Assignment: Canadian Weather - PMHD - Group 6

The data

The data is loaded.

```
load("CanadianWeather.rda")
da<-CanadianWeather[[1]]
da<-da[,,"Precipitation.mm"] # precipitation data
days<-1:365
days<-(days-min(days))/(diff(range(days)))
city.names <- colnames(da)
head(da)
```

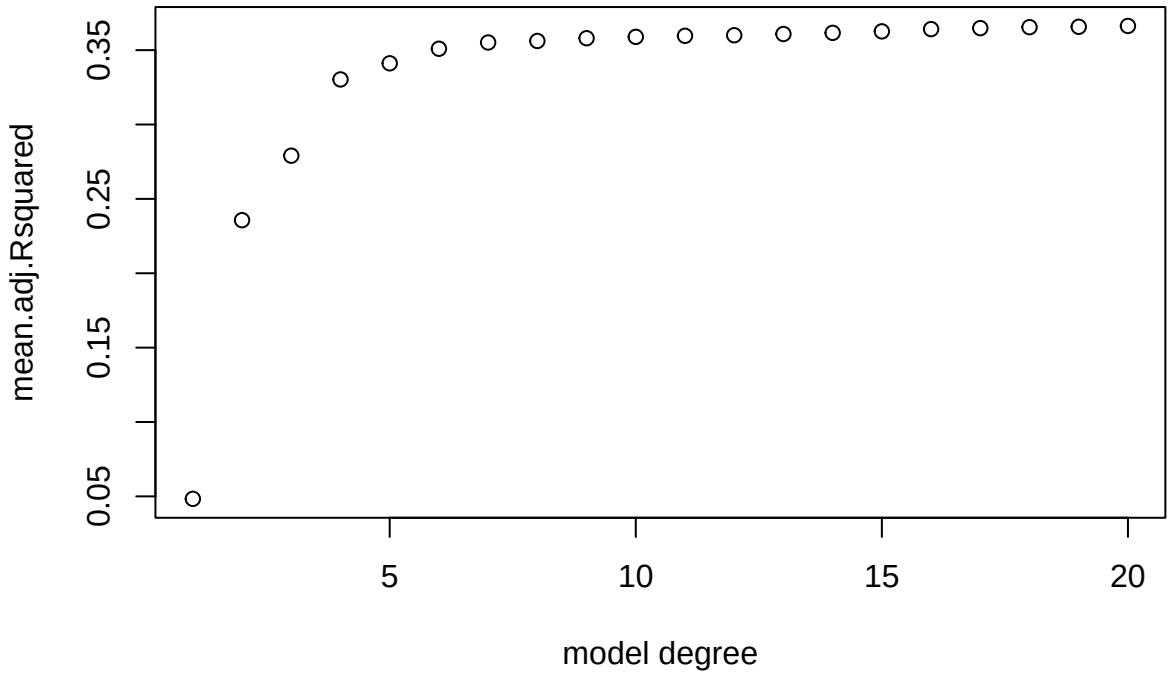
```
##       St. Johns Halifax Sydney Yarmouth Charlottvl Fredericton Scheffervll
## jan01       5.2     6.0    5.3      5.6        4.6         4.0         1.1
## jan02       5.8     5.3    5.2      3.7        4.4         3.2         1.3
## jan03       3.9     2.6    2.1      2.8        2.3         3.3         1.2
## jan04       4.3     5.3    5.0      5.3        4.8         3.3         1.3
## jan05       6.2     6.0    7.3      3.8        5.1         2.7         1.0
## jan06       3.4     2.1    2.2      2.4        1.5         0.8         1.3
##       Arvida Bagottville Quebec Sherbrooke Montreal Ottawa Toronto London
## jan01    2.6         3.0    4.1        2.9      2.9    2.5     1.8    2.4
## jan02    1.2         1.8    2.3        2.9      1.2    1.1     0.9    1.4
## jan03    2.1         1.3    2.6        1.9      1.4    1.3     0.9    1.8
## jan04    2.3         2.5    4.3        2.9      3.6    3.1     1.5    2.9
## jan05    1.7         2.1    2.3        2.1      1.6    1.3     0.8    1.1
## jan06    2.0         1.6    1.5        0.8      1.1    1.3     1.0    1.4
##       Thunder Bay Winnipeg The Pas Churchill Regina Pr. Albert Uranium City
## jan01         0.7      0.5     0.5       0.5    0.2        0.1          0.3
## jan02         1.9      0.6     0.9       0.6    0.3        0.9          0.4
## jan03         0.8      0.3     0.7       0.5    0.6        0.6          1.3
## jan04         0.3      0.5     0.5       0.4    0.3        0.3          0.6
## jan05         0.8      0.4     0.2       0.4    0.8        0.2          0.8
## jan06         1.7      0.7     0.9       0.2    0.5        0.3          1.1
##       Edmonton Calgary Kamloops Vancouver Victoria Pr. George Pr. Rupert
## jan01      0.4     0.3      0.6       5.5      5.3        2.2        6.0
## jan02      0.8     0.1      0.4       6.6      5.2        1.9        5.0
## jan03      1.1     0.3      1.2       6.8      5.4        1.9        6.7
## jan04      1.1     0.6      1.3       5.1      4.5        1.8        7.1
## jan05      1.0     1.0      1.2       3.8      4.6        1.1        6.1
## jan06      0.8     0.2      0.5       2.5      2.6        1.2        8.1
##       Whitehorse Dawson Yellowknife Iqaluit Inuvik Resolute
## jan01        0.5    0.9         0.6     1.1    0.8      0.1
## jan02        0.8    0.6         0.7     0.9    0.9      0.1
## jan03        1.1    0.8         0.3     0.8    0.8      0.0
## jan04        0.2    0.8         0.5     0.7    0.4      0.2
```

```
## jan05        0.6    1.0         0.7     0.9     0.8      0.2
## jan06        0.7    1.0         0.5     0.2     0.4      0.2
```

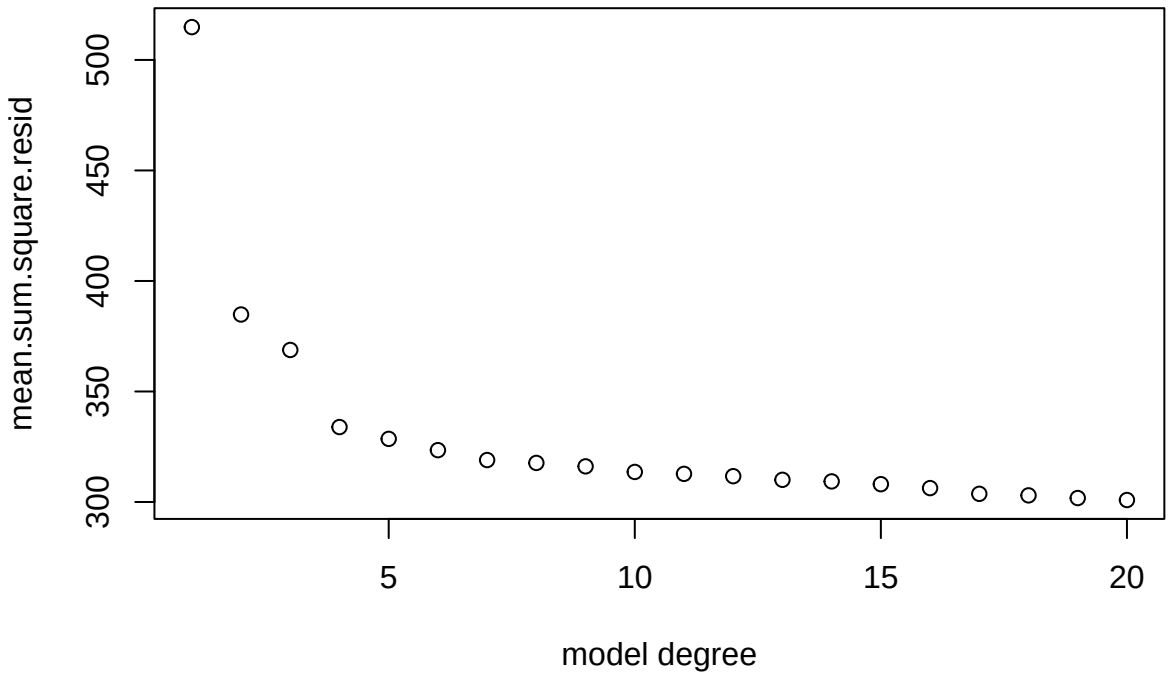
A polynomial fitting is performed. But first, the optimal degree d for the polynomial function is determined.

```
# Choose optimal m
max.d <- 20
mean.adj.Rsquared <- rep(0,max.d)
mean.sum.square.resid <- rep(0,max.d)
for (d in 1:max.d){
  cities.adj.Rsquared <- rep(0,length(city.names))
  sum.square.resid <- rep(0,length(city.names))
  phi<-poly(days,degree=d)
  for (city in 1:length(city.names)){
    m <- lm(da[,city.names[city]]~phi)
    cities.adj.Rsquared[city] <- summary(m)$adj.r.squared
    sum.square.resid[city] <- deviance(m)
  }
  mean.adj.Rsquared[d] <- mean(cities.adj.Rsquared)
  mean.sum.square.resid[d] <- mean(sum.square.resid)
}

plot(1:max.d,mean.adj.Rsquared,xlab = "model degree")
```

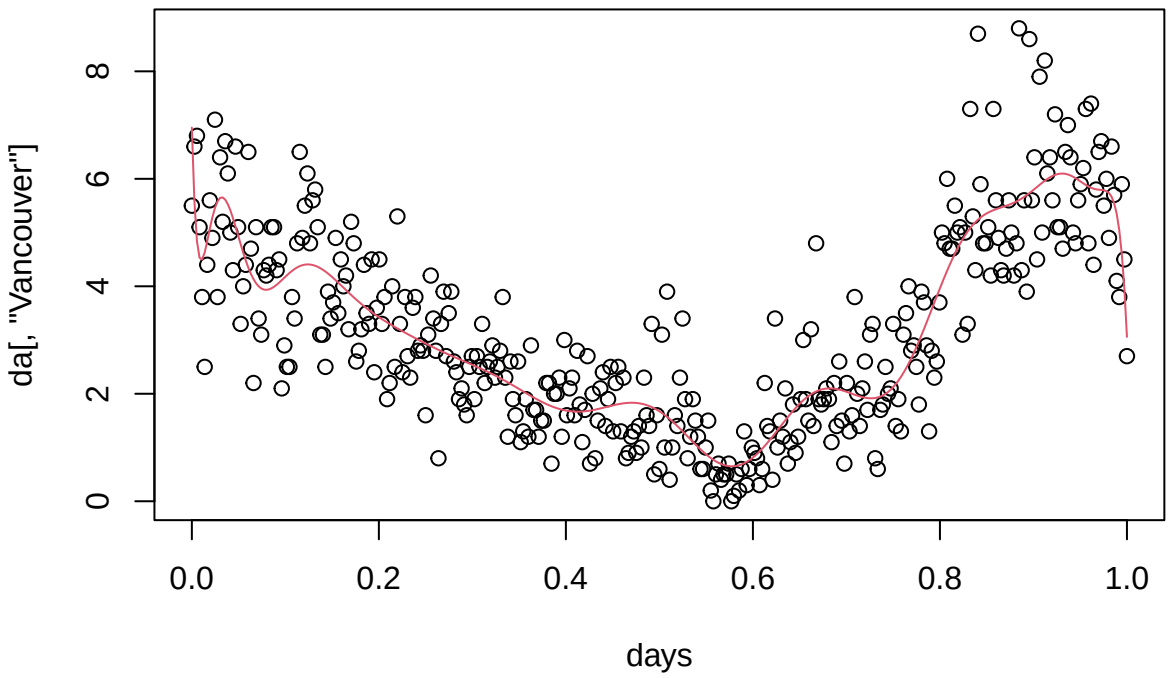


```
plot(1:max.d,mean.sum.square.resid,xlab = "model degree")
```



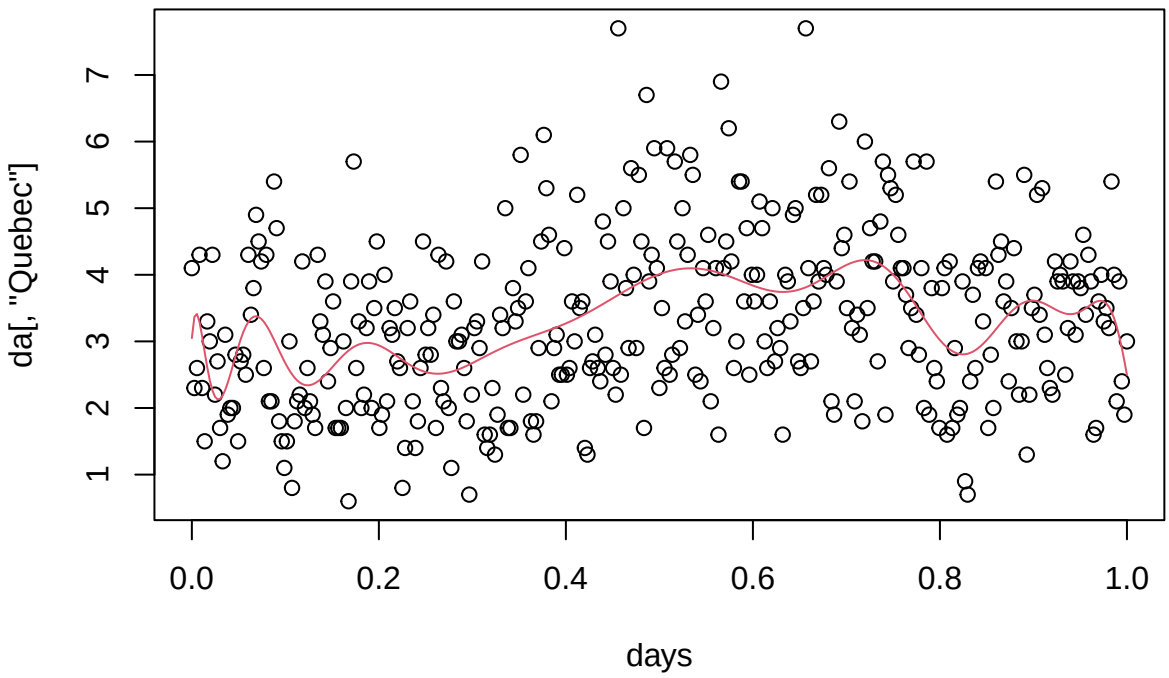
We choose to work with a degree of 5. We plot the fit for Vancouver

```
 m.Vancouver<- lm(da[,'Vancouver']~phi)
plot(days,da[,'Vancouver'])
lines(days,m.Vancouver$fitted.values,type="l", col=2)
```



and Quebec

```
 m.Quebec<- lm(da[,'Quebec']~phi)
plot(days,da[,'Quebec'])
lines(days,m.Quebec$fitted.values,type="l", col=2)
```



Then the matrix with the cities and the corresponding parameters is generated.

```
d <- 5
phi<-poly(days,degree=d)
parameters <- data.frame(matrix(0,length(city.names),d+1))
for (city in 1:length(city.names)){
  m <- lm(da[,city.names[city]]~phi)
  parameters[city,] <- m$coefficients
}
colnames(parameters)<- attr(m$coefficients, "names")
rownames(parameters)<-city.names
parameters
```

```
##              (Intercept)       phi1       phi2       phi3       phi4
## St. Johns      4.0569863  2.2288953  10.9053257 -2.3891395 -6.2302176
## Halifax        3.9863014  2.8976434  12.8613581  2.8310017 -3.1842424
## Sydney         4.0394521  3.0410601  15.2344437  2.9966536 -5.3404060
## Yarmouth       3.4589041  2.9267539  10.7152872  1.7964357 -2.0601104
## Charlottvl     3.2923288  4.6253999   6.7750350  0.7212093 -0.6081685
## Fredericton    3.0901370  3.4812455   3.3019448  0.4903060 -0.8180924
## Scheffervll    2.1950685  6.9711845  -6.6249519 -8.5835696  0.8901752
## Arvida         2.4564384  7.0505679  -5.7605540 -3.9342156  5.5516152
## Bagottville    2.5517808  6.3112292  -7.2766509 -4.4246773  5.0089138
## Quebec         3.3112329  5.7141150  -4.4837859 -3.5181070  3.3462633
## Sherbrooke     3.0391781  6.1550953  -6.3006435 -2.8096377  3.4509138
## Montreal       2.5775342  4.9373697  -2.5906299 -1.6436491  0.4532884
```

```
## Ottawa         2.5005479  4.2151695  -3.5748956  -0.6517746   0.5357917
## Toronto        2.1441096  3.9822353  -4.8799059  -0.5923539   0.3776671
## London         2.6246575  4.2772654  -1.0105323   0.2507350   0.2539975
## Thunder Bay    1.9295890  5.1496880 -11.2347219  -3.3714677   4.1401792
## Winnipeg       1.3950685  1.8360518 -13.1442874  -1.8875820   7.1235483
## The Pas        1.2304110  3.6909807  -9.9467625  -4.0657630   4.2771677
## Churchill      1.1200000  5.1087544  -6.9492345  -5.2780140   1.0864960
## Regina         1.0167123  0.5694443  -9.7918857  -0.1932783   6.5369368
## Pr. Albert     1.1139726  1.5431081 -10.3824695  -1.3446375   6.7997991
## Uranium City   0.9936986  3.1862651  -4.8324105  -4.0091722   2.1842064
## Edmonton       1.2745205  1.1305429 -12.2267111  -3.0857429   9.5222695
## Calgary        1.0972603  0.8209576 -12.6192124  -0.7115190   7.8523449
## Kamloops       0.7449315  1.9441980  -0.3536159  -0.7751786   3.6157804
## Vancouver      3.1646575  3.9234181  28.3115196   2.7690508  -6.7528795
## Victoria       2.3331507  2.6049978  28.4232708   0.7995991  -3.2480424
## Pr. George     1.6682192  3.5229243  -1.3603699  -3.8571446   3.3709507
## Pr. Rupert     7.1008219 21.0657133  30.6492594 -14.6567435 -24.8983088
## Whitehorse     0.7443836  2.8990343  -3.1579369  -3.6206515   2.5603214
## Dawson         0.8978082  3.2859663  -3.8956159  -3.3004734   3.2594136
## Yellowknife    0.7345205  3.0610301  -3.0030127  -3.6945380   0.5611231
## Iqaluit        1.1356164  3.4056376  -6.2457125  -4.7454509   1.6715828
## Inuvik         0.7126027  2.4971993  -3.1017587  -3.1791388   1.4149954
## Resolute       0.3945205  1.9424593  -3.5866789  -2.4834652   1.1092238
##                      phi5
## St. Johns     1.73316169
## Halifax      -2.38612938
## Sydney       -0.60120700
## Yarmouth     -3.28329145
## Charlottvl   -1.58467259
## Fredericton  -0.39537115
## Scheffervll   1.78738251
## Arvida        2.53235143
## Bagottville   1.89389531
## Quebec        2.05251705
## Sherbrooke    2.70985940
## Montreal      1.40517868
## Ottawa        0.94629933
## Toronto       0.60176028
## London        0.11224028
## Thunder Bay   0.41514368
## Winnipeg      0.65946104
## The Pas       1.88396201
## Churchill     1.49612094
## Regina       -0.06504242
## Pr. Albert    1.09146444
## Uranium City  1.66498277
## Edmonton      2.53308616
## Calgary       0.16612830
## Kamloops      0.14134870
## Vancouver    -6.90046271
## Victoria     -4.87567463
## Pr. George   -0.82179863
## Pr. Rupert   -5.29697611
## Whitehorse    2.18733058
```

```
## Dawson        1.30278553
## Yellowknife   1.08016645
## Iqaluit       2.48516709
## Inuvik        1.45444192
## Resolute      1.91476364
```

The MSD is performed

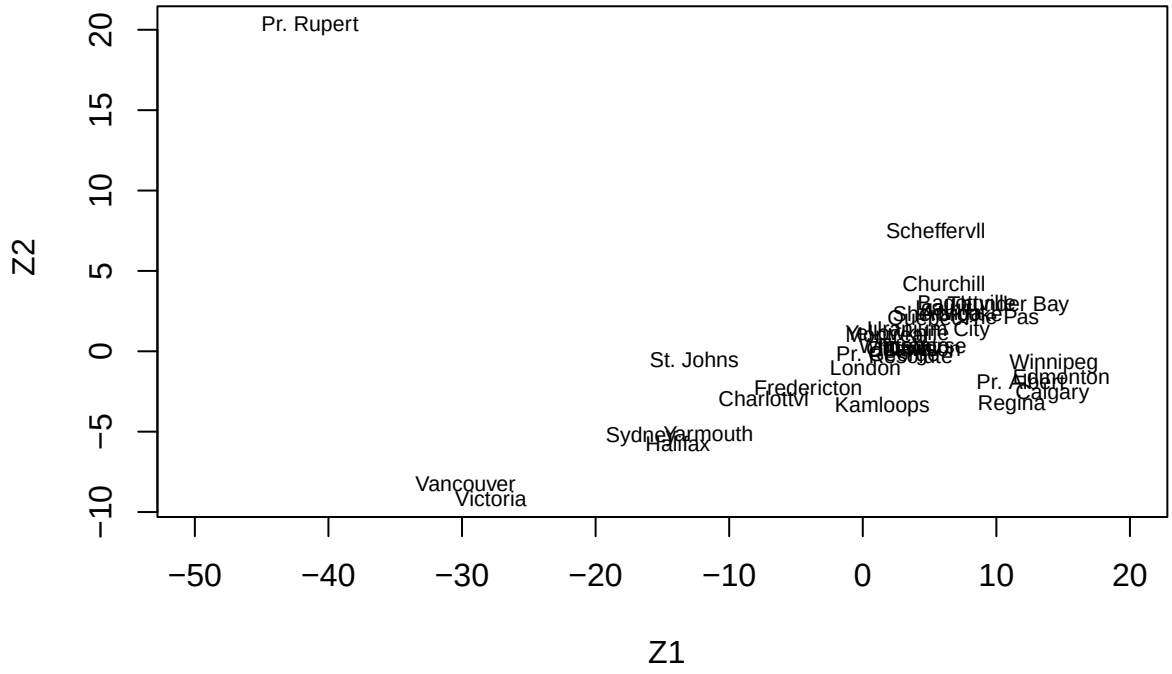
```
X<- parameters
n<- nrow (X)
H<- diag (n) -1/n* matrix (1, ncol =n, nrow =n)
X[,]<-H%*%as.matrix(X)
X.svd <- svd(X)
k <-2
Uk <-X.svd$u[ ,1:k]
Dk <- diag(X.svd$d [1:k])
Zk <-Uk%*%Dk
rownames(Zk)<- rownames(parameters)
Zk
```

```
##                    [,1]       [,2]
## St. Johns    -12.6126530 -0.5183325
## Halifax      -13.8364766 -5.7441963
## Sydney       -16.5862854 -5.2716186
## Yarmouth     -11.5566809 -5.1230364
## Charlottvl    -7.4050993 -2.9042906
## Fredericton   -4.0737941 -2.2760666
## Scheffervll    5.4710881  7.5135343
## Arvida         6.6630066  2.4326017
## Bagottville    7.7779374  2.9118066
## Quebec         4.6477291  2.0572829
## Sherbrooke     6.3564824  2.3404643
## Montreal       1.8169194  1.0622277
## Ottawa         2.7419480  0.1984213
## Toronto        3.8382898  0.3830722
## London         0.2025078 -0.9778655
## Thunder Bay   10.8901030  2.8225512
## Winnipeg      14.2989203 -0.7968765
## The Pas       10.2737290  2.1353320
## Churchill      6.0838442  4.2492354
## Regina        11.1527286 -3.3300729
## Pr. Albert    11.8375133 -1.8803467
## Uranium City   4.9291339  1.3234047
## Edmonton      14.8687194 -1.5415568
## Calgary       14.2017420 -2.6489771
## Kamloops       1.4700080 -3.4294471
## Vancouver    -29.7344245 -8.2229819
## Victoria     -27.8291228 -9.1314619
## Pr. George     1.8744790 -0.2319936
## Pr. Rupert   -41.3730097 20.2855864
## Whitehorse     3.7317165  0.3375690
## Dawson         4.4768856  0.1641284
## Yellowknife    2.5842603  1.1929133
## Iqaluit        6.0602546  2.6120506
```

```
## Inuvik          3.1484893  0.2380721
## Resolute        3.6091107 -0.2311331
```

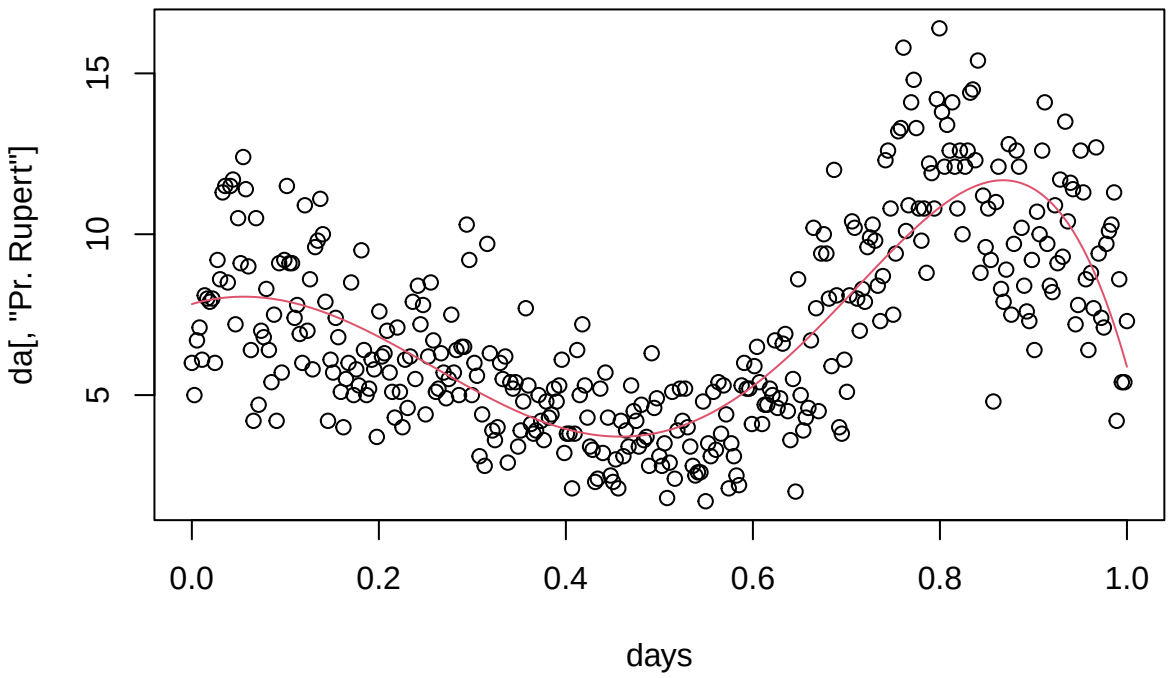
And we plot the data

```
plot (Zk , type ="n", xlab =" Z1", ylab =" Z2",xlim=c(-50,20))
text (Zk , rownames (Zk),cex =0.7,)
```



Plotting for Pr Rupert

```
m.PrRupert<- lm(da[,'Pr. Rupert']~phi)
plot(days,da[,'Pr. Rupert'])
lines(days,m.PrRupert$fitted.values,type="l", col=2)
```


da[, "Pr. Rupert"]
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0
days