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The effect of seasonality in phytoplankton community composition on carbon uptake on the Scotian Shelf, northwest Atlantic

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The short, but intense spring bloom, occurring late March to early April on the Scotian Shelf in the northwest Atlantic draws down approximately 50% of the total carbon fixed over the annual cycle in this region. In the spring and summer months following the collapse of the bloom, nutrient and chlorophyll levels plummet suggesting that further drawdown of carbon by phytoplankton will be severely limited. However, examination of the seasonality of the surface water partial pressure of CO_2 (pCO_2), measured by a CARIOCA buoy moored for several years on the Scotian Shelf, reveals that there is persistent net carbon drawdown throughout the nutrient poor, shallow mixed layer conditions of the warmer summer months at an order of magnitude comparable to that observed during the spring bloom. Using a combination of satellite ocean colour and a comprehensive in situ validation dataset consisting of phytoplankton absorption and cell counts, we employ a newly developed optical model to first accurately derive phytoplankton absorption spectra, aph(λ), from satellite reflectance, and then to estimate the dominant phytoplankton size class from aph(λ) spectral shapes. We show that despite the low chlorophyll concentrations throughout the summer (typically < 1 mg m-3), a phytoplankton community dominated by numerically abundant pico- (< 2 μm) and nano- (2-20 μm) sized cells is responsible for the net carbon drawdown evident in the pCO_2 record, suggesting that, in this shelf system, chlorophyll concentration may be a poor proxy for biomass. We then consider seasonal patterns in net community production (NCP) in the context of the seasonality in phytoplankton size structure and suggest that more accurate estimates of carbon drawdown could be obtained through optically based approaches that move beyond simple chlorophyll-centred estimates of biomass.