CERF_2025

Forest Schenck

2025-10-28

#Packages

```r
library(tidyr)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
library(lubridate)
```

```
##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```r
library(ggplot2)
library(glue) #for plot function code; plot title function
library(purrr) #for plot function code; map function
library(zoo) #approx nas from neighbors
```

```
##
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```r
#GAMs
library(mgcv)
```

```
## Loading required package: nlme

##
## Attaching package: 'nlme'

## The following object is masked from 'package:dplyr':
##
##     collapse
```

```
## This is mgcv 1.9-3. For overview type 'help("mgcv-package")'.
#Maps
library(maps)

##
## Attaching package: 'maps'

## The following object is masked from 'package:purrr':
##
##     map

library(mapdata)
library(mapproj)
library(ggnewscale)
```

#Data upload EG 2024-2025

```
d.flw.stage.WHOI <- read.csv("Data/whoi.eelgrass.flw.stage.data.csv")

d.flw.den.WHOI <- read.csv("Data/whoi.eelgrass.density.data.csv")

# d.flw.stage.RI.SNEP <- read.csv("Data/RI.snep.eelgrass.flw.stage.data.master.csv")
#
# d.flw.den.RI.SNEP <- read.csv("Data/RI.snep.eelgrass.density.data.master.csv")
#
# d.flw.stage.MA.SNEP <- read.csv("Data/snep.eelgrass.flw.stage.data.csv")
#
# d.flw.den.MA.SNEP <- read.csv("Data/snep.eelgrass.density.data.csv")
#
# d.flw.den.MApart.SNEP <- read.csv("Data/snep.mapartners.eelgrass.density.data.csv")
#
# d.flw.stage.MApart.SNEP <- read.csv("Data/snep.mapartners.eelgrass.flw.stage.data.csv")
```

#Data upload Hobos (temp/light) for sites with full 2025 data

```
d.t.AQ.1 <- read.csv("Data/Hobo/AQ_21177827.csv")
d.t.AQ.3 <- read.csv("Data/Hobo/AQ_10625902.csv")
d.t.AQ.2 <- read.csv("Data/Hobo/AQ_21258480.csv")

d.t.CB.1 <- read.csv("Data/Hobo/CB_21258498.csv")
d.t.CB.2 <- read.csv("Data/Hobo/CB_21258495.csv")
d.t.CB.3 <- read.csv("Data/Hobo/CB_21258487.csv")

d.t.DC.1 <- read.csv("Data/Hobo/DC_21258490.csv")
d.t.DC.2 <- read.csv("Data/Hobo/DC_21258491.csv")
d.t.DC.3 <- read.csv("Data/Hobo/DC_21258483.csv")

d.t.SH.1 <- read.csv("Data/Hobo/SH_21177828.csv")
d.t.SH.2 <- read.csv("Data/Hobo/SH_21258490.csv")
d.t.SH.3 <- read.csv("Data/Hobo/SH_21982356.csv")

d.t.WB.1 <- read.csv("Data/Hobo/WB_21177828.csv")
d.t.WB.2 <- read.csv("Data/Hobo/WB_21258496.csv")
d.t.WB.3 <- read.csv("Data/Hobo/WB_22288916.csv")

# d.t.CC.1 <- read.csv("Data/Hobo/CC_21982329.csv")
```

```
# d.t.CC.2 <- read.csv("Data/Hobo/CC_21982356.csv")
# d.t.CC.3 <- read.csv("Data/Hobo/CC_21982338.csv")
#
# d.t.OB.1 <- read.csv("Data/Hobo/OB_21982331.csv")
# d.t.OB.2 <- read.csv("Data/Hobo/OB_21982358.csv")
# d.t.OB.3 <- read.csv("Data/Hobo/OB_21982330.csv")
#
# d.t.WC.1 <- read.csv("Data/Hobo/WC_21982332.csv")
# d.t.WC.2 <- read.csv("Data/Hobo/WC_21982360.csv")
# d.t.WC.3 <- read.csv("Data/Hobo/WC_21982329.csv")
#
# d.t.GB.1 <- read.csv("Data/Hobo/GB_21982334.csv")
# d.t.GB.2 <- read.csv("Data/Hobo/GB_21982330.csv")
# d.t.GB.3 <- read.csv("Data/Hobo/GB_21982334_2025.csv")
#
# d.t.NK.1 <- read.csv("Data/Hobo/RI/NK_21982367.csv")
# d.t.NK.2 <- read.csv("Data/Hobo/RI/NK_21982359.csv")
#
# d.t.JB.1 <- read.csv("Data/Hobo/RI/JB_21982339_2025.csv")
# d.t.JB.2 <- read.csv("Data/Hobo/RI/JB_22329183.csv")
#
# d.t.CL.1 <- read.csv("Data/Hobo/RI/CL_21982347.csv")
```

#Data Carpentry Hobos ##AQ

```
d.t.AQ.1.water <- d.t.AQ.1 %>%
  mutate(site.id = "AQ") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-05-07 10:15") %>%
  filter(date.time <= "2024-09-30 10:45")

d.t.AQ.2.water <- d.t.AQ.2 %>%
  mutate(site.id = "AQ") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-09-30 11:00") %>%
  filter(date.time <= "2025-05-08 11:00")

d.t.AQ.3.water <- d.t.AQ.3 %>%
  mutate(site.id = "AQ") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2025-05-08 11:15") %>%
  filter(date.time <= "2025-09-24 10:15")

d.t.AQ.water <- bind_rows(d.t.AQ.1.water, d.t.AQ.2.water, d.t.AQ.3.water) %>%
  mutate(j = as.POSIXlt(date.time)$yday + 1)
```

```
str(d.t.AQ.water)
```

```
## 'data.frame':    48481 obs. of  6 variables:
##  $ reading.no          : int  6 7 8 9 10 11 12 13 14 15 ...
##  $ date.time           : POSIXct, format: "2024-05-07 10:15:00" "2024-05-07 10:30:00" ...
##  $ temp.C              : num  11 11.1 11.1 11.1 11.2 ...
##  $ Intensity.lum.per.sqft: int  1088 960 992 1216 1152 1216 1472 1344 1536 1280 ...
##  $ site.id             : chr  "AQ" "AQ" "AQ" "AQ" ...
##  $ j                   : num  128 128 128 128 128 128 128 128 128 128 ...
```

```
ggplot(data = d.t.AQ.water, aes(x = date.time, y = temp.C)) +
  geom_line() +
  coord_cartesian(y = c(-1,28))
```
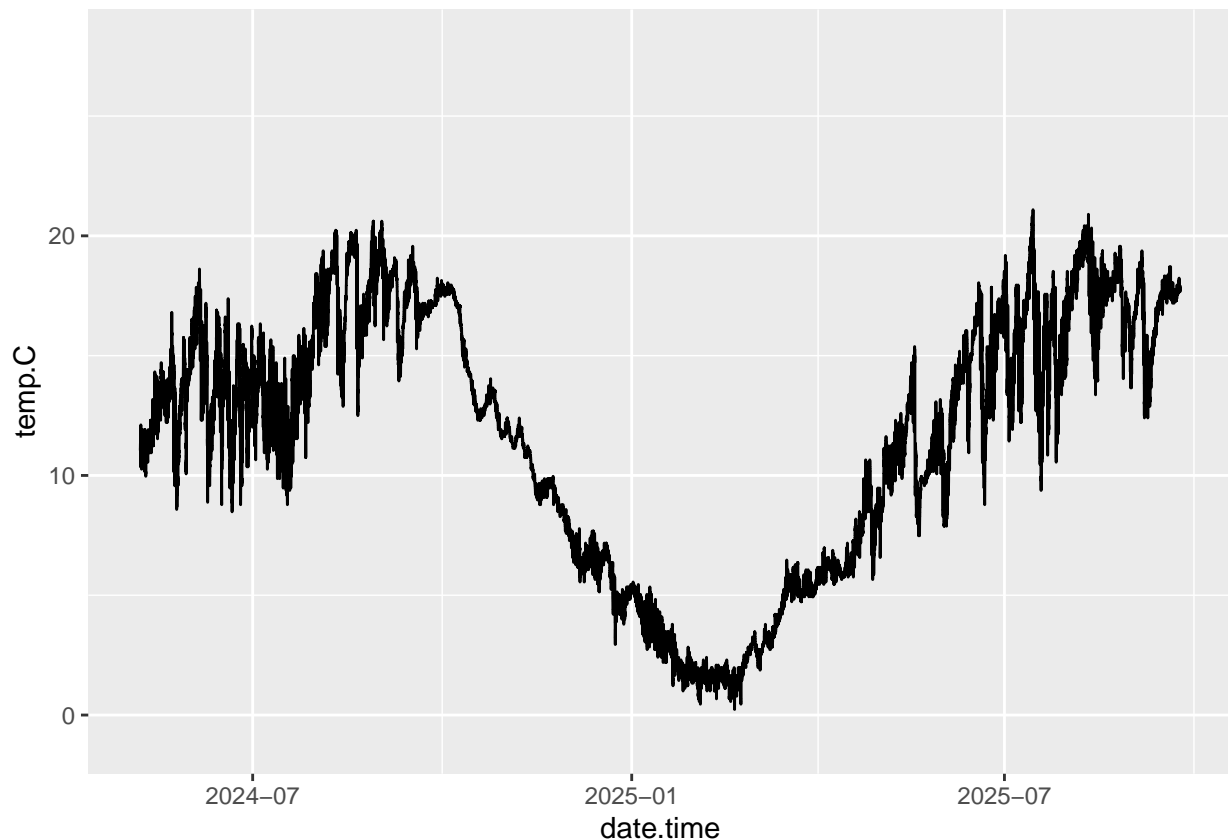


```
d.t.AQ.daily.range <- d.t.AQ.water %>%
  mutate(date = as_date(date.time)) %>%
  group_by(site.id, date) %>%
  summarize(min.T = min(temp.C), max.T = max(temp.C), median.T = median(temp.C)) %>%
  mutate(delta.T = max.T - min.T)
```

```
## `summarise()` has grouped output by 'site.id'. You can override using the
## `.groups` argument.
```

```
ggplot(data = d.t.AQ.daily.range, aes(x = date, y = median.T)) +
  geom_line() +
  coord_cartesian(y = c(-5,30))
```
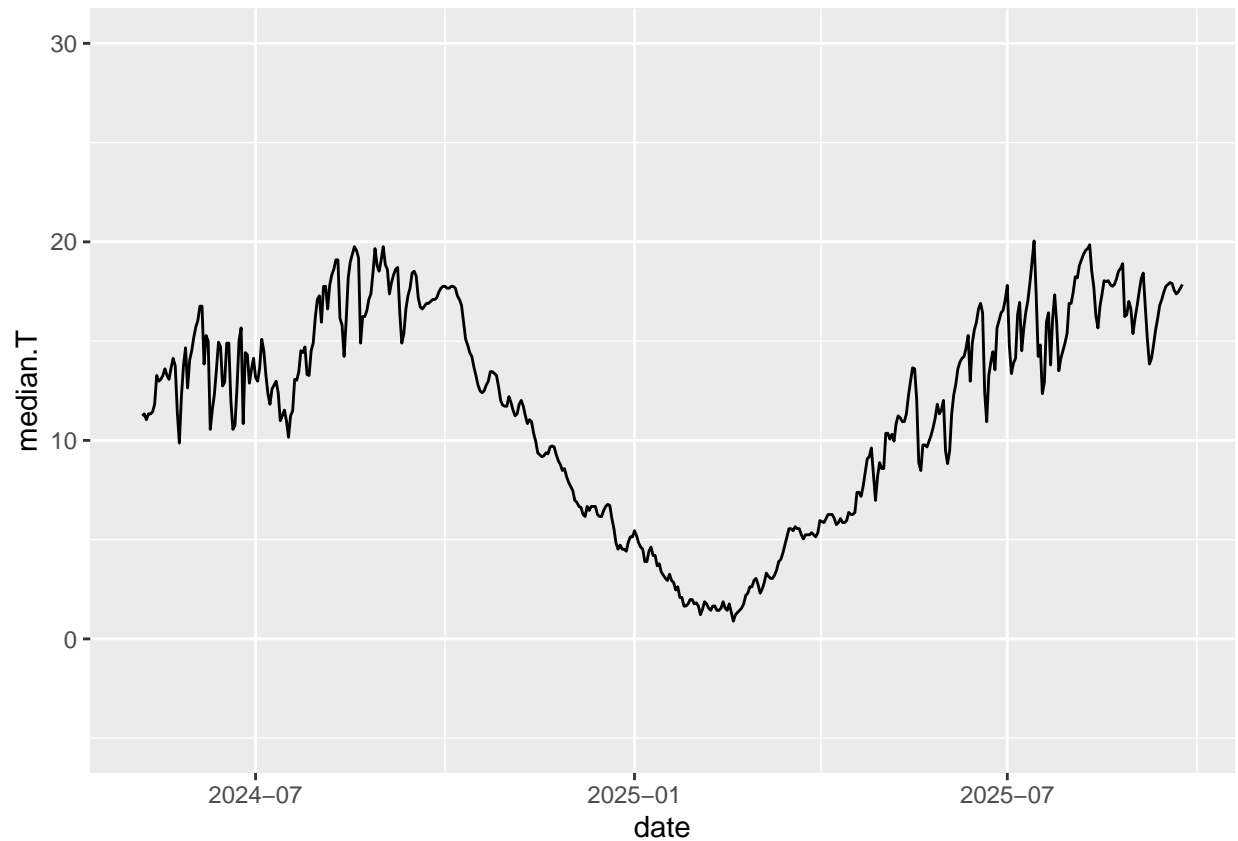
```r
d.t.AQ.GDD <- d.t.AQ.daily.range %>%
  filter(date >= "2025-01-29") %>%
  mutate(GDD.2 = median.T-2) %>%
  mutate(across(GDD.2, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.2 = cumsum(GDD.2)) %>%
  mutate(GDD.4 = median.T-4) %>%
  mutate(across(GDD.4, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.4 = cumsum(GDD.4)) %>%
  mutate(GDD.6 = median.T-6) %>%
  mutate(across(GDD.6, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.6 = cumsum(GDD.6)) %>%
  mutate(GDD.8 = median.T-8) %>%
  mutate(across(GDD.8, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.8 = cumsum(GDD.8))

d.t.AQ.GDD <- d.t.AQ.GDD %>%
  pivot_longer(cols = c("GDD.2", "GDD.4", "GDD.6", "GDD.8"), names_to = "Tbase", values_to = "GDD")

ggplot(data = d.t.AQ.GDD, aes(x = date, y = GDD, group = Tbase)) +
  geom_line()
```
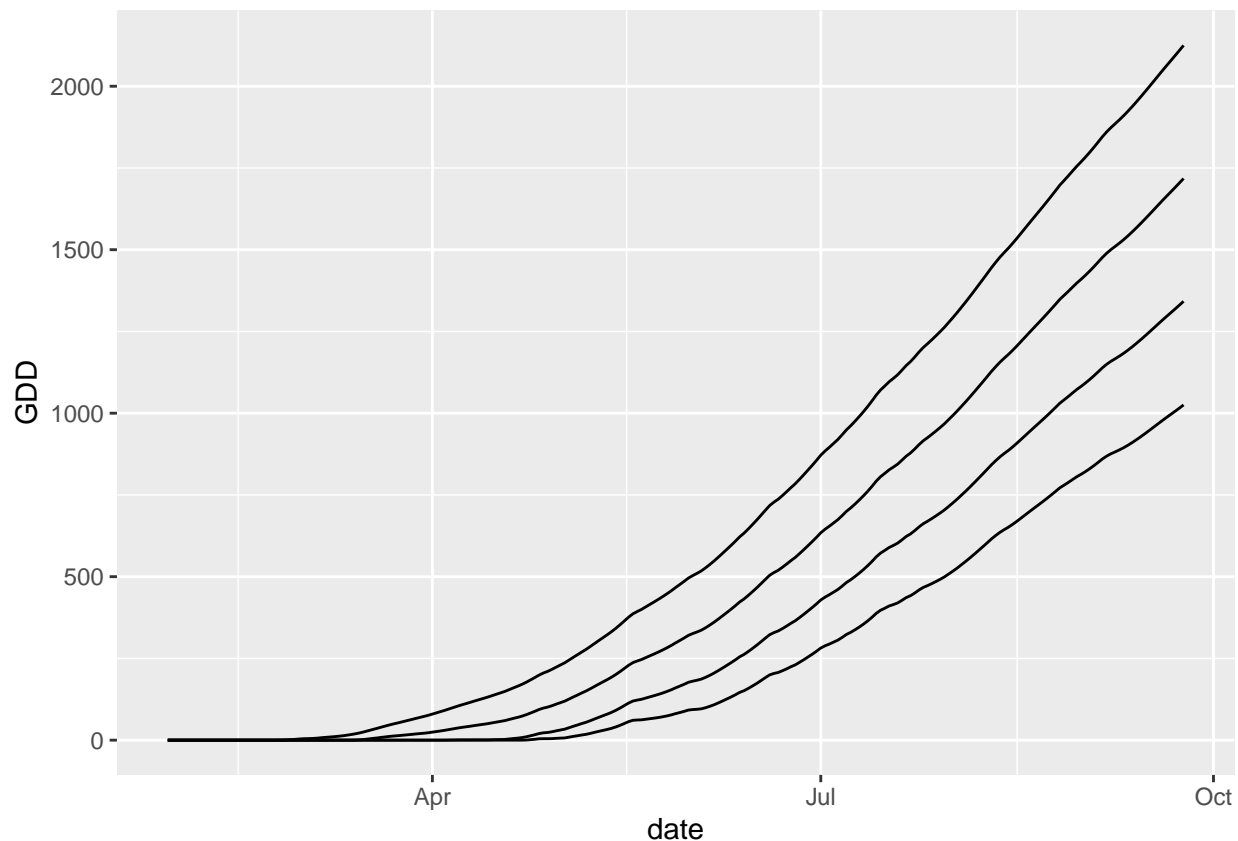
CB

```
d.t.CB.1.water <- d.t.CB.1 %>%
  mutate(site.id = "CB") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-05-07 13:30") %>%
  filter(date.time <= "2024-09-30 12:30")

d.t.CB.2.water <- d.t.CB.2 %>%
  mutate(site.id = "CB") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-09-30 12:45") %>%
  filter(date.time <= "2025-05-08 15:00")

d.t.CB.3.water <- d.t.CB.3 %>%
  mutate(site.id = "CB") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2025-05-08 15:15") %>%
```

```
    filter(date.time <= "2025-09-15 9:15")

d.t.CB.water <- bind_rows(d.t.CB.1.water, d.t.CB.2.water, d.t.CB.3.water) %>%
  mutate(j = as.POSIXlt(date.time)$yday + 1)

str(d.t.CB.water)
```

```
## 'data.frame':    47600 obs. of  6 variables:
##  $ reading.no          : int  19 20 21 22 23 24 25 26 27 28 ...
##  $ date.time           : POSIXct, format: "2024-05-07 13:30:00" "2024-05-07 13:45:00" ...
##  $ temp.C              : num  10.9 11.5 11.7 11.9 11.9 ...
##  $ Intensity.lum.per.sqft: int  1920 2432 1856 2944 1920 2048 3200 2304 608 704 ...
##  $ site.id             : chr  "CB" "CB" "CB" "CB" ...
##  $ j                   : num  128 128 128 128 128 128 128 128 128 128 ...
```

```
ggplot(data = d.t.CB.water, aes(x = date.time, y = temp.C)) +
  geom_line() +
  coord_cartesian(y = c(-1,28))
```
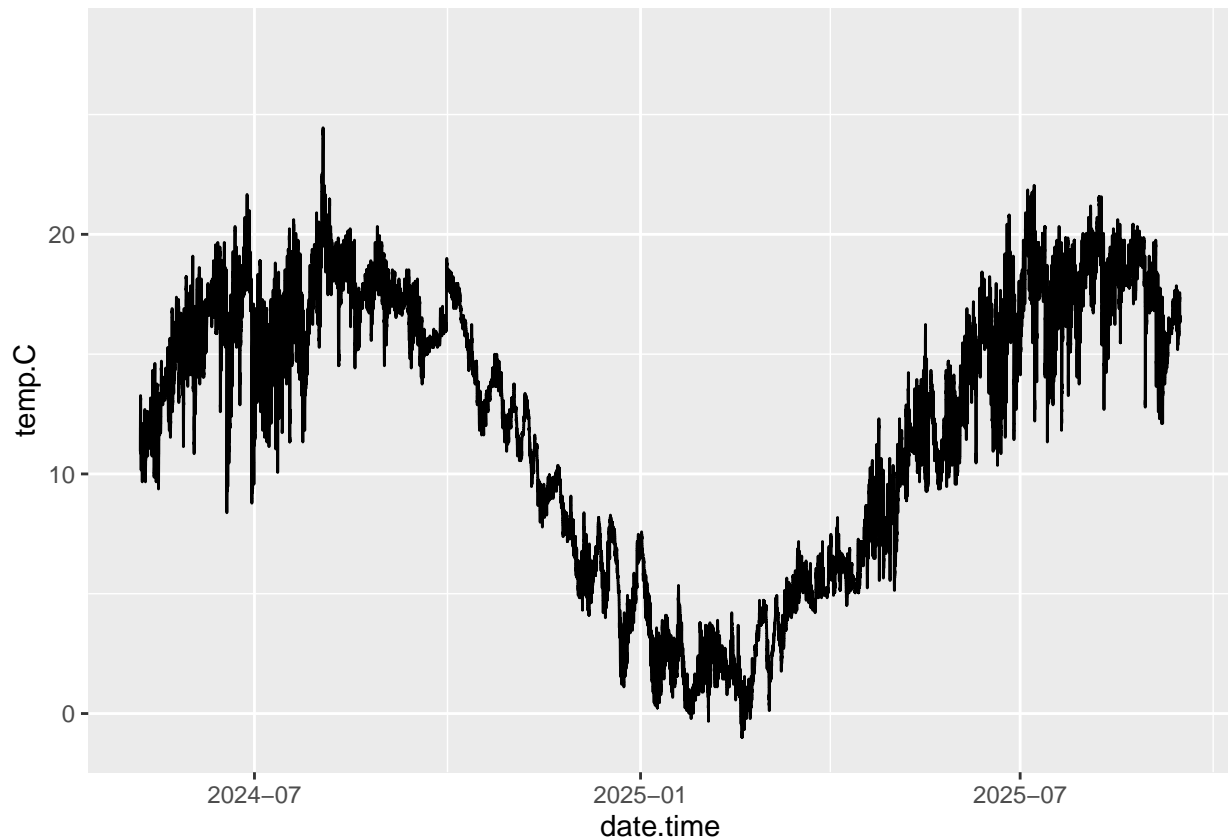


```
d.t.CB.daily.range <- d.t.CB.water %>%
  mutate(date = as_date(date.time)) %>%
  group_by(site.id, date) %>%
  summarize(min.T = min(temp.C), max.T = max(temp.C), median.T = median(temp.C)) %>%
  mutate(delta.T = max.T - min.T)
```
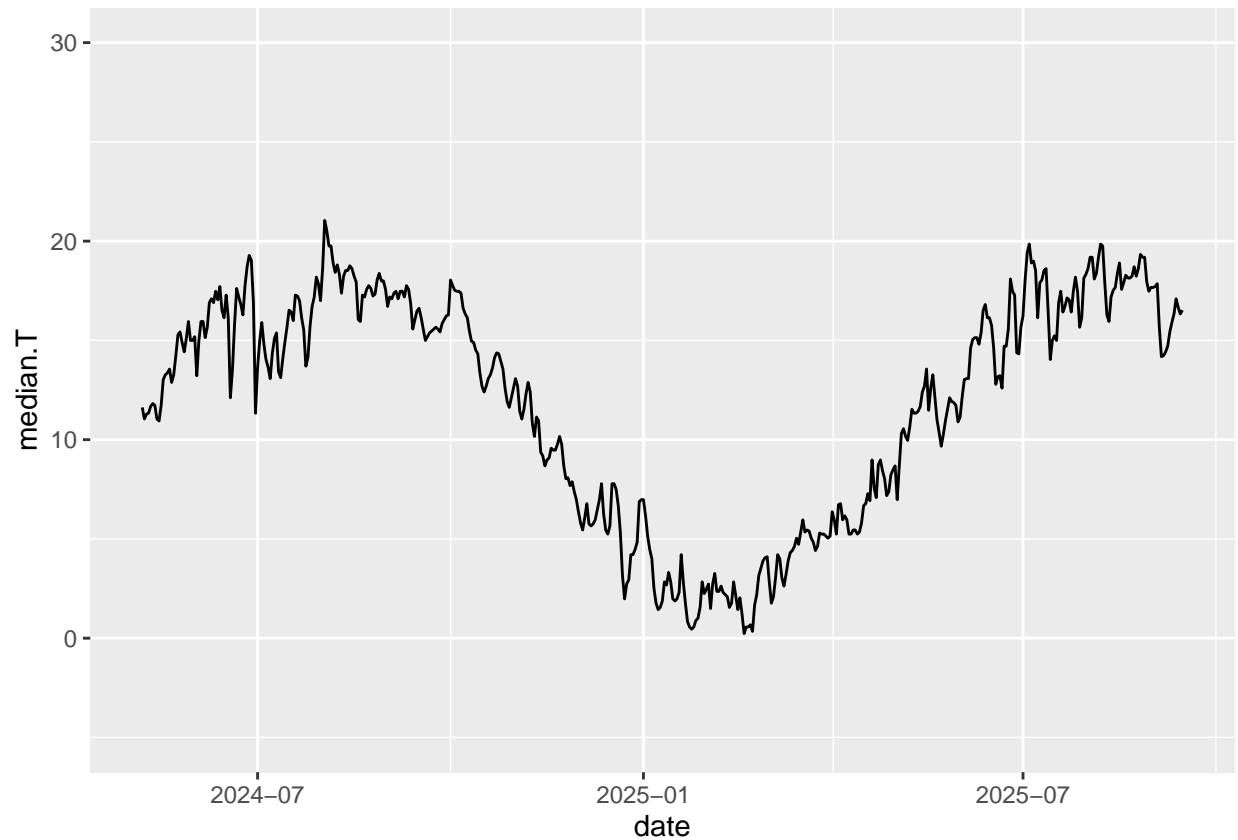
```
## `summarise()` has grouped output by 'site.id'. You can override using the
## `.groups` argument.
```

7

```
ggplot(data = d.t.CB.daily.range, aes(x = date, y = median.T)) +
  geom_line() +
  coord_cartesian(y = c(-5,30))
```



```
d.t.CB.GDD <- d.t.CB.daily.range %>%
  filter(date >= "2025-01-29") %>%
  mutate(GDD.2 = median.T-2) %>%
  mutate(across(GDD.2, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.2 = cumsum(GDD.2)) %>%
  mutate(GDD.4 = median.T-4) %>%
  mutate(across(GDD.4, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.4 = cumsum(GDD.4)) %>%
  mutate(GDD.6 = median.T-6) %>%
  mutate(across(GDD.6, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.6 = cumsum(GDD.6)) %>%
  mutate(GDD.8 = median.T-8) %>%
  mutate(across(GDD.8, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.8 = cumsum(GDD.8))

d.t.CB.GDD <- d.t.CB.GDD %>%
  pivot_longer(cols = c("GDD.2", "GDD.4", "GDD.6", "GDD.8"), names_to = "Tbase", values_to = "GDD")

ggplot(data = d.t.CB.GDD, aes(x = date, y = GDD, group = Tbase)) +
  geom_line()
```

DC
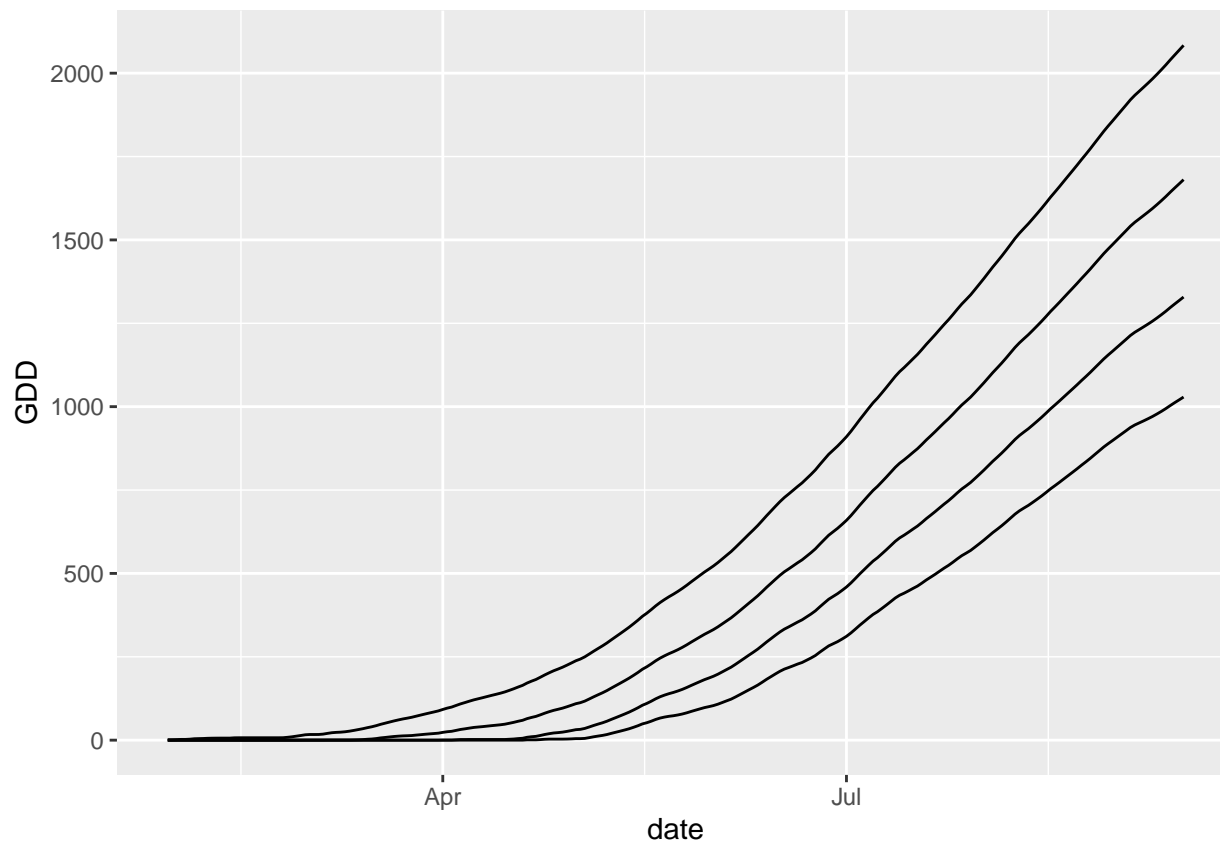
```r
d.t.DC.1.water <- d.t.DC.1 %>%
  mutate(site.id = "DC") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-05-07 14:00") %>%
  filter(date.time <= "2024-09-30 13:00")

d.t.DC.2.water <- d.t.DC.2 %>%
  mutate(site.id = "DC") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-09-30 13:15") %>%
  filter(date.time <= "2025-05-08 14:00")

d.t.DC.3.water <- d.t.DC.3 %>%
  mutate(site.id = "DC") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2025-05-08 14:15") %>%
```

```
  filter(date.time <= "2025-10-10 11:30")

d.t.DC.water <- bind_rows(d.t.DC.1.water, d.t.DC.2.water, d.t.DC.3.water) %>%
  mutate(j = as.POSIXlt(date.time)$yday + 1)

str(d.t.DC.water)
```

```
## 'data.frame':    50007 obs. of  6 variables:
##  $ reading.no          : int  21 22 23 24 25 26 27 28 29 30 ...
##  $ date.time           : POSIXct, format: "2024-05-07 14:00:00" "2024-05-07 14:15:00" ...
##  $ temp.C              : num  11.3 11.3 11.7 11.7 11.3 ...
##  $ Intensity.lum.per.sqft: int  3456 3968 3072 3840 3968 1856 1536 3456 3200 4096 ...
##  $ site.id             : chr  "DC" "DC" "DC" "DC" ...
##  $ j                   : num  128 128 128 128 128 128 128 128 128 128 ...
```

```
ggplot(data = d.t.DC.water, aes(x = date.time, y = temp.C)) +
  geom_line() +
  coord_cartesian(y = c(-1,28))
```
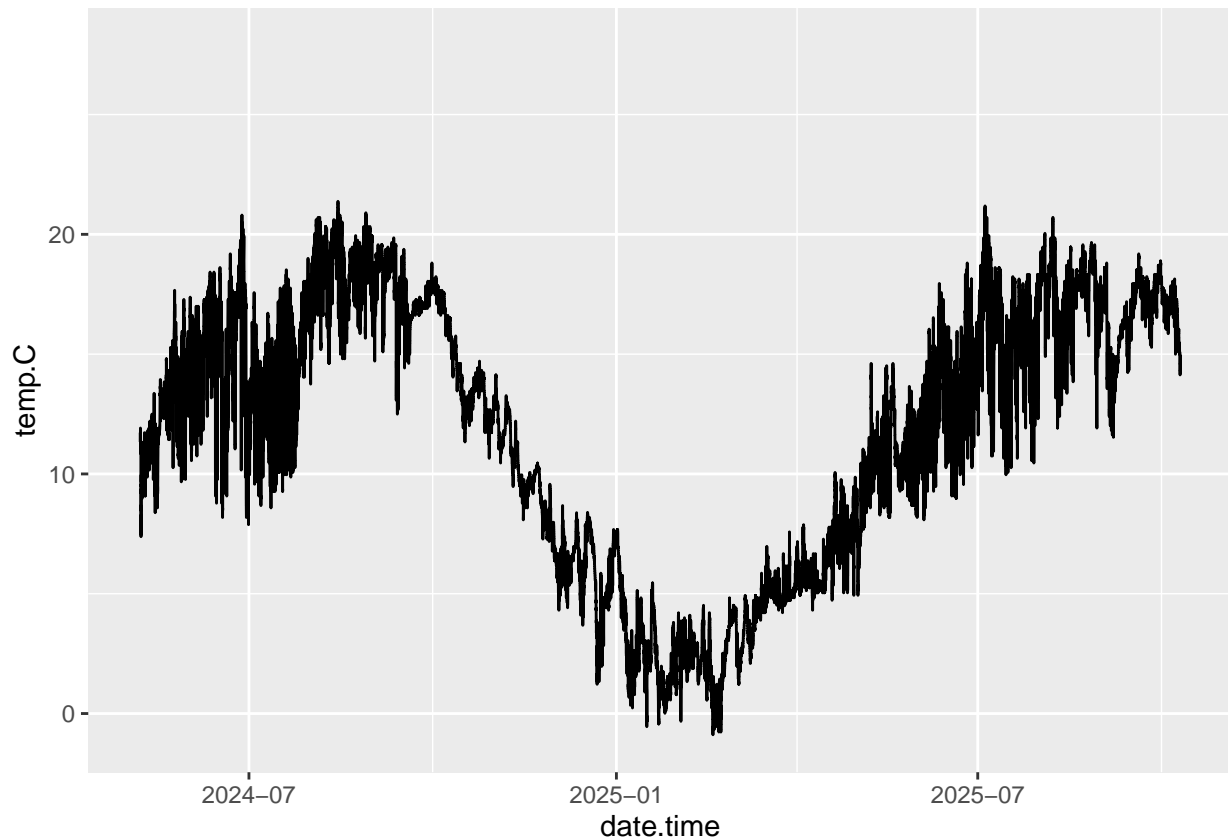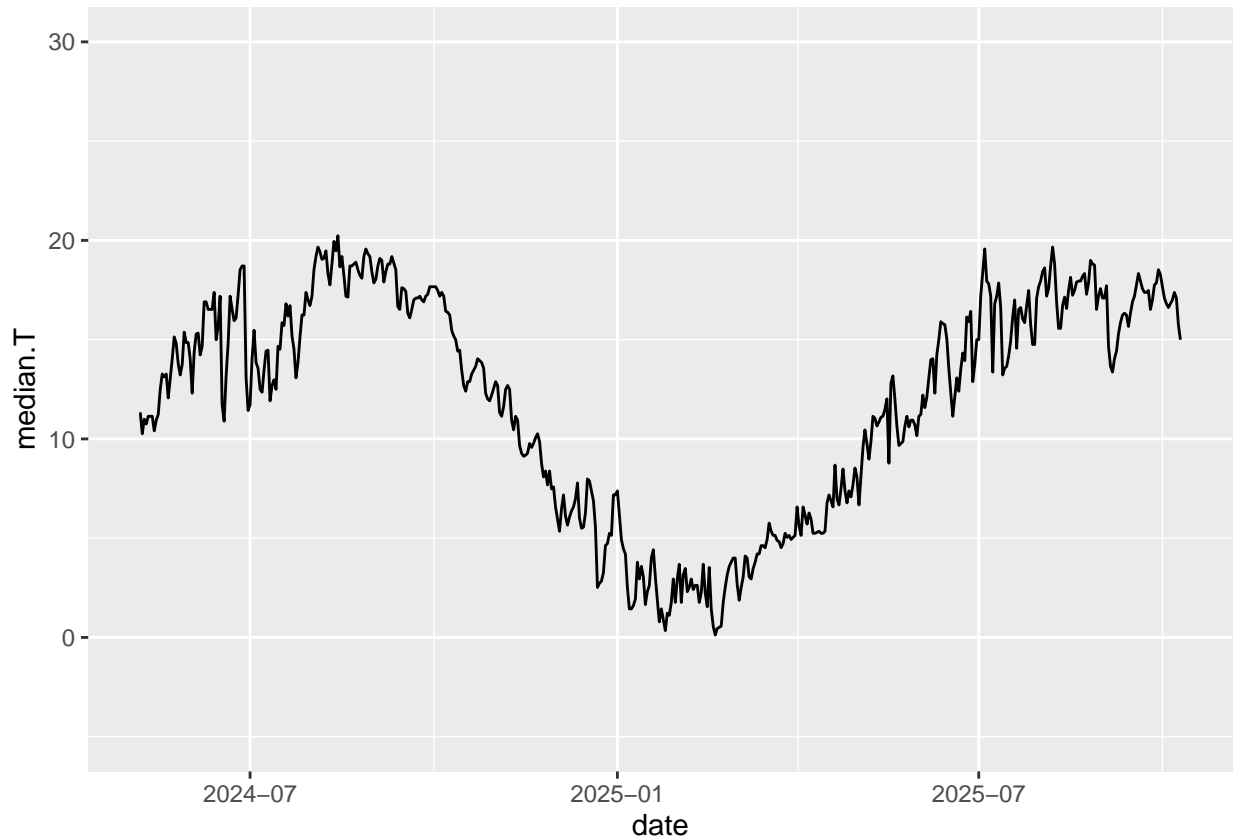


```
d.t.DC.daily.range <- d.t.DC.water %>%
  mutate(date = as_date(date.time)) %>%
  group_by(date) %>%
  summarize(min.T = min(temp.C), max.T = max(temp.C), median.T = median(temp.C)) %>%
  mutate(delta.T = max.T - min.T)

ggplot(data = d.t.DC.daily.range, aes(x = date, y = median.T)) +
  geom_line() +
```

```
coord_cartesian(y = c(-5,30))
```



```
d.t.DC.GDD <- d.t.DC.daily.range %>%
  filter(date >= "2025-01-29") %>%
  mutate(GDD.2 = median.T-2) %>%
  mutate(across(GDD.2, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.2 = cumsum(GDD.2)) %>%
  mutate(GDD.4 = median.T-4) %>%
  mutate(across(GDD.4, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.4 = cumsum(GDD.4)) %>%
  mutate(GDD.6 = median.T-6) %>%
  mutate(across(GDD.6, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.6 = cumsum(GDD.6)) %>%
  mutate(GDD.8 = median.T-8) %>%
  mutate(across(GDD.8, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.8 = cumsum(GDD.8))

d.t.DC.GDD <- d.t.DC.GDD %>%
  pivot_longer(cols = c("GDD.2", "GDD.4", "GDD.6", "GDD.8"), names_to = "Tbase", values_to = "GDD")

ggplot(data = d.t.DC.GDD, aes(x = date, y = GDD, group = Tbase)) +
  geom_line()
```
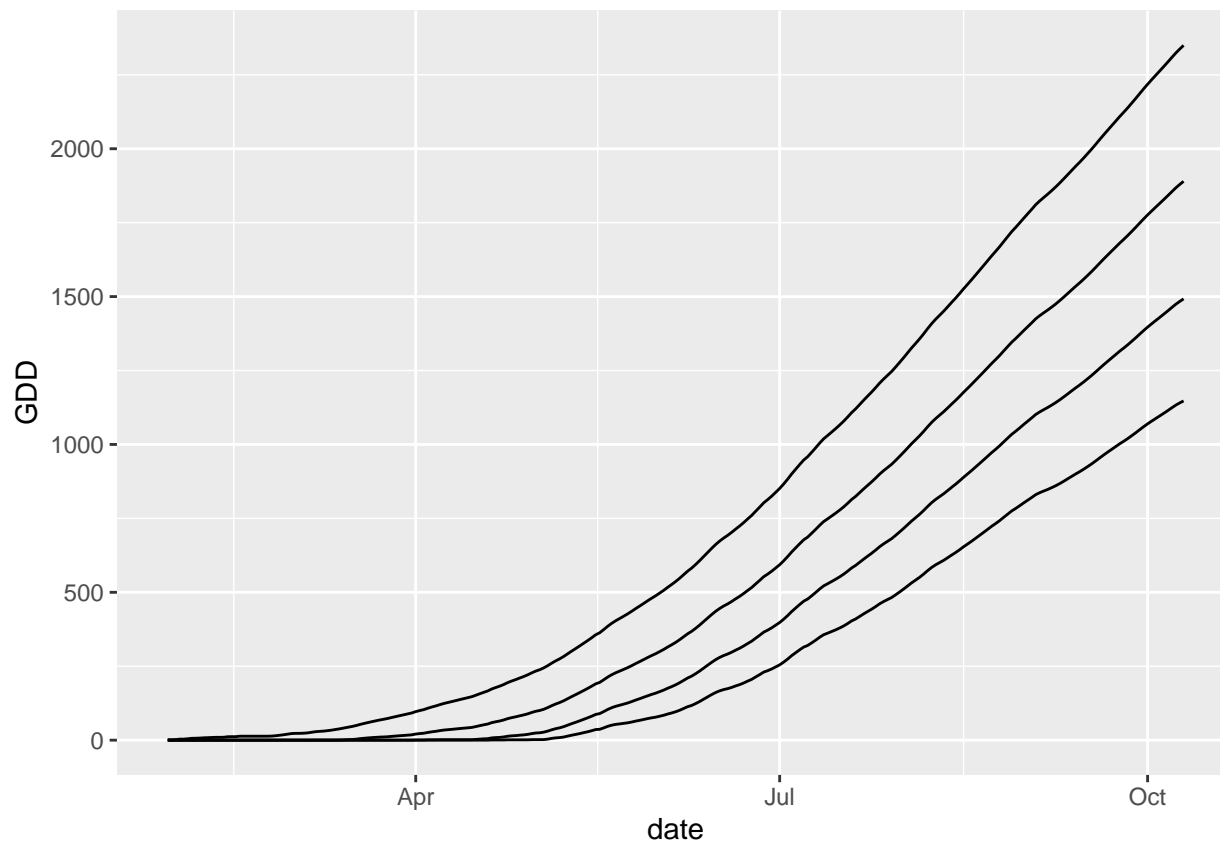
#SH*

```
d.t.SH.1.water <- d.t.SH.1 %>%
  mutate(site.id = "SH") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-05-15 10:45") %>%
  filter(date.time <= "2024-10-08 9:00")

d.t.SH.2.water <- d.t.SH.2 %>%
  mutate(site.id = "SH") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-10-08 9:15") %>%
  filter(date.time <= "2025-06-04 11:15")

d.t.SH.3.water <- d.t.SH.3 %>%
  mutate(site.id = "SH") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2025-06-04 11:30") %>%
```

```
  filter(date.time <= "2025-09-04 14:45")

d.t.SH.water <- bind_rows(d.t.SH.1.water, d.t.SH.2.water, d.t.SH.3.water) %>%
  mutate(j = as.POSIXlt(date.time)$yday + 1)
```

```
str(d.t.SH.water)
```

```
## 'data.frame':    45809 obs. of  6 variables:
##  $ reading.no          : int  12 13 14 15 16 17 18 19 20 21 ...
##  $ date.time           : POSIXct, format: "2024-05-15 10:45:00" "2024-05-15 11:00:00" ...
##  $ temp.C              : num  10.16 9.96 9.87 10.36 10.26 ...
##  $ Intensity.lum.per.sqft: int  2432 1344 1024 1728 1728 2944 896 608 1600 2816 ...
##  $ site.id             : chr  "SH" "SH" "SH" "SH" ...
##  $ j                   : num  136 136 136 136 136 136 136 136 136 136 ...
```

```
ggplot(data = d.t.SH.water, aes(x = date.time, y = temp.C)) +
  geom_line() +
  coord_cartesian(y = c(-1,28))
```
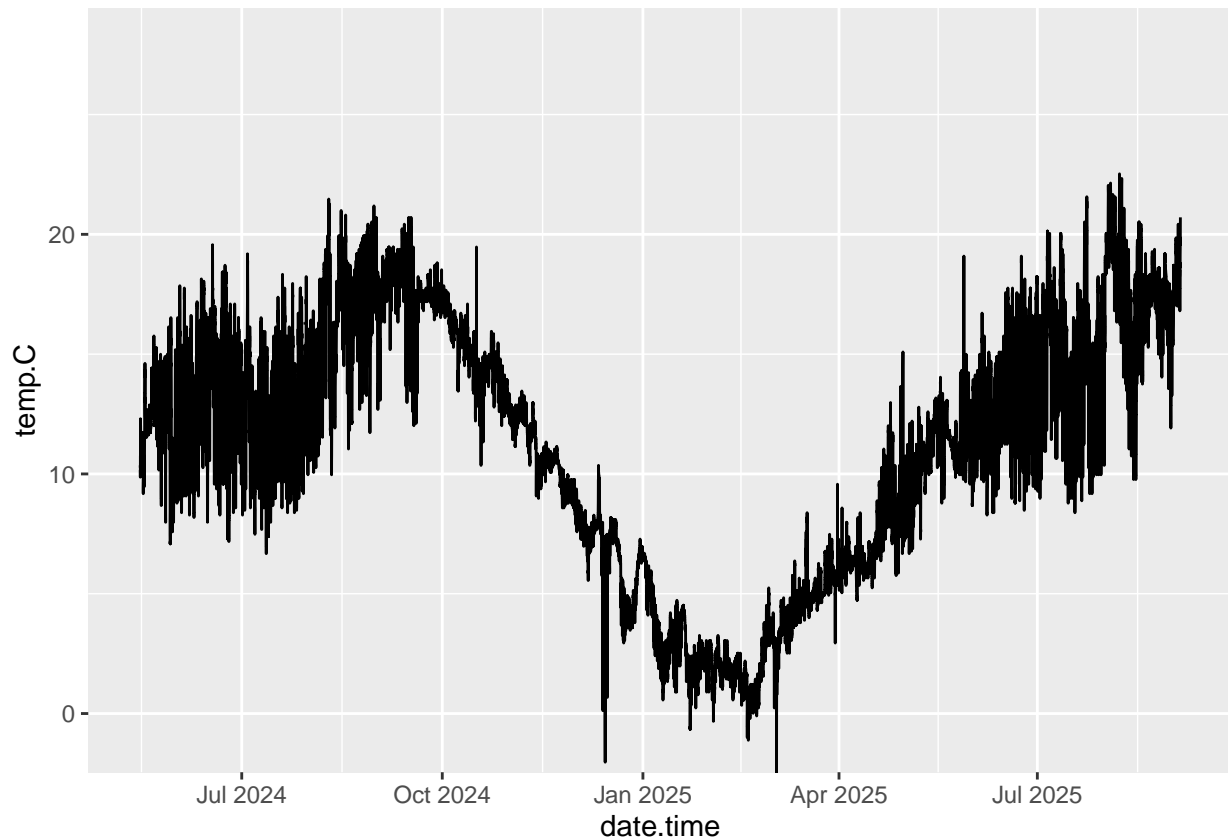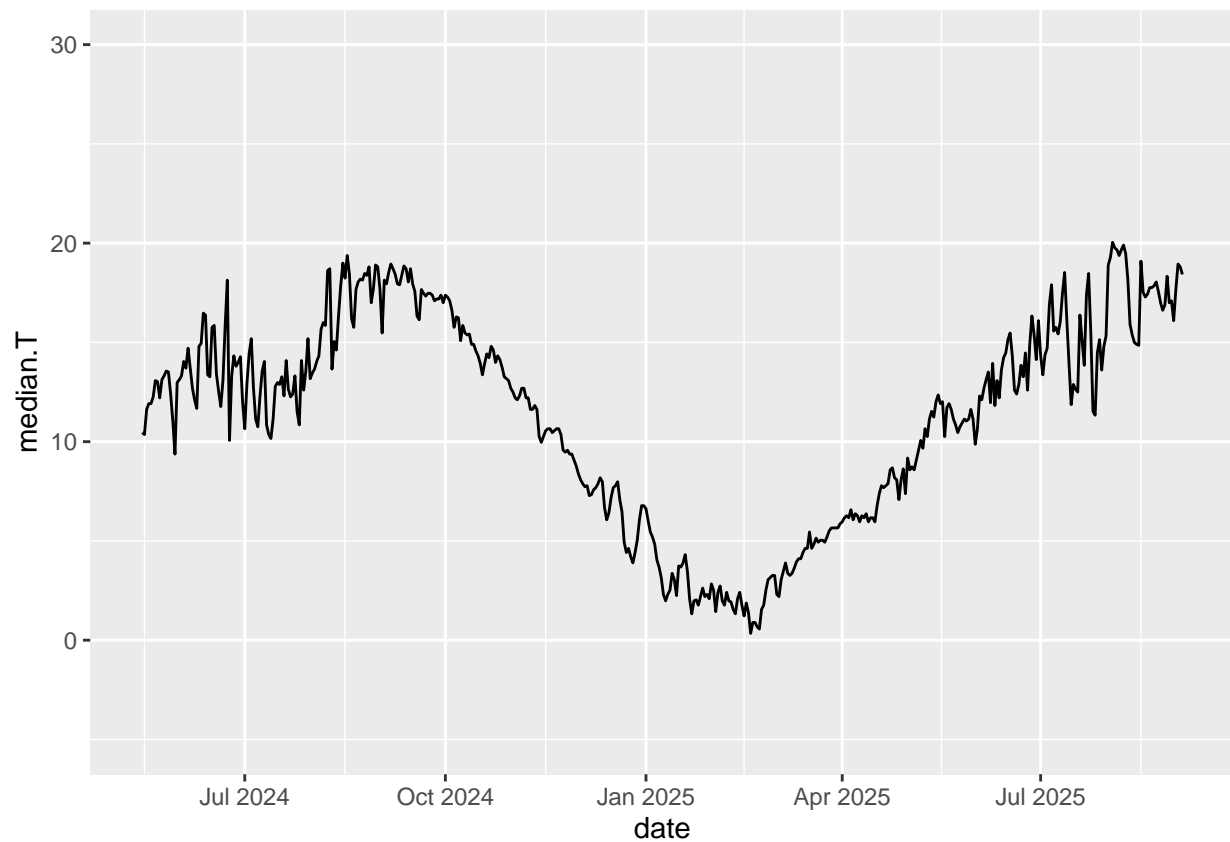


```
d.t.SH.daily.range <- d.t.SH.water %>%
  mutate(date = as_date(date.time)) %>%
  group_by(date) %>%
  summarize(min.T = min(temp.C), max.T = max(temp.C), median.T = median(temp.C)) %>%
  mutate(delta.T = max.T - min.T)

#Exclude +/- 2 hrs low tides </= -1 MLLW at Dux station
```

```
ggplot(data = d.t.SH.daily.range, aes(x = date, y = median.T)) +
  geom_line() +
  coord_cartesian(y = c(-5,30))
```



```
d.t.SH.GDD <- d.t.SH.daily.range %>%
  filter(date >= "2025-01-29") %>%
  mutate(GDD.2 = median.T-2) %>%
  mutate(across(GDD.2, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.2 = cumsum(GDD.2)) %>%
  mutate(GDD.4 = median.T-4) %>%
  mutate(across(GDD.4, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.4 = cumsum(GDD.4)) %>%
  mutate(GDD.6 = median.T-6) %>%
  mutate(across(GDD.6, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.6 = cumsum(GDD.6)) %>%
  mutate(GDD.8 = median.T-8) %>%
  mutate(across(GDD.8, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.8 = cumsum(GDD.8))

d.t.SH.GDD <- d.t.SH.GDD %>%
  pivot_longer(cols = c("GDD.2", "GDD.4", "GDD.6", "GDD.8"), names_to = "Tbase", values_to = "GDD")

ggplot(data = d.t.SH.GDD, aes(x = date, y = GDD, group = Tbase)) +
  geom_line()
```
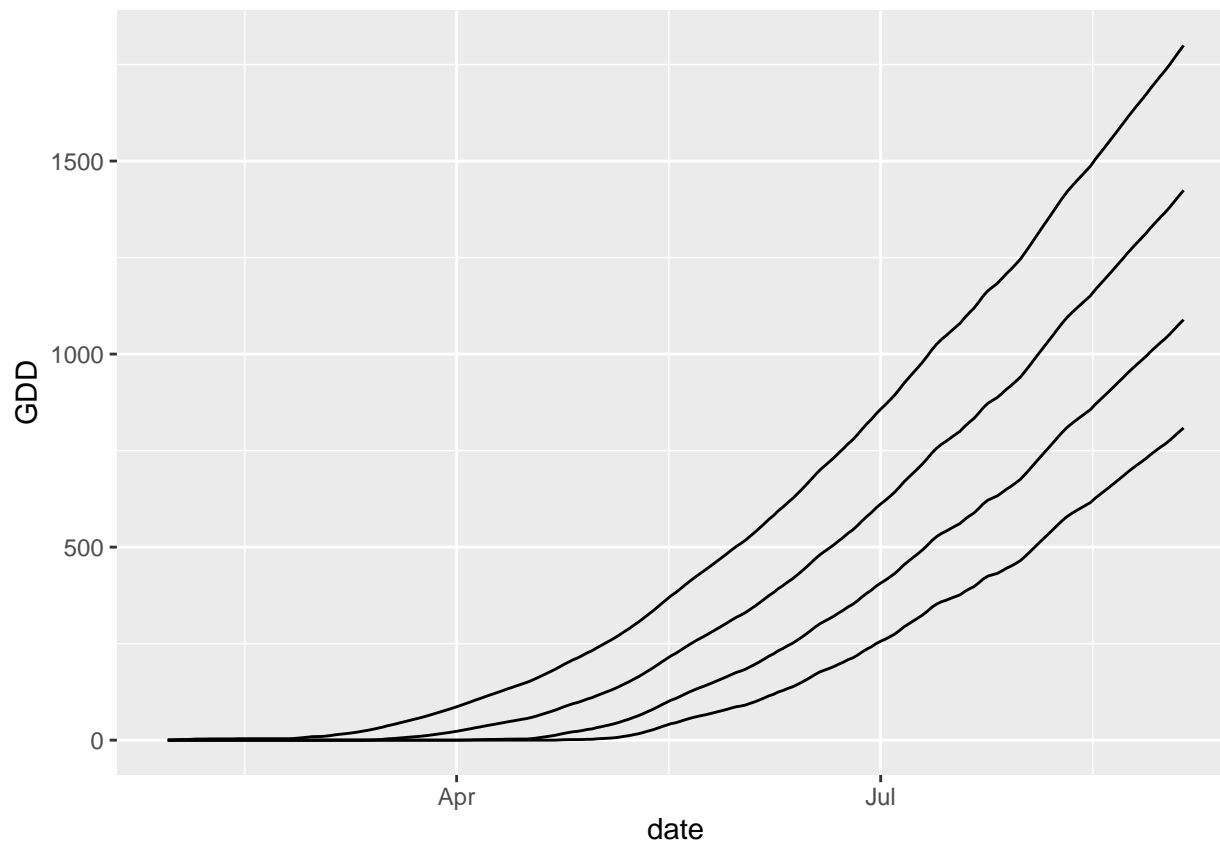
WB

```
d.t.WB.1.water <- d.t.WB.1 %>%
  mutate(site.id = "WB") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2024-10-22 12:45") %>%
  filter(date.time <= "2025-05-08 11:45")

d.t.WB.2.water <- d.t.WB.2 %>%
  mutate(site.id = "WB") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2025-05-08 12:00") %>%
  filter(date.time <= "2025-07-15 10:45")

d.t.WB.3.water <- d.t.WB.3 %>%
  mutate(site.id = "WB") %>%
  mutate(date.time = mdy_hm(date.time)) %>%
  mutate(date.time = date.time - hours(1)) %>%
  mutate(date.time = force_tz(date.time, "EST")) %>%
  mutate(date.time = with_tz(date.time, "America/New_York")) %>%
  filter(date.time >= "2025-07-15 11:00") %>%
```

```
  filter(date.time <= "2025-10-22 11:00")

d.t.WB.water <- bind_rows(d.t.WB.1.water, d.t.WB.2.water, d.t.WB.3.water) %>%
  mutate(j = as.POSIXlt(date.time)$yday + 1)

str(d.t.WB.water)
```

```
## 'data.frame':     35034 obs. of  6 variables:
##  $ reading.no          : int  16 17 18 19 20 21 22 23 24 25 ...
##  $ date.time           : POSIXct, format: "2024-10-22 12:45:00" "2024-10-22 13:00:00" ...
##  $ temp.C              : num  13 13 13.1 13.2 13.3 ...
##  $ Intensity.lum.per.sqft: int  272 256 256 232 208 176 176 160 136 128 ...
##  $ site.id             : chr  "WB" "WB" "WB" "WB" ...
##  $ j                   : num  296 296 296 296 296 296 296 296 296 296 ...
```

```
ggplot(data = d.t.WB.water, aes(x = date.time, y = temp.C)) +
  geom_line() +
  coord_cartesian(y = c(-1,28))
```
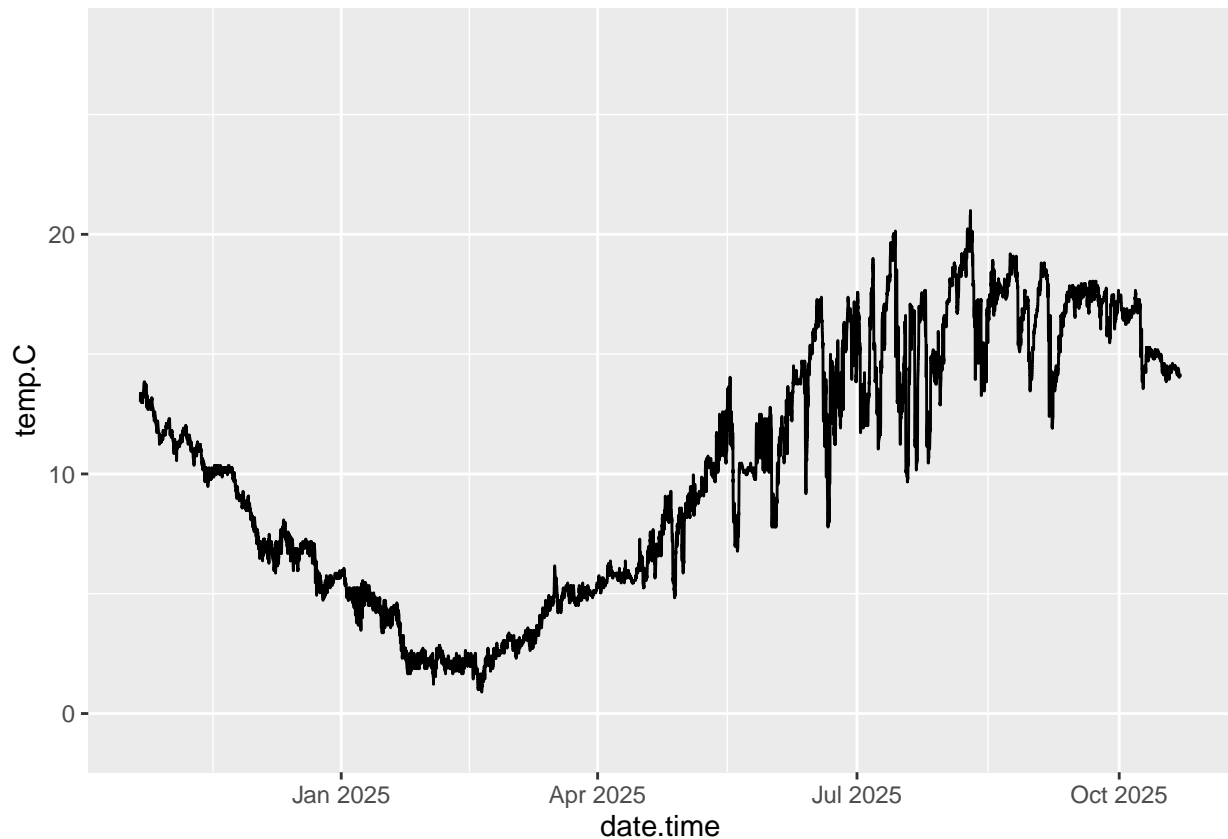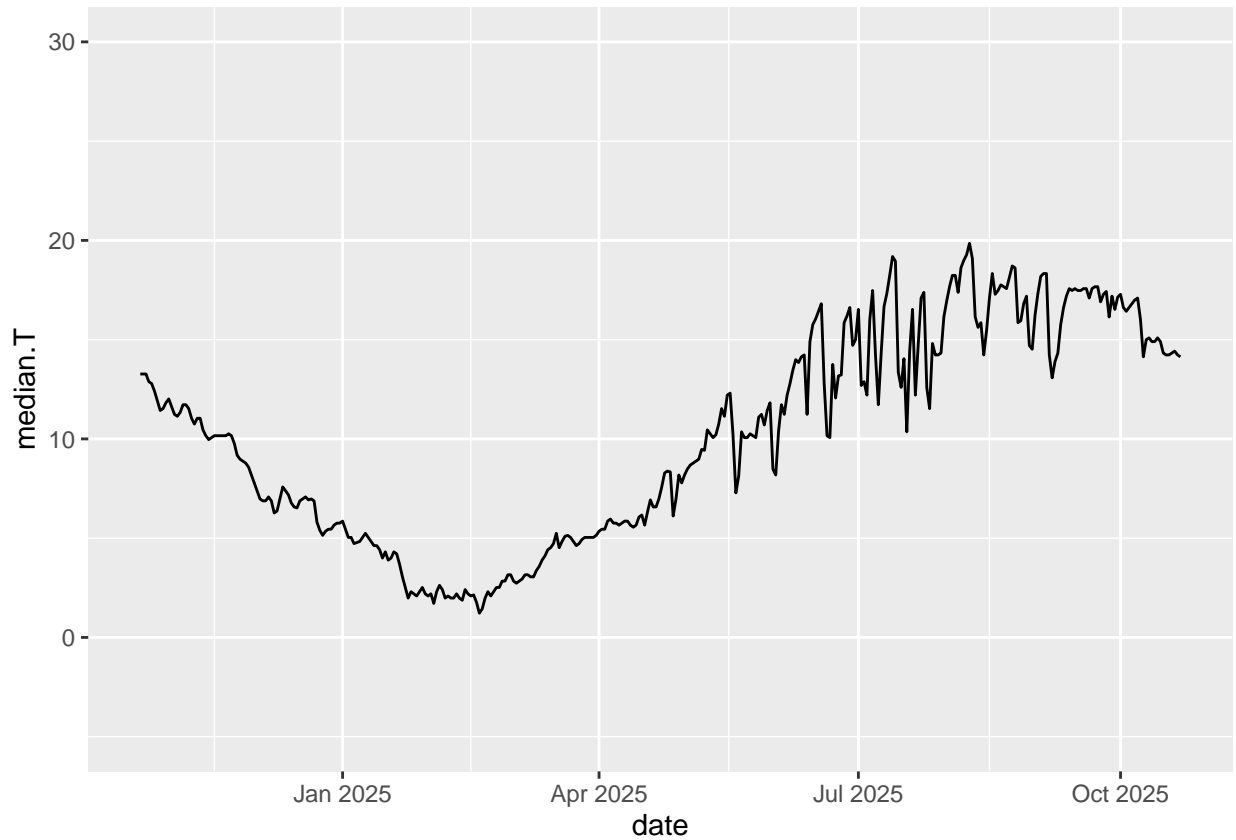


```
d.t.WB.daily.range <- d.t.WB.water %>%
  mutate(date = as_date(date.time)) %>%
  group_by(date) %>%
  summarize(min.T = min(temp.C), max.T = max(temp.C), median.T = median(temp.C)) %>%
  mutate(delta.T = max.T - min.T)

ggplot(data = d.t.WB.daily.range, aes(x = date, y = median.T)) +
  geom_line() +
```

```r
coord_cartesian(y = c(-5,30))
```



```r
d.t.WB.GDD <- d.t.WB.daily.range %>%
  filter(date >= "2025-01-29") %>%
  mutate(GDD.2 = median.T-2) %>%
  mutate(across(GDD.2, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.2 = cumsum(GDD.2)) %>%
  mutate(GDD.4 = median.T-4) %>%
  mutate(across(GDD.4, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.4 = cumsum(GDD.4)) %>%
  mutate(GDD.6 = median.T-6) %>%
  mutate(across(GDD.6, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.6 = cumsum(GDD.6)) %>%
  mutate(GDD.8 = median.T-8) %>%
  mutate(across(GDD.8, ~ ifelse(. < 0, 0, .))) %>%
  mutate(GDD.8 = cumsum(GDD.8))

d.t.WB.GDD <- d.t.WB.GDD %>%
  pivot_longer(cols = c("GDD.2", "GDD.4", "GDD.6", "GDD.8"), names_to = "Tbase", values_to = "GDD")

ggplot(data = d.t.WB.GDD, aes(x = date, y = GDD, group = Tbase)) +
  geom_line()
```