

# climatekit

Unified climate indices in R

Charles Coverdale

*London, United Kingdom*

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## The question

**How should we compute the standard suite of climate indices from daily observations in a single reproducible R interface?**

*Thirty indices, five families, one consistent tidy output schema.*

## Why it matters

- **National statistical offices** publish annual climate-index tables
- **Agricultural research** tracks growing-season and heliothermal indices
- **Insurance underwriters** price parametric drought and heat products
- **Public-health authorities** monitor heat-index exceedances in real time

## What is already out there

- **SPEI**: drought indices only, narrow scope<sup>1</sup>
- **climdex.pcic**: standard ETCCDI indices, archived on CRAN
- **Evapotranspiration, various agri packages**: fragmented, inconsistent output schemas
- **Station-level tooling**: bespoke scripts, no reusable public interface

The gap: **no single package unifies the standard workflow with a tidy output schema.**

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<sup>1</sup> Begueria & Vicente-Serrano (2017), *SPEI: Calculation of the Standardised Precipitation-Evapotranspiration Index*, R package v1.7.

## What climatekit offers

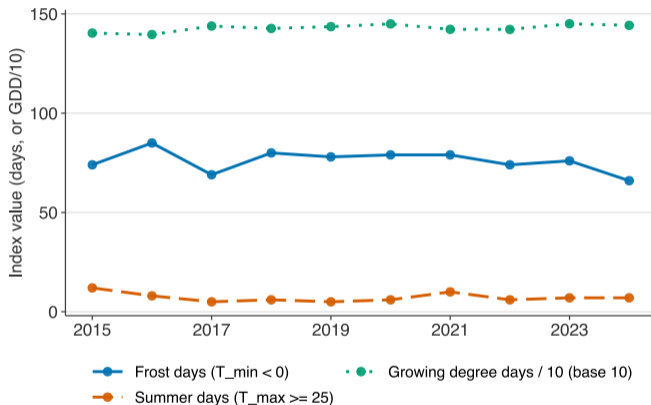
1. **Coverage:** 30+ indices across 5 families (temperature, precipitation, drought, agroclimatology, thermal comfort)
2. **Interface:** every function returns the same four-column tidy schema; outputs compose via `rbind()`
3. **Provenance:** pure computation, no API calls, no network dependency, 133 unit tests

On CRAN since March 2026. Definitions follow ETCCDI recommendations<sup>2</sup>.

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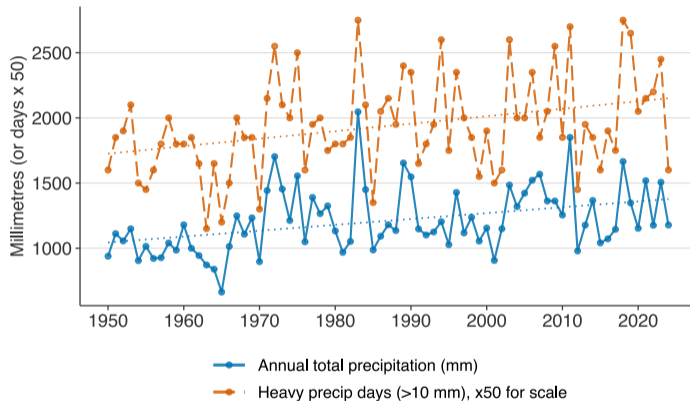
<sup>2</sup> Zhang et al. (2011), *Indices for monitoring changes in extremes based on daily temperature and precipitation data*, WIREs Climate Change 2(6).

# Temperature: frost days, summer days, GDD



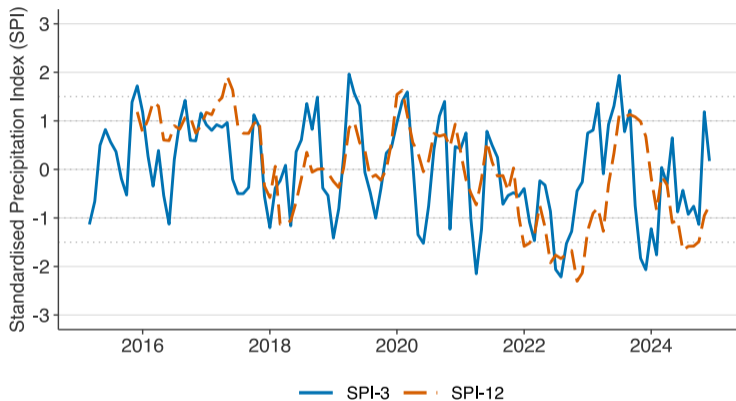
Annual temperature indices, Central Park. Eight exports: `ck_frost_days()`, `ck_summer_days()`, `ck_gdd()`, `ck_hdd()`, `ck_gsl()`, and more.

# Precipitation: totals, intensity, extremes



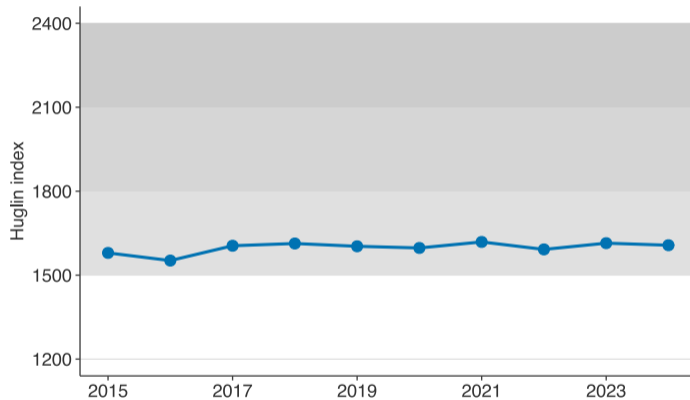
Annual totals (blue) and heavy-precip days above 10 mm (orange, scaled 50x), Central Park. Seven exports: `ck_prcptot()`, `ck_r10mm()`, and more.

## Drought: standardised precipitation indices



*SPI-3 and SPI-12, Central Park. Dashed lines at  $\pm 1$  mark moderate drought thresholds. Exports: `ck_spi()`, `ck_spei()`, `ck_pet()`.*

# Agroclimatology: Huglin heliothermal index



*Huglin index, synthetic 10-year temperate site at 51.5°N. Shaded bands mark viticultural suitability. Exports: `ck_huglin()`, `ck_winkler()`, `ck_branas()`.*

## Central formulas

**Frost days** (count below 0°C):

$$FD = \sum_t \mathbf{1}\{T_{\min,t} < 0^\circ\text{C}\} \quad (1)$$

**Growing degree days** (cumulative heat above base  $b$ ):

$$GDD_b = \sum_t \max(T_{\text{mean},t} - b, 0) \quad (2)$$

**Standardised Precipitation Index** (McKee et al. 1993):

$$SPI_s = \Phi^{-1}[F(P_s; \alpha, \beta)] \quad (3)$$

## Package at a glance

Function families:

- **Temperature:** 8 functions
- **Precipitation:** 7 functions
- **Drought** (SPI, SPEI, PET): 3 functions
- **Agroclimatology** (Huglin, Winkler, Branas): 5 functions
- **Thermal comfort:** 4 functions
- **Dispatchers:** `ck_compute()`, `ck_available()`, `ck_metadata()`

Deps: `cli`, `stats`, `tools`. R  $\geq$  4.1.0.

### Uniform output

Every function returns:

`period | value | index | unit`

Outputs compose via `rbind()` into panel data.

## Minimal working example

```
library(climatekit)

# Three indices from Central Park daily observations
fd  <- ck_frost_days(tmin,  dates, period = "annual")
gdd  <- ck_gdd(tmin, tmax,  dates, base = 10, period = "annual")
spi3 <- ck_spi(precip,    dates, scale = 3)

# Compose into a panel for plotting or modelling
panel <- rbind(fd, gdd, spi3)
```

All three calls share the same four-column schema, so `rbind()` works without reshaping or renaming.

## Central Park temperature trends, 1950 to 2024

**Data.** NOAA GHCND station USW00094728. 75 years of daily  $T_{\min}$ ,  $T_{\max}$ , and precipitation. Complete record through 2024.

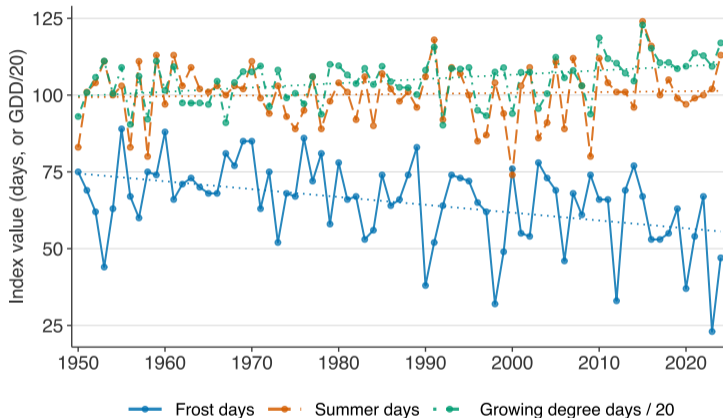
**Question.** *How have temperature indices evolved in the US Northeast over seven decades?*

**Why this case.** Flagship US long-record station. Northeast warming debate active in *J. Climate*<sup>3</sup>. Three indices with distinct signals (warming, stable, trending). Reproducible with three public function calls.

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<sup>3</sup> Brown & DeGaetano (2013), *Trends in U.S. surface humidity*, *J. Applied Meteorology* 52.

# Central Park: three temperature indices, 1950 to 2024



Frost days:  $-2.6$  per decade. Summer days:  $+0.3$  per decade. GDD (base  $10^{\circ}\text{C}$ ,  $\div 20$ ):  $+28$  per decade. Source: NOAA GHCND station USW00094728.

## What climatekit does not yet do

- **Daily observations only:** no sub-hourly heat-wave indices
- **No gridded input helpers:** users reduce rasters to per-cell series first
- **SPI / SPEI use gamma distribution:** Pearson III not exposed for arid regions
- **No station homogenisation:** quality control is upstream user responsibility

**v0.2.0 roadmap:** hourly heat-wave indices, gridded input wrappers, additional fire-weather variants (Canadian FFMC, DC, ISI).

## Contact, code, paper

### Charles Coverdale

`charles.f.coverdale@gmail.com`

`github.com/charlescoverdale/climatekit`

`charlescoverdale.github.io/publications`

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