Met\_Master Merge with Eddy\_Pro\_Master: Data from 2020-01-20

source("calc\_footprint\_FFP.R")  
library(ggplot2)  
library(modelr)  
options(na.action = na.warn)

# Lists

rm(list=ls())

# Defining the data I/O directory for the Eddy Master File

\*\*

path\_eddy<-"C:\\Users\\Tommy\\flux\\Data-exploring\\02\_Concord\\"  
path.in\_eddy<-paste(path\_eddy,"01\_Proccessed\_Data",sep="")  
path.out\_eddy<-paste(path\_eddy,"03\_combined\_data",sep="")  
ver<-"Master\_Eddy"   
file.name\_eddy<-paste("master\_eddy\_pro\_concord",sep="")

# read in eddypro full output Master file, parse variable names

data\_master\_eddy<-read.csv(paste(path.in\_eddy,"\\",ver,"\\",file.name\_eddy,".csv",sep=""),  
 header=F,  
 skip=3,  
 na.strings=c(-9999),  
 stringsAsFactors = F)  
colnames(data\_master\_eddy)<-colnames(  
 read.csv(paste(path.in\_eddy,"\\",ver,"\\",file.name\_eddy,".csv",sep=""),  
 header=T,  
 skip=1))  
  
data\_master\_eddy

# Defining the data I/O directory for the Master met\_data

path\_met<-"C:\\Users\\Tommy\\flux\\Data-exploring\\02\_Concord\\"  
path.in\_met<-paste(path\_met,"01\_Proccessed\_Data",sep="")  
path.out\_met<-paste(path\_met,"03\_combined\_data",sep="")  
ver<-"met\_data"   
file.name<-paste("MET\_data\_master",sep="")

#read in Met\_Data Master file, parse variable names and define N/As#

met\_data\_master<-read.csv(paste(path.in\_met,"\\",ver,"\\",file.name,".csv",sep=""),  
 header=F,  
 skip=4,  
 na.strings=c("NAN"),  
 stringsAsFactors = F)  
colnames(met\_data\_master)<-colnames(  
 read.csv(paste(path.in\_met,"\\",ver,"\\",file.name,".csv",sep=""),  
 header=T,  
 skip= 1))  
  
met\_data\_master

NA

# Parsing the time stamp converting it into a POSIXlt vector

**interpreting date and time into new timestamp column**

**Then taking that time stamp column and turning each time into a unique number (time.id) so I can join based on that. As it can be really tricky to join/merge based on time stamps alone**

**Or I could make sure both time stamps are characters and match them that way**

**Finally ploting time.id to make sure my times translate linearily**

data\_master\_eddy$TIMESTAMP<-strptime(paste(data\_master\_eddy$date,data\_master\_eddy$time,sep=" "),format="%m/%d/%Y %H:%M", tz = "GMT")  
  
data\_master\_eddy$time.id<-data\_master\_eddy$TIMESTAMP$year+1900+(data\_master\_eddy$TIMESTAMP$yday)/366+(data\_master\_eddy$TIMESTAMP$hour)/366/24+ (data\_master\_eddy$TIMESTAMP$min)/366/24/60  
  
data\_master\_eddy$time.id[1:50]

[1] 2019.450 2019.450 2019.450 2019.450 2019.450 2019.450 2019.450 2019.450 2019.451  
[10] 2019.451 2019.451 2019.451 2019.451 2019.451 2019.451 2019.451 2019.451 2019.451  
[19] 2019.451 2019.451 2019.451 2019.451 2019.451 2019.451 2019.451 2019.452 2019.452  
[28] 2019.452 2019.452 2019.452 2019.452 2019.452 2019.452 2019.452 2019.452 2019.452  
[37] 2019.452 2019.452 2019.452 2019.452 2019.452 2019.452 2019.452 2019.453 2019.453  
[46] 2019.453 2019.453 2019.453 2019.453 2019.453

plot(data\_master\_eddy$time.id)

which(duplicated(data\_master\_eddy$time.id))

integer(0)

#Taking the met\_data and turning the time stamp into posixt format#

met\_data\_master$TIMESTAMP<-strptime(met\_data\_master$TIMESTAMP,  
 format ="%m/%d/%Y %H:%M", tz = "GMT")  
  
met\_data\_master$TIMESTAMP[1:20]

[1] "2019-06-25 09:00:00 GMT" "2019-06-25 09:30:00 GMT" "2019-06-25 10:00:00 GMT"  
 [4] "2019-06-25 10:30:00 GMT" "2019-06-25 11:00:00 GMT" "2019-06-25 11:30:00 GMT"  
 [7] "2019-06-25 12:00:00 GMT" "2019-06-25 12:30:00 GMT" "2019-06-25 13:00:00 GMT"  
[10] "2019-06-25 13:30:00 GMT" "2019-06-25 14:00:00 GMT" "2019-06-25 14:30:00 GMT"  
[13] "2019-06-25 15:00:00 GMT" "2019-06-25 15:30:00 GMT" "2019-06-25 16:00:00 GMT"  
[16] "2019-06-25 16:30:00 GMT" "2019-06-25 17:00:00 GMT" "2019-06-25 17:30:00 GMT"  
[19] "2019-06-25 18:00:00 GMT" "2019-06-25 18:30:00 GMT"

#Making sure timestamp columns line up#

met\_data\_master$TIMESTAMP[1:10]

[1] "2019-06-25 09:00:00 GMT" "2019-06-25 09:30:00 GMT" "2019-06-25 10:00:00 GMT"  
 [4] "2019-06-25 10:30:00 GMT" "2019-06-25 11:00:00 GMT" "2019-06-25 11:30:00 GMT"  
 [7] "2019-06-25 12:00:00 GMT" "2019-06-25 12:30:00 GMT" "2019-06-25 13:00:00 GMT"  
[10] "2019-06-25 13:30:00 GMT"

data\_master\_eddy$TIMESTAMP[1:10]

[1] "2019-06-14 17:30:00 GMT" "2019-06-14 18:00:00 GMT" "2019-06-14 18:30:00 GMT"  
 [4] "2019-06-14 19:00:00 GMT" "2019-06-14 19:30:00 GMT" "2019-06-14 20:00:00 GMT"  
 [7] "2019-06-14 20:30:00 GMT" "2019-06-14 21:00:00 GMT" "2019-06-14 21:30:00 GMT"  
[10] "2019-06-14 22:00:00 GMT"

met\_data\_master

#creating a time id for the MET Data so I I can join the MET and Eddy Pro Data#

#Joining the Met\_Data and Eddy Pro Data Sets#

**with merge**

combo\_master\_ed\_met<- merge(met\_data\_master[,-which(colnames(met\_data\_master)=="TIMESTAMP")], data\_master\_eddy[,-which(colnames(data\_master\_eddy)=="TIMESTAMP")], by = "time.id")  
  
combo\_master\_ed\_met

colnames(combo\_master\_ed\_met)

[1] "time.id" "RECORD"   
 [3] "BattV\_Avg" "PTemp\_C\_Avg"   
 [5] "AM25T\_ref\_Avg" "TC\_Avg.1."   
 [7] "TC\_Avg.2." "TC\_Avg.3."   
 [9] "TC\_Avg.4." "TC\_Avg.5."   
 [11] "TC\_Avg.6." "TC\_Avg.7."   
 [13] "TC\_Avg.8." "TC\_Avg.9."   
 [15] "TC\_Avg.10." "TC\_Avg.11."   
 [17] "TC\_Avg.12." "TC\_Avg.13."   
 [19] "TC\_Avg.14." "TC\_Avg.15."   
 [21] "TC\_Avg.16." "TC\_Avg.17."   
 [23] "TC\_Avg.18." "TC\_Avg.19."   
 [25] "TC\_Avg.20." "TC\_Avg.21."   
 [27] "TC\_Avg.22." "TC\_Avg.23."   
 [29] "TC\_Avg.24." "TC\_Avg.25."   
 [31] "AirT\_Avg" "RH\_Avg"   
 [33] "AtmPressure\_Avg" "NR\_mV\_Avg"   
 [35] "NR\_Wm2\_Avg" "PAR\_in\_mV\_Avg"   
 [37] "PAR\_in\_uEm2\_Avg" "PAR\_out\_mV\_Avg"   
 [39] "PAR\_out\_uEm2\_Avg" "SHF\_1\_mV\_Avg"   
 [41] "SHF\_1\_Wm2\_Avg" "SHF\_2\_mV\_Avg"   
 [43] "SHF\_2\_Wm2\_Avg" "WaterP\_Avg"   
 [45] "WaterT\_Avg" "Precip\_mm\_Tot"   
 [47] "VWC\_Avg" "EC\_Avg"   
 [49] "T\_Avg" "P\_Avg"   
 [51] "PA\_Avg" "VR\_Avg"   
 [53] "filename" "date"   
 [55] "time" "DOY"   
 [57] "daytime" "file\_records"   
 [59] "used\_records" "Tau"   
 [61] "qc\_Tau" "H"   
 [63] "qc\_H" "LE"   
 [65] "qc\_LE" "co2\_flux"   
 [67] "qc\_co2\_flux" "h2o\_flux"   
 [69] "qc\_h2o\_flux" "H\_strg"   
 [71] "LE\_strg" "co2\_strg"   
 [73] "h2o\_strg" "co2\_v.adv"   
 [75] "h2o\_v.adv" "co2\_molar\_density"   
 [77] "co2\_mole\_fraction" "co2\_mixing\_ratio"   
 [79] "co2\_time\_lag" "co2\_def\_timelag"   
 [81] "h2o\_molar\_density" "h2o\_mole\_fraction"   
 [83] "h2o\_mixing\_ratio" "h2o\_time\_lag"   
 [85] "h2o\_def\_timelag" "sonic\_temperature"   
 [87] "air\_temperature" "air\_pressure"   
 [89] "air\_density" "air\_heat\_capacity"   
 [91] "air\_molar\_volume" "ET"   
 [93] "water\_vapor\_density" "e"   
 [95] "es" "specific\_humidity"   
 [97] "RH" "VPD"   
 [99] "Tdew" "u\_unrot"   
[101] "v\_unrot" "w\_unrot"   
[103] "u\_rot" "v\_rot"   
[105] "w\_rot" "wind\_speed"   
[107] "max\_wind\_speed" "wind\_dir"   
[109] "yaw" "pitch"   
[111] "roll" "u."   
[113] "TKE" "L"   
[115] "X.z.d..L" "bowen\_ratio"   
[117] "T." "model"   
[119] "x\_peak" "x\_offset"   
[121] "x\_10." "x\_30."   
[123] "x\_50." "x\_70."   
[125] "x\_90." "un\_Tau"   
[127] "Tau\_scf" "un\_H"   
[129] "H\_scf" "un\_LE"   
[131] "LE\_scf" "un\_co2\_flux"   
[133] "co2\_scf" "un\_h2o\_flux"   
[135] "h2o\_scf" "spikes\_hf"   
[137] "amplitude\_resolution\_hf" "drop\_out\_hf"   
[139] "absolute\_limits\_hf" "skewness\_kurtosis\_hf"   
[141] "skewness\_kurtosis\_sf" "discontinuities\_hf"   
[143] "discontinuities\_sf" "timelag\_hf"   
[145] "timelag\_sf" "attack\_angle\_hf"   
[147] "non\_steady\_wind\_hf" "u\_spikes"   
[149] "v\_spikes" "w\_spikes"   
[151] "ts\_spikes" "co2\_spikes"   
[153] "h2o\_spikes" "chopper\_LI.7500"   
[155] "detector\_LI.7500" "pll\_LI.7500"   
[157] "sync\_LI.7500" "mean\_value\_RSSI\_LI.7500"   
[159] "u\_var" "v\_var"   
[161] "w\_var" "ts\_var"   
[163] "co2\_var" "h2o\_var"   
[165] "w.ts\_cov" "w.co2\_cov"   
[167] "w.h2o\_cov" "vin\_sf\_mean"   
[169] "co2\_mean" "h2o\_mean"   
[171] "dew\_point\_mean" "co2\_signal\_strength\_7500\_mean"

#Add back time stamp to the combo\_master\_ed\_met#

combo\_master\_ed\_met$TIMESTAMP<-strptime(paste(combo\_master\_ed\_met$date,combo\_master\_ed\_met$time,sep=" "),format="%m/%d/%Y %H:%M", tz = "GMT")  
  
combo\_master\_ed\_met$TIMESTAMP[1:10]

[1] "2019-06-25 09:00:00 GMT" "2019-06-25 09:30:00 GMT" "2019-06-25 10:00:00 GMT"  
 [4] "2019-06-25 10:30:00 GMT" "2019-06-25 11:00:00 GMT" "2019-06-25 11:30:00 GMT"  
 [7] "2019-06-25 12:00:00 GMT" "2019-06-25 12:30:00 GMT" "2019-06-25 13:00:00 GMT"  
[10] "2019-06-25 13:30:00 GMT"

combo\_master\_ed\_met$TIMESTAMP[10451:10453]

[1] "2020-02-05 08:00:00 GMT" "2020-02-05 08:30:00 GMT" "2020-02-05 09:30:00 GMT"

combo\_master\_ed\_met

NA  
NA  
NA

#Creating a CSV File of my combined Master File!#

write.csv(combo\_master\_ed\_met,  
 paste(path.out\_eddy,ver,"combo\_master\_ed\_met",sep=""),  
 quote = T,  
 row.names = F)

#filtering data for quality control filters# **filtering latent heat, sensible heat, co2 flux, qc\_tau and h20flux by quality controls**

combo\_master\_ed\_met$LE.[!is.na(combo\_master\_ed\_met$qc\_LE)&combo\_master\_ed\_met$qc\_LE==2]<-NA  
  
combo\_master\_ed\_met$qqc\_h2o\_flux[!is.na(combo\_master\_ed\_met$qc\_h2o\_flux)&combo\_master\_ed\_met$qc\_h2o\_flux==2]<-NA  
  
combo\_master\_ed\_met$H[!is.na(combo\_master\_ed\_met$qc\_H)&combo\_master\_ed\_met$qc\_H==2]<-NA  
  
combo\_master\_ed\_met$u.[!is.na(combo\_master\_ed\_met$qc\_Tau)&combo\_master\_ed\_met$qc\_Tau==2]<-NA  
  
combo\_master\_ed\_met$co2\_flux[!is.na(combo\_master\_ed\_met$co2\_flux)&combo\_master\_ed\_met$co2\_flux==2]<-NA

# latent heat, sensible heat, h20\_flux, and relative humidity by day for whole period

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$LE)

hist(combo\_master\_ed\_met$LE)

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$h2o\_flux)

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$H)

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$RH)

NA  
NA  
NA  
NA  
NA  
NA

#Half Hour Flux Averages

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$co2\_flux,xlab='Time', ylab='Co2 Fluxes', main=' Half Hour Co2 Flux Averages', ylim = c(-20,20),pch=1,col="blue",cex=0.4)

#Daily average of fluxes

plot(tapply(combo\_master\_ed\_met$co2\_flux ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)), xlab='Time', ylab='Co2 Fluxes', main='Daily Co2 Flux Averages',pch=1,col="red",cex=1.5)

#Plotting Co2 flux by timstamp on x-axis. First half-hourly data and daily data stacked

layout(matrix(c(1,1,2,2), 2, 2, byrow = TRUE))  
plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$co2\_flux, xlab='Time', ylab='Co2 Fluxes', main='Half Hour Flux Averages', ylim = c(-15,15),pch=1,col="blue",cex=0.4)  
plot(tapply(combo\_master\_ed\_met$co2\_flux ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)), xlab='Time', ylab='Co2 Fluxes', main='Daily Co2 Flux Averages',pch=1,col="red",cex=1.5)

NA  
NA

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$co2\_flux,  
 ylim = c(-10, 10),  
 cex=0.6,col="grey",  
 xlab= 'Time',   
 ylab="",   
 main='',las=1,  
 lpars=list(lwd=3,col="red"))  
mtext(side=2,expression(CO[2]~Flux~'('~mu~mol~m^{-2}~s^{-1}~')'),line=2.5)

par(new= TRUE)  
plot(tapply(combo\_master\_ed\_met$co2\_flux ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),  
 xaxt='n',   
 xlab='Time',   
 ylab='',   
 main='', las =1,  
 ylim = c(-10,10),  
 lty=1,col="red",  
 lwd=2,type="l")

mtext(side=2,expression(CO[2]~Flux~'('~mu~mol~m^{-2}~s^{-1}~')'),line=2.5)  
abline(h=0,col="black")

#Plotting daily flux average over half hour fluxes

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$co2\_flux,   
 xlab='Time',   
 ylab='Co2 Fluxes',   
 main='', ylim = c(-10,10),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$co2\_flux ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Co2 Fluxes', main='',ylim = c(-10,10),lty=1,col="red",lwd=2,type="l")  
abline(h=0,col="black")

legend(x='bottomright',legend=c('1/2 hour fluxes', 'daily flux averages'),  
col=c('grey', 'red'), pch=c(1,19))

#Daily average of Sensible Heat

plot(tapply(combo\_master\_ed\_met$H,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xlab='Time', ylab='Sensible Heat', main='Daily Average of Sensible Heat')

#Daily average of Latent Heat

plot(tapply(combo\_master\_ed\_met$LE ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xlab='Time', ylab='Latent Heat', main='Daily Average of Latent Heat')

#line plot of c02\_fluxes#

ggplot(data = combo\_master\_ed\_met) +   
 geom\_line(mapping = aes(x = time.id , y = co2\_flux))

#latent heat and Sensible heat plotted over eachother

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$LE,  
 xlab='Time',   
 ylab='Latent and Sensible Heat',   
 main='Latent and Sensible Heat',pch=1,col="blue",cex=0.6)  
points(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$H,  
 col="red",  
 pch=1,  
 cex=0.6)

legend(x='bottomright',legend=c('Latent Heat', 'Sensible Heat'),  
col=c('blue', 'red'), pch=c(1,19))

#air temperatue by sensible heat an U\* by co2 flux

plot(combo\_master\_ed\_met$air\_temperature-273.15,combo\_master\_ed\_met$H,xlim=c(10,40),ylim=c(-100,500))

plot(combo\_master\_ed\_met$u. ,combo\_master\_ed\_met$co2\_flux, ylim = c(0, 10), xlim = c(0,1))

#Adding best fit line to air temperature by sensible heat

ggplot(data = combo\_master\_ed\_met) +   
 geom\_point(mapping = aes(x = air\_temperature-273.15, y = H)) +  
 geom\_smooth(mapping = aes(x = air\_temperature-273.15, y = H))

NA  
NA

#best fit line to U\* bt co2 flux

ggplot(data = combo\_master\_ed\_met) +   
 geom\_point(mapping = aes(x = u., y = co2\_flux)) +  
 geom\_smooth(mapping = aes(x = u., y = co2\_flux))

NA  
NA

hist(combo\_master\_ed\_met$wind\_dir, xlim = c(0,370), breaks = 36, main = "Wind Direction at Concord Tower", xlab = 'Degrees')

#Comparing MET Temperature data to temperature reading from Licor intruments#

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$PTemp\_C\_Avg)  
points(combo\_master\_ed\_met$TIMESTAMP,combo\_master\_ed\_met$air\_temperature-273.15,col="red",pch=2)

#Adding coefficient to Net radiation#

combo\_master\_ed\_met$Correct\_NR = (combo\_master\_ed\_met$NR\_Wm2\_Avg\*10)/14.2

#plotting air temperature from data logger. see where our gaps line up. lines up with net radiation and gaps

plot(combo\_master\_ed\_met$AirT\_Avg)

#plotting Net Radation to see the bad data.

summary(combo\_master\_ed\_met$Correct\_NR[c(1:600,2500:4000)])

Min. 1st Qu. Median Mean 3rd Qu. Max.   
-106.27 -69.79 -17.23 121.53 339.30 644.37

plot(combo\_master\_ed\_met$Correct\_NR)

#filtering out bad NR numbers

combo\_master\_ed\_met$Correct\_NR[!is.na(combo\_master\_ed\_met$Correct\_NR)&(combo\_master\_ed\_met$Correct\_NR<(-150)|combo\_master\_ed\_met$Correct\_NR>800)]<-NA  
summary(combo\_master\_ed\_met$Correct\_NR)

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
-146.97 -60.91 -37.46 56.03 135.53 775.35 3581

plot(combo\_master\_ed\_met$Correct\_NR)

summary(combo\_master\_ed\_met$Correct\_NR)

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
-146.97 -60.91 -37.46 56.03 135.53 775.35 3581

#Adding coefficient to Soil Heat Flux Data

plot(combo\_master\_ed\_met$SHF\_1\_mV\_Avg,ylim=c(-10,10))

combo\_master\_ed\_met$Correct\_shf\_1 = (combo\_master\_ed\_met$SHF\_1\_mV\_Avg\*16.455)  
plot(combo\_master\_ed\_met$Correct\_shf\_1,ylim=c(-50,50))

#plotting Soil heat flux to see the bad data.

summary(combo\_master\_ed\_met$Correct\_shf\_1)

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
-3118.222 -15.270 -6.335 -38.461 10.910 1507.278 2459

summary(combo\_master\_ed\_met$Correct\_shf\_1[c(2500:4000)])

Min. 1st Qu. Median Mean 3rd Qu. Max.   
-14.349 -8.919 -3.538 1.246 10.877 33.206

plot(combo\_master\_ed\_met$Correct\_shf\_1)

plot(combo\_master\_ed\_met$Correct\_shf\_1[c(2500:4000)], ylim = c(-50,50),xlab='8/14/2019 to 02/05/2020', ylab='Soil Heat Flux\_1 ', main='Half Hour Averages of Soil Heat Flux of the Concord Site')

#filtering out bad soil heat flux numbers

combo\_master\_ed\_met$Correct\_shf\_1[!is.na(combo\_master\_ed\_met$Correct\_shf\_1)&(combo\_master\_ed\_met$Correct\_shf\_1<(-20)|combo\_master\_ed\_met$Correct\_shf\_1>50)]<-NA  
summary(combo\_master\_ed\_met$Correct\_shf\_1)

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
-19.993 -10.251 -4.542 -0.397 7.791 49.661 5208

plot(combo\_master\_ed\_met$Correct\_shf\_1)

**Energy Balance of non-gapfilled data. Slope of line is energy balance closure. Ideally it should be 1:1 Net radiation - soil heat flux= to Latent heat +sensible heat.**

combo\_master\_ed\_met$E\_ng = (combo\_master\_ed\_met$Correct\_NR-combo\_master\_ed\_met$Correct\_shf\_1)  
  
summary(combo\_master\_ed\_met$E\_ng )

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
-138.33 -52.06 -22.43 58.95 144.07 763.13 5295

plot(combo\_master\_ed\_met$E\_ng)

combo\_master\_ed\_met$E\_le\_and\_H =(combo\_master\_ed\_met$LE+combo\_master\_ed\_met$H)  
summary(combo\_master\_ed\_met$E\_le\_and\_H )

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
-514.8600 -18.4604 0.0379 58.3382 124.1671 810.8680 1634

plot(combo\_master\_ed\_met$E\_le\_and\_H )

scatter.smooth(combo\_master\_ed\_met$E\_ng, combo\_master\_ed\_met$E\_le\_and\_H )

lm(combo\_master\_ed\_met$E\_le\_and\_H ~ combo\_master\_ed\_met$E\_ng)

Dropping 6045 rows with missing values

Call:  
lm(formula = combo\_master\_ed\_met$E\_le\_and\_H ~ combo\_master\_ed\_met$E\_ng)  
  
Coefficients:  
 (Intercept) combo\_master\_ed\_met$E\_ng   
 14.4377 0.5487

summary(lm(combo\_master\_ed\_met$E\_le\_and\_H ~ combo\_master\_ed\_met$E\_ng-1))

Dropping 6045 rows with missing values

Call:  
lm(formula = combo\_master\_ed\_met$E\_le\_and\_H ~ combo\_master\_ed\_met$E\_ng -   
 1)  
  
Residuals:  
 Min 1Q Median 3Q Max   
-460.58 -2.74 12.46 28.97 388.85   
  
Coefficients:  
 Estimate Std. Error t value Pr(>|t|)   
combo\_master\_ed\_met$E\_ng 0.578665 0.003364 172 <2e-16 \*\*\*  
---  
Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1  
  
Residual standard error: 46.69 on 5814 degrees of freedom  
 (6045 observations deleted due to missingness)  
Multiple R-squared: 0.8358, Adjusted R-squared: 0.8357   
F-statistic: 2.958e+04 on 1 and 5814 DF, p-value: < 2.2e-16

#1/2 hour and daily averages of Latent Heat

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$LE,   
 xlab='Time',   
 ylab= expression(Latent~Heat~'('~W~m^{-2}~')'),   
 main='',   
 ylim = c(-40,300),  
 pch=1,  
 col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$LE ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),  
 xaxt='n',   
 xlab='Time',   
 ylab= expression(Latent~Heat~'('~W~m^{-2}~')'),   
 main='',  
 ylim = c(-40,300),lty=1,col="red",lwd=2,type="l")  
abline(h=0,col="black")

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$LE,  
 ylim = c(-40, 300),  
 cex=0.4,col="grey",  
 xlab= 'Time',   
 ylab="",   
 main='',las=1,  
 lpars=list(lwd=3,col="red"))  
mtext(side=2,expression(Latent~Heat~'('~W~m^{-2}~')'),line=2.5)

par(new= TRUE)  
plot(tapply(combo\_master\_ed\_met$LE ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),  
 xaxt='n',   
 xlab='Time',   
 ylab='',   
 main='', las =1,  
 ylim = c(-40,300),  
 col="red",pch=1,cex=1.0)

mtext(side=2,expression(Latent~Heat~'('~W~m^{-2}~')'),line=2.5)  
abline(h=0,col="black")

legend(x='topright',legend=c('1/2 hour averages', 'daily averages'),  
col=c('grey', 'red'), pch=c(19,1))

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$LE,   
 xlab='Time',   
 ylab='Latent Heat',   
 main='Latent Heat: Daily and Half Hour Averages',   
 ylim = c(-40,300),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$LE ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n'  
 , xlab='Time',  
 ylab='Latent Heat',   
 main='Latent Heat: Daily and Half Hour Averages',  
 ylim = c(-40,300),  
 col="red",pch=1,cex=1.0)  
abline(h=0,col="black")

legend(x='topright',legend=c('1/2 hour averages', 'daily averages'),  
col=c('grey', 'red'), pch=c(1,1))

#1/2 hour and daily averages of Sensible Heat

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$H, xlab='Time', ylab='Sensible Heat', main='Sensible Heat: Daily and Half Hour Averages', ylim = c(-40,300),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$H ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Sensible Heat', main='Sensible Heat: Daily and Half Hour Averages',ylim = c(-40,300),lty=1,col="red",lwd=2,type="l")  
abline(h=0,col="black")

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$H, xlab='Time', ylab='Sensible Heat', main='Sensible Heat: Daily and Half Hour Averages', ylim = c(-40,300),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$H ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Sensible Heat', main='Sensible Heat: Daily and Half Hour Averages',ylim = c(-40,300),col="red",pch=1,cex=1.0)  
abline(h=0,col="black")

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$H,  
 ylim = c(-40, 300),  
 cex=0.4,col="grey",  
 xlab= 'Time',   
 ylab="",   
 main='',las=1,  
 lpars=list(lwd=3,col="red"))  
mtext(side=2,expression(Sensible~Heat~'('~W~m^{-2}~')'),line=2.5)

par(new= TRUE)  
plot(tapply(combo\_master\_ed\_met$H ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),  
 xaxt='n',   
 xlab='Time',   
 ylab='',   
 main='', las =1,  
 ylim = c(-40,300),  
 col="red",pch=1,cex=1.0)

mtext(side=2,expression(Sensible~Heat~'('~W~m^{-2}~')'),line=2.5)  
abline(h=0,col="black")

#Net Radiation Daily and 1/2 hour averages

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$Correct\_NR, xlab='Time', ylab='Net Radiation', main='Net Radiation: Daily and Half Hour Averages', ylim = c(-80,800),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$Correct\_NR ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Net Radiation', main='Net Radiation: Daily and Half Hour Averages',ylim = c(-80,800),lty=1,col="red",lwd=2,type="l")  
abline(h=0,col="black")

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$Correct\_NR, xlab='Time', ylab='Net Radiation', main='Net Radiation: Daily and Half Hour Averages', ylim = c(-80,800),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$Correct\_NR ,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Net Radiation', main='Net Radiation: Daily and Half Hour Averages',ylim = c(-80,800),col="red",pch=1,cex=1.0)  
abline(h=0,col="black")

#soil heat flux

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$Correct\_shf\_1, xlab='Time', ylab='Soil Heat Flux 1', main='Soil Heat Flux 1: Daily and Half Hour Averages', ylim = c(-20,40),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$Correct\_shf\_1,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Soil Heat Flux 1', main='Soil Heat Flux 1: Daily and Half Hour Averages',ylim = c(-20,40),lty=1,col="red",lwd=2,type="l")  
abline(h=0,col="black")

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$Correct\_shf\_1, xlab='Time', ylab='Soil Heat Flux', main='Soil Heat Flux 1: Daily and Half Hour Averages', ylim = c(-20,40),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$Correct\_shf\_1,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Soil Heat Flux 1', main='Soil Heat Flux 1: Daily and Half Hour Averages',ylim = c(-20,40),col="red",pch=1,cex=1.0)  
abline(h=0,col="black")

#air temperature daily and 1/2 hour averages

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$air\_temperature-273.15, xlab='Time', ylab='Air Temperature C: Daily and 1/2 Hour Averages', main=' ', ylim = c(5,40),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$air\_temperature-273.15,round(combo\_master\_ed\_met$DOY),function(x) mean(x,na.rm=T)),xaxt='n', xlab='Time', ylab='Air Temperature C: Daily and 1/2 Hour Averages', main='',ylim = c(5,40),lty=1,col="red",lwd=2,type="l")  
abline(h=0,col="black")

#Water Fluxes daily and 1/2 hour averages. cumulative water and co2

plot(combo\_master\_ed\_met$TIMESTAMP ,combo\_master\_ed\_met$h2o\_flux, xlab='Time', ylab='H2O Fluxes', main='H2O Fluxes: Daily and Half Hour Averages', ylim = c(-2,5),pch=1,col="grey",cex=0.4)  
par(new= TRUE)

plot(tapply(combo\_master\_ed\_met$h2o\_flux,  
 round(combo\_master\_ed\_met$DOY),  
 function(x) mean(x,na.rm=T)),  
 xaxt='n',  
 xlab='Time',  
 ylab='H2O Fluxes',  
 main='H2O Fluxes: Daily and Half Hour Averages',  
 ylim = c(-2,5),  
 lty=1,  
 col="red",  
 lwd=2,  
 type="l")  
abline(h=0,col="black")

plot(cumsum(tapply(combo\_master\_ed\_met$h2o\_flux,  
 round(combo\_master\_ed\_met$DOY),  
 function(x) mean(x,na.rm=T)))\*18.02/1000000\*1800\*48,  
 xaxt='n',  
 xlab='Days since June 25',  
 ylab=expression(Cumulative~Evapotranspiration~'('~mm~')'),  
 main='',  
 ylim = c(0,240),  
 lty=1,  
 col="red",  
 lwd=2,  
 type="l")  
axis(side=1,at=seq(0,240,by=30))

plot(cumsum(tapply(combo\_master\_ed\_met$co2\_flux,  
 round(combo\_master\_ed\_met$DOY),  
 function(x) mean(x,na.rm=T)))\*12/1000000\*1800\*48,  
 xaxt='n',  
 xlab='Days since June 25',  
 ylab=expression(Cumulative~NEE~'('~g~C~m^{-2}~')'),  
 main='',  
 ylim = c(-100,100),  
 lty=1,  
 col="red",  
 lwd=2,  
 type="l")  
axis(side=1,at=seq(0,240,by=30))

#Co2 fluxes v.s u star, temperature, and VPD

plot(combo\_master\_ed\_met$u. ,combo\_master\_ed\_met$co2\_flux, ylim = c(-5, 10), xlim = c(0,1), xlab='U\*', ylab='Co2 Fluxes', main='Co2 Fluxes v.s U\*')

plot(combo\_master\_ed\_met$VPD ,combo\_master\_ed\_met$co2\_flux, ylim = c(-5, 10), xlab='VPD', ylab='Co2 Fluxes', main='Co2 Fluxes v.s VPD\*')

plot(combo\_master\_ed\_met$air\_temperature-273.15 ,combo\_master\_ed\_met$co2\_flux, ylim = c(-5, 10), xlab='Air Temperature (C)', ylab='Co2 Fluxes', main='Co2 Fluxes v.s Air temperature\*')

plot(combo\_master\_ed\_met$Correct\_NR[combo\_master\_ed\_met$daytime==1] ,combo\_master\_ed\_met$co2\_flux[combo\_master\_ed\_met$daytime==1], ylim = c(-10, 10), xlab='Net Radiation', ylab='Co2 Fluxes', main='Co2 Fluxes v.s Net Radiation')

summary(combo\_master\_ed\_met$VPD)

Min. 1st Qu. Median Mean 3rd Qu. Max. NA's   
 0.0 217.0 565.6 890.6 1278.5 5784.0 540

scatter.smooth(combo\_master\_ed\_met$Correct\_NR[combo\_master\_ed\_met$daytime==1],  
 combo\_master\_ed\_met$co2\_flux[combo\_master\_ed\_met$daytime==1],  
 ylim = c(-10, 10),  
 cex=0.6,col="grey",  
 xlab=expression(Daytime~Net~Radiation~'('~W~m^{-2}~')'),   
 ylab="",   
 main='',las=1,  
 lpars=list(lwd=3,col="red"))  
mtext(side=2,expression(CO[2]~Flux~'('~mu~mol~m^{-2}~s^{-1}~')'),line=2.5)

scatter.smooth(combo\_master\_ed\_met$air\_temperature[combo\_master\_ed\_met$daytime==0&  
 combo\_master\_ed\_met$u.>=0.15]-273.15,  
 combo\_master\_ed\_met$co2\_flux[combo\_master\_ed\_met$daytime==0&  
 combo\_master\_ed\_met$u.>=0.15],  
 ylim = c(-5, 10),  
 cex=0.6,col="grey",  
 xlab=expression(Air~Temperature~'('~degree~C~')'),   
 ylab="",   
 main='',las=1,  
 lpars=list(lwd=3,col="red"))  
mtext(side=2,expression(CO[2]~Flux~'('~mu~mol~m^{-2}~s^{-1}~')'),line=2.5)

#cumulative