1. For this bit of question, we are given temperature data observed for more than 150 years. The file is given in *.txt* format; for ease of use in Matlab, I have converted the file to *.xlsx* or *.csv* format. Here as the question states, it is expected to find the general trend over these years.

1.1 For this bit of question, it is expected to fit a linear model using maximum temperature and time span and another curve for minimum temperature and time span. After fitting obtained results and used codes are attached below.

Matlab Code -

```
M = csvread('climate-csv-data set - Sheet1.csv',1,1);
%% tmin and time series plot
tempmin = zeros(167,1);
years = zeros(167,1);
for i = 1:167
   a = 0;
   for j = 1:12
       b = M((12*(i-1))+j,3);
       a = b+a;
   end
   tempmin(i) = a/12;
   years(i) =1853+i-1;
end
%% fitting the line among the mean of max temp over all years
x = years;
y = tempmin;
b = [ones(size(x,1),1) x]\y;
RegressionLine = [ones(size(x,1),1) x]*b;
SS_X = sum((RegressionLine-mean(RegressionLine)).^2);
SS_Y = sum((y-mean(y)).^2);
SS_XY = sum((RegressionLine-mean(RegressionLine)).*(y-mean(y)));
R_squared = SS_XY/sqrt(SS_X*SS_Y);
fprintf('R2: %0.2f\n',R_squared)
%ploting
subplot(2,1,1);
plot(years, tempmin, '*','displayname','min tempetature scatter')
xlabel('years');
ylabel('average of min temperature')
title('plot mean of min temperature over all years')


% Plot it in the scatter plot and show equation.
hold on,
plot(x,RegressionLine,'displayname',sprintf('Regression line (y = %0.2f*x +
%0.2f)',b(2),b(1)))
legend('location','nw')
```

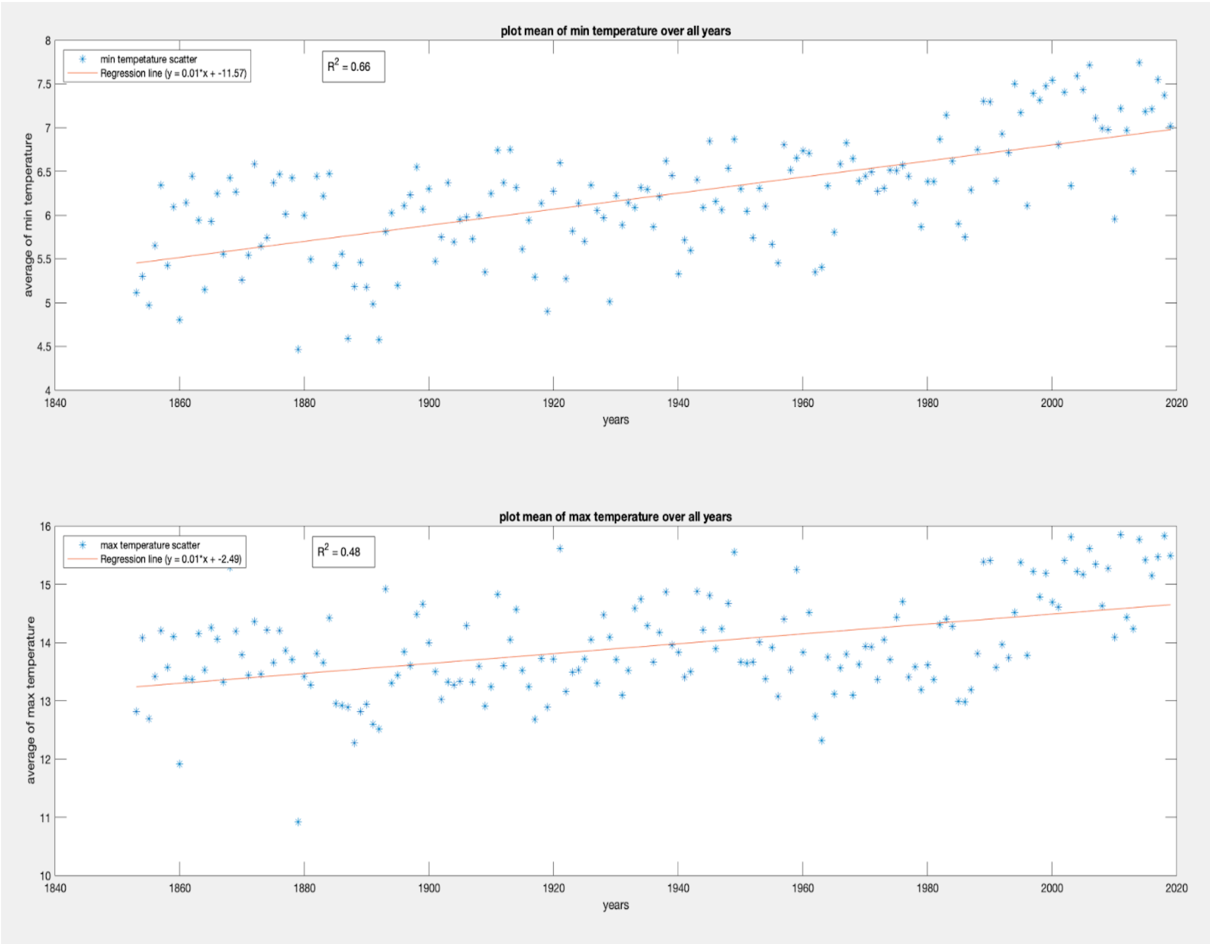
```
%% doing same thing for maximum temperature
tempmax = zeros(167,1);
for i = 1:167
   a = 0;
   for j = 1:12
       b = M((12*(i-1))+j,2);
       a = b+a;
   end
   tempmax(i) = a/12;
end
x = years;
y = tempmax;
b = [ones(size(x,1),1) x]\y;
RegressionLine = [ones(size(x,1),1) x]*b;
SS_X = sum((RegressionLine-mean(RegressionLine)).^2);
SS_Y = sum((y-mean(y)).^2);
SS_XY = sum((RegressionLine-mean(RegressionLine)).*(y-mean(y)));
R_squared = SS_XY/sqrt(SS_X*SS_Y);
fprintf('R2: %0.2f\n',R_squared)
%ploting
subplot(2,1,2);
plot(years, tempmax, '*','displayname','max temperature scatter')
xlabel('years');
ylabel('average of max temperature')
title('plot mean of max temperature over all years')


% Plot it in the scatter plot and show equation.
hold on,
plot(x,RegressionLine,'displayname',sprintf('Regression line (y = %0.2f*x +
%0.2f)',b(2),b(1)))
legend('location','nw')
```

Results obtained -

for minimum temperature, $y = 0.00918x + 5.4$

for maximum temperature, $y = 0.0084x + 13.5$

Matlab plot -



Plot of min, max temperature over time

Xlabel - Year

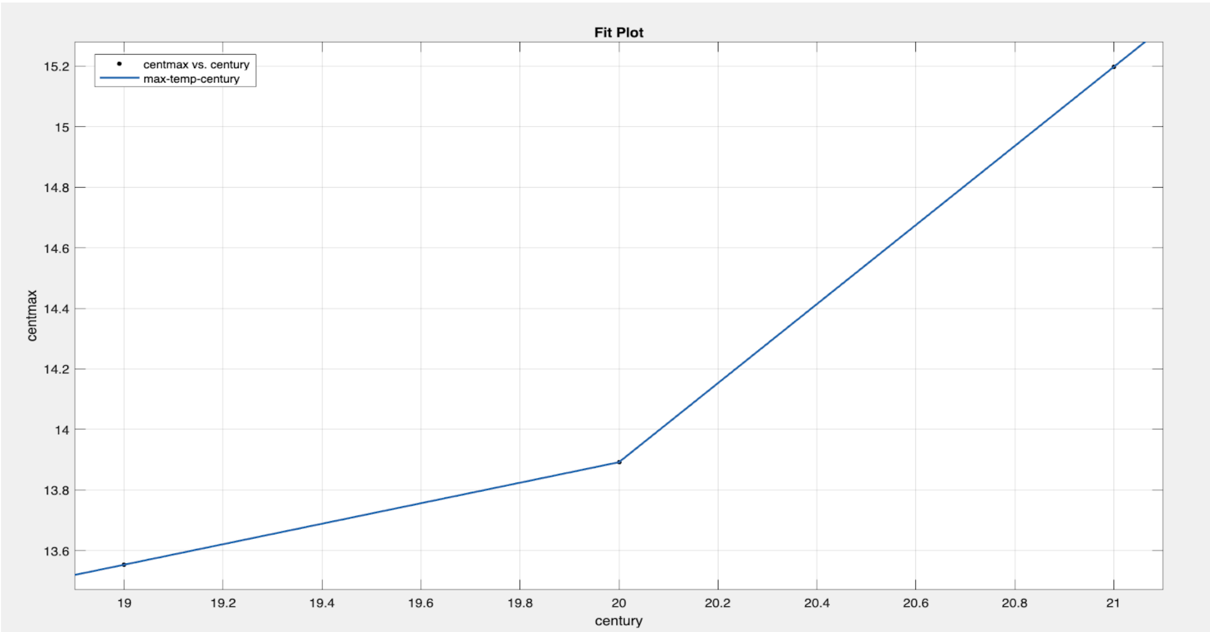
Ylabel - Min, Max temperature

For Century average plot - I have separately considered all three-century average over 18th century, 19th century and 20th century. Matlab code and Matlab plot are attached below

Matlab code -

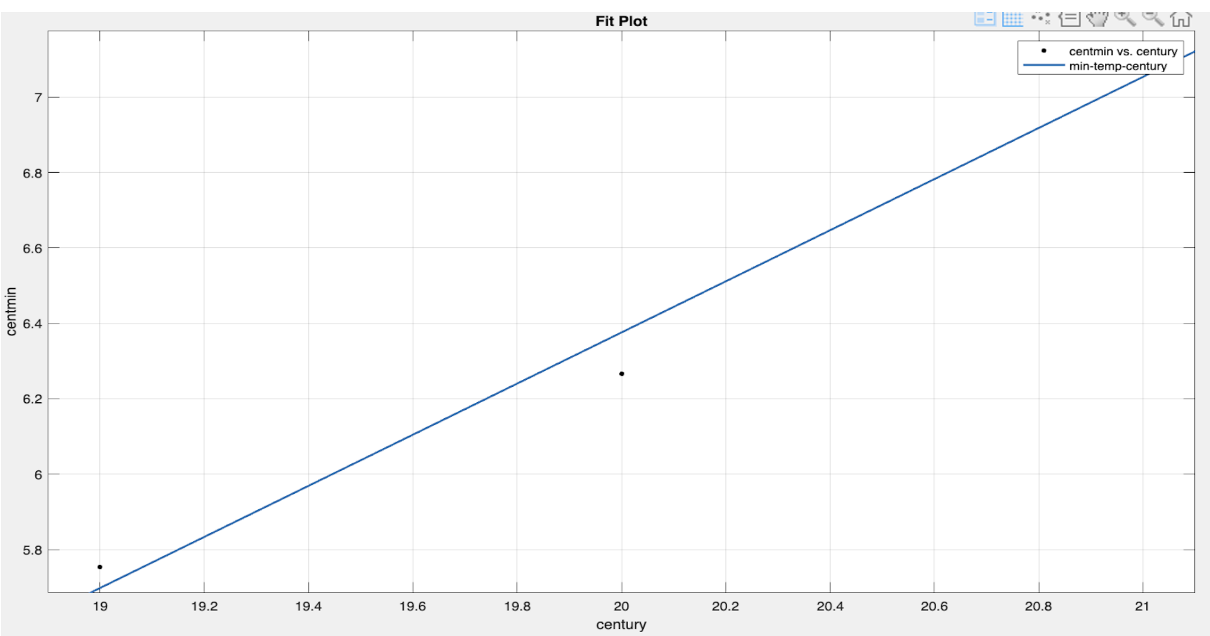
```
%% finding century avg from our data;
a = 0;
idxa = 0;
b = 0;
idxb = 0;
c = 0;
idxc = 0;
```

```
for i = 1:2004
   d = SimT1Q12S1{i,1};
   if d <1901
       a = a + SimT1Q12S1{i,4};
       idxa = idxa+1;
   elseif d>1900 && d<2001
       b = b+SimT1Q12S1{i,4};
       idxb =idxb+1;
   else
       c = c+SimT1Q12S1{i,4};
       idxc = idxc+1;
   end
end
%% calculating century avg
a = a/idxa;
b = b/idxb;
c = c/idxc;
%% ploting century avg line for tmax
centmax = zeros(3,1);
centmax(1) = a;
centmax(2) = b;
centmax(3) = c;
century = zeros(3,1);
century(1) = 19;
century(2) = 20;
century(3) = 21;
%% tmin treand calculations for
a = 0;
b = 0;
c = 0;
for i = 1:2004
   d = SimT1Q12S1{i,1};
   if d <1901
       a = a + SimT1Q12S1{i,5};
   elseif d>1900 && d<2001
       b = b+SimT1Q12S1{i,5};
   else
       c = c+SimT1Q12S1{i,5};
   end
end
a = a/idxa;
b = b/idxb;
c = c/idxc;
centmin = zeros(3,1);
centmin(1) = a;
centmin(2) = b;
centmin(3) = c;
```



Average plot of max temperatures and century

SSE: 0.156, R-square: 0.8966, Adjusted R-square: 0.7932, RMSE: 0.395



Average plot of min temperatures and century

SSE: 0.01829, R-square: 0.9805, Adjusted R-square: 0.9609, RMSE: 0.1352

1.2 For this bit of question we are expected to fit a model that accounts the seasonal variations also. The equations given are as -

$$y = \beta_o + \beta_1 cos\left(\frac{2\Pi t}{12}\right) + \beta_2 sin\left(\frac{2\Pi t}{12}\right) + \beta_3 t$$

code used for fitting the data are inserted below -

For maximum temperature and time -

```
%% here we are calculating for max temp
%1st and then we will be calculating for min temp trend over all seasons
%%
x = SimT1Q1S1{:,"time"};
y = SimT1Q1S1{:,"tmax"};
ft = fittype(' b0+b1*cos((2*pi)*(x)/12)+b2*sin((2*pi)*(x))+b3*(x)',...
   'dependent',{'y'},'independent',{'x'},...
   'coefficients',{'b0','b1','b2','b3'});
f = fit(x,y,ft)
plot(f,x,y,'O')
xlabel('time');
ylabel('max temperature')
title('linear model accounting seasonal effects.')
```

For minimum temperature and time -

```
%% seasonal linear plotting for min temperature
x = SimT1Q1S1{:,"time"};
y = SimT1Q1S1{:,"tmin"};
ft = fittype(' b0+b1*cos((2*pi)*(x)/12)+b2*sin((2*pi)*(x))+b3*(x)',...
   'dependent',{'y'},'independent',{'x'},...
   'coefficients',{'b0','b1','b2','b3'});
f = fit(x,y,ft)
plot(f,x,y,'O')
xlabel('time');
ylabel('min temperature scatter')
title('linear model accounting seasonal effects for min temp.')
```

Results obtained are attached below -

For maximum temperature

curve fitted for max temperature and seasonal variations

```
f =

     General model:
     f(x) = b0+b1*cos((2*pi)*(x)/12)+b2*sin((2*pi)*(x))+b3*(x)
     Coefficients (with 95% confidence bounds):
       b0 =       13.21
       b1 =      -6.361
       b2 =      0.7655
       b3 =    0.000729  (0.0004662, 0.0009919)
>>
```

Seasonal variation fitted curve result

For minimum temperature -

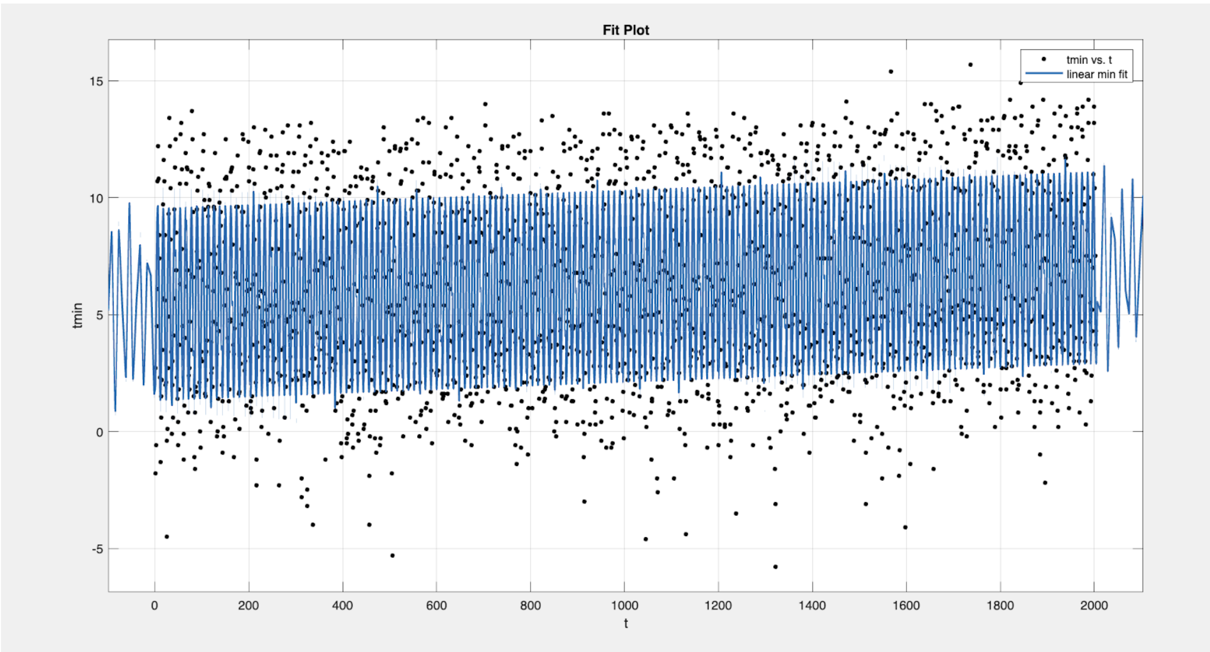
curve fitted for minimum temperature

```
Warning: Start point not provided,
choosing random start point.

f =

     General model:
     f(x) = b0+b1*cos((2*pi)*(x)/12)+b2*sin((2*pi)*(x))+b3*(x)
     Coefficients (with 95% confidence bounds):
       b0 =       5.428
       b1 =      -4.093
       b2 =      0.5853
       b3 =   0.0007842  (0.0005547, 0.001014)
>> |
```

Seasonal variation fitted curve result

By curve fit tool -

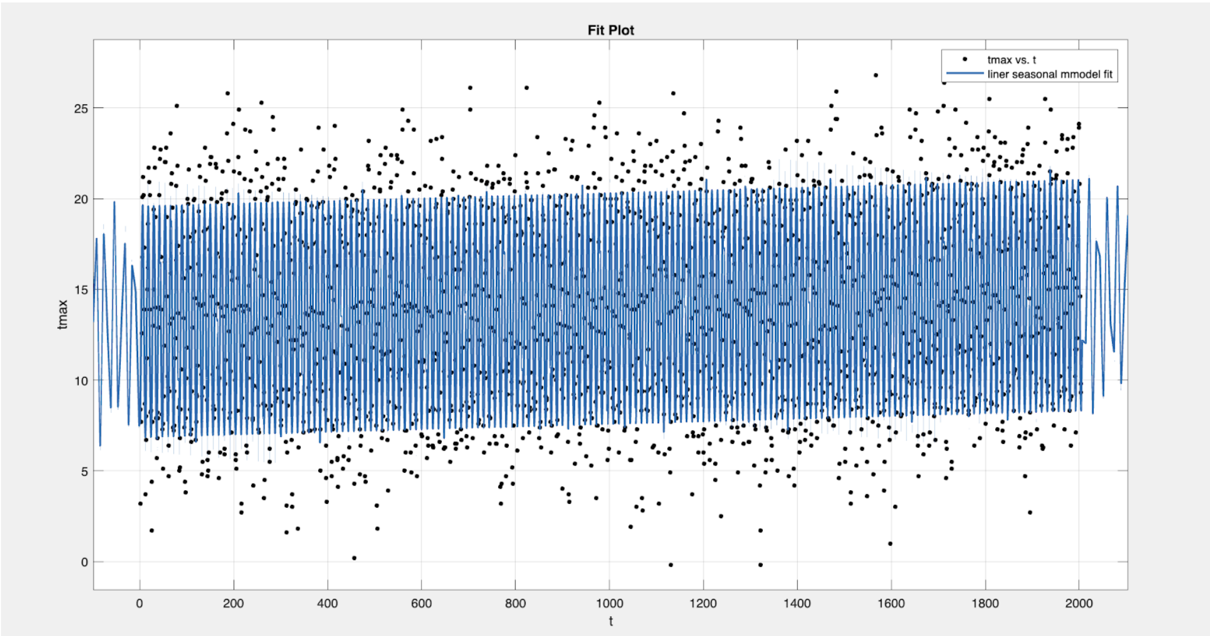
For maximum temperatur -



General model:
f(x) = b0+b1*cos((2*pi)*(x)/12)+b2*sin((2*pi)*(x))+b3*(x)
Coefficients (with 95% confidence bounds):
b0 = 5.428
b1 = -4.093
b2 = 0.6491
b3 = 0.0007842 (0.0005547, 0.001014)

Goodness of fit:
SSE: 1.834e+04
R-square: 0.4839
Adjusted R-square: 0.4831
RMSE: 3.028

For minimum Temperature -



General model:

f(x) = b0+b1*cos((2*pi)*(x)/12)+b2*sin((2*pi)*(x))+b3*(x)

Coefficients (with 95% confidence bounds):

b0 = 13.21

b1 = -6.361

b2 = 0.6491

b3 = 0.000729 (0.0004662, 0.0009919)

Goodness of fit:

SSE: 2.406e+04

R-square: 0.6295

Adjusted R-square: 0.629

RMSE: 3.469

2. For this bit of question we are given a data set of cyclone, cyclone parameters are maximum wind velocity V_{max}, radius of maximum wind R_{max}, central pressure P_c. Similar to 1st question here data set given in format *.txt* format, for ease of use i have changed the format to *.xlsx* .

2.1 In this bit of question, it is expected to fit a linear model and derive an empirical equation between (R_{max} and V_{max}) and another one similarly between (P_c and V_{max})

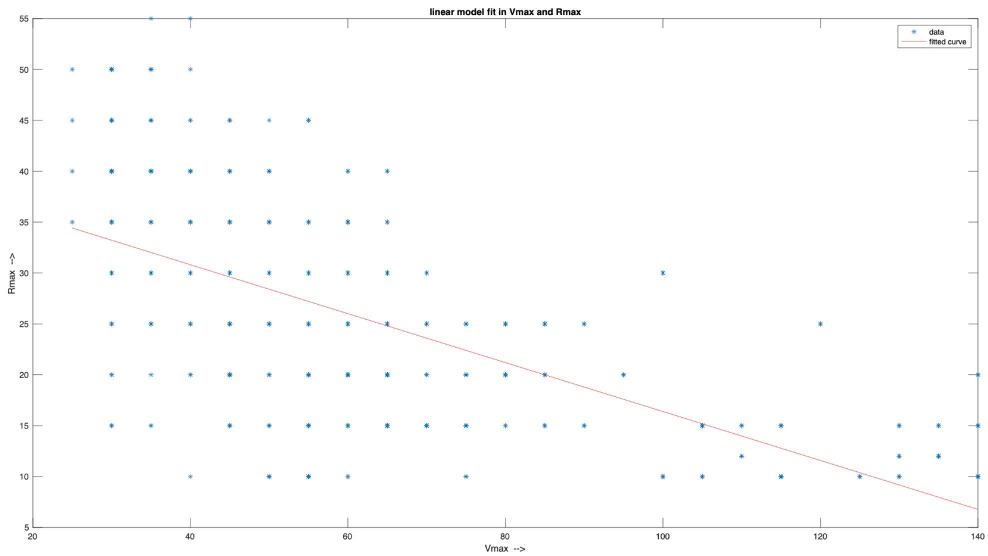
Between R_{max} and V_{max} -

Matlab code -

```
%% fitting Rmax and Vmax
clc
y = cyclone{:,"Rmax"};
x = cyclone{:,"Vmax"};
myfittype = fittype('a0 + a1*x',...
   'dependent',{'y'},'independent',{'x'},...
   'coefficients',{'a0','a1'})
myfit = fit(x,y,myfittype)
plot(myfit,x,y)
xlabel('Vmax  -->')
ylabel('Rmax  -->')
title('linear model fit in Vmax and Rmax')
```

Results obtained -

```
myfittype =

     General model:
     myfittype(a0,a1,x) = a0 + a1*x
Warning: Start point not provided, choosing
random start point.
> In curvefit.attention/Warning/throw (line 30)
In fit>iFit (line 307)
In fit (line 116)
In cyclone1a (line 7)

myfit =

     General model:
     myfit(x) = a0 + a1*x
     Coefficients (with 95% confidence bounds):
       a0 =       40.43  (38.99, 41.87)
       a1 =     -0.2404  (-0.2618, -0.219)
```



plotting between R_{max} and V_{max}

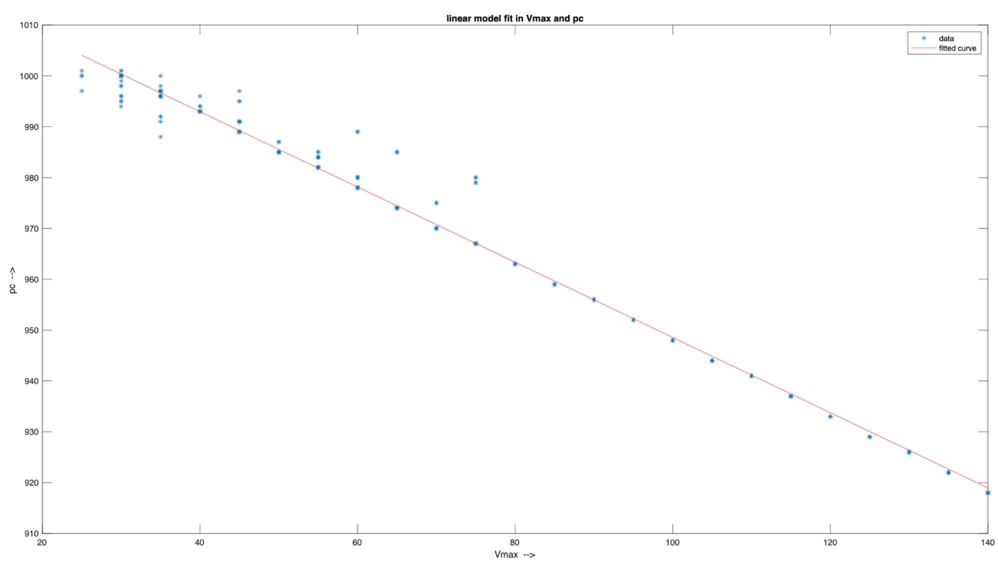
Between P_c and V_{max} -

Matlab code -

```
%% fitting pc and Vmax
clc
y = cyclone{:,"Pc"};
x = cyclone{:,"Vmax"};
myfittype = fittype('a0 + a1*x',...
   'dependent',{'y'},'independent',{'x'},...
   'coefficients',{'a0','a1'})
myfit = fit(x,y,myfittype)
plot(myfit,x,y)
xlabel('Vmax  -->')
ylabel('pc  -->')
title('linear model fit in Vmax an
```

Results obtained -

```
myfittype =

     General model:
     myfittype(a0,a1,x) = a0 + a1*x
Warning: Start point not provided, choosing
random start point.

myfit =

     General model:
     myfit(x) = a0 + a1*x
     Coefficients (with 95% confidence bounds):
       a0 =        1023  (1022, 1023)
       a1 =     -0.7398  (-0.745, -0.7347)
>>
```



plotting between P_c and V_{max}