

system of ODEs

$$\text{Mixing } K = \frac{1}{M(t)} \cdot \left(\kappa + \max \left(0, \frac{d}{dt} M(t) \right) \right) \quad \text{LightHarvesting} = \frac{1}{M(t) \cdot k_w} \cdot \left(e^{1 - \frac{PAR(t)}{Opt_I^I}} + e^{1 - \frac{PAR(t)}{Opt_I^I} \cdot e^{-M(t) \cdot k_w}} \right)$$

$$\text{ZooMixing} = \frac{1}{M(t)} \cdot \frac{d}{dt} M(t) \quad (?) \quad \text{Steele} = \frac{1}{M(t)} \cdot \int_0^M \frac{I_z}{Opt_I^I} \cdot e^{1 - \frac{I_z}{Opt_I^I}} dz$$

$$N_{Mixing} = K \cdot (N_0 - N(t)) \quad \text{Irradiance at depth } I_z = I_0 \cdot e^{-k_w \cdot z}$$

$$\text{Nitrate } N = N_{Mixing} + N_{Remineralisation} - \sum_{i=1}^{i_{max}} Gains_i$$

$$\text{Silicate } N = Si_{Mixing} + Si_{Remineralization} - \sum_{i=1}^{i_{max}} Gains_i$$

$$\text{Phytoplankton } Gains = \text{LightHarvesting} + \min \left(\frac{N(t)}{N(t) + U_i^N}, \frac{Si(t)}{Si(t) + U_i^S} \right) + e^{0.063 \cdot T}$$

$$\text{Phytoplankton } Losses = K + mo_P + \frac{v}{M(t)} + \frac{I_{tot}}{R} \cdot P_i(t) \cdot p_i \quad \text{Total } P_i = P_i(t) \cdot (Gains_i - Losses_i)$$

$$\text{Zooplankton } Z_j = I_{tot} \cdot \delta_Z - \frac{1}{M(t)} \cdot \frac{d}{dt} M(t) - mo_Z \cdot Z_j^2 \quad I_{tot} = \frac{R \cdot \mu_Z}{R + k_Z} \quad R = \sum_{i=1}^{i_{max}} P_i(t) \cdot p_i$$

$$\text{Detritus } D = -D(t) \cdot K - D(t) \cdot \text{delta} D_N - D(t) \cdot \text{delta} D_{Si} + \sum_{i=1}^{i_{max}} P_i(t) \cdot mo_P + \sum_{j=1}^{j_{max}} \left(I_{tot} \cdot (1 - \delta_Z) + mo_Z \cdot Z_j^2 \right)$$