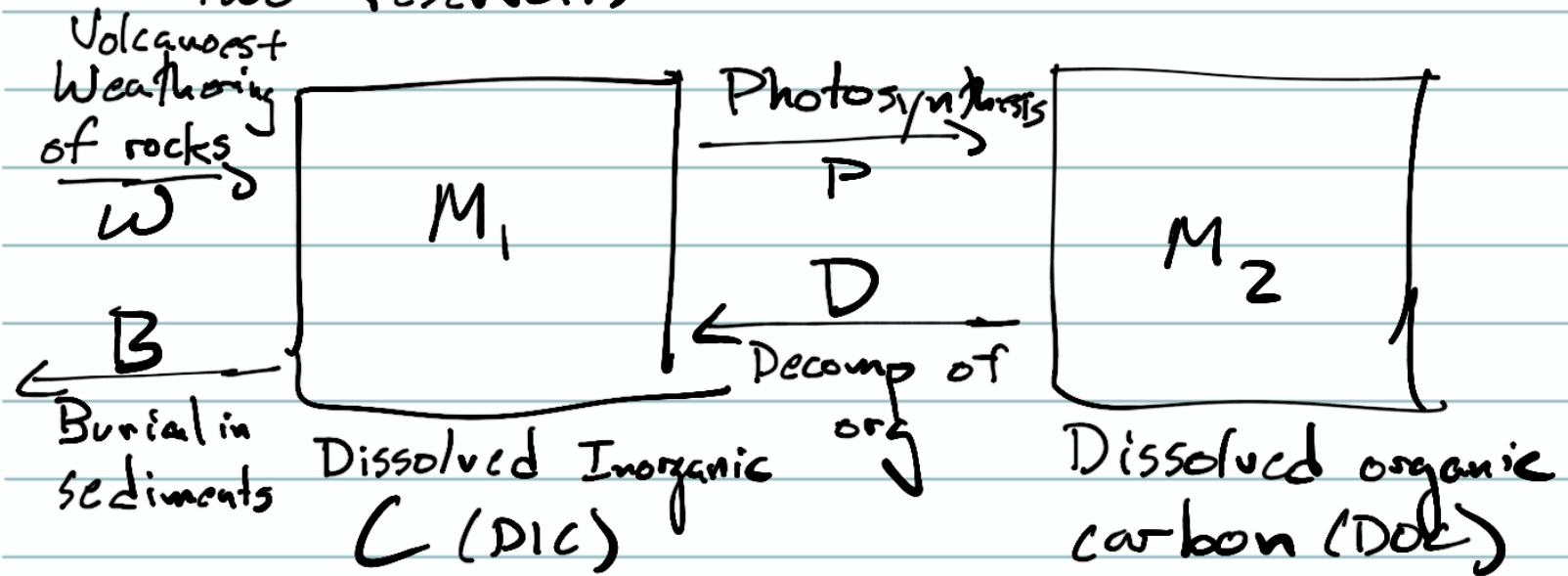


# Box Model Examples

## ① Rothman's ocean carbon cycle:

Two reservoirs



$W$  depends on stuff happening on land

$$B = bM_1, \quad P = pM_1, \quad D = dM_2$$

$$\frac{dM_1}{dt} = W + dM_2 - (p + b)M_1$$

$$\frac{dM_2}{dt} = pM_1 - dM_2$$

① Calculate steady states?

② Calculate response to step change in  $W$  (opening of large river input)?

$$\begin{aligned} W &= 0.1 \text{ Gt/yr} \\ d &= 2 \times 10^{-6} \text{ /yr} \\ p &= 2 \times 10^{-4} \text{ /yr} \\ b &= 2 \times 10^{-6} \text{ /yr} \end{aligned}$$

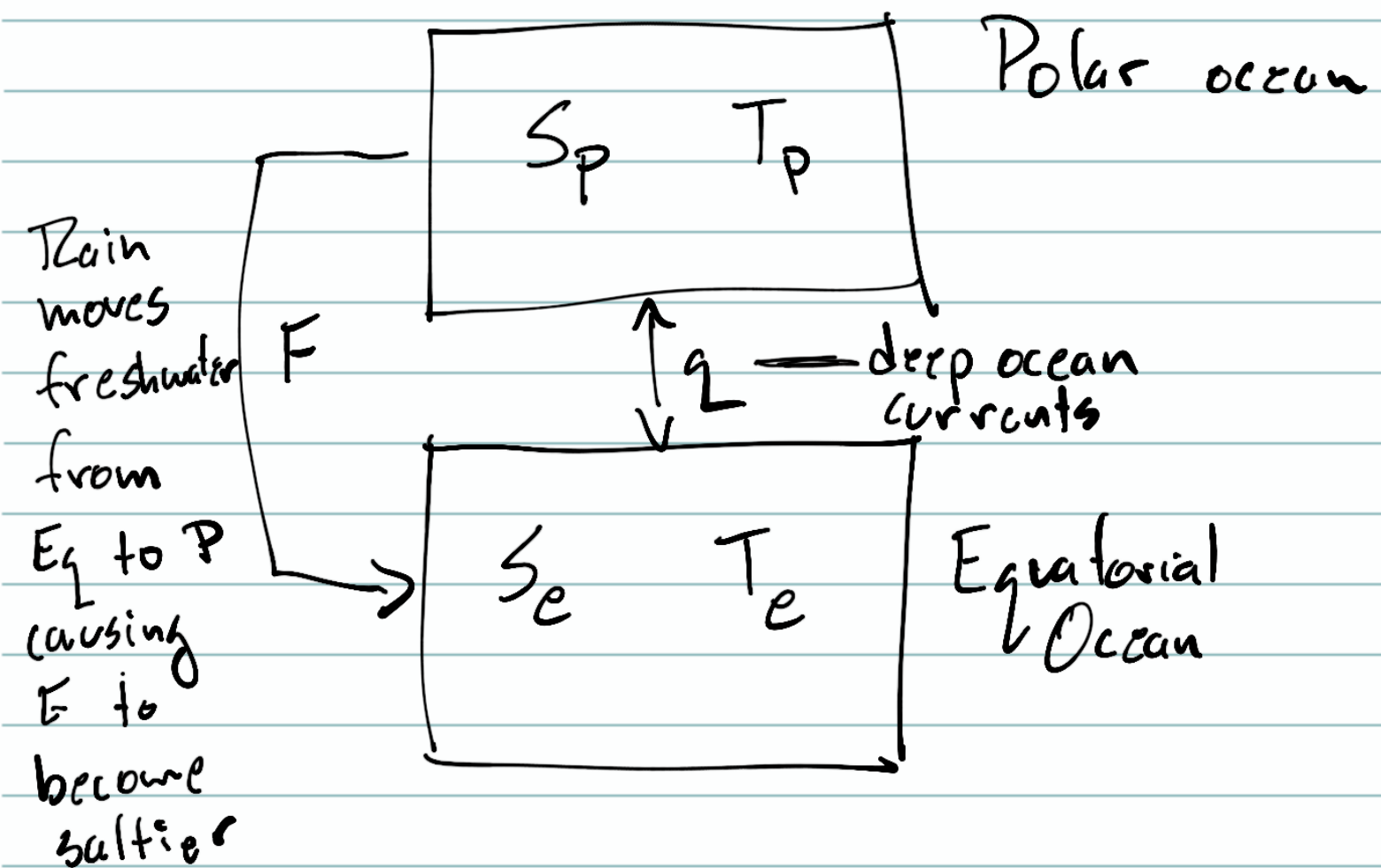
③ Response to evolution of much more efficient photosynthesis pt

Live coding ex  $\rightarrow$  validate S-S calc

## ② Stommel's Box Model (HW)

→ The meridional overturning circulation of the ocean is the density-driven exchange of waters b/w low and high latitudes

Marotzke's (1984) version of the classic Stommel (1961) model



$V \rightarrow$  volume of each ocean basin  
(constant and equal)

$T_p, T_e \rightarrow$  temperatures (assumed constant)  
(original Stommel model had temps varying, but this isn't strictly necessary)

$q \rightarrow$  water always flows to equalize  
density/salinity

$$V \frac{ds_p}{dt} = -FS_0 + |q|(s_e - s_p)$$

$\swarrow$  ref salinity

$$V \frac{ds_e}{dt} = FS_0 + |q|(s_p - s_e)$$

$$q = -\frac{k}{\rho_0} (\rho_e - \rho_p)$$

$$\rho = \rho_0 (1 - \alpha T + \beta s) \rightarrow \text{Equation of state for sea water}$$