



Fig.1 CO₂ ppmv values, monthly and detrended from march,1958 (left). Detrended from january,2015 and the same interpolated.Last value march,2021

Monthly amount of atmospheric CO₂ since March 1958 is regularly measured at the [Mauna Loa Observatory](https://www.esrl.noaa.gov/gmd/mauna_loa/), Hawaii. Data are reported as a dry mole fraction defined as the number of molecules of carbon dioxide divided by the number of molecules of dry air (water vapour removed), multiplied by one million (ppm).

The comprehensive monthly data are plotted in fig.1 left, indicating an apparent exponential rise from 316 ppm of 1958. Black monthly values (column 4, see below) and red de-seasonalized data(column 5, see below). The last six years interpolation of the de-seasonalized data shows a parabola with a downward opening. This is why the second degree coefficient is negative. This indicates a decrease in the slope of the Mauna Loa curve in the last six years.

First step is the download of the data into a local file (the name is 'co2_mm_mlo.txt' or whatever you prefer)

```
f = urlwrite('https://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/co2/co2_mm_mlo.txt', 'co2_mm_mlo.txt')
```

Once the file is downloaded the above instruction is no more needed, unless a new version is available (normally in the first days of each month). In the Octave here below is transformed into a comment by preceding the line with '%'.
Data are preceded by useful informations, that the user should read.
Data section is dived in 8 columns, respectively :
1 = year, 2= month, 3= decimal date, 4= monthly average, 5= de-seasonalized, 6= number of days per month
7 = standard deviantion of days, 8 = uncertantity of mothly mean.

Data from March 1958 through April 1974 were obtained by C. David Keeling of the Scripps Institution of Oceanography (SIO) and they do not contain 7,8 values. Monthly mean CO2 is constructed from daily mean values. In order to obtain fig.1, we use in the script only column 3,4,5.

The file 'co2_mm_mlo.txt' is stored in a character string with the instruction **fileread**. The data are preceded by comments, so we have to find data start and end using **index**. Two data starts are here selected, namely 1958,march (that corresponds to the beginning of records) and january,2015. The procedure happens therefore twice; a new character string 'M' is extracted and then transformed in a numeric matrix 'X' by the function **str2num()**. Of the matrix 'X' we use the third column (decimal date), the fourth (monthly averaged data) and the fifth (same data as fouth, but de-seasonalized). **xYear** vector contains the decimal year format, **y** and **yd** store the CO2 concentration data. In fig. 1(a) the monthly and de-seasonalized data are shown. In fig.1(b) some more data elaboration is done, in order to calculate the trend from 2015 until do-day, using de-seasonalized data. The two mighty functions **polyfit()** and **polyval()** do the job of interpolate the points. The first function requires x,y vectors and a degree for the polynomial (in this case 2, but it can be varied), the second calculates the polynomial values according to abscissa xYear and the coefficients stored in vector **p**.

As it can be seen from the negative sign of the second order coefficient, the parabola is downward opening, indicating a decrease in the rate of increment of the CO2 concentration(fig.1).

clear;clc;format short;format compact;

```
% f = urlwrite('https://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/co2/co2_mm_mlo.txt','co2_mm_mlo.txt')
S = fileread('co2_mm_mlo.txt');           % co2_mm_mlo.txt is the file 'as downloaded' from web site
a1 = index(S,' 1958   3');                % find data start, whole set
a2 = index(S,' 2015');                    % find data start, from january,2015
% from march,1958
M = S(a1:end);                           % M is a 'reduced' string only containing data
X = str2num(M);                           % the row vector is converted into a proper matrix
xYear = X(':',3);                         % decimal date
y = X(':',4);                             % monthly average ppmv CO2 in dry air
yd = X(':',5);                            % de-seasonalized data
subplot(1,2,1);plot(xYear,y,'k',xYear,yd,'r');grid on;grid minor on;
axis([1957,2024,300,430]);xlabel('Year');ylabel('ppmv CO2');
legend('measured','de-seasonalized','location','northwest');
title('Mauna Loa Observatory CO2 data');
% from january,2015
```

```
M = S(a2:end); % M is a 'reduced' string only containing data
X = str2num(M); % the row vector is converted into a proper matrix
xYear = X(':',3); % decimal date
yd = X(':',5); % de-seasonalized data
p = polyfit(xYear,yd,2) % displays the coefficients of parabole starting from x^2, then x and const
x = (2015:1/12:2023);
y = polyval(p,x);
subplot(1,2,2);plot(x,y,'r','LineWidth',2,xYear,yd,'k');grid on;grid minor on;
axis([2014,2024,395,425]);xlabel('Year');ylabel('ppmv CO2');
legend('de-seasonalized','parabolic trend','location','northwest');
title(['parabola : ',num2str(p(1),'%.2f'),' x^2 ',num2str(p(2),'%.2f'),' x ',num2str(p(3),'%.2f')]);
```