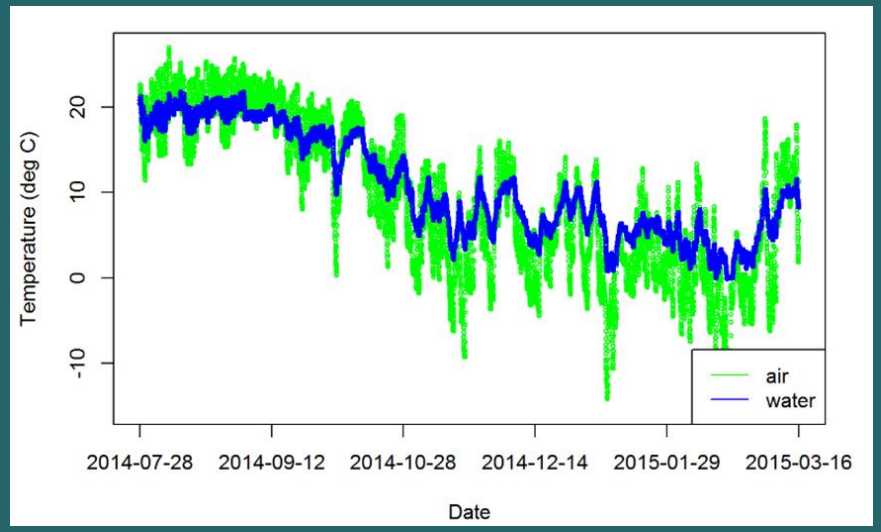
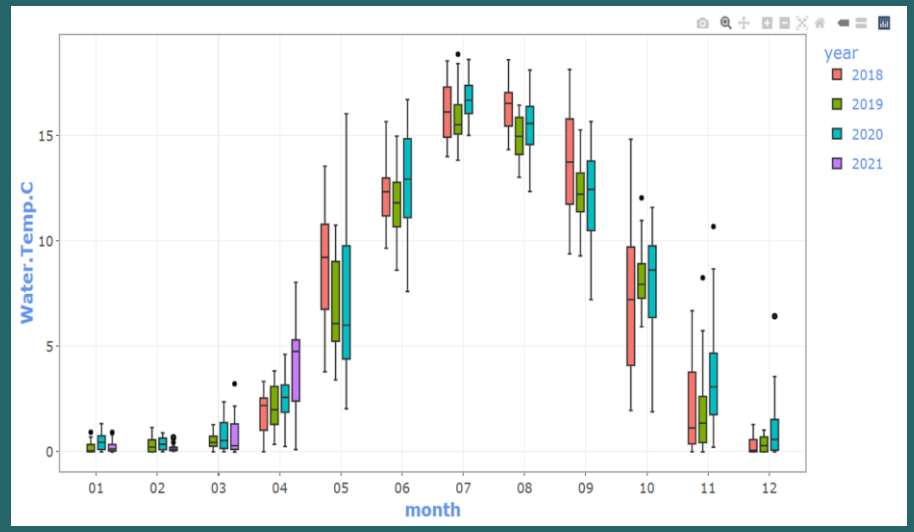
R-based Tools to Perform Quality Control Procedures, Summarize, and Visualize Continuous Sensor Data





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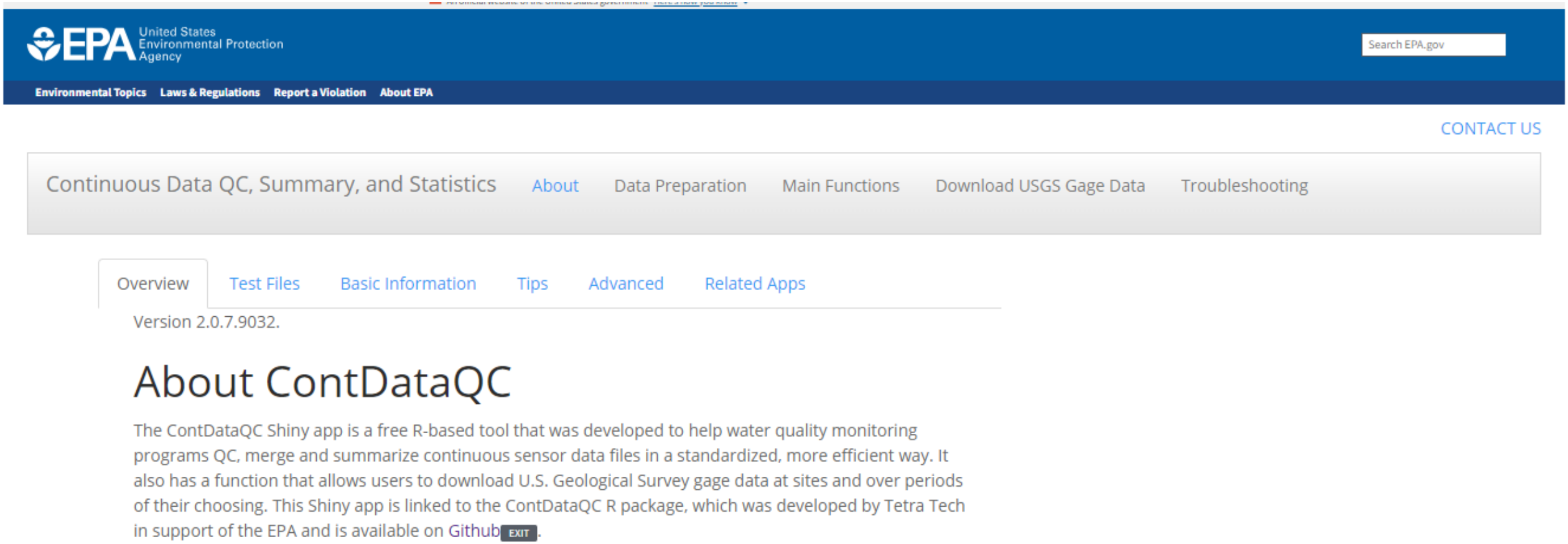
Tool # 1 - ContDataQC

Purpose: help QC continuous sensor data

Current website (Shiny app) - https://nalms.shinyapps.io/ContDataQC/



ContDataQC

- Developed for the Regional Monitoring Networks (RMNs) (but has applicability beyond)
- Most RMN partners did not have
  - Data management systems that could accommodate continuous data
  - Formal systems in place for QC'ing continuous sensor data

ContDataQC

- Provides a file naming and organizational scheme
- Puts data into a standardized format that make analysis and data sharing easier
- Calculates summary statistics (which can then be uploaded to WQX)

ContDataQC is flexible & customizable

Parameters

- Temperature
- Water level
- Discharge
- Conductivity
- Dissolved oxygen
- pH
- Turbidity
- Chlorophyll-a
- Salinity

Can be used on any sensor

- Formatting functions currently available for Onset HOBO sensors and PME miniDOTs

Customization is possible

- Users can add new parameters and customize many of the requirements by editing a plain text configuration file

ContDataQC – QC reports

QC checks	Description
Flag tests	• Unrealistic values • Spikes • Rate of change (RoC) • Flat line
Missing observations	‘Count’ tables • Number of measurements per day
Time series plots	Visually check plots for errors • Individual parameters and combinations
	Discrete (accuracy check) measurements taken during site visits are overlaid onto the time series plot

ContDataQC - Flag Tests

Test	Description
Unrealistic values ('Gross range')	Values are above or below the upper and lower thresholds
Spikes	Adjacent measurements change by more than 'x' amount
Rate of change (RoC)	Change exceeds a given threshold (e.g., ≥ 3 standard deviations within 25 hrs)
Flat line	A certain number of consecutive measurements are within a certain amount of each other

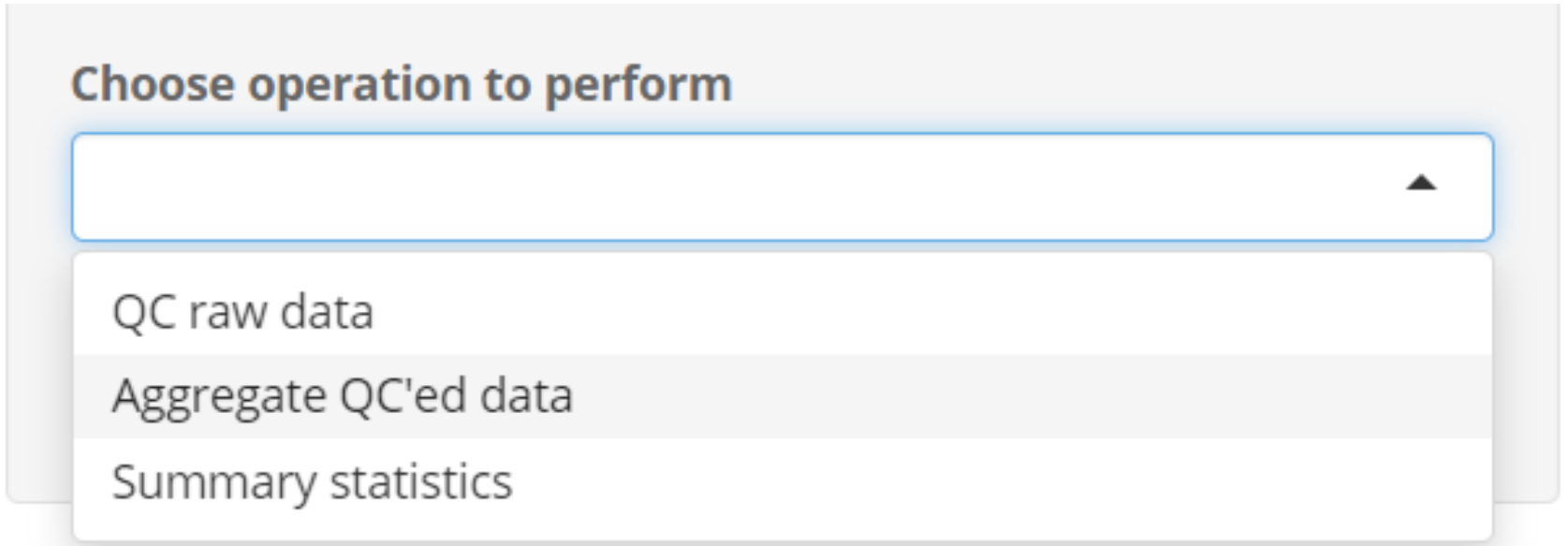
ContDataQC – thresholds

Example - water temperature defaults (based on eastern cool water streams)

Test	Flag	Default threshold
Gross l	Fail - Hi	> 30 deg C
	Fail - Lo	< -3 deg C
Spike	Fail	≥ 5 deg C (+/-)
	Suspect	≥ 1 deg C (+/-)
Rate of change	Fail	≥ 3 standard deviations within 25 hours
	Suspect	NA
Flat line	Fail	> 30 consecutive measurements within 0.01 units of one another
	Suspect	> 20 consecutive measurements within 0.01 units of one another

Flag test thresholds should be evaluated and customized if needed

ContDataQC – aggregate QC’d data files



- Merge QC’d data files from different time periods
- Generate time series plots and basic summary statistics

Daily summary statistics can be uploaded to WQX

Tool # 2 - ContDataSumViz

Purpose: summarize and visualize QC'd continuous sensor data

Currently in user testing, then revisions and post on EPA server

ContDataSumViz - Exploration

Summary statistics tables	Time series plots (traditional)	Time series plots (annual overlays)	Box plots	CDFs	Raster graphs

ContDataSumViz – time series plots

Summary tables | Time series plots | Time series - Annual overlays | Box plots | CDFs | Raster graphs

Select variable name

Water.Temp.C

Select daily statistics metrics

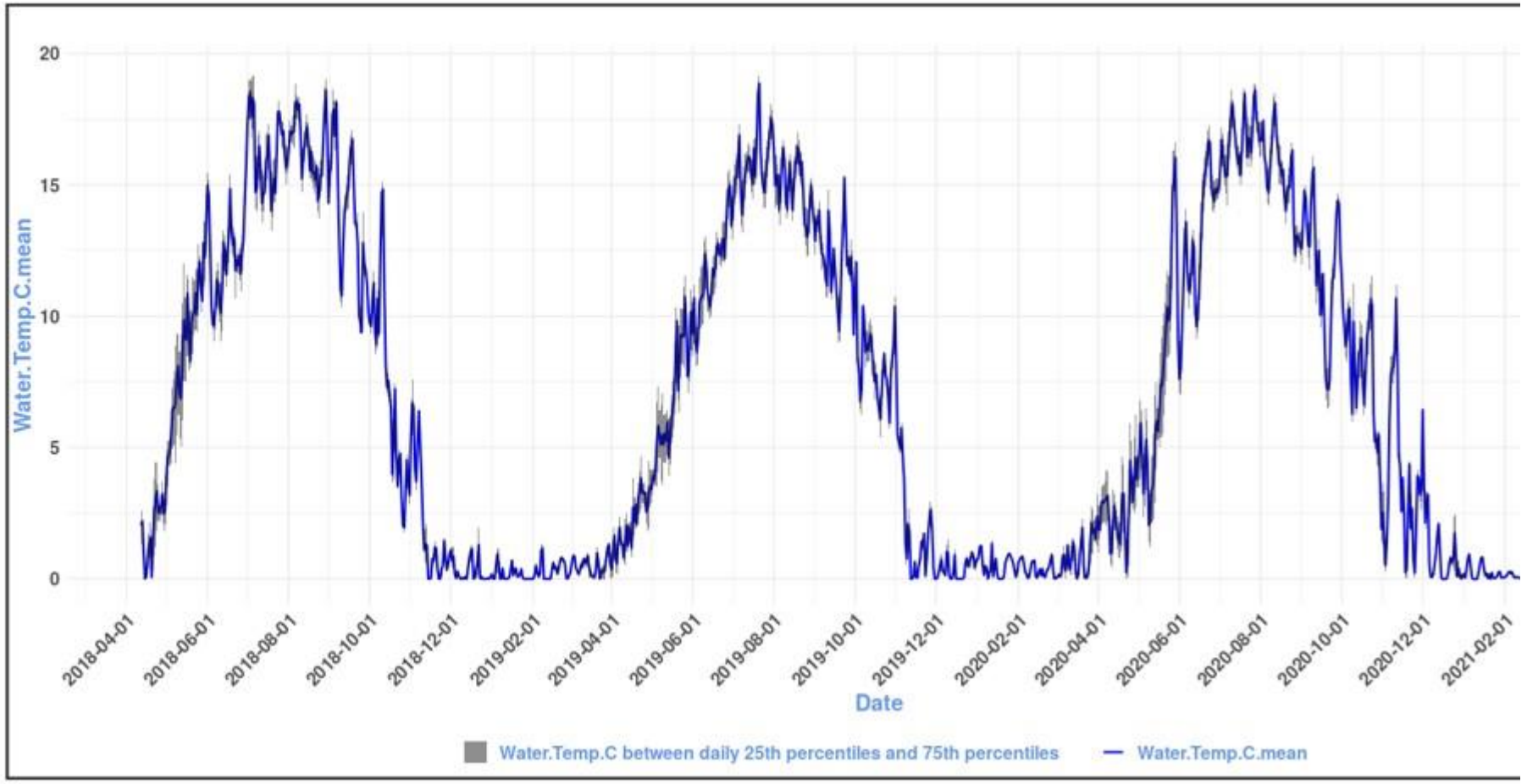
mean

Add shading with

- (•) 25th & 75th percentiles
- ( ) minimum & maximum
- ( ) newData

Plot title

Display | Add more...



ContDataSumViz – time series annual overlay plots

Summary tables | Time series plots | Time series - Annual overlays | Box plots | CDFs | Raster graphs

Select variable name

Water.Temp.C

Select daily statistics metrics

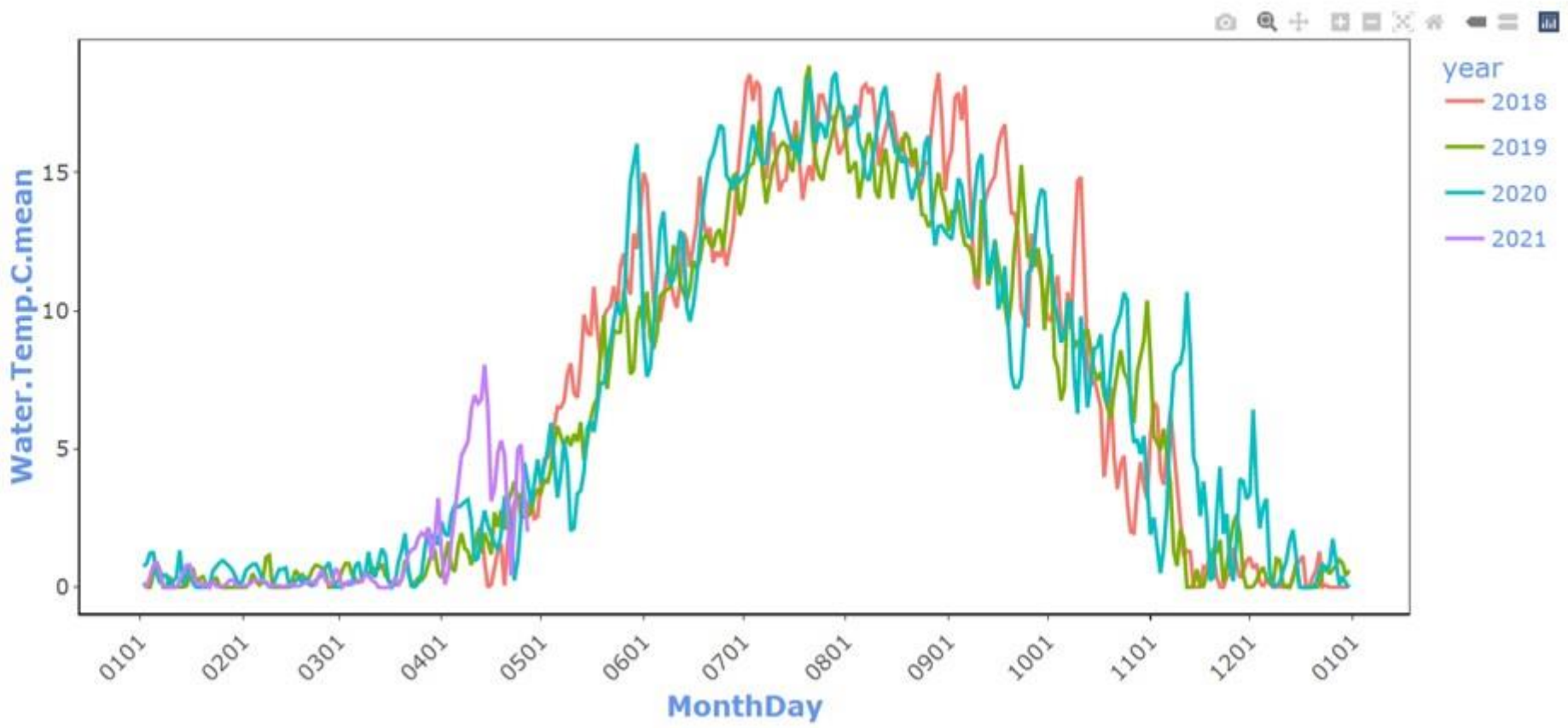
mean

Plot title

Add shading with

- none
- overall minimum and maximum(all years)
- newData

Display



ContDataSumViz – box plots

Summary tables | Time series plots | Time series - Annual overlays | Box plots | CDFs | Raster graphs

Select variable name

Water.Temp.C

Select daily statistics metrics

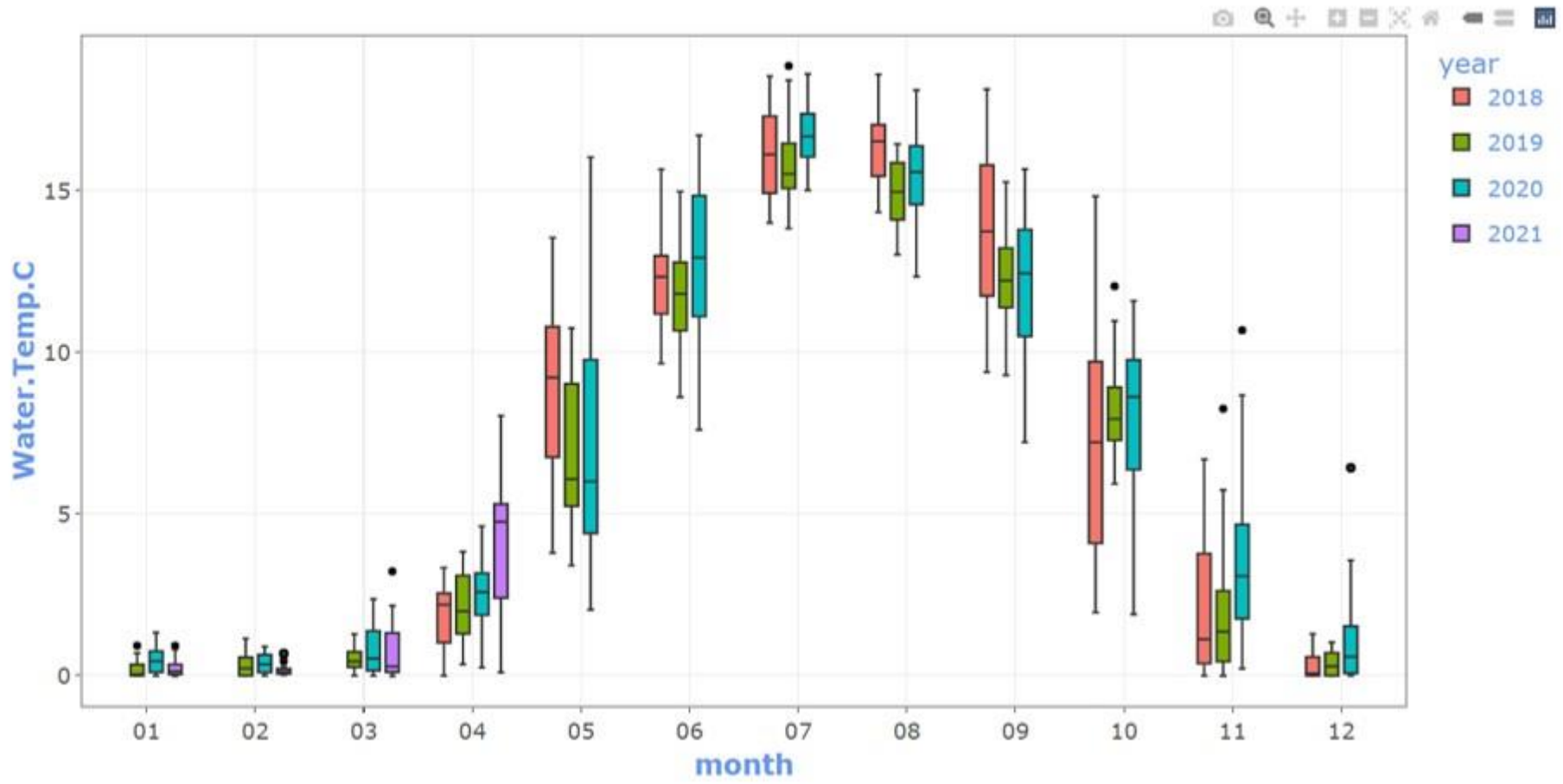
mean

Group by

- month
- month(years side by side)
- year
- season
- season(years side by side)

Plot title

Display



ContDataSumViz - CDFs

Summary tables | Time series plots | Time series - Annual overlays | Box plots | CDFs | Raster graphs

Select variable name

Water.Temp.C

Add shading with

- 25th & 75th percentiles
- minimum & maximum
- newData

Select year

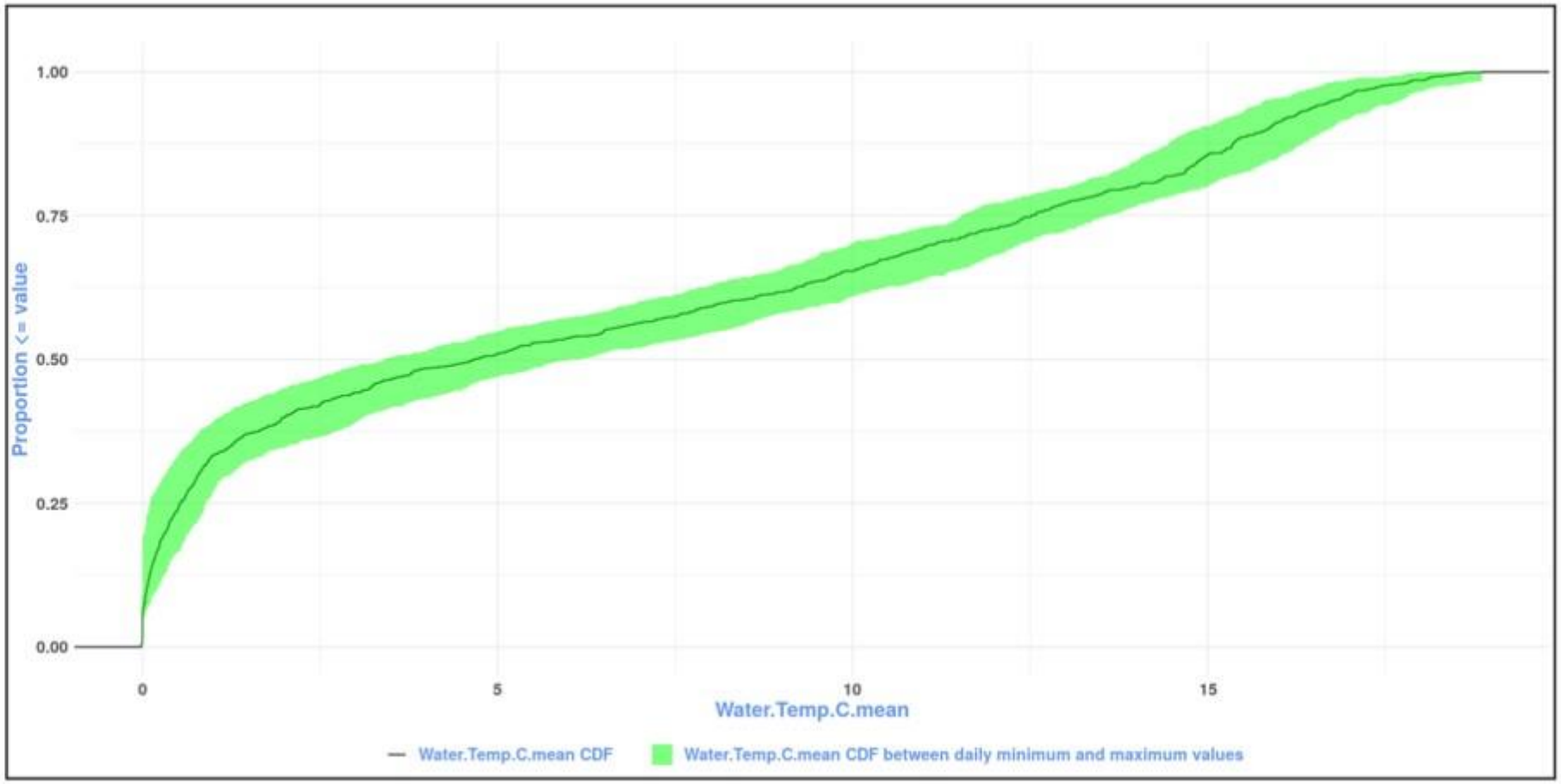
All

Select season

All

Plot title

Run and display



ContDataSumViz – raster graphs

Summary tables | Time series plots | Time series - Annual overlays | Box plots | CDFs | Raster graphs

Select variable name

Water.Temp.C

Select daily statistics metrics

mean

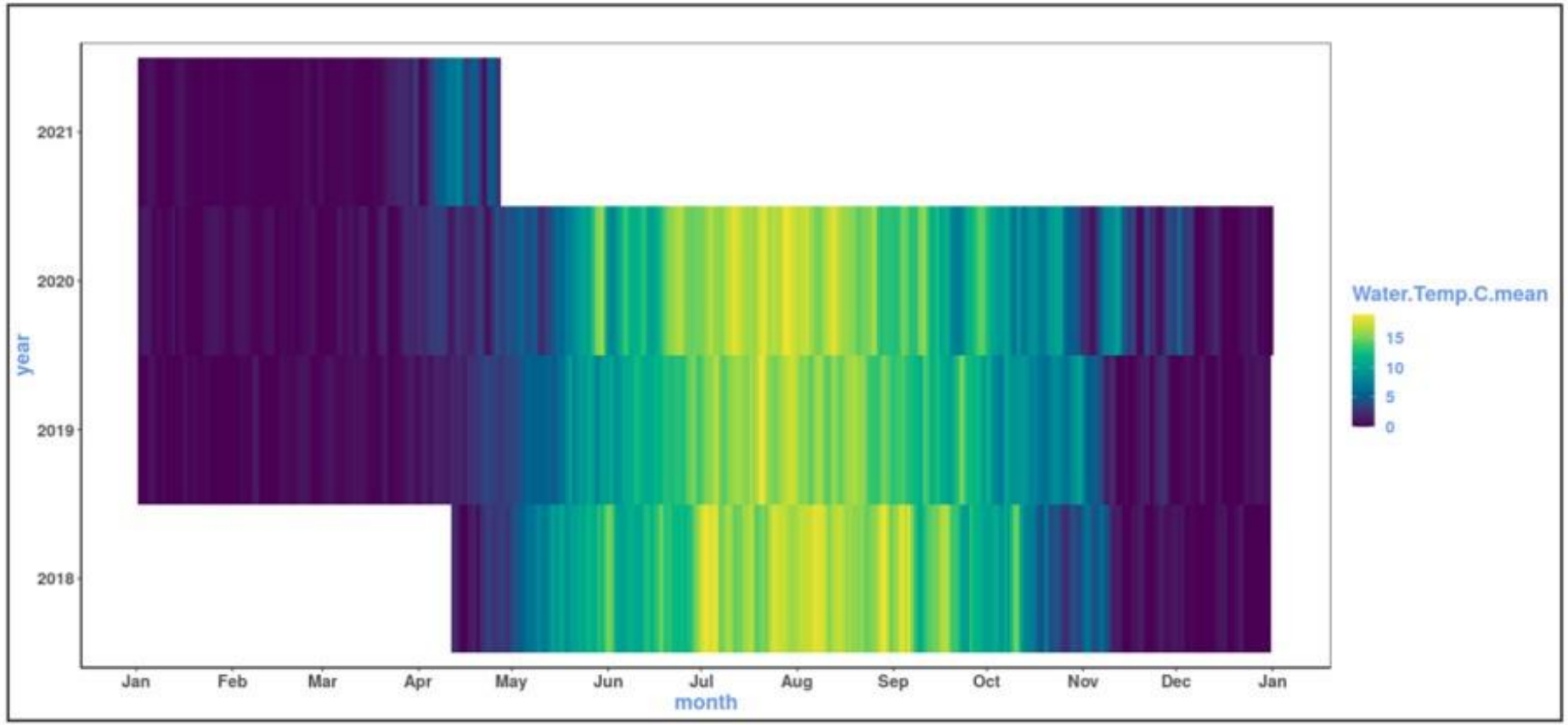
Plot title

Adjust plot aspect ratio

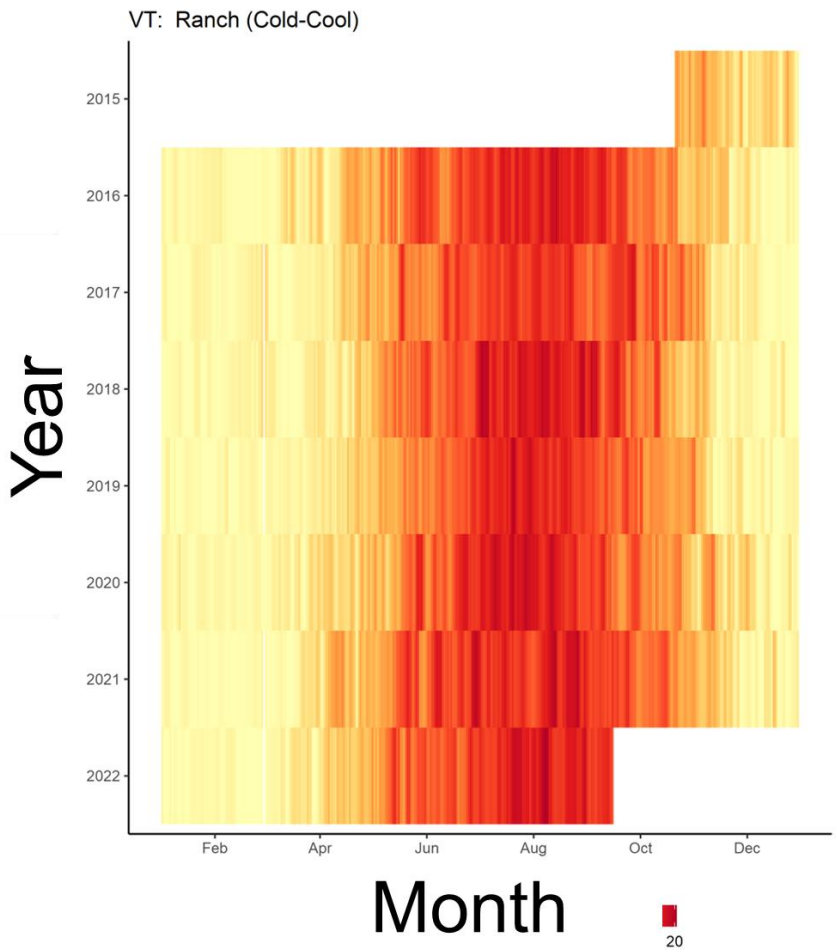
0.5

Color palette options

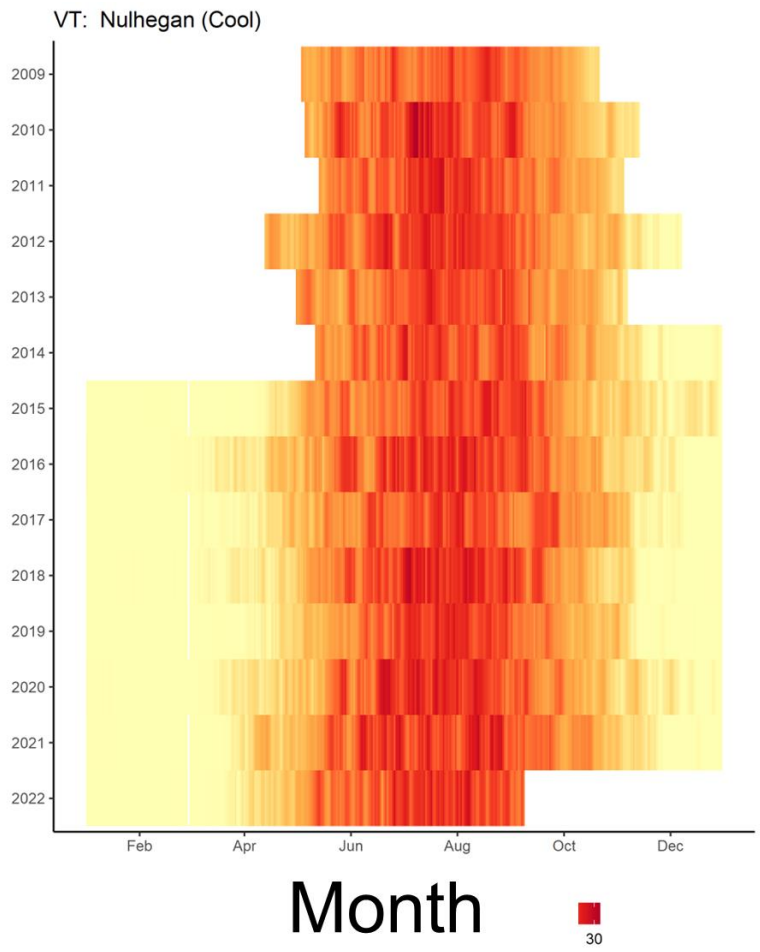
- (•) hcl
- ( ) rainbow
- ( ) heat



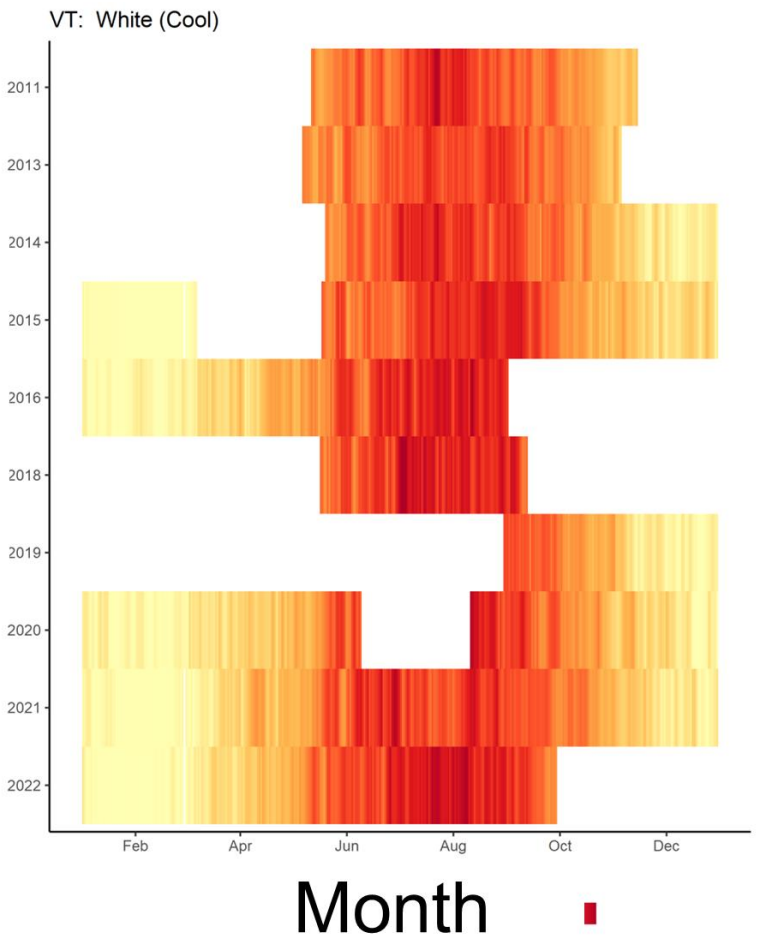
Visualize changes in duration, timing, magnitude



- Year-round
- No gaps



- Seasonal, then year-round
- No gaps



- Seasonal, then year-round
- Gaps

Acknowledgments

- ContDataSumViz version 2 –
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