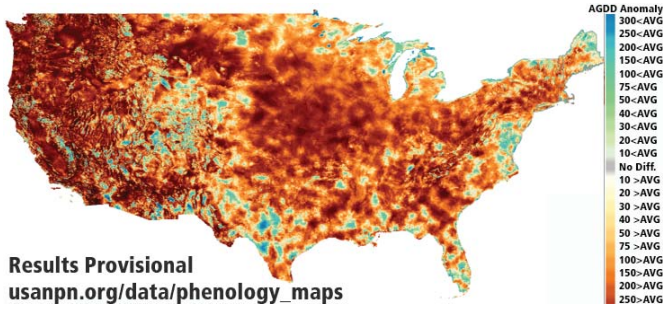
To assess the level of uncertainty in the USA-NPN AGDD products, we compare our URMA/RTMA-based calculations of Accumulated Growing Degree Days to those made using measurements from U.S. Climate Reference Network stations, accessed via the Applied Climate Information System, in the AGDD Uncertainty Assessment Dashboard (usanpn.org/agdd_uncertainty).



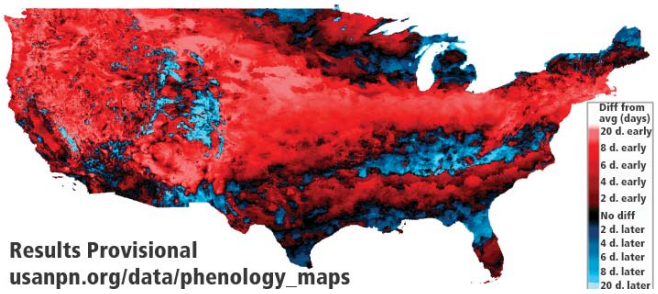
2016 AGDD for 1 July 2016 (32°F base) (provisional)



2016 Spring Index First Leaf threshold dates as of 1 July (provisional)



Anomaly for 1 July 2016 AGDD (32°F base) relative to 30-year (1981-2010) mean for 1 July (provisional)



Anomaly for 2016 Spring Index First Leaf dates as of 1 July relative to 30-year (1981-2010) mean for 1 July (provisional)

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 [4,5]. 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 [6] and the *National Climate Indicators System*, part of the *U.S. National Climate Assessment* [7]. The Spring Index models were used to demonstrate that 2012 had the earliest spring on record in North America [8]. More recently, they showed that of 276 U.S. National Parks, 76% of parks are showing advances in the onset of spring, and 53% of parks are now experiencing "extreme" early onsets of spring [9]. The maps below were generated from the USA-NPN Geoserver Request Builder.

National Spring Index Maps and Gridded Data

The USA-NPN is generating and distributing Spring Index maps constructed using NOAA NCEP RTMA/URMA and NDFD [1,2] and PRISM [3] gridded temperature products and are available at 2.5 km spatial resolution. Spring Index products available from USA-NPN include:

- Current year maps of Spring Index First Leaf and First Bloom dates
- 6-day forecast maps of Spring Index First Leaf and First Bloom dates
- Current year anomaly maps of First Leaf and First Bloom dates (current year compared to 30-year [1981-2010] mean)
- Annual First Leaf and First Bloom date maps, 1981-2015
- 30-year (1981-2010) mean maps for First Leaf and First Bloom dates

To assess the level of uncertainty in the USA-NPN Spring Index products, we compare our URMA/RTMA-based calculations of Spring Index First Leaf and First Bloom dates to those made using measurements from U.S. Climate Reference Network stations, accessed via the Applied Climate Information System. These results will be posted on the USA-NPN Spring Index webpage, at usanpn.org/data/spring_indices.

Acknowledgements

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Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government. This report complies with the US Geological Survey Fundamental Science Practice standards. It has undergone peer and policy review and approval.

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USGS THE UNIVERSITY OF ARIZONA

Contact Information
Jake F. Weltzin, US Geological Survey
Program Manager, Status & Trends Program
Executive Director, USA National Phenology Network
1311 East 4th Street, Tucson, AZ 85721
Phone: (520) 626-3821
E-mail: jweltzin@usgs.gov