Supplement of

Variable particle size distributions reduce the sensitivity of global export flux to climate change

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Figure S1: PRiSM-calculated particle flux profiles with varying surface $\beta$ values. Larger $\beta$ values correspond with smaller particles.
Figure S2: Annual means of all nine monthly time series of global export considered here, computed from all possible permutations of three net primary productivity (NPP) and three e-ratio (export/NPP) algorithms (described in Section 2.2.2). Units are molC m\(^{-2}\) yr\(^{-1}\). NPP algorithm key: VGPM = the Vertically Generalized Production Model (VGPM) (Behrenfeld & Falkowski, 1997); VGPME = the Eppley-VGPM model (Carr et al., 2006); CbPM = the Carbon-based Production Model (Behrenfeld et al., 2005). E-ratio algorithm key: L2000 = Laws et al. (2000); D2005 = Dunne et al. (2005); L2011 = Laws et al. (2011).
Figure S3: All nine monthly $\beta$ versus time-mean normalized export ($\frac{d\beta_{sat}}{dE_{n,sat}}$, unitless) maps considered here. Title colors correspond to the NPP and e-ratio export combinations in Fig. 4a.
Figure S4: Example $\beta$ and time-mean normalized export ($E_n$) time series at the randomly chosen grid points within each ocean region shown in the map. The first letter of each ocean region name denotes the location of the chosen grid point. All $E_n$ time series shown here are derived from combining VGPM NPP and D2005 e-ratio. $\Delta \beta_{\text{sat}} / \Delta E_{\text{sat}}$ values are calculated over the entire SeaWiFS period (September 1997 – December 2010), but we show only a random subset of these years for visual clarity.
Figure S5: Example $\beta$ and time-mean normalized export ($E_n$) time series at the randomly chosen grid point within the SAZ (Subantarctic Zone) denoted in the map in Fig. S4. The NPP and e-ratio algorithms used to derive the $E_n$ time series are denoted above each subplot. $\frac{\partial \beta_{sat}}{\partial E_n_{sat}}$ values are calculated over the entire SeaWiFS period (September 1997 – December 2010), but we show only a random subset of these years for visual clarity.
### Particle parameters

| Parameter | Definition | Units   | Value  |
|-----------|------------|---------|--------|
| $D_L(z' = 0)$ | Largest particle diameter at surface | um | 2000 |
| $D_S(z' = 0)$ | Smallest particle diameter at surface | um | 20 |
| $c_w$ | Coefficient in the relationship between particle sinking velocity and particle size | m$^{(1-\eta)}$ day$^{-1}$ | 2.2e5 |
| $\eta$ | Exponent in the relationship between particle sinking velocity and particle size | Unitless | 1.17 |
| $c_r$ | Degradation rate of sinking particles | day$^{-1}$ | 1/29 |
| $\zeta$ | Exponent in the relationship between particle mass and particle size | Unitless | 1.62 |

### Biogeochemical parameters

| Parameter | Definition | Units | Value |
|-----------|------------|------|-------|
| $\tau$ | Nutrient restoring timescale | days | 30 |
| $\kappa$ | DOP to PO$_4$ first-order decay rate | year$^{-1}$ | 0.5 |
| $\sigma$ | Fraction of production routed directly to DOP in the euphotic zone | Unitless | 0.1 |
| $z_s$ | Nominal mixing depth | m | 115 |

Table S1: PRiSM parameter values (reproduced from Table 1 in DeVries et al., 2014 – see DeVries et al., 2014 for the equations in which the parameters are used)

### Prognostic production scheme parameter values

| Parameter | Definition | Units | Value |
|-----------|------------|------|-------|
| $T_0$ | Reference temperature | °C | 25 |
| $\mu_{max}$ | Maximum growth rate at reference temperature | year$^{-1}$ | 365.25 |
| $K_p$ | Half-saturation coefficient for PO$_4$ uptake | mmol m$^{-3}$ | 0.1 |
| $K_l$ | Saturating light level | W m$^{-2}$ | 40 |
| $k_T$ | Temperature sensitivity of growth | Unitless | 0.03 |
| $m_1$ | Linear mortality rate | year$^{-1}$ | 36.525 |
| $m_2$ | Quadratic mortality rate | year$^{-1}$ mmol$^{-1}$ m$^3$ | 3652.5 |

Table S2: Prognostic production scheme parameter values, with minor differences from those used in Weber and Deutsch (2012). These parameter values were re-derived by matching model surface PO$_4$ values with World Ocean Atlas observations on a 2-degree horizontal grid, in contrast with the 4-degree grid used in Weber and Deutsch (2012).
| Export algorithms | AAZ region | SAZ region | STA region | STP region | ETA region | ETP region | NA region | NP region |
|-------------------|------------|------------|------------|------------|------------|------------|-----------|-----------|
| VGPM NPP + e-ratio from: |            |            |            |            |            |            |           |           |
| Laws 2000         | 0.1139     | 0.3207     | 0.2308     | 0.0504     | 0.0656     | 0.0656     | 0.0478    | 0.0000    |
| Dunne 2005        | 0.1508     | 0.2328     | 0.1677     | 0.0300     | 0.0729     | 0.0729     | 0.0697    | 0.0026    |
| Laws 2011         | 0.0927     | 0.0454     | 0.0975     | 0.0208     | 0.0445     | 0.0445     | 0.1169    | 0.1855    |
| VGPM-Eppley NPP + e-ratio from: |            |            |            |            |            |            |           |           |
| Laws 2000         | 0.1507     | 0.0420     | 0.1419     | 0.0663     | 0.1213     | 0.1213     | 0.1184    | 0.1197    |
| Dunne 2005        | 0.1349     | 0.0212     | 0.0993     | 0.0435     | 0.1516     | 0.1516     | 0.1294    | 0.2379    |
| Laws 2011         | 0.0622     | 0.0036     | 0.0636     | 0.0292     | 0.1080     | 0.1080     | 0.1308    | 0.1211    |
| CbPM NPP + e-ratio from: |            |            |            |            |            |            |           |           |
| Laws 2000         | 0.0478     | 0.2014     | 0.0900     | 0.2688     | 0.1667     | 0.1667     | 0.1263    | 0.0107    |
| Dunne 2005        | 0.1215     | 0.1141     | 0.0640     | 0.2695     | 0.1047     | 0.1047     | 0.1322    | 0.0978    |
| Laws 2011         | 0.1255     | 0.0188     | 0.0451     | 0.2216     | 0.1648     | 0.1648     | 0.1286    | 0.2247    |
| Sum               | 1.00       | 1.00       | 1.00       | 1.00       | 1.00       | 1.00       | 1.00      | 1.00      |

*Table S3: Regional weights for export map calculation (reproduced from Table S2 in Weber et al., 2016)*