Air/Sea Transfer of a Gas:

The rate of air-to-sea transfer (mole flux), for gas "A", is described using

$$F_A = e_A \cdot \Psi \cdot (H_A \cdot P_A - [A]) \qquad (3)$$

Here e_A is the gas' transfer velocity (m/s), H_A the gas' Henry's law coefficient (mol kg^{-1} Pa^{-1}), P_A is the gas' partial pressure (Pascal) (within the atmospheric surface layer), $[A]$ is the gas' concentration within the ocean surface layer (mol/kg) and Ψ is a factor that converts mole per kilogram to mole per cubic meter of solution

Note:

1) The dimensions of F_A are mol m^{-2} s^{-1}. Can you convert this molar flux to a mass flux?

2) For studies of geochemical cycling we are interested in the mass flux of an element (e.g. oxygen). Suppose the mole flux of CO_2 is 100 mole per square meter per year, what is the carbon mass flux?

2) Transfer velocity is a function of the chemical nature of the species fluxing, turbulence within the atmospheric surface layer and turbulence within the ocean surface layer

3) For CO_2 the transfer velocity is ~3×10^{-5} m/s.

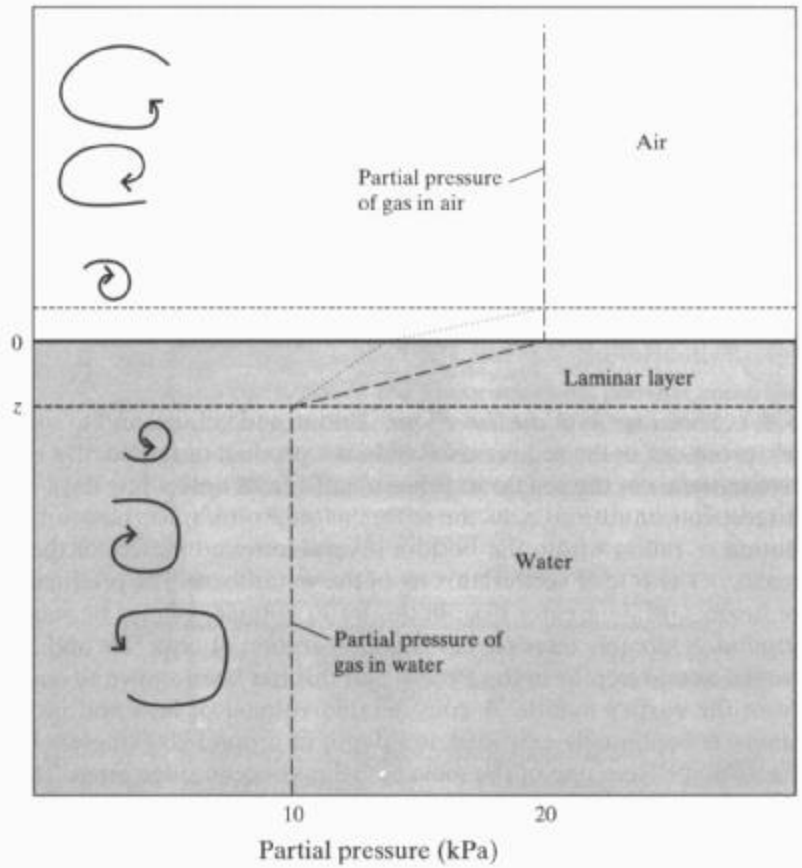

Figure 5.4 *Conceptual model of air-sea gas exchange, according to the theory that unstirred laminar boundry layers form a barrier at the surface. The drawing is made for a situation where some gas has a partial pressure in the liquid phase only one-half that in the air, so that transport of gas is from the air to the liquid.*

Irregular turbulent eddies maintain a homogeneous partial pressure (and concentration) in the bulk of each phase, but rarely penetrate the boundry layers. Within the boundry layers the transport is by molecular diffusion alone, a much slower process.

For nonreactive gases, such as O_2, N_2, and the noble gases, it can be shown that the laminar boundry layer in the air is not a significant barrier, and only the aqueous barrier need be taken into account. For very reactive gases, such as SO_2, the reaction rate at the water surface is so great that diffusion in the boundry layer of the air limits transport rates (light dotted lines above), so this must also be considered. (Liss and Slater 1974, Broecker and Peng 1974.)

Note:

1) Thermodynamic driving force for *air-to-sea* transfer $\equiv H_A \cdot P_A - [A]$

2) If $[A] < H_A \cdot P_A$, then "A" is said to be *subsaturated* ("A" is fluxing from the atmosphere to the sea)

3) If $[A] > H_A \cdot P_A$, then "A" is said to be *supersaturated* ("A" is fluxing from the sea to the atmosphere)

The Carbon Biogeochemical Cycle in the Anthropocene:

http://en.wikipedia.org/wiki/Anthropocene