Boston Buoy Data Analysis

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Make URLs and read Data

Make URLs

```
url1="http://www.ndbc.noaa.gov/view_text_file.php?filename=mlrf1h"
url2=".txt.gz&dir=data/historical/stdmet/"
years=c(1987:2016)
urls=paste0(url1,years,url2)
Dnames=paste0('D',years)
```

Read the data from the URLs

```
for(i in years) assign(Dnames[i-years[1]+1],read_table2(urls[i-years[1]+1]))
coln=colnames(get(Dnames[1]))
```

Combine, clean and transfer data

Combine data

```
for(i in years){
  D=get(Dnames[i-years[1]+1])
  # From Y2000 to Y2016, delete an additional variable of 'TIDE'
  if(i %in% 2000:2016){D=select(D,-TIDE)}
  # From Y2005 to Y2016, delete an additional variable of 'mm'
  if(i %in% 2005:2016){D=select(D,-mm)}
  # From Y2007 to Y2016, delete first row of units
  if(i %in% 2007:2016){D=D[-1,]}
  # Check and unify col names and set data type as 'numeric'
  if(ncol(D)==length(coln)){colnames(D)=coln}
  D=sapply(D, as.numeric)
  # From Y1987 to Y1999, transfer the Year from 'XX' to '19XX'
  D[,1][D[,1]<100]=D[,1][D[,1]<100]+1900
  # Create and combine to form final data set Buoy
  if(i==years[1]){Buoy=D}
  else{Buoy=rbind.data.frame(Buoy,D)}
}
```

Transfer data

```
#Time transfer
Buoy$DT=make_datetime(Buoy$YY,Buoy$MM,Buoy$DD,Buoy$hh)
Buoy=Buoy[,-c(2:4)]
save(Buoy,file='Buoy.Rdata')
```

Prepare for analysis

```
load('Buoy.Rdata')
month=c('Jan','Feb','Mar','Apr','May','Jun',
        'Jul','Aug','Sep','Oct','Nov','Dec')
```

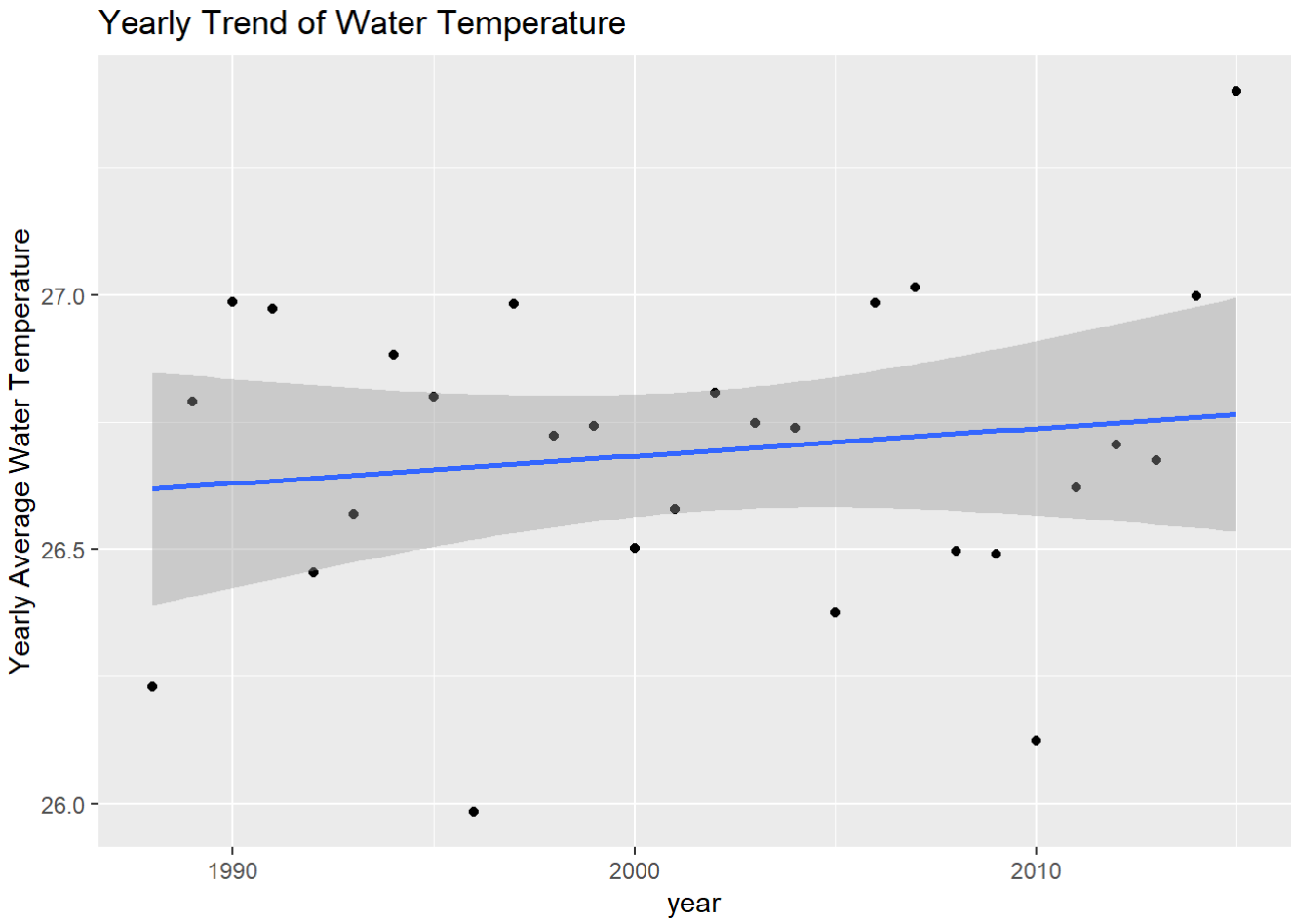
Analysis using 'Water Temperature'

Delete those lines with 999.0 and 99.0

```
Buoy_W=Buoy[Buoy$WTMP<99,]
```

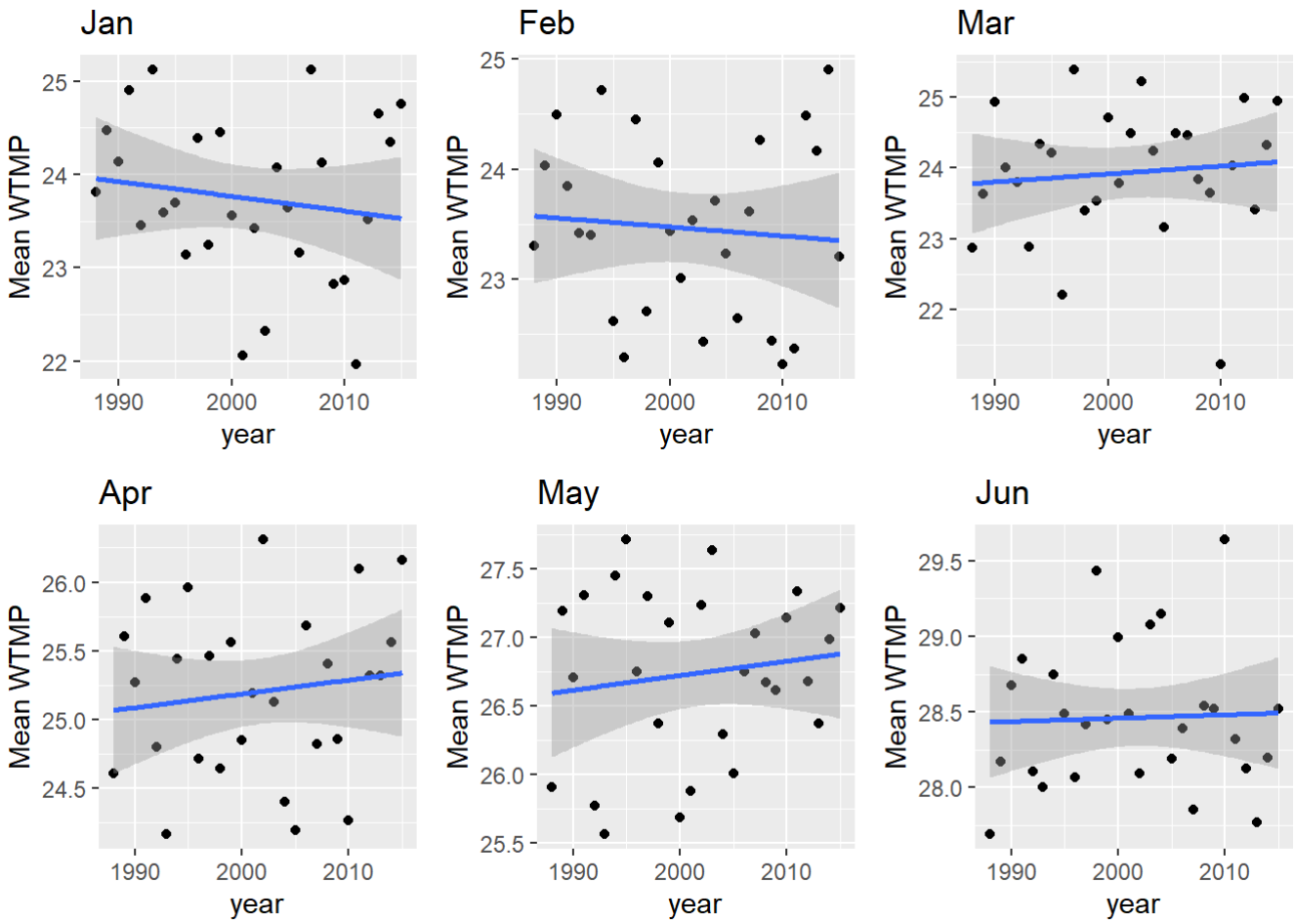
Trend of average temperature per year

```
Y_W=0
for(i in 1988:2015){
  Y_W[i-1987]=mean(Buoy_W$WTMP
                   [date(Buoy_W$DT)>=make_date(i)&
                       date(Buoy_W$DT)<make_date(i+1)]
                   )
}
D_W=data.frame(Time=1988:2015,TMP=Y_W)
P_W=ggplot(D_W,aes(Time,TMP))+
  geom_point()+
  geom_smooth(method="lm",formula=y~x)+
  labs(title='Yearly Trend of Water Temperature',
       x="year", y='Yearly Average Water Temperature')
P_W
```

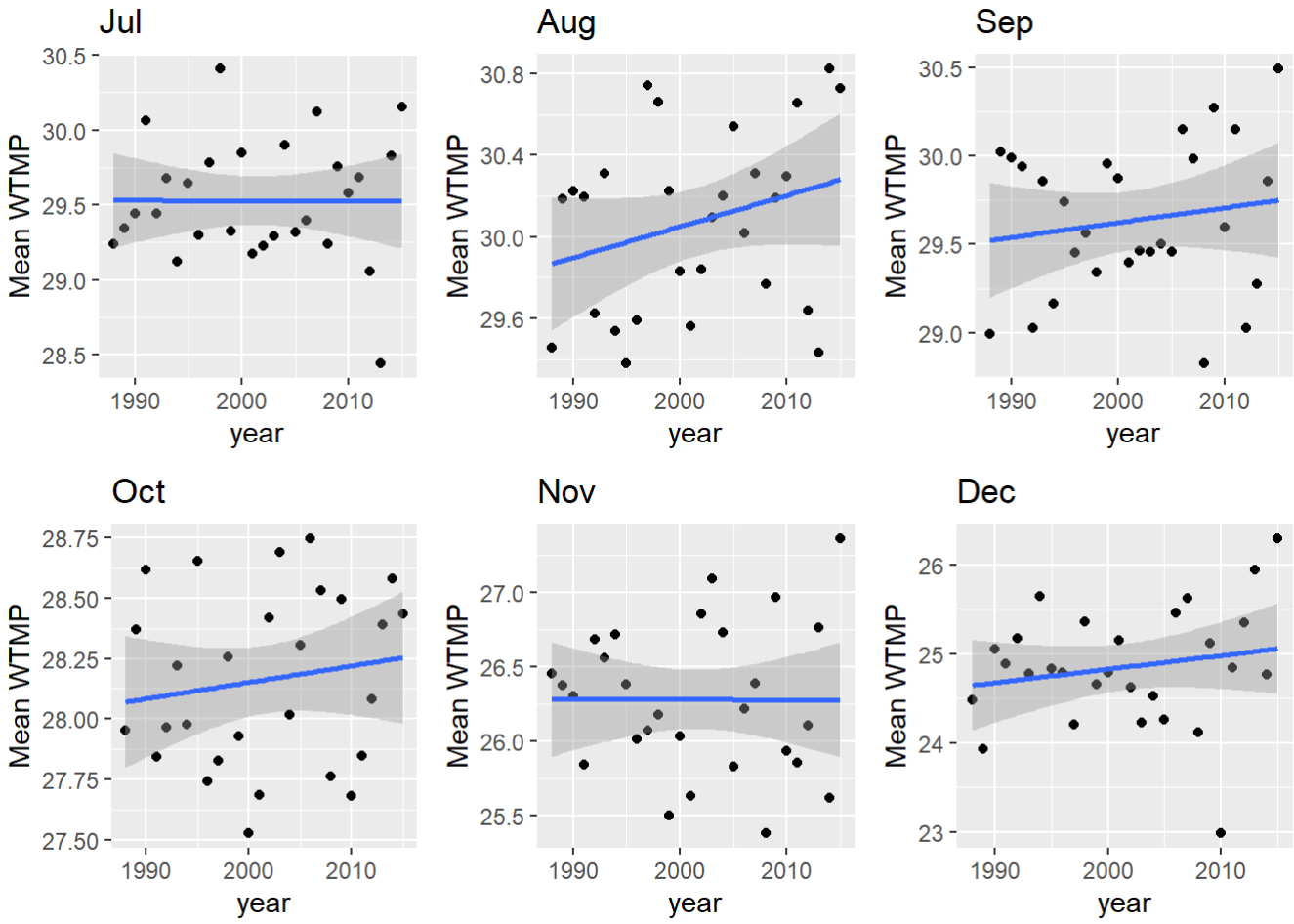


Trend of monthly average temperature per

```
M_W=0
P_WM_name=str_c('P_W',1:12,sep='')
for(j in 1:12){
  for(i in 1988:2015){
    M_W[i-1987]=mean(Buoy_W$WTMP
                     [date(Buoy_W$DT)>=
                         make_date(i,j)&
                         date(Buoy_W$DT)<
                         make_date(ifelse(j==12,i+1,i),
                                   ifelse(j==12,1,j+1))])
  }
  D_W=data.frame(Time=1988:2015,TMP=M_W)
  assign(P_WM_name[j],
         ggplot(D_W,aes(Time,TMP))+
         geom_point()+
         geom_smooth(method="lm",formula=y~x)+
         labs(title=month[j],x="year",y="Mean WTMP"))
}
ggarrange(P_W1,P_W2,P_W3,P_W4,P_W5,P_W6,ncol=3,nrow=2)
```




```
ggarrange(P_W7, P_W8, P_W9, P_W10, P_W11, P_W12, ncol=3, nrow=2)
```



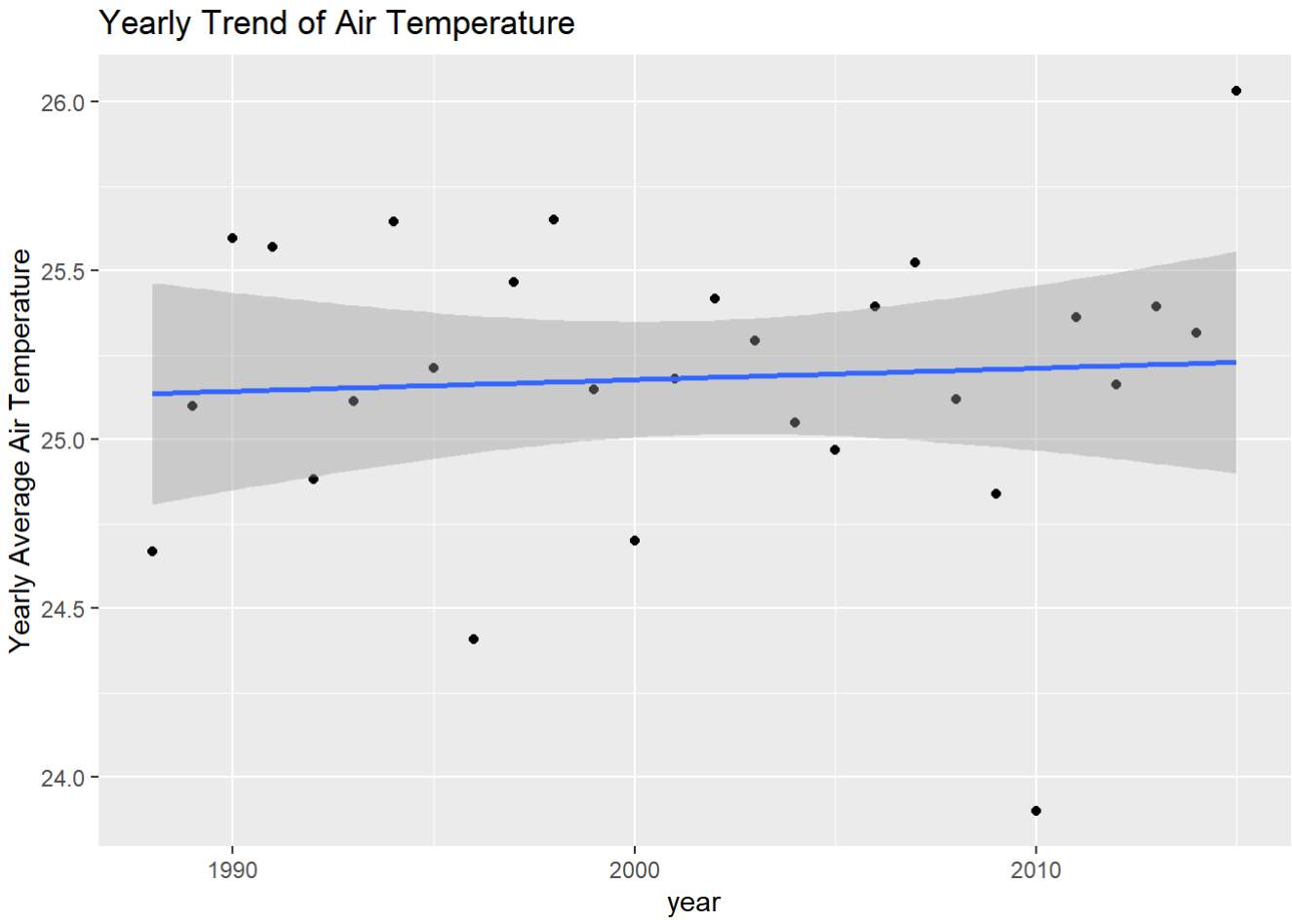
Analysis using ‘Air Temperature’

Delete those lines with 999.0 and 99.0

```
Buoy_A=Buoy[Buoy$ATMP<99,]
```

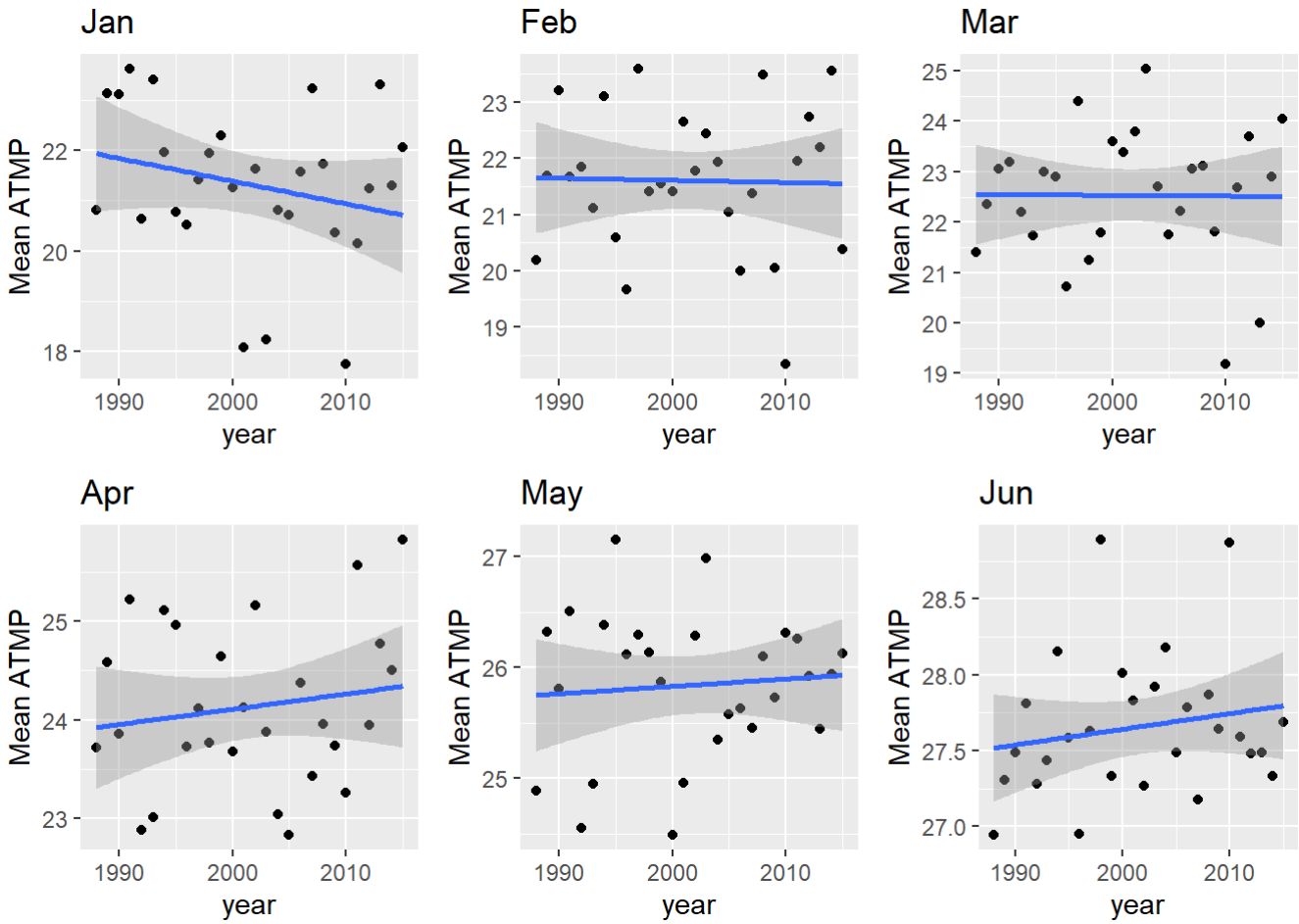
Trend of average temperature per year

```
Y_A=0
for(i in 1988:2015){
  Y_A[i-1987]=mean(Buoy_A$ATMP
                   [date(Buoy_A$DT)>=make_date(i)&
                       date(Buoy_A$DT)<make_date(i+1)])
}
D_A=data.frame(Time=1988:2015,TMP=Y_A)
P_A=ggplot(D_A,aes(Time,TMP))+
  geom_point()+
  geom_smooth(method="lm",formula=y~x)+
  labs(title='Yearly Trend of Air Temperature',
       x="year", y='Yearly Average Air Temperature')
P_A
```

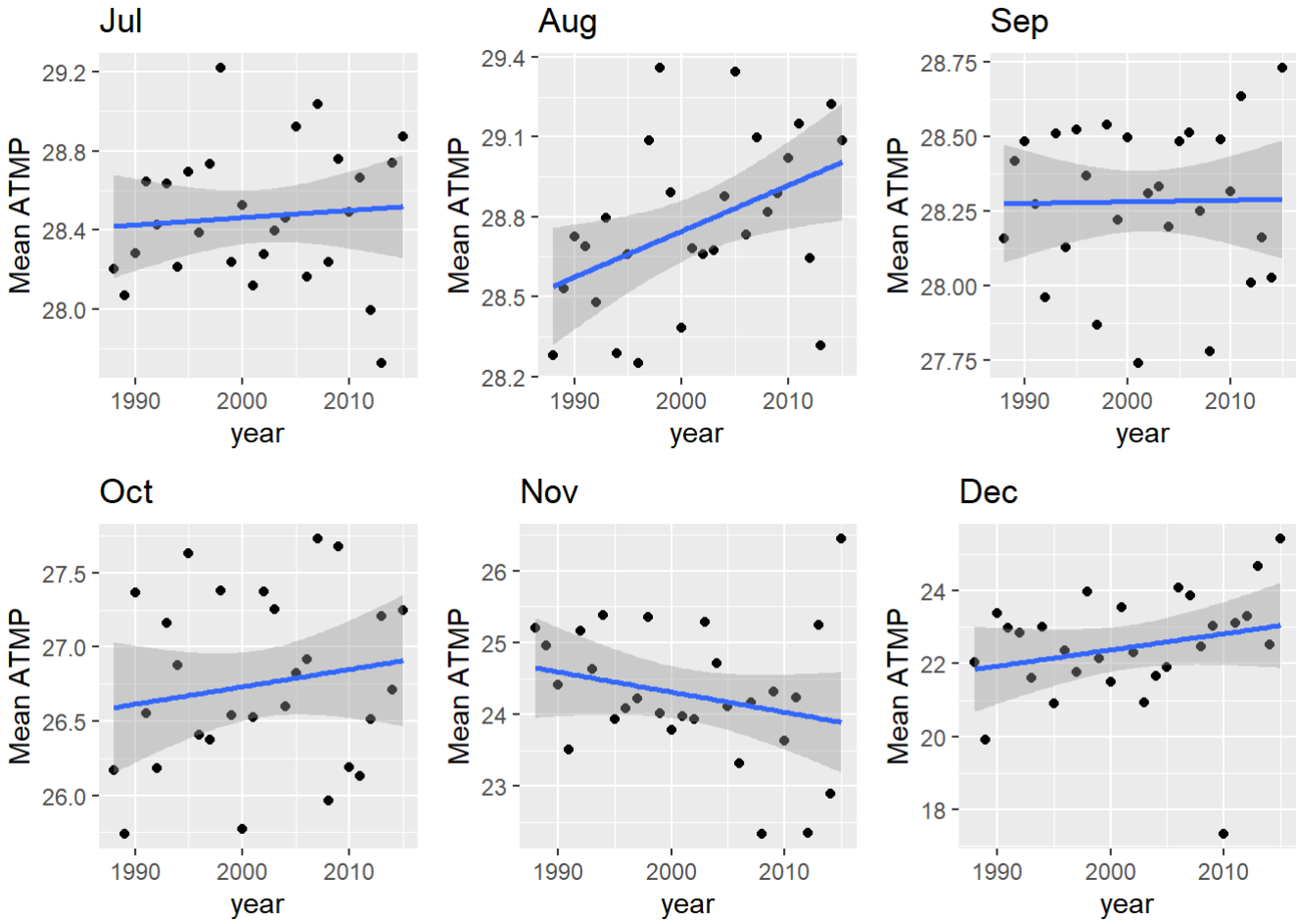


Trend of monthly average temperature per year

```
M_A=0
P_AM_name=str_c('P_A',1:12,sep='')
for(j in 1:12){
  for(i in 1988:2015){
    M_A[i-1987]=mean(Buoy_A$ATMP
                     [date(Buoy_A$DT)>=
                         make_date(i,j)&
                         date(Buoy_A$DT)<
                         make_date(ifelse(j==12,i+1,i),
                                   ifelse(j==12,1,j+1))])
  }
  D_A=data.frame(Time=1988:2015,TMP=M_A)
  assign(P_AM_name[j],
         ggplot(D_A,aes(Time,TMP))+
         geom_point()+
         geom_smooth(method="lm",formula=y~x)+
         labs(title=month[j],x="year",y="Mean ATMP"))
}
ggarrange(P_A1,P_A2,P_A3,P_A4,P_A5,P_A6,ncol=3,nrow=2)
```




```
ggarrange(P_A7,P_A8,P_A9,P_A10,P_A11,P_A12,ncol=3,nrow=2)
```



Conclusion

There is the evidence of global warming. The annually average water and air temperature are raising. 8 out of 12 months per year shows annually increases in average water and air temperature.