# Appendix

The rates of change are defined by the following set of equations:

(1)

(2)

(3)

(4)

(5)

(6)

(7)

where DIN and DIP are dissolved inorganic nitrogen and phosphorus, C is carbon biomass (POC), N is particulate nitrogen (PON), P is particulate phosphorus (POP) and Chl is chlorophyll of the respective model compartments, *V* is net acquisition by the model compartment in the subscript of the element in the superscript, is excretion by all zooplankton compartments present, *L* is predation loss of the compartment in the subscript, and are phytoplankton N:C and P:C ratios, and is the whole-cell phytoplankton Chl:C ratio. The NNP configuration is obtained by setting all zooplankton-related terms to 0 in Equations (1)-(6).

The change of the whole-cell Chl:C ratio over time is given by

(8)

The first term in Eq. (8), , represents the light dependence of chlorophyll driven by the chloroplast, where is the whole cell Chl:C. The second term, , describes the nutrient-driven change of the whole-cell Chl:C ratio () as a consequence of changes in the N:P ratio (). The whole-cell Chl:C ratio is a function of the chloroplast Chl:C ratio () and the N:C ratio:

(9)

where the optimal allocation factor for nutrient acquisition () maximises net balanced growth rate:

(10)

The predation loss terms are defined by:

, (11)

where *I* is ingestion of the compartment *x* by zooplankton.

The excretion terms for N and P are defined by:

(12)

(13)

The summed root mean square errors (RMSE) of the NNPZ simulations for 4 state variables (DIN, DIP, phytoplankton POC (phyto POC) and zooplankton POC (zoo POC)) of the PU1 and PU2 model simulations are defined by:

, (14)

where *o* represents the mesocosm observations, *n* the number of days of the experiments and the number of replicates per treatment. is either the model simulation (PU1) or the mean of the 3 ensemble model simulations per treatment (PU2), calculated for the state variable (x) in consideration (see above).

We then normalised the RMSE with the mean of mesocosm observations () of the PU1 and PU2 experiments, respectively, to obtain the coefficient of variation (CV) of the RMSE: