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

```r
# 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_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

```r
# 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")

# remove sensor 1 from 2021 KBS because it failed
KBS_season1 <- KBS_season[!(KBS_season$sensor == 1 & KBS_season$year =="2021" ),]
```

```r
# 1m
KBS_season <- KBS_season1 %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  dplyr::select(Date_Time, year, month, hour, XH_warmed_air_1m, XH_ambient_air_1m)

# 10cm
KBS_season_10cm <- KBS_season1 %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  dplyr::select(Date_Time, year, month, hour, XU_warmed_air_10cm, XU_ambient_air_10cm)

# 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)
KBS_avg_year_10cm <- KBS_season_10cm %>%
  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)
outliers <- KBS_avg_year_10cm %>%
  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)
```

```r
print(KBS_avg_temp)
```

```
## # A tibble: 2 x 3
##   treatment          mean_temp sd_temp
##   <chr>                  <dbl>   <dbl>
## 1 XH_ambient_air_1m       21.5    8.75
## 2 XH_warmed_air_1m        23.4    9.34
```

```r
KBS_avg_temp_10cm <- KBS_avg_year_10cm %>%
        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)
```

```r
print(KBS_avg_temp)
```

```
## # A tibble: 2 x 3
##   treatment        mean_temp sd_temp
##   <chr>                <dbl>   <dbl>
## 1 XH_ambient_air_1m     21.5    8.75
## 2 XH_warmed_air_1m      23.4    9.34
```

```r
# 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)
```

```r
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    8.38
## 14 2021  XH_warmed_air_1m      24.2    9.12
```

```r
# 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)
```

```r
print(KBS_avg_hot_day)
```

```
## # A tibble: 2 x 3
##   treatment        mean_temp sd_temp
##   <chr>                <dbl>   <dbl>
## 1 XH_ambient_air_1m     30.8    2.60
## 2 XH_warmed_air_1m      33.1    3.40
```

```r
# avg temps from march-april and july-august (early season vs late season)
KBS_early <- KBS_season %>%
```

```r
        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)

```r
print(KBS_early)
```

```
## # A tibble: 2 x 3
##   treatment        mean_temp sd_temp
##   <chr>                <dbl>   <dbl>
## 1 XH_ambient_air_1m     10.4    7.34
## 2 XH_warmed_air_1m      12.7    8.56
```

```r
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)

```r
print(KBS_late)
```

```
## # A tibble: 2 x 3
##   treatment        mean_temp sd_temp
##   <chr>                <dbl>   <dbl>
## 1 XH_ambient_air_1m     26.4    5.82
## 2 XH_warmed_air_1m      28.1    6.62
```

```r
# 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[!(KBS_winter$sensor == 1 & KBS_winter$year =="2021"),]

KBS_winter <- KBS_winter %>%
        filter(month > "10" | month < "03") %>%
        filter(hour > "06") %>%
        filter(hour < "20") %>%
        dplyr::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)

```r
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    -1.55     6.50
## 14 2021  XH_warmed_air_1m     -0.569    7.21
```

```r
#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)
```

```r
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

```r
UMBS_season1 <- UMBS
UMBS_season1$month <- format(UMBS_season1$Date_Time,format="%m")
UMBS_season1$year <- format(UMBS_season1$Date_Time,format="%Y")
UMBS_season1$hour <- format(UMBS_season1$Date_Time, format="%H")

# remove sensor 1 from 2021 for July-Nov at UMBS because of a wasp nest
UMBS_season1 <- UMBS_season1[!(UMBS_season1$sensor == 1 & UMBS_season1$year =="2021" & UMBS_season1$mon
UMBS_season1 <- UMBS_season1[!(UMBS_season1$sensor == 1 & UMBS_season1$year =="2021" & UMBS_season1$mon
UMBS_season1 <- UMBS_season1[!(UMBS_season1$sensor == 1 & UMBS_season1$year =="2021" & UMBS_season1$mon
UMBS_season1 <- UMBS_season1[!(UMBS_season1$sensor == 1 & UMBS_season1$year =="2021" & UMBS_season1$mon
UMBS_season1 <- UMBS_season1[!(UMBS_season1$sensor == 1 & UMBS_season1$year =="2021" & UMBS_season1$mon

# 1m
UMBS_season <- UMBS_season1 %>%
  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)

# 10cm
UMBS_season_10cm <- UMBS_season1 %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  dplyr::select(Date_Time, year, month, hour, XU_warmed_air_10cm, XU_ambient_air_10cm)

# 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)
UMBS_avg_year_10cm <- UMBS_season_10cm %>%
  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)
outliers <- UMBS_avg_year_10cm %>%
  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)
```

```r
print(UMBS_avg_temp)
```

```
## # A tibble: 2 x 3
```

```
##    treatment         mean_temp sd_temp
##    <chr>                 <dbl>   <dbl>
## 1 XH_ambient_air_1m        19.0    9.09
## 2 XH_warmed_air_1m         22.0   10.3
```

```r
UMBS_avg_temp_10cm <- UMBS_avg_year_10cm %>%
        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)
```

```r
print(UMBS_avg_temp)
```

```
## # A tibble: 2 x 3
##    treatment         mean_temp sd_temp
##    <chr>                 <dbl>   <dbl>
## 1 XH_ambient_air_1m        19.0    9.09
## 2 XH_warmed_air_1m         22.0   10.3
```

```r
# 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)
```

```r
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      18.7    8.77
## 14 2021  XH_warmed_air_1m       21.9   10.1
```

```r
# 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    5.40
## 2 XH_warmed_air_1m       27.4    7.13
```

```
# 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
```

```r
#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)
```

```r
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

```r
# 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[!(KBS_season_soil$sensor == 1 & KBS_season_soil$year =="2021" ),]

KBS_season_soil <- KBS_season_soil %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
  dplyr::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 ?
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)
```

```r
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
```

```r
# 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[!(KBS_season_moist$sensor == 1 & KBS_season_moist$year =="2021" ),]

KBS_season_moist <- KBS_season_moist %>%
  filter(month > "03") %>%
  filter(month < "09") %>%
  filter(hour > "06") %>%
  filter(hour < "20") %>%
```

```r
  dplyr::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)
```

```r
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

```r
# merge the data + filter data for only the daytime during the growing season
UMBS_season_soil1 <- UMBS
UMBS_season_soil1$month <- format(UMBS_season_soil1$Date_Time,format="%m")
UMBS_season_soil1$year <- format(UMBS_season_soil1$Date_Time,format="%y")
UMBS_season_soil1$hour <- format(UMBS_season_soil1$Date_Time, format="%H")

UMBS_season_soil <- UMBS_season_soil1 %>%
      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
```