Improving Quality Control and detecting extreme events through Multivariate analysis. A case study in the Cretan Sea."

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In recent years, the impact of extreme weather events, driven by climate change, has been increased but poorly monitored in dynamic coastal areas. This study addresses, firstly, the need for additional high quality control (QC) of physical-biochemical data from the coastal environment and, secondly, the satellites inadequately monitoring of extreme weather events signals on ocean variables (e.g. Chl-a). In situ data of seawater temperature (T), salinity (S), chlorophyll-a (Chl-a), dissolved oxygen (DO) and turbidity (Tur) were used from September 2022 to February 2023 with high-frequency (1 h) temporal resolution from a moored CTD system equipped with biochemical sensors located at the Underwater Biotechnological Park seafloor observatory (UBPC, N35.35° E25.28°, 20 m depth). An advanced multivariate (MT) test is applied to all measured variables to achieve high QC data and to detect suspicious values that would have been flagged as erroneous without the MT application. The use of a dynamic threshold for flagging bad values and a full covariance test between all measured variables was able to detect extreme events showing unusual (e.g. abrupt) changes of the variables signal. Meteorological (rainfall, wind) high frequency (3 h) in situ time series from 2019 to 2023 were used for the extreme events identification (i.e. exceeding the 95th percentile threshold). A threshold of 8.6 mm in 3 hours is set for extreme rainfall and 4.4 m/s for wind speed. The MT test applied to the time series (T, S, Chla, DO, Tur) increased the amount of good data (20%) that were flagged as bad without MT application, and detected two extreme events over the 5-month study period (rain and wind). The study focuses on an extreme rainfall event in mid-October, revealing strong (>60%) rapid (within 5-6h) changes of S and Tur variables. Changes of S, Tur started immediately (hours) after the event and lasted for about 4 days before returning to the pre-event state. Increases in Chla (60%) and DO (40%) concentration started with a lag of 5 days lasting for more than 6 days. In addition, three satellite Chl-a products were tested at the specific area and time period and found to be insufficient to fully capture the timing and magnitude of extreme events on coastal Chl-a concentrations. Emphasizing the need for comprehensive monitoring in dynamic environments, the study suggests the use of multivariate QC test to distinguish outliers from natural variability indicative of extreme events, providing critical insights for understanding oceanic impacts on hydrodynamic properties and ecosystem functioning. As a next step, full covariance testing could be incorporated into near real-time QC procedures for high quality data to support data assimilation or hindcast modeling studies, and algorithms developed and trained on such data would be able to detect extreme

events.