Oxic-anoxic regime shifts mediated by feedbacks between biogeochemical processes and microbial community dynamics

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Supplementary Figure 1. Hysteresis loops for different depths in Lake Vechten. The graphs plot the oxygen saturation level against the inverse of the stratification strength (1/N^2, where N^2 is the squared buoyancy frequency). The inverse of the stratification strength provides a simple proxy of oxygen diffusivity across the thermocline (see Methods). A hysteresis loop is found irrespective of whether oxygen saturation is measured at a depth of a, 2 m; b, 5 m; c, 6 m; d, 7 m; e, 9 m. Data points are from March 2013 to March 2014; arrows indicate the direction of time.
### Supplementary Table 1. Parameter values of the model.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Meaning</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$g_{\text{max,CB}}$</td>
<td>Maximum specific growth rate of CB</td>
<td>0.05 hr$^{-1}$</td>
<td>1</td>
</tr>
<tr>
<td>$g_{\text{max,PB}}$</td>
<td>Maximum specific growth rate of PB</td>
<td>0.07 hr$^{-1}$</td>
<td>2</td>
</tr>
<tr>
<td>$g_{\text{max,SB}}$</td>
<td>Maximum specific growth rate of SB</td>
<td>0.1 hr$^{-1}$</td>
<td>3,4</td>
</tr>
<tr>
<td>$K_{PB,SR}$</td>
<td>Half-saturation constant of PB on reduced sulfur</td>
<td>10 μM</td>
<td>5</td>
</tr>
<tr>
<td>$K_{SB,SO}$</td>
<td>Half-saturation constant of SB on oxidized sulfur</td>
<td>5 μM</td>
<td>6</td>
</tr>
<tr>
<td>$K_{CB,P}$</td>
<td>Half-saturation constant of CB on phosphorus</td>
<td>0.2 μM</td>
<td>7</td>
</tr>
<tr>
<td>$K_{PB,P}$</td>
<td>Half-saturation constant of PB on phosphorus</td>
<td>0.5 μM</td>
<td>8</td>
</tr>
<tr>
<td>$K_{SB,P}$</td>
<td>Half-saturation constant of SB on phosphorus</td>
<td>0.5 μM</td>
<td>-</td>
</tr>
<tr>
<td>$H_{CB,SR}$</td>
<td>Half-inhibition constant of CB on reduced sulfur</td>
<td>300 μM</td>
<td>9</td>
</tr>
<tr>
<td>$H_{PB,O}$</td>
<td>Half-inhibition constant of PB on oxygen</td>
<td>100 μM</td>
<td>10</td>
</tr>
<tr>
<td>$H_{SB,O}$</td>
<td>Half-inhibition constant of SB on oxygen</td>
<td>100 μM</td>
<td>10</td>
</tr>
<tr>
<td>$y_{SB}$</td>
<td>Yield of SB on oxidized sulfur</td>
<td>$3.33 \times 10^7$ cells μM$^{-1}$</td>
<td>11</td>
</tr>
<tr>
<td>$y_{PB}$</td>
<td>Yield of PB on reduced sulfur</td>
<td>$1.25 \times 10^7$ cells μM$^{-1}$</td>
<td>9</td>
</tr>
<tr>
<td>$y_{CB}$</td>
<td>Yield of CB on phosphorus</td>
<td>$1.67 \times 10^8$ cells μM$^{-1}$</td>
<td>12</td>
</tr>
<tr>
<td>$y_{PB}$</td>
<td>Yield of PB on phosphorus</td>
<td>$1.67 \times 10^8$ cells μM$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$y_{SB}$</td>
<td>Yield of SB on phosphorus</td>
<td>$1.67 \times 10^8$ cells μM$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$p_{CB}$</td>
<td>Production of oxygen per cyanobacterial cell</td>
<td>$6 \times 10^{-9}$ μM cell$^{-1}$</td>
<td>13</td>
</tr>
<tr>
<td>$m_{CB}$</td>
<td>Mortality rate of CB</td>
<td>0.020 hr$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$m_{PB}$</td>
<td>Mortality rate of PB</td>
<td>0.028 hr$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$m_{SB}$</td>
<td>Mortality rate of SB</td>
<td>0.040 hr$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$\alpha_{S}$</td>
<td>Diffusivity of sulfur</td>
<td>0.001 hr$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$\alpha_{O}$</td>
<td>Diffusivity of oxygen</td>
<td>$10^{-6} - 10^{-2}$ hr$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$\alpha_{P}$</td>
<td>Diffusivity of phosphorus*</td>
<td>0.01 hr$^{-1}$</td>
<td>-</td>
</tr>
<tr>
<td>$S_{R,b}$</td>
<td>Background concentration of reduced sulfur</td>
<td>300 μM</td>
<td>14</td>
</tr>
<tr>
<td>$S_{O,b}$</td>
<td>Background concentration of oxidized sulfur</td>
<td>300 μM</td>
<td>14</td>
</tr>
<tr>
<td>$O_{b}$</td>
<td>Background concentration of oxygen</td>
<td>300 μM</td>
<td>15</td>
</tr>
<tr>
<td>$P_{b}$</td>
<td>Background concentration of phosphorus</td>
<td>$2 - 10$ μM</td>
<td>16</td>
</tr>
<tr>
<td>$c$</td>
<td>Oxidation rate of reduced sulfur</td>
<td>$4 \times 10^{-5}$ μM$^{-1}$ hr$^{-1}$</td>
<td>17,18</td>
</tr>
</tbody>
</table>

*CB = cyanobacteria; PB = phototrophic sulfur bacteria; SB = sulfate-reducing bacteria
*We assumed a higher diffusive influx for phosphorus than for sulfur and oxygen, because the phosphorus influx also includes phosphorus release from the sediment and remineralization from dead biomass.

### Supplementary References


