Effectiveness of an operational forecasting system to predict anomalous 2022 water formation and intense bloom event in the southeastern Mediterranean Sea

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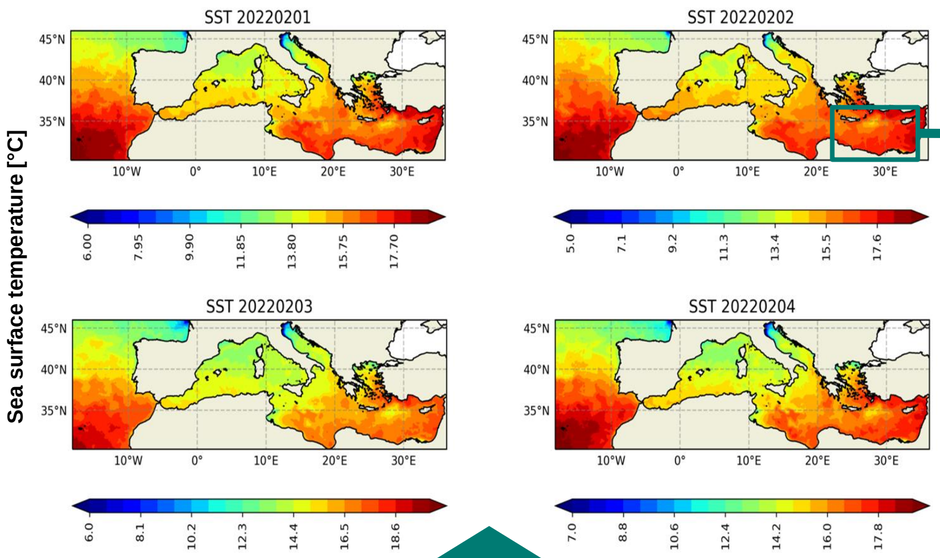
Mediterranean analysis and forecast

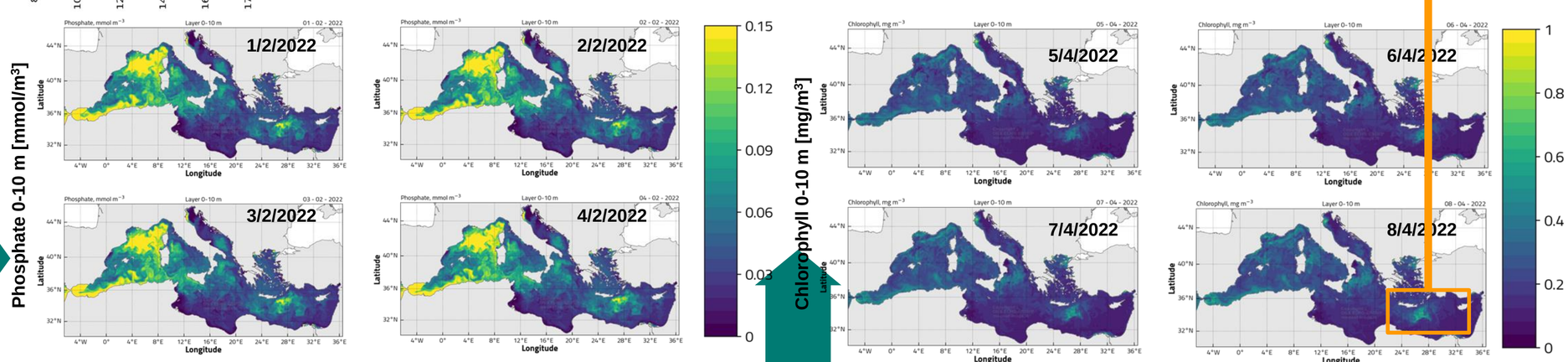
In the framework of the **Copernicus Marine Service** (marine.copernicus.eu), the operational near real time analysis and forecast products for the Mediterranean Sea marine physics and biogeochemistry highlighted an anomalous event in the **eastern Mediterranean Sea** starting in **late winter** and evolving until **spring 2022**.

Late winter-spring 2022 event

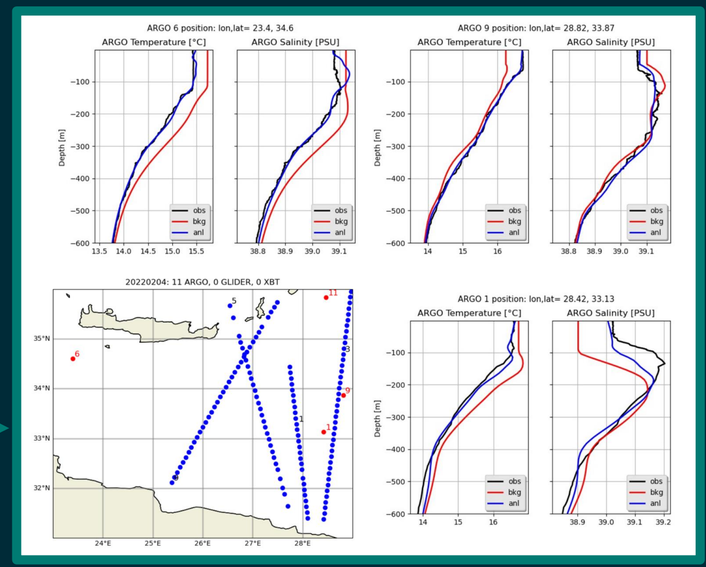


Starting in **February 2022** in the Levantine sub-basin in the eastern Mediterranean Sea **low sea surface temperature (SST)** was detected as well as **high nutrient concentration**.

An intense **phytoplankton bloom** occurred in the same area in early **April 2022**.

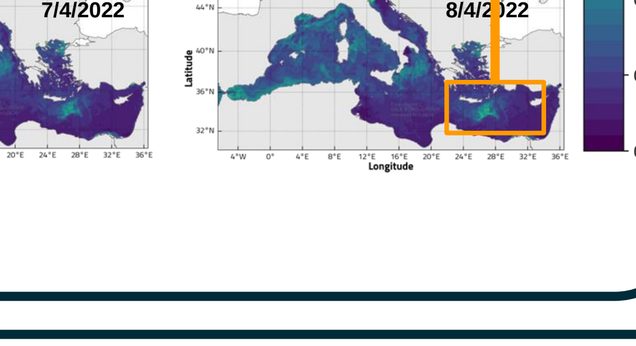


Observations



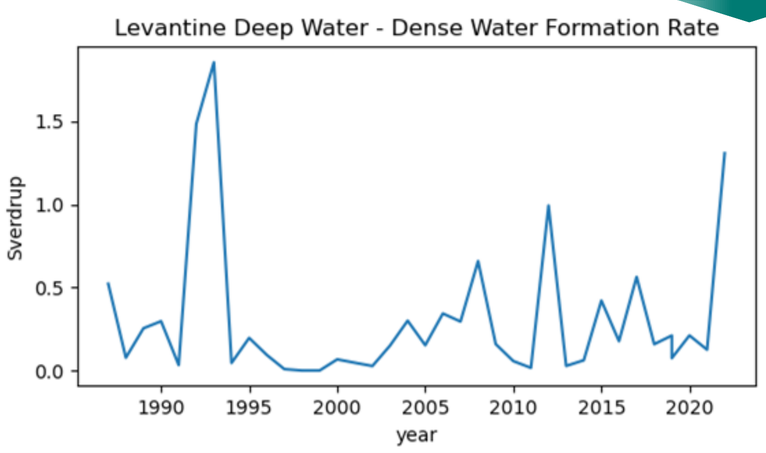
In-situ physics observations are not available at the time and location of the event. ARGO profilers (black) in the region show a discrepancy with the model estimate (red) which are corrected by the analysis (blue).

Chlorophyll concentrations estimated from satellite observations show a bloom in the Levantine sub-basin consistent with the model analysis and forecast product.
The observed bloom intensity is equal to 0.13 mg/m^3 on average with peaks close to 0.4 mg/m^3.

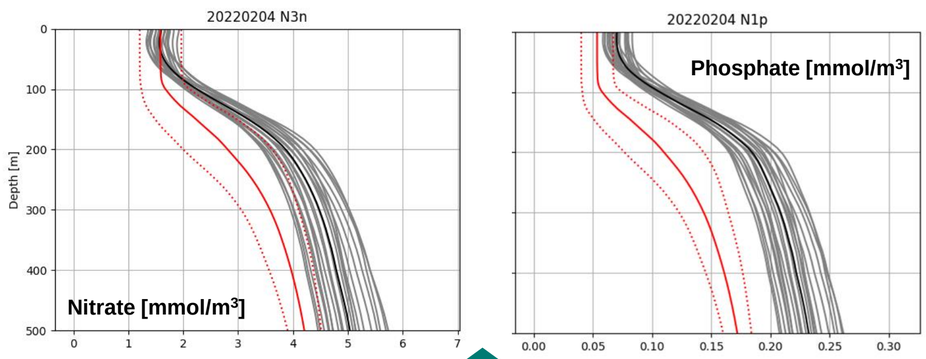


Comparison with past events and reanalysis

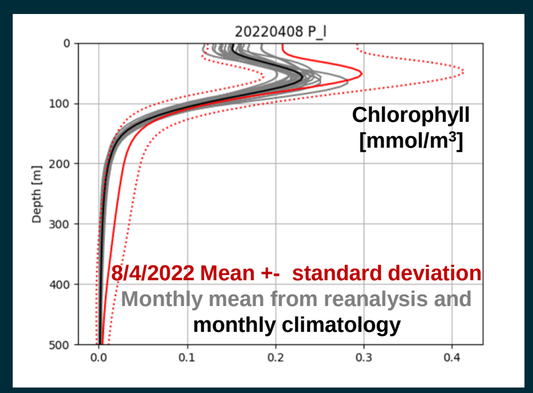
The beginning of year 2022 shows a **dense water formation** rate, the second largest since 1987.



4/2/2022 Mean +- standard deviation
Monthly mean from reanalysis (1999-2020) and monthly climatology



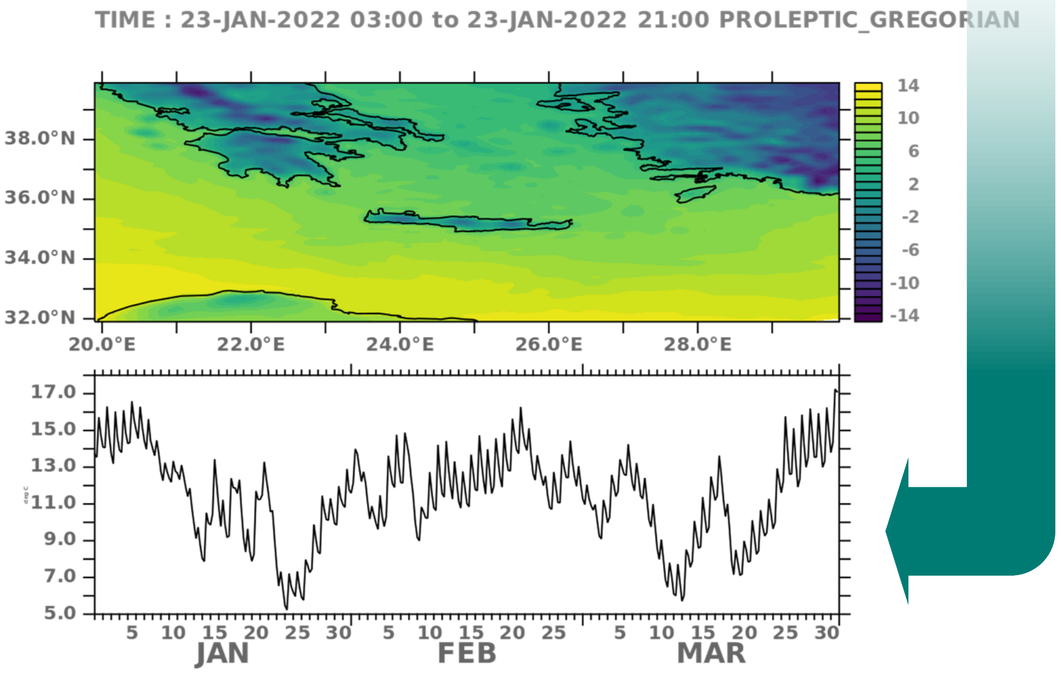
In the Levantine in February, nutrients from near real time forecasts (red) show a **deeper nutricline** than reanalysis (grey and black), both for phosphate and nitrate.

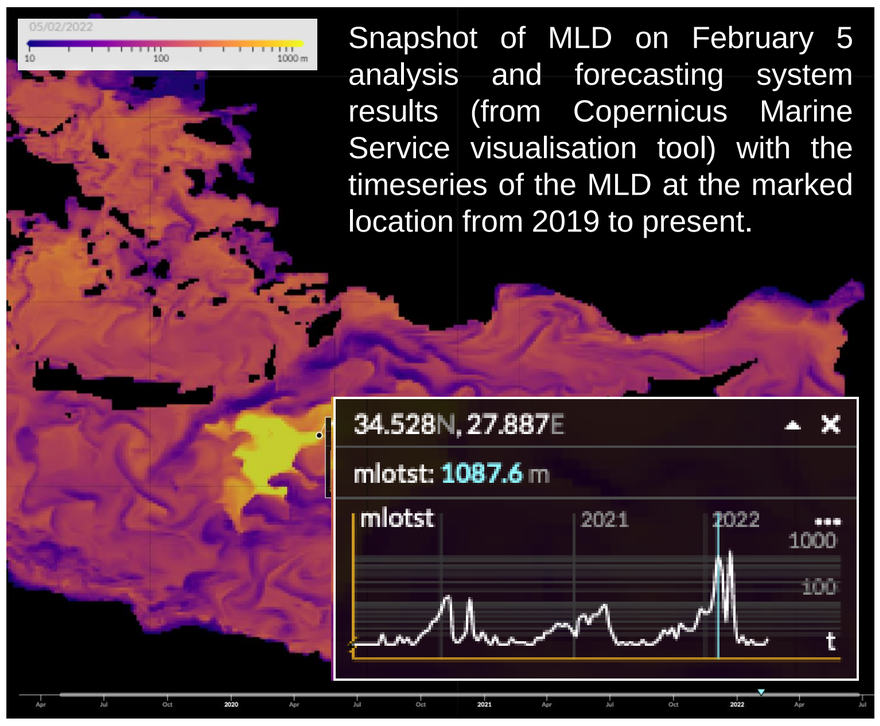


In April 2022, after the mixing that brings nutrient close to the surface, near real time chlorophyll concentrations are higher than reanalysis in the Cretan area.

Looking at the event causes

The timeseries of the 2m air temperature from the ECMWF analysis between 1/1-31/3 2022 in the Cretan Sea and surrounding land shows two intense **cooling episodes** in the southeastern Europe.





Snapshot of MLD on February 5 analysis and forecasting system results (from Copernicus Marine Service visualisation tool) with the timeseries of the MLD at the marked location from 2019 to present.

The cooling results in a **deepening of the mixed layer** in the southeast Crete where there is a dense water formation.

The near real time analysis and forecast system for Mediterranean Sea physics and biogeochemistry in the Copernicus Marine Service captured anomalous SST, nutrient concentration and bloom event in the eastern Mediterranean in late-winter and spring 2022.

Causes of the event are to be searched in the winter cooling episodes and consequent deep dense water formation.

Further investigation can be focused on the possible role played by atmospheric deposition on the phytoplankton bloom event.