Calculating Normal Grazing Periods Using Historical nClimGrid-Daily Data

A reproducible reanalysis of FSA's NAP-190 methodology anchored to the 1991–2020 climate normals

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ABSTRACT

Eligibility for FSA drought and disaster relief programs — including NAP, LFP, and ELAP — depends in part on whether a qualifying loss occurs during the "normal grazing period" established for each pasture or grazing crop type in each county. FSA Notice NAP-190 (2017) defines a probabilistic, temperature-based procedure for proposing those grazing periods, but the operative county dates still largely trace to a one-time national calculation. Here we re-implement the NAP-190 procedure as a fully scripted, reproducible workflow and re-calculate full-, cool-, and warm-season normal grazing periods for every county in the contiguous United States using NOAA's nClimGrid-daily gridded weather dataset and the current 1991–2020 climate normals. The same pipeline can be re-run on each new decadal climate normal — so program criteria can stay current with measured conditions rather than going stale.

KEY FINDINGS

- Normal grazing periods can be re-derived for all 3,100+ CONUS counties directly from FSA's own NAP-190 methodology, using open data and open code, in a workflow that re-runs on each new 30-year climate normal.
- Smoothed daily Gumbel-distribution climatologies of county temperature extremes reproduce the probabilistic freeze-date definitions in NAP-190 while resolving ambiguities in its cool-season language.
- Grazing-period start and end dates are rounded only outward, so rounding never shortens a producer's eligible season.
- The resulting county table of full-, cool-, and warm-season grazing periods is published as an open, analysis-ready dataset alongside this report.

Sustainable FSA
ENHANCING DISASTER RELIEF

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BY THE NUMBERS

3,100+
CONUS counties with re-derived normal grazing periods

1991–2020
climate normals period, the current 30-year standard

~3.75 km
resolution of the NOAA nClimGrid-daily temperature grids

3
grazing seasons derived per county — full, cool, and warm

PROJECT AT A GLANCE

Three-year cooperative agreement with the USDA Office of the Chief Economist (OEEP), in partnership with the USDA Climate Hubs and the Farm Service Agency. Led by the Montana Climate Office at the University of Montana — Montana's official state climate office.

HOW TO CITE

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DATA & CODE

sustainable-fsa.com/nclimgrid-normal-grazing-period

Montana Climate Office

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Background

In several US Department of Agriculture (USDA) Farm Service Agency (FSA) drought and disaster relief programs — including the Noninsured Crop Disaster Assistance Program (NAP), Livestock Forage Disaster Program (LFP), and Emergency Assistance for Livestock, Honey Bees, and Farm-raised Fish (ELAP) — program eligibility is determined in part by whether the qualifying disaster (and resulting loss) occurs during the "normal grazing period" for a particular type of pasture or grazing crop. State FSA offices have broad discretion to define normal grazing periods for their regions based on local conditions.

In April 2018, USDA FSA issued Notice NAP-190, *Review of Normal Grazing Periods and Carrying Capacities for* NAP, LFP, *and* ELAP, which sought to provide a more consistent definition of growing, coverage, and grazing periods across these programs. According to NAP-190, "the normal grazing periods established for each pasture or grazing crop type for LFP are to be consistent with grazing periods established for NAP purposes according to 1-LDAP (Rev. 1), subparagraph 411 M. DAFP has determined the grazing periods are to be consistent with ELAP as well." Also, "for program integrity purposes, growing periods, coverage periods, and grazing periods are analogous to each other and need to be consistent for each crop and type intended for forage or grazing".[1, p. 1]

NAP-190 defines a process for proposing normal grazing periods by county across the US based on daily temperature recordings.[1, p. 1] The USDA Deputy Administrator for Farm Programs (DAFP) office initially calculated normal grazing periods across the US. These county-level grazing period definitions were then shared with the state FSA offices, which were invited to review and recommend amendments. Amended grazing periods were returned to the National Office for review and approval.

Here, we use the procedures outlined in NAP-190[1, pp. 4–7] to re-calculate normal grazing periods for all counties in the US, using the latest thirty-year climate normals (1991–2020).

Guidelines for establishing normal grazing periods

NAP-190 describes a probabilistic, temperature-based definition of the start and end dates of the grazing period:[1, p. 4]

> *Livestock receive daily nutrients and obtain net energy requirements during the spring and early summer months of the forage growth period without supplemental feed. DAFP has reviewed available information and determined:*
>
> - *full season and/or warm season grazed forage crops' types plant growth historically: begins on or after the last date of an 80 percent probability that a 28 degree Fahrenheit temperature (freeze date) occurs in a county, known as the beginning date of the grazing period; ends on or before the first date of an 80 percent probability of a 28 degree Fahrenheit temperature (freeze date) occurring in a county, known as the normal harvest date (grazing period end date).*
> - *cool season grazed forage crops' plant growth development for nutritional value historically begins on or after the first date the minimum average temperature is approximately 50 degrees Fahrenheit and transitions to a semi-dormant stage when temperatures reach an average maximum of 90 degrees Fahrenheit. This date is the normal harvest date (grazing period end date) for cool season grasses.*

The definition used for cool-season crops is unfortunately ambiguous. The start date uses the phrasing "minimum average temperature" (suggesting the minimum of averages, presumably across the county), while the end date uses "average maximum" (suggesting the average maximum temperature that occurs in a county, analogous to the definition for full/warm season crops). Here, we apply the phrasing for the end date to both the start and end dates, and use the mode of the distribution instead of the average (due to skewness) — we take the climatological modes of minimum and maximum temperatures that occur in each county, and set start and end dates using the 50° and 90° thresholds, as described.

NAP-190 offers further guidance on the determination of warm- and cool-season grazing periods: only Arkansas, Mississippi, and Oklahoma had been approved by DAFP for establishing both warm- and cool-season grazing periods as of the notice, with Alabama, Florida, Georgia, Louisiana, North Carolina, South Carolina, and Texas identified as states where both may also apply.[1, p. 3] Paired seasons need not be equal in length, cannot overlap, and combined may not exceed 12 months. Dates are customarily rounded to the 1st or 15th of the month for start dates, and the 15th or last day of the month for end dates.[1, p. 7]

Establishing normal grazing periods using a 1991–2020 climatology

"Climate normals" are statistical descriptions of typical climate conditions. Normals are often calculated using past weather data, and can be predictive of conditions in the near future. Conventional practice since the 1930s is to calculate climate normals using 30 years of data, updated decadally; the last decadal update of the NOAA climate normals is for the 1991–2020 period.

Traditionally, temperature normals (for daily minimum and maximum temperature) are represented by the average value of thirty years of data. However, it is useful to represent the expected range of variability as well, and the methods described in NAP-190 require probabilistic estimates of temperatures to define grazing period start and end dates. Here, we develop a method for estimating the parameters of statistical distributions describing daily temperature extremes. Our methods are similar in principle to those described by Rennie et al.,[2] except that we derive daily distribution parameters which we smooth annually, and from which we calculate values such as the mode and exceedance probabilities.

3.1 Method summary and example

In order to establish normal grazing periods for each county, we must first define normal climatologies for the US. The basic steps of the analysis are:

1. Find the minimum and maximum daily temperature in each county
2. Estimate Gumbel distribution parameters using L-moments
3. Smooth annual series of daily Gumbel distribution parameters using a cyclic smoother
4. Identify and round first and last days of grazing periods

To illustrate the method, we derive annual daily climatologies for minimum and maximum temperature for Missoula County, Montana. All analyses are scripted in the *R* statistical programming language for reproducibility,[3] relying on the `dplyr`,[4] `tidyr`,[5] and `magrittr` [6] packages; the complete code is published with this report.

Estimate Gumbel distribution parameters using L-moments. Each day of the year is represented by a series of thirty minimum and maximum temperatures observed in the county, 1991–2020. Gaussian (normal) distributions are traditionally used for average temperature, but minimum and maximum temperature distributions are often skewed. We therefore fit Gumbel distributions — appropriate for modeling extreme values such as temperature minima and maxima — to each day's series using L-moments, which provide robust estimates of distribution location, scale, and shape.[7; 8]

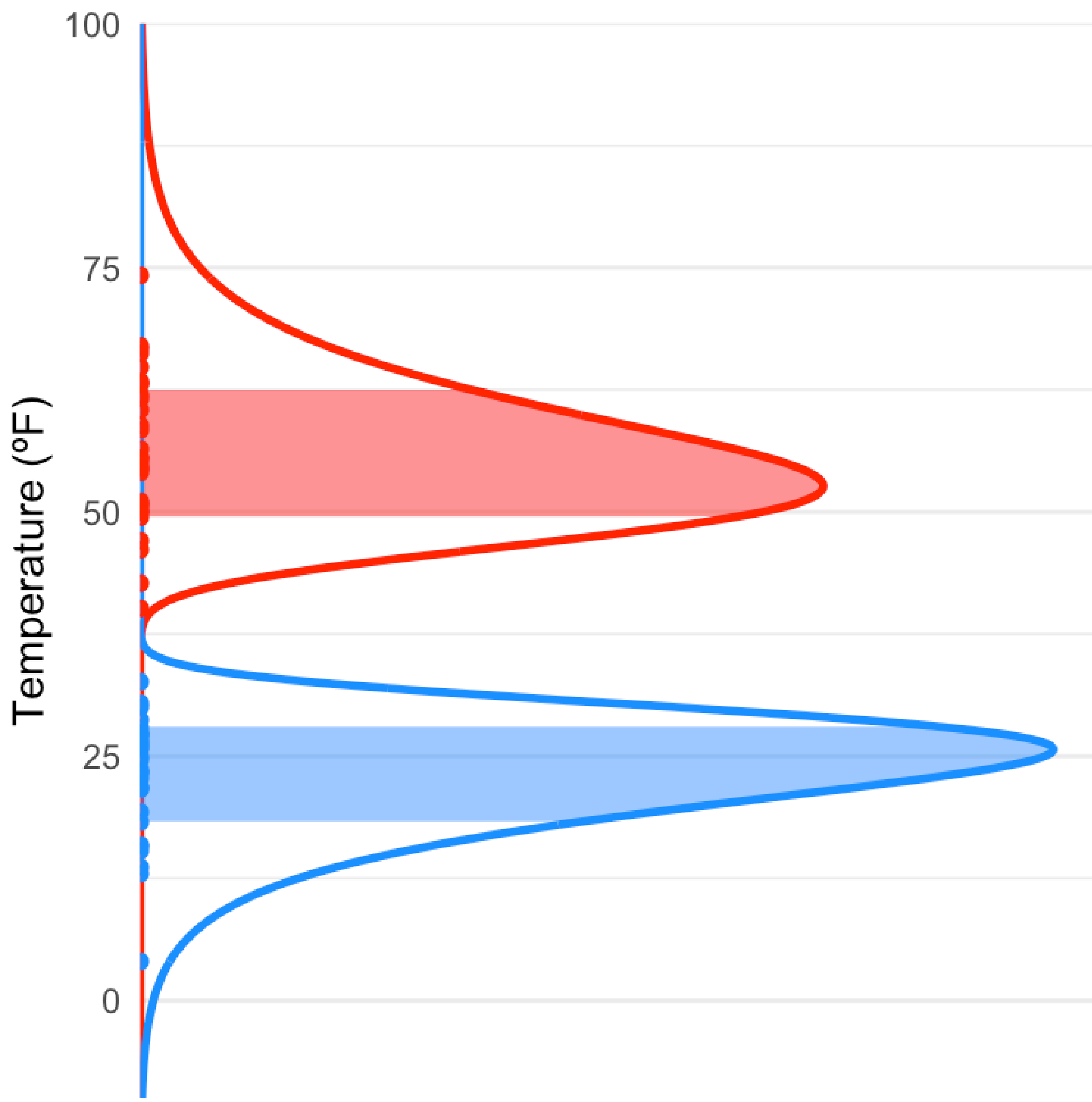

Figure 1. Gumbel distributions fit to observed minimum and maximum temperatures for October 23 in Missoula County, Montana, 1991–2020, with the 20th–80th percentile range shaded. The minimum-temperature distribution is narrower than the maximum-temperature distribution.

Performing the fit for every day of the year captures the annual cycle of both the magnitude and the spread of expected temperatures: the spread of maximum temperature is relatively stable through the year, while minimum temperature is narrower in summer and wider in winter.

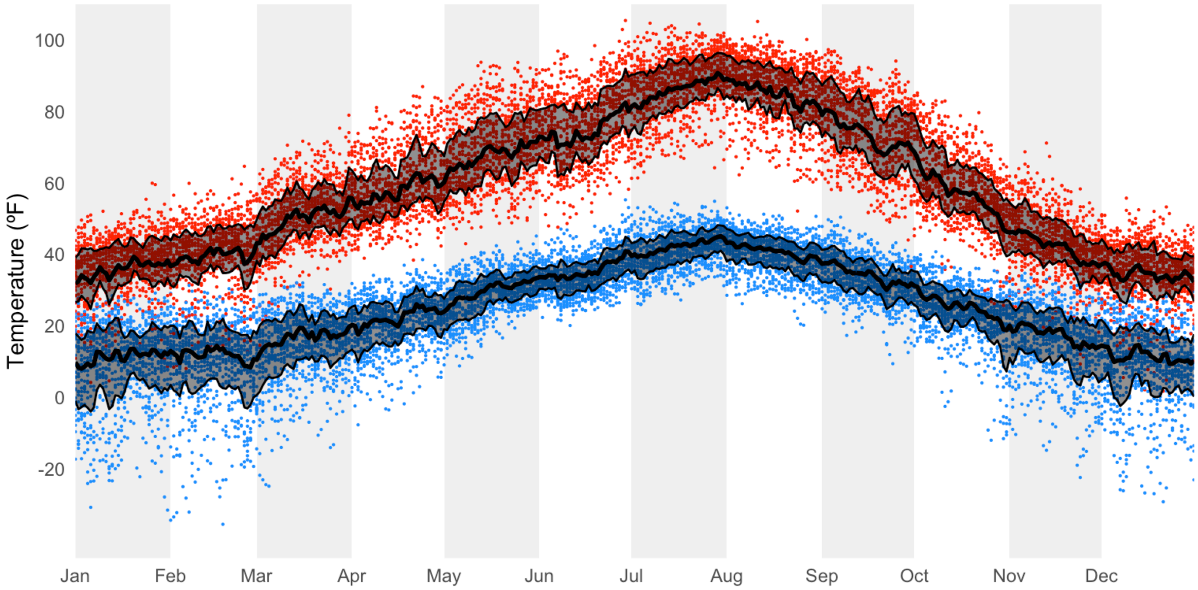

Figure 2. Daily 20th–80th percentile ranges of the fitted minimum and maximum temperature distributions for Missoula County across the year.

Smooth the daily parameters with a cyclic smoother. The raw daily distribution parameters are jagged, as is typical of daily normals. We apply a cyclic generalized additive model with 12 knots (allowing monthly variability) to the parameters of the daily Gumbel distributions, yielding smooth daily climate normals that capture variability in both the magnitude and spread of temperature through the year.

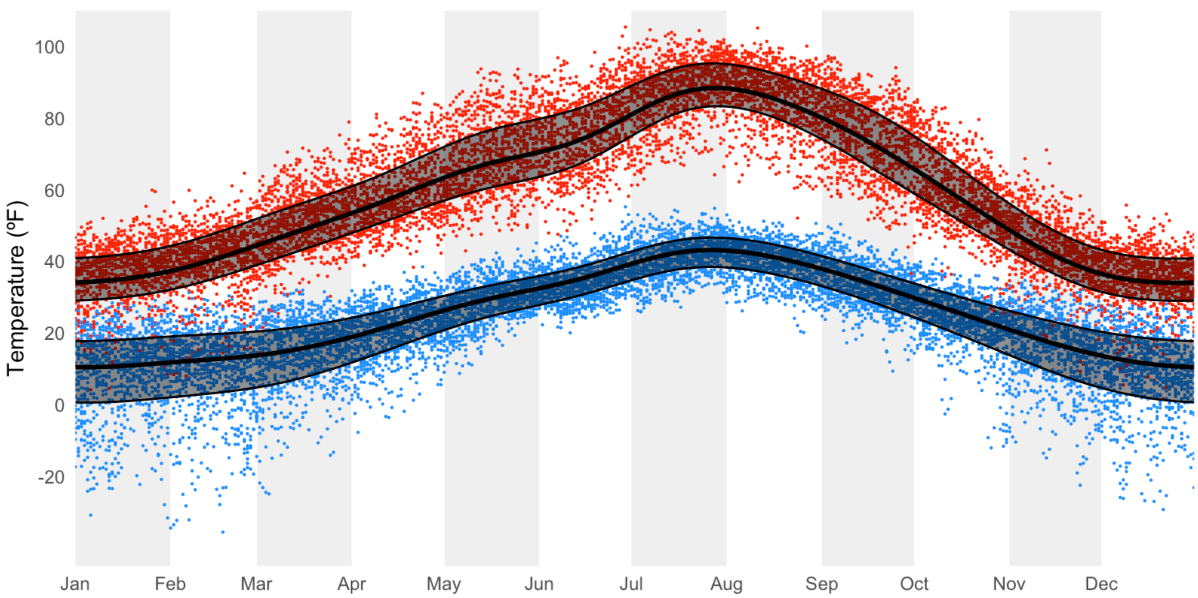

Figure 3. Smoothed daily climate normals for Missoula County: cyclic-GAM-smoothed Gumbel distribution parameters yield continuous daily distributions of minimum and maximum temperature.

Identify and round grazing period dates. For most of the US (including Missoula County), the grazing period depends only on the 80th percentile of minimum temperature: it is the period when the 80th percentile of daily minimum temperature is 28°F or higher.[1, p. 4] Defined this way, the normal grazing period for Missoula County begins on April 20 and ends on October 24. NAP-190 allows rounding to the 1st, 15th, or last day of the month; we round only so as to *expand* the grazing period — start dates round earlier, end dates round later — so rounding never shortens a producer's eligible season. The rounded normal grazing period for Missoula County is April 15 – October 31.

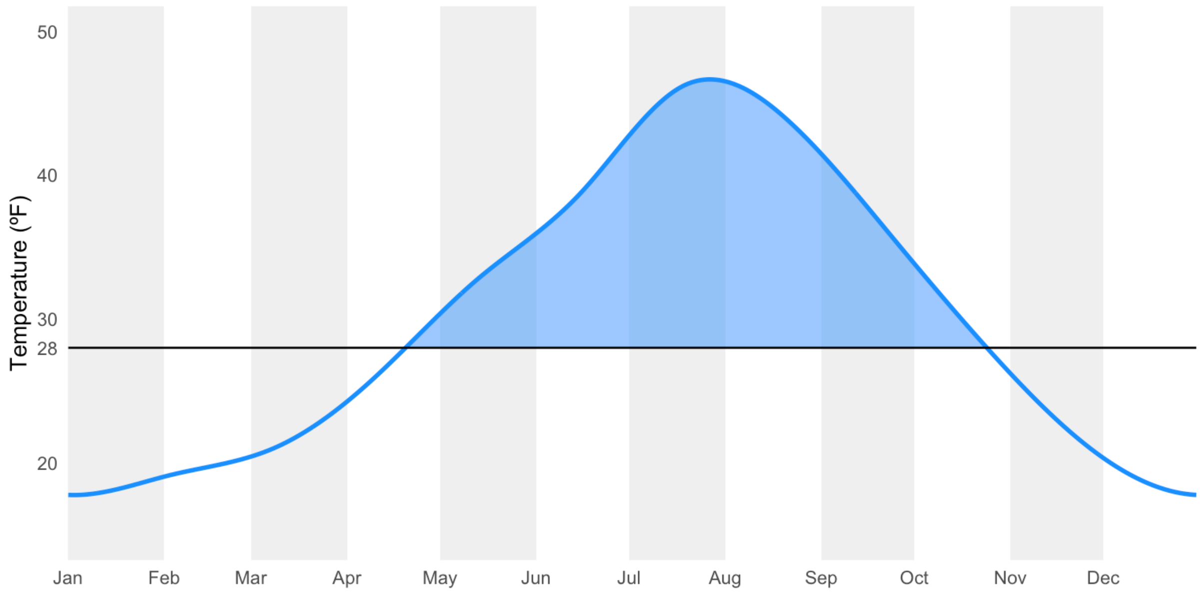

Figure 4. The derived normal grazing period for Missoula County, Montana: the period when the smoothed 80th percentile of daily minimum temperature is at or above 28°F.

Normal grazing periods across the contiguous United States

We calculate grazing periods using the methods described above for every county in the contiguous United States (CONUS). Grazing periods could, in principle, be calculated for areas outside the CONUS as well (e.g., Alaska, Hawaii, and other US territories); however, the dataset used here is only available within the CONUS. Future work will identify appropriate gridded datasets for calculating normal grazing periods elsewhere.

4.1 nClimGrid-daily data

The NOAA nClimGrid-daily dataset is NOAA's operational gridded weather dataset.[9] The data are derived from *in situ* weather station observations from the Global Historical Climatology Network daily data (GHCNd), and processed to capture weather variability due to topographic and other landscape effects while addressing the temporal and spatial idiosyncrasies of the GHCNd record. nClimGrid-daily is produced at a resolution of 1/24 of a degree (0.0417°), roughly 3.75 km per grid cell, and data become available two to three days after the observation date. For this analysis, we downloaded daily minimum and maximum temperature for all days from January 1, 1991 through December 31, 2020 from NOAA's public Amazon S3 archive, parallelized with the `furrr` and `future` packages for R.[10; 11]

4.2 Calculating normal grazing periods for each county

We calculated daily summaries recording the minimum and maximum temperature occurrences in each CONUS county, using generalized (1:500k) county boundaries from the US Census TIGER/Line Shapefiles database via the `tigris` package[12] and fast zonal extraction via `exactextractr`;[13] daily county summaries are stored in the Apache Arrow IPC format.[14] Sample L-moments and Gumbel parameters are estimated with the `lmom` package,[15] and parameter series are smoothed with 12-dimension cyclic cubic regression splines using `mgcv`.[16]

We then calculate full-, cool-, and warm-season normal grazing periods. Full-season periods are defined as described above for Missoula County; in counties that never exceed an 80% probability of a 28°F minimum temperature, the normal grazing period is the full year. Cool-season periods are defined using the modal minimum and maximum daily temperatures against the 50°F and 90°F thresholds, rounded outward as above; warm-season periods are the remainder of the full season after the cool season ends. Warm- and cool-season grazing periods are calculated only for the states specified in NAP-190, and only for counties within those states where valid grazing periods can be derived.

4.3 Results

The output of this analysis is a table of CONUS counties and their respective full-, cool-, and warm-season normal grazing periods, as derived for the 1991–2020 climatology period. The complete dataset, interactive maps, and all source code are published at sustainable-fsa.com/nclimgrid-normal-grazing-period.

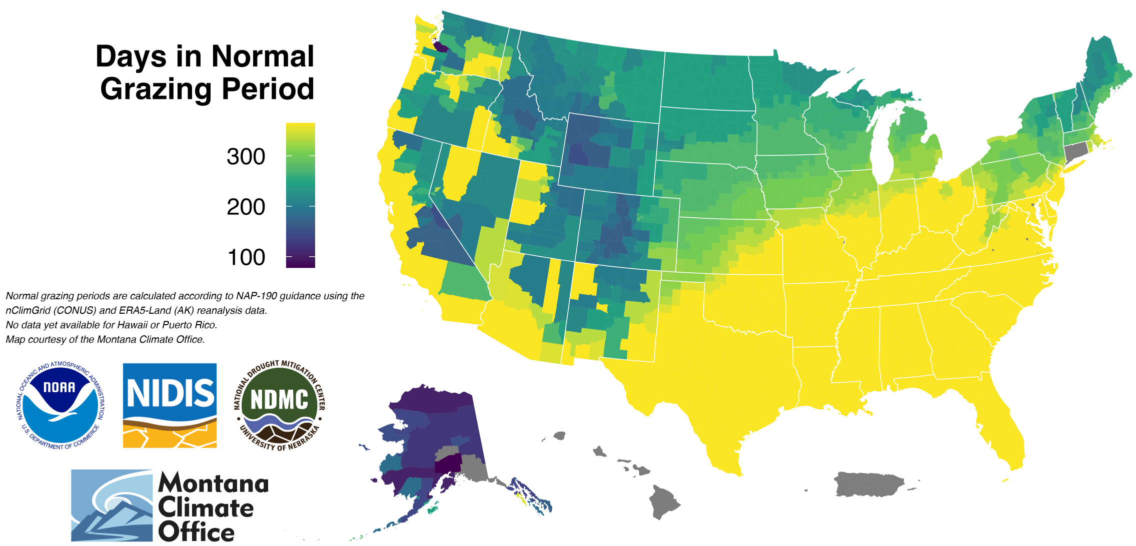

Figure 5. Normal grazing period start, end, and duration for every county in the contiguous United States, derived from the 1991–2020 nClimGrid-daily climatology using the NAP-190 methodology.

Next steps

This reanalysis demonstrates that FSA's own grazing-period methodology can be maintained as a living, reproducible workflow: anchored to the current climate normals, re-runnable on each decadal update, and auditable from raw weather observations through final county dates. Planned work will migrate the pipeline from nClimGrid-daily to ERA5-Land forcing in order to extend coverage beyond the CONUS to Alaska, Hawaii, and Puerto Rico — bringing every LFP-eligible county under a single, consistent grazing-period methodology.

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