The Carbon Linkage

The linkage of carbon system to this ecosystem model is through the consumption and remineralization of nutrient of the fixed nitrogen in the water column by using Redfield stoichiometric ratios. The C/N ratio of 117/16 (=7.3) of Anderson and Sarmiento (1994) is used. The total dissolved inorganic carbon (DIC) is initiated with the mean value for the region of 2250 μmol/kg. To estimate the CO_2 gas exchange flux across the sea-air interface, the partial pressure of CO_2 in the surface water has to be determined. Based on the thermodynamics of carbon chemistry, the CO_2 partial pressure can be determined by the DIC and total alkalinity (TA) concentrations. Instead of modeling the distribution of alkalinity in the water column, the alkalinity of the surface box is determined only by a statistical regional representation of salinity normalized alkalinity for the equatorial Pacific Ocean with surface water temperature between 20°C and 29°C (Millero et al. 1998). The distribution of DIC in the water column can be given as:

Eq. 24 $(DIC) / t = PHYSICS(DIC) + BIOLOGY(DIC) + EVASION(DIC)$

where PHYSICS(DIC) includes all mixing processes, BIOLOGY(DIC) is determined by the total phytoplankton uptake of NO_3, $Si(OH)_4$, and NH_4 in each layer and the corresponding changes in DIC through Redfield C/N ratio, and EVASION(DIC) is determined by the equation:

Eq. 25 $EVASION(DIC) = E \Delta pCO_2$

where E is the mean CO_2 exchange flux of 20 mol/m^2/yr at pCO_2 of 280 ppm, and ΔpCO_2 is the difference in partial pressure of CO_2 between surface water and atmosphere. To simulate the carbon cycle in 1992, the atmospheric pCO_2 is assumed to be constant at 357 ppm. In the Equatorial Pacific, the surface water pCO_2 is higher than the atmospheric pCO_2 and hence the evasion of CO_2 from the ocean into the atmosphere. The EVASION(DIC) term is only applied to the surface level, and is equal to zero in the water column below surface level.