Size-fractionated measurements of phytoplankton absorption: How representative are current models and how do they influence estimates of shelf sea primary production?

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Temperate shelf seas contain some of Earth's most productive environments and often exhibit strong seasonal changes in pelagic biogeochemistry, influenced by phytoplankton dynamics. Measurements and models of the primary production (PP) of individual phytoplankton functional types or size-fractions benefit our understanding of their role in shelf sea ecology and biogeochemistry. Spectral models of PP that incorporate multiple phytoplankton size classes require group-specific parameterisation of photo-physiology. Though increasingly common for photosynthetic rate parameters, size-fractionated (S-F) measurements of specific absorption coefficients (a*ph) from natural populations are limited, particularly in shelf seas.

From two cruises in the Celtic Sea during August 2014 & April 2015 we present measurements of S-F phytoplankton absorption using pre-filtration of samples at 20 μm & 2.0 μm and compare values to spectra from existing models of a*ph (Ciotti et at 2002; Uitz et al, 2008; Brewin et al, 2011; Varunan & Shanmugam, 2015). These modelled and measured values of a*ph were used in the calculation of S-F PP using a coincident dataset of S-F photosynthetic parameters. Measured a*ph spectra were highly variable, with differences between surface mixed layer and sub-surface chlorophyll maximum samples only significant for nanophytoplankton. Mean a*ph spectra of nano and picophytoplankton were significantly lower than the models of Uitz et al (2008) and Varunan & Shanmugam (2015) and higher than those of Ciotti et al (2002).

Comparisons of modelled daily PP indicate that the spectra of Uitz et al (2008) produce the most representative estimates of daily integrated PP (g C m-2 d-1), with differences in the vertical distribution of PP (g C m-3 d-1)between models. The agreement in modelled integrated S-F PP using measured a*ph spectra and those from the model of Uitz et al (2008) provides validation for the use of modelled spectra despite differences in the shape and magnitude of a*ph between datasets.