EAS 4305/6305 Physics and Chemistry of the Oceans
Homework #8: Due before class, November 15th

Preindustrial Global Carbon Cycle

1-box atmosphere 2-box ocean model

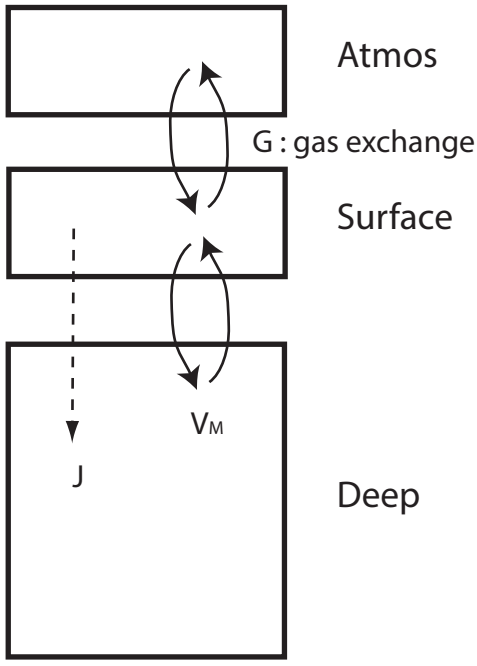
Consider the 1-box atmosphere 2-box ocean model of the global carbon cycle. The nutrient cycle in this model is discussed in the week 12 slides.

Dissolved inorganic carbon (DIC) is **Cs** in the surface and **Cd** in the deep box.

K_0 is set to **0.04** (**molC/L/atm**). Surface alkalinity is set to **2300 μmol/L (10^{-6}mol/L).**
pK_1 is 6 and **pK_2** is 9.

We assume that the stoichiometric ratio of organic matter in the ocean is 1:16:106:-138 for P:N:C:O_2.

Assume that the ocean and atmosphere were in steady state with the atmospheric pCO_2 of **280 ppm** in the preindustrial condition. It is equivalent of **280 x 10^{-6} atm**.



Analytic solution

a. What is the surface ocean pCO_2 at steady state?

b. What is the concentration of surface ocean DIC, **Cs,** at steady state?

c. Surface (**Ps**) and deep-water phosphate (**Pd**) are set to **Ps = 1.0 μmolP/L** and **Pd = 2.2 μmolP/L.** What is the concentration of deep-water DIC, **Cd,** at steady state?

d. If the circulation rate **V_M** is **3 x 10^8 m^3/s**, what is the magnitude of the global export production of P (**J**) in the units of **PgC/yr**?

e. What is the atmospheric, oceanic and total carbon inventory of this system (in PgC)? Assume that **1 ppm** of atmospheric pCO_2 is equivalent of **2.2 PgC**. The surface area of the ocean is **4 x 10^{14} m^2** and the depth of surface box is **100m** and that of deep box is **3000m**.