

# warmXtrophic: HOBO analyses

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**DATA INPUT:** CSV files are located in the HOBO\_data folder in the shared Google drive

**DATA OUTPUT:** Computes different averages + error for hobo variables measured at each site

```
# clear all existing data
rm(list=ls())

# load in packages and set working directory
library(tidyverse)
library(plotrix)
library(ggpubr)
library(rstatix)

# Set working directory
L1_dir<-Sys.getenv("L1DIR")

# load in the data
KBS <- read.csv(file.path(L1_dir,"HOBO_data/HOBO_paired_sensor_data/KBS/KBS_pairedsensors_L1.csv"))
UMBS <- read.csv(file.path(L1_dir,"HOBO_data/HOBO_paired_sensor_data/UMBS/UMBS_pairedsensors_L1.csv"))

KBS_par <- read.csv(file.path(L1_dir,"PAR/KBS_PAR_L1.csv"))
UMBS_par <- read.csv(file.path(L1_dir,"PAR/UMBS_PAR_L1.csv"))

KBS_pend <- read.csv(file.path(L1_dir,"HOBO_data/HOBO_pendant_data/KBS/KBS_HOBOpendant_L1.csv"))
UMBS_pend <- read.csv(file.path(L1_dir,"HOBO_data/HOBO_pendant_data/UMBS/UMBS_HOBOpendant_L1.csv"))

# date is a character column - convert to date format
KBS$Date_Time <- as.POSIXct(KBS$Date_Time, format = "%Y-%m-%d %H:%M")
UMBS$Date_Time <- as.POSIXct(UMBS$Date_Time, format = "%Y-%m-%d %H:%M")
```

## KBS air temperatures

```
# merge the data + filter data for only the daytime during the growing season
KBS_season <- KBS
KBS_season$month <- format(KBS_season$Date_Time,format="%m")
KBS_season$year <- format(KBS_season$Date_Time,format="%Y")
KBS_season$hour <- format(KBS_season$Date_Time, format="%H")
```

```

KBS_season <- KBS_season %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)

# create new dataframes for temperatures averaged by year & averaged by month and year
KBS_avg_year <- KBS_season %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time)

# test for outliers - none extreme
outliers <- KBS_avg_year %>%
  group_by(treatment, year) %>%
  identify_outliers(temp)
view(outliers)

# avg temps in the chambers during the daytime
KBS_avg_temp <- KBS_avg_year %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

```

```

## `summarise()` ungrouping output (override with `.groups` argument)
print(KBS_avg_temp)

```

```

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>    <dbl>
## 1 XH_ambient_air_1m      21.5     8.72
## 2 XH_warmed_air_1m      23.4     9.34

```

```

# avg temps in the chambers during the daytime for each year
KBS_avg_temp_year <- KBS_avg_year %>%
  group_by(year, treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

```

```

## `summarise()` regrouping output by 'year' (override with `.groups` argument)
print(KBS_avg_temp_year)

```

```

## # A tibble: 14 x 4
## # Groups:   year [7]
##   year treatment      mean_temp sd_temp
##   <chr> <chr>          <dbl>    <dbl>
## 1 2015 XH_ambient_air_1m      23.9     5.18
## 2 2015 XH_warmed_air_1m      25.7     6.06
## 3 2016 XH_ambient_air_1m      21.2     9.34
## 4 2016 XH_warmed_air_1m      23.4    10.1
## 5 2017 XH_ambient_air_1m      21.1     7.65
## 6 2017 XH_warmed_air_1m      23.3     8.53
## 7 2018 XH_ambient_air_1m      21.4     9.63
## 8 2018 XH_warmed_air_1m      23.0     9.89

```

```

## 9 2019 XH_ambient_air_1m      21.1    8.97
## 10 2019 XH_warmed_air_1m       22.4    8.97
## 11 2020 XH_ambient_air_1m      21.6    9.45
## 12 2020 XH_warmed_air_1m       23.4   10.0
## 13 2021 XH_ambient_air_1m      21.5    8.35
## 14 2021 XH_warmed_air_1m       24.2    9.12

# avg temps in the chambers on hot days
KBS_avg_hot_day <- KBS_season %>%
  filter(XH_ambient_air_1m > 27) %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)

print(KBS_avg_hot_day)

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>   <dbl>
## 1 XH_ambient_air_1m      30.7     2.57
## 2 XH_warmed_air_1m      33.1     3.40

# avg temps from march-april and july-august (early season vs late season)
KBS_early <- KBS_season %>%
  filter(month == "03" | month == "04") %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)

print(KBS_early)

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>   <dbl>
## 1 XH_ambient_air_1m      10.6     7.35
## 2 XH_warmed_air_1m      12.7     8.56

KBS_late <- KBS_season %>%
  filter(month == "07" | month == "08") %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)

print(KBS_late)

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>   <dbl>
## 1 XH_ambient_air_1m      26.4     5.79

```

```
## 2 XH_warmed_air_1m      28.1    6.62

# winter warming?
KBS_winter <- KBS
KBS_winter$month <- format(KBS_winter$Date_Time,format="%m")
KBS_winter$year <- format(KBS_winter$Date_Time,format="%Y")
KBS_winter$hour <- format(KBS_winter$Date_Time, format="%H")
KBS_winter <- KBS_winter %>%
  filter(month > "10" | month < "03") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)
KBS_avg_winter <- KBS_winter %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(year, treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` regrouping output by 'year' (override with `.groups` argument)

print(KBS_avg_winter)

## # A tibble: 14 x 4
## # Groups:   year [7]
##   year treatment      mean_temp sd_temp
##   <chr> <chr>          <dbl>   <dbl>
## 1 2015 XH_ambient_air_1m      6.23     6.69
## 2 2015 XH_warmed_air_1m      6.78     7.11
## 3 2016 XH_ambient_air_1m      0.766    7.65
## 4 2016 XH_warmed_air_1m      1.49     7.80
## 5 2017 XH_ambient_air_1m      0.772    7.14
## 6 2017 XH_warmed_air_1m      1.60     7.62
## 7 2018 XH_ambient_air_1m     -0.294    6.28
## 8 2018 XH_warmed_air_1m      0.422    6.51
## 9 2019 XH_ambient_air_1m     -0.947    6.67
## 10 2019 XH_warmed_air_1m     -0.245    6.77
## 11 2020 XH_ambient_air_1m      1.84     6.56
## 12 2020 XH_warmed_air_1m      2.00     6.60
## 13 2021 XH_ambient_air_1m     -1.90     6.30
## 14 2021 XH_warmed_air_1m     -0.569    7.21

#nighttime warming?
KBS_night <- KBS
KBS_night$month <- format(KBS_night$Date_Time,format="%m")
KBS_night$year <- format(KBS_night$Date_Time,format="%Y")
KBS_night$hour <- format(KBS_night$Date_Time, format="%H")
KBS_night <- KBS_night %>%
  filter(month > "03" | month < "09") %>%
  filter(hour > "20" | hour < "06") %>%
  select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)
KBS_avg_night <- KBS_night %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(year, treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))
```

```
## `summarise()` regrouping output by 'year' (override with `.groups` argument)
```

```
print(KBS_avg_night)
```

```
## # A tibble: 14 x 4
## # Groups:   year [7]
##   year treatment      mean_temp sd_temp
##   <chr> <chr>          <dbl>   <dbl>
## 1 2015 XH_ambient_air_1m    10.8     7.15
## 2 2015 XH_warmed_air_1m     9.61     7.44
## 3 2016 XH_ambient_air_1m     6.82     9.50
## 4 2016 XH_warmed_air_1m     6.51     9.47
## 5 2017 XH_ambient_air_1m     7.15     9.31
## 6 2017 XH_warmed_air_1m     6.77     9.26
## 7 2018 XH_ambient_air_1m     6.47    10.2
## 8 2018 XH_warmed_air_1m     6.34    10.3
## 9 2019 XH_ambient_air_1m     6.11     9.82
## 10 2019 XH_warmed_air_1m     6.03     9.90
## 11 2020 XH_ambient_air_1m     6.87     8.75
## 12 2020 XH_warmed_air_1m     6.58     9.01
## 13 2021 XH_ambient_air_1m     8.09    10.4
## 14 2021 XH_warmed_air_1m     7.84    10.4
```

## UMBS air temperatures

```
UMBS_season <- UMBS
UMBS_season$month <- format(UMBS_season$Date_Time,format="%m")
UMBS_season$year <- format(UMBS_season$Date_Time,format="%Y")
UMBS_season$hour <- format(UMBS_season$Date_Time, format="%H")

UMBS_season <- UMBS_season %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)

# create new dataframes for temperatures averaged by year & averaged by month and year
UMBS_avg_year <- UMBS_season %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time)

# test for outliers - none extreme
outliers <- UMBS_avg_year %>%
  group_by(treatment, year) %>%
  identify_outliers(temp)

# avg temps in the chambers during the daytime
UMBS_avg_temp <- UMBS_avg_year %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```

print(UMBS_avg_temp)

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>    <dbl>
## 1 XH_ambient_air_1m      19.1     9.05
## 2 XH_warmed_air_1m       22.1    10.3

# avg temps in the chambers during the daytime for each year
UMBS_avg_temp_year <- UMBS_avg_year %>%
  group_by(year, treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` regrouping output by 'year' (override with `.groups` argument)

print(UMBS_avg_temp_year)

## # A tibble: 14 x 4
## # Groups:   year [7]
##   year treatment      mean_temp sd_temp
##   <chr> <chr>          <dbl>    <dbl>
## 1 2015 XH_ambient_air_1m      23.5     5.60
## 2 2015 XH_warmed_air_1m       26.2     7.22
## 3 2016 XH_ambient_air_1m      19.2     9.58
## 4 2016 XH_warmed_air_1m       22.2    10.6
## 5 2017 XH_ambient_air_1m      18.3     7.71
## 6 2017 XH_warmed_air_1m       20.9     8.92
## 7 2018 XH_ambient_air_1m      19.6    10.3
## 8 2018 XH_warmed_air_1m       22.5    11.6
## 9 2019 XH_ambient_air_1m      17.7     8.90
##10 2019 XH_warmed_air_1m       20.9    10.3
##11 2020 XH_ambient_air_1m      18.7     9.65
##12 2020 XH_warmed_air_1m       21.9    10.9
##13 2021 XH_ambient_air_1m      19.4     8.56
##14 2021 XH_warmed_air_1m       22.6     9.85

# avg temps in the chambers on hot days
UMBS_avg_hot_day <- UMBS_season %>%
  filter(XH_ambient_air_1m > 27) %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)

# avg temps from march-april and july-august (early season vs late season)
UMBS_early <- UMBS_season %>%
  filter(month == "03" | month == "04") %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)

```

```

print(UMBS_early)

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>    <dbl>
## 1 XH_ambient_air_1m      6.93      6.93
## 2 XH_warmed_air_1m      9.53      8.46

UMBS_late <- UMBS_season %>%
  filter(month == "07" | month == "08") %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)

print(UMBS_late)

## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>    <dbl>
## 1 XH_ambient_air_1m      24.3      5.39
## 2 XH_warmed_air_1m      27.4      7.12

# winter warming?
UMBS_winter <- UMBS
UMBS_winter$month <- format(UMBS_winter$Date_Time, format="%m")
UMBS_winter$year <- format(UMBS_winter$Date_Time, format="%Y")
UMBS_winter$hour <- format(UMBS_winter$Date_Time, format="%H")
UMBS_winter <- UMBS_winter %>%
  filter(month > "10" | month < "03") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)
UMBS_avg_winter <- UMBS_winter %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(year, treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` regrouping output by 'year' (override with `.groups` argument)

print(UMBS_avg_winter)

## # A tibble: 14 x 4
## # Groups:   year [7]
##   year treatment      mean_temp sd_temp
##   <chr> <chr>          <dbl>    <dbl>
## 1 2015 XH_ambient_air_1m      3.75      5.70
## 2 2015 XH_warmed_air_1m      4.12      6.12
## 3 2016 XH_ambient_air_1m     -1.15      7.25
## 4 2016 XH_warmed_air_1m     -0.605     7.45
## 5 2017 XH_ambient_air_1m     -2.47      6.46
## 6 2017 XH_warmed_air_1m     -1.90      6.55
## 7 2018 XH_ambient_air_1m     -3.18      6.02
## 8 2018 XH_warmed_air_1m     -2.73      6.23

```

```
## 9 2019 XH_ambient_air_1m -4.27 6.28
## 10 2019 XH_warmed_air_1m -3.81 6.25
## 11 2020 XH_ambient_air_1m -0.649 6.43
## 12 2020 XH_warmed_air_1m 0.0331 6.67
## 13 2021 XH_ambient_air_1m -2.77 7.14
## 14 2021 XH_warmed_air_1m -1.62 7.50

#nighttime warming?
UMBS_night <- UMBS
UMBS_night$month <- format(UMBS_night$Date_Time,format="%m")
UMBS_night$year <- format(UMBS_night$Date_Time,format="%Y")
UMBS_night$hour <- format(UMBS_night$Date_Time, format="%H")
UMBS_night <- UMBS_night %>%
  filter(month > "03" | month < "09") %>%
  filter(hour > "20" | hour < "06") %>%
  select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)
UMBS_avg_night <- UMBS_night %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time) %>%
  group_by(year, treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` regrouping output by 'year' (override with `.groups` argument)

print(UMBS_avg_night)
```

```
## # A tibble: 14 x 4
## # Groups:   year [7]
##   year treatment mean_temp sd_temp
##   <chr> <chr>      <dbl>   <dbl>
## 1 2015 XH_ambient_air_1m 9.82 7.52
## 2 2015 XH_warmed_air_1m 9.55 7.55
## 3 2016 XH_ambient_air_1m 5.38 9.79
## 4 2016 XH_warmed_air_1m 5.16 9.61
## 5 2017 XH_ambient_air_1m 4.84 9.61
## 6 2017 XH_warmed_air_1m 4.61 9.47
## 7 2018 XH_ambient_air_1m 4.23 10.8
## 8 2018 XH_warmed_air_1m 4.02 10.7
## 9 2019 XH_ambient_air_1m 3.44 10.3
## 10 2019 XH_warmed_air_1m 3.12 10.1
## 11 2020 XH_ambient_air_1m 5.13 9.19
## 12 2020 XH_warmed_air_1m 4.74 9.09
## 13 2021 XH_ambient_air_1m 6.60 10.0
## 14 2021 XH_warmed_air_1m 6.20 9.93
```

## KBS soil temp & moisture

```
# merge the data + filter data for only the daytime during the growing season
KBS_season_soil <- KBS
KBS_season_soil$month <- format(KBS_season_soil$Date_Time,format="%m")
KBS_season_soil$year <- format(KBS_season_soil$Date_Time,format="%Y")
KBS_season_soil$hour <- format(KBS_season_soil$Date_Time, format="%H")

KBS_season_soil <- KBS_season_soil %>%
  filter(month > "03") %>%
```



```

filter(month < "09") %>%
filter(hour > "06") %>%
filter(hour < "20") %>%
select(Date_Time, year, month, hour, XU_warmed_soil_temp_5cm, XU_ambient_soil_temp_5cm)

# create new dataframes for temperatures averaged by year & averaged by month and year
KBS_avg_soil <- KBS_season_soil %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time)

# test for outliers - some extreme, go back and remove soil temp >30
outliers <- KBS_avg_soil %>%
  group_by(treatment, year) %>%
  identify_outliers(temp)

# avg soil temps in the chambers during the daytime
KBS_avg_soil_temp <- KBS_avg_soil %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)
print(KBS_avg_soil_temp)

## # A tibble: 2 x 3
##   treatment          mean_temp sd_temp
##   <chr>          <dbl>    <dbl>
## 1 XU_ambient_soil_temp_5cm      17.2     5.61
## 2 XU_warmed_soil_temp_5cm      17.5     6.04

# merge the data + filter data for only the daytime during the growing season
KBS_season_moist <- KBS
KBS_season_moist$month <- format(KBS_season_moist$Date_Time,format="%m")
KBS_season_moist$year <- format(KBS_season_moist$Date_Time,format="%y")
KBS_season_moist$hour <- format(KBS_season_moist$Date_Time, format="%H")

KBS_season_moist <- KBS_season_moist %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XH_warmed_soil_moisture_5cm, XH_ambient_soil_moisture_5cm)

# create new dataframes for temperatures averaged by year & averaged by month and year
KBS_avg_moist <- KBS_season_moist %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time)

# test for outliers - some extreme, but they seem like reasonable values
outliers <- KBS_avg_moist %>%
  group_by(treatment, year) %>%
  identify_outliers(temp)

# avg soil temps in the chambers during the daytime
KBS_avg_soil_moist <- KBS_avg_moist %>%
  group_by(treatment) %>%

```

```

      summarize(mean_temp = mean(temp, na.rm = T),
                sd_temp = sd(temp, na.rm = T))

```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
print(KBS_avg_soil_moist)
```

```
## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>   <dbl>
## 1 XH_ambient_soil_moisture_5cm    0.179  0.0564
## 2 XH_warmed_soil_moisture_5cm    0.169  0.0592
```

## UMBS soil temp & moisture

```

# merge the data + filter data for only the daytime during the growing season
UMBS_season_soil <- UMBS
UMBS_season_soil$month <- format(UMBS_season_soil$Date_Time,format="%m")
UMBS_season_soil$year <- format(UMBS_season_soil$Date_Time,format="%y")
UMBS_season_soil$hour <- format(UMBS_season_soil$Date_Time, format="%H")

UMBS_season_soil <- UMBS_season_soil %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XU_warmed_soil_temp_5cm, XU_ambient_soil_temp_5cm)

# create new dataframes for temperatures averaged by year & averaged by month and year
UMBS_avg_soil <- UMBS_season_soil %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time)

# test for outliers - none extreme
outliers <- UMBS_avg_soil %>%
  group_by(treatment, year) %>%
  identify_outliers(temp)

# avg soil temps in the chambers during the daytime
UMBS_avg_soil_temp <- UMBS_avg_soil %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
print(UMBS_avg_soil_temp)
```

```
## # A tibble: 2 x 3
##   treatment      mean_temp sd_temp
##   <chr>          <dbl>   <dbl>
## 1 XU_ambient_soil_temp_5cm    17.8    8.28
## 2 XU_warmed_soil_temp_5cm    18.6    8.20
```

```

# merge the data + filter data for only the daytime during the growing season
UMBS_season_moist <- UMBS
UMBS_season_moist$month <- format(UMBS_season_moist$Date_Time,format="%m")

```

```

UMBS_season_moist$year <- format(UMBS_season_moist$Date_Time,format="%y")
UMBS_season_moist$hour <- format(UMBS_season_moist$Date_Time, format="%H")

UMBS_season_moist <- UMBS_season_moist %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  select(Date_Time, year, month, hour, XH_warmed_soil_moisture_5cm, XH_ambient_soil_moisture_5cm)

# create new dataframes for temperatures averaged by year & averaged by month and year
UMBS_avg_moist <- UMBS_season_moist %>%
  gather(key = "treatment", value = "temp", -year, -month, -hour, -Date_Time)

# test for outliers - some extreme, but they seem like reasonable values
outliers <- UMBS_avg_moist %>%
  group_by(treatment, year) %>%
  identify_outliers(temp)

# avg soil temps in the chambers during the daytime
UMBS_avg_soil_moist <- UMBS_avg_moist %>%
  group_by(treatment) %>%
  summarize(mean_temp = mean(temp, na.rm = T),
            sd_temp = sd(temp, na.rm = T))

## `summarise()` ungrouping output (override with `.groups` argument)
print(UMBS_avg_soil_moist)

## # A tibble: 2 x 3
##   treatment          mean_temp sd_temp
##   <chr>          <dbl>     <dbl>
## 1 XH_ambient_soil_moisture_5cm 0.0933 0.0493
## 2 XH_warmed_soil_moisture_5cm 0.0903 0.0474

```