Homework 8

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close all
clear all

% parameters
A = 4e14;   % m2, surf area
Vs = A*100; % m3, surf box vol
Vd = A*3000; % m3, deep box
K0 = 0.04;   % solubility of CO2
K1 = 1e-6;   % K1
K2 = 1e-9;   % K2
Ps = 1.0e-6; % mol/L, surface P
Pd = 2.2e-6; % mol/L, deep P
Vm = 3e8;    % m3/s
G  = 2000/3e7; % m/s, gas transfer coefficient
Rcp= 106;    % C:P ratio
MA = 2.2e6;  % Conversion factor, atm -> PgC
Alk= 2300e-6;% Alkalinity, mol/L

% (a) At equilibrium, ocean and atmos pCO2 are the same
pCO2atm = 280e-6;
pCO2ocn = pCO2atm;
disp('.....');
disp(['(a) At steady state, pCO2ocn is ',num2str(pCO2ocn*1e6,4),' ppm']);

% (b) We can calculate this by solving the quadratic equation
g = K1*K0*pCO2ocn/K2;
a = 4;
b = g-4*Alk;
c = Alk*Alk-g*Alk;
Cs = 1/(2*a)*(-b+sqrt(b*b-4*a*c));
disp('.....');
disp(['(b) At steady state, Cs is ',num2str(Cs*1e6,4),' u molC/L']);

% (c) Solution for Cd
Cd = Cs + (106/1)*(Pd-Ps);
disp('.....');
disp(['(c) At steady state, Cd is ',num2str(Cd*1e6,4),' u molC/L']);

% (d) Solution for export production
J = Vm*1e3*(Pd-Ps)*(106/1)*12*3e7;
disp('.....');
disp(['(d) Export production is ',num2str(J*1e-15,3),' PgC/yr']);

% (e) Total carbon inventory
Atmos = pCO2atm * MA;
Ocean = (Cd*Vd+Cs*Vs)*1e3*12e-15;
disp('.....');
disp(['(e) Atmospheric carbon inventory is ',num2str(Atmos,3),' PgC']);
disp(['Oceanic carbon inventory is ',num2str(Ocean,5),' PgC']);
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disp(['Total carbon inventory is ',num2str(Atmos+Ocean,5),' PgC']);
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.....
(a) At steady state, pCO2ocn is 280 ppm
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(b) At steady state, Cs is 2026 u molC/L
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(c) At steady state, Cd is 2153 u molC/L
.....
(d) Export production is 13.7 PgC/yr
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(e) Atmospheric carbon inventory is 616 PgC
Oceanic carbon inventory is 31978 PgC
Total carbon inventory is 32594 PgC
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