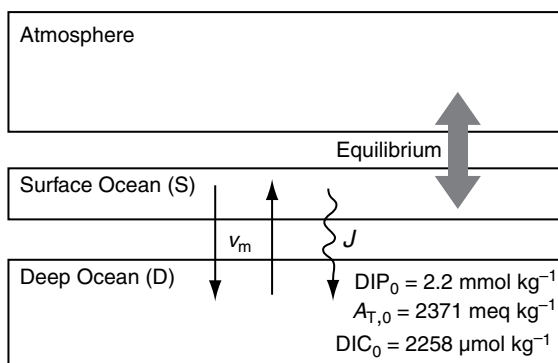


Figure 11.2. Sketch of the three-box model of the atmosphere, surface and deep ocean. Equations indicate the circulation dynamics (V_M in m y^{-1} , is the mixing rate between the surface and deep ocean.); stoichiometry of the particulate transport (J in $\text{mol m}^{-2} \text{y}^{-1}$); and chemical equilibria of the carbonate system.



$$\text{Dynamics: } V_D \times \frac{d[C_D]}{dt} = 0 = V_m \times ([C_S] - [C_D]) + J$$

$$\text{Stoichiometry: } \Delta P : \Delta N : \Delta \text{DIC} : \Delta A_T : \Delta \text{Ca} \\ 1 : 16 : 136 : 44 : 30$$

Equilibrium:

$$\text{DIC} = [\text{HCO}_3^-] + [\text{CO}_3^{2-}] + [\text{CO}_2]$$

$$A_{C\&B} = [\text{HCO}_3^-] + 2 \times [\text{CO}_3^{2-}] + [\text{B}(\text{OH})_4^-]$$

$$B_T = \text{B}(\text{OH})_3 + \text{B}(\text{OH})_4^-$$

$$K_{\text{H,CO}_2} = \frac{[\text{CO}_2]}{f_{\text{CO}_2}^a}$$

$$K_2' = \frac{[\text{CO}_3^{2-}][\text{H}^+]}{[\text{HCO}_3^-]}$$

$$K_1' = \frac{[\text{HCO}_3^-][\text{H}^+]}{[\text{CO}_2]}$$

$$K_B' = \frac{[\text{B}(\text{OH})_4^-][\text{H}^+]}{[\text{B}(\text{OH})_3]}$$