ATM S 558
Problem Set #1
Due: Wednesday April 6, 2011

Measures of atmospheric composition

a) The OH radical has an average number density that is nearly constant with altitude at ~ $1x10^6$ molec cm^{-3}. Does the mixing ratio change with altitude? To check determine what the OH mixing ratio is at the surface: P ~ 1 atm, T ~ 288K? Now calculate the mixing ratio at 10 km altitude: P ~ 0.260 atm, T ~ 220 K.

b) Over the oceans, sea salt aerosols can affect visibility and marine clouds. If the typical number concentration of 10 μm diameter particles is 10 per cm^3, what is the mass concentration (density = 2 g cm^{-3}) of sea salt? What is the volume mixing ratio of sea salt (cm^3 of sea salt per cm^3 of air) in units of parts per billion?

c) CO_2 is ~380 ppm throughout the atmosphere. What is the partial pressure of CO_2 at the surface? Does the partial pressure of CO_2 vary with altitude?

Problems from Text
3.1, 3.2

Additional problem: Global CH_4

CH_4 is one of the most important anthropogenic greenhouse gases but it has significant biogenic sources ~ 50% of the total. Its present day mixing ratio in the northern hemisphere (NH) is ~ 1800 ppb while in the southern hemisphere (SH) it is 1600 ppb. We will use this observed gradient to determine the difference between sources in the NH and the SH. We take as the timescale for mixing air between the two hemispheres to be 1 year and the CH_4 lifetime by oxidation in the atmosphere is ~ 9 years.

a) Given the above methane lifetime, is it valid to assume CH_4 is well mixed throughout each hemisphere?

b) Using a two-box model for the NH and SH, write the mass balance equations for CH_4 in these two boxes.

c) Assume that the gradient between the hemispheres is constant, i.e. $d(m_N - m_S)/dt = 0$, where m_N is the amount of methane in the NH and m_S is the amount in the SH. Calculate ΔE, the *difference* between NH and SH methane emission rates in units of moles of methane per year.

d) If the total global emission rate of CH_4 $E_{Tot} = E_N + E_S \sim 5x10^{13}$ moles/yr, what do you conclude about the distribution of methane sources between the two hemispheres? Does your calculation support a large terrestrial (land-based) component to the methane source? Why or why not?