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Combination of automated approaches for the characterization of spatial and temporal variability of phytoplankton dynamics, at high resolution, in coastal waters.

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Monitoring of coastal waters is of upmost importance for understanding physical, biogeochemical and biodiversity fundamental processes as well as for addressing changes that could be driven by anthropogenic pressure and/or global change and that would need to be managed in the frame of environmental policy. Phytoplankton micro-organisms, which are at the base of most food webs, mediate biogeochemical cycles and can be responsible for harmful events (HABs). Moreover, changes in their community's growth rate, size structure, taxonomic and/or pigmentary composition, can occur at different time and spatial scales, evidencing rapid as well as long-term changes in environmental conditions. Currently, phytoplankton monitoring is based on discrete sampling and reference laboratory methods such as microscopic identification and counts, as well as pigment analysis. However, sampling frequency (fortnightly to monthly) and spatial cover (mainly in coastal single stations) might not be sufficient to fully understand and evidence of phytoplankton dynamics in marine waters. Therefore, in order to better understand phytoplankton changes and to increase both the spatial and temporal resolution and automated in approaches are being deployed during the last decade. Whether being less precise in identifying different phytoplankton taxa or pigmentary groups than in vitro laboratory techniques (including molecular methods), these innovative approaches provide new insights into phytoplankton dynamics and thus allow gathering useful complementary information for robust calculation of indicators, which are crucial for better defining the environmental state, trends and potential regime shifts within marine ecosystems. Moreover, when implemented in automated environmental monitoring platforms, as fixed stations, moorings, research vessels and/or ships of opportunity, these techniques can represent early-warning systems of phytoplankton changes, as the occurrence of blooms and, in particular, of harmful algal blooms (HAB), of special interest in areas of fishing, aquaculture and tourism. Therefore, there is an urgent need to improve the operability and discrimination of automated techniques addressing phytoplankton diversity (at taxonomical and/or functional levels) and productivity. Within the Joint European Research Infrastructure network for Coastal Observatories – Novel European expertise for coastal observatories (JERICO-Next – H2020, 2015-2019), scientists are applying a combination of phytoplankton automated observation approaches, based on single cell/particle or bulk optical characteristics, in several coastal systems ranging from oligotrophic (West Mediterranean) to mesotrophic and eutrophic systems (Channel, North Sea, Baltic). Three main techniques, image in flow acquisition and analysis, pulse shape-recording flow cytometry, as well as multispectral and variable fluorometry, are being critically explored, new information gathered on phytoplankton dynamics in coastal marine waters is presented and remaining challenges are discussed in the frame of fundamental and operational oceanography and environmental policy requirements.