# User Manual — Radial Climatological Rings Chart

This manual describes the data requirements, plotting model, all CLI options, and troubleshooting tips for the **seasonality rings** chart.

## 1) Concept & Layout

Each **ring** is a year; rings proceed outward from the **most recent year** (inner) to the **earliest** (outer). Each ring has **12 wedges** for months, oriented like a clock:

* **December** at **12 o’clock** (top)
* **January** at ~1 o’clock
* …
* **November** at ~11 o’clock

This orientation makes northern‑winter centered at the top.

The **year axis** is a radial guideline used for placing year labels and ticks. You can rotate it to any angle (degrees). By default it sits between **September** and **October** (--year-axis-angle-deg 165).

## 2) Data Requirements

* Input **CSV** with at least these columns:
  + year (integer)
  + month (1–12, or strings like Jan/January)
  + a numeric value column (e.g., anomaly, average)
* Use --year-col, --month-col, --value-col if your columns have different names.
* If the month is a string, the script will parse it automatically; you can force a style with --month-format = auto|abbr|full|number.
* Rows with invalid year/month are dropped; missing months are drawn in a neutral grey.

## 3) Color Scaling & Colorbar

### 3.1 Smart symmetric scaling

* **smart symmetric** (default **on**) inspects the data:
  + If the range **crosses zero** (e.g., anomalies), it uses a **symmetric** scale around 0.
  + If the range is **entirely positive/negative** (e.g., CO₂), it uses a **non‑symmetric** scale.
* Override behavior with --symmetric or --no-symmetric, or set explicit --vmin/--vmax for reproducible scales.

### 3.2 Robust min/max

* With --robust (default on), min/max are taken from **quantiles** (--quantiles 2,98 by default) to reduce outlier impact.
* Use --no-robust to span the full min/max.

### 3.3 Steps, segments, and labels

* --cbar-step sets the **exact segment step** (e.g., 0.1).
* If omitted, the script picks a **nice** step (1, 2, 2.5, 5 × 10^k) to achieve about --cbar-segments bins and **aligns** min/max to step boundaries.
* --cbar-label-step controls **label spacing** and is forced to be a multiple of --cbar-step to keep labels aligned to boundaries. If omitted, the script chooses a multiple to target --cbar-bins labels.
* Safety caps:
  + --cbar-max-segments (default 512) prevents drawing thousands of slivers.
  + --cbar-max-ticks (default 400) limits label count; extra labels are thinned.

### 3.4 Size & position

* --cbar-fraction controls **thickness**; --cbar-shrink controls **length**.
* --cbar-pad controls spacing from the main axes.
* --cbar-extend = neither|min|max|both adds triangular ends if values exceed plotted bounds.

## 4) Year Axis, Labels & Ticks

* **Angle**: --year-axis-angle-deg (degrees). 90° = 12 o’clock; angles **decrease clockwise**. Example: **165°** lands between **September** and **October**.
* **Label cadence**: --year-label-step (e.g., 10 → every 10th ring). If omitted, an auto step is chosen constrained by --max-year-labels.
* **Styling**:
  + --year-label-fontsize, --year-label-weight
  + --year-label-offset (offset along the axis-normal; increase to pull labels off the line)
  + --year-axis-linewidth, --year-tick-width, --year-tick-length
* Labels and ticks are **centered** on their corresponding ring midlines.

## 5) Month Labels

* Toggle with --month-labels/--no-month-labels (default on).
* Style with --month-label-fontsize and --month-label-offset (distance outside the outer ring).

## 6) Geometry & Appearance

* Ring order: **latest** year inner → older years outward.
* Radii: --inner-radius, --ring-width, --ring-gap.
* Figure size & DPI: --figsize (inches, square), --dpi (default 600).
* Colormap: any Matplotlib name via --cmap (diverging colormaps recommended for anomalies).
* Missing months use a neutral grey fill.
* Z‑order: wedges (bottom), center hole (below text), then axis/labels (top). Ensures labels are never hidden.

## 7) Full CLI Reference

### Required

* --data PATH — CSV file with monthly data
* --value-col NAME — numeric column to plot

### Data columns

* --year-col NAME (default: year)
* --month-col NAME (default: month)
* --month-format {auto,abbr,full,number} (default: auto)

### Time filtering

* --year-min INT — earliest year to include
* --year-max INT — latest year to include

### Figure & rings

* --figsize FLOAT (default 7.5)
* --inner-radius FLOAT (default 0.55)
* --ring-width FLOAT (default 0.28)
* --ring-gap FLOAT (default 0.02)

### Titles & labels

* --title STR
* --center-label STR (omit/empty to hide)
* --hide-center-label (force hide)
* --title-fontsize INT (default 12)
* --center-label-fontsize INT (default 18)

### Color scaling

* --cmap STR (default coolwarm)
* --symmetric / --no-symmetric (default symmetric; may be overridden by smart-symmetric)
* --smart-symmetric / --no-smart-symmetric (default on)
* --robust / --no-robust (default on)
* --quantiles "L,H" (default 2,98)
* --vmin FLOAT, --vmax FLOAT

### Colorbar

* --cbar-step FLOAT — **exact** segment step; if omitted, auto-
* --cbar-label-step FLOAT — exact label spacing (multiple of step); if omitted, auto-
* --cbar-segments INT — target segments if step is auto (default 21)
* --cbar-bins INT — target label count for auto (default 10)
* --cbar-max-segments INT (default 512)
* --cbar-max-ticks INT (default 400)
* --cbar-fraction FLOAT — thickness (default 0.045)
* --cbar-shrink FLOAT — length multiplier (default 0.8)
* --cbar-pad FLOAT — gap from axes (default 0.03)
* --cbar-extend {neither,min,max,both} (default both)
* --cbar-tick-fontsize INT (default 9)
* --cbar-label-fontsize INT (default 10)

### Year axis, labels, ticks

* --show-year-labels / --no-year-labels (default on)
* --year-axis-angle-deg FLOAT (default 165)
* --year-label-step INT (default 10)
* --max-year-labels INT (default 9999)
* --year-label-fontsize INT (default 6)
* --year-label-weight STR|INT (default bold)
* --year-label-offset FLOAT (default 0.0)
* --year-tick-length FLOAT (default 0.08)
* --year-axis-linewidth FLOAT (default 1.4)
* --year-tick-width FLOAT (default 1.4)

### Month labels

* --month-labels / --no-month-labels (default on)
* --month-label-fontsize INT (default 10)
* --month-label-offset FLOAT (default 0.08)

### Output

* --save PATH — output filename (PNG). If omitted, a sensible name is used.
* --dpi INT — resolution (default 600)

## 8) Worked Examples

### 8.1 SST anomalies (symmetric, 0.1 steps)

python seasonal\_ring\_chart.py \  
 --data HadSST.4.2.0.0\_monthly\_GLOBE.csv \  
 --value-col anomaly --year-col year --month-col month \  
 --year-min 1970 --year-max 2025 \  
 --title "Global SST anomaly (HadSST4)" \  
 --hide-center-label --month-labels \  
 --year-axis-angle-deg 165 --year-label-step 10 \  
 --cbar-step 0.1 --cbar-shrink 0.8 --cbar-fraction 0.045 --cbar-pad 0.03 \  
 --year-label-fontsize 6 --year-label-weight bold --year-label-offset 0.22 \  
 --year-axis-linewidth 1.4 --year-tick-width 1.4 --year-tick-length 0.10

### 8.2 Mauna Loa CO₂ (non-symmetric, auto steps)

python seasonal\_ring\_chart.py \  
 --data co2\_mm\_mlo.csv \  
 --value-col average --year-col year --month-col month \  
 --year-min 1970 --year-max 2025 \  
 --title "Mauna Loa CO₂ (ppm)" \  
 --hide-center-label --month-labels \  
 --year-axis-angle-deg 165 --year-label-step 10 \  
 --cbar-shrink 0.6 --cbar-fraction 0.05 --cbar-pad 0.03 \  
 --year-label-fontsize 8 --year-label-weight bold --year-label-offset 0.20 \  
 --year-axis-linewidth 1.2 --year-tick-width 1.2 --year-tick-length 0.10

## 9) Troubleshooting

### “Locator attempting to generate N ticks … exceeds MAXTICKS”

* Cause: extremely fine --cbar-step over a very large range (e.g., 0.1 step across 800 units).
* Fix: omit --cbar-step (let auto choose), or increase it; alternatively set --cbar-label-step larger and keep --cbar-step small. You can also raise --cbar-max-ticks (default 400), but very high values clutter plots.

### Colorbar ticks don’t look aligned

* Ensure your tick spacing is a **multiple** of the segment step. If you set --cbar-step, the script forces --cbar-label-step to be a multiple; otherwise, set --cbar-label-step manually.

### Year labels hidden or mis-layered

* The plot enforces high z‑order for labels and axis elements. If labels still get busy, increase --year-label-offset, reduce --year-label-fontsize, or increase --figsize.

### Month names misinterpreted

* Use --month-format abbr for Jan/Feb/… or --month-format full for January/February/…

### Very long time ranges

* Consider smaller --ring-width and --ring-gap, a larger --figsize, and a bigger --year-label-step (e.g., 20 or 25).

## 10) Reproducibility & Publication Tips

* Fix --vmin/--vmax to maintain identical color scales across figures.
* Set --dpi 600 or higher for print; --dpi 300 is often fine for slides.
* Prefer a diverging colormap (e.g., coolwarm) for anomalies; sequential for absolute values (e.g., viridis).

## 11) Acknowledgements

Thanks for ideas and feedback that drove these features: robust scaling, aligned ticks/segments, label positioning, and axis rotation.