Notebook

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2018-07-26

Contents

Chapter 1

Preamble

I am a PhD student in Biology at University of Washington. I'm intersted in boundary layer climate, and the effects of microclimates(think of climate right above ground) on plants and animals. I like to develop *computational tools* in **R and Python**. I embrace openness in research and believe in sharing knowledge.

Below are the packages developed in ***R*** that could be used in any field.

```
# TrenchR - Energy balance functions
# devtools::install_github("trenchproject/TrenchR")
# TrenchR - UI to extract microclimate data
# devtools::install_github("trenchproject/ebm")
# TrenchR - Backend processor for UI (Uses Amazon Mail API)
# devtools::install_github("trenchproject/tecor-monitor")
```

Few sites where my research can be visualized. Extract microclimate data at http://microclim.org/.

1.1 Areas of interest

1.2 Published papers

Ausmees, Kristiina, Aji John, Salman Z. Toor, Andreas Hellander, and Carl Nettelblad. "BAMSI: a multi-cloud service for scalable distributed filtering of massive genome data." BMC bioinformatics 19, no. 1 (2018): 240.

Ausmees, Kristiina, and Pushpam Aji John. "Analysis of Chromosome 20-A Study." arXiv preprint arXiv:1607.00276 (2016).

John, Pushpam Aji, et al. "868 MHz Wireless Sensor Network-A Study." arXiv preprint arXiv:1609.00475 (2016).

1.3 Un-Published papers

Chapter 2

Introduction

You can label chapter and section titles using `{#label}` after them, e.g., we can reference Chapter 2. If you do not manually label them, there will be automatic labels anyway, e.g., Chapter 5.

Figures and tables with captions will be placed in `figure` and `table` environments, respectively.

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure 3.1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 3.1.

You can write citations, too. For example, we are using the **bookdown** package (**?**) in this sample book, which was built on top of R Markdown and **knitr** (John, 2018).

Chapter 3

Background

This section deals with what I had to learn or I learnt from the courses I took. You can label chapter and section titles using `{#label}` after them, e.g., we can reference Chapter 2. If you do not manually label them, there will be automatic labels anyway, e.g., Chapter 5.

Figures and tables with captions will be placed in `figure` and `table` environments, respectively.

```
par(mar = c(4, 4, .1, .1))
plot(pressure, type = 'b', pch = 19)
```

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure 3.1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 3.1.

```
knitr::kable(
  head(iris, 20), caption = 'Here is a nice table!',
  booktabs = TRUE
)
```

You can write citations, too. For example, we are using the **bookdown** package (**?**) in this sample book, which was built on top of R Markdown and **knitr** (John, 2018).

3.1 Algaebra

3.2 Statistics

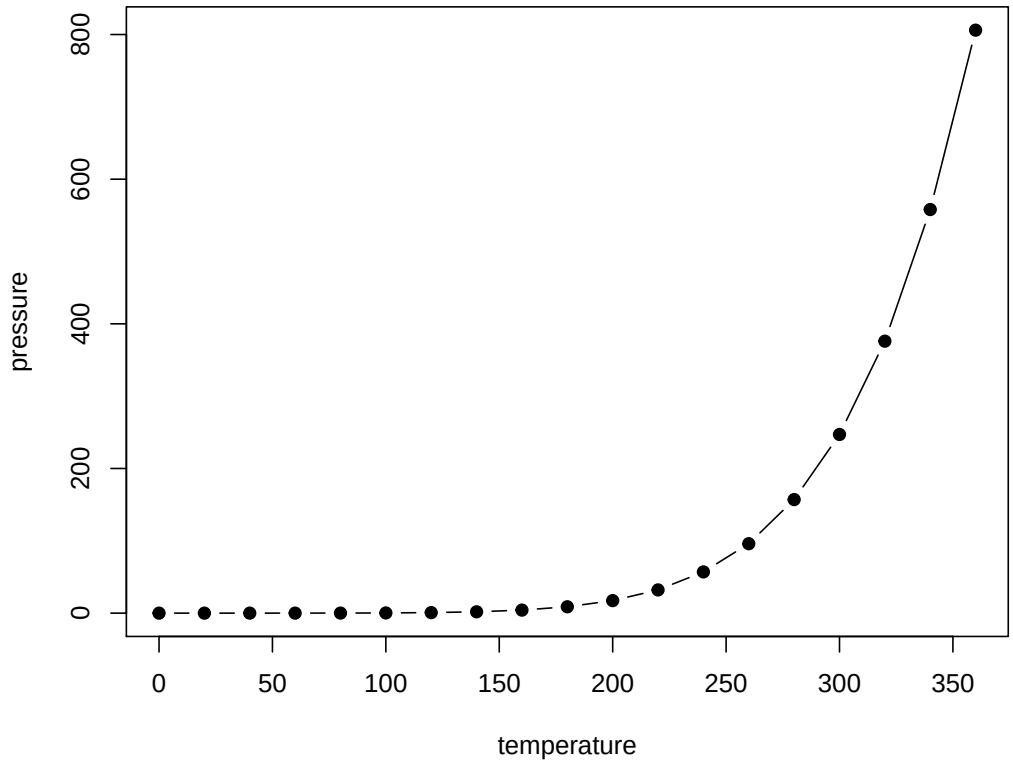


Figure 3.1: Here is a nice figure!

Table 3.1: Here is a nice table!

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa

Chapter 4

Literature

Here is a review of existing methods.

Chapter 5

Methods

We describe our methods in this chapter.

Chapter 6

Applications

Some *significant* applications are demonstrated in this chapter.

6.1 Example one

6.2 Example two

Chapter 7

Final Words

We have finished a nice book.

Chapter 8

Journal

Daily *lab notes*

```
library(ggplot2)
library(tidyverse)
library(lubridate)
```

8.1 4-12-2018

8.1.1 ekoseminar

Urban ecosystems are undergoing evolution at a much faster pace than one would imagine. Thinking about mutation which introduce allele frequency key to heritable diversity ?

8.1.2 meeting with jhrl

Certain species do flower early - confirmed by JHRL. The poster we presented does make sense.

8.1.3 ekoclimate

The energy budget of the area increases if the type of the cover changes, i.e if it changes from deciduous forest to crop/grassland then the net Long Wave radiation(flux?) increases. Long wave is the one that is reflected, so the area with a grass will absorb more heat through the day , and emilt radiation during the night? (More cooling ?). So, should we see more diurnal variation in crop/grasslands than forests ?. How should one charaterize the total energy flux on grasslands vs forests?

Shortware is the incoming radiation - i.e having a shorter wavelength, and when is reflected, it becomes long wave radiation. The longwave radiation emitted out is calculated by multipying Stephan Boltzman constant multiplied by epsilion(emissivity) and Temperature^4(Temperature of the object).

8.1.4 trenchR

Thermal conductance wrt to animals define the amount of heat which can escape out of animals. It depends on the difference between the animal and the outside temperature and you multipy by the thickness(lambda) and a proportion of the surface area(true area exposed to solar radiation).

Surace area to calculate the exposure is related to the exposed area - tricky as animals come in all shapes, mostly cylindrical with a sphere head if land based.

8.2 4-13-2018

8.3 4-20-2008

Heat transfer coefficient for Lizards. It is linear with windspeeed, and slope changes when the lizard is parallel or transverse

8.4 4-23-2008

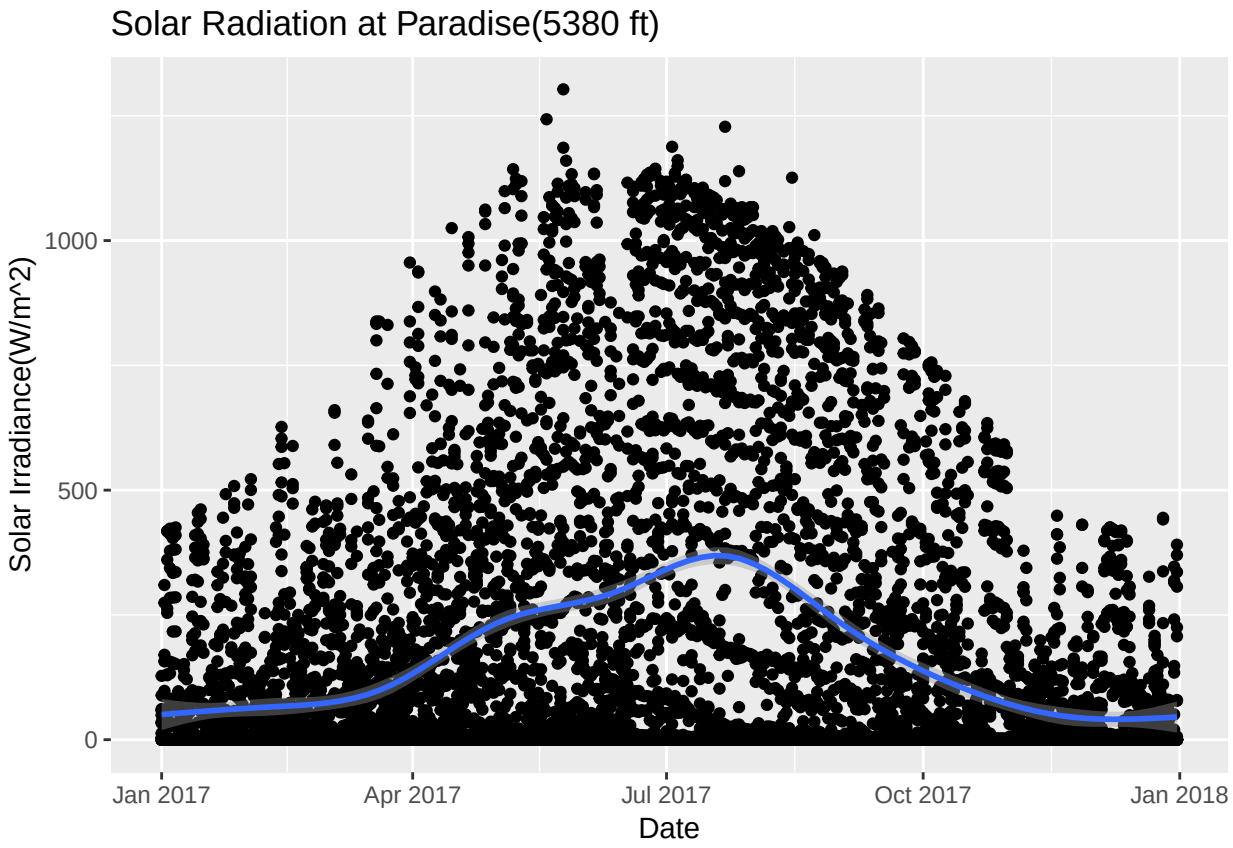
Get diurnal variation across 5 sites at Mt Rainier

```
#Load a file
Paradise_2017<- read.csv('./data/ParadiseWind_5380_feet_2017.csv')
CampMuir_2017<- read.csv('./data/CampMuir_10110_feet_2017.csv')
Sunriseupper_2017<- read.csv('./data/SunriseUpper_6880_feet_2017.csv')

Paradise_2017$date <- as.Date(Paradise_2017$Date.Time..PST., "%Y-%m-%d")
Paradise_2017$hr <-strftime(Paradise_2017$Date.Time..PST.,'%H')
Paradise_2017$min <-strftime(Paradise_2017$Date.Time..PST.,'%M')
Paradise_2017$month <- strftime(Paradise_2017$Date.Time..PST.,'%m')
CampMuir_2017$date <- as.Date(CampMuir_2017$Date.Time..PST., "%Y-%m-%d")
CampMuir_2017$hr <-strftime(CampMuir_2017$Date.Time..PST.,'%H')
CampMuir_2017$min <-strftime(CampMuir_2017$Date.Time..PST.,'%M')
CampMuir_2017$month <-strftime(CampMuir_2017$Date.Time..PST.,'%m')
Sunriseupper_2017$date <- as.Date(Sunriseupper_2017$Date.Time..PST., "%Y-%m-%d")
Sunriseupper_2017$hr <-strftime(Sunriseupper_2017$Date.Time..PST.,'%H')
Sunriseupper_2017$min <-strftime(Sunriseupper_2017$Date.Time..PST.,'%M')
Sunriseupper_2017$month <- strftime(Sunriseupper_2017$Date.Time..PST.,'%m')


str(Paradise_2017)
```

```
## 'data.frame':    8760 obs. of  11 variables:
##  $ Date.Time..PST.          : Factor w/ 8760 levels "2017-01-01 00:00",..: 8760 8759 8758 8757 8756 8
##  $ Battery.Voltage..v.      : num  13 13 12.4 12.9 12.9 ...
##  $ Wind.Speed.Minimum..mph.: num  0 0 0 0.71 1.42 2.13 0 0 0 0.71 ...
##  $ Wind.Speed.Average..mph.: num  1.68 1.68 1.6 2.23 2.76 ...
##  $ Wind.Speed.Maximum..mph.: num  3.55 3.55 3.55 3.55 3.55 4.26 3.55 3.55 4.26 6.39 ...
##  $ Wind.Direction..deg..    : num  21.04 6.89 19.41 26.65 16.74 ...
##  $ Solar.Pyranometer..W.m2.: num  0 0 0 0 0 ...
##  $ date                     : Date, format: "2017-12-31" "2017-12-31" ...
##  $ hr                       : chr  "00" "00" "00" "00" ...
##  $ min                      : chr  "00" "00" "00" "00" ...
##  $ month                    : chr  "12" "12" "12" "12" ...
```

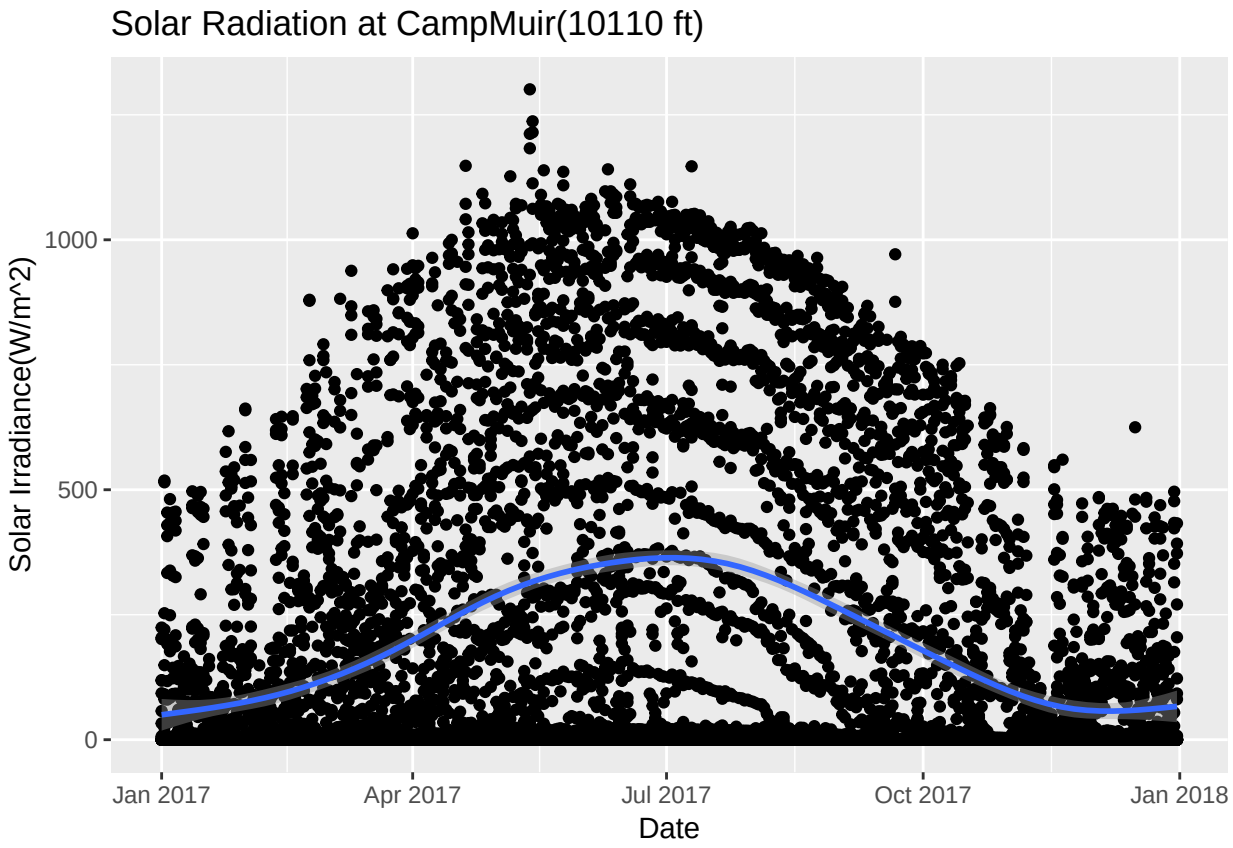
```
Paradise_2017 %>% ggplot(aes(date,Solar.Pyranometer..W.m2.)) +geom_point() +  stat_smooth(se = TRUE) + g
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



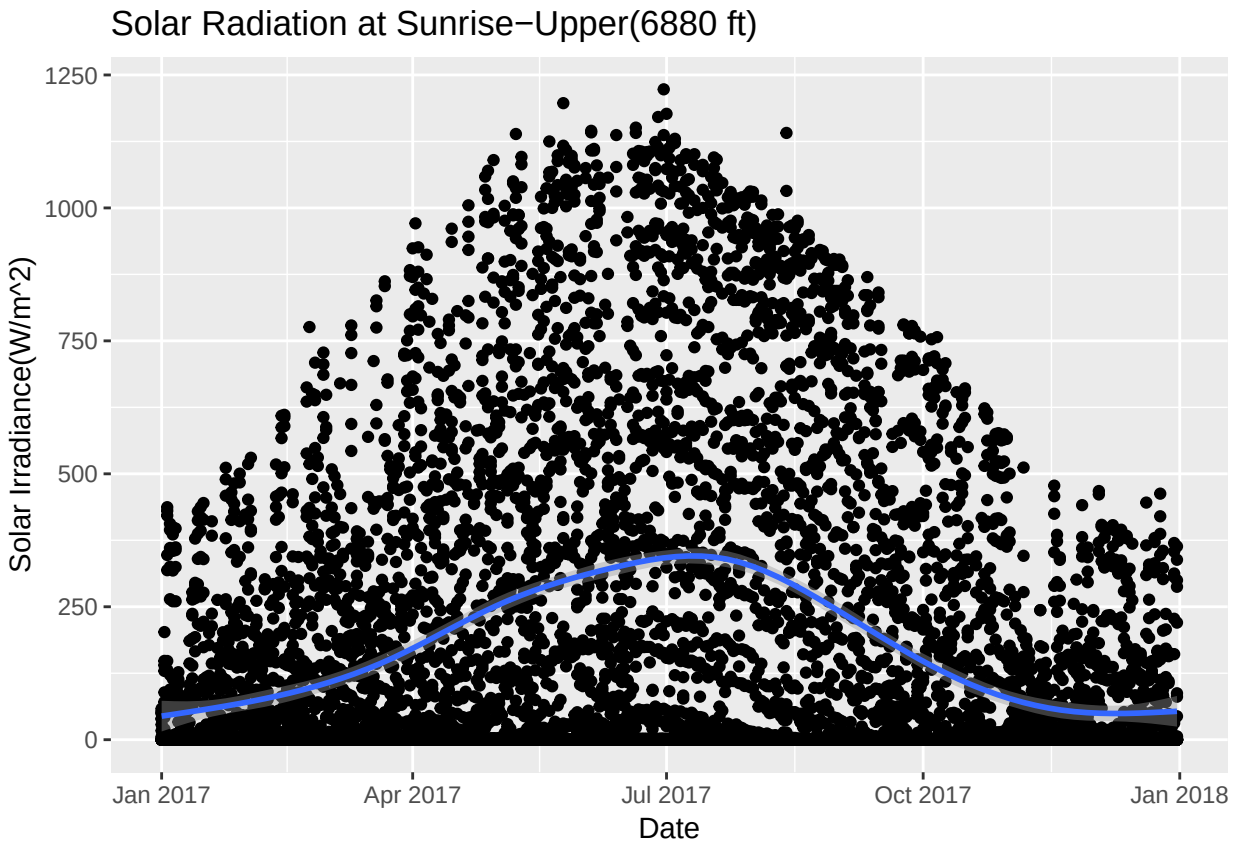

```
CampMuir_2017 %>% ggplot(aes(date,Solar.Pyranometer..W.m2.)) + geom_point() +  stat_smooth(se = TRUE) +
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
Sunriseupper_2017 %>% ggplot(aes(date,Solar.Pyranometer..W.m2.)) + geom_point() +  stat_smooth(se = TRU
```

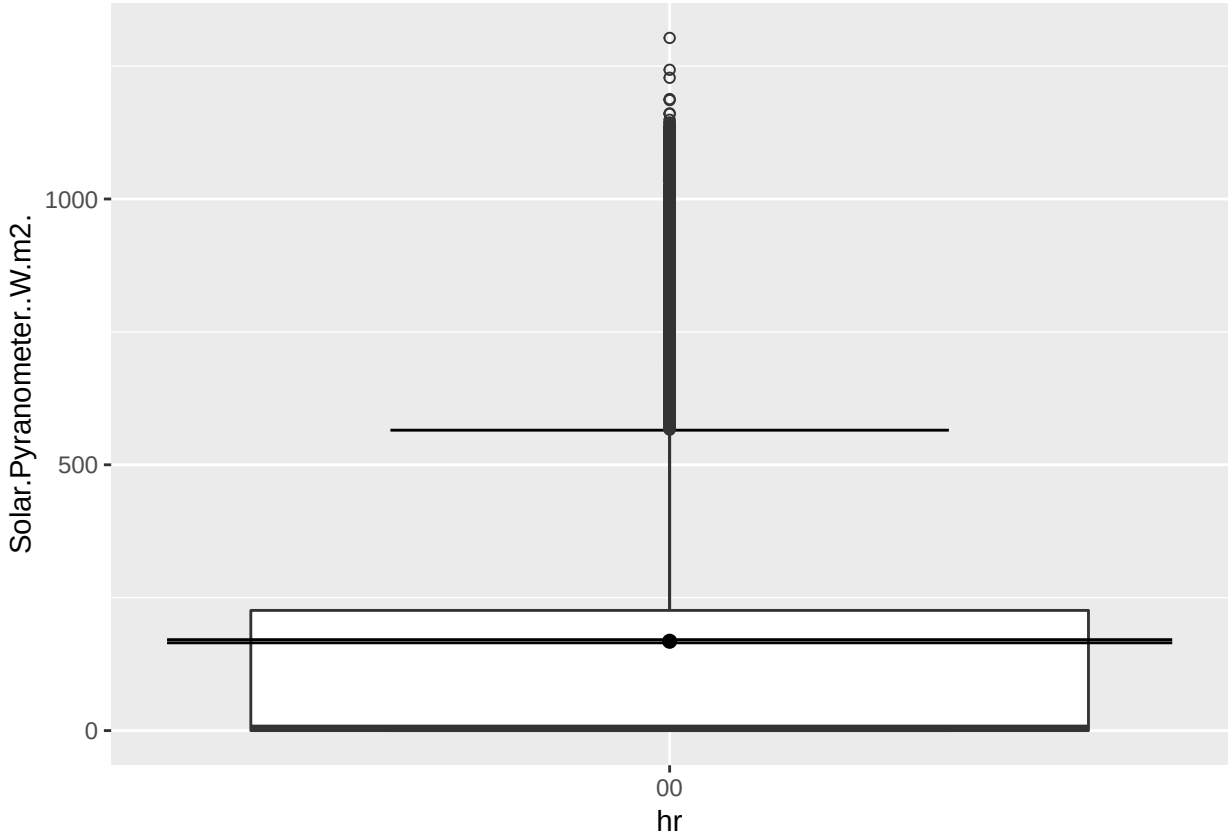
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Feedback

Better to do it houry so that daily patterns do confound it. So, now we have hourly solar radiation across all the sites.

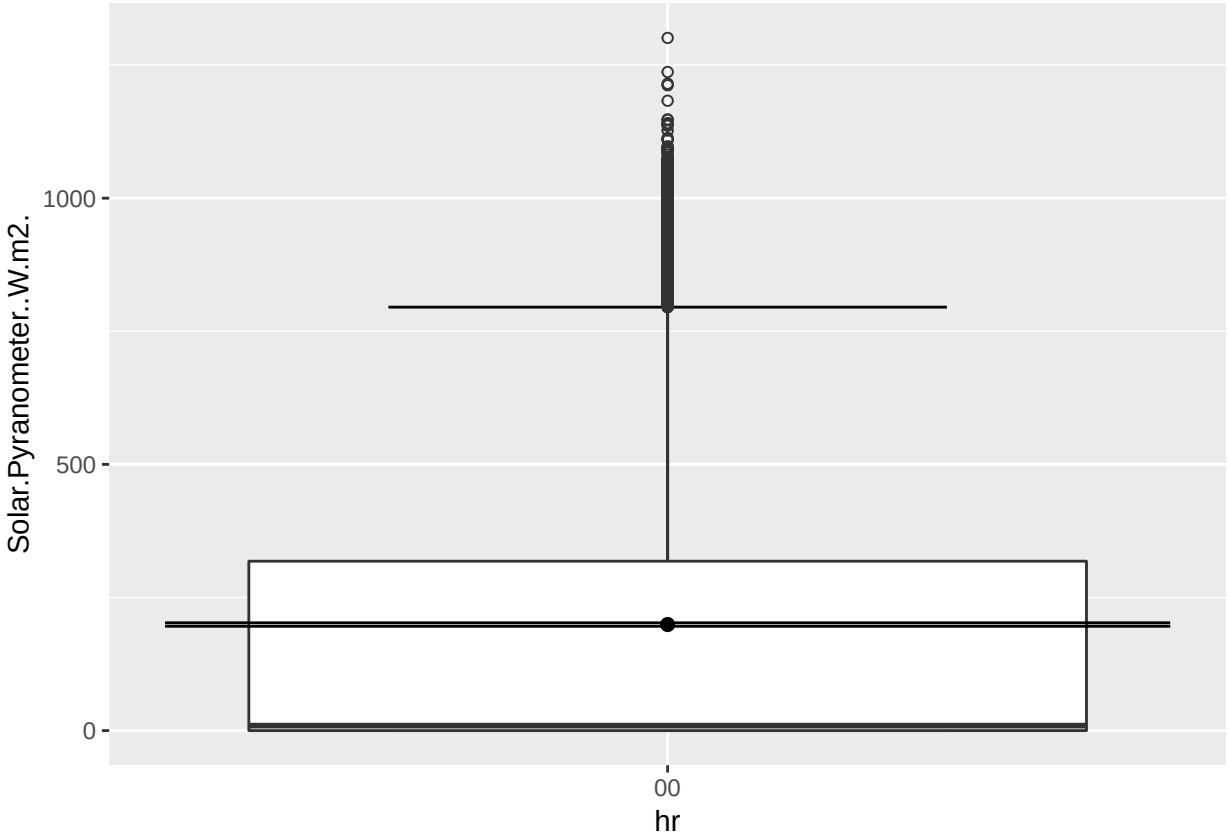
```
## 4-28-2008

#

ggplot(Paradise_2017, aes(hr,Solar.Pyranometer..W.m2.))+
  stat_boxplot( aes(hr,Solar.Pyranometer..W.m2.),
    geom='errorbar', linetype=1, width=0.5)+  #whiskers
  geom_boxplot( aes(hr,Solar.Pyranometer..W.m2.),outlier.shape=1) +
  stat_summary(fun.y=mean, geom="point", size=2) +
  stat_summary(fun.data = mean_se, geom = "errorbar")
```




```
 annotate("text",x=20,y=55,label="wassup!" , family="xkcd"
           )
```

```
## mapping: x = ~x, y = ~y
## geom_text: na.rm = FALSE
## stat_identity: na.rm = FALSE
## position_identity
```

```
## 4-28-2008

#
ggplot(CampMuir_2017, aes(hr,Solar.Pyranometer..W.m2.))+
  stat_boxplot( aes(hr,Solar.Pyranometer..W.m2.),
    geom='errorbar', linetype=1, width=0.5)+  #whiskers
  geom_boxplot( aes(hr,Solar.Pyranometer..W.m2.),outlier.shape=1) +
  stat_summary(fun.y=mean, geom="point", size=2) +
  stat_summary(fun.data = mean_se, geom = "errorbar")
```



It does confirm that higher the sites, the solar radiation is slightly higher.

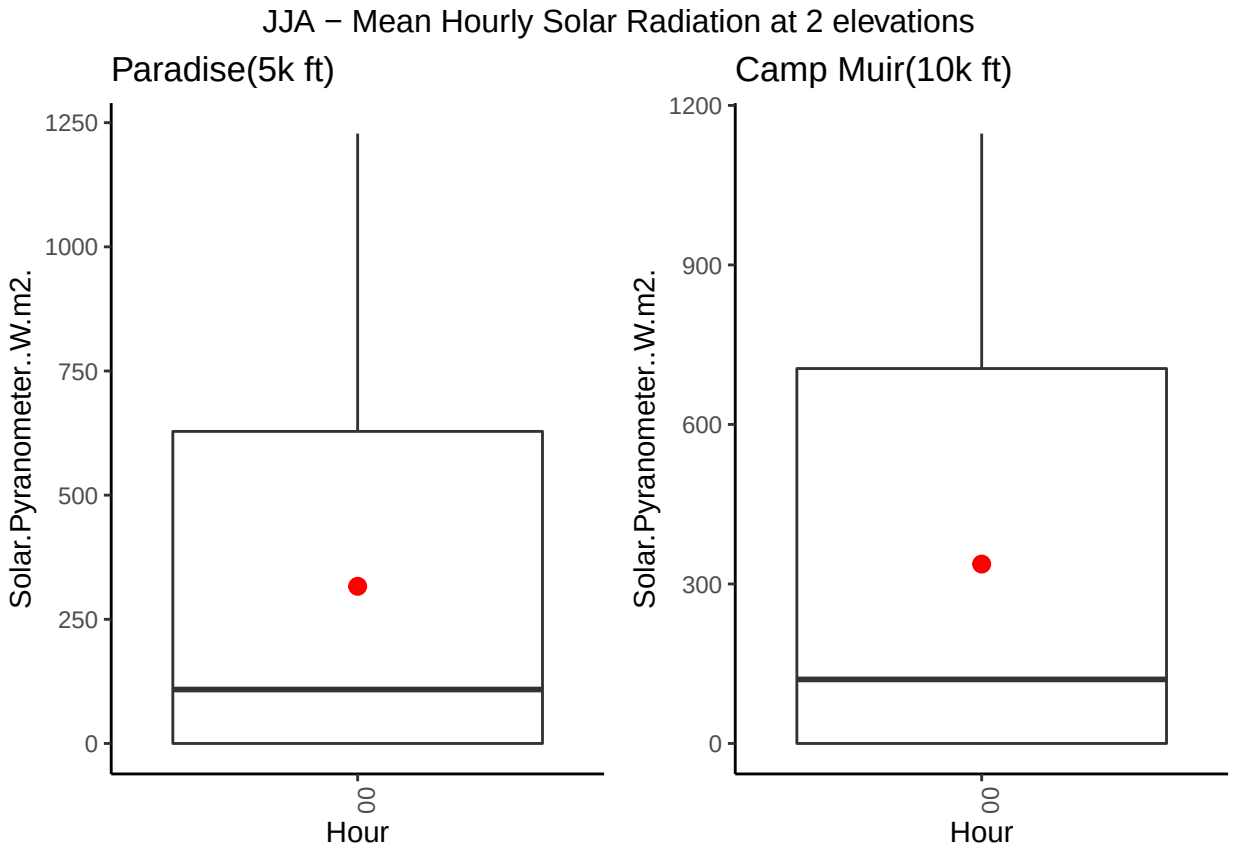
8.5 4-29-2008

Lets assume that solar radiation is infact more relevant at higher elevations, so snowmelt would be at a faster rate at higher elevations. Is snowmelt even at all the elevations ? Intuitively no as we often see that peaks hold-on to snow longer. (Just aside discussion).

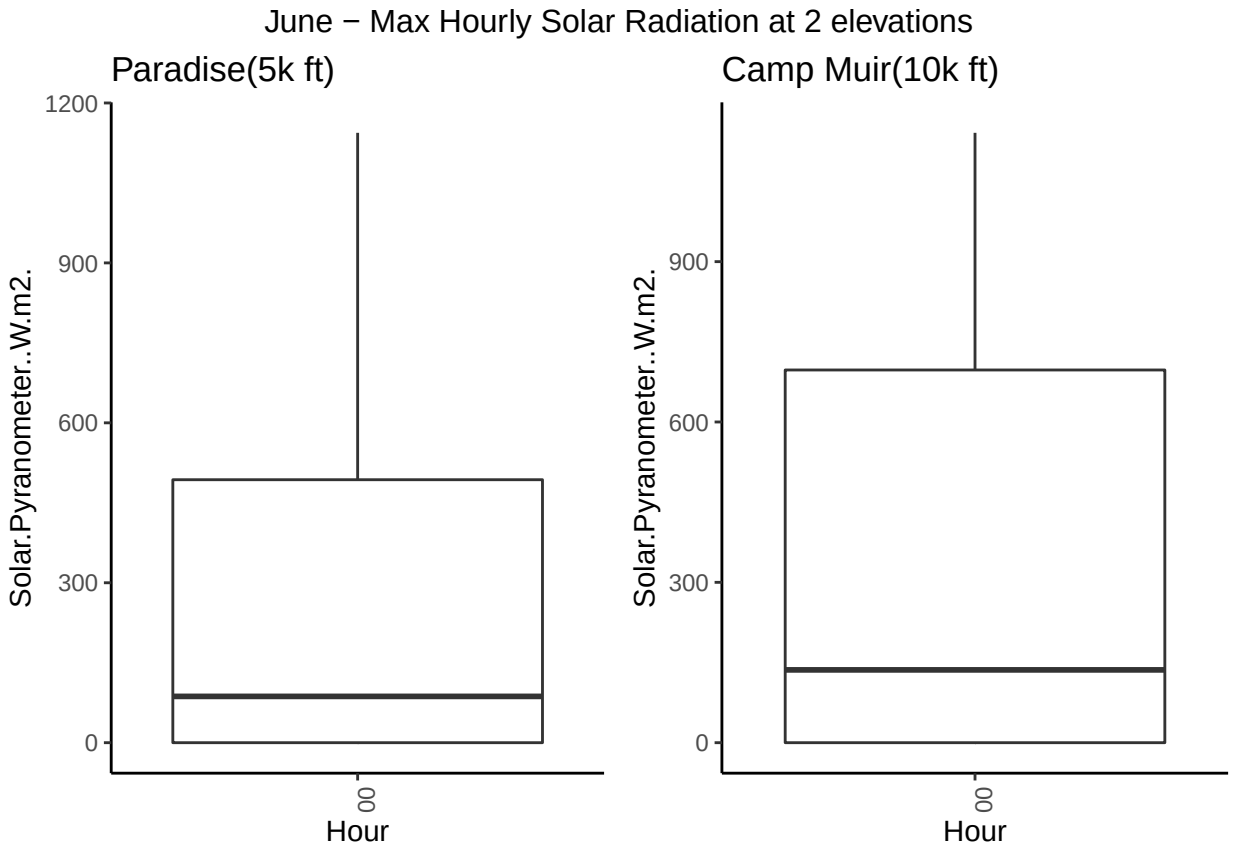
Here, the goal is to see if there is a difference in radiation recieved at the sites. Reasoning being if the solar radiation recorded is different, that would mean differemt growing degree days. Lets look for June, July and August(JJA Summer). Summer solstice - June 21st.

```
## 4-29-2008
library(gridExtra)
#



g1 <- Paradise_2017 %>%  filter(month %in% c('06','07','08')) %>% ggplot( aes(hr,Solar.Pyranometer..W.m
    stat_summary(colour = "red",size=0.5) + theme_classic() +theme(axis.text.x = element_text(angle = 9


g2 <- CampMuir_2017 %>%  filter(month %in% c('06','07','08')) %>% ggplot( aes(hr,Solar.Pyranometer..W.m
    stat_summary(colour = "red",size=0.5) + theme_classic() +theme(axis.text.x = element_text(angle = 9


grid.arrange(g1, g2,ncol=2, top = "JJA - Mean Hourly Solar Radiation at 2 elevations")
```

```
## No summary function supplied, defaulting to `mean_se()
## No summary function supplied, defaulting to `mean_se()
```



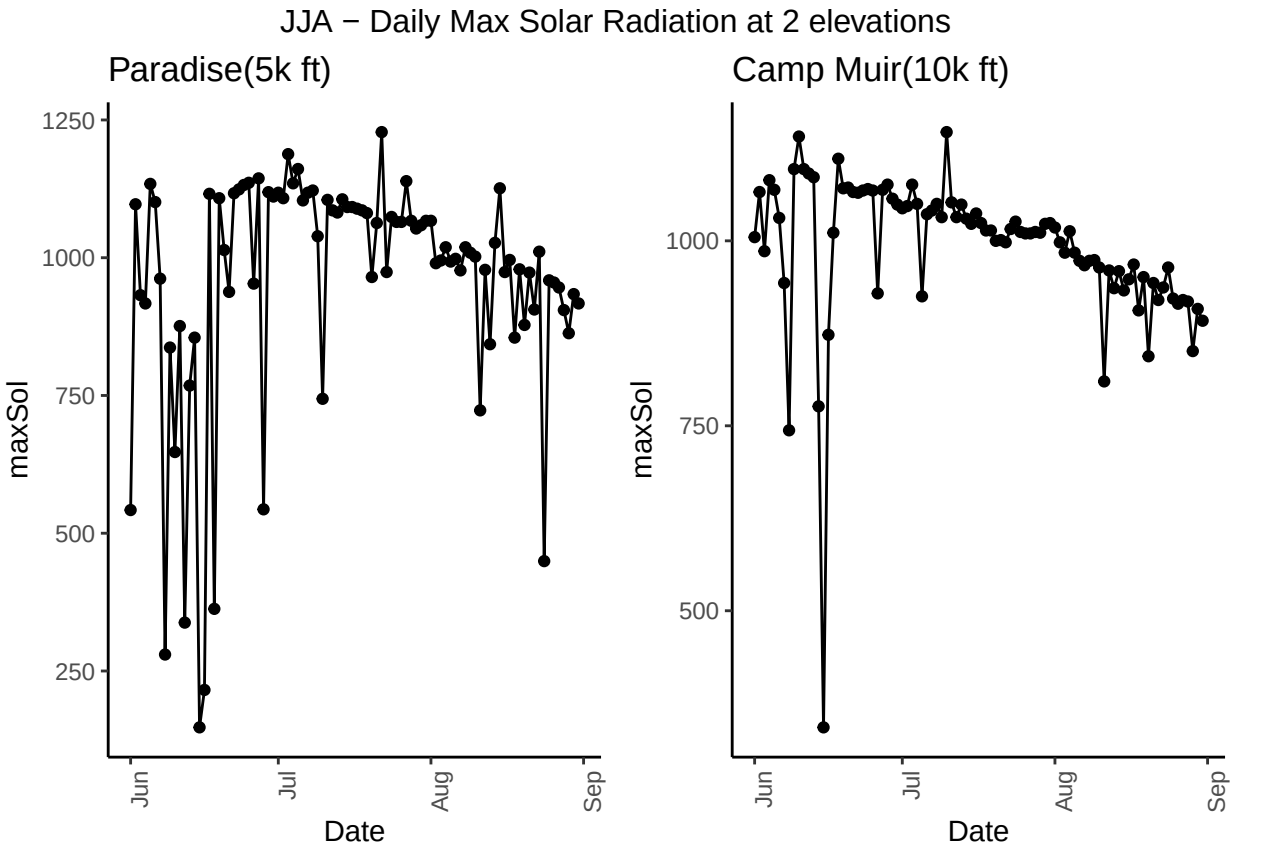

```
## 4-29-2008
library(gridExtra)
#



g3 <- Paradise_2017 %>%  filter(month %in% c('06')) %>% ggplot( aes(hr,Solar.Pyranometer..W.m2.)) + geom
    theme_classic() +theme(axis.text.x = element_text(angle = 90, hjust = 1)) +     xlab("Hour") + ggtit



g4 <- CampMuir_2017 %>%  filter(month %in% c('06')) %>% ggplot( aes(hr,Solar.Pyranometer..W.m2.)) + geom
   theme_classic() +theme(axis.text.x = element_text(angle = 90, hjust = 1)) +     xlab("Hour") + ggtitl



grid.arrange(g3, g4,ncol=2, top = "June - Max Hourly Solar Radiation at 2 elevations")
```




```
#ggplotly()
```

Lets check the daily max for each day in summer(JJA)

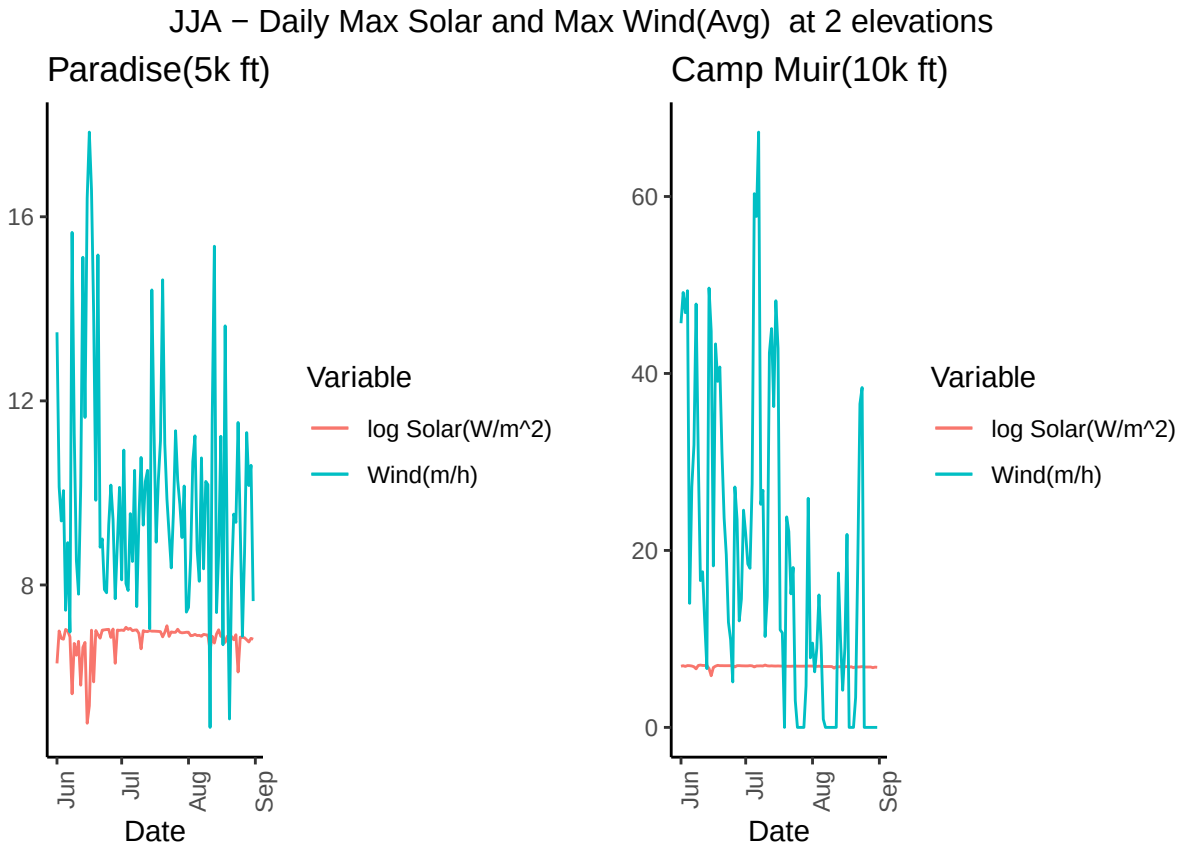
```
## 4-29-2008
library(gridExtra)
#



g5 <- Paradise_2017 %>%  filter(month %in% c('06','07','08')) %>% dplyr::group_by(date) %>%
  dplyr::summarise(maxSol = max(Solar.Pyranometer..W.m2.)) %>%
  ggplot( aes(date,maxSol)) + geom_point() + geom_line() +
    theme_classic() +theme(axis.text.x = element_text(angle = 90, hjust = 1)) +     xlab("Date") + ggti


g6 <- CampMuir_2017 %>%  filter(month %in% c('06','07','08')) %>% dplyr::group_by(date) %>%
  dplyr::summarise(maxSol = max(Solar.Pyranometer..W.m2.)) %>%
  ggplot( aes(date,maxSol)) + geom_point() +  geom_line() +
    theme_classic() +theme(axis.text.x = element_text(angle = 90, hjust = 1)) +     xlab("Date") + ggti


grid.arrange(g5, g6,ncol=2, top = "JJA - Daily Max Solar Radiation at 2 elevations")
```




```
#ggplotly()
```

Compare wind and solar at two sites

```
## 4-29-2008
library(gridExtra)
#



g5 <- Paradise_2017 %>%  filter(month %in% c('06','07','08')) %>% dplyr::group_by(date) %>%
  dplyr::summarise(maxSol = max(Solar.Pyranometer..W.m2.),maxWind = max(Wind.Speed.Average..mph.)) %>%
  ggplot() + geom_line(aes(date,log(maxSol),color='log Solar(W/m^2)') ) + geom_line(aes(date,maxWind,col
    theme_classic() +theme(axis.text.x = element_text(angle = 90, hjust = 1)) +     xlab("Date") + ylab


g6 <- CampMuir_2017 %>%  filter(month %in% c('06','07','08')) %>% dplyr::group_by(date) %>%
  dplyr::summarise(maxSol = max(Solar.Pyranometer..W.m2.),maxWind = max(Wind.Speed.Average..mph.)) %>%
  ggplot() + geom_line(aes(date,log(maxSol),color='log Solar(W/m^2)') ) + geom_line(aes(date,maxWind,col
    theme_classic() +theme(axis.text.x = element_text(angle = 90, hjust = 1)) +     xlab("Date") + ylab


grid.arrange(g5, g6,ncol=2, top = "JJA - Daily Max Solar and Max Wind(Avg)  at 2 elevations")
```




```
#ggplotly()
```

8.6 5-21-2018

Wrangle the microclimate data

```
## 5-21-2018
mclim_2018<- read.csv('./data/DATALOG.5.15.2018.csv')

#ggplotly()
```

Look at the data

```
## 5-21-2018
str(mclim_2018)
```

```
## 'data.frame':    326489 obs. of  4 variables:
##  $ X2018.5.8.16.35.01: Factor w/ 73277 levels "2018/5/10 0:00:03",..: 60336 60336 60336 60336 60336 6
##  $ X28CF6F0400008059 : Factor w/ 6 levels "287F5B04000080C5",..: 1 5 6 4 3 2 1 5 6 4 ...
##  $ X14.31            : num  14.8 14.4 14.8 14.3 14.1 ...
##  $ X4.14             : num  4.14 4.14 4.14 4.14 4.14 4.14 4.14 4.14 4.14 4.14 ...
```

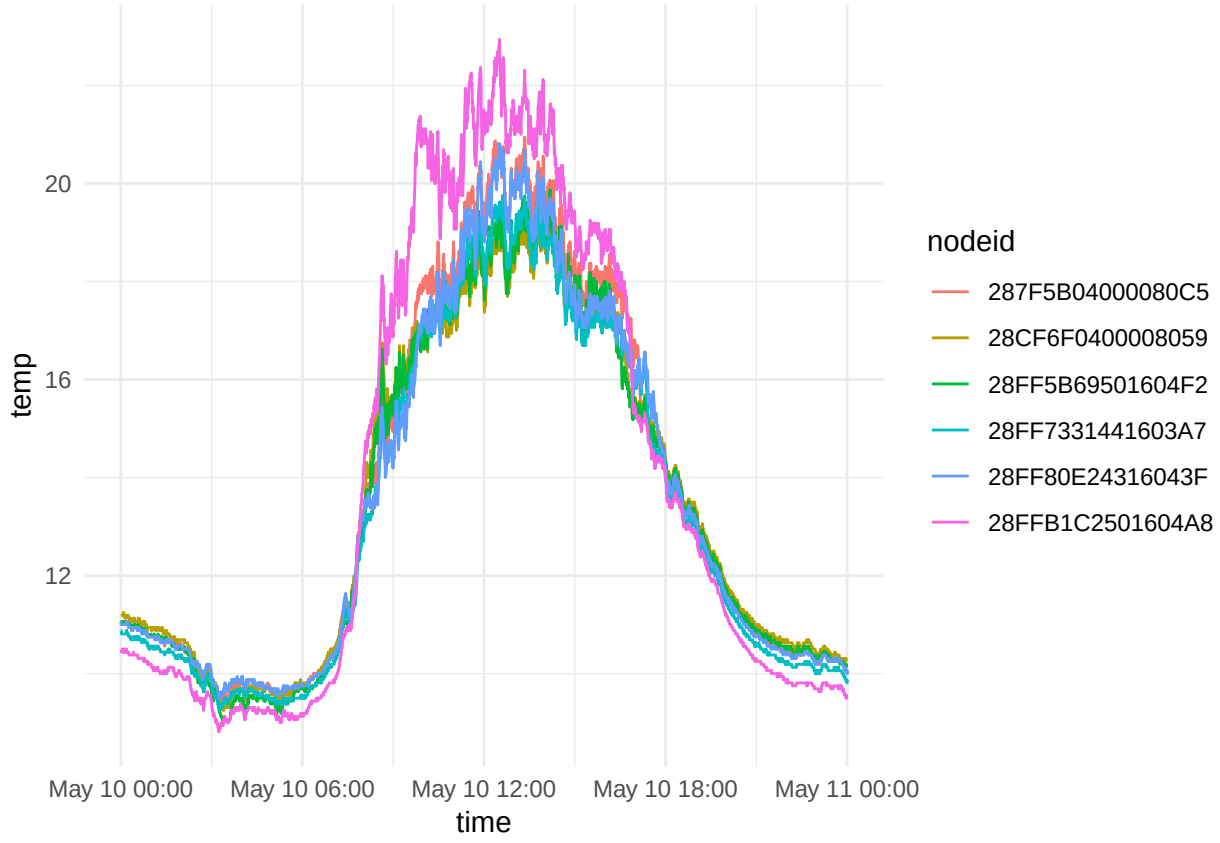
```
names(mclim_2018) <- c('time','nodeid','temp','batt')
mclim_2018$time <- as.POSIXct(mclim_2018$time, "%Y/%m/%d %H:%M:%S")
```

Add Hour, month and day

```
## 5-21-2018
mclim_2018$hr <- hour(mclim_2018$time)
mclim_2018$day <- day(mclim_2018$time)
mclim_2018$month<- month(mclim_2018$time)
```

Basic plot (May 10th)

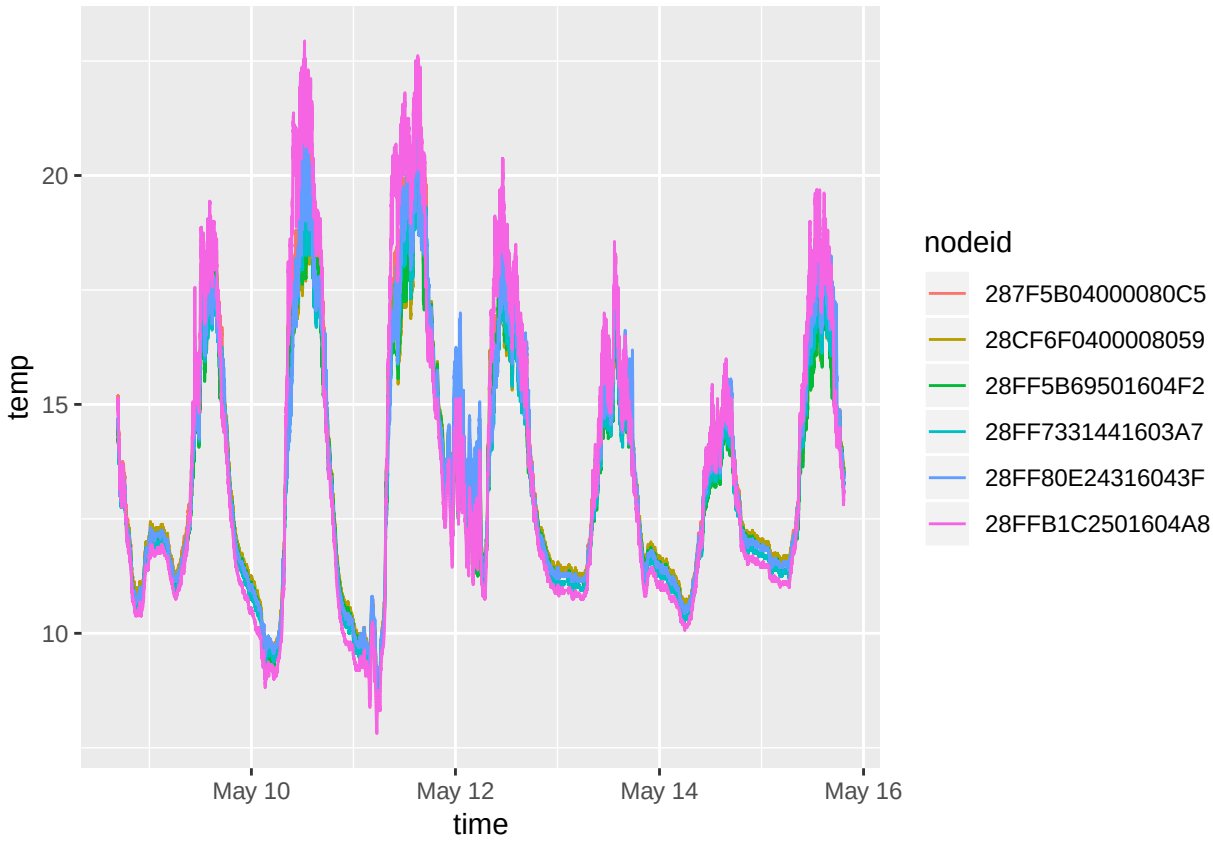
```
## 5-21-2018
mclim_2018 %>% filter(day(time) %in% '10') %>%
ggplot( aes(time,temp,color = nodeid)) + geom_line() + theme_minimal()
```




```
#ggplotly()
```

Whole week

```
## 5-21-2018
mclim_2018 %>%
ggplot( aes(time,temp,color = nodeid)) + geom_line()
```



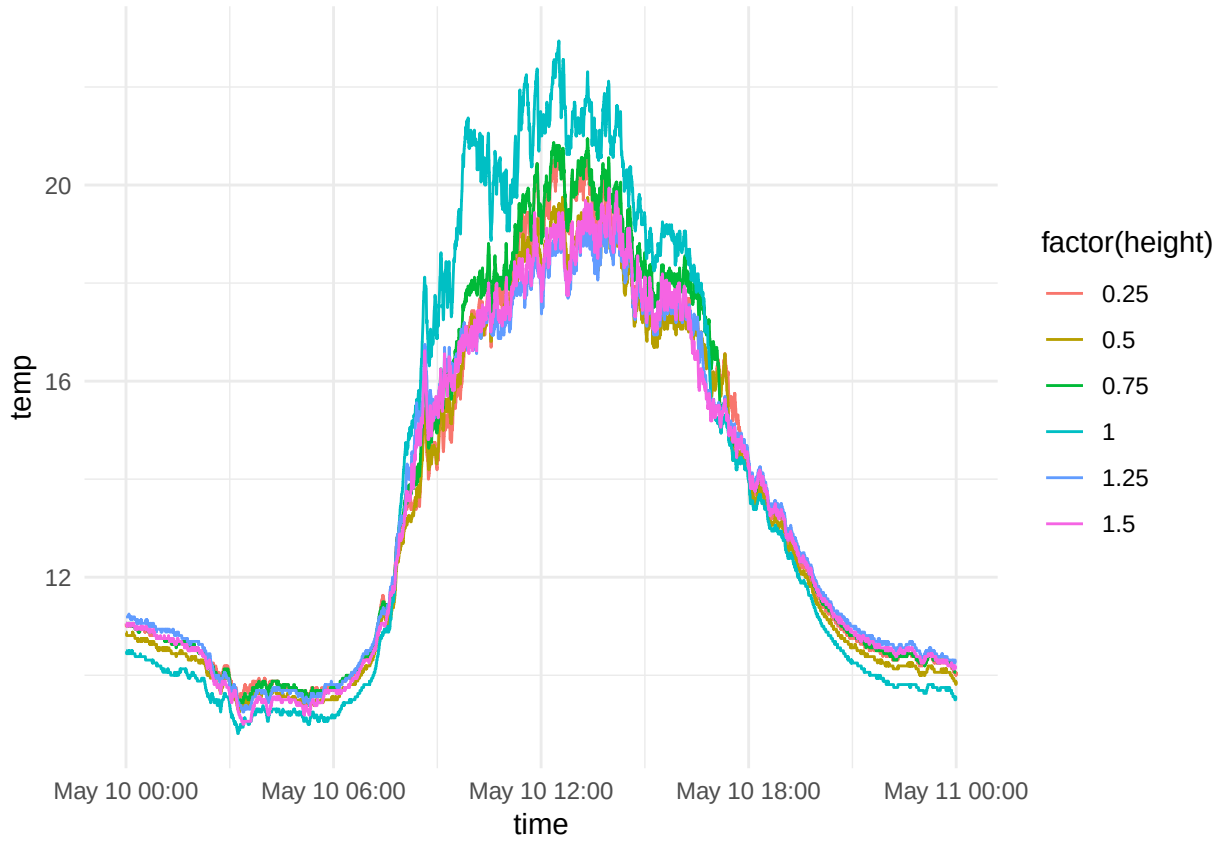

```
#ggplotly()
```

Add heights (Roghly .25 m apart)

```
mclim_2018$height <- 0

mclim_2018[mclim_2018$nodeid=='28FF80E24316043F' ,]$height <- 0.25
mclim_2018[mclim_2018$nodeid=='28FF7331441603A7' ,]$height <- 0.5
mclim_2018[mclim_2018$nodeid=='287F5B04000080C5' ,]$height <- 0.75
mclim_2018[mclim_2018$nodeid=='28FFB1C2501604A8' ,]$height <- 1
mclim_2018[mclim_2018$nodeid=='28CF6F0400008059' ,]$height <-1.25
mclim_2018[mclim_2018$nodeid=='28FF5B69501604F2' ,]$height <- 1.5
```

Basic plot (May 10th) - By height

```
## 5-21-2018
mclim_2018 %>% filter(day(time) %in% '10') %>%
ggplot( aes(time,temp,color = factor(height))) + geom_line() + theme_minimal()
```



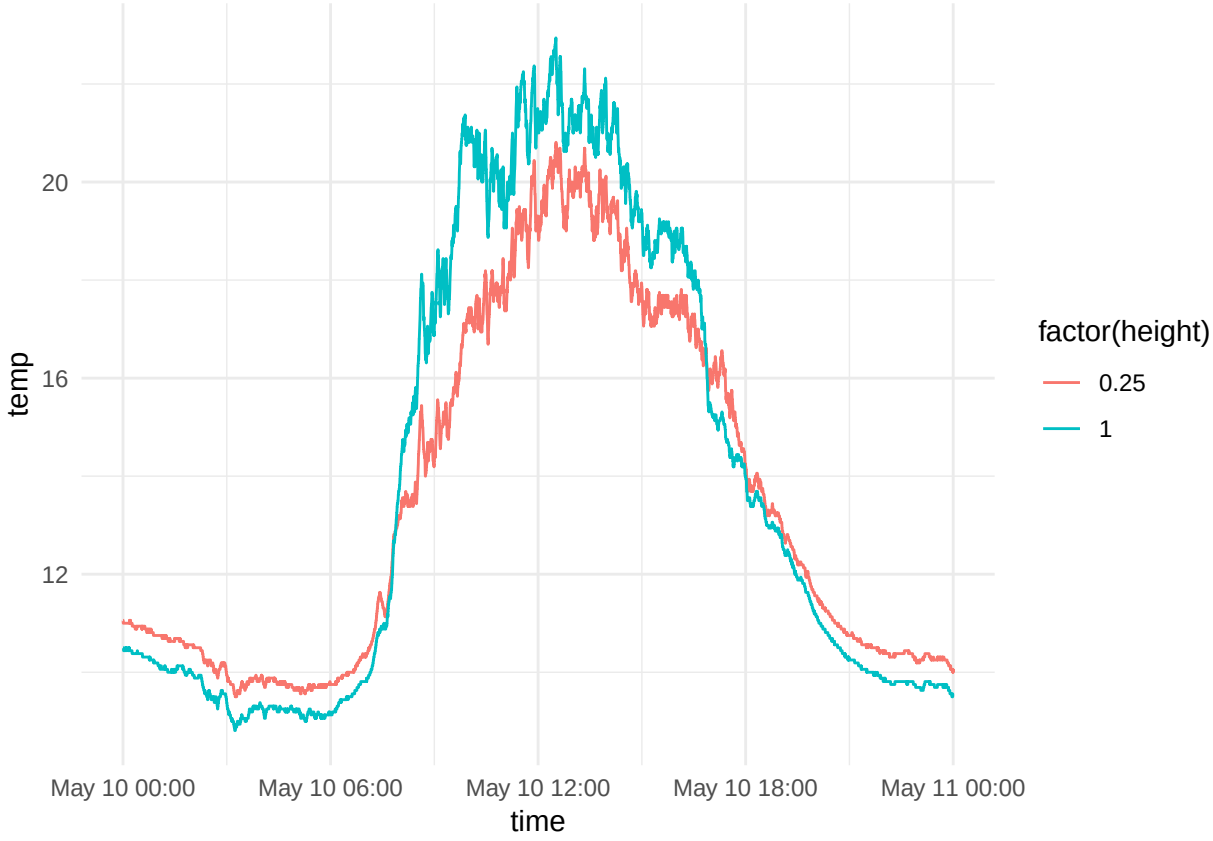

```
#ggplotly()
```

Add simulated wind profile

```
mclim_2018$ws <- 0
mclim_2018[mclim_2018$nodeid=='287F5B04000080C5',]$ws <- 4.34
mclim_2018[mclim_2018$nodeid=='28FF80E24316043F' ,]$ws <- 2.02
mclim_2018[mclim_2018$nodeid=='28FFB1C2501604A8' ,]$ws <- 5.20
mclim_2018[mclim_2018$nodeid=='28FF7331441603A7' ,]$ws <- 3.45
mclim_2018[mclim_2018$nodeid=='28FF5B69501604F2' ,]$ws <- 7.56
mclim_2018[mclim_2018$nodeid=='28CF6F0400008059' ,]$ws <-6.54
```

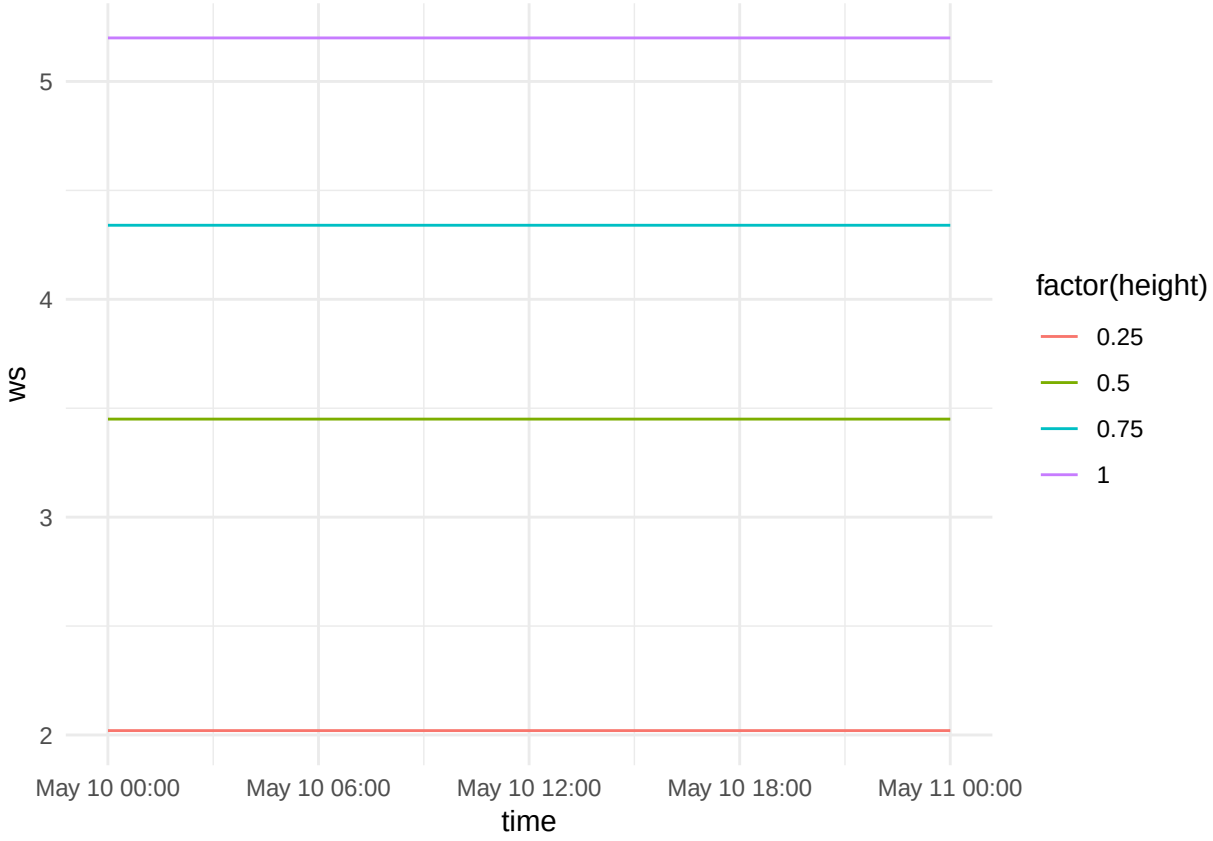
Redo the plot by height

```
## 5-21-2018
mclim_2018 %>% filter(day(time) %in% '10', height %in% c(0.25,1)) %>%
ggplot( aes(time,temp,color = factor(height))) + geom_line() + theme_minimal()
```



Redo the plot by height for Wind Speed

```
## 5-21-2018
mclim_2018 %>% filter(day(time) %in% '10', height %in% c(0.25,0.5,0.75,1)) %>%
ggplot( aes(time,ws,color = factor(height))) + geom_line() + theme_minimal()
```



Calculate (Wind speed at any height = U_star/K*log(Z/Z0))

Calculate zero plane displcement

```
#TODO - Do by each hour
zeroDM<- lm(log(mclim_2018$height) ~ mclim_2018$ws)
zD <- exp(zeroDM$coeff[1])
#.16
```

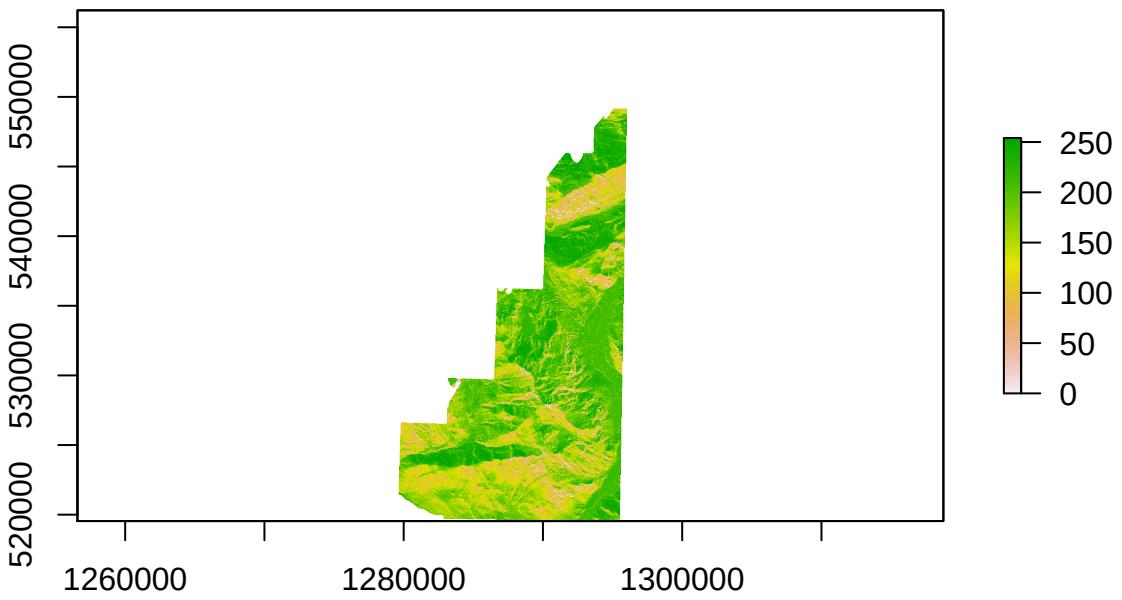
Calculate roughness and Z*

```
#With zero plane dispacement
sRM<- lm(mclim_2018$ws ~ log(mclim_2018$height-zD))

srIntercept <- sRM$coeff[1]
srSlope <- sRM$coeff[2]

K=0.4 # Von Karman constant

z0<-  exp(-srIntercept/srSlope) #0.04
U_star<-  srSlope*K
```

Repeat this for each site ## 7-21-2018

```
#With zero plane dispacement
library(rgdal) #this package is necessary to import the .asc file in R.
library(rasterVis) #this package has the function which allows the 3D plotting.

#set the path where the file is, and import it into R.
r= raster(paste("./data/rainier_2012_dtm_5_hs.tif", sep=""))
```

```
#visualize the raster in 3D
plot(r,lit=TRUE)
```

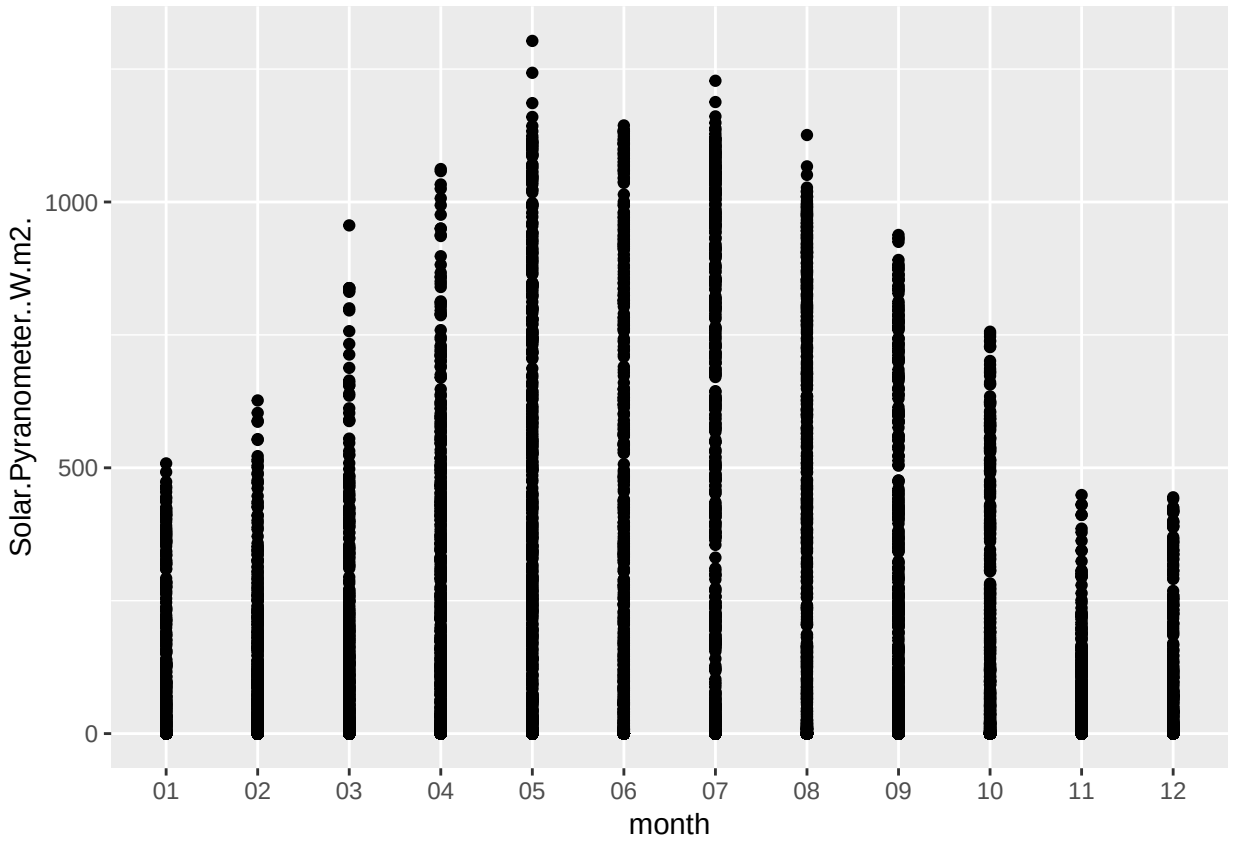



```
library(tidyverse)
fs <- list.files(path="./data", pattern = "rainier*", full.names = TRUE)

r1 <- raster(fs[1])
r1[] <- 1:ncell(r1)
r2 <- raster(fs[2])
r3 <- raster(fs[3])
r4 <- raster(fs[4])
res(r2) <- c(xres(r1), yres(r1))
r2[] <- 1:ncell(r2)
r3[] <- 1:ncell(r3)
r4[] <- 1:ncell(r4)

x <- list(r1, r2,r3,r4)
x$filename <- 'test.tif'
x$overwrite <- TRUE
m <- do.call(merge, x)
```

8.7 7-25-2018

Check the diurnal variation for summer, using Paradise as a proxy

```
Paradise_2017 %>% group_by(date,month,hr) %>% ggplot(aes(month,Solar.Pyranometer..W.m2.)) + geom_point()
```

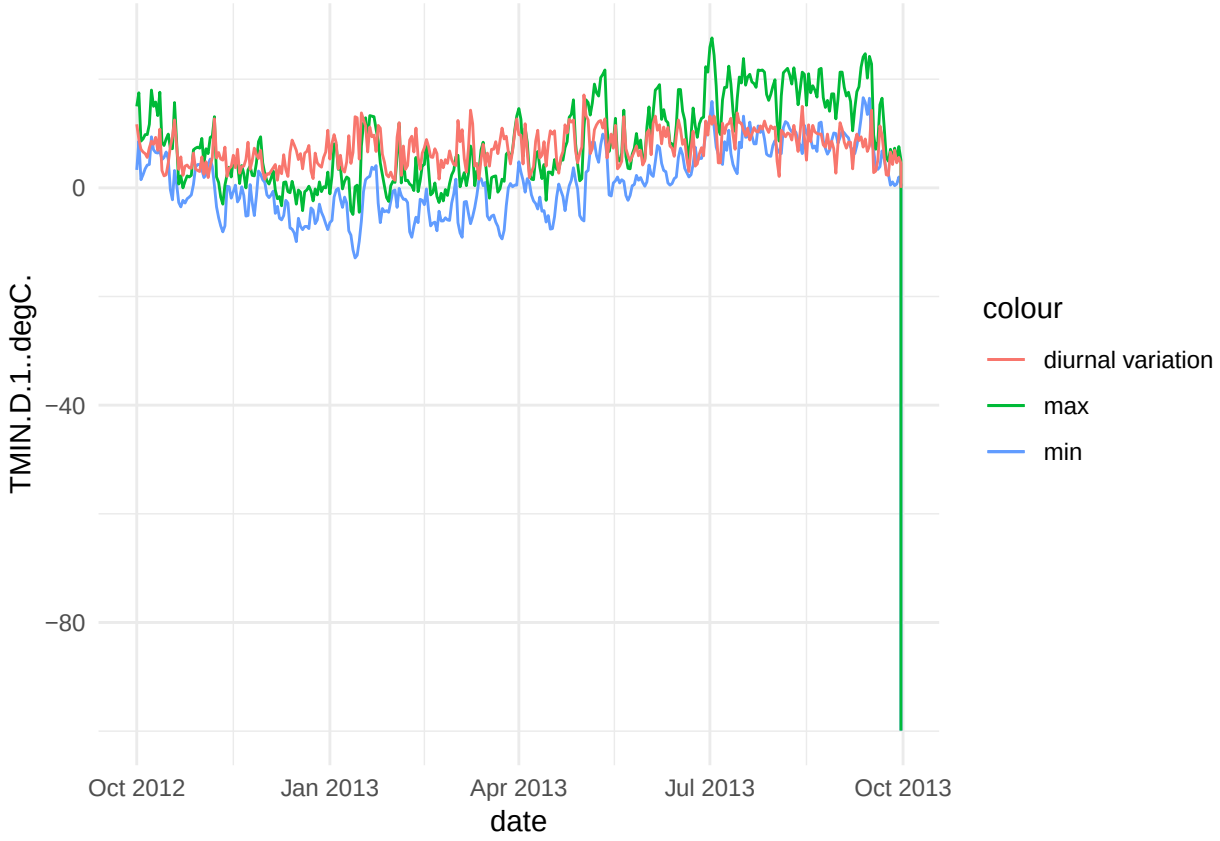



```
#.16
```

Use SNOTEL data from Paradise(Latitude: 46.78 Longitude: -121.74)

Check the diurnal variation for summer, using Paradise as a proxy

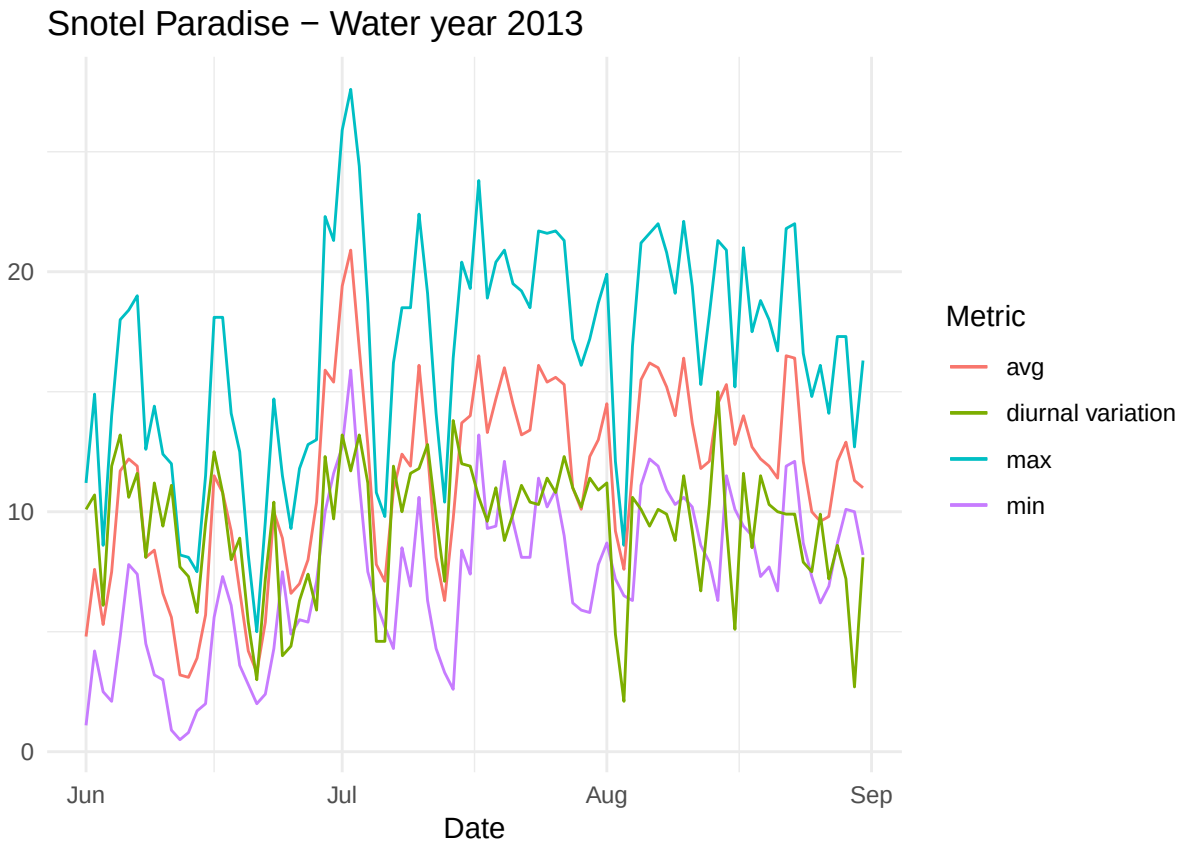
```
Paradise_Snotel_2013<- read.csv('./data/679_STAND_WATERYEAR=2013.csv')
Paradise_Snotel_2013$date <- as.Date(Paradise_Snotel_2013$Date, "%Y-%m-%d")
Paradise_Snotel_2013$month <- strftime(Paradise_Snotel_2013$Date,'%m')

Paradise_Snotel_2012<- read.csv('./data/679_STAND_WATERYEAR=2012.csv')
Paradise_Snotel_2012$date <- as.Date(Paradise_Snotel_2012$Date, "%Y-%m-%d")
Paradise_Snotel_2012$month <- strftime(Paradise_Snotel_2012$Date,'%m')

Paradise_Snotel_2011<- read.csv('./data/679_STAND_WATERYEAR=2011.csv')
Paradise_Snotel_2011$date <- as.Date(Paradise_Snotel_2011$Date, "%Y-%m-%d")
Paradise_Snotel_2011$month <- strftime(Paradise_Snotel_2011$Date,'%m')

Paradise_Snotel_2013 %>% group_by(date,month) %>% mutate(diva=TMAX.D.1..degC.-TMIN.D.1..degC.)%>% ggplo
```




```
#.16
```

Only Summer

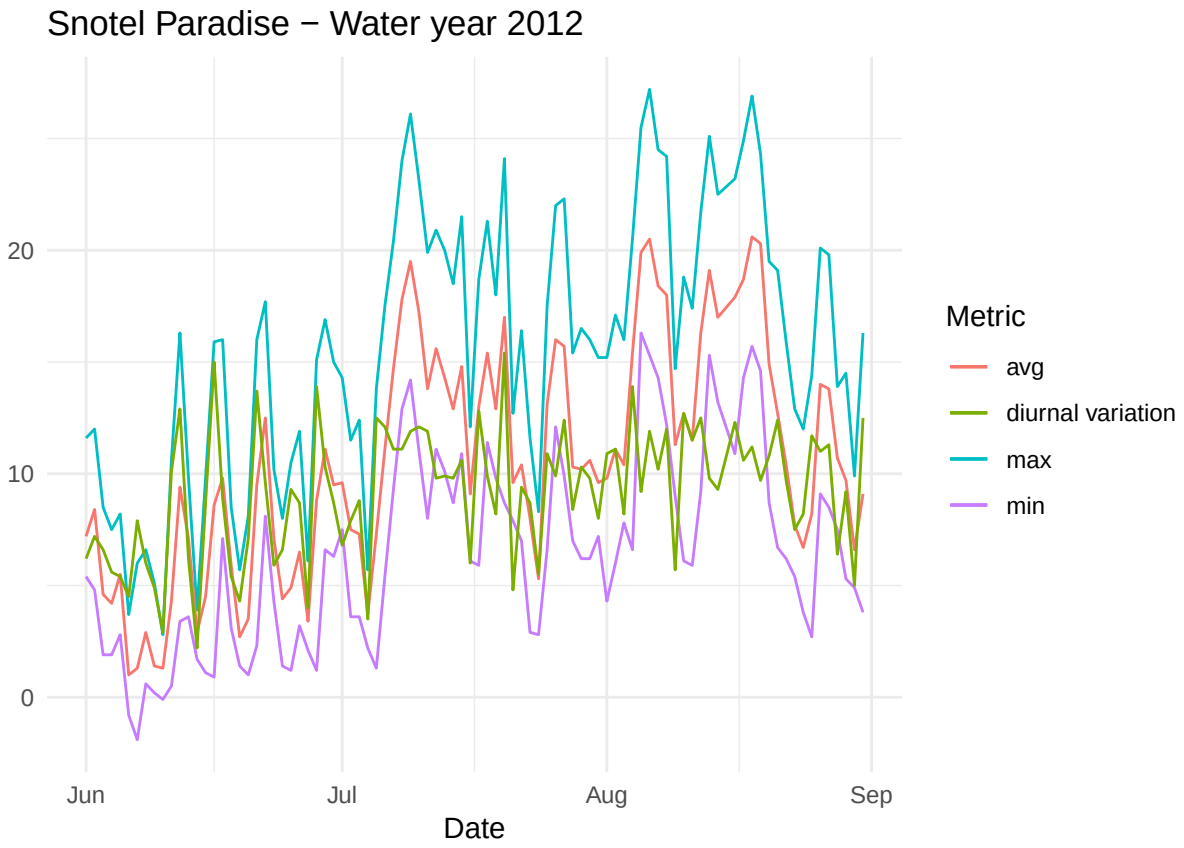
```
Paradise_Snotel_2013 %>% group_by(date,month) %>% filter(as.numeric(month) %in% c(6,7,8)) %>% mutate(di
```




```
#.16
```

For 2012

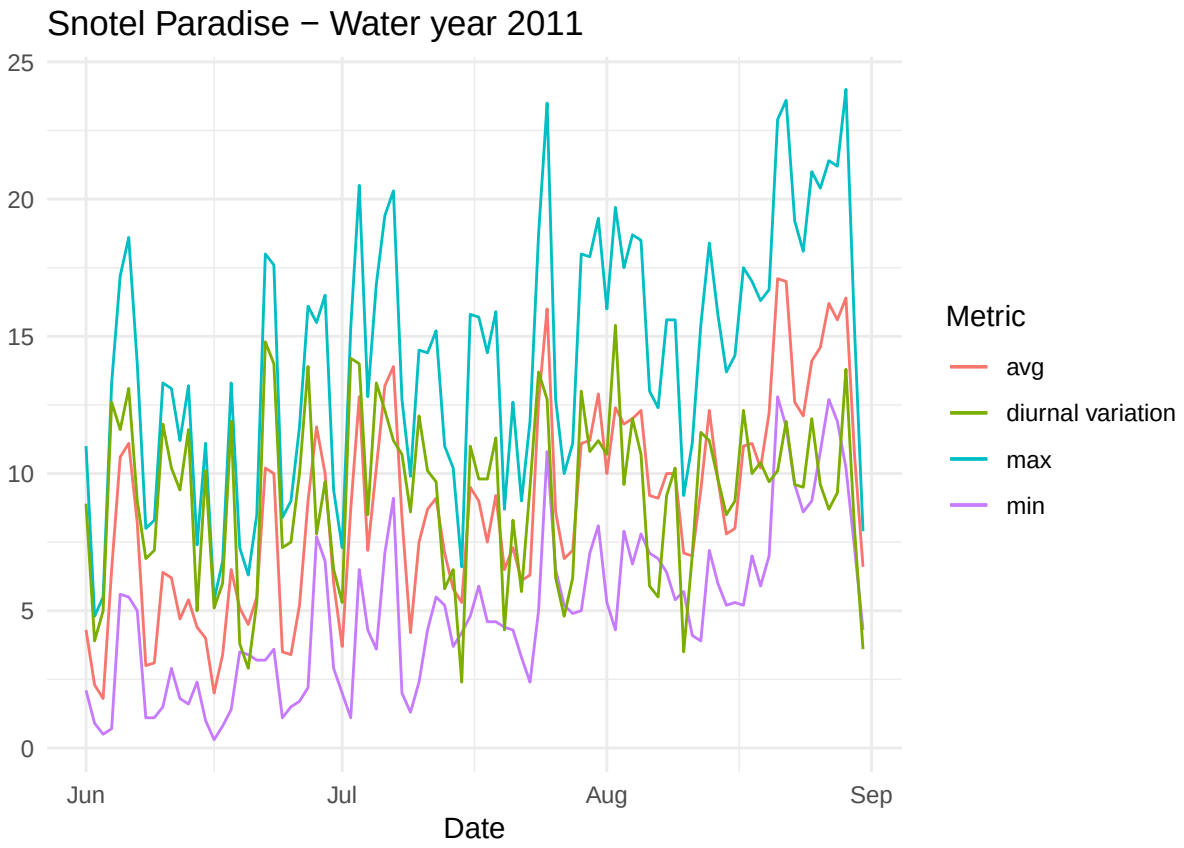
```
Paradise_Snotel_2012 %>% group_by(date,month) %>% filter(as.numeric(month) %in% c(6,7,8) & TMIN.D.1..deg
```




```
#.16
```

For 2011

```
Paradise_Snotel_2011 %>% group_by(date,month) %>% filter(as.numeric(month) %in% c(6,7,8)) %>% mutate(di
```

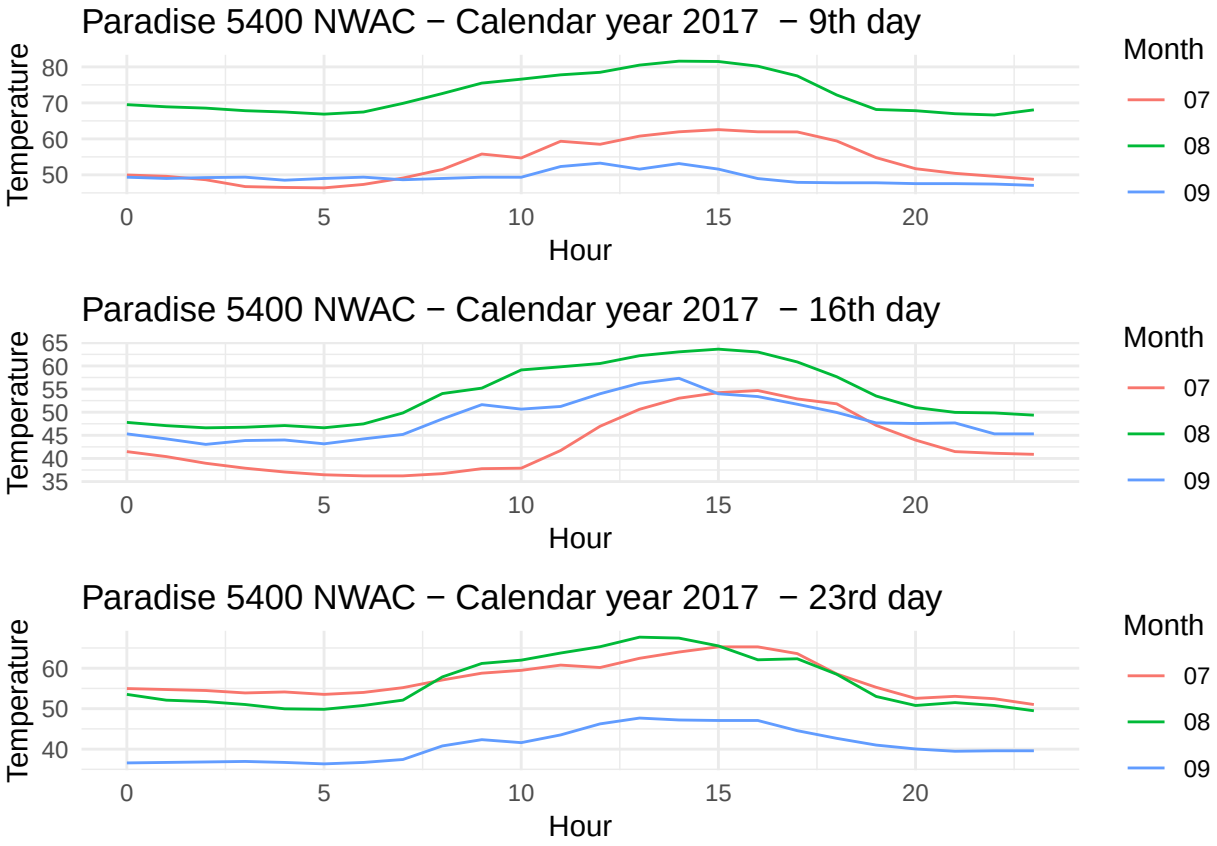



```
#.16
```

8.8 7-26-2018

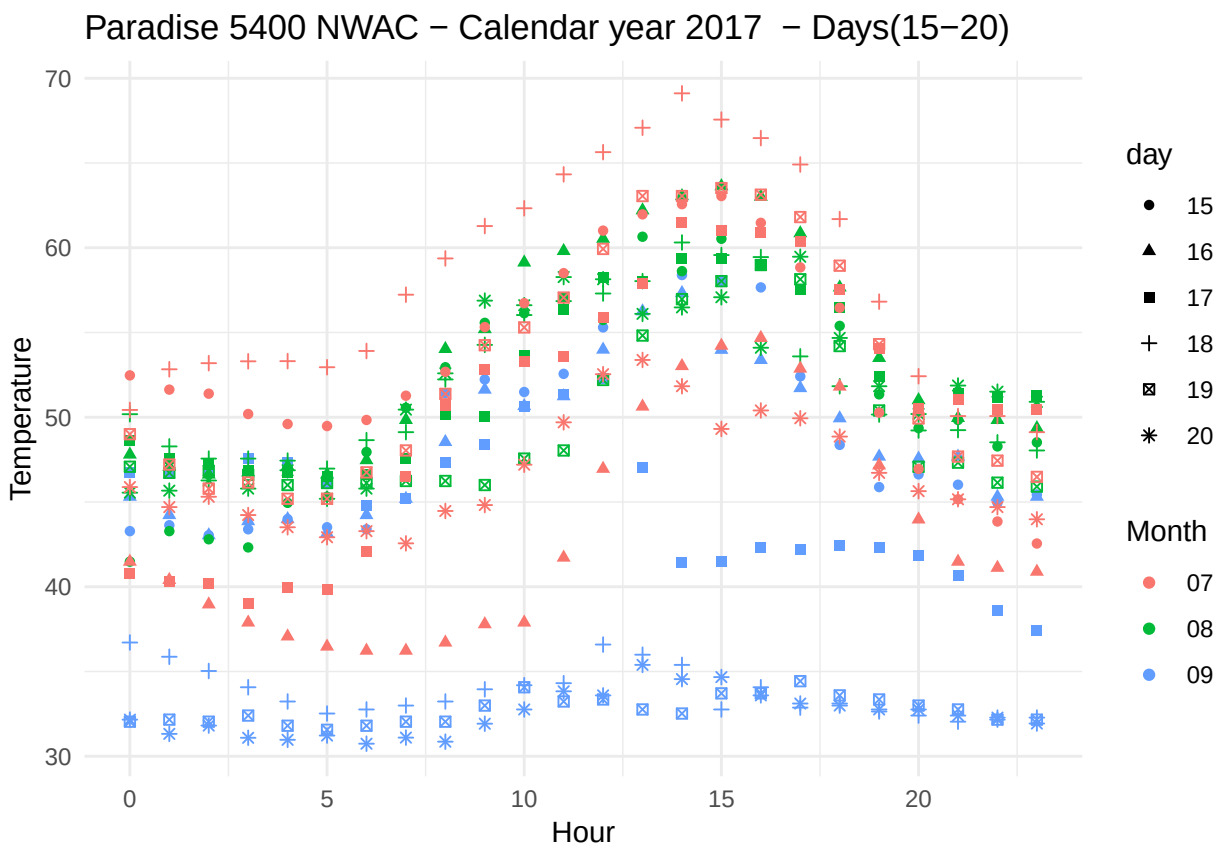
Lets look at the diurnal variation for three months, need to switch to NWAC as Snotel does not provide hourly breakdown

```
Paradise_5400_2017<- read.csv('./data/Paradise_5400_feet_2017.csv')
Paradise_5400_2016<- read.csv('./data/Paradise_5400_feet_2016.csv')
Paradise_5400_2015<- read.csv('./data/Paradise_5400_feet_2015.csv')

Paradise_5400_2017$date <- as.Date(Paradise_5400_2017$Date.Time..PST., "%Y-%m-%d")
Paradise_5400_2017$datetime <- as.Date(Paradise_5400_2017$Date.Time..PST., "%Y-%m-%d %H:%M")
library(lubridate)
library(gridExtra)
Paradise_5400_2017$hr <-lubridate::hour(lubridate::as_datetime(Paradise_5400_2017$Date.Time..PST.))
Paradise_5400_2017$min <-lubridate::minute(lubridate::as_datetime(Paradise_5400_2017$Date.Time..PST.))
Paradise_5400_2017$month <- strftime(Paradise_5400_2017$Date.Time..PST.,'%m')
Paradise_5400_2017$day <-strftime(Paradise_5400_2017$Date.Time..PST.,'%d')

Paradise9<- Paradise_5400_2017 %>% group_by(date,month,day,hr) %>% filter(as.numeric(month) %in% c(7,8,
Paradise16<- Paradise_5400_2017 %>% group_by(date,month,day,hr) %>% filter(as.numeric(month) %in% c(7,8
Paradise23<- Paradise_5400_2017 %>% group_by(date,month,day,hr) %>% filter(as.numeric(month) %in% c(7,8

grid.arrange(Paradise9,Paradise16,Paradise23)
```



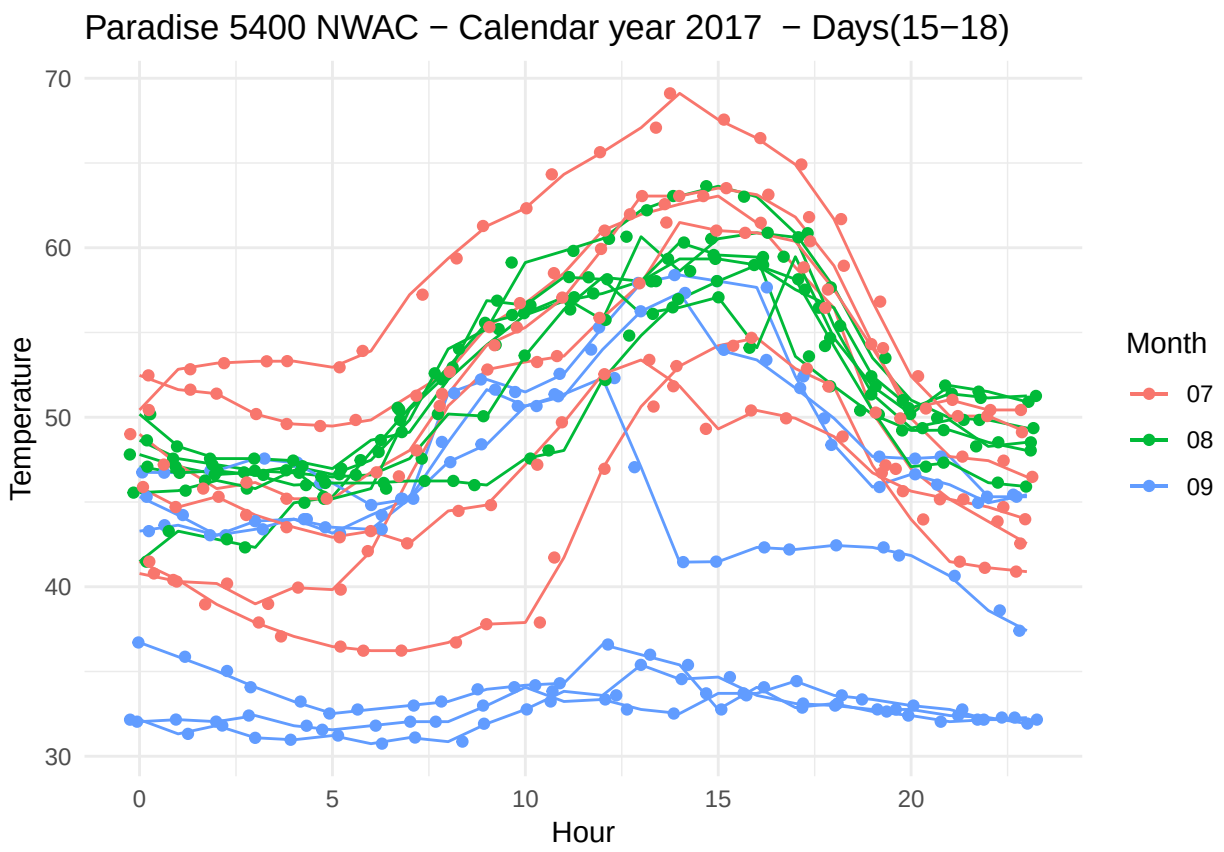
Days overlapping eath other

```
Paradise_5400_2017 %>% group_by(date,month,day,hr) %>% filter(as.numeric(month) %in% c(7,8,9) & as.nume
```



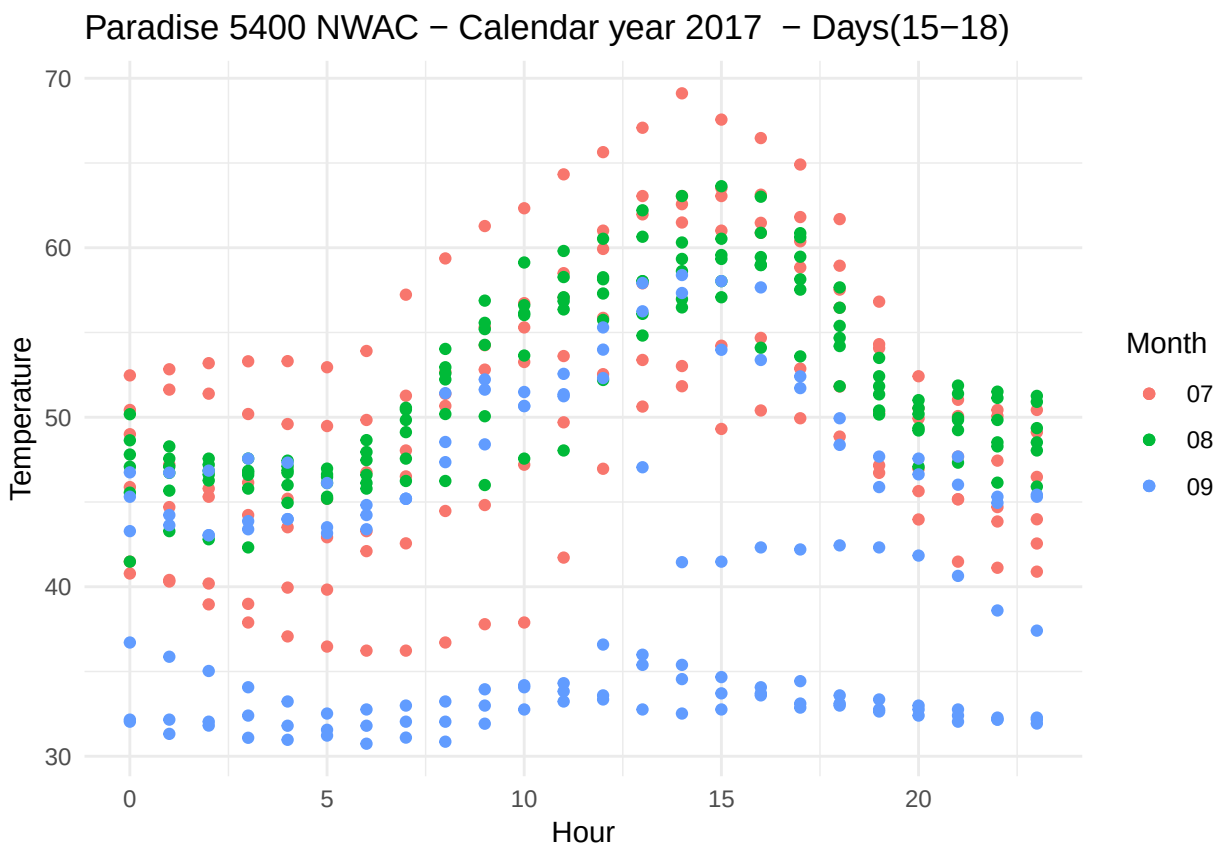
Removing symbols, each line representing different day of the month

```
Paradise_5400_2017 %>% group_by(date,month,day,hr) %>% filter(as.numeric(month) %in% c(7,8,9) & as.nume
geom_line(data = subset(Paradise_5400_2017,month %in% c("07") & day %in% c("16")  ))+ geom_line(data = 
geom_line(data = subset(Paradise_5400_2017,month %in% c("07") & day %in% c("17")  ))+ geom_line(data = 
geom_line(data = subset(Paradise_5400_2017,month %in% c("07") & day %in% c("18")  ))+ geom_line(data = 
geom_line(data = subset(Paradise_5400_2017,month %in% c("07") & day %in% c("19")  ))+ geom_line(data = 
geom_line(data = subset(Paradise_5400_2017,month %in% c("07") & day %in% c("20")  ))+ geom_line(data = 
theme_minimal() + xlab("Hour") + ylab("Temperature") + ggtitle("Paradise 5400 NWAC - Calendar year 2017
```



Removing symbols, point plot

```
Paradise_5400_2017 %>% group_by(date,month,day,hr) %>% filter(as.numeric(month) %in% c(7,8,9) & as.nume
```


Paradise 5400 NWAC − Calendar year 2017 − Days(15−18)
Temperature
70
60
50
40
30
0
5
10
15
20
Hour
Month
07
08
09

Bibliography

John, A. (2018). *Time seriously*. Chapman and Hall/CRC, Seattle, Washington, 1st edition. ISBN 978-1498716963.