Interannual variability of the Mediterranean seascape based on phytoplankton phenology detected from satellite observations

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Mediterranean marine ecosystems are tremendously impacted by climate change, leading to profound consequences on the structure and services provided by living communities, starting from primary producers and circulation patterns. Hence, the Mediterranean seascape is changing, which might directly affect the management and conservation of marine ecosystems and, thus, the livelihood of about 500 million people around the basin. Various studies have attempted to define the Mediterranean seascape objectively using satellite-derived surface chlorophyll-a concentration (as a proxy for phytoplankton) or other methods, such as circulation patterns described by hydrological models. Yet, the inter-annual variability of the resulting regionalization has not been fully addressed, much less the link with climate. Within the ESA 4DMED-Sea project, we explored 26 years (1998-2023) of daily satellite-derived chlorophyll-a images at 1 km of spatial resolution from which the interannual variability of the Mediterranean pelagic seascape was assessed. The research specifically applied two distinct clustering techniques confirming the existence of seven major ecoregions in the Mediterranean Sea based on the phenology of phytoplankton. The average chlorophyll seasonal cycle was revealed to be different for coastal regions to previous works, indicating the complexity of the pelagic ecosystem. The analysis also showed high inter-annual variability for most regions except those associated with oligotrophic low chlorophyll environments, further highlighting the intricate nature of these ecosystems. Thus, we have mapped the areas with the highest variability and attempted to relate them with temperature trends, circulation patterns, and climatic indices to assess the drivers of changes.