Derived parameters:

- Particulate organic matter (POM)

Particulate organic matter (POM) was calculated from POC by multiplying a weight ratio of 1.88 g POM/g POC (Lam et al., 2011; Lam et al., 2017; Lam et al., 2015), determined by Nuclear Magnetic Resonance (NMR) measurements of the phytoplankton biochemical composition (Hedges et al., 2002).

$$\text{POM}\left[\frac{\mu\text{g}}{\text{L}}\right] = \text{POC}\ [\mu\text{M}] \times 12\ \left[\frac{\mu\text{g POC}}{\mu\text{mol POC}}\right] \times 1.88\ \left[\frac{\text{g POM}}{\text{g POC}}\right]$$

- Calcium carbonate (CaCO3)

The mass concentration of $CaCO_3$ was calculated from PIC using a constant weight ratio:

$$\text{CaCO}_3\left[\frac{\mu\text{g}}{\text{L}}\right] = \text{PIC}\ [\mu\text{M}] \times 100.08\ \left[\frac{\mu\text{g CaCO}_3}{\mu\text{mol PIC}}\right]$$

- Opal

A hydrated form of silica as $SiO_2 \cdot (0.4\ H_2O)$ was assumed in order to calculate the mass concentrations of opal (Mortlock and Froelich, 1989):

$$\text{Opal}\left[\frac{\mu\text{g}}{\text{L}}\right] = \text{bSi}\ [\mu\text{M}] \times 67.2\ \left[\frac{\mu\text{g opal}}{\mu\text{mol bSi}}\right]$$

- Lithogenic particles (Litho)

Aluminum (Al) is highly abundant in the crust and relatively invariant between two main lithogenic sources, upper continental crust (UCC Al = 8.04 wt%) and bulk continental crust (BCC Al = 8.41 wt%) (Taylor and McLennan, 1995), serving as an appropriate tracer for lithogenic particles. We assumed that most of particulate Al originates from lithogenic sources and use UCC Al wt% to calculate concentrations of lithogenic particles in the western Arctic Ocean.

$$\text{LITHO}\left[\frac{\mu\text{g}}{\text{L}}\right] = \text{Al}\ [\text{nmol/L}] \times 27\times10^{-3}\ \left[\frac{\mu\text{g}}{\text{nmol}}\right] / 0.0804\ \left[\frac{\mu\text{g Al}}{\mu\text{g UCC}}\right]$$

- Fe and Mn (oxy)hydroxide (Fe(OH)3 & MnO2)

Excess Fe and Mn beyond their lithogenic contributions were assumed to be Fe and Mn (oxy)hydroxide and calculated by subtracting the lithogenic Fe and Mn from the totals. The UCC Fe/Al (0.211) and Mn/Al (0.00367) ratios were used in the lithogenic corrections. Fe oxyhydroxides are treated as $Fe(OH)_3$ (ferrihydrite approximation) and Mn oxides are as MnO_2 (birnessite approximation). We apply the formula weights of 106.9 g $Fe(OH)_3$/mol Fe and 86.9 g MnO_2/mol Mn, respectively. Negative numbers were set to 0.

$$\text{Fe(OH)}_3\left[\frac{\mu\text{g}}{\text{L}}\right] = \left(\text{Fe}\ [\text{nM}] - \left(\text{Al}\ [\text{nM}] \times 0.211\ \left[\frac{\text{nmol Fe}}{\text{nmol Al}}\right]\right)\right)$$

$$\times 106.9\ \left[\frac{\text{ng Fe(OH)}_3}{\text{nmol Fe}}\right] \times [10^{-3}\ \mu\text{g/ng}]$$

$$\text{MnO}_2\left[\frac{\mu\text{g}}{\text{L}}\right] = \left(\text{Mn}\ [\text{nM}] - \left(\text{Al}\ [\text{nM}] \times 0.00367\ \left[\frac{\text{nmol Mn}}{\text{nmol Al}}\right]\right)\right)$$

$$\times 86.9\ \left[\frac{\text{ng MnO}_2}{\text{nmol Mn}}\right] \times [10^{-3}\ \mu\text{g/ng}]$$

- SPM

Direct comparisons between gravimetric and chemical dry weight have been made in the equatorial Atlantic, and they were found to be quite similar to each other (Bishop et al., 1977). The chemical dry weight is used to estimate SPM for each size fraction in this paper, as the sum of all major particle composition, which is the sum of POM, $CaCO_3$, opal, lithogenic material (Litho), and Fe and Mn (oxyhydr)oxides. Negative numbers show up in major particle composition when concentrations are below the detection limit. When adding each major particle composition up to calculate the SPM, negative numbers in different components are regarded as 0.

$$\mathrm{SPM}\left[\frac{\mu g}{L}\right] = \mathrm{POM}\left[\frac{\mu g}{L}\right] + \mathrm{CaCO_3}\left[\frac{\mu g}{L}\right] + \mathrm{OPAL}\left[\frac{\mu g}{L}\right] + \mathrm{LITHO}\left[\frac{\mu g}{L}\right]$$

$$+ \mathrm{Fe(OH)_3}\left[\frac{\mu g}{L}\right] + \mathrm{MnO_2}\left[\frac{\mu g}{L}\right]$$

Note that the resolution of this data is dictated by the lowest resolution of the component parts.