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Interannual variability of the Mediterranean trophic regimes from ocean color satellites

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Abstract. D'Ortenzio and Ribera d'Alcalà (2009, DR09 hereafter) divided the Mediterranean Sea into "bioregions" based on the climatological seasonality (phenology) of phytoplankton. Here we investigate the interannual variability of this bioregionalization. Using 16 years of available ocean color observations (i.e., SeaWiFS and MODIS), we analyzed the spatial distribution of the DR09 trophic regimes on an annual basis. Additionally, we identified new trophic regimes, exhibiting seasonal cycles of phytoplankton biomass different from the DR09 climatological description and named "Anomalous". Overall, the classification of the Mediterranean phytoplankton phenology proposed by DR09 (i.e., "No Bloom", "Intermittently", "Bloom" and "Coastal"), is confirmed to be representative of most of the Mediterranean phytoplankton phenologies. The mean spatial distribution of these trophic regimes (i.e., bioregions) over the 16 years studied is also similar to the one proposed by DR09, although some annual variations were observed at regional scale. Discrepancies with the DR09 study were related to interannual variability in the sub-basin forcing: winter deep convection events, frontal instabilities, inflow of Atlantic or Black Sea Waters and river run-off. The large assortment of phytoplankton phenologies identified in the Mediterranean Sea is thus verified at the interannual scale, further supporting the "sentinel" role of this basin for detecting the impact of climate changes on the pelagic environment.

1 Introduction

The Mediterranean Sea is one of the oceanic regions most impacted by climate change (Giorgi, 2006; Giorgi and Lionello, 2008). These important environmental modifications are supposed to strongly modify the dynamics of the Mediterranean marine ecosystems (The Mermex Group, 2011), by modifying the food web structure (Coll et al., 2008), triggering regime shifts (Conversi et al., 2010) or unexpected events (e.g., jellyfish blooms, Purcell, 2005), which should have strong consequences on human activities. In the context of climate change, phytoplankton plays a key role, because any perturbations on its dynamics would affect the rest of the marine food web (Edwards and Richarson, 2004). In a relatively small semi-enclosed sea, such as the Mediterranean, those kinds of processes should be particularly accelerated. A modification of the phytoplankton communities could impact the whole ecosystems much more rapidly than in other oceanic regions (Siokou-Frangou et al., 2010).

In the Mediterranean, as in many of the oceanic regions, the phytoplankton dynamics are characterized by a strong spatio-temporal variability (Estrada, 1996; Mann and Lazier, 2006), determined by the concomitant influence of several biotic and abiotic factors (Williams and Follows, 2003; Mann and Lazier, 2006). The link between abiotic factors and phytoplankton variability, in the Mediterranean Sea, has been mainly inferred by using satellite ocean color data (Antoine et al., 1995; Bosc et al., 2004; Mélin et al., 2011; Volpe et al., 2012). Based on band-ratio algorithms that infer surface chlorophyll *a* concentration (considered as a proxy of phy-

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