clear

close all

clc

[data txt raw] = xlsread('lab3\_data.xlsx');

date = data(:,1);

ubctanom = data(:,2); % Celsius, UBC temp anomaly

gtanom = data(:,3); % Celsiu, global temp anomaly

TSI = data(:,4); % W/m^2, solar irradiance at top of atmosphere

AOD = data(:,5); % Aerosol Optical Depth

CO2 = data(:,6); % ppm, atmospheric CO2 concentration

SO2 = data(:,7); % Tg/year, anthropogenic SO2 emissions

MEI = data(:,8); % Multivariate El Nino Index

%% Part 1: Plot each time series and linear regression of Temp Series

figure('pos',[30 30 900 600])

subplot(421)

plot(date,ubctanom,'k'); hold on

xlabel('Date'); ylabel({'Temp ' ,'Anomaly ({\circ}C)'})

title({'UBC Temperature Anomaly' ,'from 1959-2016'})

axis([1955,2018,-5,6])

mubc = ~isnan(ubctanom);

[coef,bint,r,rint,stats] = ...

regress(ubctanom,[ones(size(ubctanom)) date]);

ubctanomlinfit = coef(1)+coef(2).\*date;

ubctanomlinfitbotlim = coef(1)+bint(2,1).\*date;

ubctanomlinfittoplim = coef(1)+bint(2,2).\*date;

plot(date(mubc),ubctanomlinfit(mubc),'r'); hold on

% plot(date(mubc),ubctanomlinfitbotlim(mubc),'r--'); hold on

% plot(date(mubc),ubctanomlinfittoplim(mubc),'r--'); hold on

text(1956,5.2,['Slope = ',num2str(round(coef(2),3)),...

'; R^2=',num2str(round(stats(1),3))...

'; conf = [' num2str(round(bint(2,1),3)) ','...

num2str(round(bint(2,2),3)) ']'])

subplot(422)

plot(date,gtanom,'k'); hold on

xlabel('Date'); ylabel({'Temp ' ,'Anomaly (C^{\circ})'})

title({'Global Temperature Anomaly' ,' from 1950-2016'})

axis([1950,2018,-1,1.5])

mgt = ~isnan(gtanom);

clear bint

[coef,bint,r,rint,stats] = ...

regress(gtanom,[ones(size(gtanom)),date]);

gtanomlinfit = coef(1)+coef(2).\*date;

gtanomlinfitbotlim = coef(1)+bint(2,1).\*date;

gtanomlinfittoplim = coef(1)+bint(2,2).\*date;

plot(date,gtanomlinfit,'r--'); hold on

% plot(date,gtanomlinfitbotlim,'r--'); hold on

% plot(date,gtanomlinfittoplim,'r--'); hold on

text(1951,1.2,['Slope = ',num2str(round(coef(2),3)),...

'; R^2=',num2str(round(stats(1),3))...

'; conf = [' num2str(round(bint(2,1),3)) ','...

num2str(round(bint(2,2),3)) ']'])

subplot(423)

plot(date,TSI,'r'); xlabel('Date');

ylabel({'Total Solar ' ,'Irradiance (W/m^2)'})

title({'Total Solar ' ,'Irradiance from 1950-2016'})

subplot(424)

plot(date,AOD,'b'); xlabel('Date');

ylabel('AOD')

title({'Aerosol Optical' ,' Depth from 1950-2016'})

subplot(425)

plot(date,CO2,'r'); xlabel('Date');

ylabel('CO\_2 (ppm)')

title({'Atmospheric CO2 ' ,'from 1950-2016'})

subplot(426)

plot(date,SO2,'b'); xlabel('Date');

ylabel('SO\_2 (Tg/year)')

title({'Anthropogenic Atmospheric ' ,'SO\_2 from 1950-2016'})

subplot(427)

plot(date,MEI,'g'); xlabel('Date');

ylabel('MEI')

title({'Multivariate El Niño' ,' Index from 1950-2016'})

% Histogram Plots

m1 = date <= 1985;

m2 = date > 1985;

numbins = 40;

figure(2)

subplot(211)

histogram(ubctanom(m1),linspace(min(ubctanom),max(ubctanom),numbins),...

'normalization','probability'); hold on

xlabel('Temp Anomaly ({\circ}C)'); ylabel('Count per bin')

title(['Histogram of UBC Temperature Anomalies, binsize = ',...

num2str(numbins)])

histogram(ubctanom(m2),linspace(min(ubctanom),max(ubctanom),numbins),...

'normalization','probability');

legend('<1985','>1985')

subplot(212)

histogram(gtanom(m1),linspace(min(gtanom),max(gtanom),numbins),...

'normalization','probability'); hold on

xlabel('Temp Anomaly ({\circ}C)'); ylabel('Count per bin')

title(['Histogram of Global Temperature Anomalies, binsize = ',...

num2str(numbins)])

histogram(gtanom(m2),linspace(min(gtanom),max(gtanom),numbins),...

'normalization','probability');

legend('<=1985','>1985')

%% Part 2: Decadal Timescale Trends

Table1Global=zeros(7,4);

%columns 1,2,3,4,5 are decade (start year), slope,CI(min),CI(max) respectively

figure(3)

n = 1;

for i = 1960:10:2020

subplot(4,2,n)

mMEIandganom = date>=i-10 & date<i;

[coef,bint,r,rint,stats] = ...

regress(gtanom(mMEIandganom),[ones(size(gtanom(mMEIandganom))),date(mMEIandganom)]);

gtanomlinfit = coef(1)+coef(2).\*date(mMEIandganom);

plot(date(mMEIandganom),gtanom(mMEIandganom),'k-'); hold on

plot(date(mMEIandganom),gtanomlinfit,'r-'); hold on

text(i-10,max(gtanom(mMEIandganom)),['Slope = ',num2str(round(coef(2),3)),...

' {\circ}C/yr; R^2=',num2str(round(stats(1),3))...

'; 95% conf = [' num2str(round(bint(2,1),3)) ','...

num2str(round(bint(2,2),3)) ']'])

xlabel('Date'); ylabel('Temp Anomaly ({\circ}C)')

title(['Global Temp Anomaly for ' num2str(i-10) '-' num2str(i)])

Table1Global(n,1)=i-10;

Table1Global(n,2)=coef(2);

Table1Global(n,3)=bint(2,1);

Table1Global(n,4)=bint(2,2);

n = n+1;

end

Table1UBC=zeros(7,4);

%columns 1,2,3,4,5 are decade (start year), slope,CI(min),CI(max) respectively

figure(4)

n = 1;

for i = 1960:10:2020

subplot(4,2,n)

mMEIandganom = date>=i-10 & date<i;

[coef,bint,r,rint,stats] = ...

regress(ubctanom(mMEIandganom),[ones(size(ubctanom(mMEIandganom))),date(mMEIandganom)]);

ubctanomlinfit = coef(1)+coef(2).\*date(mMEIandganom);

plot(date(mMEIandganom),ubctanom(mMEIandganom),'k-'); hold on

plot(date(mMEIandganom),ubctanomlinfit,'r-'); hold on

text(i-10,max(ubctanom(mMEIandganom)),['Slope = ',num2str(round(coef(2),3)),...

' {\circ}C/yr; R^2=',num2str(round(stats(1),3))...

'; 95% conf = [' num2str(round(bint(2,1),3)) ','...

num2str(round(bint(2,2),3)) ']'])

xlabel('Date'); ylabel('Temp Anomaly ({\circ}C)')

title(['UBC Temp Anomaly for ' num2str(i-10) '-' num2str(i)])

Table1UBC(n,1)=i-10;

Table1UBC(n,2)=coef(2);

Table1UBC(n,3)=bint(2,1);

Table1UBC(n,4)=bint(2,2);

n = n+1;

end

%% Part 3: Local vs. Global Temp

figure(5)

plot(gtanom,ubctanom,'k.'); hold on

xlabel('UBC Temp ({\circ}C)'); ylabel('Global Temp ({\circ}C)')

mMEIandganom = isnan(ubctanom) | isnan(gtanom);

[R,p] = corrcoef(ubctanom(~mMEIandganom),gtanom(~mMEIandganom));

[coef,bint,r,rint,stats] = regress(ubctanom(~mMEIandganom),[ones(size(gtanom(~mMEIandganom))) gtanom(~mMEIandganom)]);

R1 = stats(1)^2; p1 = stats(3);

text(-0.4,-5,['Correlation Coefficient = ' num2str(R(2,1)) '; p-value = ' num2str(p(2,1))]);

%% Part 4: Impact of specific forcingon global temperature anomaly

AllForcingsMatrix=[TSI,AOD,CO2,SO2,MEI];

Table2SimpleLinear = zeros(5,4);

%rows 1,2,3,4,5 are TSI,AOD,CO2,SO2,MEI respectively

%columns 1,2,3,4 are slope, CI,CI,coeffecient of determination respectively

n = 1;

for forcing = AllForcingsMatrix

mindependentForcing = isnan(forcing) | isnan(gtanom);

[coef,bint,r,rint,stats] = regress(gtanom(~mindependentForcing),[ones(size(forcing(~mindependentForcing))) forcing(~mindependentForcing)]);

Table2SimpleLinear(n,1)= coef(2);

Table2SimpleLinear(n,2)=bint(2,1);

Table2SimpleLinear(n,3)=bint(2,2);

Table2SimpleLinear(n,4)=stats(1);

n=n+1;

end

figure(6)

subplot(2,1,1)

mMEIandganom = ~(isnan(MEI) | isnan(gtanom));

hold on

plot(MEI(mMEIandganom),gtanom(mMEIandganom),'k.');

xlabel('MEI');

ylabel('Global Temp Anomaly({\circ}C)');

title('Global Temp Anomaly VS MEI');

clear bint

[coef,bint,r,rint,stats] = regress(gtanom(mMEIandganom),[ones(size(gtanom(mMEIandganom))),MEI(mMEIandganom)]);

glMEIlinfit = coef(1)+coef(2).\*MEI(mMEIandganom);

glMEIlinfitbotlim = coef(1)+bint(2,1).\*MEI(mMEIandganom);

glMEIlinfittoplim = coef(1)+bint(2,2).\*MEI(mMEIandganom);

plot(MEI(mMEIandganom),glMEIlinfit,'r--');

%plot(MEI(mMEIandganom),glMEIlinfitbotlim,'b--'); hold on

%plot(MEI(mMEIandganom),glMEIlinfittoplim,'r--'); hold on

axis([-2.5,3.5,-0.7,1.3])

text(-2.4,1,['Slope = ',num2str(round(coef(2),3))])

hold off

subplot(2,1,2)

mMEIandubcanom = ~(isnan(MEI) | isnan(ubctanom));

hold on

plot(MEI(mMEIandubcanom),ubctanom(mMEIandubcanom),'k.');

xlabel('MEI');

ylabel('UBC Temp Anomaly({\circ}C)');

title('UBC Temp Anomaly VS MEI');

clear bint

clear coef

[coef,bint,r,rint,stats] = regress(ubctanom(mMEIandubcanom),[ones(size(ubctanom(mMEIandubcanom))),MEI(mMEIandubcanom)]);

UBCMEIlinfit = coef(1)+coef(2).\*MEI(mMEIandubcanom);

UBCMEIlinfitbotlim = coef(1)+bint(2,1).\*MEI(mMEIandubcanom);

UBCMEIlinfittoplim = coef(1)+bint(2,2).\*MEI(mMEIandubcanom);

plot(MEI(mMEIandubcanom),UBCMEIlinfit,'r--');

%plot(MEI(mMEIandubcanom),UBCMEIlinfitbotlim,'b--'); hold on

%plot(MEI(mMEIandubcanom),UBCMEIlinfittoplim,'r--'); hold on

axis([-2.2,3.2,-6,6])

text(-2.1,5,['Slope = ',num2str(round(coef(2),3))])

hold off

%% Part 5: Combined impacts of multipleforcingon global temperature anomaly

%MULTILINEAR REGRESSION

Table2Multi = zeros(7,3);

clear bint

clear coef

%rows 2,3,4,5,6 are TSI,AOD,CO2,SO2,MEI respectively

%row 1 is y intercept

%row 7 is R^2

%columns 1,2,3 are slope, CI,CI respectively

all\_forcings\_mask = ~(isnan(AOD) |isnan(CO2) |isnan(SO2) |isnan(MEI) |isnan(TSI) | isnan(gtanom));

bigX=[ones(size(TSI(all\_forcings\_mask))) TSI(all\_forcings\_mask) AOD(all\_forcings\_mask) CO2(all\_forcings\_mask) SO2(all\_forcings\_mask) MEI(all\_forcings\_mask) ];

[coef,bint,r,rint,stats] = regress(gtanom(all\_forcings\_mask),bigX);

Table2Multi(1,1)=coef(1);

Table2Multi(2,1)=coef(2);

Table2Multi(3,1)=coef(3);

Table2Multi(4,1)=coef(4);

Table2Multi(5,1)=coef(5);

Table2Multi(6,1)=coef(6);

Table2Multi(1,2)=bint(1,1);

Table2Multi(1,3)=bint(1,2);

Table2Multi(2,2)=bint(2,1);

Table2Multi(2,3)=bint(2,2);

Table2Multi(3,2)=bint(3,1);

Table2Multi(3,3)=bint(3,2);

Table2Multi(4,2)=bint(4,1);

Table2Multi(4,3)=bint(4,2);

Table2Multi(5,2)=bint(5,1);

Table2Multi(5,3)=bint(5,2);

Table2Multi(6,2)=bint(6,1);

Table2Multi(6,3)=bint(6,2);

Table2Multi(7,1)=stats(1);

TpredAllForcings = bigX\*coef;

[coef,bint,r,rint,stats] = regress(gtanom,[ones(size(gtanom)),TpredAllForcings]);

figure(7)

plot(TpredAllForcings,gtanom,'b.','MarkerSize',8);

hold on

plot(gtanom,gtanom,'r--','LineWidth',3);

title('Observed temp VS predicted temp');

xlabel('Predicted temp ({\circ}C)');

ylabel('Observed temp ({\circ}C)');

text(-0.3,1,['Coeff of determination = ',num2str(stats(1))]);

hold off

%% Part 6: What can we conclude?

dummyData = xlsread('dummyvariables\_lab3.xlsx');

donaldAge=dummyData(:,1);

trunacatedCO2=dummyData(:,3);

trunacatedTemp=dummyData(:,4);

completeCO2=dummyData(:,5);

completeTemp=dummyData(:,6);

mask = ~(isnan(donaldAge)|isnan(gtanom));

[R,p]=corrcoef(donaldAge(mask),gtanom(mask));

figure(8)

plot(donaldAge(mask),gtanom(mask));

title("Global mean temp anomaly VS Donald Trump's age");

xlabel("Donald Trump's age (years)");

ylabel('Global Temp Anomaly({\circ}C)');

text(1,1.1,['Correlation Coefficient = ' num2str(R(2,1)) '; p-value = ' num2str(p(2,1))]);

mask = ~(isnan(trunacatedCO2)|isnan(trunacatedTemp));

[coef,bint,r,rint,stats] = regress(trunacatedCO2(mask),[ones(size(trunacatedCO2(mask))),trunacatedTemp(mask)]);

figure

subplot(211)

hold on

plot(trunacatedTemp(mask),trunacatedCO2(mask), 'r.', 'Markersize', 10);

title("Trunacated CO2 VS Trunacated Temp");

ylabel("CO2 (ppm)");

xlabel('Global Temp Anomaly({\circ}C)');

text(-1.9,450,['R^2 = ' num2str(stats(1)) '; p-value = ' num2str(stats(3))]);

fit = coef(1)+coef(2).\*trunacatedTemp(mask);

plot(trunacatedTemp(mask),fit);

axis([-2,4,250,500]);

%y=mx+b, so x=(y-b)/m

subplot(212)

hold on

plot(completeCO2, completeTemp, 'r.', 'Markersize', 10);

title("Complete CO2 VS Complete Temp");

xlabel("CO2 (ppm)");

ylabel('Global Temp Anomaly({\circ}C)');

%text(-1.9,450,['R^2 = ' num2str(stats(1)) '; p-value = ' num2str(stats(3))]);

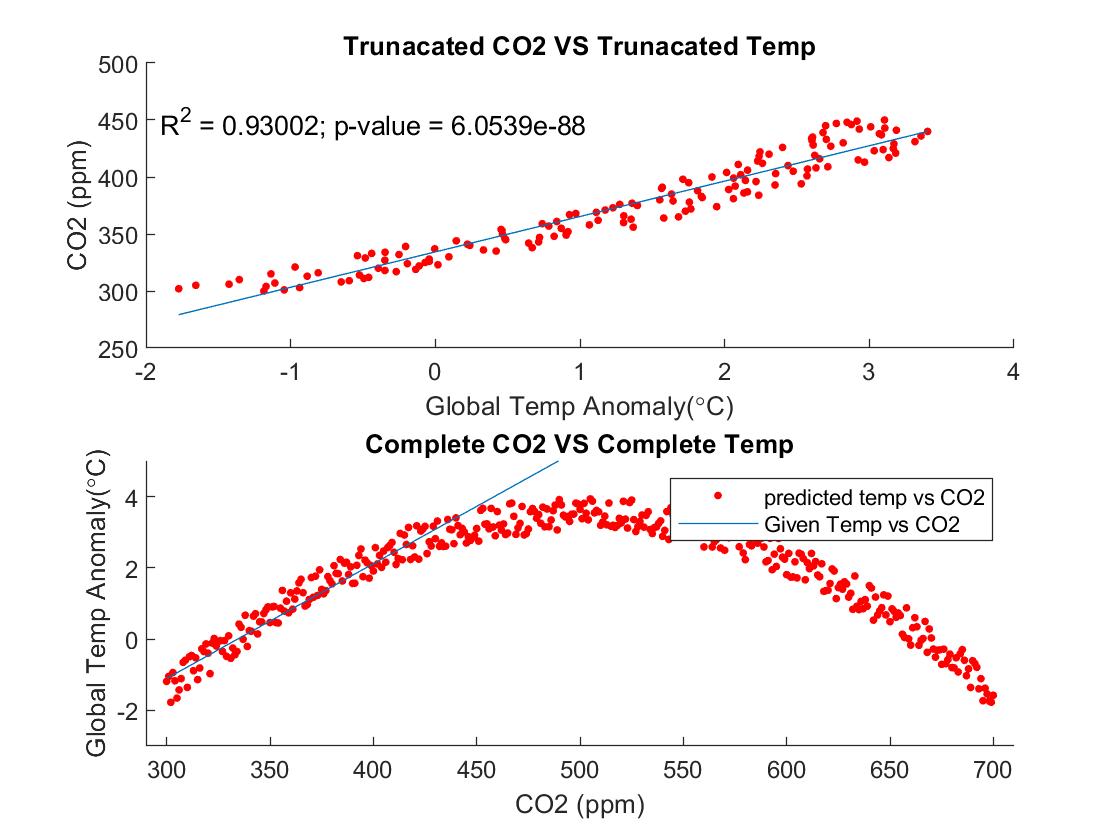
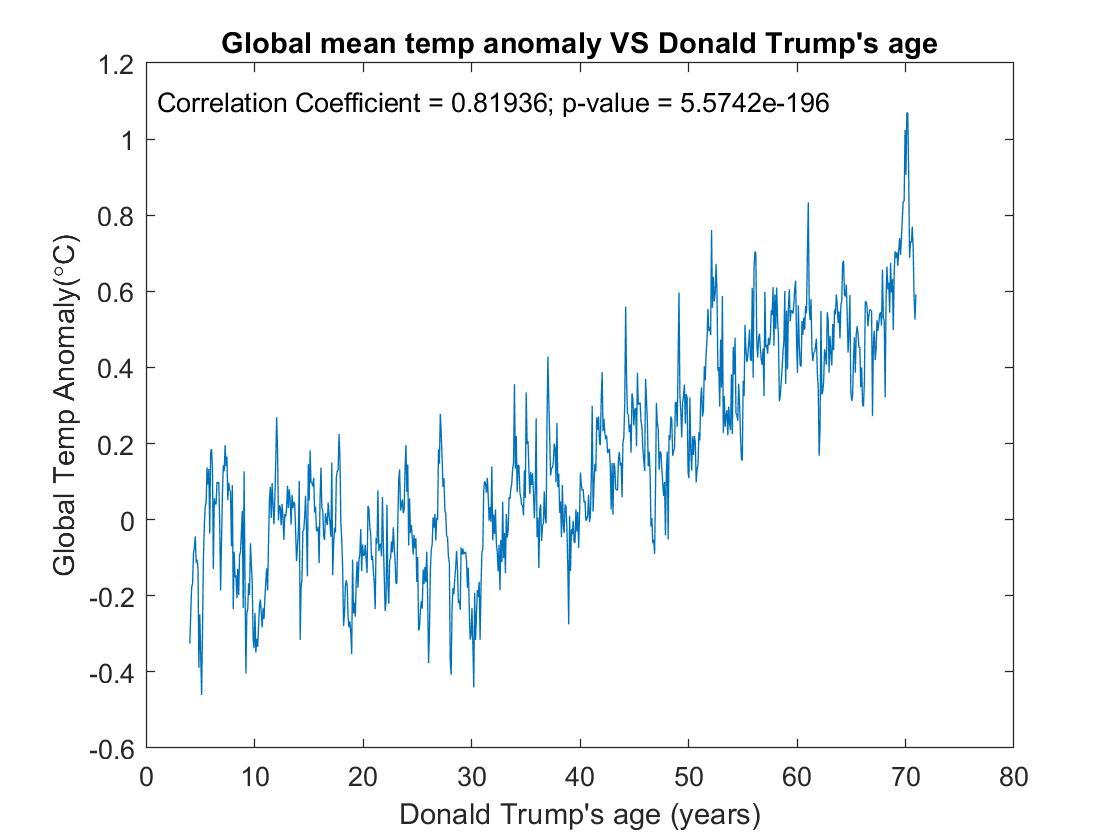
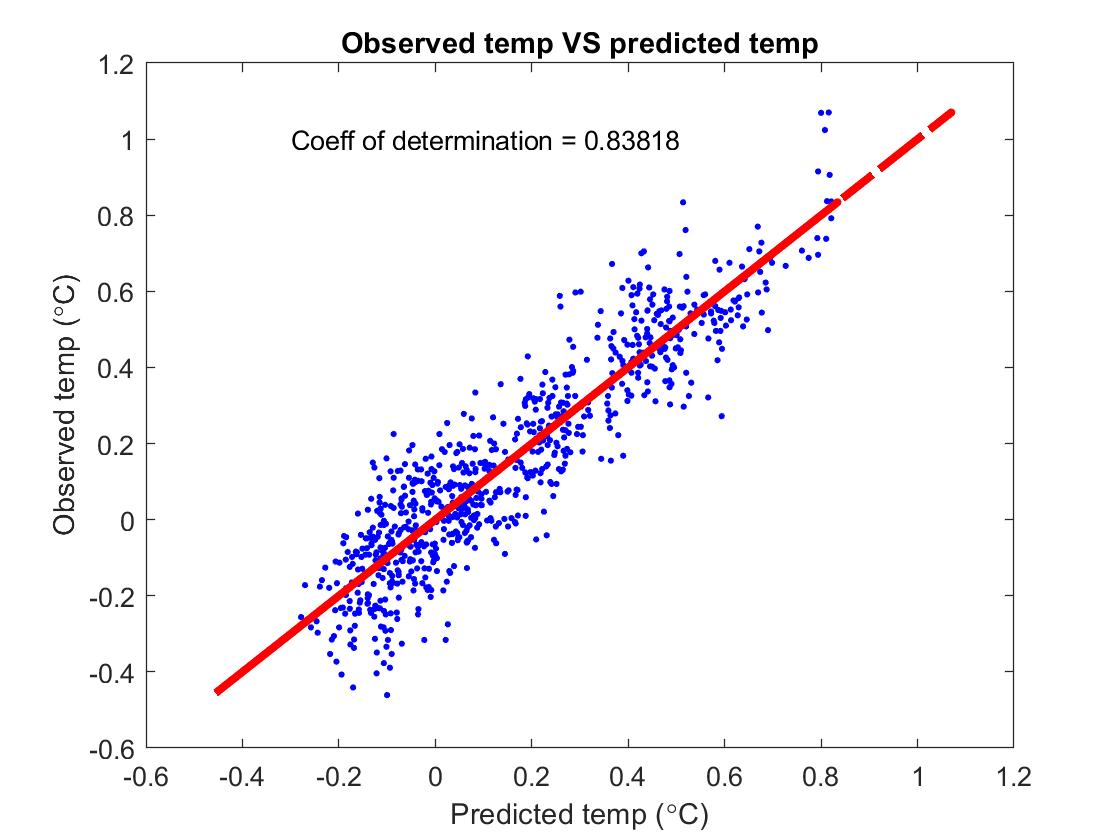
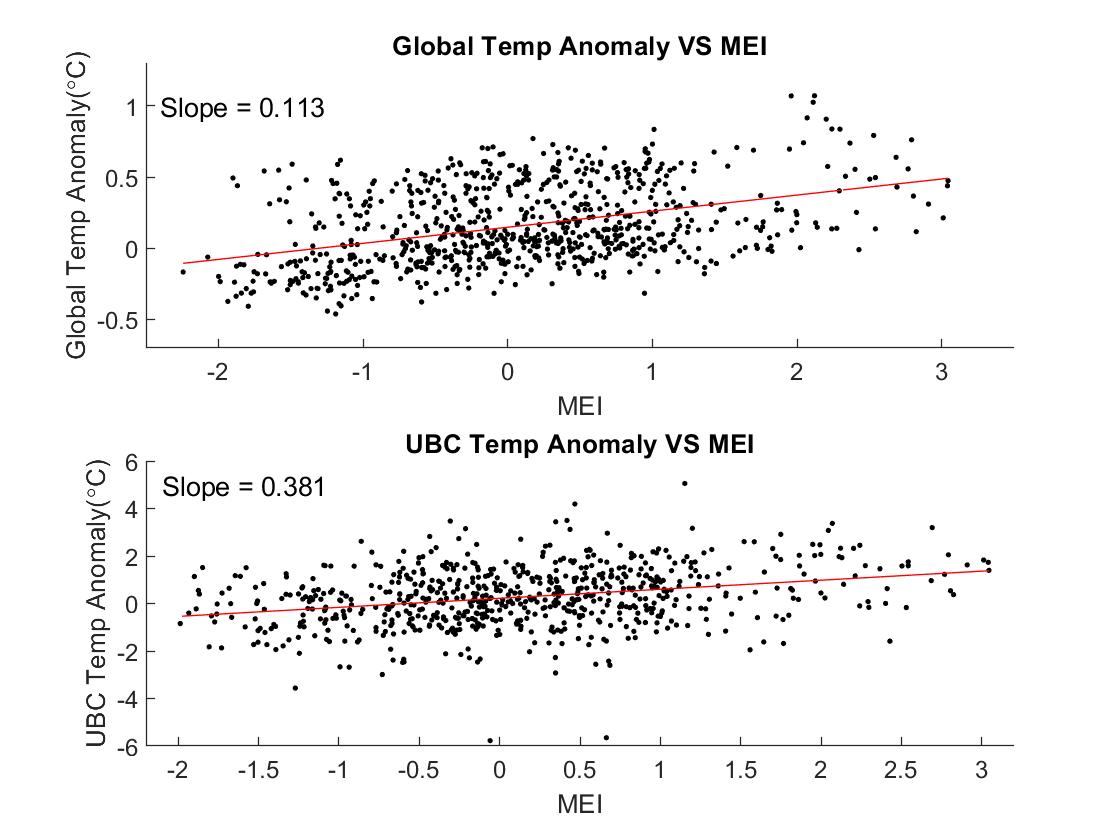
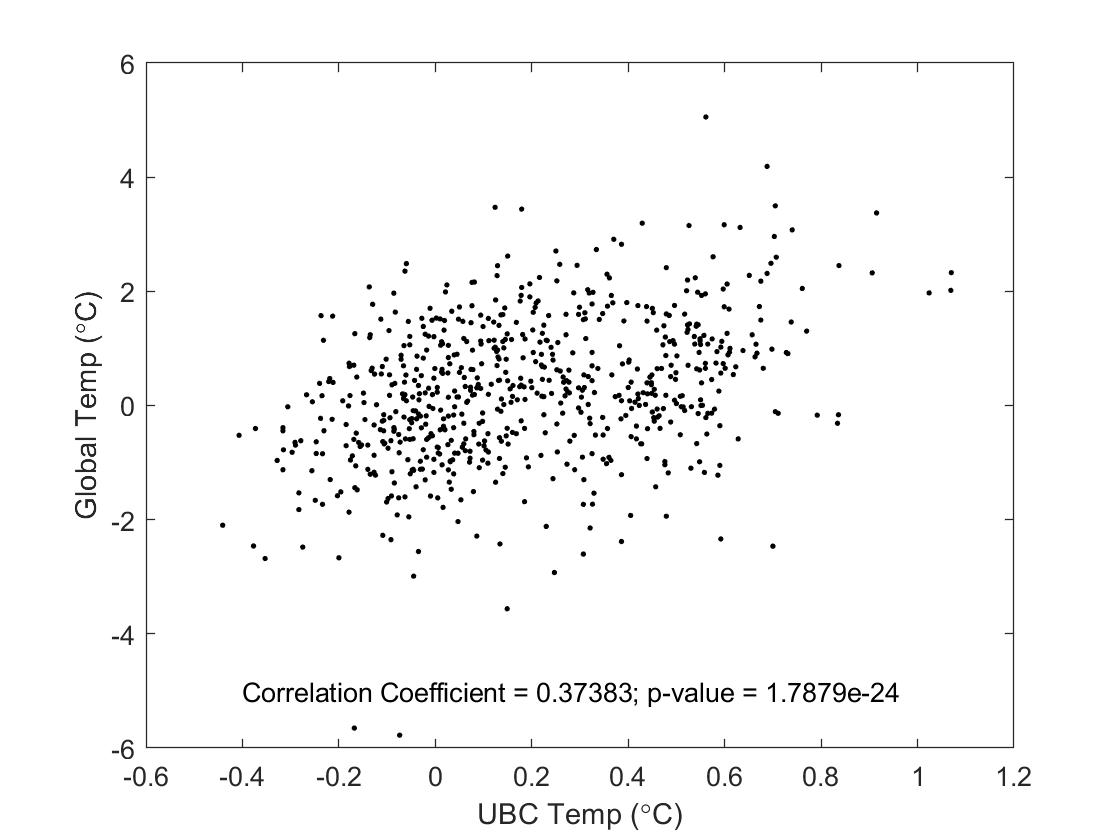
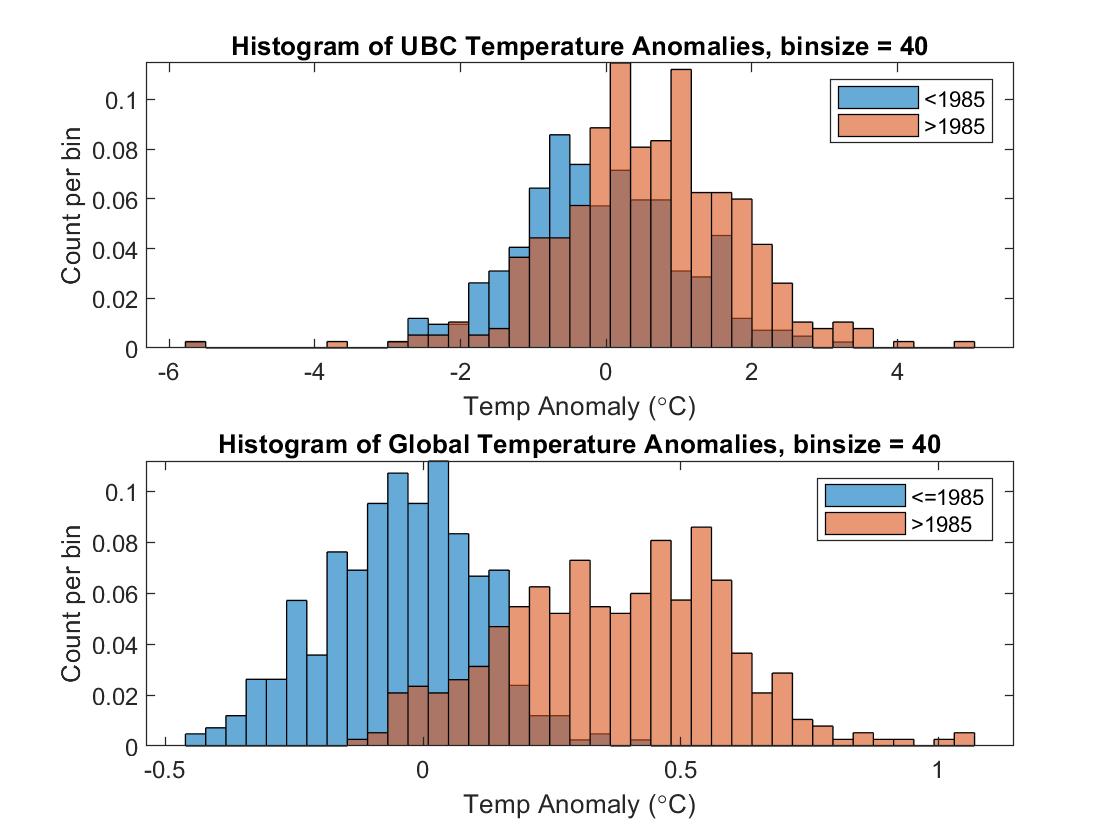
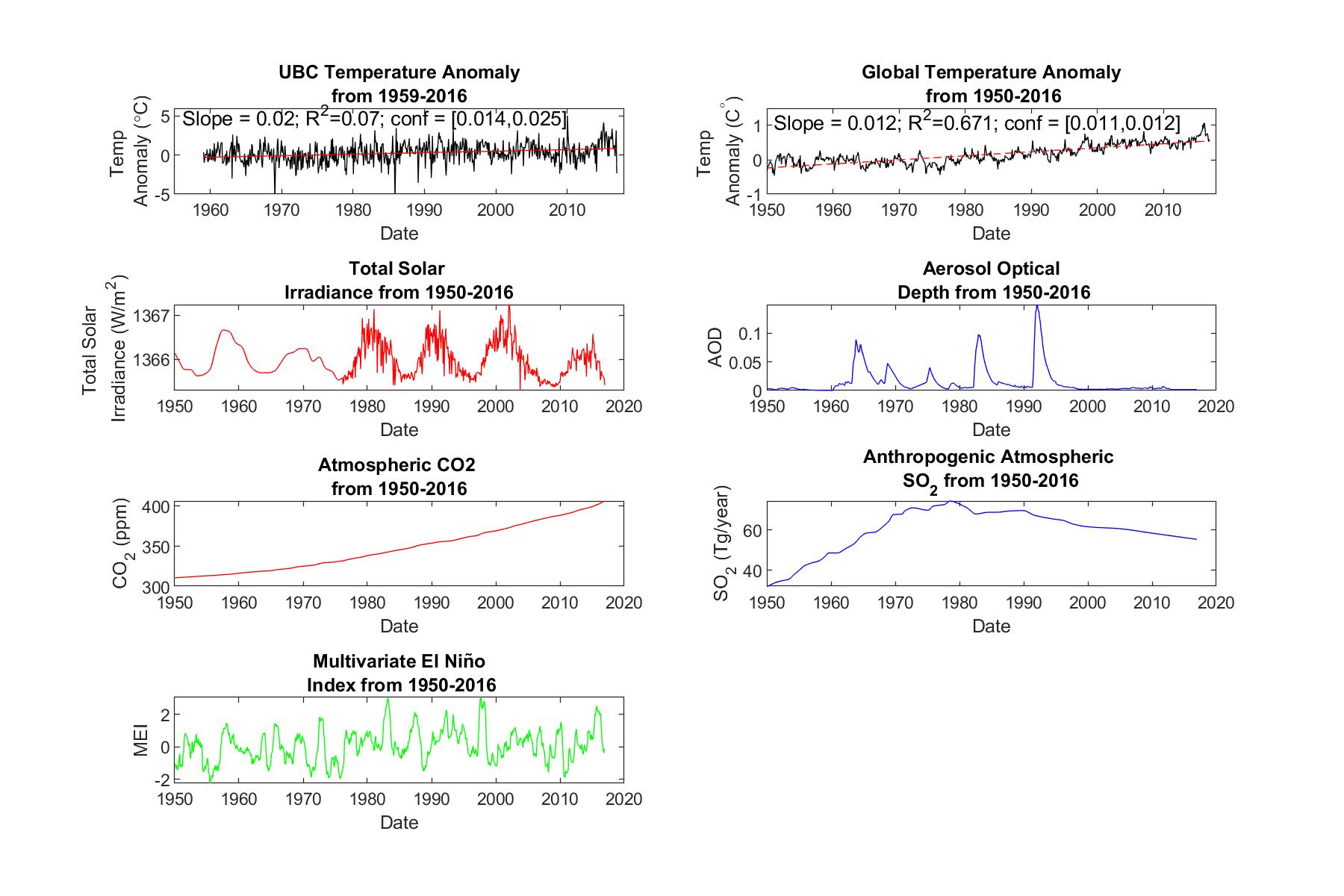
fit = (completeCO2-coef(1))/coef(2);

plot(completeCO2,fit);

legend('predicted temp vs CO2','Given Temp vs CO2');

axis([290,710,-3,5]);

**FIGURES:**

****