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Role of photoacclimation on phytoplankton's seasonal cycle in the Mediterranean Sea through satellite ocean color data

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Photoacclimation changes the intracellular chlorophyll-a concentration (Chl), a process that is not currently taken into account by standard ocean colour algorithms. The cellular Chl production is an energy-demanding process, so that it occurs when nutrients are available and under light limiting conditions. Historically, Chl has been used as a proxy for marine algal biomass. This work aims at comparing Chl-based with Carbon-based estimates calculated from the particulate backscattering coefficient, bbp (λ) (Behrenfeld et al., 2005). The equation for the phytoplankton carbon biomass is $C = (bbp(443) - bbpNAP(443))SF$, where $bbpNAP(443)$ represents the contribution of non algal particles to $bbp(443)$ and is a constant value, and SF a scalar factor (13,000 mg C m^{-2}) to match the carbon biomass units. Here we allow $bbpNAP$ to vary monthly over the Mediterranean SeaWiFS time series, and use the 555 nm channel for coherence with the method used to derive SF (Loisel et al., 2001). The comparison between the two methods yields the Mediterranean Sea to be 2 to 7 times lower, and closer to the real system variability as measured by in situ observations. In both methods, the Chl:C ratio is the footprint showing that phytoplankton cells enhance the major photosynthetic pigment production to optimize photosynthesis under low light regime and high nutrients (e.g., winter). Minimum Chl:C ratio values are observed during summer when photoinhibition is the dominant intracellular process. We suggest that a new proxy for phytoplankton biomass is strongly needed, particularly for the Mediterranean Sea, where Chl:C ratio varies of 1 order of magnitude, clearly highlighting dominance of photoacclimation at seasonal and basin scales.