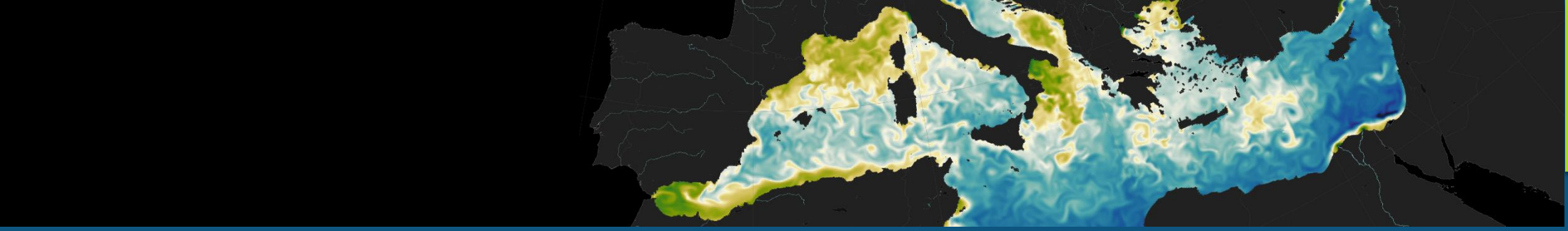
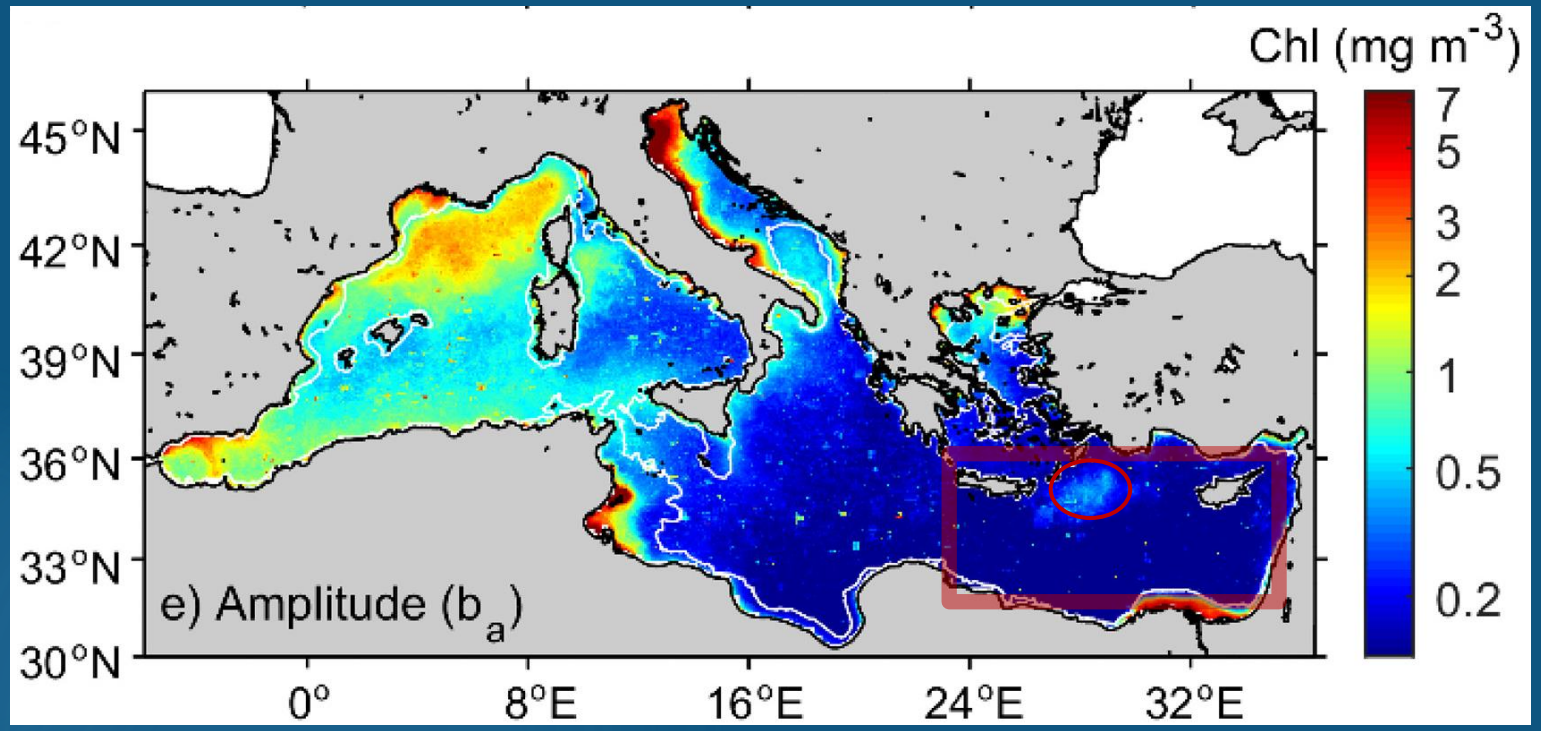


Using Copernicus operational models and observations to investigate the 2022 anomalous spring event in the eastern Mediterranean

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

MEAP-TT online seminar – 4 September 2024

Background

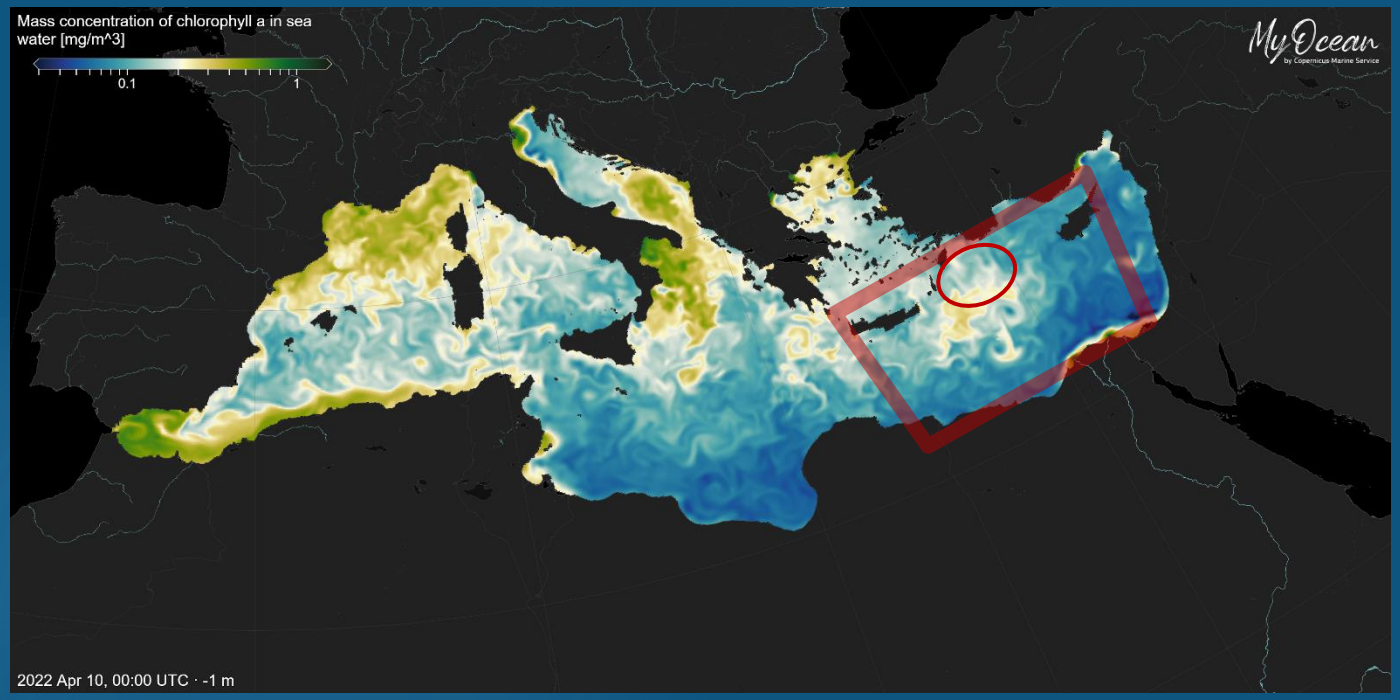


Salgado-Hernanz et al. (2019) Chlorophyll mean amplitude of the winter bloom

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

2022 anomalous phytoplankton bloom

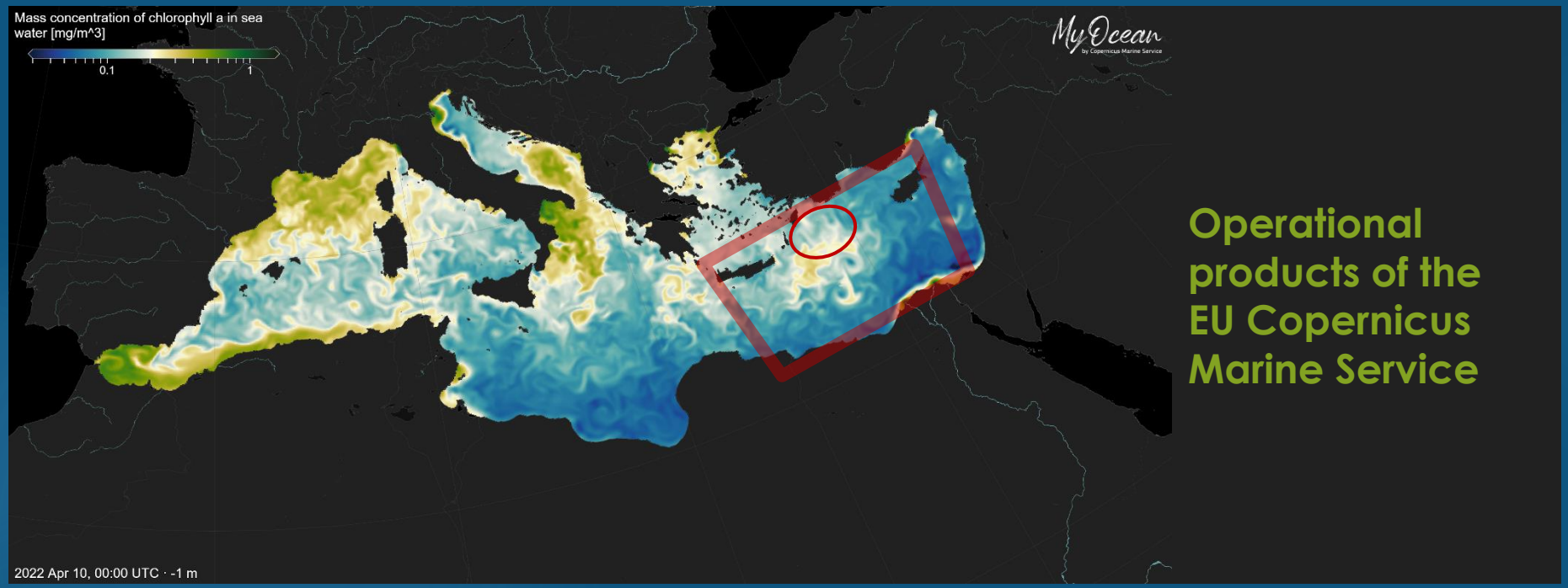
- **Intense April 2022 phytoplankton bloom in the Cretan area**



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

2022 anomalous phytoplankton bloom

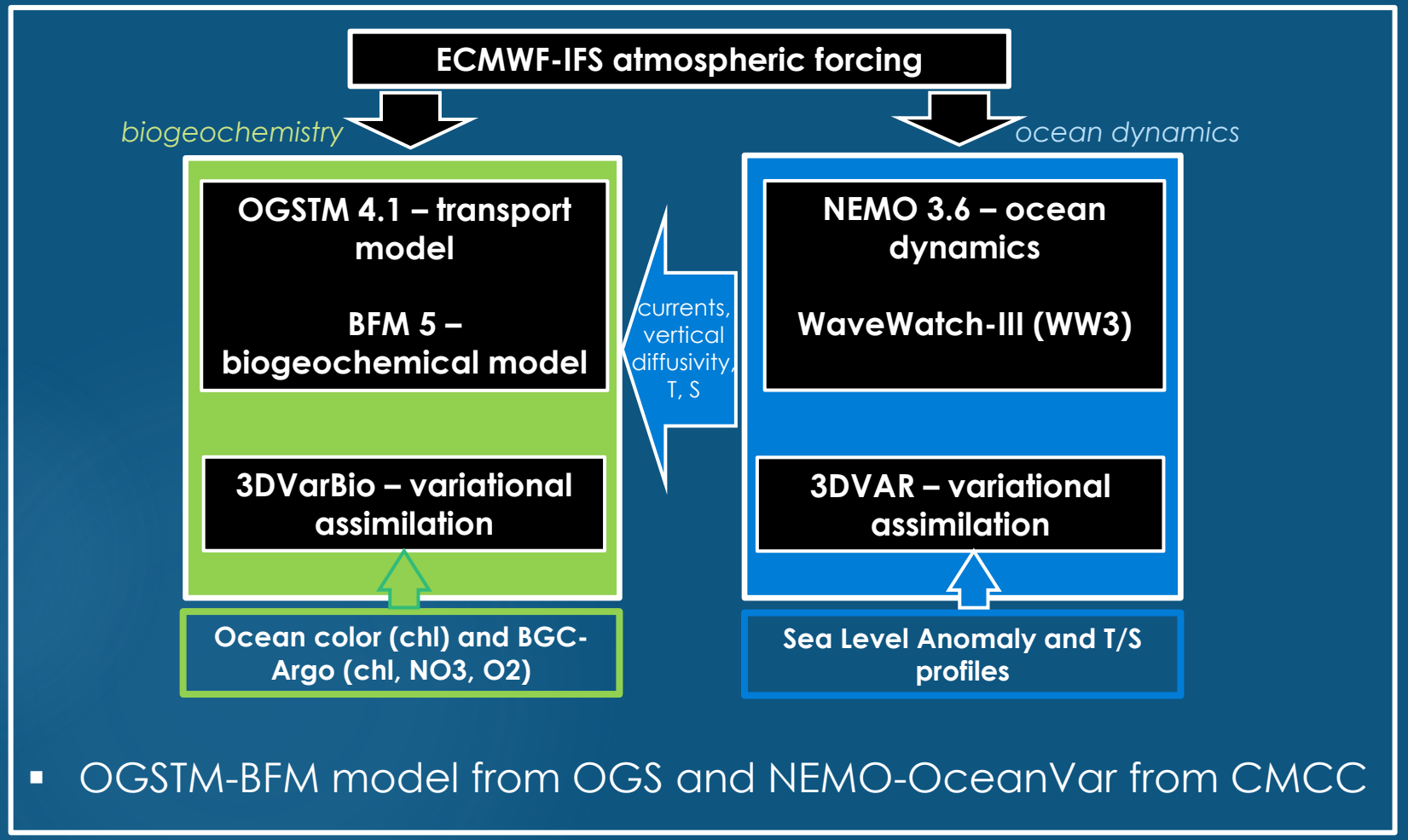
- **Intense April 2022 phytoplankton bloom in the Cretan area**



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

Copernicus Marine Service

2022 anomalous phytoplankton bloom

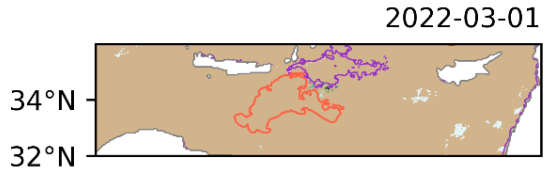


- OGSTM-BFM model from OGS and NEMO-OceanVar from CMCC
- Ocean colour from and sea surface temperature from CNR
- Atmospheric forcings from ECMWF

Copernicus Marine Service

Detection of the bloom

Ocean colour chlorophyll



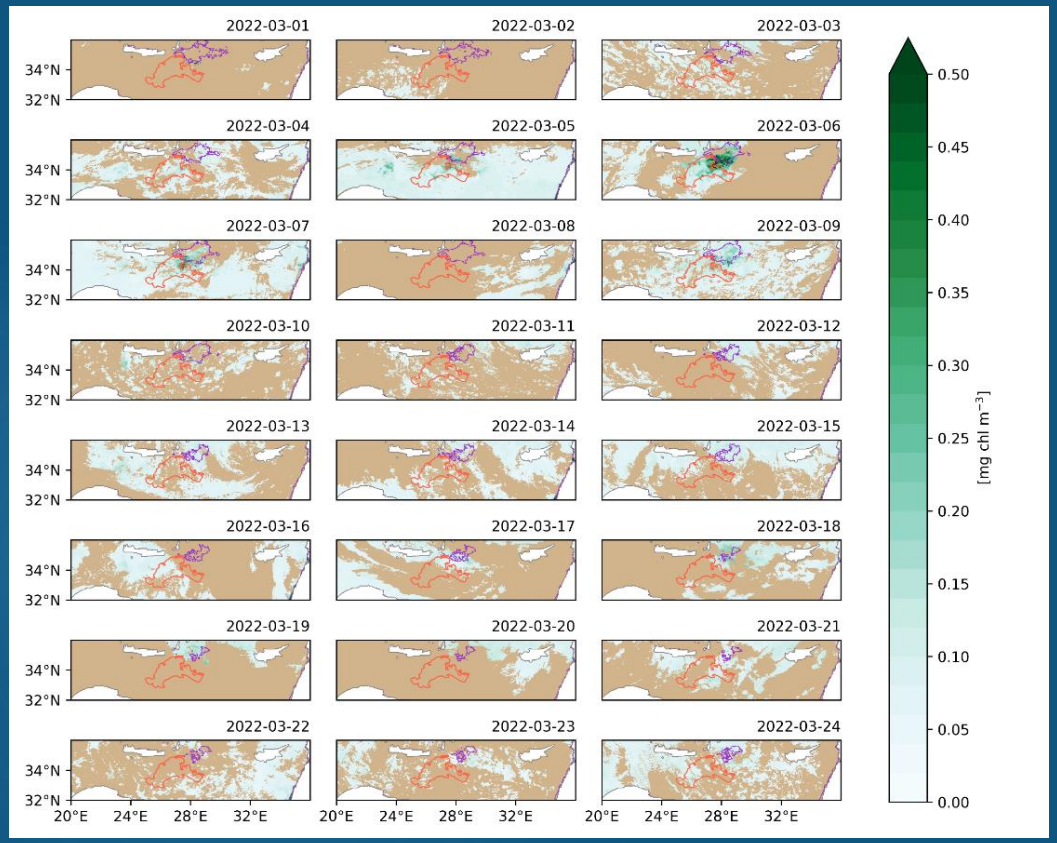
Cloud coverage

Satellite daily climatology above to 0.115 mg chl m^{-3}

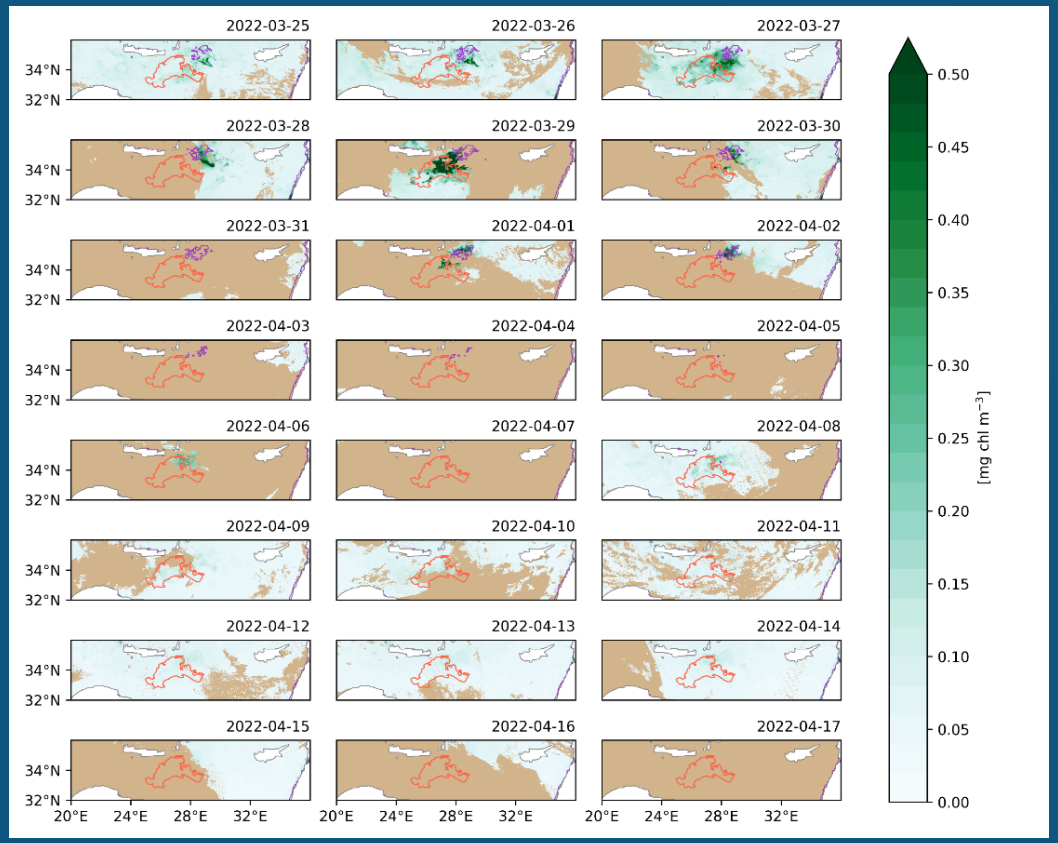
Detection of the bloom

Ocean colour chlorophyll

1 March – 24 March 2022



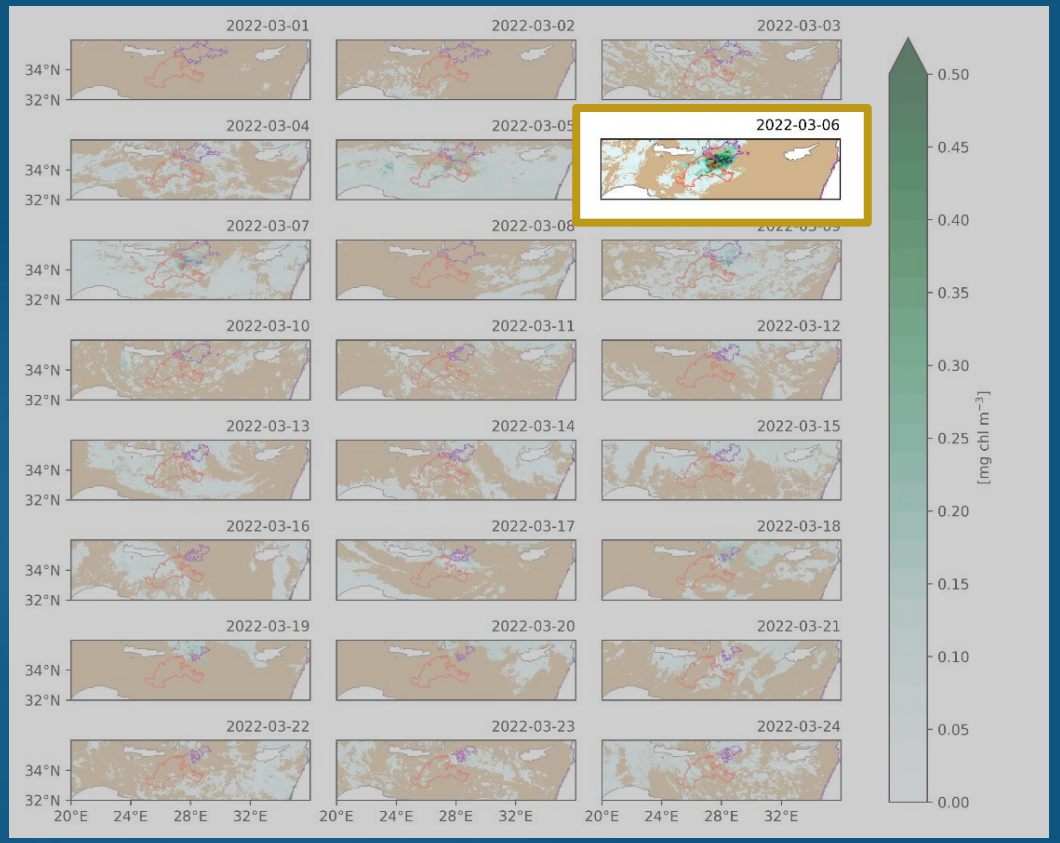
25 March – 17 April 2022



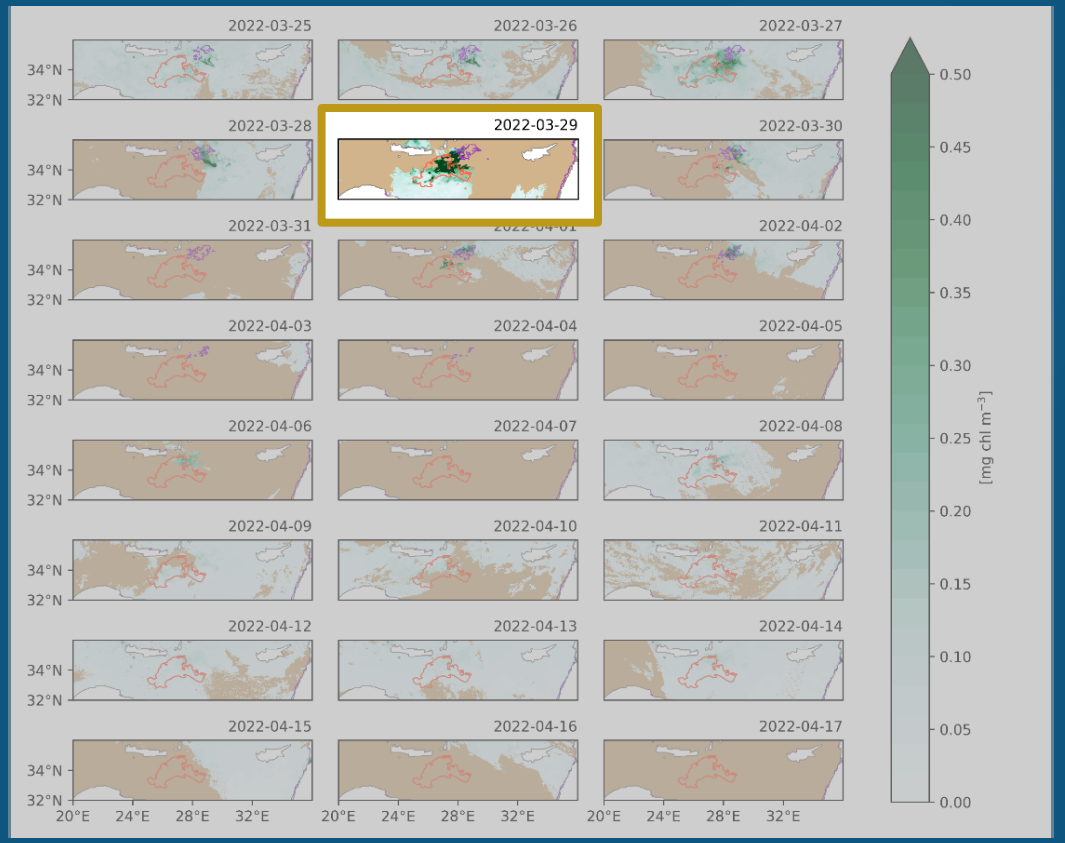
Detection of the bloom

Ocean colour chlorophyll

1 March – 24 March 2022

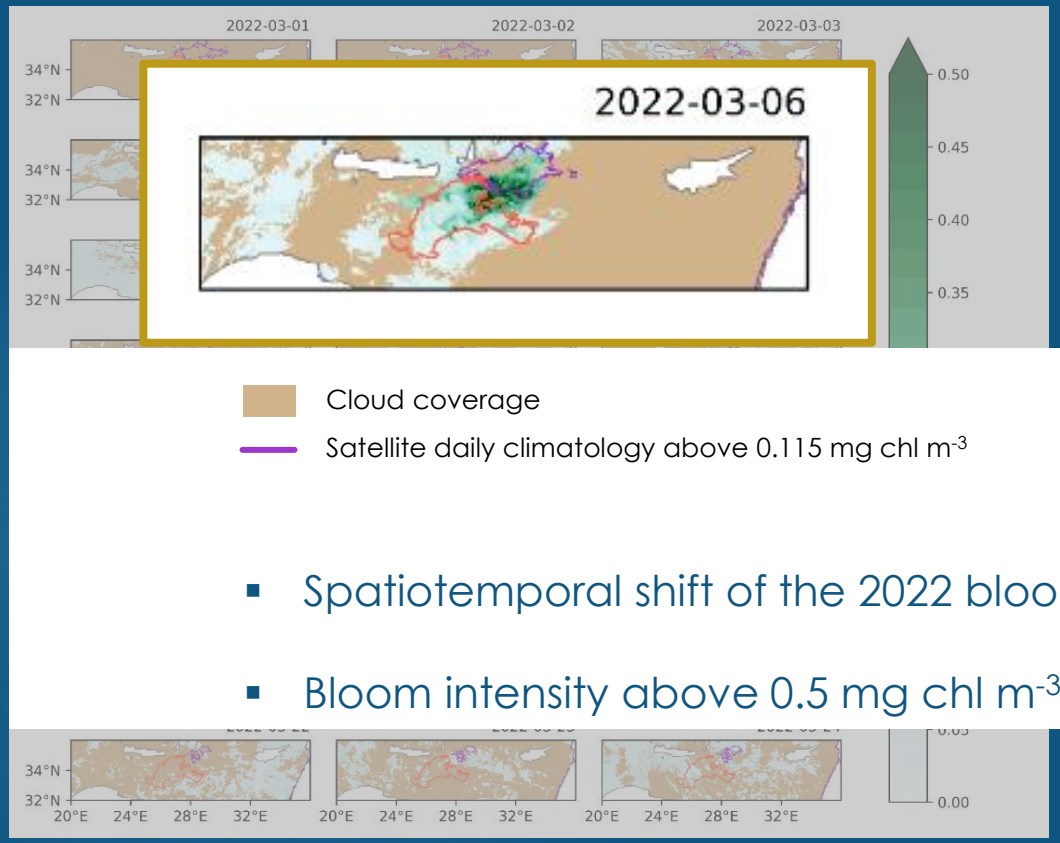


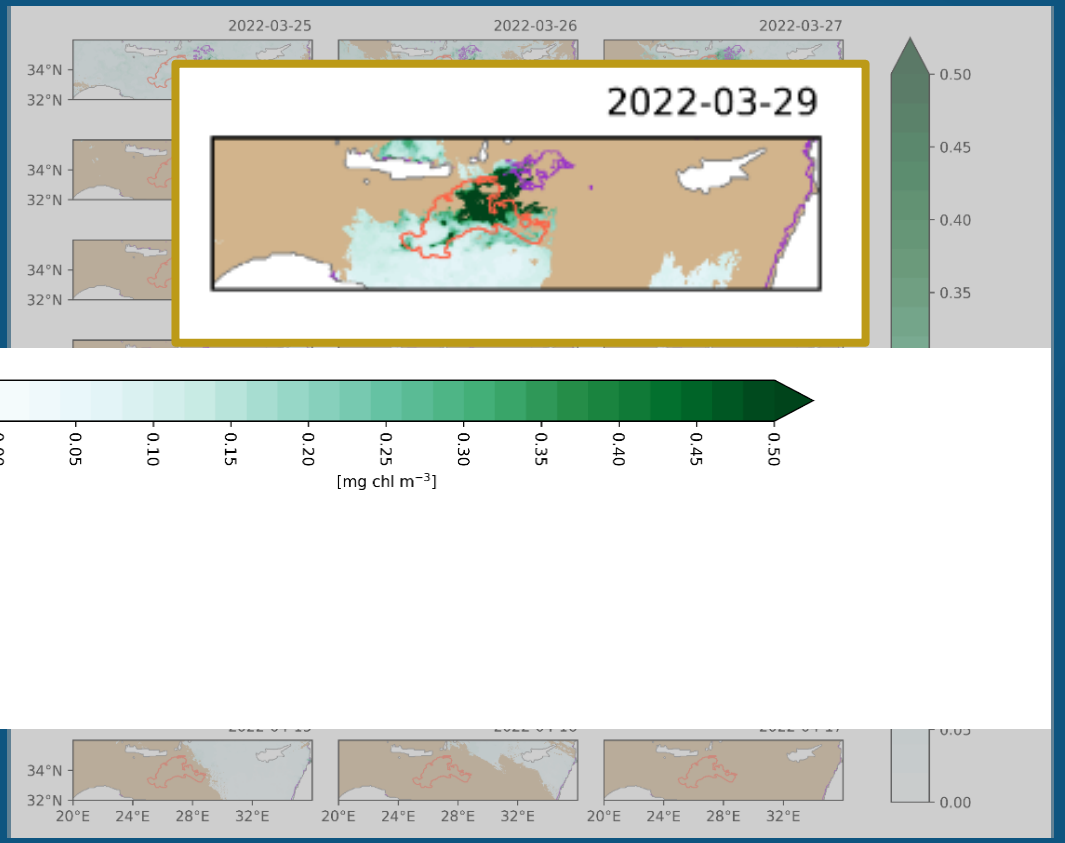
25 March – 17 April 2022



Detection of the bloom

Ocean colour chlorophyll





Cloud coverage

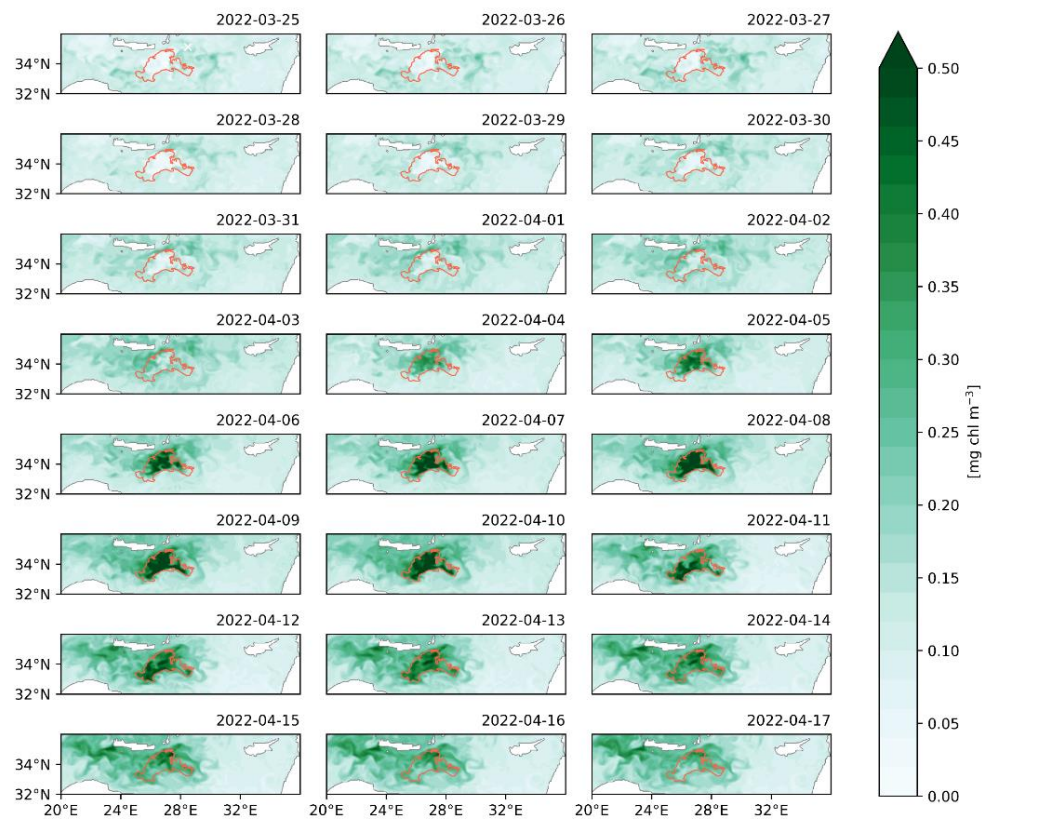
Satellite daily climatology above 0.115 mg chl m^{-3}

- Spatiotemporal shift of the 2022 bloom
- Bloom intensity above 0.5 mg chl m^{-3}

Detection of the bloom

Model chlorophyll

1 March – 24 March 2022

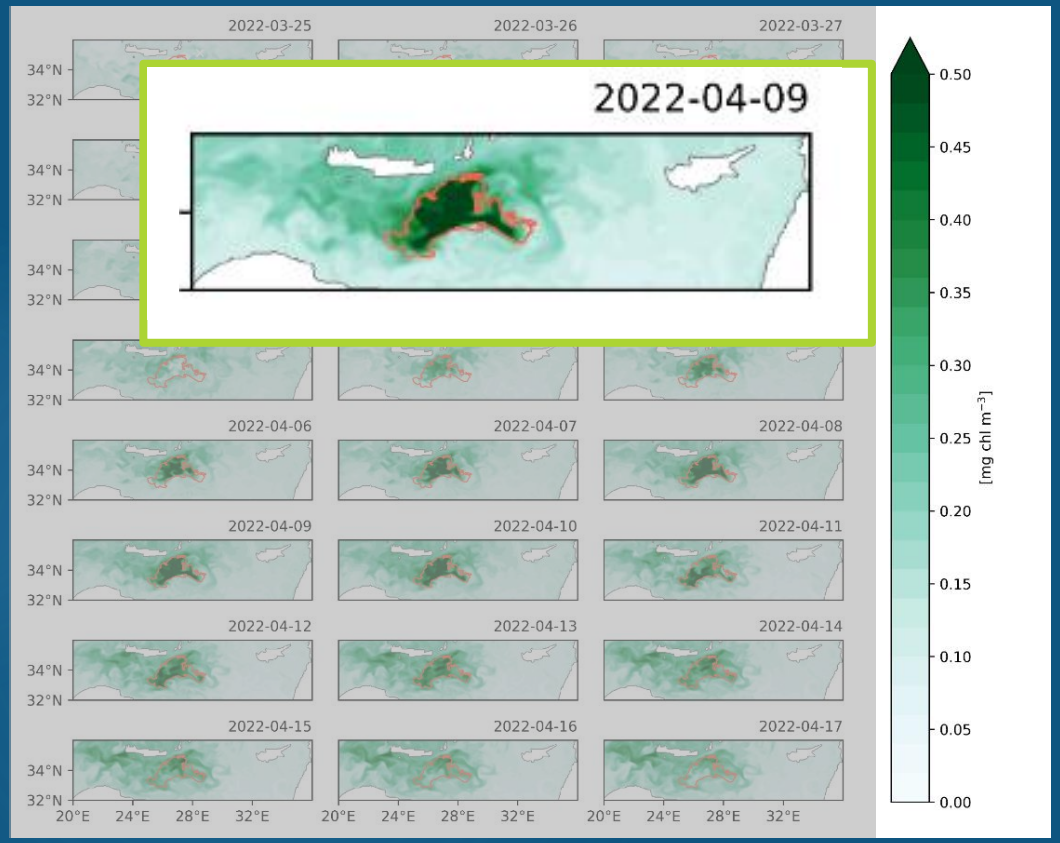


- Model bloom peak on 9 April
- Bloom intensity well simulated
- Temporal mismatch

Detection of the bloom

Model chlorophyll

1 March – 24 March 2022

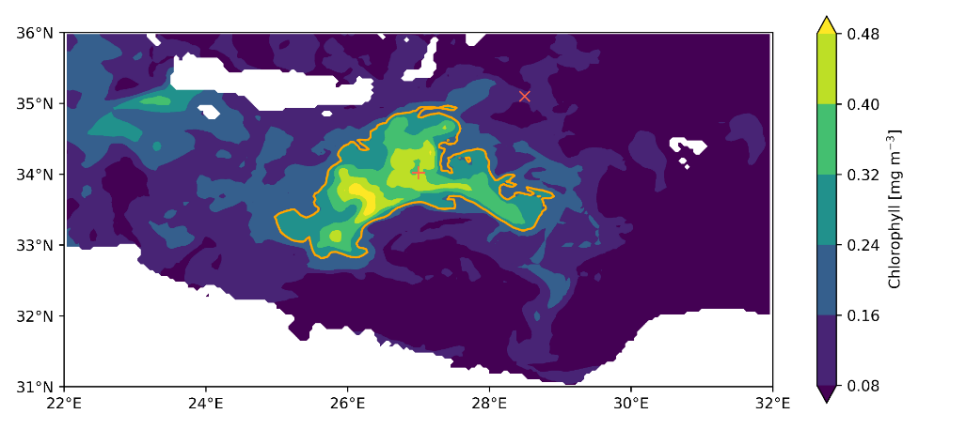


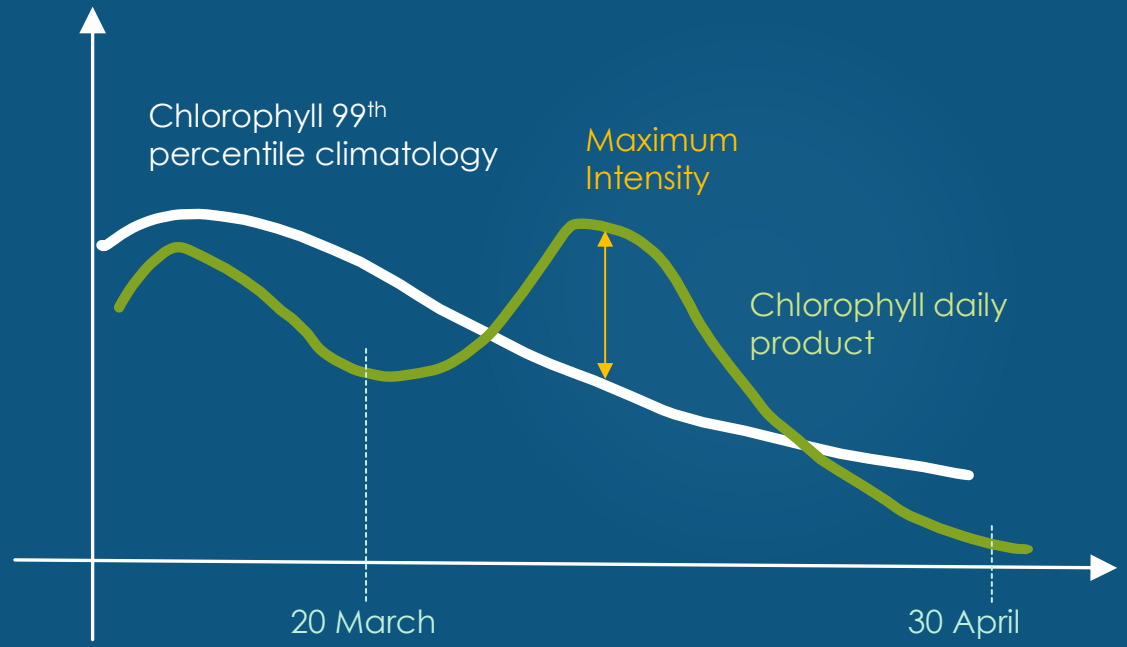
- Model bloom peak on 9 April
- Bloom intensity well simulated
- Temporal mismatch

Detection of the bloom

Chlorophyll maximum intensity

20 March – 30 April





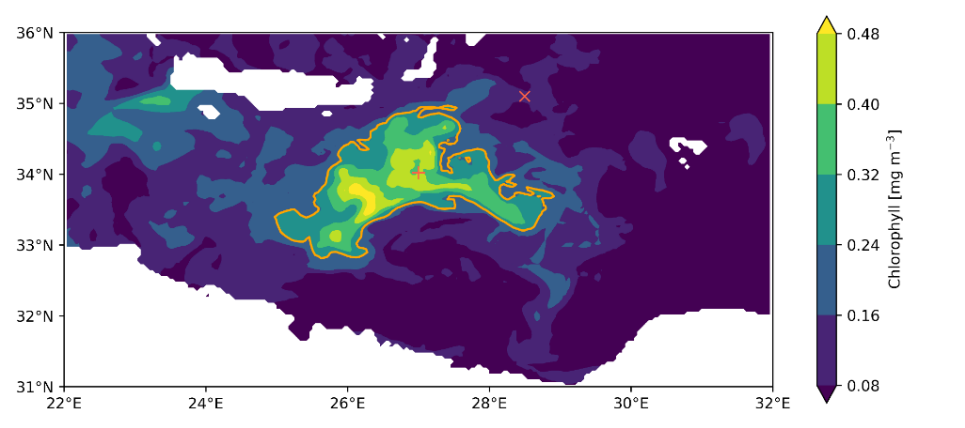
Definition of the event area

- 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

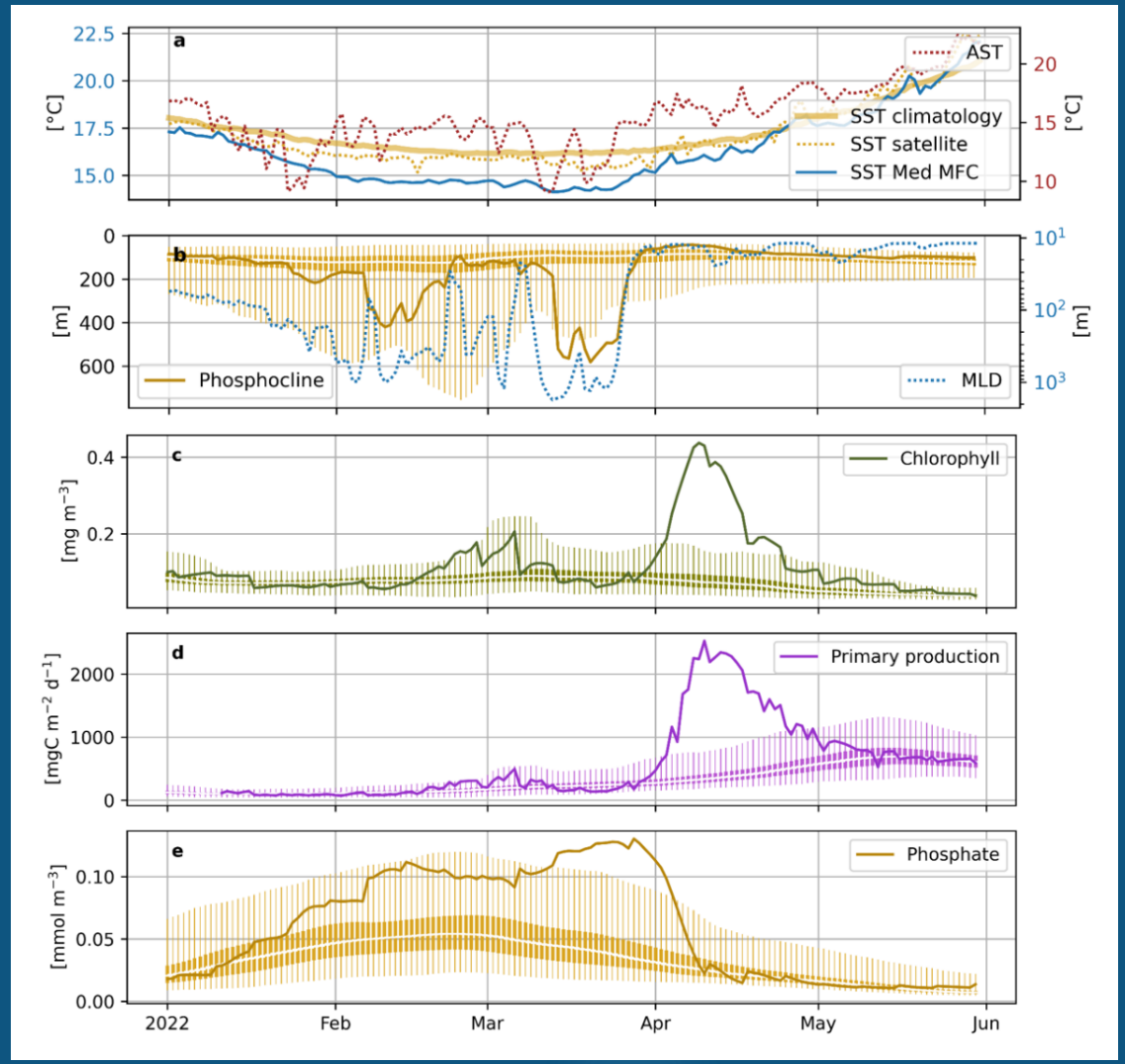
Chlorophyll maximum intensity

20 March – 30 April



Definition of the event area

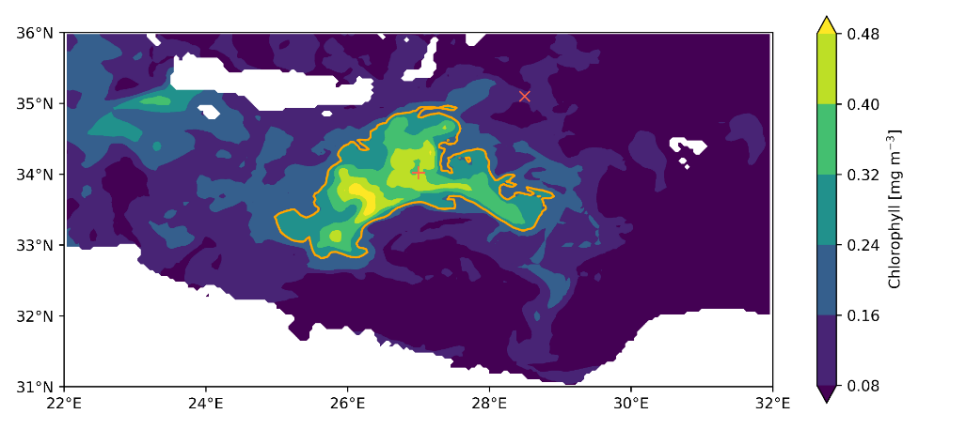
- Use of three-dimensional daily model products
- Climatology from model reanalysis (1999-2020)
- Maximum difference with respect to climatology threshold (maximum intensity; Hobday et al.,2016)



Characterization of the event

Chlorophyll maximum intensity

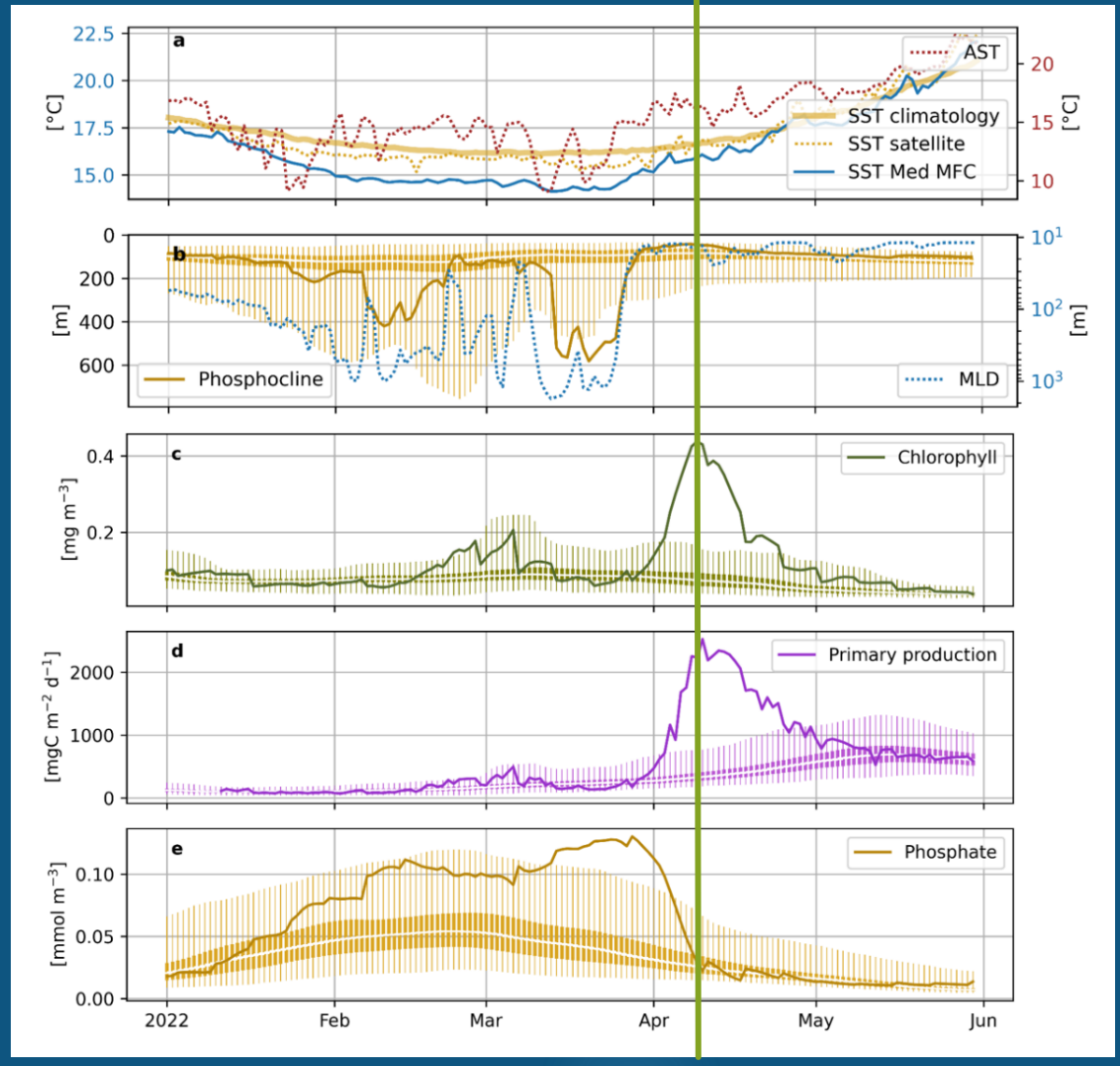
20 March – 30 April



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)

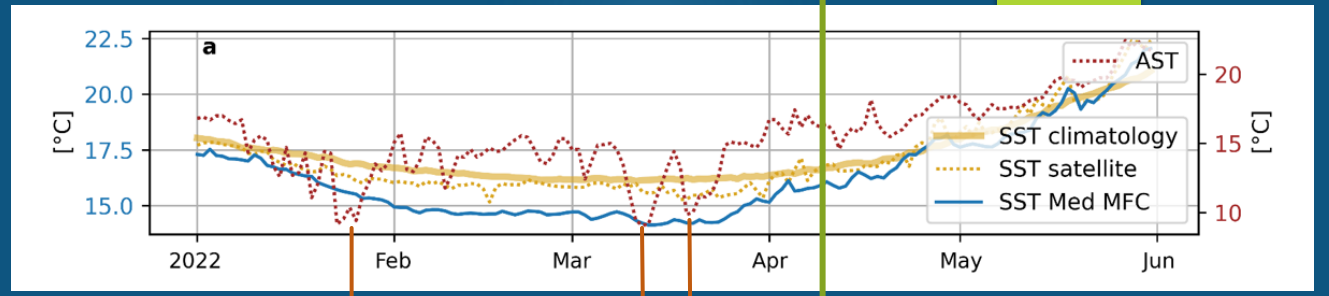
Phytoplankton bloom peak



Drivers

Atmospheric surface temperature AST ·····

- AST minima in January and March
- Documented cold spells



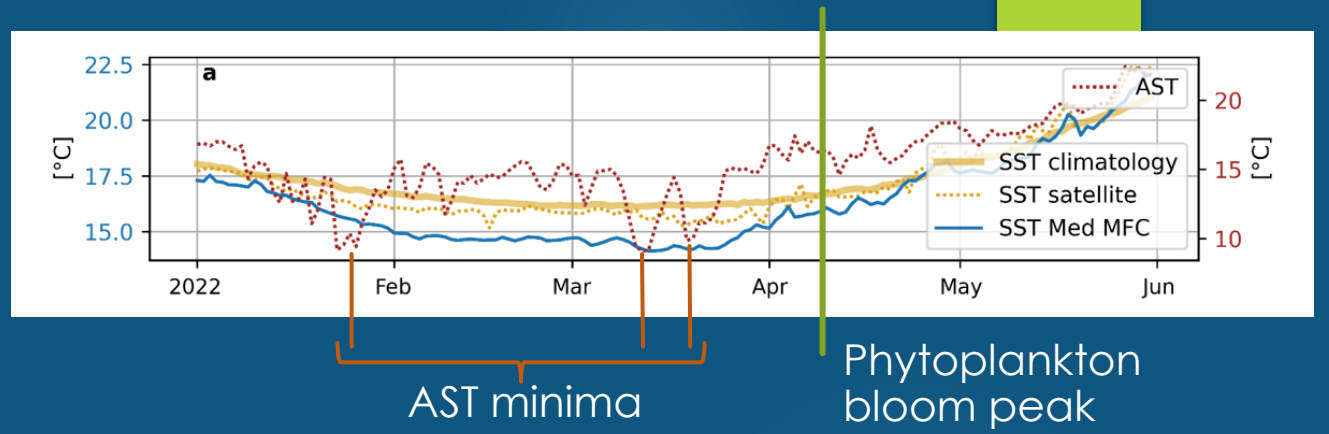
AST minima

Phytoplankton bloom peak

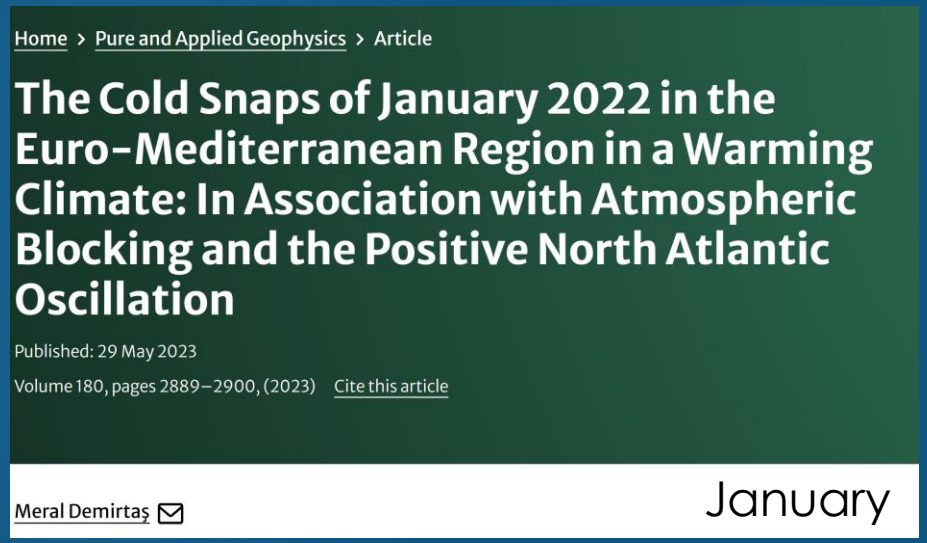
Drivers

Atmospheric surface temperature AST ·····

- AST minima in January and March
- Documented cold spells



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



January

March

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

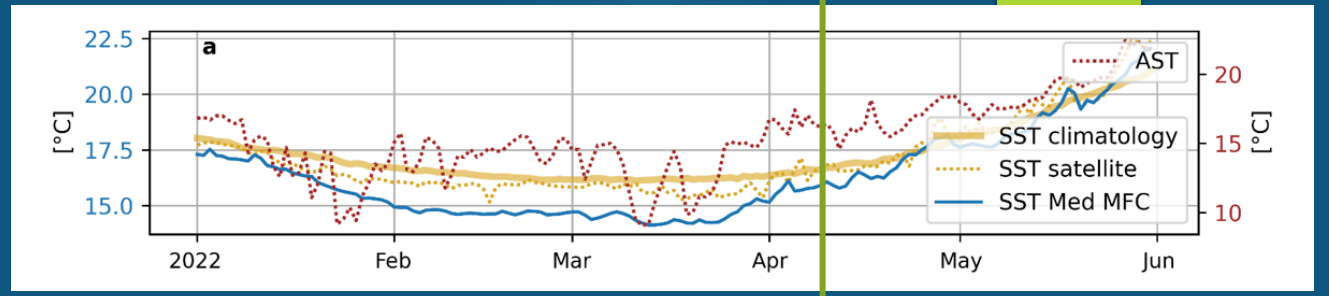
Marine dynamics

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

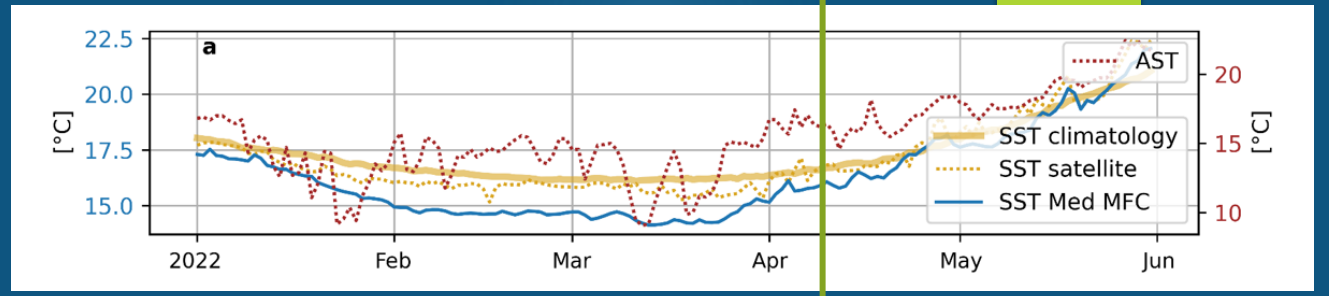
Marine dynamics

Sea surface temperature SST

Satellite — Model

Satellite climatology

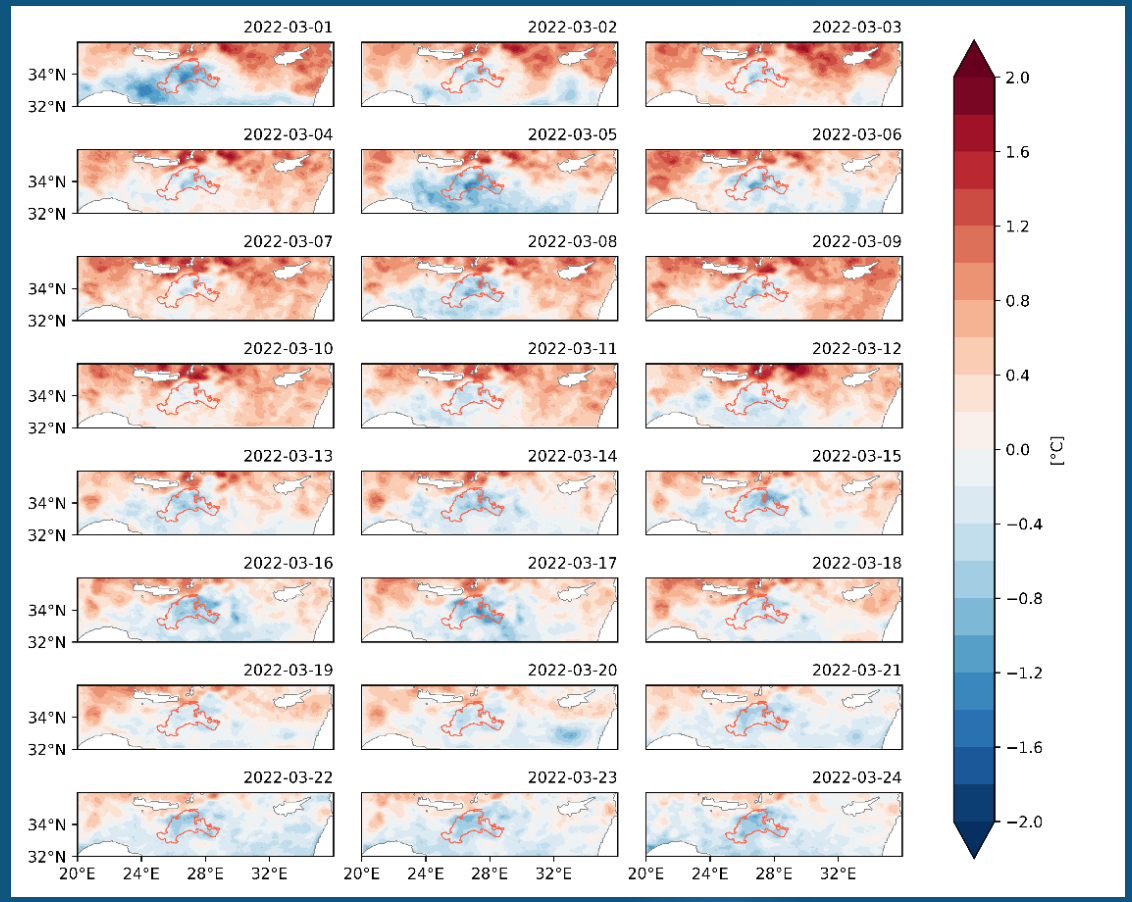
- SST lower than climatology starting from mid January
- Nearly persistent negative anomaly
- Model SST even lower



SST negative anomaly

Phytoplankton bloom peak

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

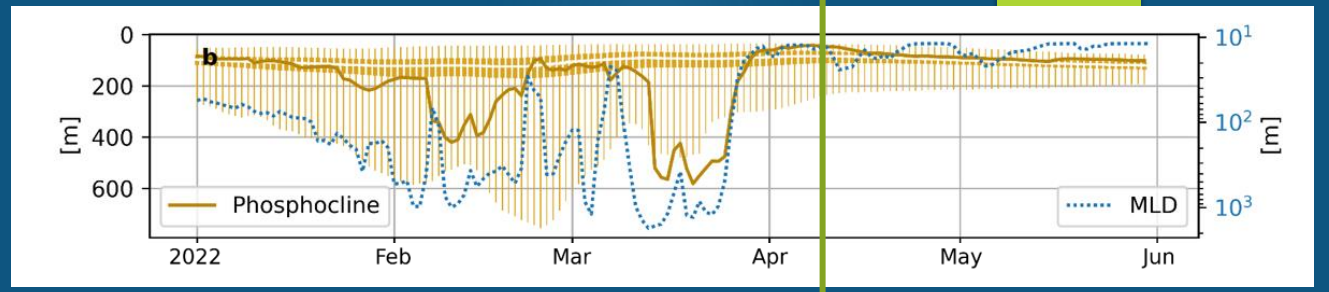


1 – 24 March model SST anomaly

Marine dynamics

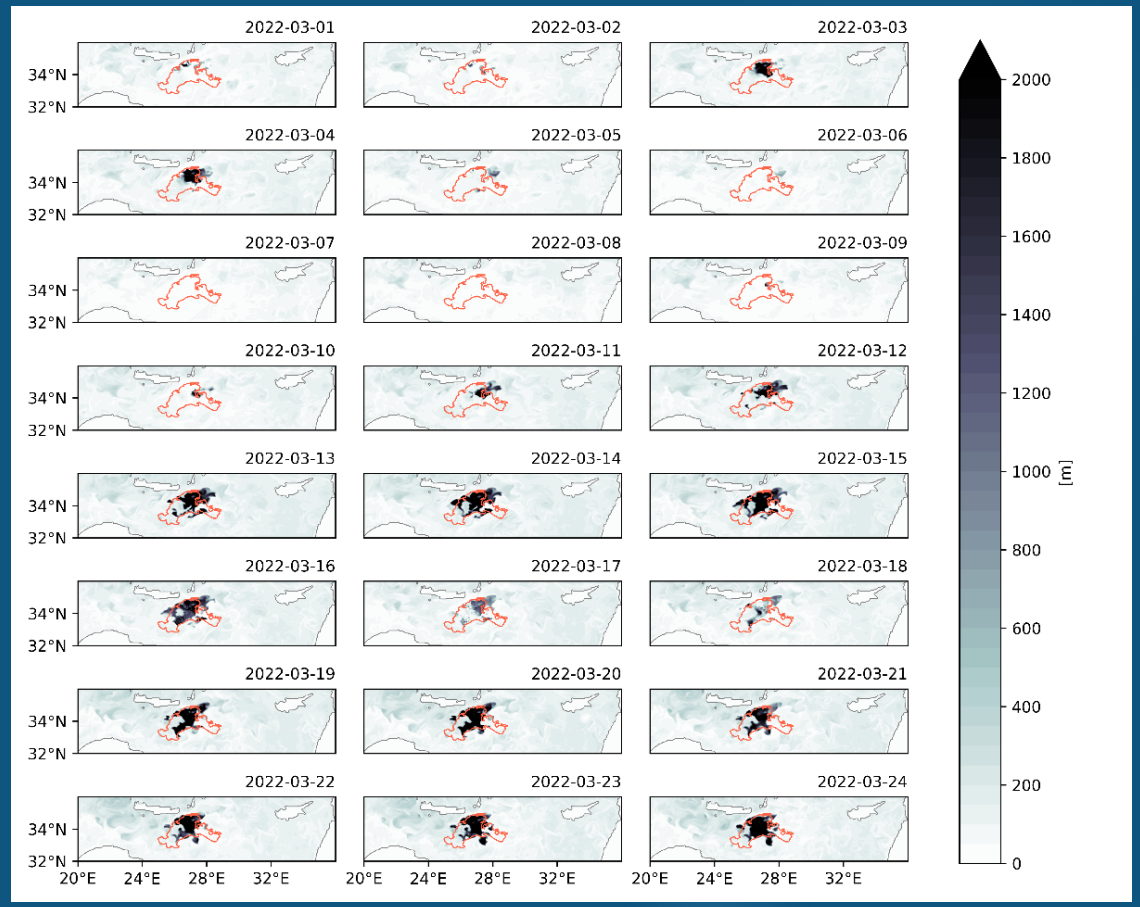
Mixed layer depth MLD ·····

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



Phytoplankton bloom peak

1 – 24 March MLD



Marine dynamics

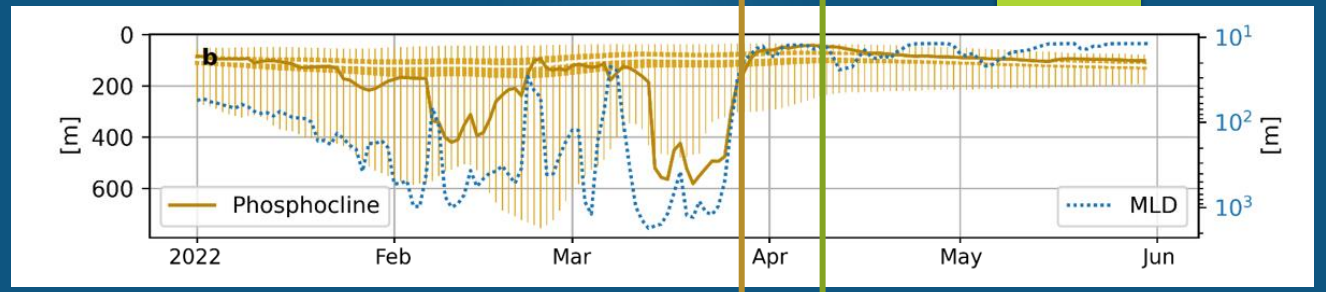
Mixed layer depth MLD ·····

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

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

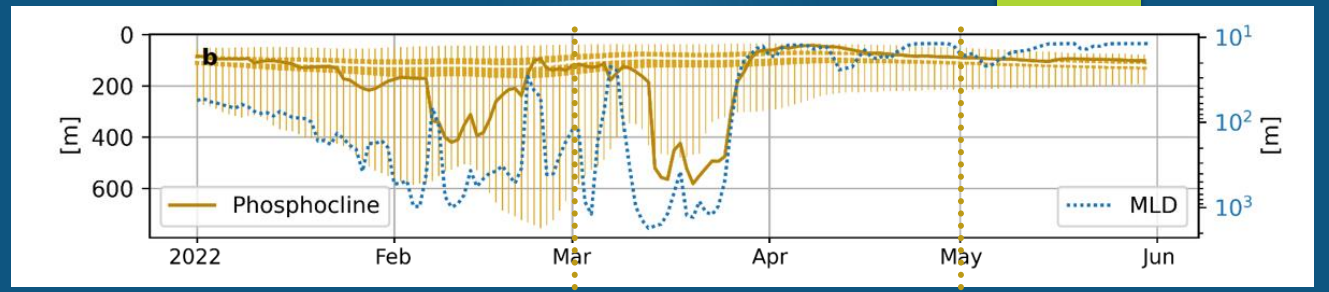
Mixed layer depth MLD ·····

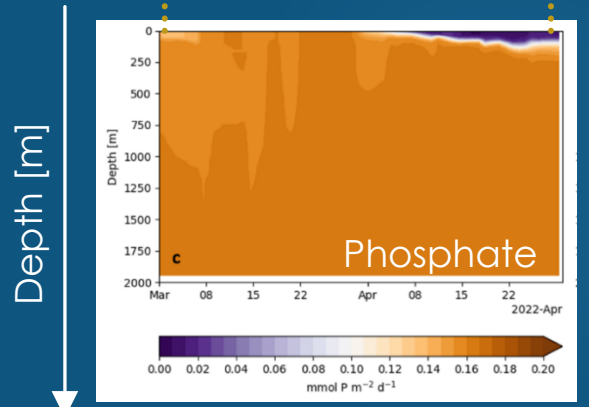
- MLD deepening since late January
- Intense March deepening down to nearly 2000 m

Phosphocline depth

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

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



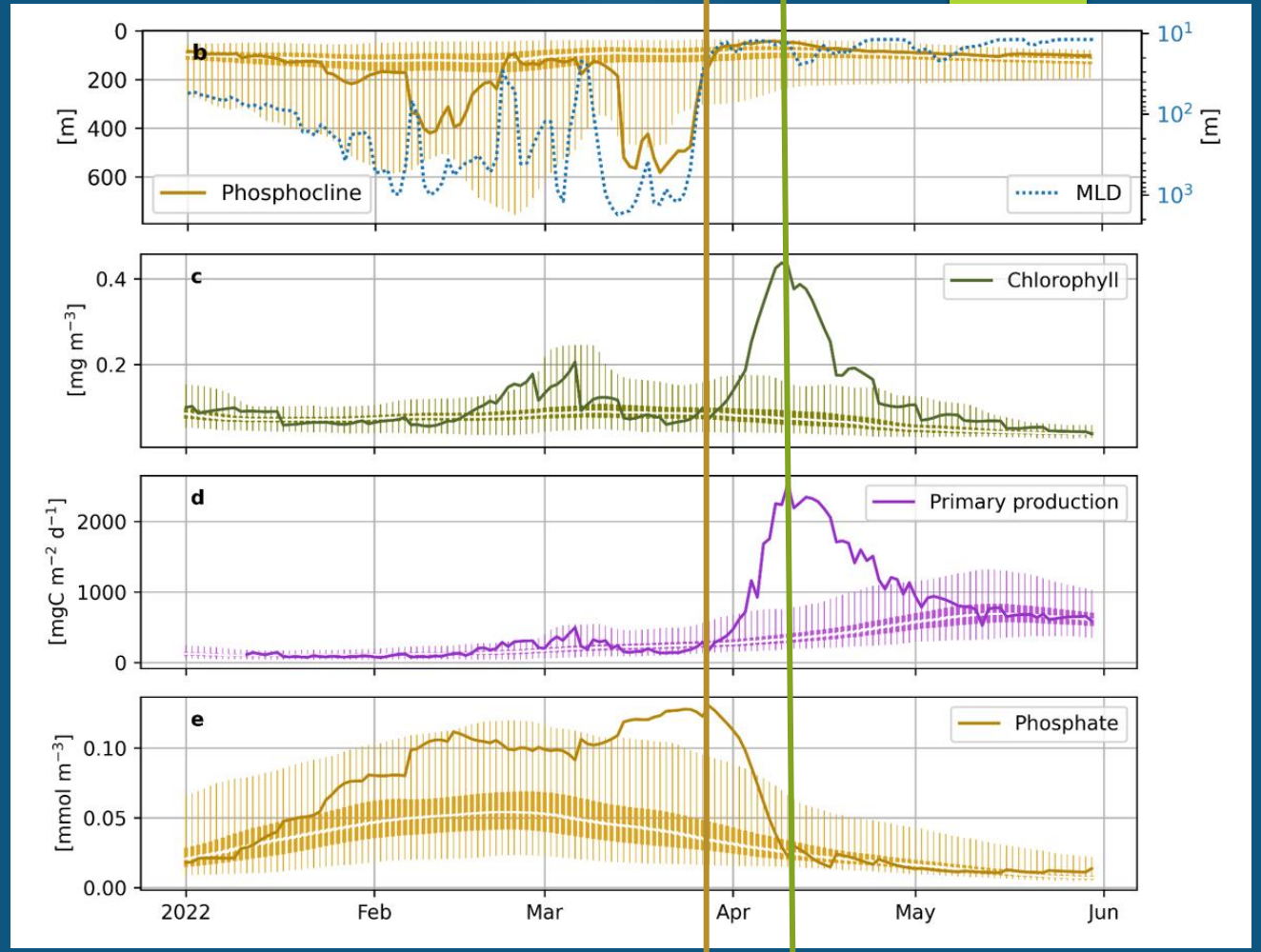


1 March – 30 April

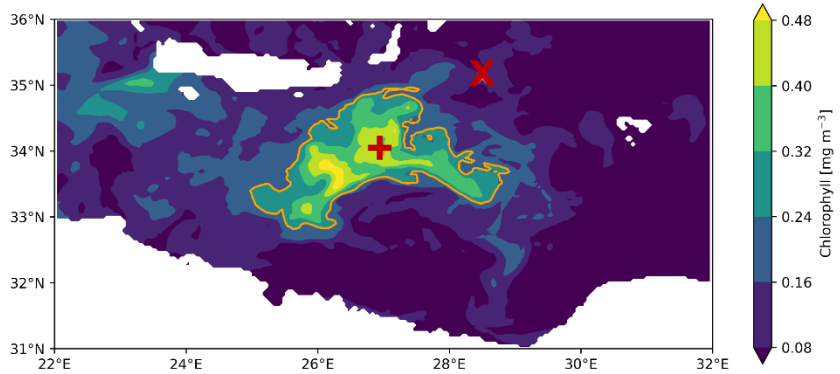
Marine dynamics

- **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)



Water column

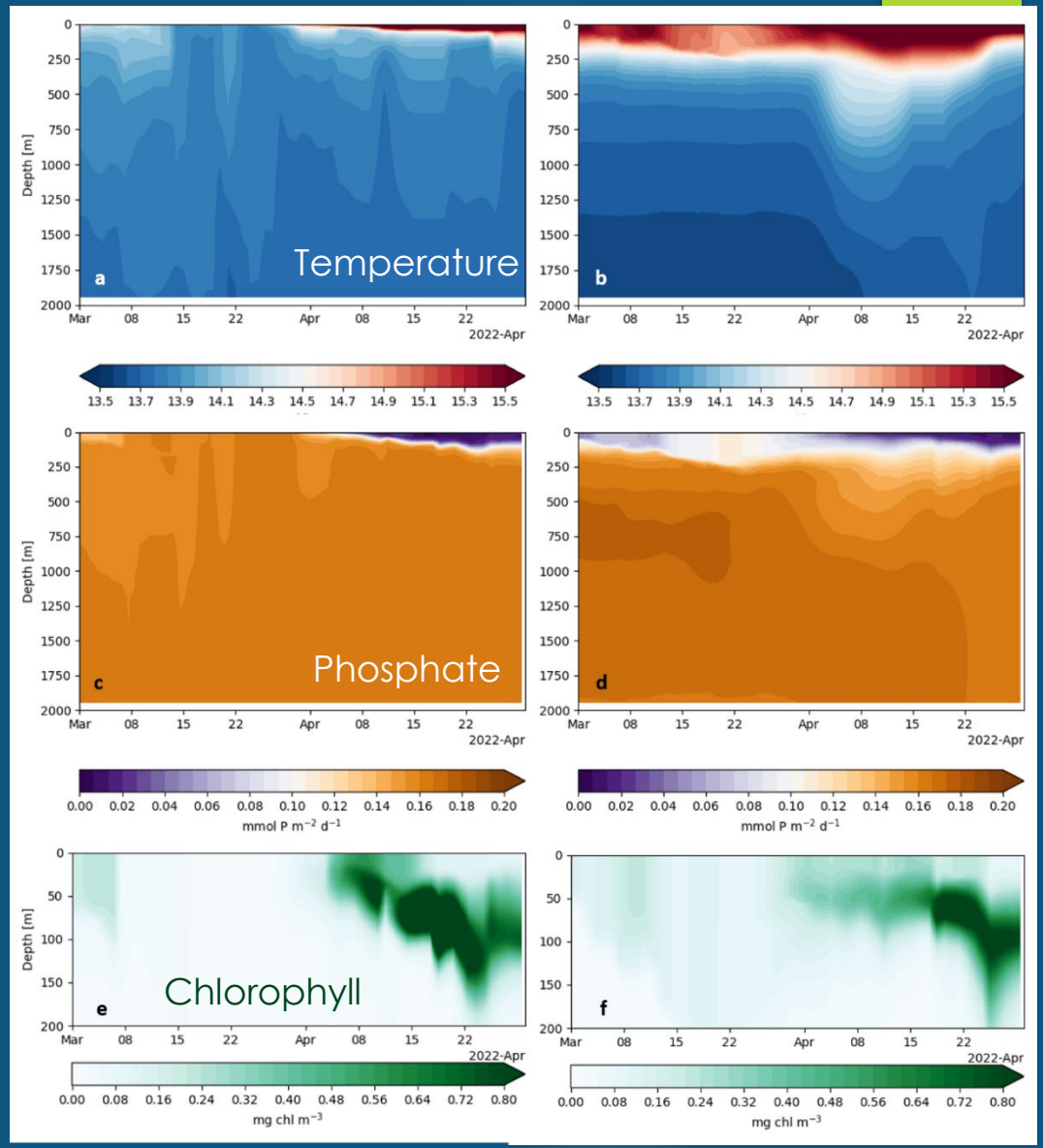


x Outside the 2022 event area
Usual spring bloom area

+ Inside the 2022 event area

+ 2022 event

x Usual bloom



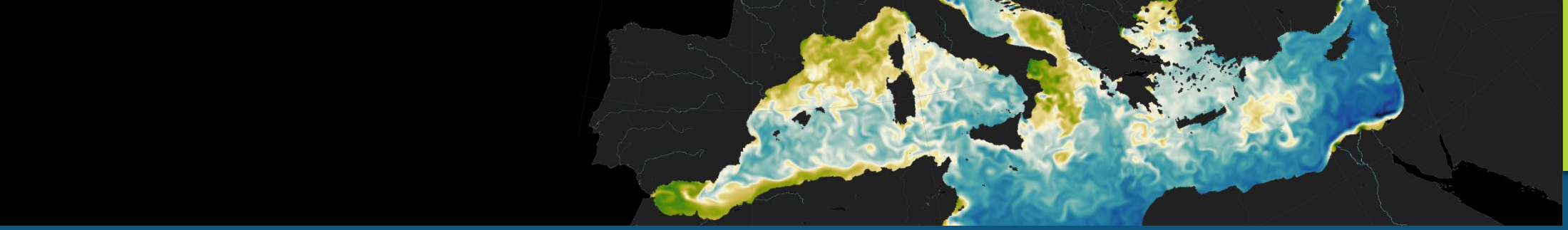
1 March – 30 April

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)

→ 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