

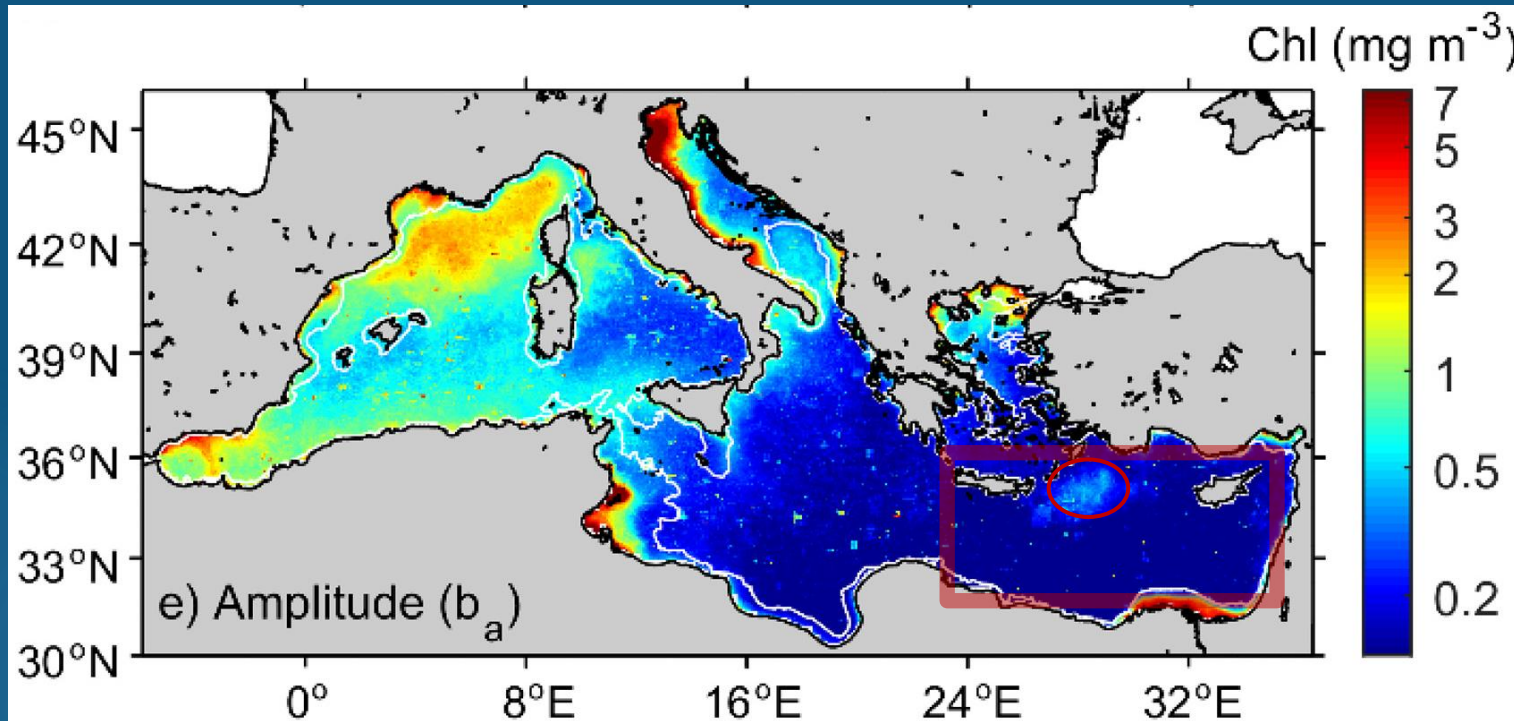
Using Copernicus operational models and observations to investigate the 2022 anomalous spring event in the eastern Mediterranean



ANNA TERUZZI AND COLLABORATORS FROM COPERNICUS MARINE MEDITERRANEAN MFC, OCEAN COLOUR AND SEA SURFACE TEMPERATURE TAC



Background

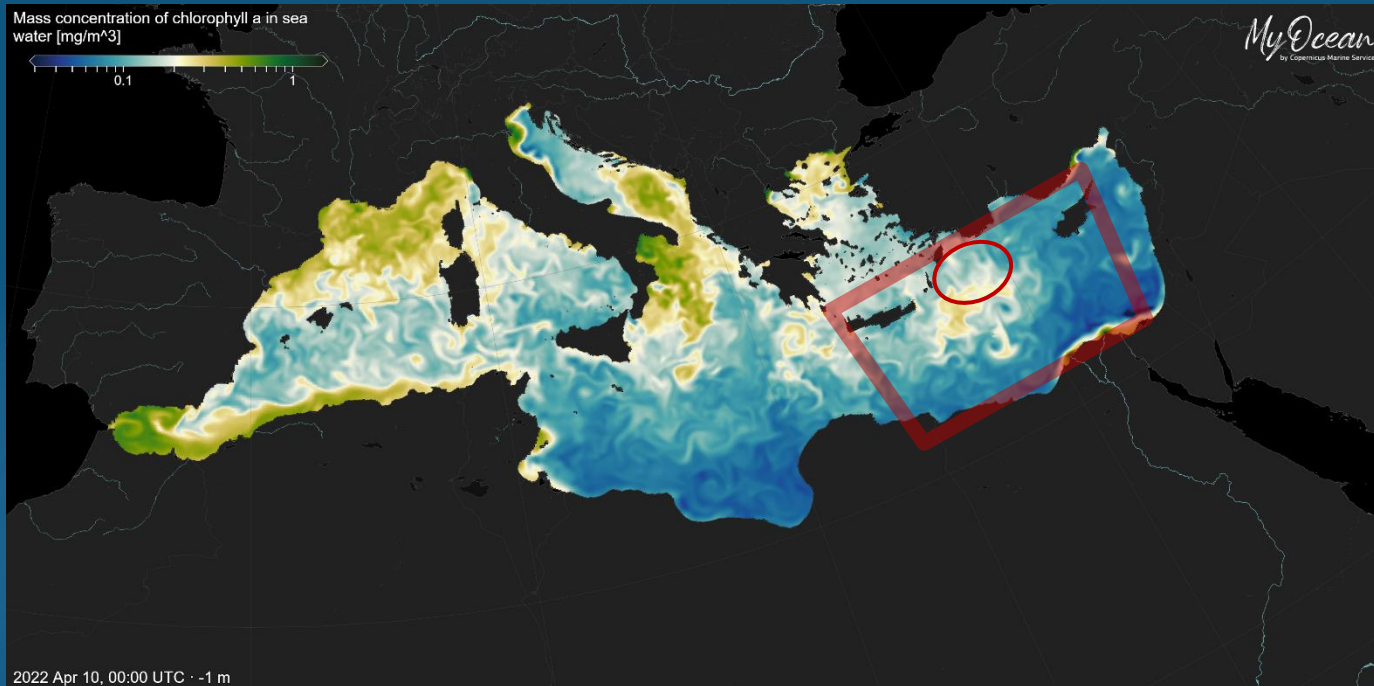


Salgado-Hernanz
et al. (2019)
Chlorophyll mean
amplitude of the
winter bloom

- Eastern Mediterranean oligotrophy with local variability
- Rhodes gyre productive zone with bloom peak at beginning of March

2022 anomalous phytoplankton bloom

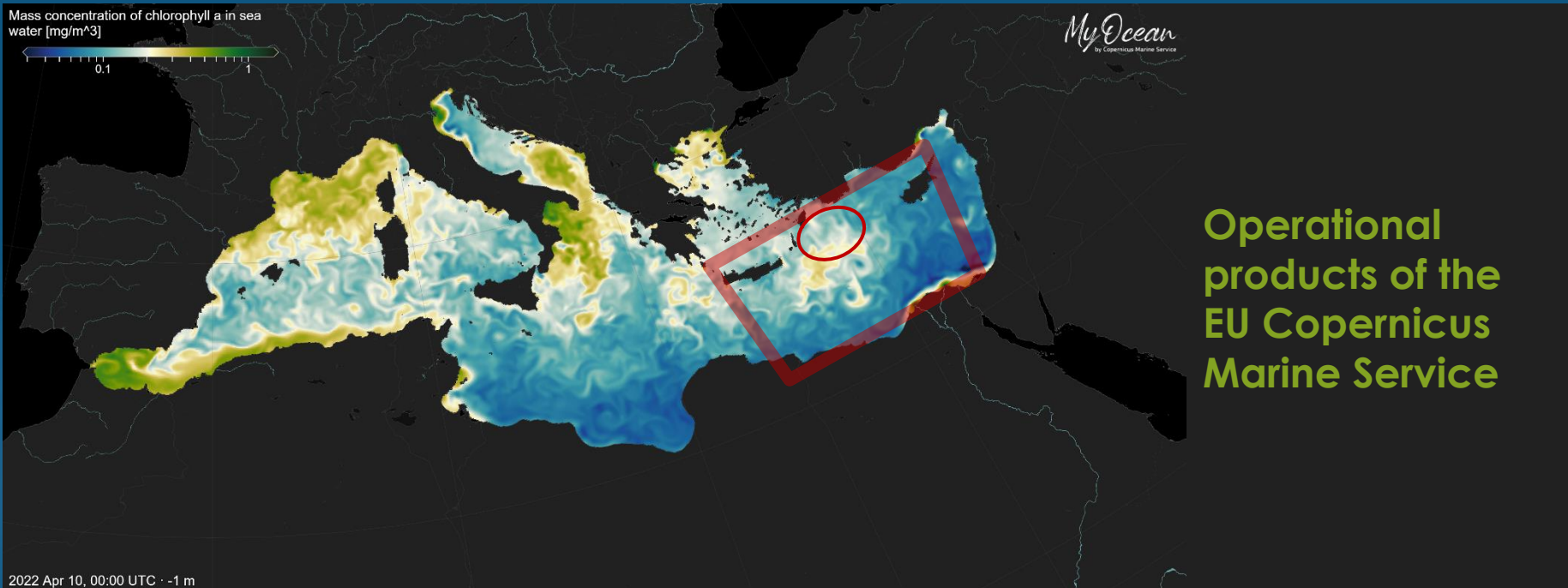
► Intense April 2022 phytoplankton bloom in the Cretan area



- Detection through observations and model products
- Identification of drivers
- Characterization of physics and biogeochemistry of the event

2022 anomalous phytoplankton bloom

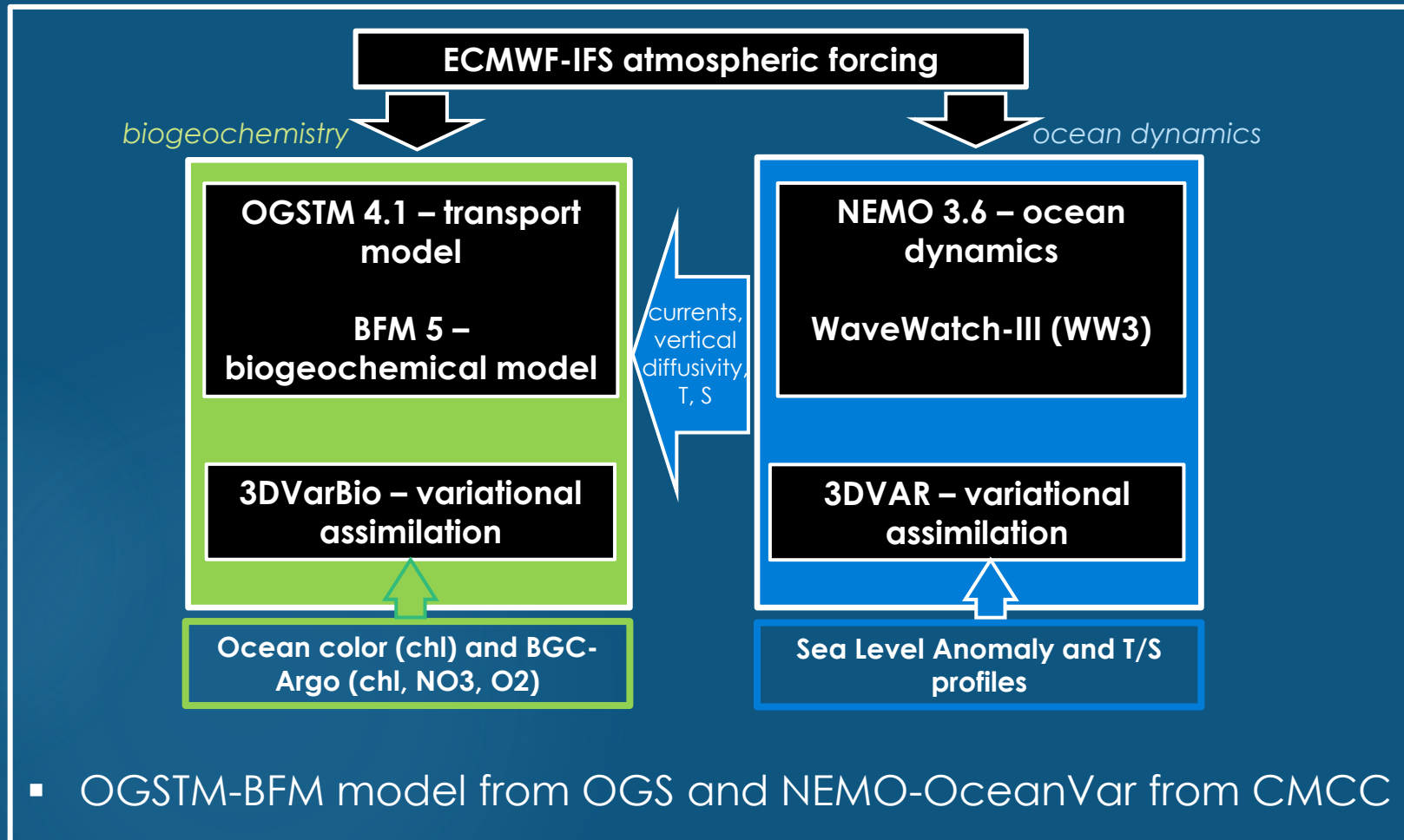
► Intense April 2022 phytoplankton bloom in the Cretan area



- OGSTM-BFM model from OGS and NEMO-OceanVar from CMCC
- Ocean colour from and sea surface temperature from CNR
- Atmospheric forcings from ECMWF



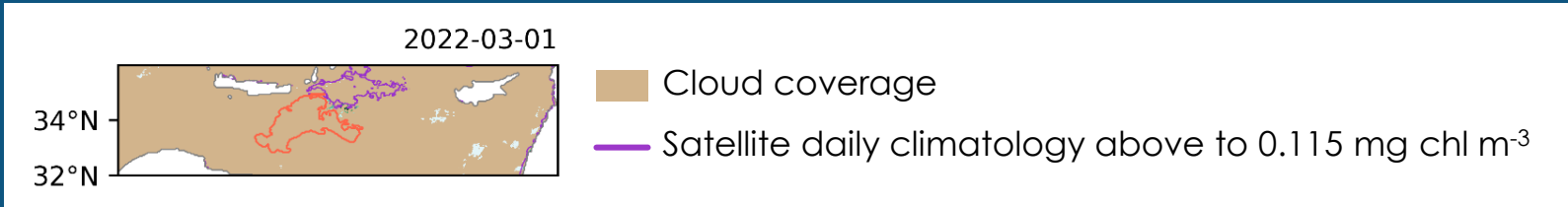
2022 anomalous phytoplankton bloom



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Detection of the bloom

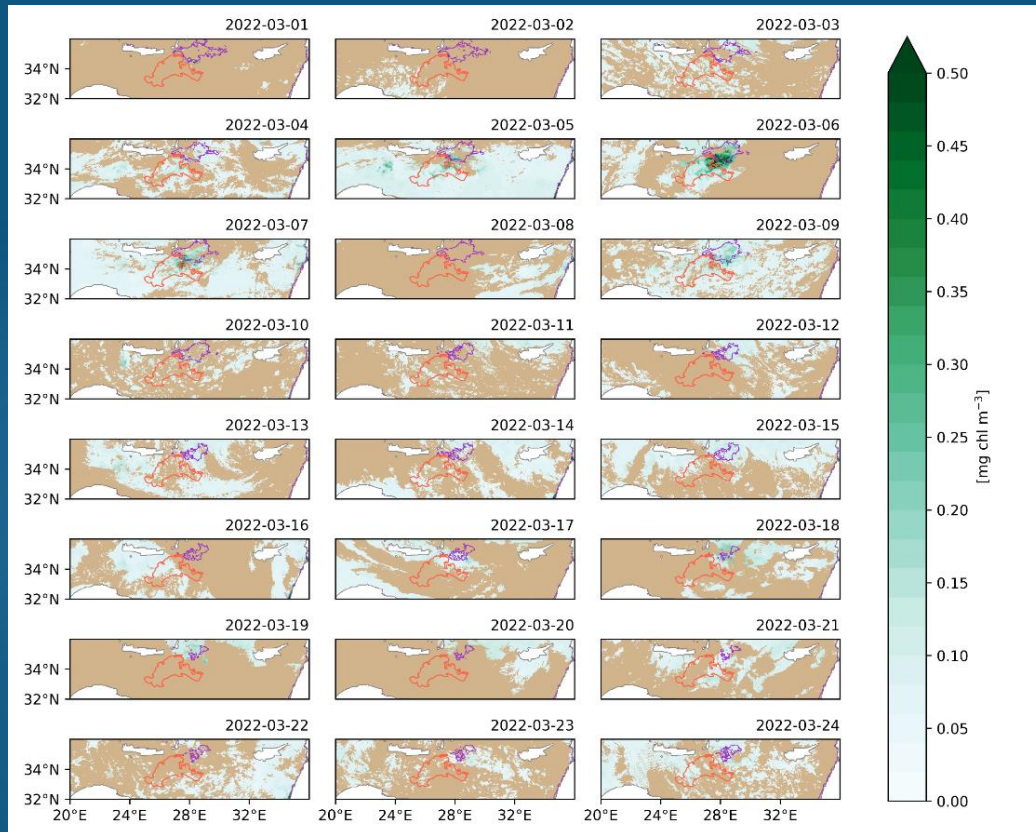
Ocean colour chlorophyll



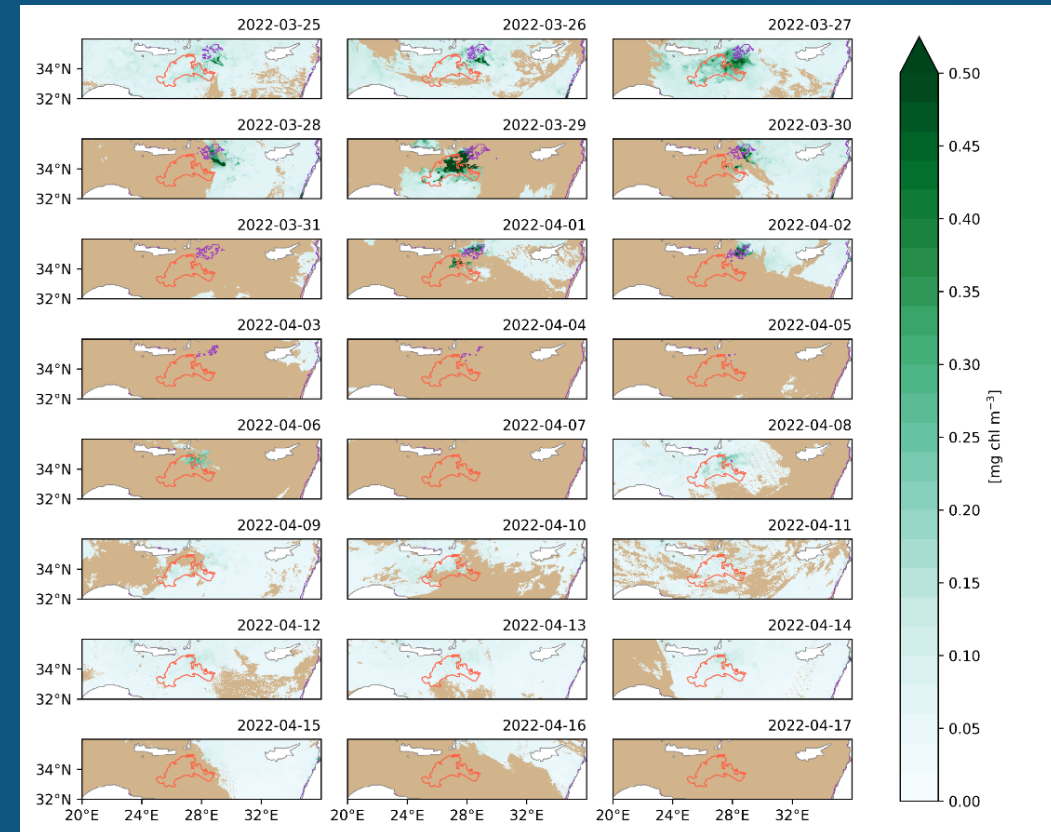
Detection of the bloom

Ocean colour chlorophyll

1 March – 24 March 2022



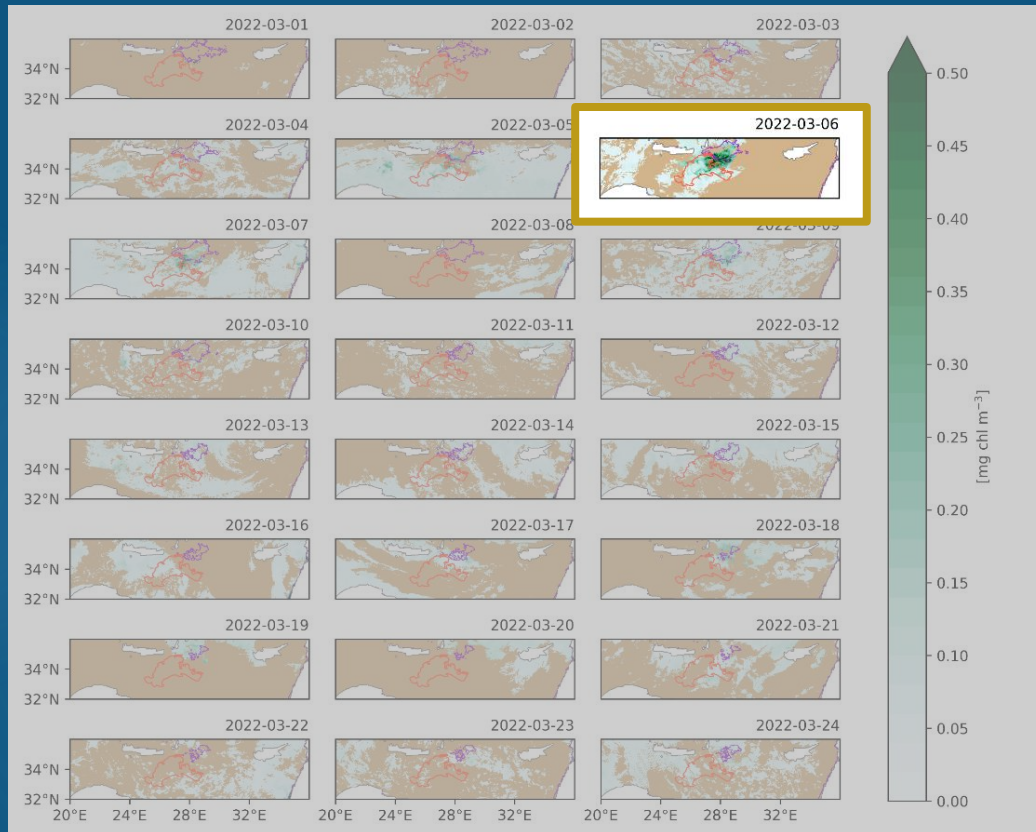
25 March – 17 April 2022



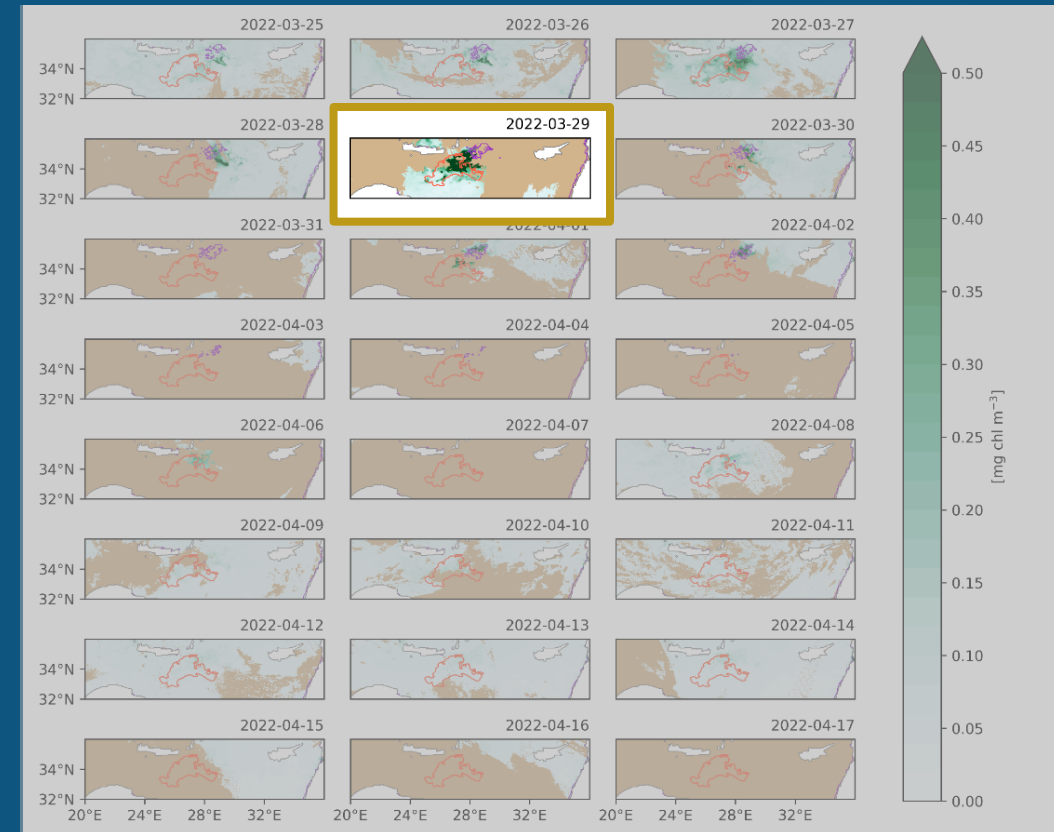
Detection of the bloom

Ocean colour chlorophyll

1 March – 24 March 2022

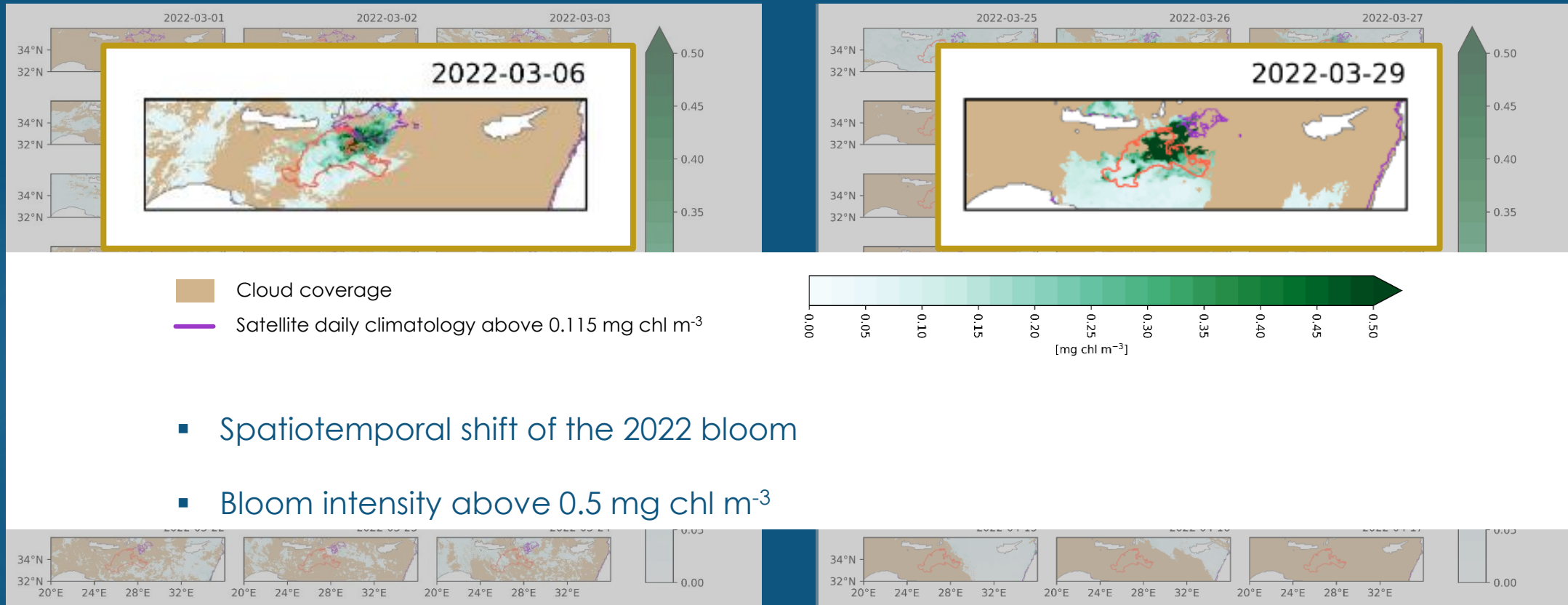


25 March – 17 April 2022



Detection of the bloom

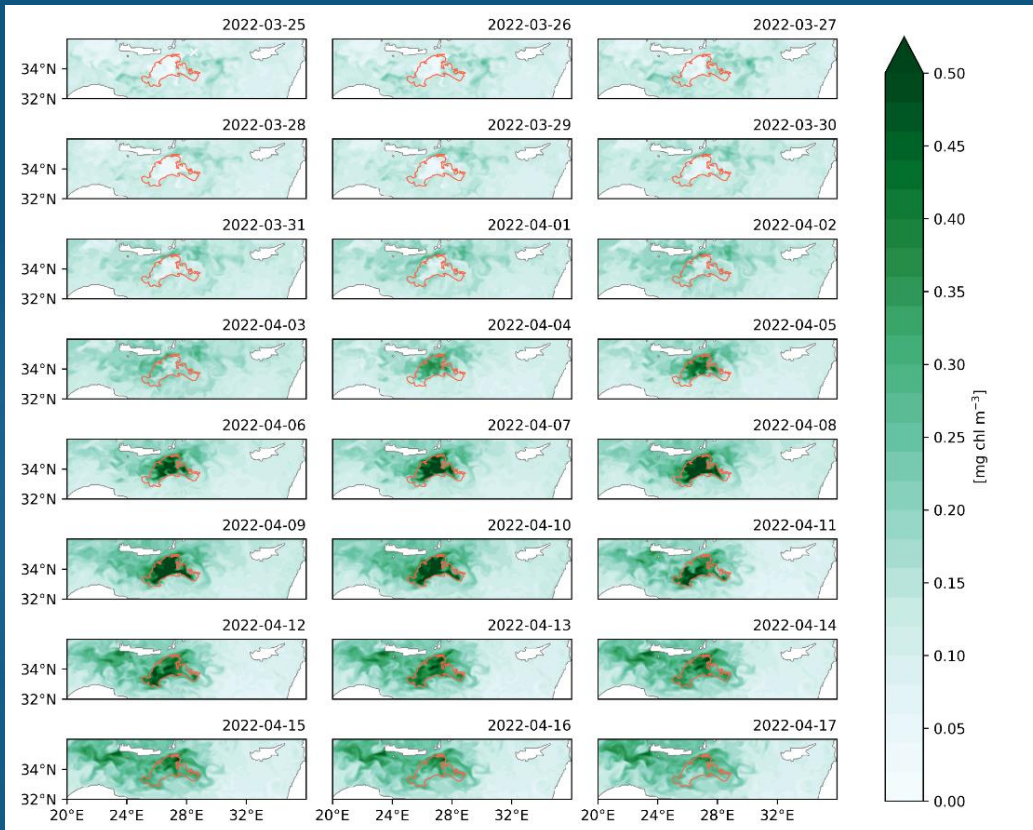
Ocean colour chlorophyll



Detection of the bloom

Model chlorophyll

1 March – 24 March 2022

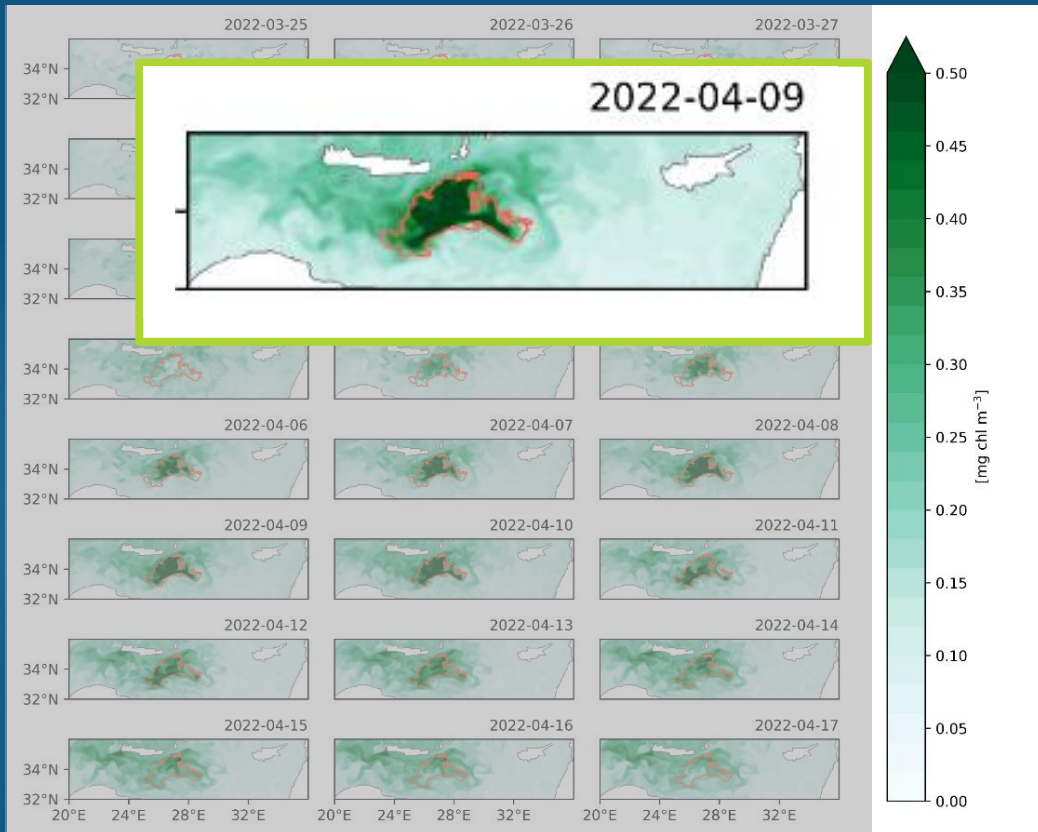


- Model bloom peak on 9 April
- Bloom intensity well simulated
- Temporal mismatch

Detection of the bloom

Model chlorophyll

1 March – 24 March 2022

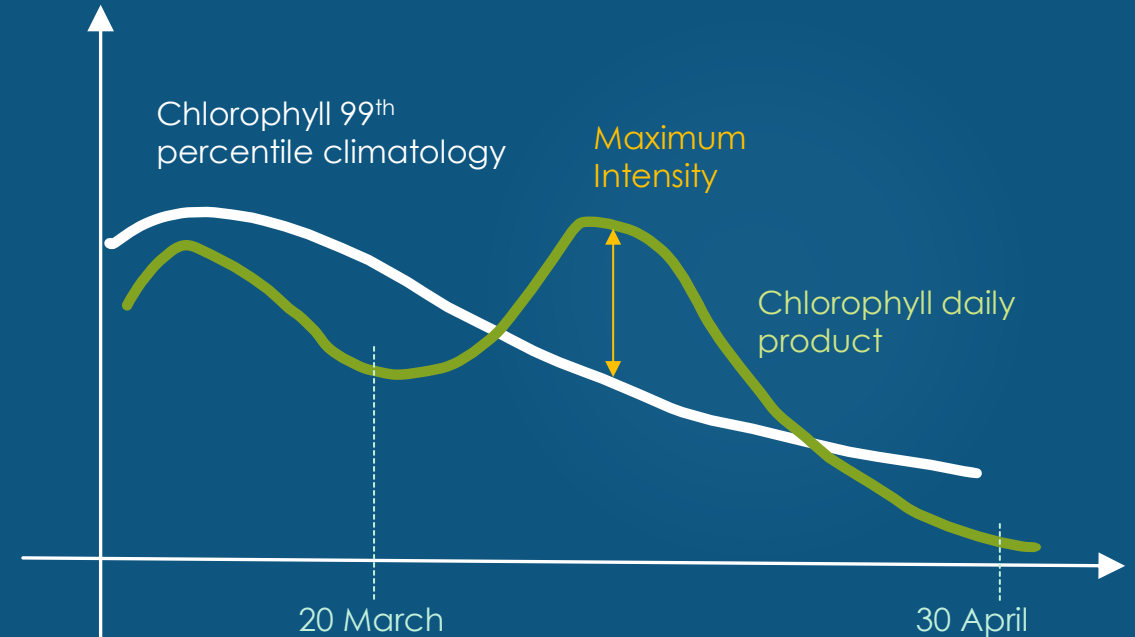
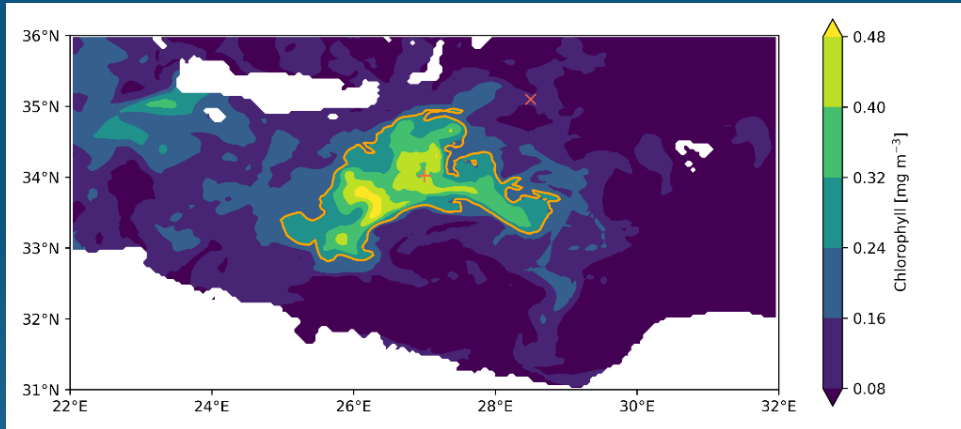


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Detection of the bloom

Chlorophyll maximum intensity

20 March – 30 April



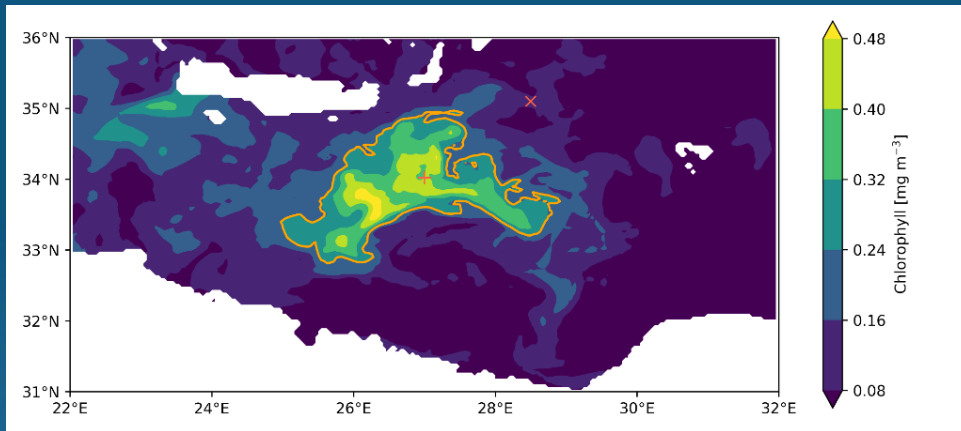
Definition of the event area

- Use of three-dimensional daily model products
- Climatology from model reanalysis (1999-2020)
- Maximum difference with respect to climatology threshold (maximum intensity; Hobday et al., 2016)

Characterization of the event

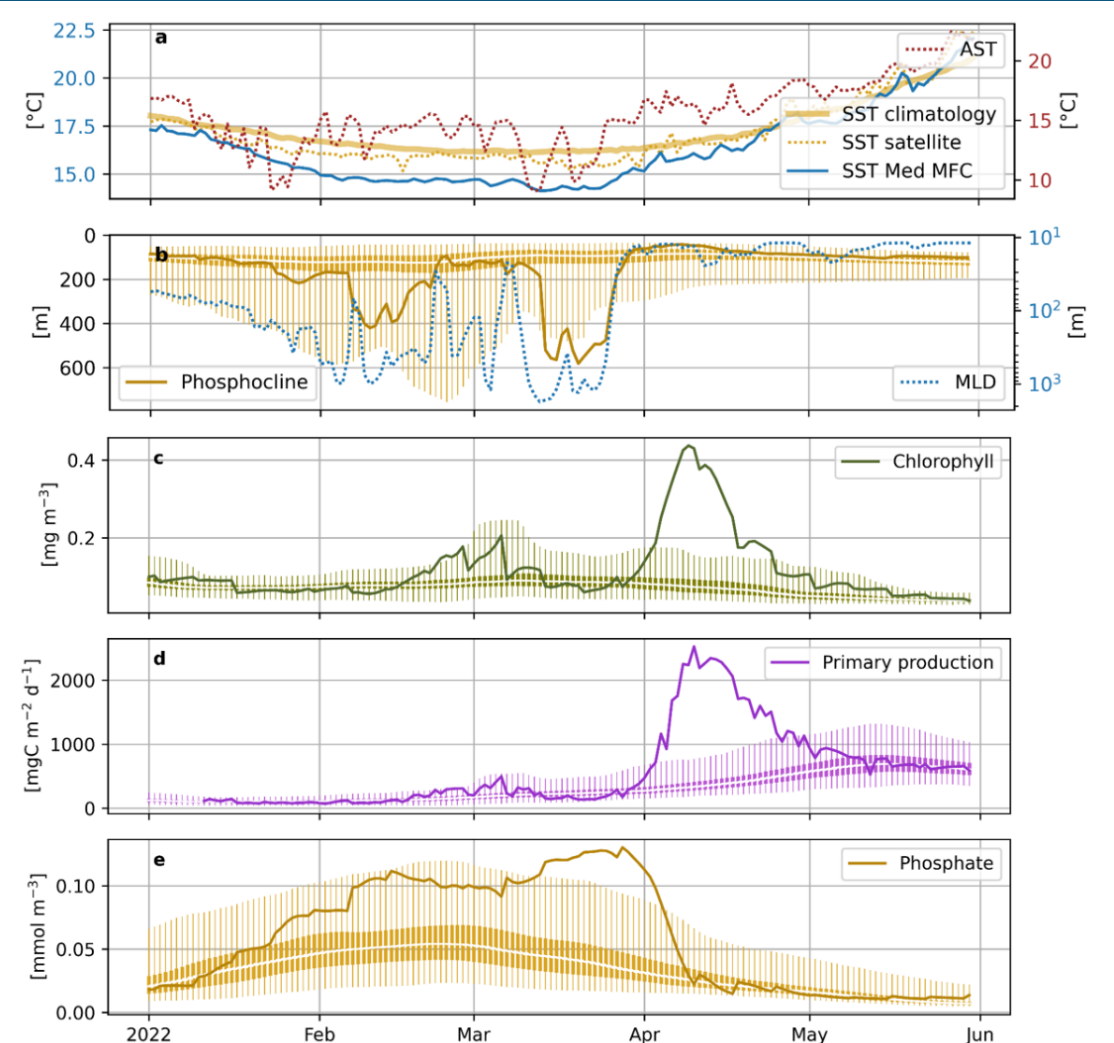
Chlorophyll maximum intensity

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Definition of the event area

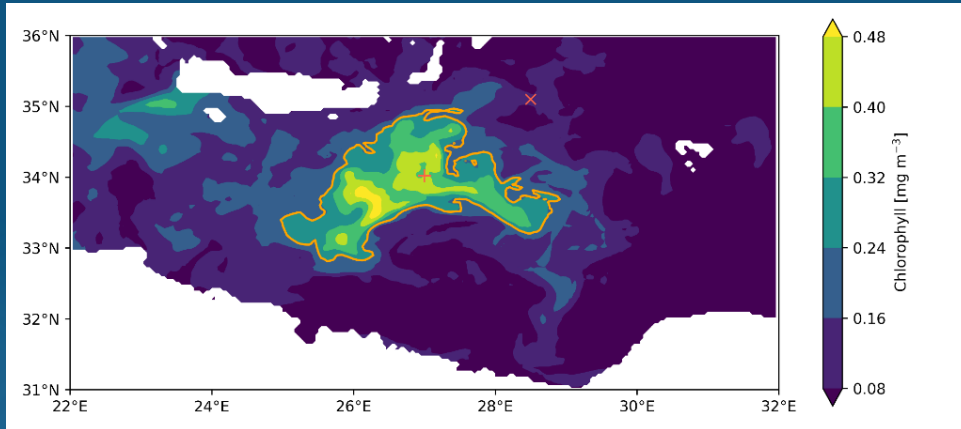
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Characterization of the event

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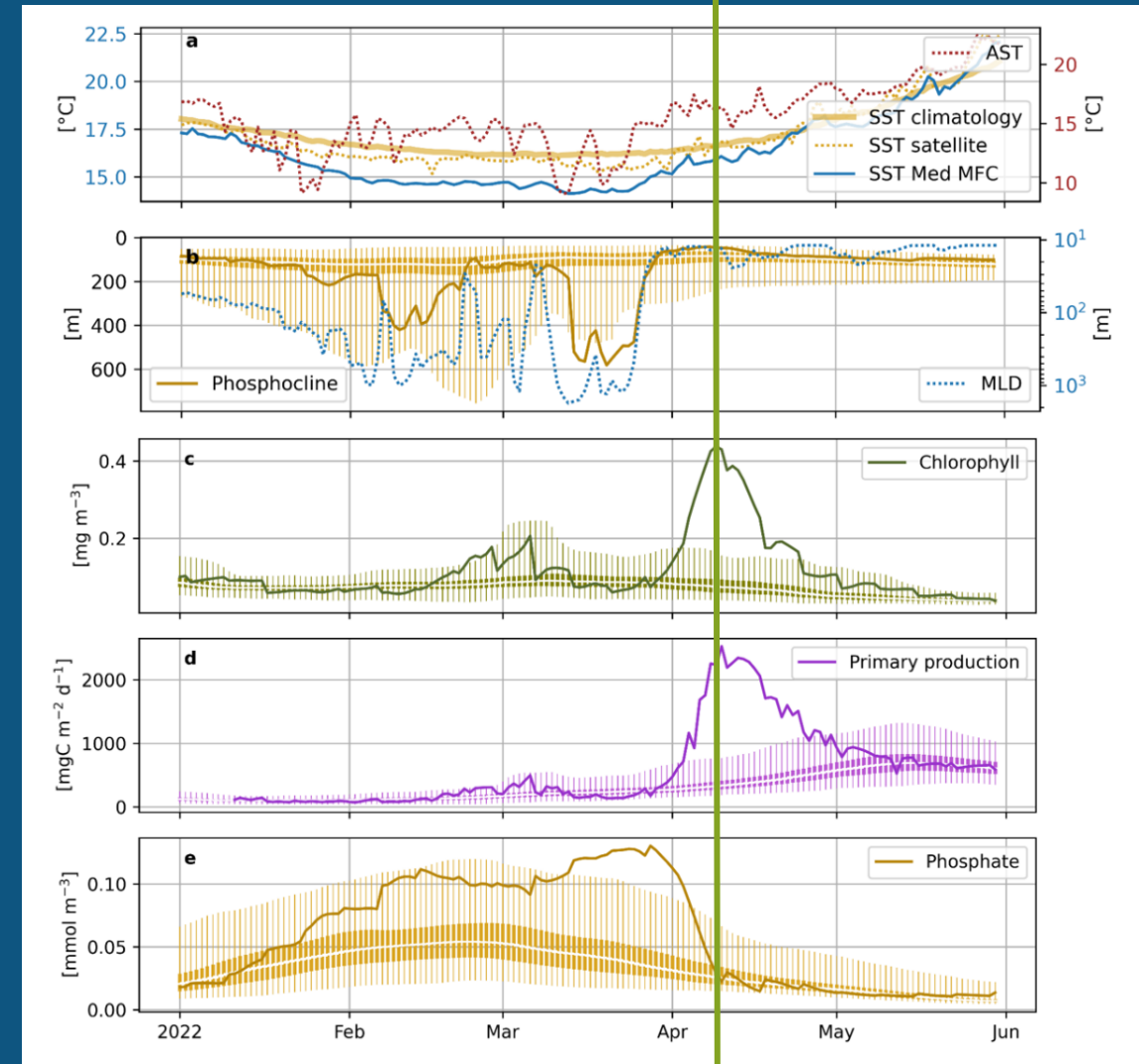
20 March – 30 April



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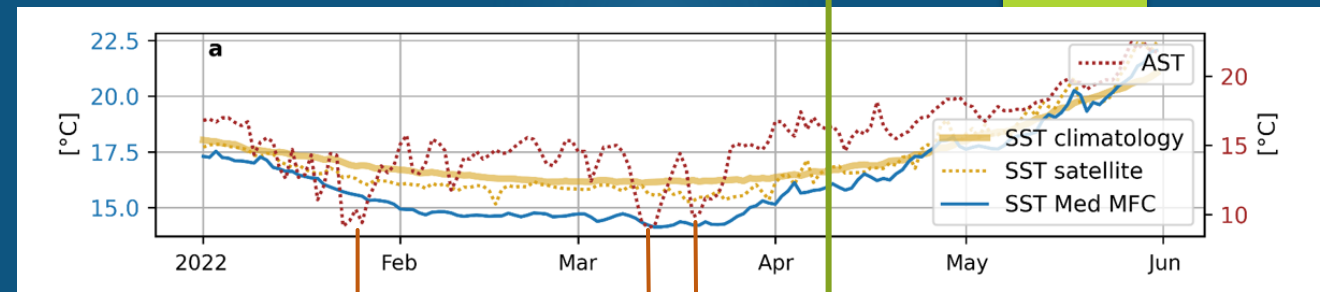
Phytoplankton
bloom peak



Drivers

Atmospheric surface temperature AST

- AST minima in January and March
- Documented cold spells



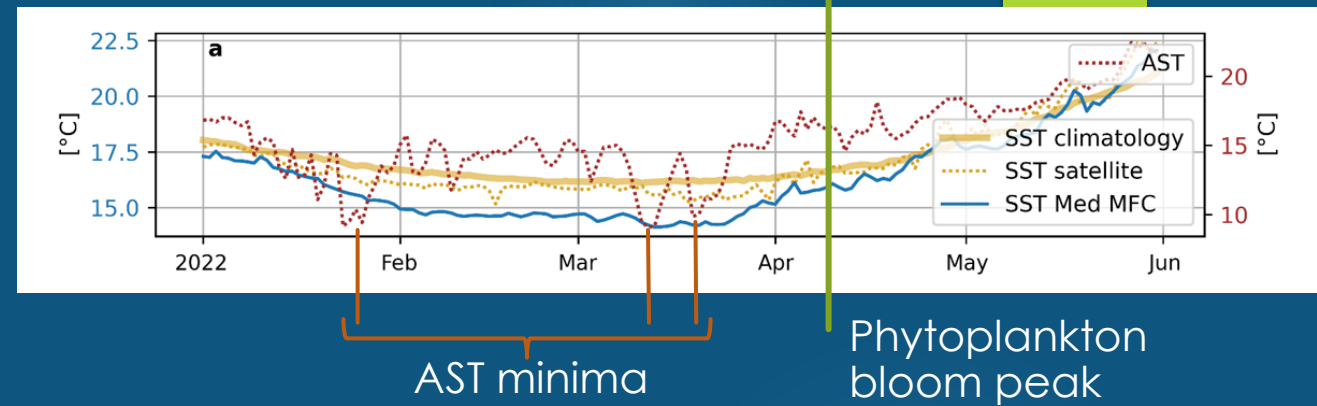
AST minima

Phytoplankton bloom peak

Drivers

Atmospheric surface temperature AST

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- Documented cold spells



<https://doi.org/10.1007/s00024-023-03297-9>

Home > Pure and Applied Geophysics > Article

The Cold Snaps of January 2022 in the Euro-Mediterranean Region in a Warming Climate: In Association with Atmospheric Blocking and the Positive North Atlantic Oscillation

Published: 29 May 2023

Volume 180, pages 2889–2900, (2023) [Cite this article](#)

Meral Demirtaş

January

March

SEVERE WEATHER EUROPE

WEATHER

ABOUT

Eastern Europe impacted by an Extreme Arctic Cold Blast and Snow next week, as the southern lobe of the Polar Vortex heads over Russia

By Marko Korosec

Published: 04/03/2022

Global weather

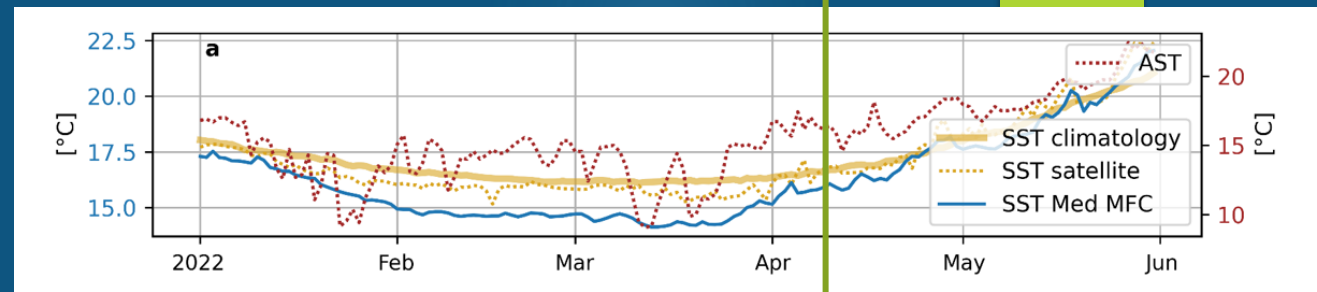
<https://www.severe-weather.eu/global-weather/polar-vortex-2022-arctic-extreme-cold-snow-russia-ukraine-eastern-europe-mk/>

Marine dynamics

Sea surface temperature SST

..... Satellite — Model
—— Satellite climatology

- SST lower than climatology starting from mid January
- Nearly persistent negative anomaly
- Model SST even lower



SST negative anomaly

Phytoplankton bloom peak

Marine dynamics

Sea surface temperature SST

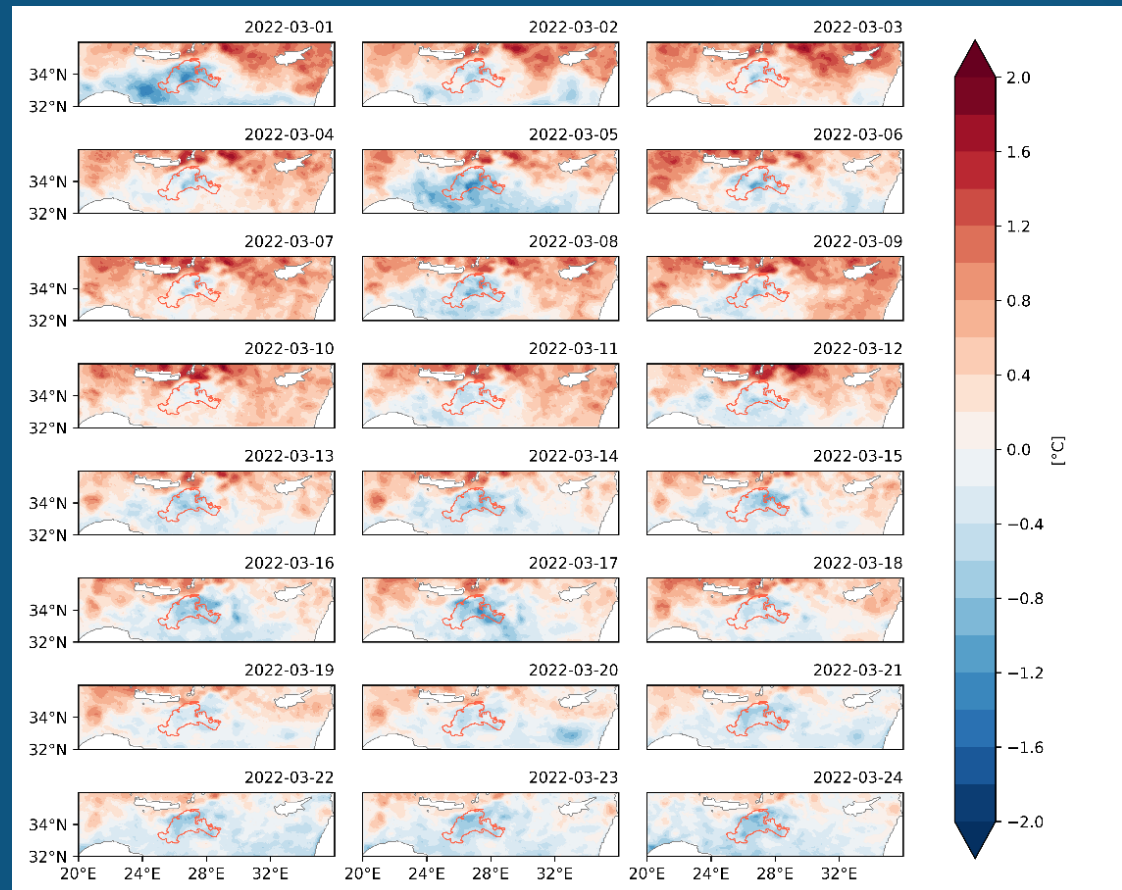
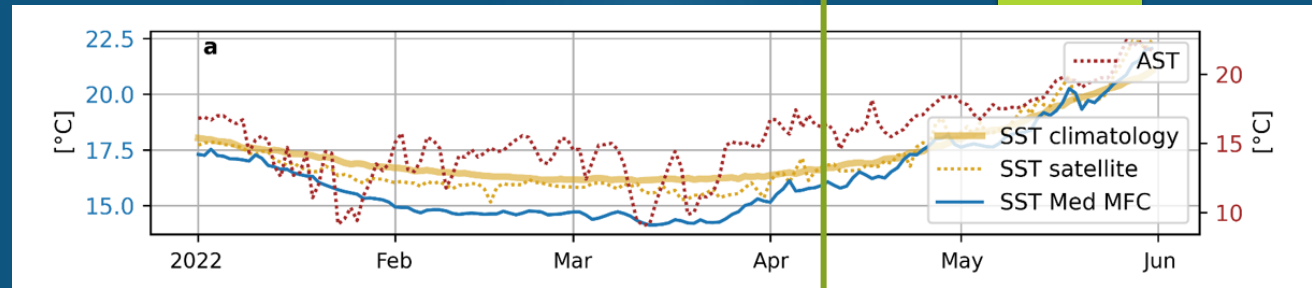
..... Satellite — Model
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Impact of 2022 cold spells on the North-Central Aegean Sea demonstrated by Potiris et al. (2024) with buoyancy losses previous years of dense water formation in the Aegean Sea

<https://doi.org/10.3390/jmse12020221>

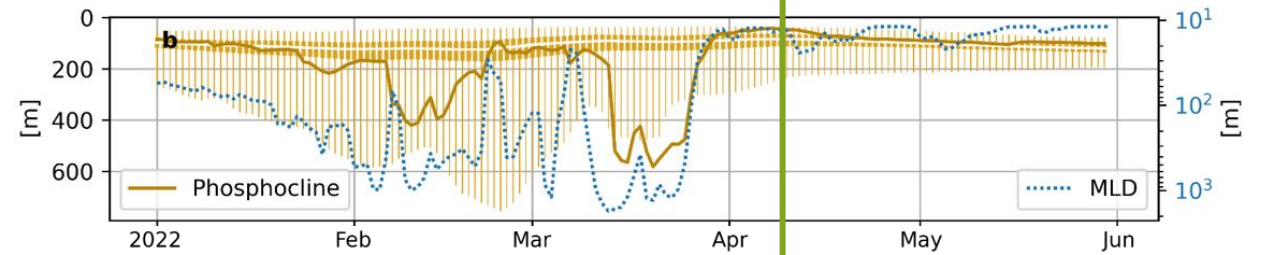
1 – 24 March
model SST anomaly



Marine dynamics

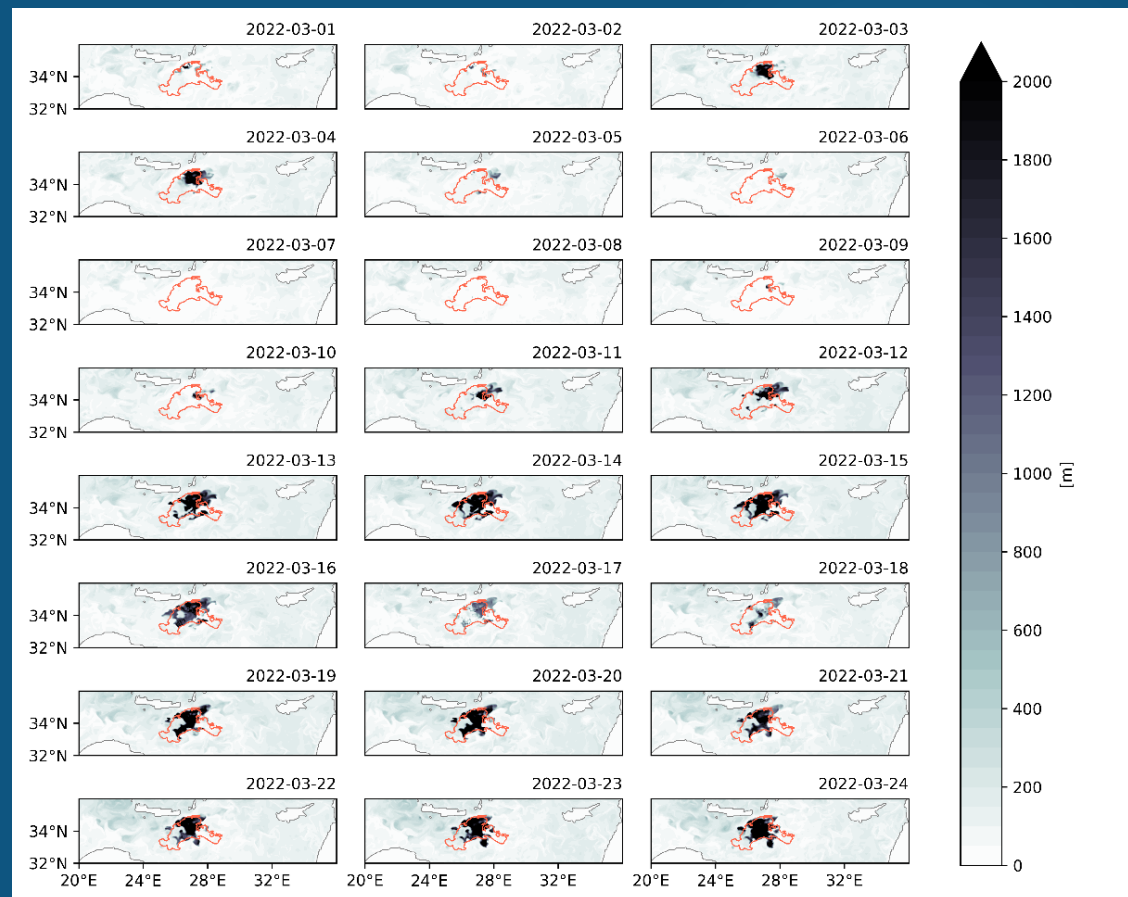
Mixed layer depth MLD

- MLD deepening since late January
- Intense March deepening down to nearly 2000 m



Phytoplankton bloom peak

1 – 24 March MLD



Marine dynamics

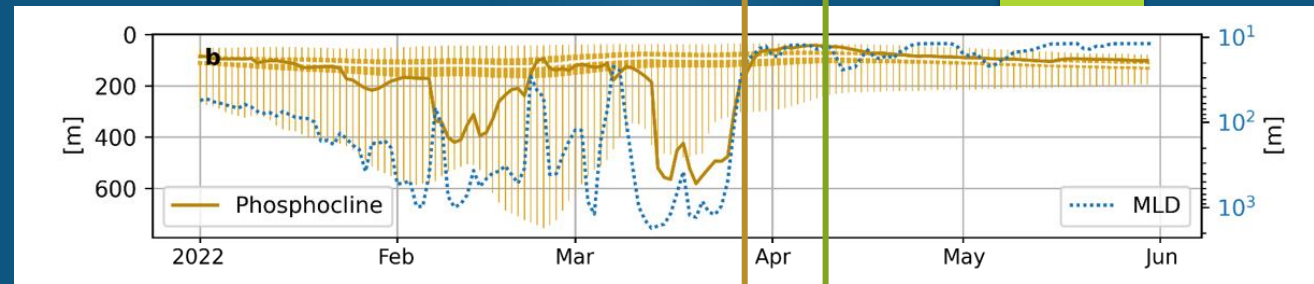
Mixed layer depth MLD

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Phosphocline depth

Climatology percentiles
(1st, 25th, 50th, 75th and 99th)

- Pattern similar to MLD in the middle of March
- Really efficient injection of nutrients



Phytoplankton
bloom peak

Stratification and
phosphocline
shallowing

Marine dynamics

Mixed layer depth MLD

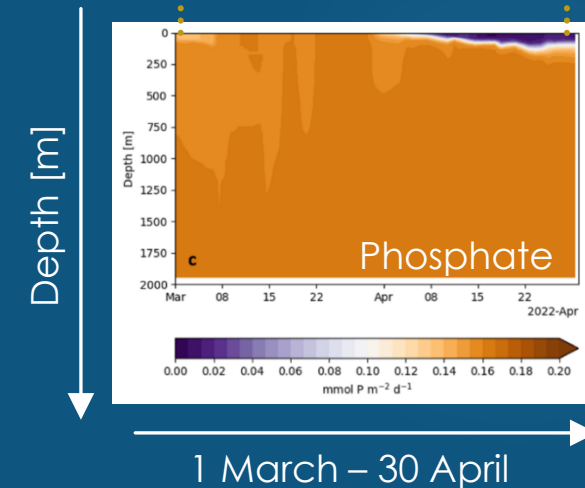
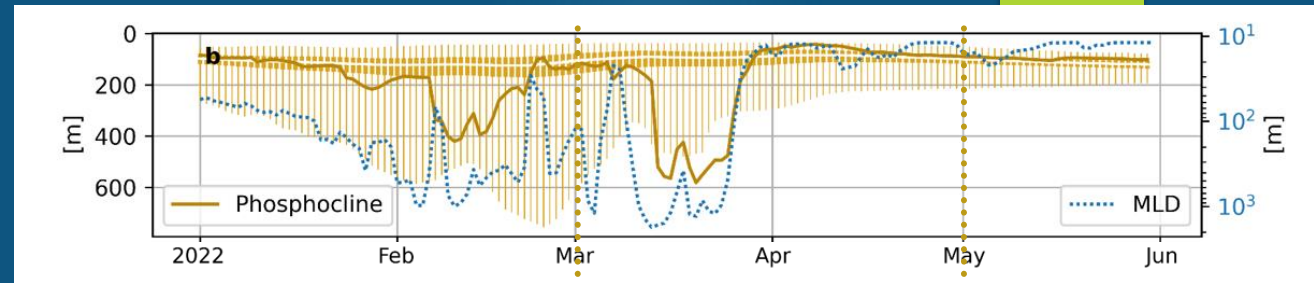
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Phosphocline depth



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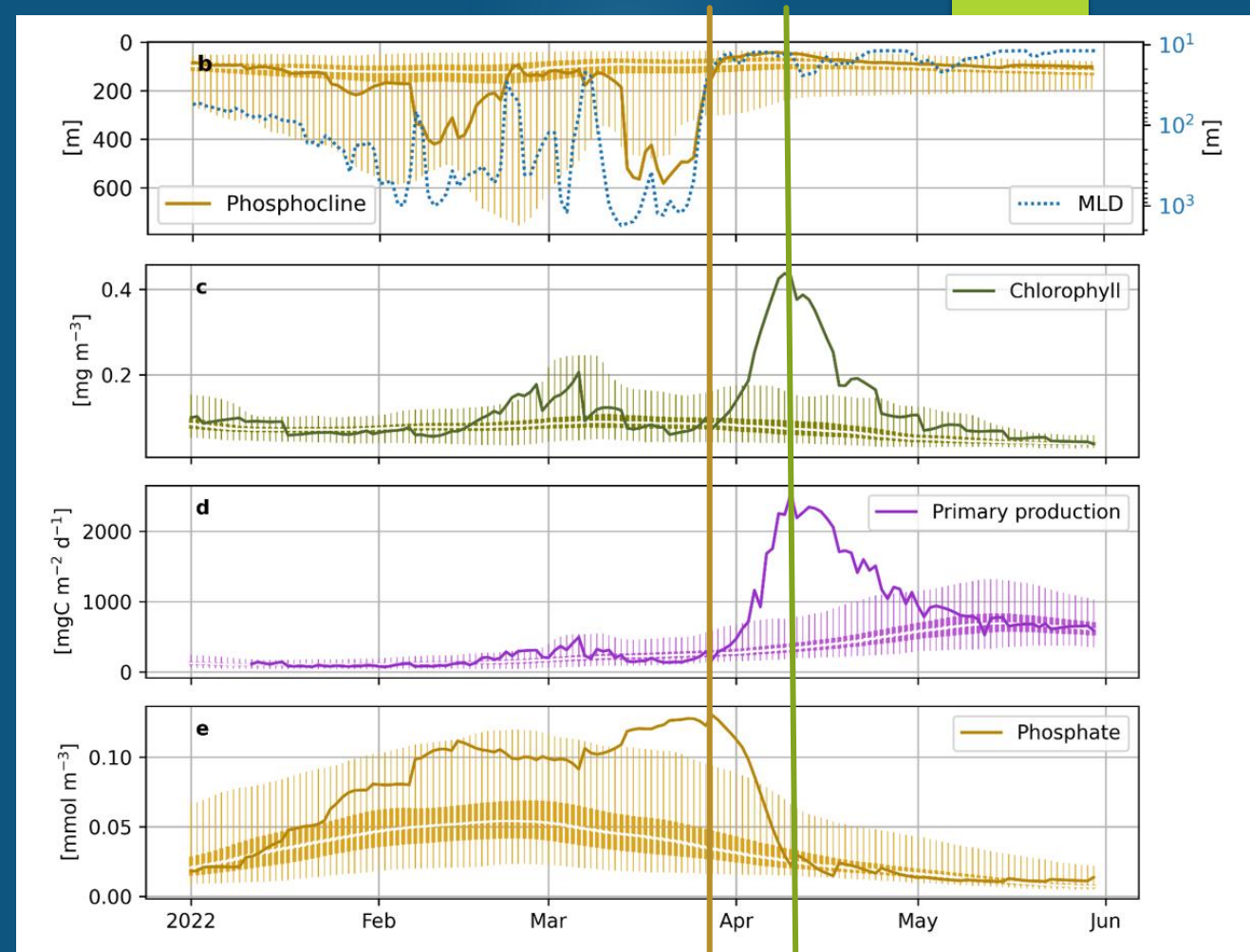
- Pattern similar to MLD in the middle of March
- Really efficient injection of nutrients



Marine dynamics

- Chlorophyll at surface
- Primary production (0-200 m)
- Phosphate concentration above the phosphocline

- Relevant positive anomaly
- Primary production peak coincides with the chlorophyll peak
- 35% higher primary production in an area of 1.4% of the Mediterranean Sea
- Rapid onset of the bloom after the stratification (Sverdrup paradigm)

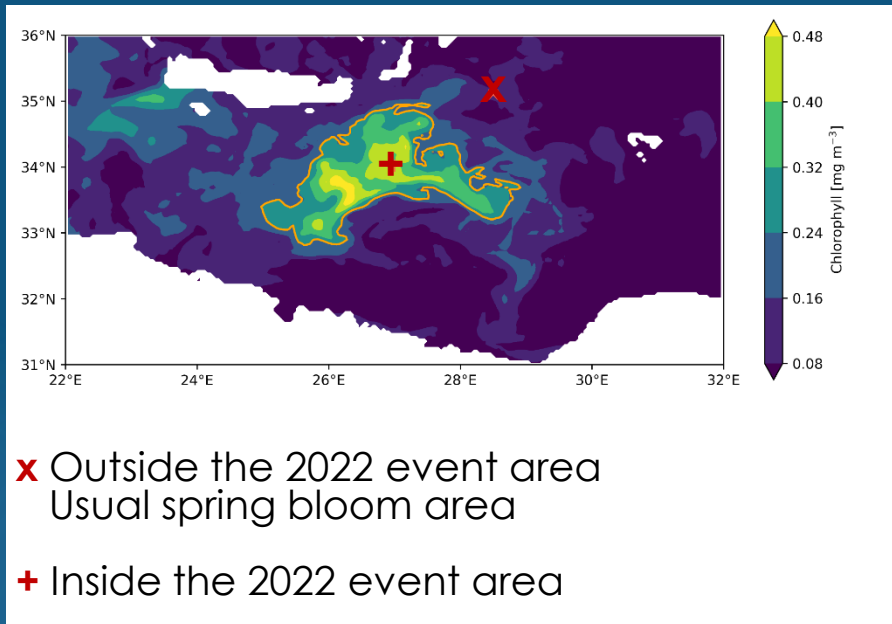


Start of the bloom
and nutrient
consumption

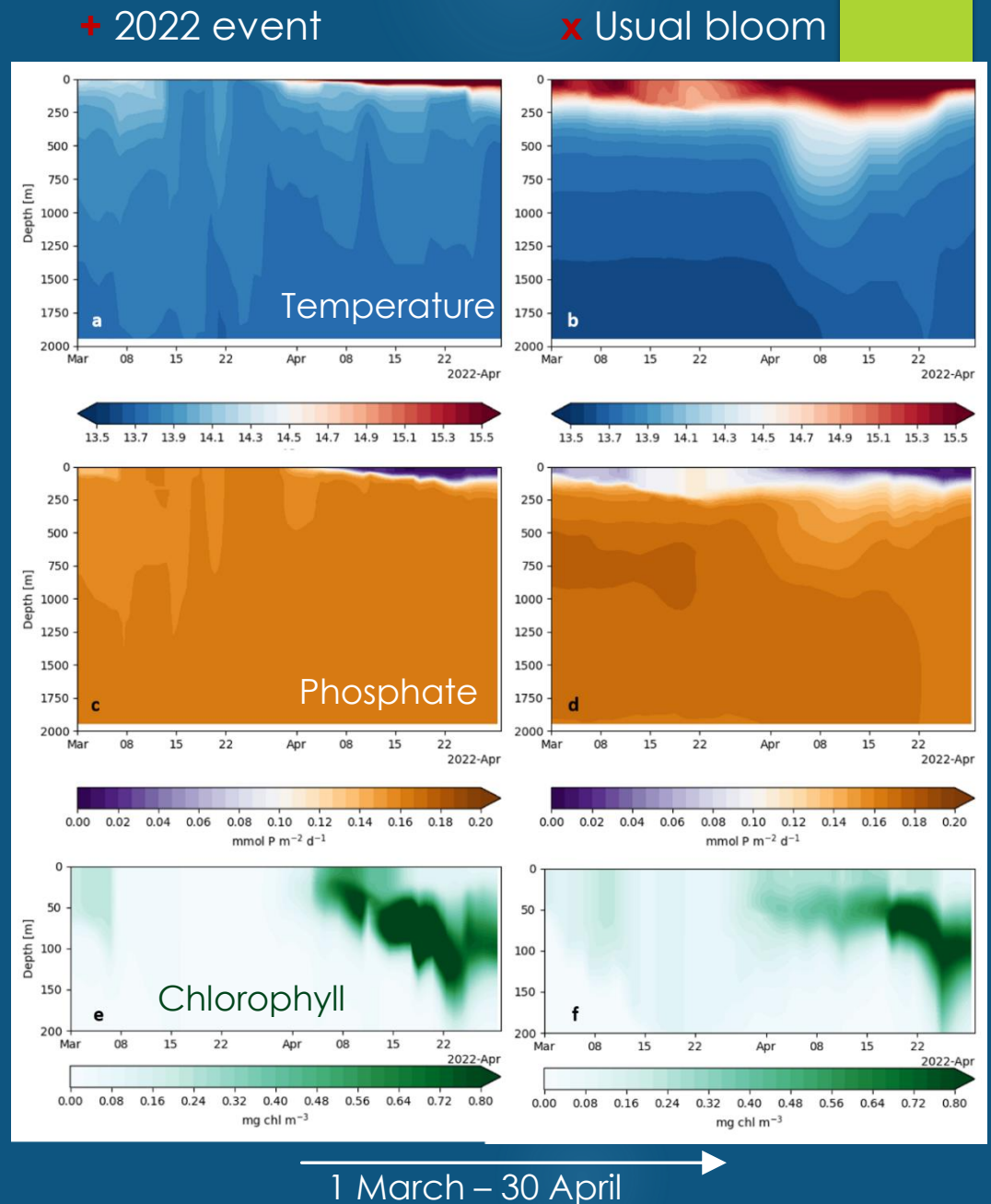
Phytoplankton
bloom peak

Stratification

Water column



Depth [m]



Take home messages

- **Modelling operational system** can be used to detect anomalous event even when observation coverage is low
- **Added value of models** in explaining the processes an anomalous deep mixing and intense bloom event
- **Impacts on higher trophic level** related to primary production anomaly (Piroddi et al., 2017)

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Preprint

Preprints / Preprint sp-2023-30

<https://doi.org/10.5194/sp-2023-30>
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Abstract Discussion 10 Oct 2023

Status: a revised version of this preprint was accepted for the journal SP and is expected to appear here in due course.

Anomalous 2022 deep water formation and intense phytoplankton bloom in the Cretan area

Anna Teruzzi ES, Ali Aydogdu, Carolina Amadio, Emanuela Clementi, Simone Colella, Valeria Di Biagio, Massimiliano Drudi, Claudia Fanelli, Laura Feudale, Alessandro Grandi, Pietro Miraglio, Andrea Pisano, Jenny Pistoia, Marco Reale, Stefano Saloni, Gianluca Volpe, and Gianpiero Cossarini

Abstract. The Mediterranean Sea is a quasi-permanently stratified and oligotrophic basin with intense late-winter early-spring phytoplankton blooms typically limited to few regions (i.e., northwestern Mediterranean Sea, the Southern Adriatic Sea and the Rhodes gyre). In these areas, blooms are sustained by nutrients injection to surface layers by winter vertical mixing and convective processes. A markedly intense bloom was predicted in spring 2022 in an unusual area of the southeastern Mediterranean Sea (i.e., southeastern of Crete) by the Med-MFC system, the production centre of the Copernicus Marine Service for the Mediterranean Sea. Combining Copernicus modelling and observation products, the 2022 event and a number of driving and concurrent features have been investigated in a multidisciplinary way. A noticeable cold spell that occurred in eastern Europe at the beginning of 2022 has been identified as the main driver of an intense deep water formation event, with associated high nutrient concentrations in the surface layers. Consequently, an extreme phytoplankton bloom that was 50 % more intense than usual occurred in the area southeast of Crete, starting nearly one month later than usual and lasting for 3–4 weeks. Impacts on primary production were also relevant in the 2022 event area, being 35 % higher than the climatological annual primary production. Further, the documented link between primary productivity and fish catches suggests possible consequences along the whole food chain up to the marine ecosystem in the eastern Mediterranean Sea.

Download

- Preprint (1644 KB)
- Metadata XML
- BibTeX
- EndNote

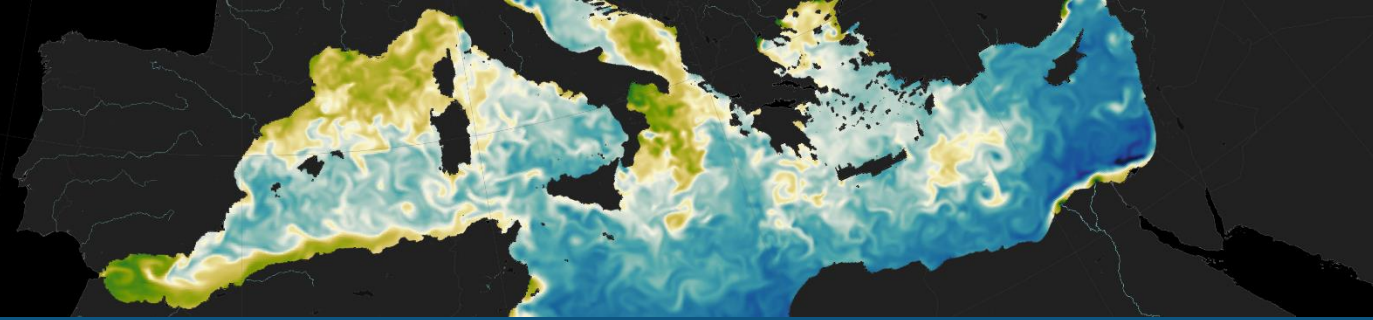
Short summary

A noticeable cold spell occurred in eastern Europe at the beginning of 2022 and was the main...

Report

8th edition of the Copernicus Ocean State Report...

→ Manuscript accepted for publication in State of the Planet (Ocean state Report 8) ateruzzi@ogs.it



THANK YOU

COPERNICUS MARINE MEDITERRANEAN MFC, OCEAN COLOUR
AND SEA SURFACE TEMPERATURE TAC – ANNA TERUZZI



MEAP-TT online seminar – 4 September 2024