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Quantification of multiple simultaneously occurring nitrogen flows in the euphotic ocean

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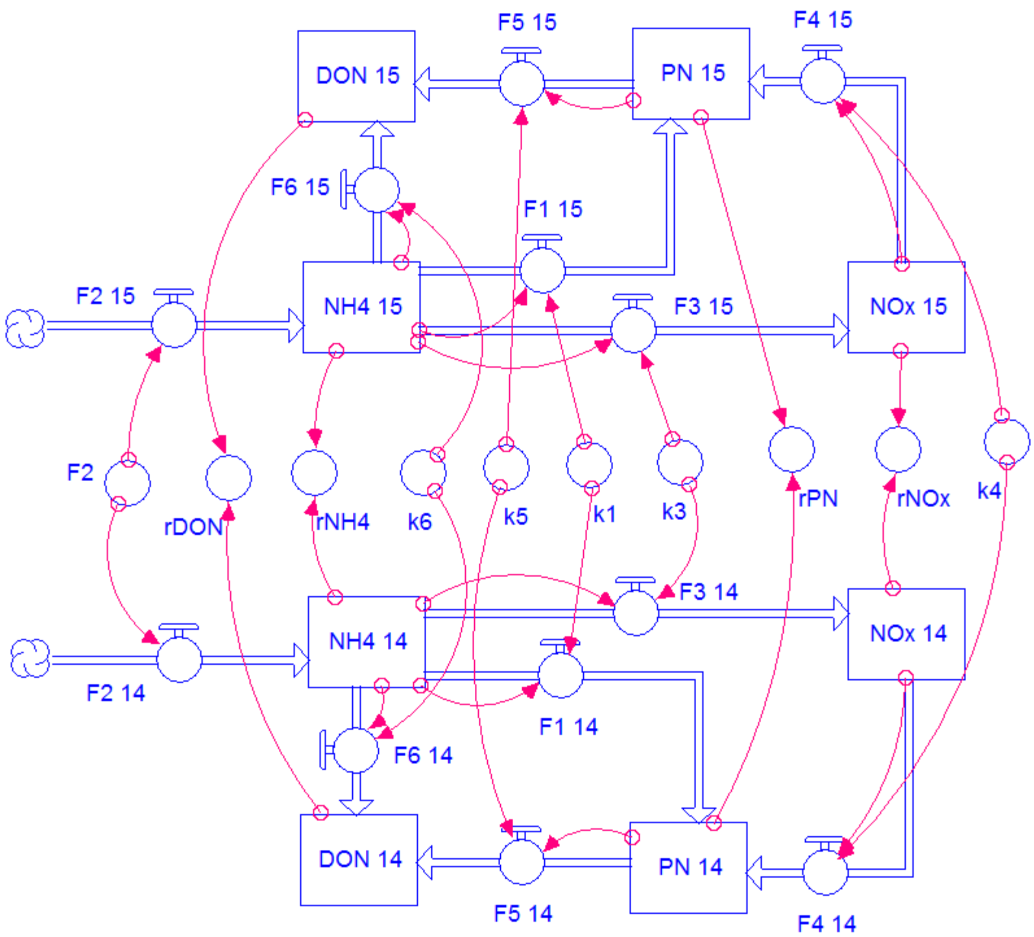
Figure S1. Structure of the equation based STELLA box model (Version 9.14) for the low nutrient case. Square represents pool. Pools of NH_4^+, NO_x^- and PN were separated into two modules (i.e., ^{14}N and ^{15}N). Faucet (Fi, i = 1~6, was for N process rate) stands for regulator controlled by associated arrows determined by rate constant (ki, i = 1~6) and reactant concentration. Fractionation between ^{14}N and ^{15}N was not considered, thus, ki is the same for both ^{14}N and ^{15}N. The output, r, stands for the ratio of ^{15}N to $^{14}N+^{15}N$ derived from instantaneous ^{15}N and ^{14}N amounts in pools. Exported equations were shown below.



Low nutrient case Equations:

DON_14(t) = DON_14(t - dt) + (F6_14 + F5_14) * dt
INIT DON_14 = 5376.4
INFLOWS:
F6_14 = k6*NH4_14
F5_14 = k5*PN_14
DON_15(t) = DON_15(t - dt) + (F5_15 + F6_15) * dt
INIT DON_15 = 19.8
INFLOWS:
F5_15 = PN_15*k5

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F6_15 = NH4_15*k6
NH4_14(t) = NH4_14(t - dt) + (F2_14 - F6_14 - F1_14 - F3_14) * dt
INIT NH4_14 = 112.9
INFLOWS:
F2_14 = F2*(1-0.00366)
OUTFLOWS:
F6_14 = k6*NH4_14
F1_14 = k1*NH4_14
F3_14 = k3*NH4_14
NH4_15(t) = NH4_15(t - dt) + (F2_15 - F3_15 - F1_15 - F6_15) * dt
INIT NH4_15 = 29.8
INFLOWS:
F2_15 = F2*0.00366
OUTFLOWS:
F3_15 = NH4_15*k3
F1_15 = NH4_15*k1
F6_15 = NH4_15*k6
NOx_14(t) = NOx_14(t - dt) + (F3_14 - F4_14) * dt
INIT NOx_14 = 518.8
INFLOWS:
F3_14 = k3*NH4_14
OUTFLOWS:
F4_14 = k4*NOx_14
NOx_15(t) = NOx_15(t - dt) + (F3_15 - F4_15) * dt
INIT NOx_15 = 1.9
INFLOWS:
F3_15 = NH4_15*k3
OUTFLOWS:
F4_15 = NOx_15*k4
PN_14(t) = PN_14(t - dt) + (F4_14 + F1_14 - F5_14) * dt
INIT PN_14 = 435.1
INFLOWS:
F4_14 = k4*NOx_14
F1_14 = k1*NH4_14
OUTFLOWS:
F5_14 = k5*PN_14
PN_15(t) = PN_15(t - dt) + (F4_15 + F1_15 - F5_15) * dt
INIT PN_15 = 1.7
INFLOWS:
F4_15 = NOx_15*k4
F1_15 = NH4_15*k1
OUTFLOWS:
F5_15 = PN_15*k5

rDON = DON_15/(DON_14+DON_15)
rNH4 = NH4_15/(NH4_14+NH4_15)
rNOx = NOx_15/(NOx_14+NOx_15)
rPN = PN_15/(PN_14+PN_15)
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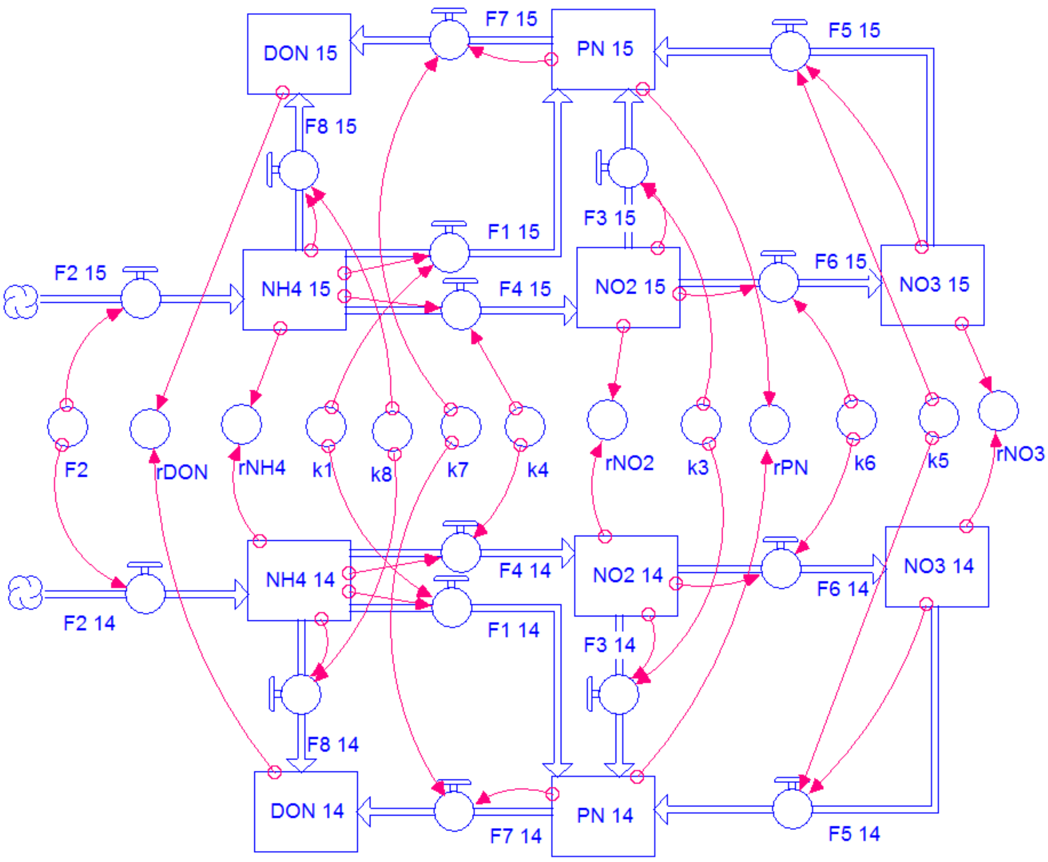
Figure S2. The STELLA model (Version 9.14) for high nutrient case. The Fi (i = 1~8) indicates rate of the relevant N process controlled by multiplying rate constant (ki, i = 1~8) with substrate concentration. Similar to low nutrient case, NH_4^+, NO_2^-, NO_3^- and PN pools were separated into two modules (i.e., ^{14}N and ^{15}N). Exported equations were shown below the figure.



High nutrient case equations (e.g. 80%sPAR case):

DON_14(t) = DON_14(t - dt) + (F8_14 + F7_14) * dt
INIT DON_14 = 17.39
INFLOWS:
F8_14 = k8*NH4_14
F7_14 = k7*PN_14
DON_15(t) = DON_15(t - dt) + (F7_15 + F8_15) * dt
INIT DON_15 = 0.064
INFLOWS:
F7_15 = k7*PN_15
F8_15 = k8*NH4_15
NH4_14(t) = NH4_14(t - dt) + (F2_14 - F8_14 - F1_14 - F4_14) * dt
INIT NH4_14 = 25.54
INFLOWS:
F2_14 = F2*(1-0.00366)
OUTFLOWS:
F8_14 = k8*NH4_14
F1_14 = k1*NH4_14

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F4_14 = k4*NH4_14
NH4_15(t) = NH4_15(t - dt) + (F2_15 - F4_15 - F8_15 - F1_15) * dt
INIT NH4_15 = 1.09
INFLOWS:
F2_15 = F2*0.00366
OUTFLOWS:
F4_15 = k4*NH4_15
F8_15 = k8*NH4_15
F1_15 = k1*NH4_15
NO2_14(t) = NO2_14(t - dt) + (F4_14 - F6_14 - F3_14) * dt
INIT NO2_14 = 5.56
INFLOWS:
F4_14 = k4*NH4_14
OUTFLOWS:
F6_14 = k6*NO2_14
F3_14 = k3*NO2_14
NO2_15(t) = NO2_15(t - dt) + (F4_15 - F6_15 - F3_15) * dt
INIT NO2_15 = 0.020
INFLOWS:
F4_15 = k4*NH4_15
OUTFLOWS:
F6_15 = k6*NO2_15
F3_15 = k3*NO2_15
NO3_14(t) = NO3_14(t - dt) + (F6_14 - F5_14) * dt
INIT NO3_14 = 30.02
INFLOWS:
F6_14 = k6*NO2_14
OUTFLOWS:
F5_14 = k5*NO3_14
NO3_15(t) = NO3_15(t - dt) + (F6_15 - F5_15) * dt
INIT NO3_15 = 0.11
INFLOWS:
F6_15 = k6*NO2_15
OUTFLOWS:
F5_15 = k5*NO3_15
PN_14(t) = PN_14(t - dt) + (F5_14 + F1_14 + F3_14 - F7_14) * dt
INIT PN_14 = 8.72
INFLOWS:
F5_14 = k5*NO3_14
F1_14 = k1*NH4_14
F3_14 = k3*NO2_14
OUTFLOWS:
F7_14 = k7*PN_14
PN_15(t) = PN_15(t - dt) + (F5_15 + F3_15 + F1_15 - F7_15) * dt
INIT PN_15 = 0.032
INFLOWS:
F5_15 = k5*NO3_15
F3_15 = k3*NO2_15
F1_15 = k1*NH4_15
OUTFLOWS:
F7_15 = k7*PN_15
rDON = DON_15/(DON_14+DON_15)
rNH4 = NH4_15/(NH4_14+NH4_15)
rNO2 = NO2_15/(NO2_14+NO2_15)
rNO3 = NO3_15/(NO3_14+NO3_15)
rPN = PN_15/(PN_14+PN_15)
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Figure S3. The temporal variations of pico-eukaryote and *Synechococcus* in the low-nutrient incubations.