Assignment 2

2024-10-02

#Boone - 1980-1999  
early\_boone <- boone %>%   
 filter(year < 2000)  
  
#Calculate moving sum  
library(zoo)

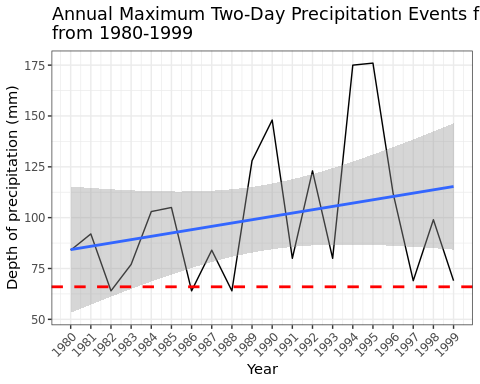
##   
## Attaching package: 'zoo'

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

moving\_sum\_early\_boone <- rollapply(  
 early\_boone$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
moving\_early\_boone <- data.frame(  
 Original\_Data = early\_boone,  
 Moving\_Sum = moving\_sum\_early\_boone  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate annual two-day max  
movingearly\_boone\_annual <- moving\_early\_boone %>%   
 filter(Original\_Data.year < 2000) %>%   
 group\_by(Original\_Data.year) %>%   
 summarise(twoday\_max\_annual = max(Moving\_Sum))  
  
#Calculate return period  
rp\_early\_boone\_moving <- moving\_early\_boone %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(number\_events = 3986) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 66 mm  
  
#Plot annual two-day max + return period  
ggplot(movingearly\_boone\_annual, aes(x = Original\_Data.year, y = twoday\_max\_annual)) +  
 geom\_line() +  
 geom\_smooth(method = "lm") +  
 geom\_hline(yintercept = 66, color = "red", linetype = "dashed", size = 1) +  
 scale\_x\_continuous(breaks = seq(1980, 1999, 1)) +  
 labs(title = "Annual Maximum Two-Day Precipitation Events for Boone\nfrom 1980-1999",  
 x = "Year",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))

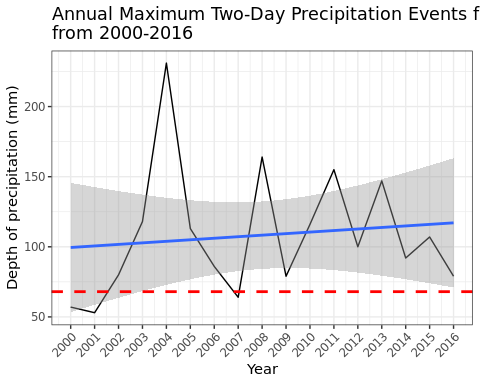
## Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.  
## ℹ Please use `linewidth` instead.  
## This warning is displayed once every 8 hours.  
## Call `lifecycle::last\_lifecycle\_warnings()` to see where this warning was  
## generated.

## `geom\_smooth()` using formula = 'y ~ x'



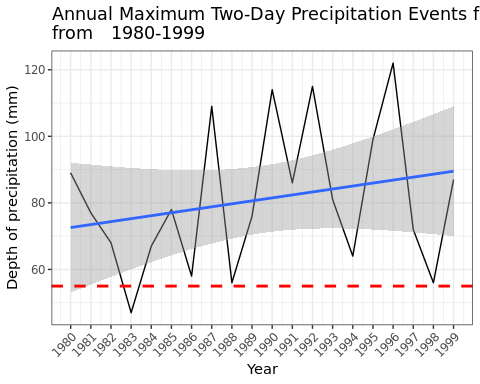
#Boone - 2000-2016  
late\_boone <- boone %>%   
 filter(year >= 2000)  
  
#Calculate moving sum  
moving\_sum\_late\_boone <- rollapply(late\_boone$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
moving\_late\_boone <- data.frame(  
 Original\_Data = late\_boone,  
 Moving\_Sum = moving\_sum\_late\_boone  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate annual two-day max  
movinglate\_boone\_annual <- moving\_late\_boone %>%   
 filter(Original\_Data.year >= 2000) %>%   
 group\_by(Original\_Data.year) %>%   
 summarise(twoday\_max\_annual = max(Moving\_Sum))  
  
#Calculate return period  
rp\_late\_boone\_moving <- moving\_late\_boone %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(number\_events = 3460) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 80 mm  
  
#Plot annual two-day max and return period  
ggplot(movinglate\_boone\_annual, aes(x = Original\_Data.year, y = twoday\_max\_annual)) +  
 geom\_line() +  
 geom\_smooth(method = "lm") +  
 geom\_hline(yintercept = 68, color = "red", linetype = "dashed", size = 1) +  
 scale\_x\_continuous(breaks = seq(2000, 2016, 1)) +  
 labs(title = "Annual Maximum Two-Day Precipitation Events for Boone\nfrom 2000-2016",  
 x = "Year",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))

## `geom\_smooth()` using formula = 'y ~ x'



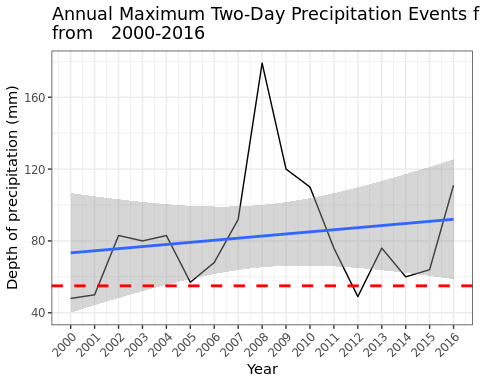
#Greensboro, 1980-1999  
early\_greensboro <- greensboro %>%   
 filter(year < 2000)  
  
#Calculate moving sum  
moving\_sum\_early\_greensboro <- rollapply(early\_greensboro$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
moving\_early\_greensboro <- data.frame(  
 Original\_Data = early\_greensboro,  
 Moving\_Sum = moving\_sum\_early\_greensboro  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate annual two-day max   
movingearly\_greensboro\_annual <- moving\_early\_greensboro %>%   
 filter(Original\_Data.year < 2000) %>%   
 group\_by(Original\_Data.year) %>%   
 summarise(twoday\_max\_annual = max(Moving\_Sum))  
  
#Calculate return period  
rp\_early\_greensboro\_moving <- moving\_early\_greensboro %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(number\_events = 3291) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 55 mm  
  
#Plot annual two-day max and return period  
ggplot(movingearly\_greensboro\_annual, aes(x = Original\_Data.year, y = twoday\_max\_annual)) +  
 geom\_line() +  
 geom\_smooth(method = "lm") +  
 geom\_hline(yintercept = 55, color = "red", linetype = "dashed", size = 1) +  
 scale\_x\_continuous(breaks = seq(1980, 1999, 1)) +  
 labs(title = "Annual Maximum Two-Day Precipitation Events for Greensboro\nfrom 1980-1999",  
 x = "Year",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))

## `geom\_smooth()` using formula = 'y ~ x'



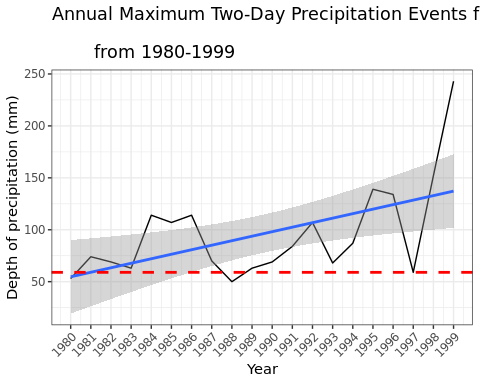
#Greensboro, 2000-2016  
late\_greensboro <- greensboro %>%   
 filter(year >= 2000)  
  
#Calculate moving sum  
moving\_sum\_late\_greensboro <- rollapply(late\_greensboro$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
moving\_late\_greensboro <- data.frame(  
 Original\_Data = late\_greensboro,  
 Moving\_Sum = moving\_sum\_late\_greensboro  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate annual two-day max  
movinglate\_greensboro\_annual <- moving\_late\_greensboro %>%   
 filter(Original\_Data.year >= 2000) %>%   
 group\_by(Original\_Data.year) %>%   
 summarise(twoday\_max\_annual = max(Moving\_Sum))  
  
#Calculate return period  
rp\_late\_greensboro\_moving <- moving\_late\_greensboro %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(number\_events = 2879) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 55 mm  
  
#Plot annual two-day max and return period  
ggplot(movinglate\_greensboro\_annual, aes(x = Original\_Data.year, y = twoday\_max\_annual)) +  
 geom\_line() +  
 geom\_smooth(method = "lm") +  
 geom\_hline(yintercept = 55, color = "red", linetype = "dashed", size = 1) +  
 scale\_x\_continuous(breaks = seq(2000, 2016, 1)) +  
 labs(title = "Annual Maximum Two-Day Precipitation Events for Greensboro\nfrom 2000-2016",  
 x = "Year",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))

## `geom\_smooth()` using formula = 'y ~ x'



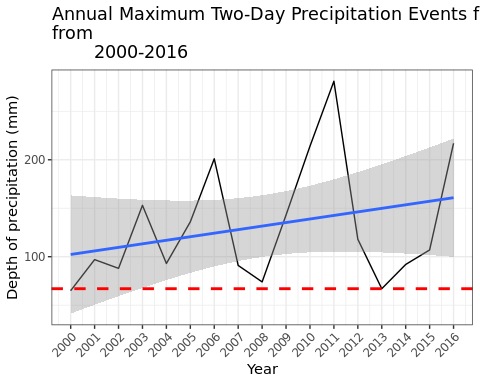
#Greenville, 1980-1999  
early\_greenville <- greenville %>%   
 filter(year < 2000)  
  
#Calculate moving sum  
moving\_sum\_early\_greenville <- rollapply(early\_greenville$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
moving\_early\_greenville <- data.frame(  
 Original\_Data = early\_greenville,  
 Moving\_Sum = moving\_sum\_early\_greenville  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate annual two-day max  
movingearly\_greenville\_annual <- moving\_early\_greenville %>%   
 filter(Original\_Data.year < 2000) %>%   
 group\_by(Original\_Data.year) %>%   
 summarise(twoday\_max\_annual = max(Moving\_Sum))  
  
#Calculate return period  
rp\_early\_greenville\_moving <- moving\_early\_greenville %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(number\_events = 3393) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 59 mm  
  
#Plot annual two-day max and return period  
ggplot(movingearly\_greenville\_annual,   
 aes(x = Original\_Data.year, y = twoday\_max\_annual)) +  
 geom\_line() +  
 geom\_smooth(method = "lm") +  
 geom\_hline(yintercept = 59, color = "red", linetype = "dashed", size = 1) +  
 scale\_x\_continuous(breaks = seq(1980, 1999, 1)) +  
 labs(title = "Annual Maximum Two-Day Precipitation Events for Greenville\n  
 from 1980-1999",  
 x = "Year",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))

## `geom\_smooth()` using formula = 'y ~ x'



#Greenville, 1980-1999  
late\_greenville <- greenville %>%   
 filter(year >= 2000)  
  
#Calculate moving sum  
moving\_sum\_late\_greenville <- rollapply(late\_greenville$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
moving\_late\_greenville <- data.frame(  
 Original\_Data = late\_greensboro,  
 Moving\_Sum = moving\_sum\_late\_greenville  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate annual two-day max  
movinglate\_greenville\_annual <- moving\_late\_greenville %>%   
 filter(Original\_Data.year >= 2000) %>%   
 group\_by(Original\_Data.year) %>%   
 summarise(twoday\_max\_annual = max(Moving\_Sum))  
  
#Calculate return period  
rp\_late\_greenville\_moving <- moving\_late\_greenville %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 2907) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 67 mm  
  
#Plot annual two-day max and return period  
ggplot(movinglate\_greenville\_annual, aes(x = Original\_Data.year, y = twoday\_max\_annual)) +  
 geom\_line() +  
 geom\_smooth(method = "lm") +  
 geom\_hline(yintercept = 67, color = "red", linetype = "dashed", size = 1) +  
 scale\_x\_continuous(breaks = seq(2000, 2016, 1)) +  
 labs(title = "Annual Maximum Two-Day Precipitation Events for Greenville\nfrom  
 2000-2016",  
 x = "Year",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))

## `geom\_smooth()` using formula = 'y ~ x'



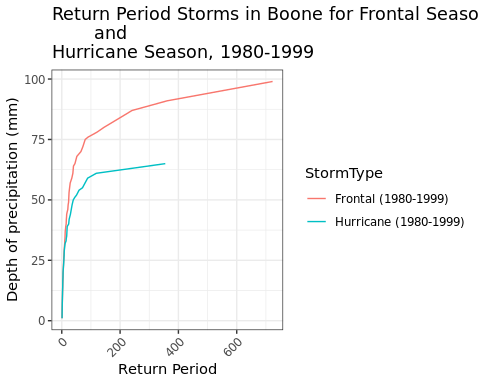
#Seasonal, Boone 1980-1999  
#Hurricane season  
hurricane\_boone <- boone %>%   
 filter(month == 7:10) %>%   
 filter(year < 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 7:10`.  
## Caused by warning in `month == 7:10`:  
## ! longer object length is not a multiple of shorter object length

#Frontal season  
frontal\_boone <- boone %>%   
 filter(month == 1:6 | month == 11:12) %>%   
 filter(year < 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 1:6 | month == 11:12`.  
## Caused by warning in `month == 1:6`:  
## ! longer object length is not a multiple of shorter object length

#Calculate moving sum durring hurricane season  
sum\_boone\_hurricane <- rollapply(  
 hurricane\_boone$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_boone\_hurricane <- data.frame(  
 Original\_Data = hurricane\_boone,  
 Moving\_Sum = sum\_boone\_hurricane  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_boone\_hurricane <- movingsum\_boone\_hurricane %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 355) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 52 mm  
  
#Calculate moving sum for frontal seaosn  
sum\_boone\_frontal <- rollapply(  
 frontal\_boone$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_boone\_frontal <- data.frame(  
 Original\_Data = frontal\_boone,  
 Moving\_Sum = sum\_boone\_frontal  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_boone\_frontal <- movingsum\_boone\_frontal %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 723) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 68 mm  
  
#Add new column specifying type  
rp\_boone\_frontal$StormType = "Frontal (1980-1999)"  
rp\_boone\_hurricane$StormType = "Hurricane (1980-1999)"  
  
#Combine into one data set  
boone\_combined <- bind\_rows(rp\_boone\_frontal, rp\_boone\_hurricane)  
  
#Plot - 1980-1999 only  
ggplot(boone\_combined, aes(x = return\_period, y = Moving\_Sum, color = StormType)) +  
 geom\_line() +  
 labs(title = "Return Period Storms in Boone for Frontal Season   
 and\nHurricane Season, 1980-1999",  
 x = "Return Period",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))



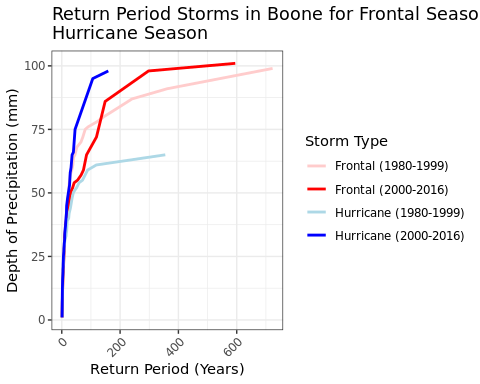
#Seasonal, boone 2000-2016  
#Hurricane season  
hurricane\_boone\_2016 <- boone %>%   
 filter(month == 7:10) %>%   
 filter(year >= 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 7:10`.  
## Caused by warning in `month == 7:10`:  
## ! longer object length is not a multiple of shorter object length

#Frontal season  
frontal\_boone\_2016 <- boone %>%   
 filter(month == 1:6 | month == 11:12) %>%   
 filter(year >= 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 1:6 | month == 11:12`.  
## Caused by warning in `month == 1:6`:  
## ! longer object length is not a multiple of shorter object length

#Calculate moving sum of hurricane season  
sum\_boone\_hurricane\_2016 <- rollapply(hurricane\_boone\_2016$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum,   
 fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_boone\_hurricane\_2016 <- data.frame(  
 Original\_Data = hurricane\_boone\_2016,  
 Moving\_Sum = sum\_boone\_hurricane\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period   
rp\_boone\_hurricane\_2016 <- movingsum\_boone\_hurricane\_2016 %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 319) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 75 mm  
  
#Calculate moving sum of frontal season  
sum\_boone\_frontal\_2016 <- rollapply(  
 frontal\_boone\_2016$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_boone\_frontal\_2016 <- data.frame(  
 Original\_Data = frontal\_boone\_2016,  
 Moving\_Sum = sum\_boone\_frontal\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_boone\_frontal\_2016 <- movingsum\_boone\_frontal\_2016 %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 595) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 55 mm  
  
#Add new columns to specify storm type  
rp\_boone\_frontal\_2016$StormType = "Frontal (2000-2016)"  
rp\_boone\_hurricane\_2016$StormType = "Hurricane (2000-2016)"  
  
#Combine all years  
boone\_combined\_all <- bind\_rows(rp\_boone\_frontal, rp\_boone\_hurricane,   
 rp\_boone\_frontal\_2016, rp\_boone\_hurricane\_2016)  
  
#Plot  
ggplot(boone\_combined\_all, aes(x = return\_period, y = Moving\_Sum, color = StormType)) +  
 geom\_line(size = 1) +  
 labs(title = "Return Period Storms in Boone for Frontal Season and\nHurricane Season",  
 x = "Return Period (Years)",  
 y = "Depth of Precipitation (mm)",  
 color = "Storm Type") +  
 scale\_color\_manual(  
 values = c("Frontal (1980-1999)" = "#FFCCCC",  
 "Frontal (2000-2016)" = "red",  
 "Hurricane (1980-1999)" = "#ADD8E6",  
 "Hurricane (2000-2016)" = "blue")) +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))



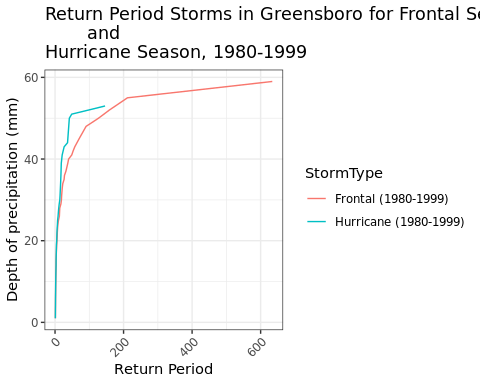
#Seasonal, Greensboro 1980-1999  
#Hurricane season  
hurricane\_greensboro <- greensboro %>%   
 filter(month == 7:10) %>%   
 filter(year < 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 7:10`.  
## Caused by warning in `month == 7:10`:  
## ! longer object length is not a multiple of shorter object length

#Frontal season  
frontal\_greensboro <- greensboro %>%   
 filter(month == 1:6 | month == 11:12) %>%   
 filter(year < 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 1:6 | month == 11:12`.  
## Caused by warning in `month == 1:6`:  
## ! longer object length is not a multiple of shorter object length

#Calculate moving sum of hurricane season  
sum\_greensboro\_hurricane <- rollapply(hurricane\_greensboro$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
movingsum\_greensboro\_hurricane <- data.frame(  
 Original\_Data = hurricane\_greensboro,  
 Moving\_Sum = sum\_greensboro\_hurricane  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greensboro\_hurricane <- movingsum\_greensboro\_hurricane %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 292) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 51 mm  
  
#Calculate moving sum of frontal season  
sum\_greensboro\_frontal <- rollapply(  
 frontal\_greensboro$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_greensboro\_frontal <- data.frame(  
 Original\_Data = frontal\_greensboro,  
 Moving\_Sum = sum\_greensboro\_frontal  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greensboro\_frontal <- movingsum\_greensboro\_frontal %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 634) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 42 mm  
  
#Add columns specifying storm type  
rp\_greensboro\_frontal$StormType = "Frontal (1980-1999)"  
rp\_greensboro\_hurricane$StormType = "Hurricane (1980-1999)"  
  
#Comvine frontal and hurricane  
greensboro\_combined <- bind\_rows(rp\_greensboro\_frontal, rp\_greensboro\_hurricane)  
  
#Plot, 1980-1999 only  
ggplot(greensboro\_combined, aes(x = return\_period, y = Moving\_Sum, color = StormType)) +  
 geom\_line() +  
 labs(title = "Return Period Storms in Greensboro for Frontal Season   
 and\nHurricane Season, 1980-1999",  
 x = "Return Period",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))



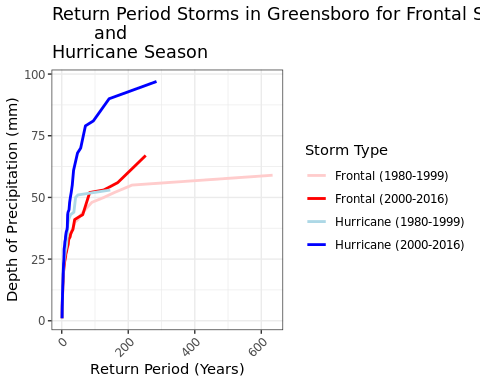
#Seasonal, Greensboro 2000-2016  
#Hurricane season  
hurricane\_greensboro\_2016 <- greensboro %>%   
 filter(month == 7:10) %>%   
 filter(year >= 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 7:10`.  
## Caused by warning in `month == 7:10`:  
## ! longer object length is not a multiple of shorter object length

#Frontal season  
frontal\_greensboro\_2016 <- greensboro %>%   
 filter(month == 1:6 | month == 11:12) %>%   
 filter(year >= 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 1:6 | month == 11:12`.  
## Caused by warning in `month == 1:6`:  
## ! longer object length is not a multiple of shorter object length

#Calculate moving sum of hurricane season  
sum\_greensboro\_hurricane\_2016 <- rollapply(  
 hurricane\_greensboro\_2016$Area.Weighted.Mean.Precipitation..mm.per.day.,  
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_greensboro\_hurricane\_2016 <- data.frame(  
 Original\_Data = hurricane\_greensboro\_2016,  
 Moving\_Sum = sum\_greensboro\_hurricane\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greensboro\_hurricane\_2016 <- movingsum\_greensboro\_hurricane\_2016 %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 285) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 69 mm  
  
#Calculate moving sum of frontal season  
sum\_greensboro\_frontal\_2016 <- rollapply(  
 frontal\_greensboro\_2016$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_greensboro\_frontal\_2016 <- data.frame(  
 Original\_Data = frontal\_greensboro\_2016,  
 Moving\_Sum = sum\_greensboro\_frontal\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greensboro\_frontal\_2016 <- movingsum\_greensboro\_frontal\_2016 %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 505) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 42 mm  
  
#Add columns specifying storm type  
rp\_greensboro\_frontal\_2016$StormType = "Frontal (2000-2016)"  
rp\_greensboro\_hurricane\_2016$StormType = "Hurricane (2000-2016)"  
  
#Combine all years  
greensboro\_combined\_all <- bind\_rows(rp\_greensboro\_frontal,   
 rp\_greensboro\_hurricane,   
 rp\_greensboro\_frontal\_2016,   
 rp\_greensboro\_hurricane\_2016)  
  
#Plot all years  
ggplot(greensboro\_combined\_all, aes(x = return\_period, y = Moving\_Sum,   
 color = StormType)) +  
 geom\_line(size = 1) +  
 labs(title = "Return Period Storms in Greensboro for Frontal Season   
 and\nHurricane Season",  
 x = "Return Period (Years)",  
 y = "Depth of Precipitation (mm)",  
 color = "Storm Type") +  
 scale\_color\_manual(  
 values = c("Frontal (1980-1999)" = "#FFCCCC",  
 "Frontal (2000-2016)" = "red",  
 "Hurricane (1980-1999)" = "#ADD8E6",  
 "Hurricane (2000-2016)" = "blue")) +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))



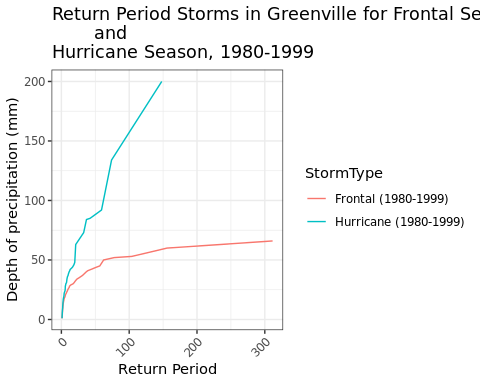
#Seasonal, Greenville 1980-1999  
#Hurricane season  
hurricane\_greenville <- greenville %>%   
 filter(month == 7:10) %>%   
 filter(year < 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 7:10`.  
## Caused by warning in `month == 7:10`:  
## ! longer object length is not a multiple of shorter object length

#Frontal season  
frontal\_greenville <- greenville %>%   
 filter(month == 1:6 | month == 11:12) %>%   
 filter(year < 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 1:6 | month == 11:12`.  
## Caused by warning in `month == 1:6`:  
## ! longer object length is not a multiple of shorter object length

#Calculate moving sum of hurricane season  
sum\_greenville\_hurricane <- rollapply(hurricane\_greenville$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
movingsum\_greenville\_hurricane <- data.frame(  
 Original\_Data = hurricane\_greenville,  
 Moving\_Sum = sum\_greenville\_hurricane  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greenville\_hurricane <- movingsum\_greenville\_hurricane %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 296) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 89 mm  
  
#Calculate moving sum of frontal season  
sum\_greenville\_frontal <- rollapply(  
 frontal\_greenville$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_greenville\_frontal <- data.frame(  
 Original\_Data = frontal\_greenville,  
 Moving\_Sum = sum\_greenville\_frontal  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greenville\_frontal <- movingsum\_greenville\_frontal %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 623) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 44 mm  
  
#Add columns specifying storm type  
rp\_greenville\_frontal$StormType = "Frontal (1980-1999)"  
rp\_greenville\_hurricane$StormType = "Hurricane (1980-1999)"  
  
#Combine data  
greenville\_combined <- bind\_rows(rp\_greenville\_frontal, rp\_greenville\_hurricane)  
  
#Plot, 1980-1999 only  
ggplot(greenville\_combined, aes(x = return\_period, y = Moving\_Sum,   
 color = StormType)) +  
 geom\_line() +  
 labs(title = "Return Period Storms in Greenville for Frontal Season   
 and\nHurricane Season, 1980-1999",  
 x = "Return Period",  
 y = "Depth of precipitation (mm)") +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))



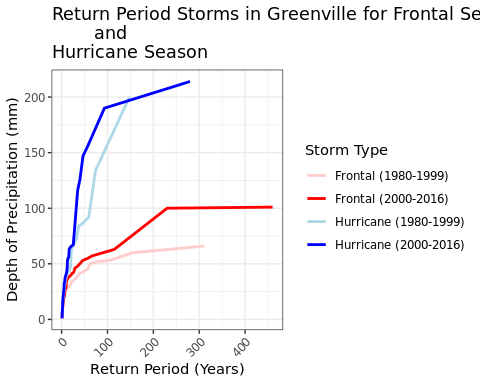
#Seasonal, greenville 2000-2016  
#Hurricane season  
hurricane\_greenville\_2016 <- greenville %>%   
 filter(month == 7:10) %>%   
 filter(year >= 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 7:10`.  
## Caused by warning in `month == 7:10`:  
## ! longer object length is not a multiple of shorter object length

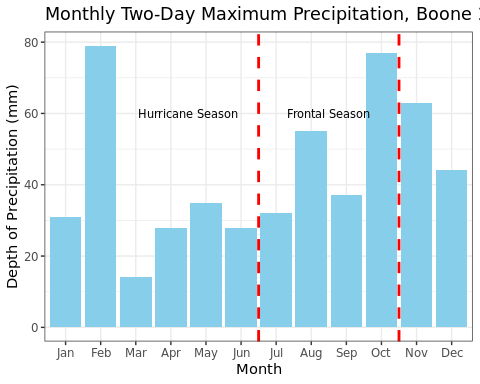
#Frontal season  
frontal\_greenville\_2016 <- greenville %>%   
 filter(month == 1:6 | month == 11:12) %>%   
 filter(year >= 2000)

## Warning: There was 1 warning in `filter()`.  
## ℹ In argument: `month == 1:6 | month == 11:12`.  
## Caused by warning in `month == 1:6`:  
## ! longer object length is not a multiple of shorter object length

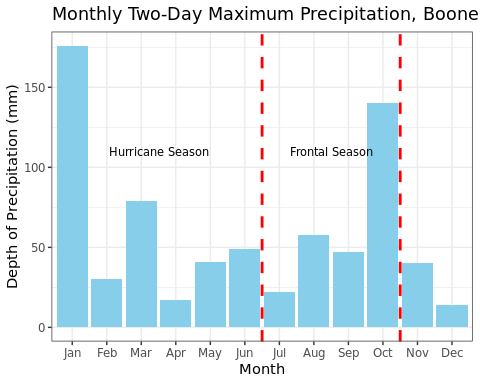
#Calculate moving sum of hurricane season  
sum\_greenville\_hurricane\_2016 <- rollapply(  
 hurricane\_greenville\_2016$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA, align = "right")  
  
#Turn into data frame  
movingsum\_greenville\_hurricane\_2016 <- data.frame(  
 Original\_Data = hurricane\_greenville\_2016,  
 Moving\_Sum = sum\_greenville\_hurricane\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greenville\_hurricane\_2016 <- movingsum\_greenville\_hurricane\_2016 %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 280) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 151 mm  
  
#Calculate moving sum of frontal season  
sum\_greenville\_frontal\_2016 <- rollapply(frontal\_greenville\_2016$Area.Weighted.Mean.Precipitation..mm.per.day.,   
 width = 2, FUN = sum, fill = NA,   
 align = "right")  
  
#Turn into data frame  
movingsum\_greenville\_frontal\_2016 <- data.frame(  
 Original\_Data = frontal\_greenville\_2016,  
 Moving\_Sum = sum\_greenville\_frontal\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate return period  
rp\_greenville\_frontal\_2016 <- movingsum\_greenville\_frontal\_2016 %>%   
 filter(Moving\_Sum > 0) %>%   
 mutate(rank = rank(-Moving\_Sum,  
 ties.method = "max")) %>%   
 mutate(number\_events = 460) %>%   
 mutate(weibull = (rank/number\_events)) %>%   
 mutate(return\_period = 1/weibull)  
#moving sum for 50-year 48-hour storm event = 54 mm  
  
#Add columns specifying storm type  
rp\_greenville\_frontal\_2016$StormType = "Frontal (2000-2016)"  
rp\_greenville\_hurricane\_2016$StormType = "Hurricane (2000-2016)"  
  
#Combine all years  
greenville\_combined\_all <- bind\_rows(rp\_greenville\_frontal,   
 rp\_greenville\_hurricane,   
 rp\_greenville\_frontal\_2016,   
 rp\_greenville\_hurricane\_2016)  
  
#Plot all years  
ggplot(greenville\_combined\_all, aes(x = return\_period, y = Moving\_Sum,   
 color = StormType)) +  
 geom\_line(size = 1) +  
 labs(title = "Return Period Storms in Greenville for Frontal Season   
 and\nHurricane Season",  
 x = "Return Period (Years)",  
 y = "Depth of Precipitation (mm)",  
 color = "Storm Type") +  
 scale\_color\_manual(  
 values = c("Frontal (1980-1999)" = "#FFCCCC",  
 "Frontal (2000-2016)" = "red",  
 "Hurricane (1980-1999)" = "#ADD8E6",  
 "Hurricane (2000-2016)" = "blue")) +  
 theme\_bw() +  
 theme(axis.text.x = element\_text(angle = 45, hjust = 1))



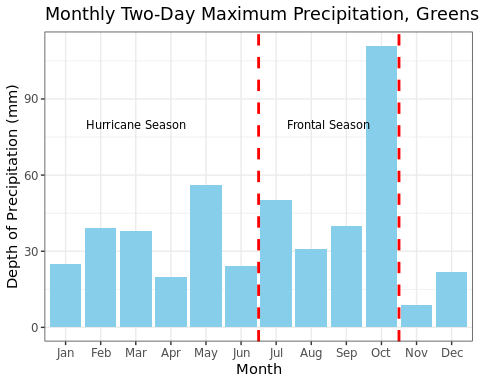
#Boone, 2016  
boone\_2016 <- boone %>%   
 filter(year == 2016)  
  
#Calculate the moving sum  
moving\_boone\_2016 <- rollapply(  
 boone\_2016$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
boone\_2016\_movingsum <- data.frame(  
 Original\_Data = boone\_2016,  
 Moving\_Sum = moving\_boone\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate two-day monthly max  
boone\_2016\_monthly <- boone\_2016\_movingsum %>%   
 group\_by(Original\_Data.month) %>%   
 summarise(twoday\_max\_monthly = max(Moving\_Sum))  
  
#Change month to a factor  
boone\_2016\_monthly$Original\_Data.month <- factor(boone\_2016\_monthly$Original\_Data.month,   
 levels = 1:12,  
 labels = month.abb)  
  
#Plot the monthly two-day max precip  
ggplot(boone\_2016\_monthly, aes(x = Original\_Data.month, y = twoday\_max\_monthly)) +  
 geom\_bar(stat = "identity", fill = "skyblue") +   
 labs(title = "Monthly Two-Day Maximum Precipitation, Boone 2016",   
 x = "Month",   
 y = "Depth of Precipitation (mm)") +  
 geom\_vline(xintercept = 6.5, linetype = "dashed", color = "red", size = 1) +  
 geom\_vline(xintercept = 10.5, linetype = "dashed", color = "red", size = 1) +  
 annotate("text", x = 4.5, y = 60, label = "Hurricane Season", size = 3) +  
 annotate("text", x = 8.5, y = 60, label = "Frontal Season", size = 3) +  
 theme\_bw()



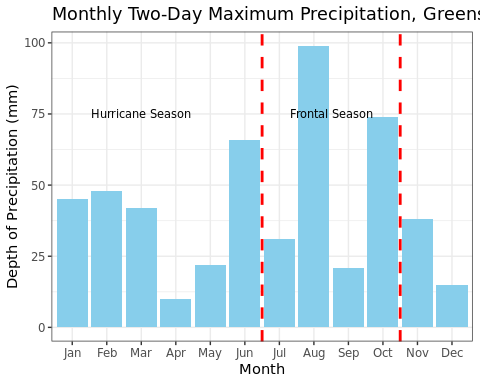
#Boone, 1995  
boone\_1995 <- boone %>%   
 filter(year == 1995)  
  
#Calculate the moving sum  
moving\_boone\_1995 <- rollapply(  
 boone\_1995$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
boone\_1995\_movingsum <- data.frame(  
 Original\_Data = boone\_1995,  
 Moving\_Sum = moving\_boone\_1995  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate two-day annual max  
boone\_1995\_monthly <- boone\_1995\_movingsum %>%   
 group\_by(Original\_Data.month) %>%   
 summarise(twoday\_max\_monthly = max(Moving\_Sum))  
  
#Change month to factor  
boone\_1995\_monthly$Original\_Data.month <- factor(boone\_1995\_monthly$Original\_Data.month,   
 levels = 1:12,  
 labels = month.abb)  
   
#Plot the monthly two-day max precip   
ggplot(boone\_1995\_monthly, aes(x = Original\_Data.month, y = twoday\_max\_monthly)) +  
 geom\_bar(stat = "identity", fill = "skyblue") +   
 labs(title = "Monthly Two-Day Maximum Precipitation, Boone 1995",   
 x = "Month",   
 y = "Depth of Precipitation (mm)") +  
 geom\_vline(xintercept = 6.5, linetype = "dashed", color = "red", size = 1) +  
 geom\_vline(xintercept = 10.5, linetype = "dashed", color = "red", size = 1) +  
 annotate("text", x = 3.5, y = 110, label = "Hurricane Season", size = 3) +  
 annotate("text", x = 8.5, y = 110, label = "Frontal Season", size = 3) +  
 theme\_bw()



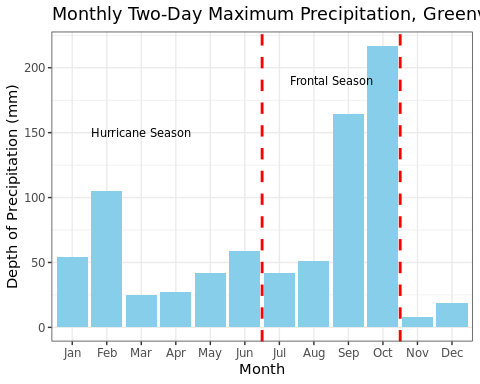
#Greensboro, 2016  
greensboro\_2016 <- greensboro %>%   
 filter(year == 2016)  
  
#Calculate the moving sum  
moving\_greensboro\_2016 <- rollapply(  
 greensboro\_2016$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
greensboro\_2016\_movingsum <- data.frame(  
 Original\_Data = greensboro\_2016,  
 Moving\_Sum = moving\_greensboro\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate two-day annual max  
greensboro\_2016\_monthly <- greensboro\_2016\_movingsum %>%   
 group\_by(Original\_Data.month) %>%   
 summarise(twoday\_max\_monthly = max(Moving\_Sum))  
  
#Change month to a factor  
greensboro\_2016\_monthly$Original\_Data.month <- factor(  
 greensboro\_2016\_monthly$Original\_Data.month,   
 levels = 1:12,  
 labels = month.abb)  
  
#Plot the monthly two-day max precip  
ggplot(greensboro\_2016\_monthly, aes(x = Original\_Data.month, y = twoday\_max\_monthly)) +  
 geom\_bar(stat = "identity", fill = "skyblue") +   
 labs(title = "Monthly Two-Day Maximum Precipitation, Greensboro 2016",   
 x = "Month",   
 y = "Depth of Precipitation (mm)") +  
 geom\_vline(xintercept = 6.5, linetype = "dashed", color = "red", size = 1) +  
 geom\_vline(xintercept = 10.5, linetype = "dashed", color = "red", size = 1) +  
 annotate("text", x = 3, y = 80, label = "Hurricane Season", size = 3) +  
 annotate("text", x = 8.5, y = 80, label = "Frontal Season", size = 3) +  
 theme\_bw()



#Greensboro, 1995  
greensboro\_1995 <- greensboro %>%   
 filter(year == 1995)  
  
#Calculate the moving sum  
moving\_greensboro\_1995 <- rollapply(  
 greensboro\_1995$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
greensboro\_1995\_movingsum <- data.frame(  
 Original\_Data = greensboro\_1995,  
 Moving\_Sum = moving\_greensboro\_1995  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate two-day annual max  
greensboro\_1995\_monthly <- greensboro\_1995\_movingsum %>%   
 group\_by(Original\_Data.month) %>%   
 summarise(twoday\_max\_monthly = max(Moving\_Sum))  
  
#Change month to factor  
greensboro\_1995\_monthly$Original\_Data.month <- factor(  
 greensboro\_1995\_monthly$Original\_Data.month,   
 levels = 1:12,  
 labels = month.abb)  
   
#Plot the monthly two-day max precip   
ggplot(greensboro\_1995\_monthly, aes(x = Original\_Data.month, y = twoday\_max\_monthly)) +  
 geom\_bar(stat = "identity", fill = "skyblue") +   
 labs(title = "Monthly Two-Day Maximum Precipitation, Greensboro 1995",   
 x = "Month",   
 y = "Depth of Precipitation (mm)") +  
 geom\_vline(xintercept = 6.5, linetype = "dashed", color = "red", size = 1) +  
 geom\_vline(xintercept = 10.5, linetype = "dashed", color = "red", size = 1) +  
 annotate("text", x = 3, y = 75, label = "Hurricane Season", size = 3) +  
 annotate("text", x = 8.5, y = 75, label = "Frontal Season", size = 3) +  
 theme\_bw()



#Greenville, 2016  
greenville\_2016 <- greenville %>%   
 filter(year == 2016)  
  
#Calculate the moving sum  
moving\_greenville\_2016 <- rollapply(  
 greenville\_2016$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
greenville\_2016\_movingsum <- data.frame(  
 Original\_Data = greenville\_2016,  
 Moving\_Sum = moving\_greenville\_2016  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate two-day annual max  
greenville\_2016\_monthly <- greenville\_2016\_movingsum %>%   
 group\_by(Original\_Data.month) %>%   
 summarise(twoday\_max\_monthly = max(Moving\_Sum))  
  
#Change month to a factor  
greenville\_2016\_monthly$Original\_Data.month <- factor(  
 greenville\_2016\_monthly$Original\_Data.month,   
 levels = 1:12,  
 labels = month.abb)  
  
#Plot the monthly two-day max precip  
ggplot(greenville\_2016\_monthly, aes(x = Original\_Data.month, y = twoday\_max\_monthly)) +  
 geom\_bar(stat = "identity", fill = "skyblue") +   
 labs(title = "Monthly Two-Day Maximum Precipitation, Greenville 2016",   
 x = "Month",   
 y = "Depth of Precipitation (mm)") +  
 geom\_vline(xintercept = 6.5, linetype = "dashed", color = "red", size = 1) +  
 geom\_vline(xintercept = 10.5, linetype = "dashed", color = "red", size = 1) +  
 annotate("text", x = 3, y = 150, label = "Hurricane Season", size = 3) +  
 annotate("text", x = 8.5, y = 190, label = "Frontal Season", size = 3) +  
 theme\_bw()



#Greenville, 1995  
greenville\_1995 <- greenville %>%   
 filter(year == 1995)  
  
#Calculate the moving sum  
moving\_greenville\_1995 <- rollapply(  
 greenville\_1995$Area.Weighted.Mean.Precipitation..mm.per.day., width = 2,   
 FUN = sum, fill = NA, align = "right")  
  
#Turn into a data frame  
greenville\_1995\_movingsum <- data.frame(  
 Original\_Data = greenville\_1995,  
 Moving\_Sum = moving\_greenville\_1995  
) %>%   
 filter(Moving\_Sum > 0)  
  
#Calculate two-day annual max  
greenville\_1995\_monthly <- greenville\_1995\_movingsum %>%   
 group\_by(Original\_Data.month) %>%   
 summarise(twoday\_max\_monthly = max(Moving\_Sum))  
  
#Change month to factor  
greenville\_1995\_monthly$Original\_Data.month <- factor(  
greenville\_1995\_monthly$Original\_Data.month,   
 levels = 1:12,  
 labels = month.abb)  
   
#Plot the monthly two-day max precip   
ggplot(greenville\_1995\_monthly, aes(x = Original\_Data.month, y = twoday\_max\_monthly)) +  
 geom\_bar(stat = "identity", fill = "skyblue") +   
 labs(title = "Monthly Two-Day Maximum Precipitation, Greenville 1995",   
 x = "Month",   
 y = "Depth of Precipitation (mm)") +  
 geom\_vline(xintercept = 6.5, linetype = "dashed", color = "red", size = 1) +  
 geom\_vline(xintercept = 10.5, linetype = "dashed", color = "red", size = 1) +  
 annotate("text", x = 3, y = 90, label = "Hurricane Season", size = 3) +  
 annotate("text", x = 8.5, y = 90, label = "Frontal Season", size = 3) +  
 theme\_bw()

