A comparison of Gösta Pettersson's carbon cycle model with observations – computer code

by Pehr Björnbom

This document shows Scilab computer codes for calculations and plotting the figures in the report according to the title. Two Scilab files are given, the first resulting in Fig. 1-3 in the report, the second resulting in Fig. 4-6.

```
0001  //This is the program for the calculations generating Fig. 1 - 3.

0002  clear
0003
0004  //Object function for minimizing sum of least squares  according to Levenberg-Marquardt method

0005  function y1=f1(p, m)
0006      y0=p(1);E=p(2);k=p(3);
0007      y1=ydot-Fantt/1000*y0/x0+k*y-k*y0.*exp(E/R./T0).*exp(-E/R./T)
0008  endfunction
0009
0010  //Loading observational data

0011  exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\Hadcrut420130819\HCRUT4.sce', -1)
0012  exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\ML1959-2010.sce', -1)
0013  exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\LD-ML-1832-2012.sce', -1)
0014  exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\Fant.sce', -1)
0015  exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\Fland.sce', -1)
0016
0017  //Amending the emissions from land use change with values for 2006-2010

0018
  Fland1=[Fland;2006 Fland(156,2);2007 Fland(156,2);2008 Fland(156,2);2009 Fland(156,2);2010 Fland(156,2)]
0019
0020  //Preparing the data for 1959-2010 for minimization of the sum of least squares

0021  ydot=ydotML(:,1);y=yML(:,1);
0022  i1=1959-1849;i2=2010-1849;
0023  T=HCRUT4(i1:i2,2)+287.15;
0024  x0=600;
0025  i3=1959-1949; i4=2010-1949;
0026  Fantt=Fant2(i3:i4,2)+Fland1(i1:i2,2);
0027  R=8.314; T0=286.73;k=1/17;E=165000;
0028
0029  //Minimizing the sum of least squares and displaying

0030  [xsol,v]=lsqrsolve([280;166000;14],f1,52)
0031  S=sum(v.*v)
0032  y0=xsol(1);
0033  disp(xsol(1),"y0=")
0034  E=xsol(2);
0035  disp(xsol(2),"E=")
0036  k=xsol(3);
0037  disp(1/k,"tao=")
0038  disp(S,"S=")
0039
0040  //Calculating values according to the model for 1959-2010

0041  ydotb=Fantt/1000*y0/x0-k*y+k*y0.*exp(E/R./T0).*exp(-E/R./T);
0042  t=1959:2010;
0043
0044  //Plot of Fig. 1 comparing calculated values of rate of change with observational data

0045  plot(t,ydotb,t,ydot)
0046  xgrid
0047
0048  //Calculating carbon dioxide mixing ratios for 1959-2010

0049  yb=y(1);i=2
0050  while i<2010-1957
0051      ti=t(1:i);ydotbi=ydotb(1:i)
0052      ybi=inttrap(ti,ydotbi)+y(1)
0053      yb=[yb;ybi]
0054      i=i+1
0055  end
0056
0057  //Plott of Fig. 2

0058  scf(1)
0059  plot(t,yb,t,y)
0060  xgrid
0061
0062  //Calculating carbon dioxide mixing ratios for 1850-2010
```

```
T2=HCRUT4(1:i2,2)+287.15;
i5=1850-1750;i6=2010-1750;
Fantt2=Fant(i5:i6,2)+Fland1(1:i2,2);
i7=1850-1831;i8=2010-1831;
y2=yLDML(i7:i8,2)

ydotb2=Fantt2/1000*y0/x0-k*y2+k*y0.*exp(E/R./T0).*exp(-E/R./T2);
t2=1850:2010;

islut=2010-1849;y2b=y2(islut);i=islut-1;
while i>0
    t2i=t2(i:islut);ydotb2i=ydotb2(i:islut)
    y2bi=-inttrap(t2i,ydotb2i)+y2(islut)
    y2b=[y2bi;y2b]
    i=i-1
end

//Plot of Fig. 3

scf(2)
plot(t2,y2b,t2,y2)
xgrid
```

End of the first Scilab file

```
clear

function y1=f1(p, m)
    y0=p(1);
    y1=ydot-Fantt/1000*y0/x0+k*y-k*y0.*exp(E/R./T0).*exp(-E/R./T)
endfunction

exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\Hadcrut420130819\HCRUT4.sce', -1)
exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\ML1959-2010.sce', -1)
exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\LD-ML-1832-2012.sce', -1)
exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\Fant.sce', -1)
exec('C:\Users\Pehr\Documents\Scilabfiler\Klimatberäkningar\GPs ekvation\Fland.sce', -1)

Fland1=[Fland;2006 Fland(156,2);2007 Fland(156,2);2008 Fland(156,2);2009 Fland(156,2);2010 Fland(156,2)]

ydot=ydotML(:,1);y=yML(:,1);
i1=1959-1849;i2=2010-1849;
T=HCRUT4(i1:i2,2)+287.15;
x0=600;
i3=1959-1949; i4=2010-1949;
Fantt=Fant2(i3:i4,2)+Fland1(i1:i2,2);
R=8.314; T0=286.73;k=1/14;E=165000;

[xsol,v]=lsqrsolve([280],f1,52)
S=sum(v.*v)
y0=xsol(1);
disp(xsol(1),"y0=")
disp(E,"E=")
disp(1/k,"tao=")
disp(S,"S=")

ydotb=Fantt/1000*y0/x0-k*y+k*y0.*exp(E/R./T0).*exp(-E/R./T);
t=1959:2010;

plot(t,ydotb,t,ydot)
xgrid

yb=y(1);i=2
while i<2010-1957
    ti=t(1:i);ydotbi=ydotb(1:i)
    ybi=inttrap(ti,ydotbi)+y(1)
    yb=[yb;ybi]
    i=i+1
end

scf(1)
plot(t,yb,t,y)
xgrid

T2=HCRUT4(1:i2,2)+287.15;
i5=1850-1750;i6=2010-1750;
Fantt2=Fant(i5:i6,2)+Fland1(1:i2,2);
i7=1850-1831;i8=2010-1831;
y2=yLDML(i7:i8,2)

ydotb2=Fantt2/1000*y0/x0-k*y2+k*y0.*exp(E/R./T0).*exp(-E/R./T2);
t2=1850:2010;

islut=2010-1849;y2b=y2(islut);i=islut-1;
while i>0
    t2i=t2(i:islut);ydotb2i=ydotb2(i:islut)
    y2bi=-inttrap(t2i,ydotb2i)+y2(islut)
    y2b=[y2bi;y2b]
    i=i-1
end

scf(2)
plot(t2,y2b,t2,y2)
xgrid
```

End of the second Scilab file