POSEIDON: Phytoplankton and fisheries under regional warming in the global oceans

John A. Gittings & Dionysios Raitsos

European Space Agency Living Planet Symposium
23rd May 2022

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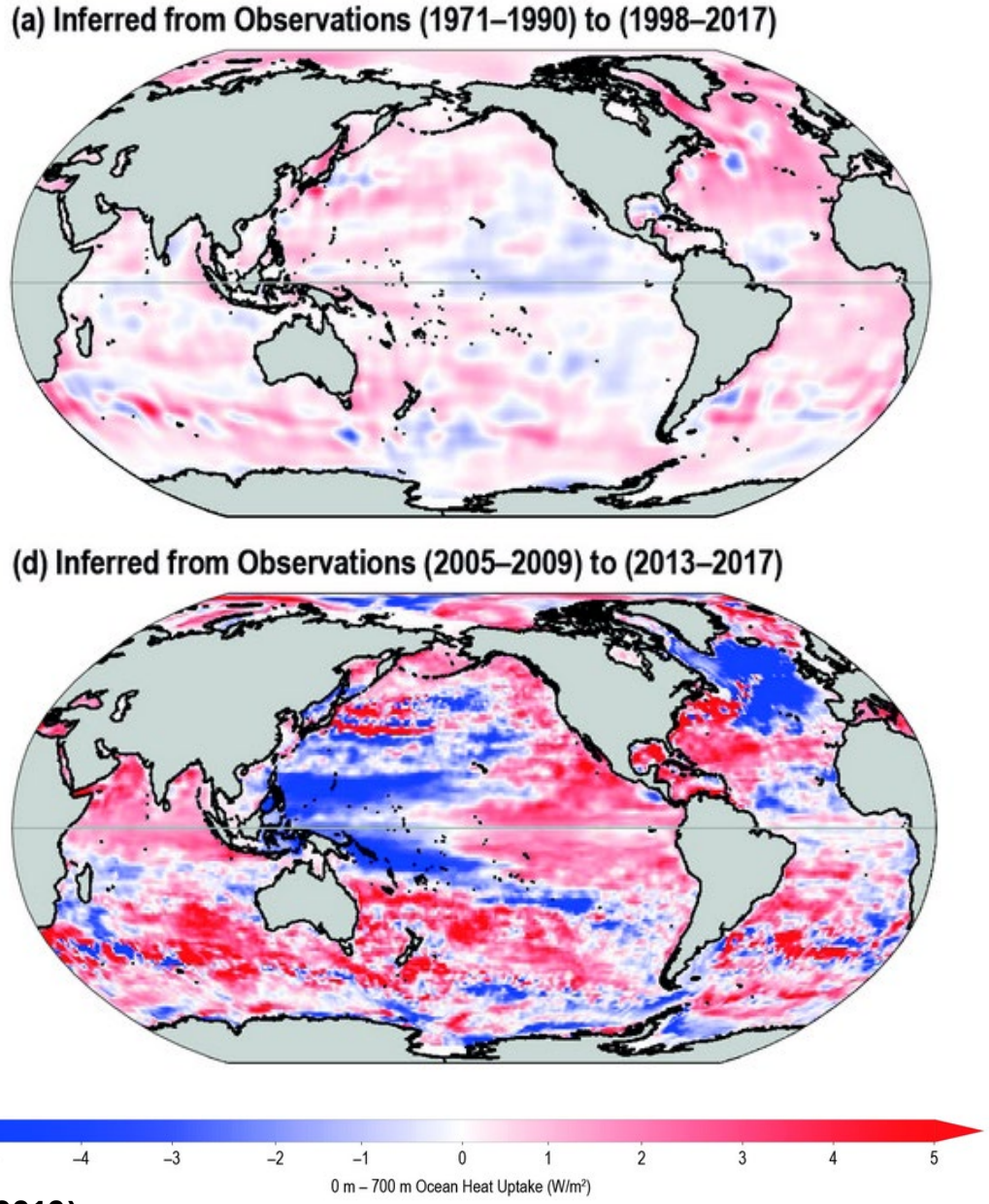


IPCC (2019)

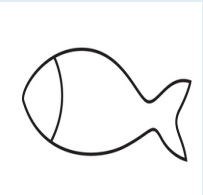
Heat uptake by the top 700 m of the ocean, as determined by differences between the averages over two 5- or 20-year intervals. Values represent heat flux into the ocean (W m^{-2}).

POSEIDON*: Aims & Objectives*

1. Establish knowledge on long-term trends and spatiotemporal variability of phytoplankton ecological indicators across a range of different oceanic environments

2. Assess the impacts of climate-related extremes, such as marine heatwaves (MHWs), on phytoplankton indicators

3. Explore the impacts of climate change at the ecosystem level, and link phytoplankton variability with fisheries yield over decadal timescales.



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POSEIDON: *Aims & Objectives*

FOUR PROPOSED STUDY REGIONS:

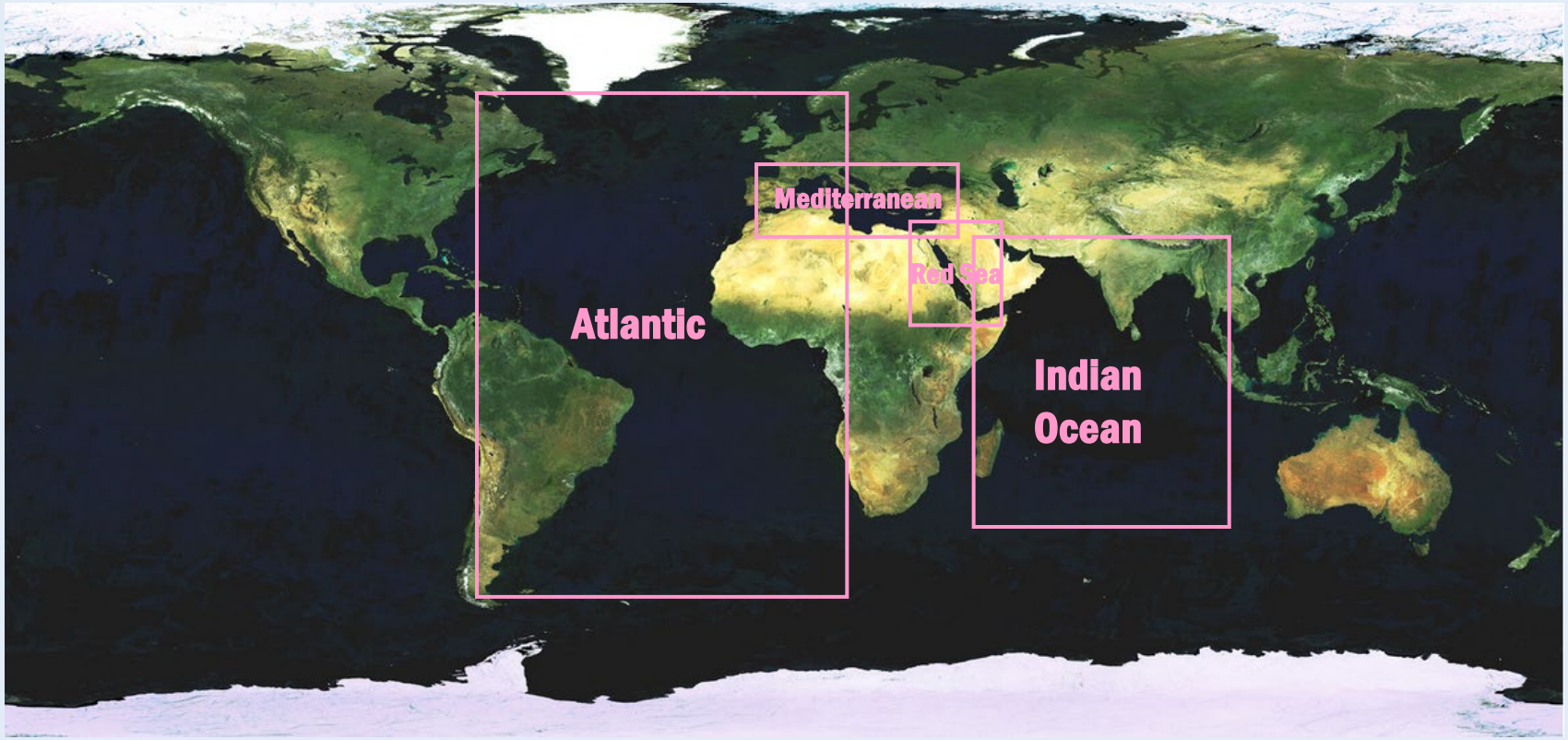

Image: Mosaic from Envisat's MERIS (May – November 2004)

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POSEIDON*: Aims & Objectives*

1. Establish knowledge on long-term trends and spatiotemporal variability of phytoplankton ecological indicators across a range of different oceanic environments

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Ecological Indicators

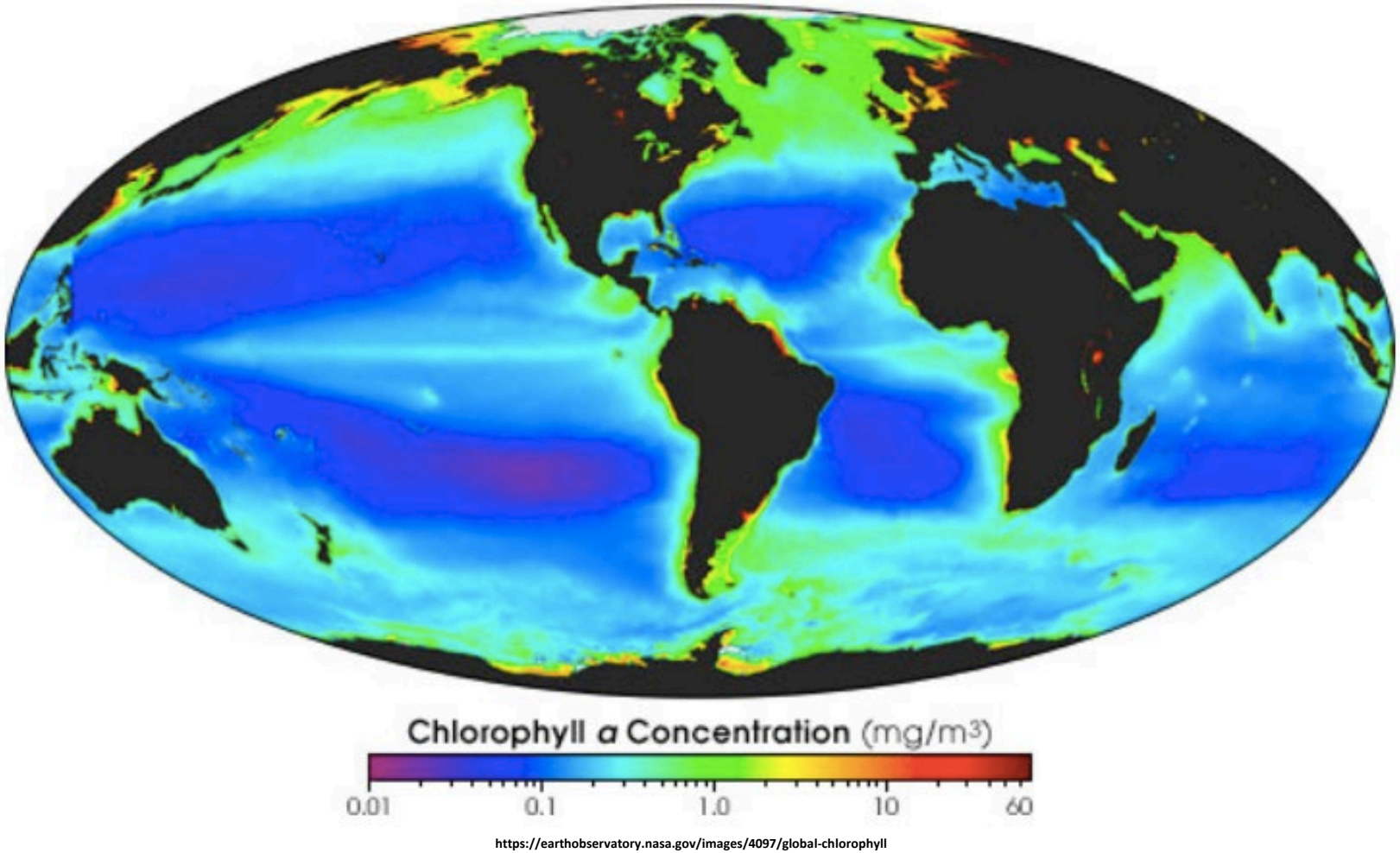
Quantifiable metrics that characterise ecosystem structure, composition or function

May serve as early-warning signals of ecological disturbances and gauges of long-term trends

Typically based on the presence of phytoplankton (as indexed by chlorophyll concentration)

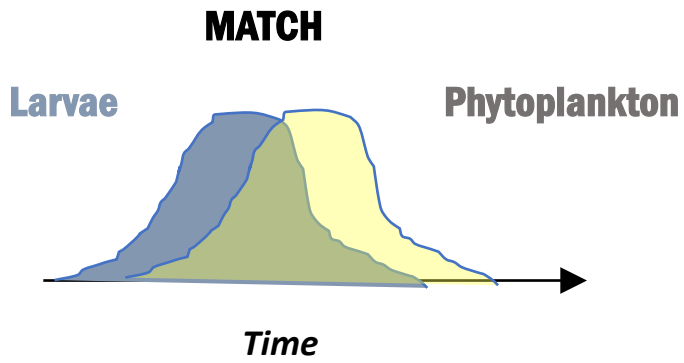
https://www.uts.edu.au/research-and-teaching/our-research/climate-change-cluster/events/c3-colloquium-functional-genetics

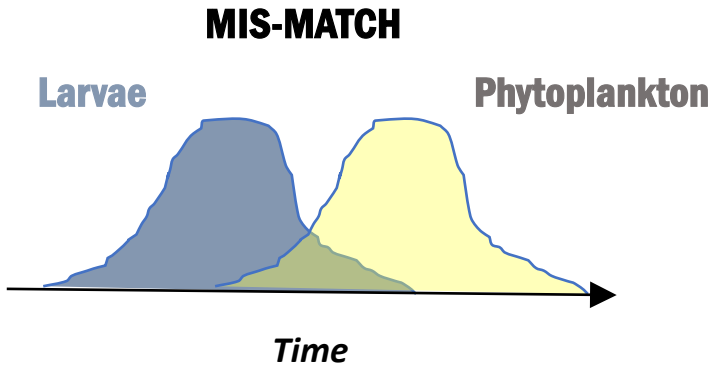
Ecological Indicators



https://earthobservatory.nasa.gov/images/4097/global-chlorophyll

Phytoplankton Phenology





Adapted from Platt *et al.* (2003)

Match-mismatch hypothesis (Cushing, 1974)

The timing of phytoplankton growth periods has far-reaching impacts on marine food web structure and ecosystem functioning

Basin-Scale Coherence in Phenology of Shrimps and Phytoplankton in the North Atlantic Ocean

P. Koeller,[1*] C. Fuentes-Yaco,[1,2] T. Platt,[1,3] S. Sathyendranath,[1,2,3] A. Richards,[4] P. Ouellet,[5] D. Orr,[6] U. Skúladóttir,[7] K. Wieland,[8] L. Savard,[5] M. Aschan[9]

nature
International journal of science

Brief Communication | Published: 22 May 2003

Marine ecology

Spring algal bloom and larval fish survival

Trevor Platt, Csar Fuentes-Yaco & Kenneth T. Frank

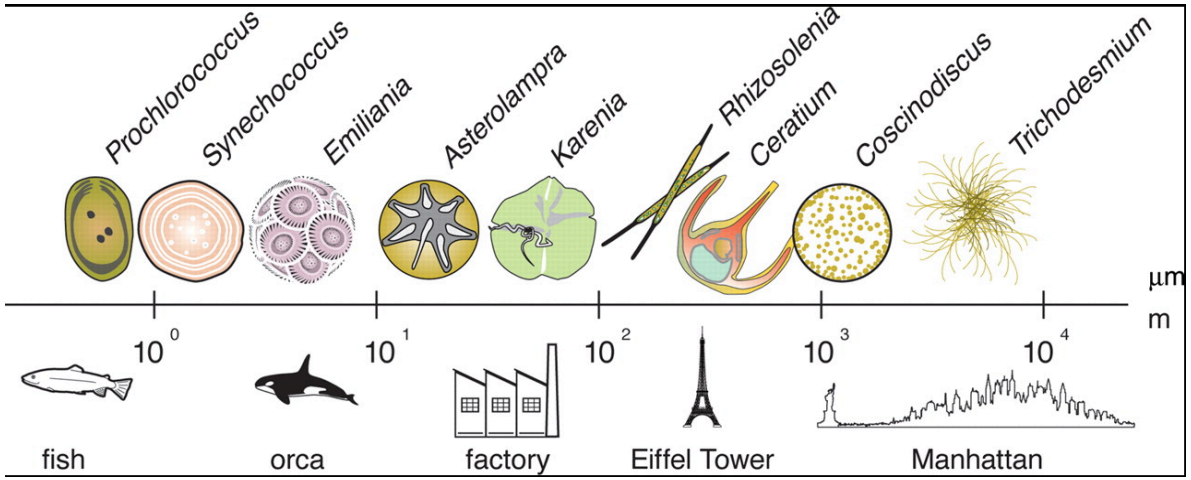
Nature **423**, 398–399 (2003) | Download Citation

Phytoplankton size structure

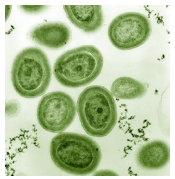
Phytoplankton communities exist over a continuum of different sizes

Important for marine food web structure, fisheries, carbon export and biogeochemical cycling

Phytoplankton size classes (PSC) are sufficient for distinguishing the major functional groups

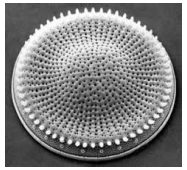


Finkel et al. 2009



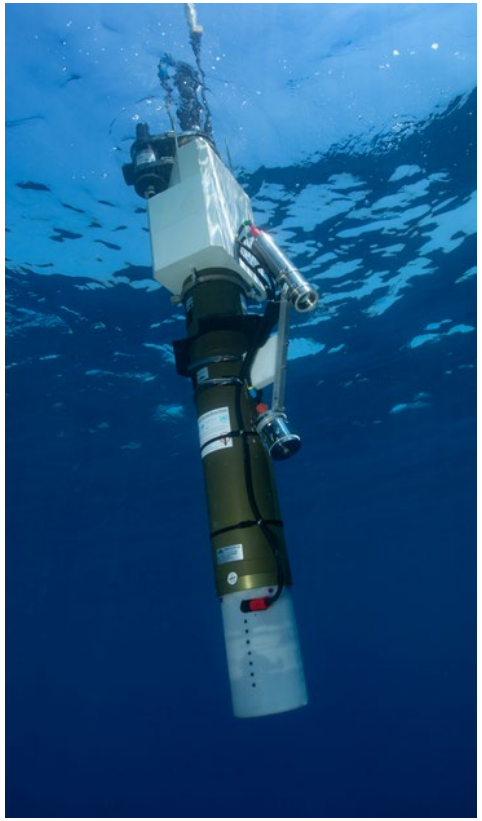
Pico
0.2 – 2 µm

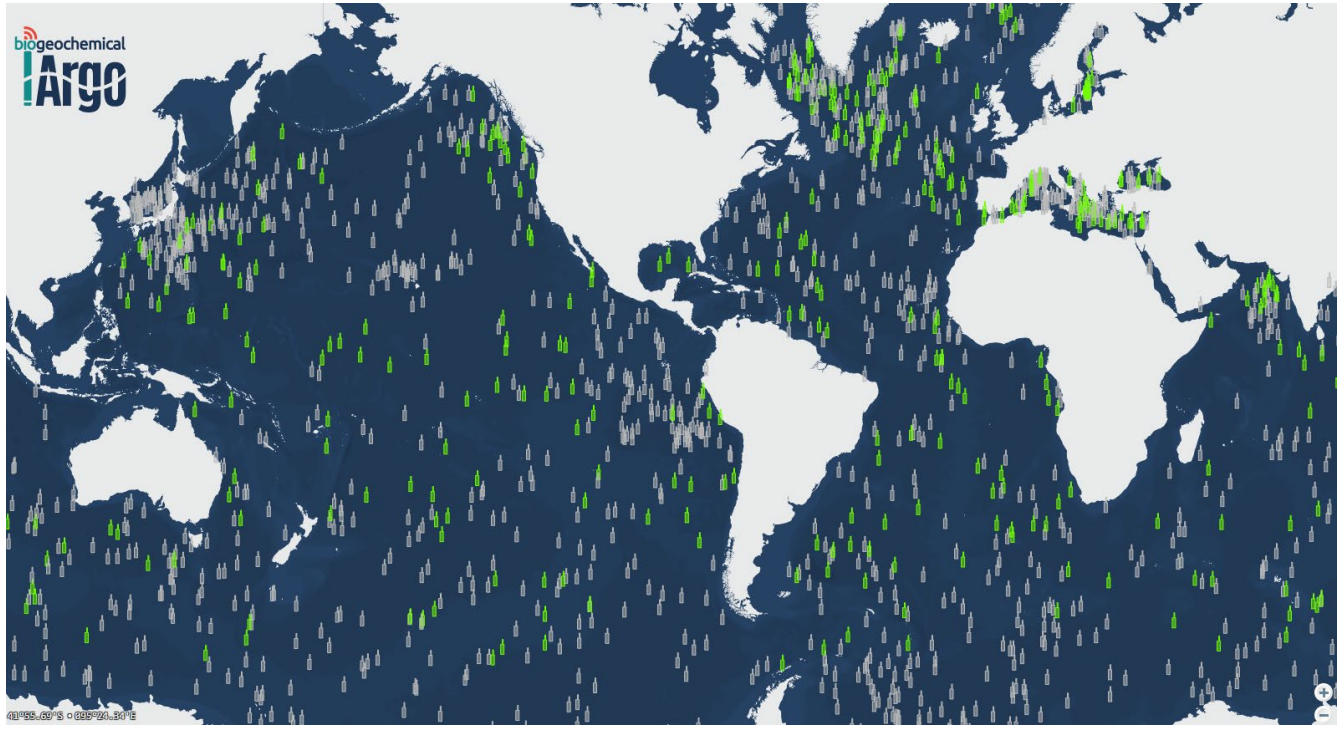
Nano
2 – 20 µm



Micro
20 – 200 µm

Additional Contemporary Ocean Platforms





Freely-available BGC-Argo/ARGO datasets in our regions of interest - which have been designed for the global analysis of phytoplankton dynamics

POSEIDON: *Aims & Objectives*

2. Assess the impacts of climate-related extremes, such as marine heatwaves (MHWs), on phytoplankton indicators

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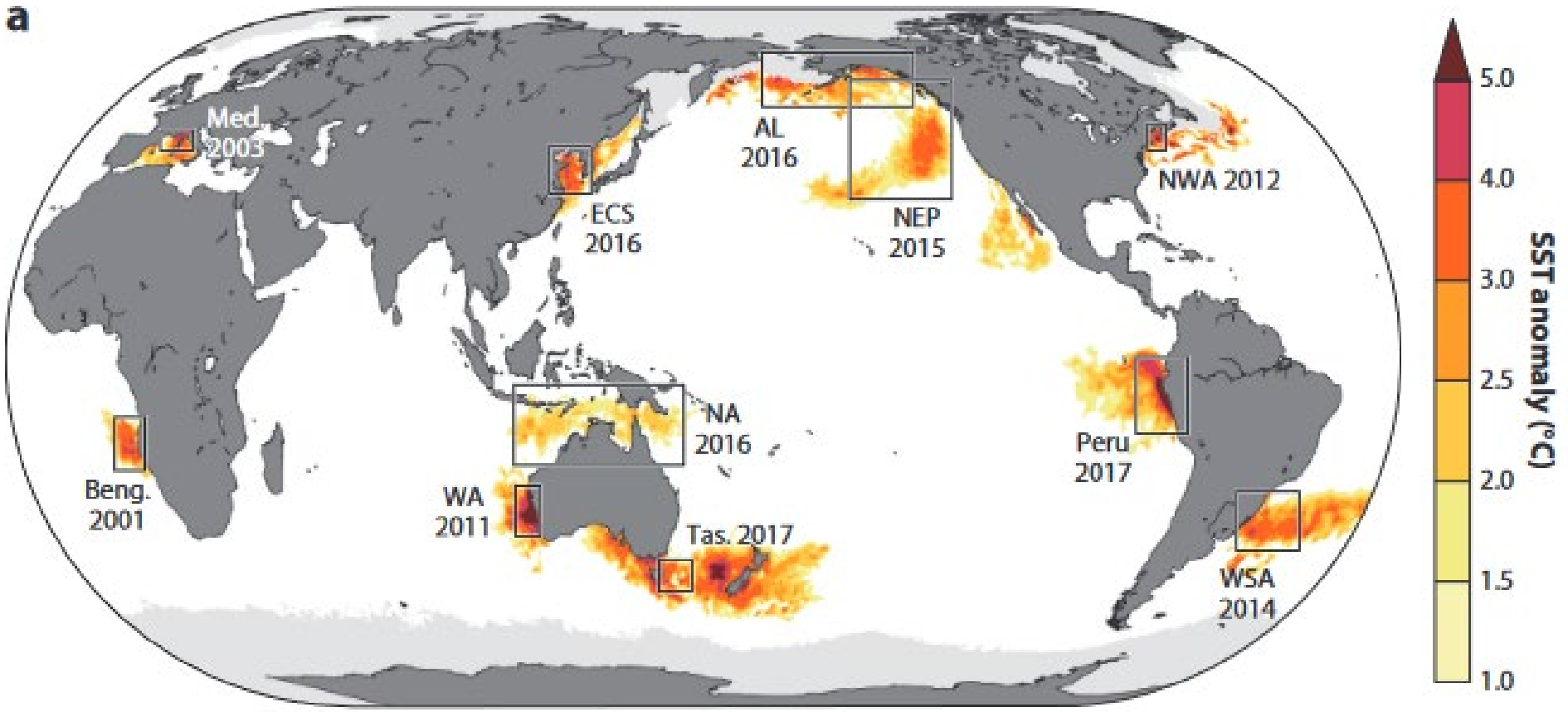
Marine heatwaves



Oliver et al. 2021

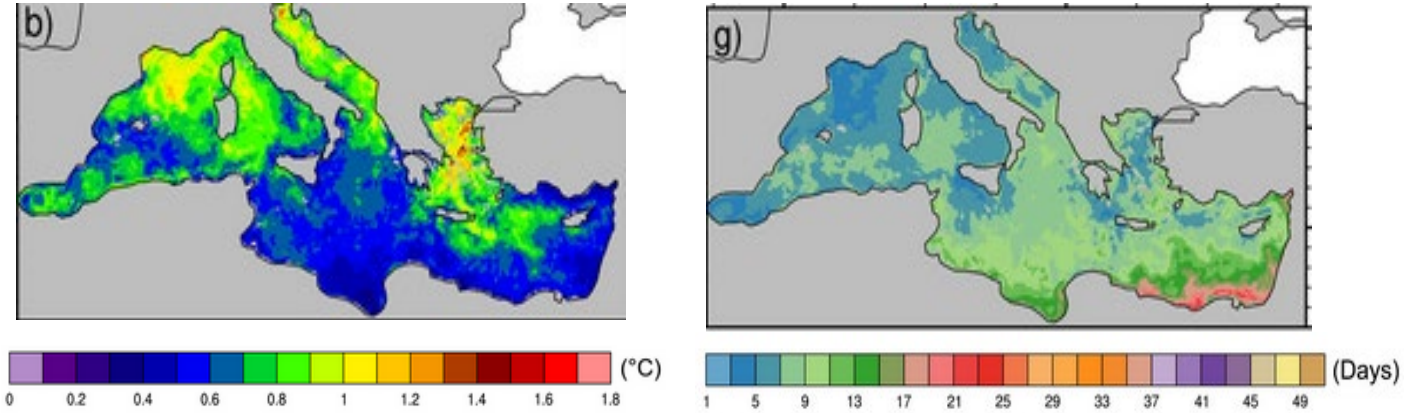
"…anomalous warm sea-water events that can substantially affect marine ecosystems".

Marine heatwaves

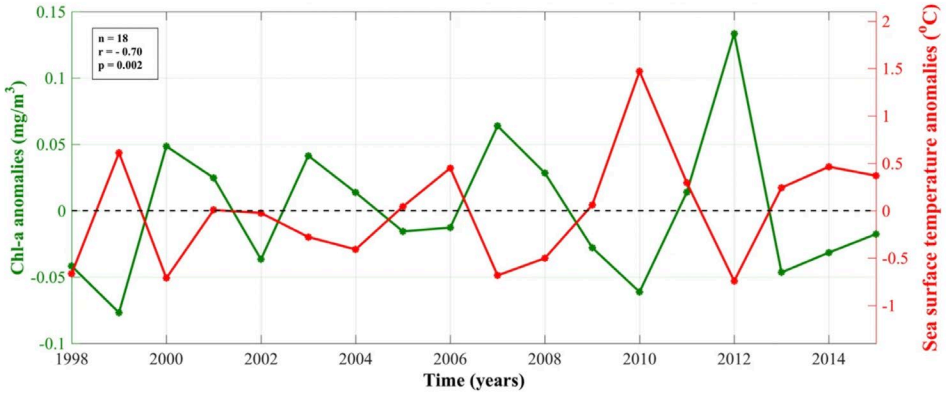
Long-term analyses of satellite-derived SST time series (ESA SST-CCI, OSTIA).

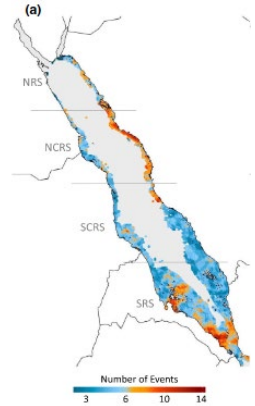
Explore the spatiotemporal distribution of these extreme heating events, and describes their frequency, intensity and duration.

Implementation of MHW detection algorithm (Hobday et al. 2016; Darmaraki et al. 2019a, 2019b; Genevier et al.)



Darmaraki et al. 2019

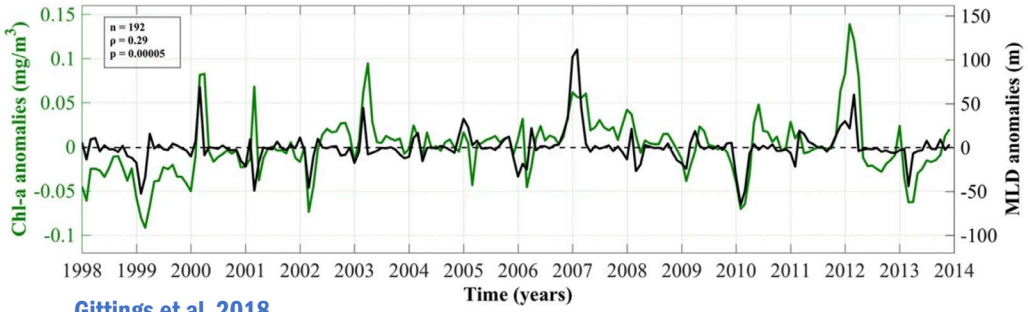




Genevier et al. 2019

How do phytoplankton ecological indicators respond?

- *Poster by Iason Theodorou (NKUA, 24/05/2022, 17:42)*
- *Talk by Dr Sofia Darmaraki (NKUA, 24/05/2022, 09:15)*



Gittings et al. 2018

POSEIDON*: Aims & Objectives*

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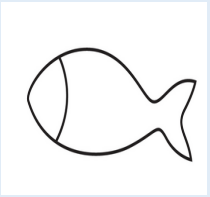

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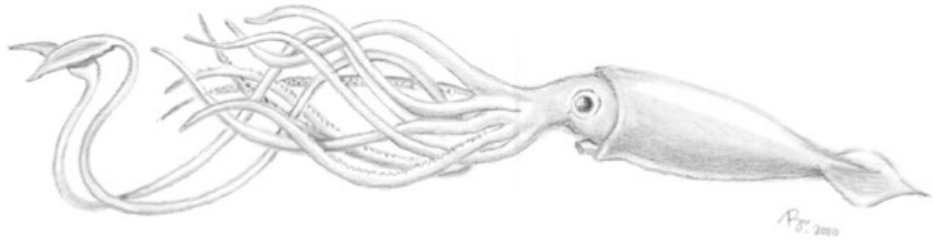
Links between phytoplankton ecological indicators and fisheries

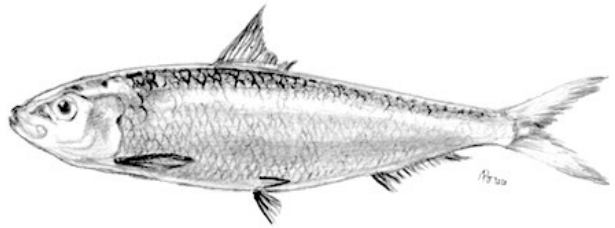
Marine fish constitute a major source of animal protein and provide an essential source of micronutrients

Bridge the gap between long-term trends in phytoplankton ecological indicators, regional warming and fisheries stocks over the regions of interest

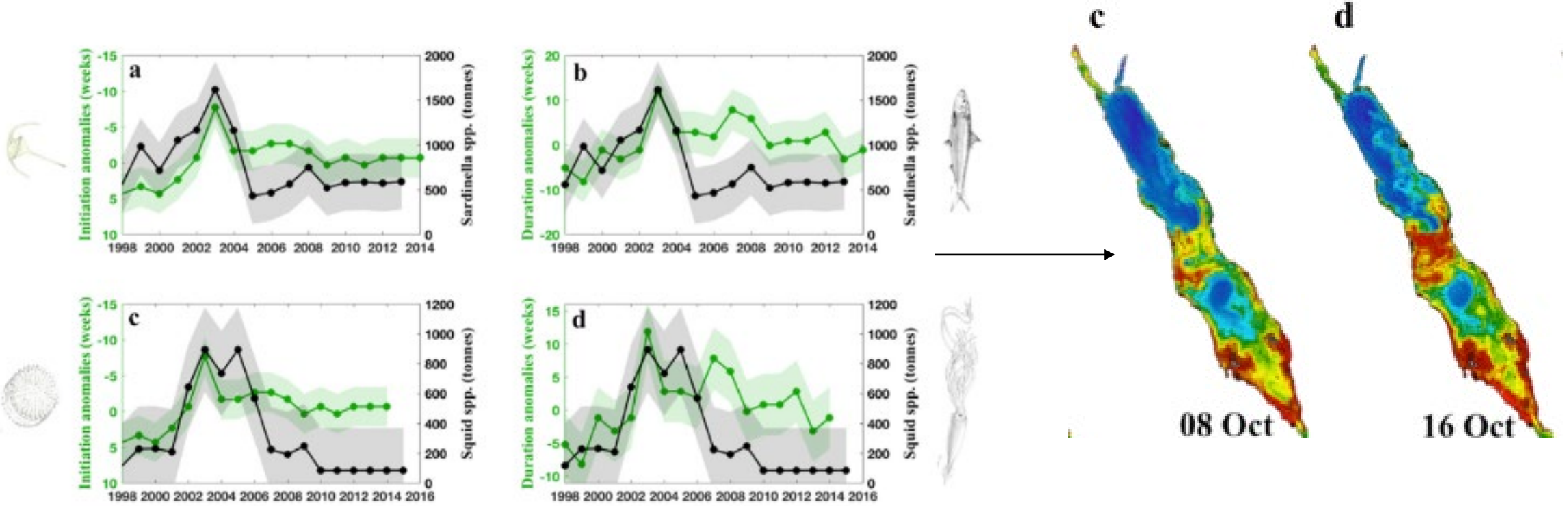
Are metrics characterising the stocks of fisheries resources are related to the variability of phytoplankton indicators?

https://al-bab.com/yemen%E2%80%99s-fisheries-need-management%C2%A0

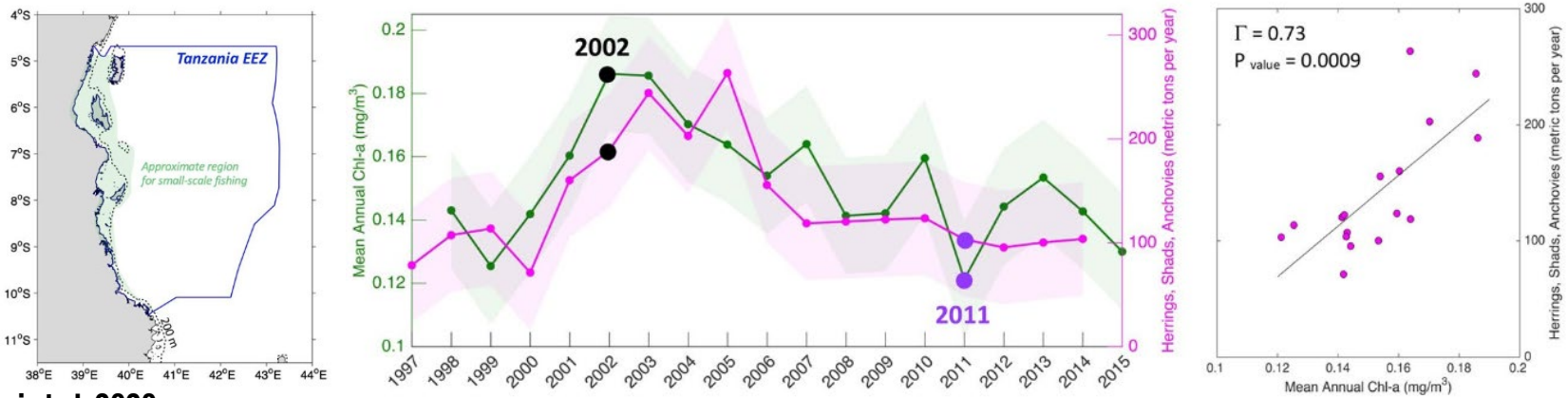




Links between phytoplankton ecological indicators and fisheries



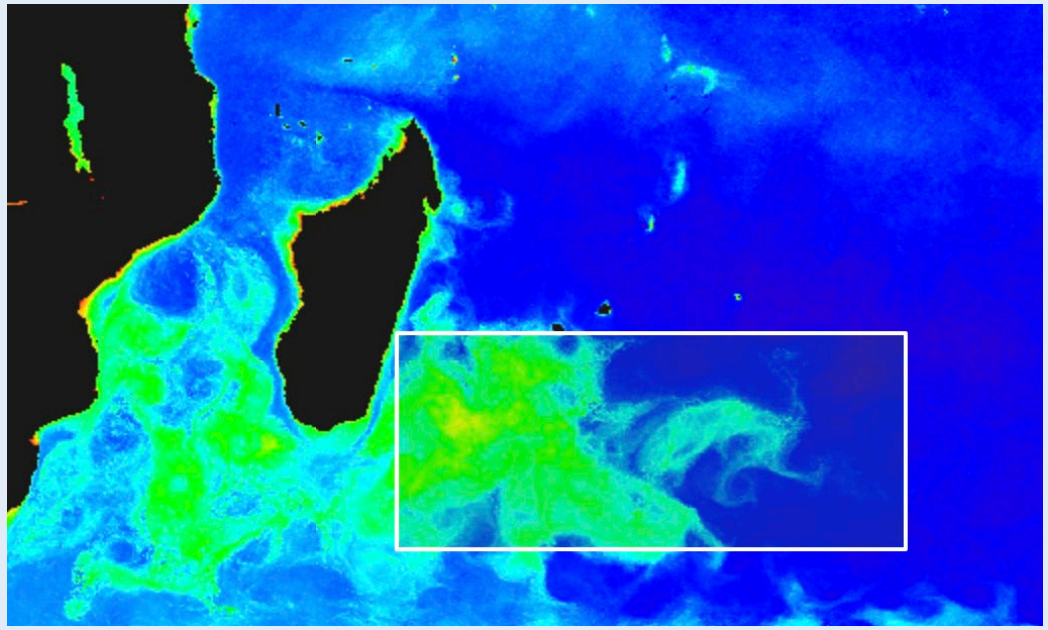
Gittings et al. 2021

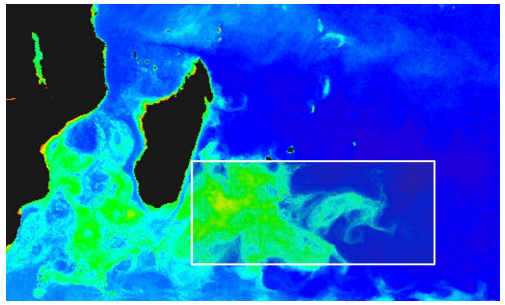


Jebri et al. 2020

POSEIDON: *Preliminary results*

The 2019/2020 Madagascar Phytoplankton Bloom

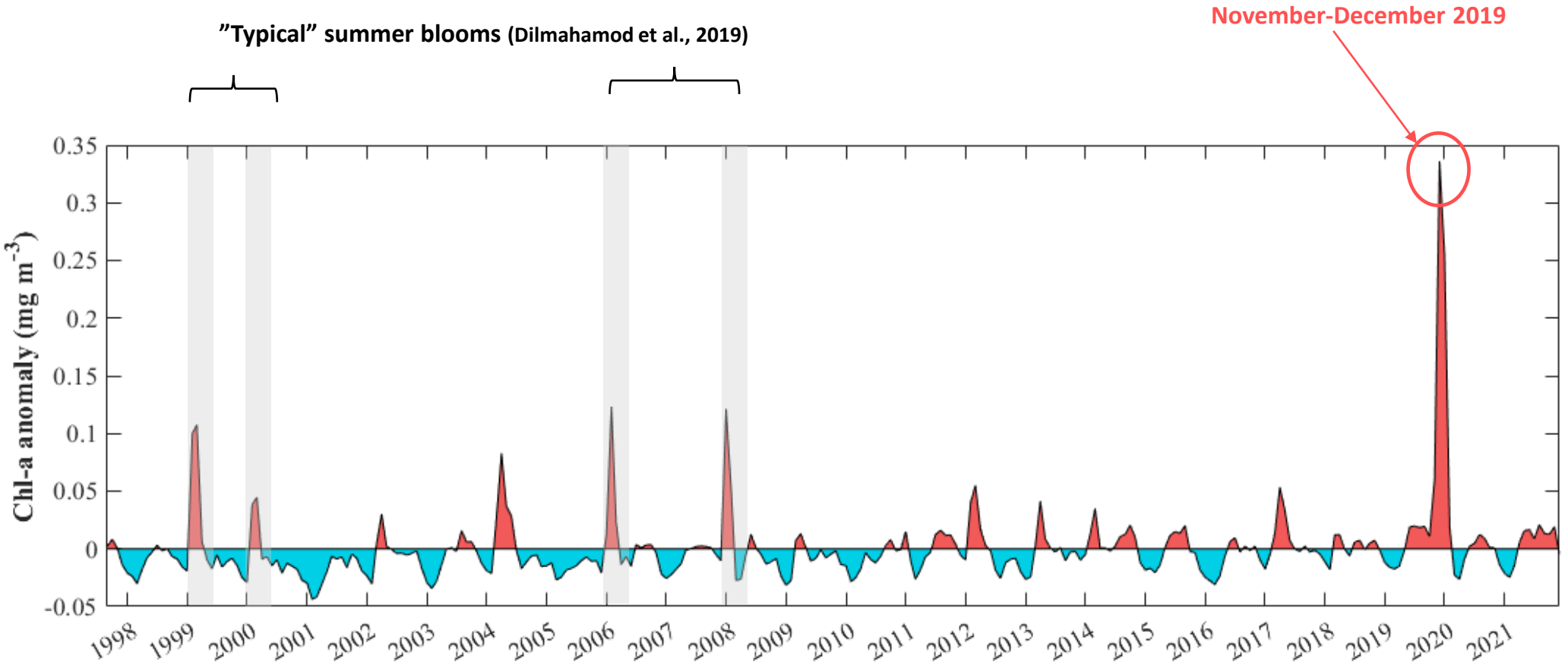




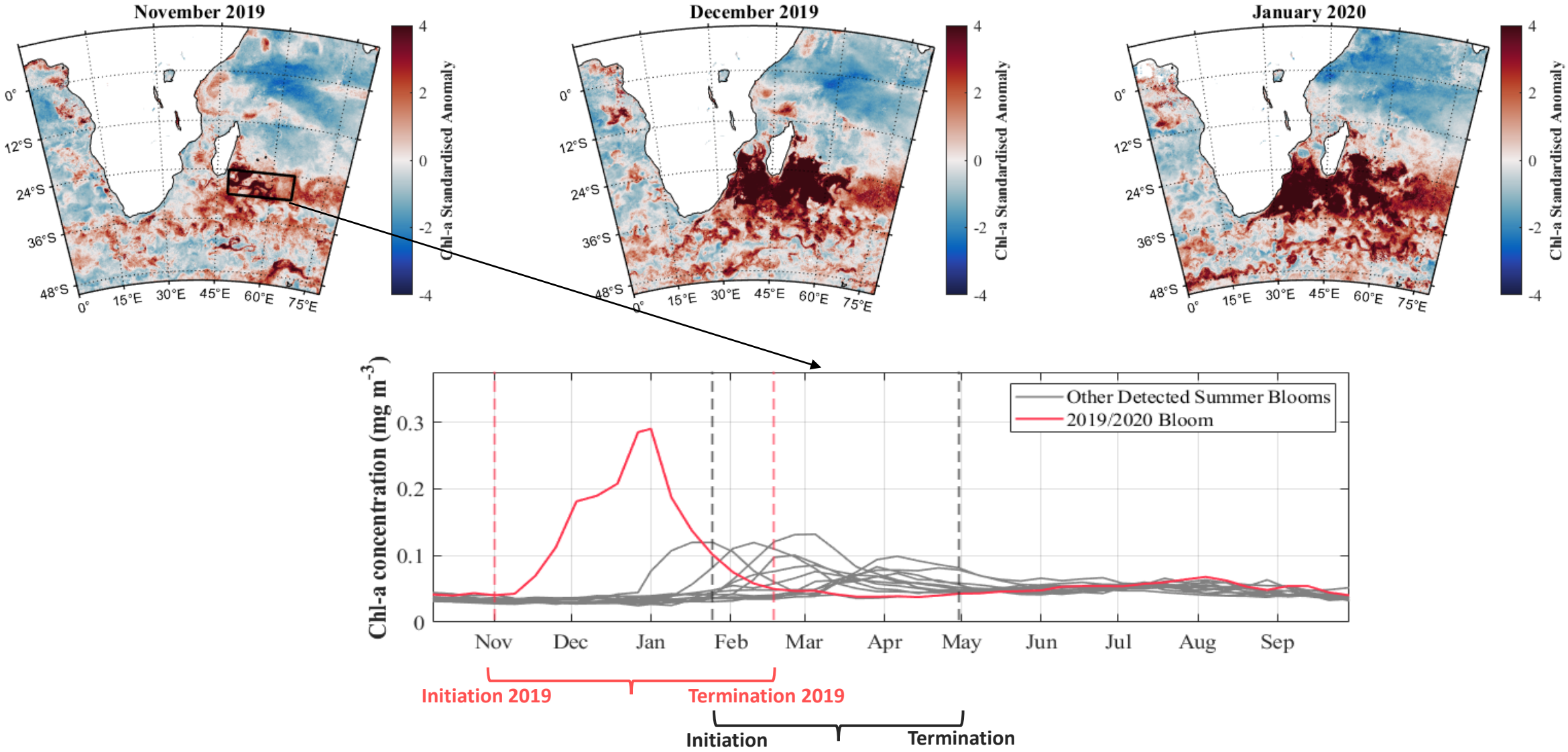
ocean colour cci

”Typical” summer blooms (Dilmahamod et al., 2019)

November-December 2019



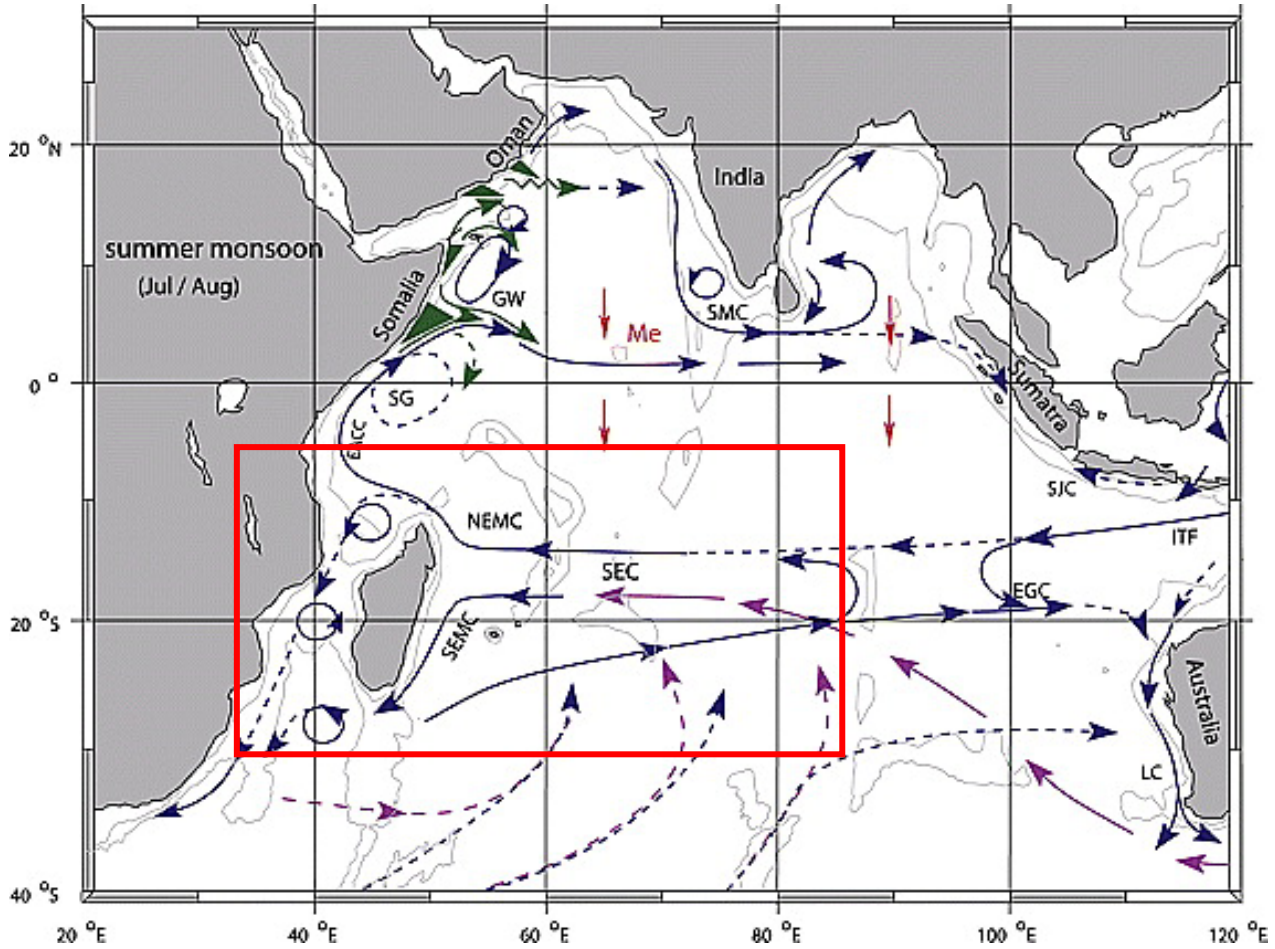
Chl-a 8-day means (1997 – 2020) – extreme event in spring 2019 (November-December)



Phenology threshold criterion algorithm (Racault et al., 2012; Gittings et al., 2018, 2019)

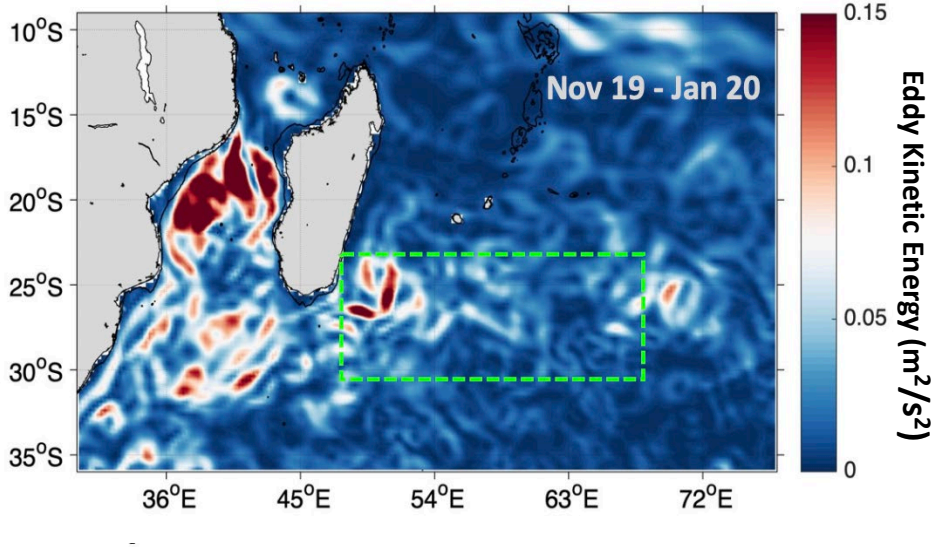
Uncovering the mechanisms....

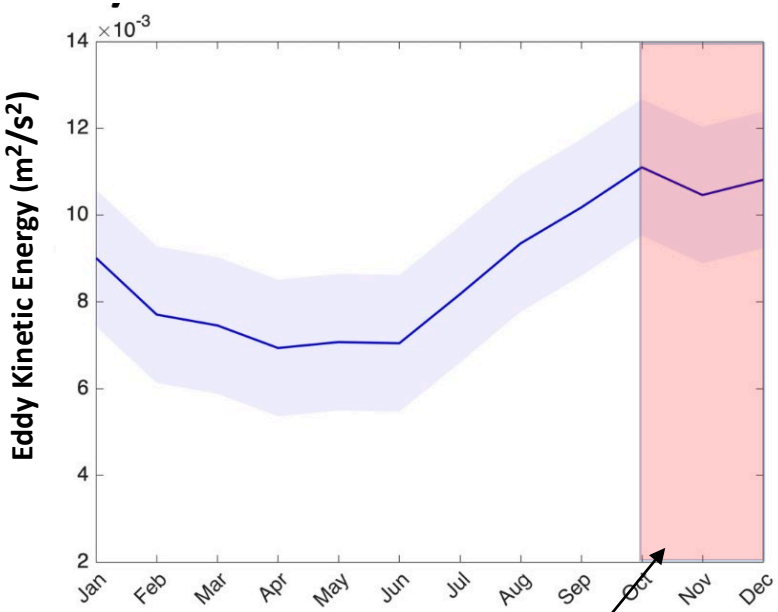
Schott et al. (2009)

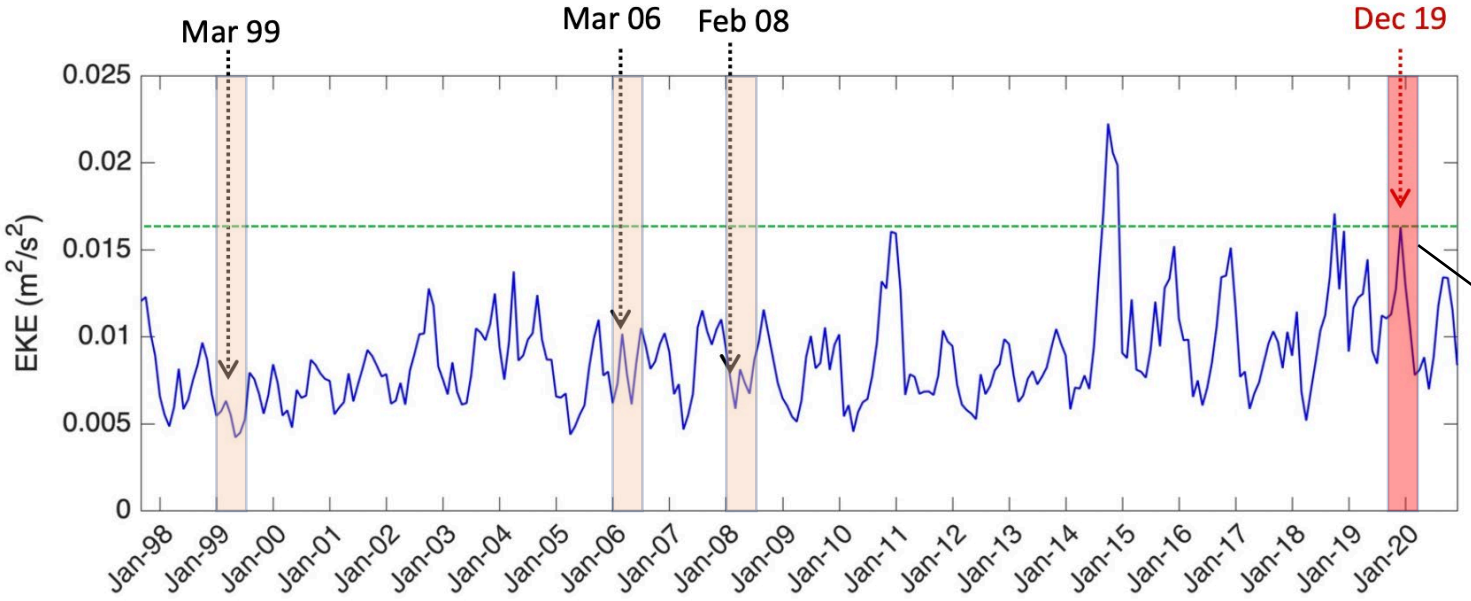


The region is incredibly complex and the cause of previous blooms occurring during austral summer is still debated (several different hypotheses)

Uncovering the mechanisms….



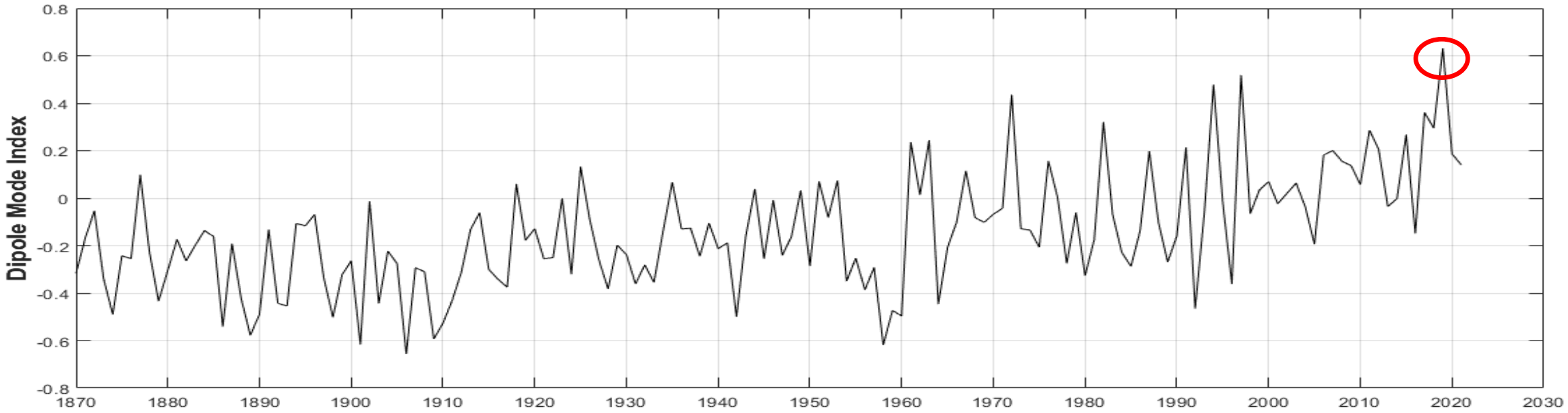




October-December seasonal peak in EKE corresponds to 2019/2020 bloom months

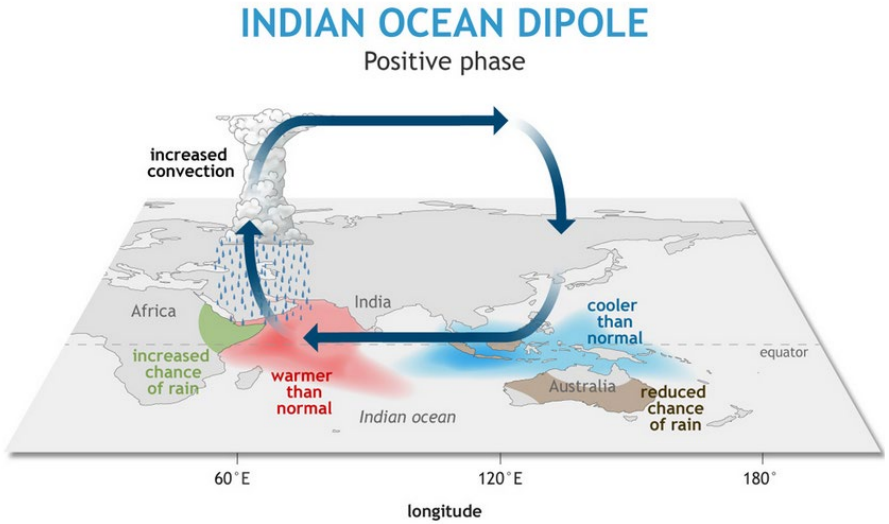
One of the strongest austral springs in terms of EKE observed over the ocean colour satellite record…

Uncovering the mechanisms….



Also the strongest positive Indian Ocean Dipole observed over the last ~150 years….

Analysis ongoing!



Thank you and enjoy the rest of the conference!

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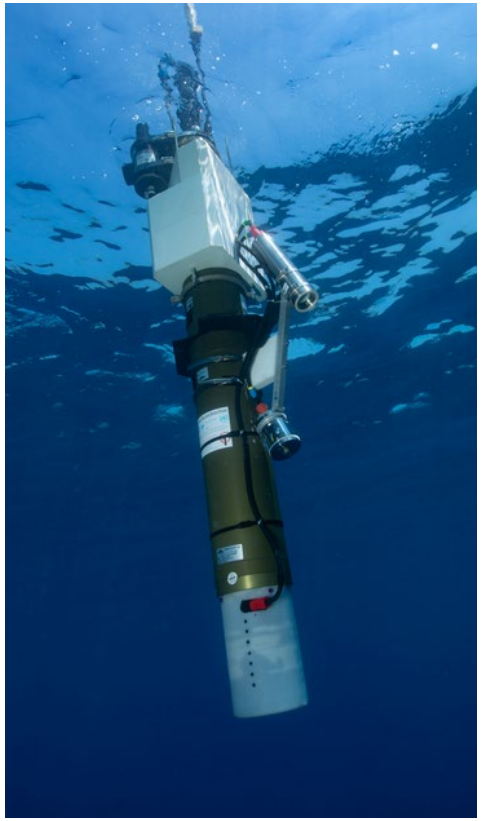
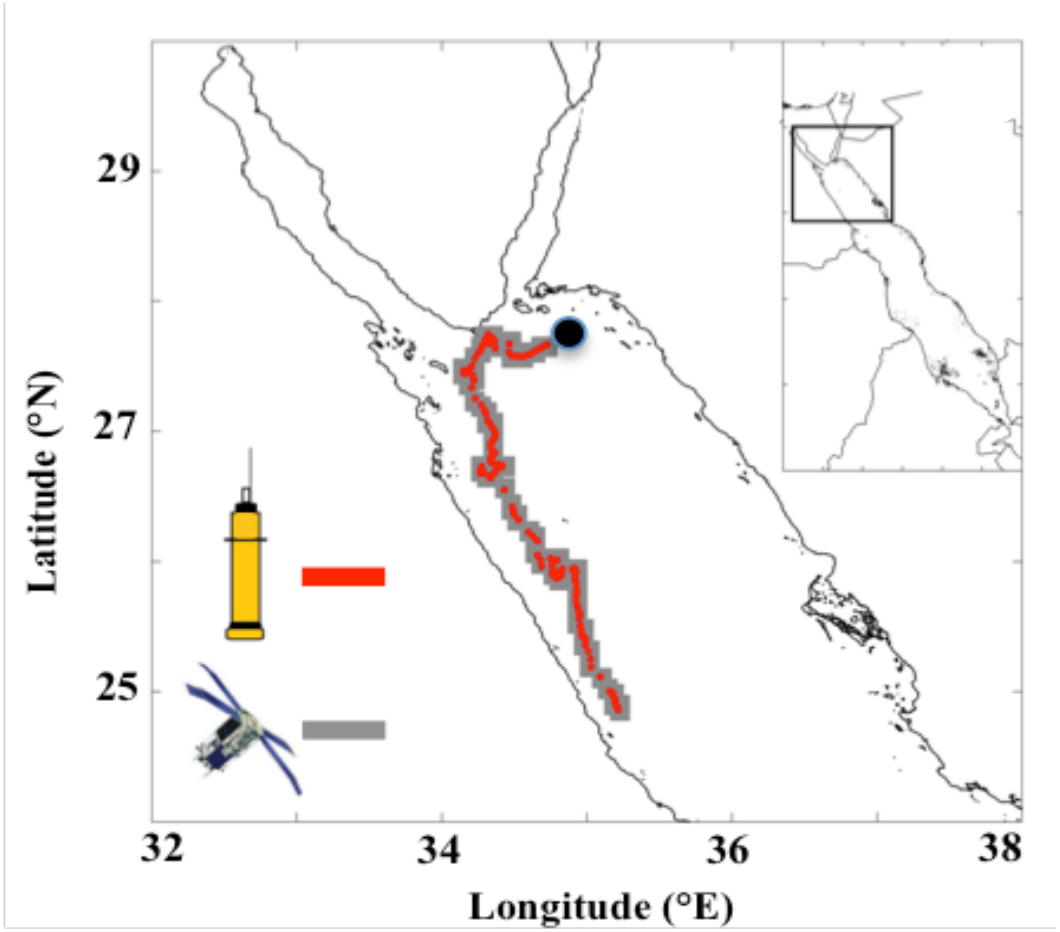
Additional Contemporary Ocean Platforms

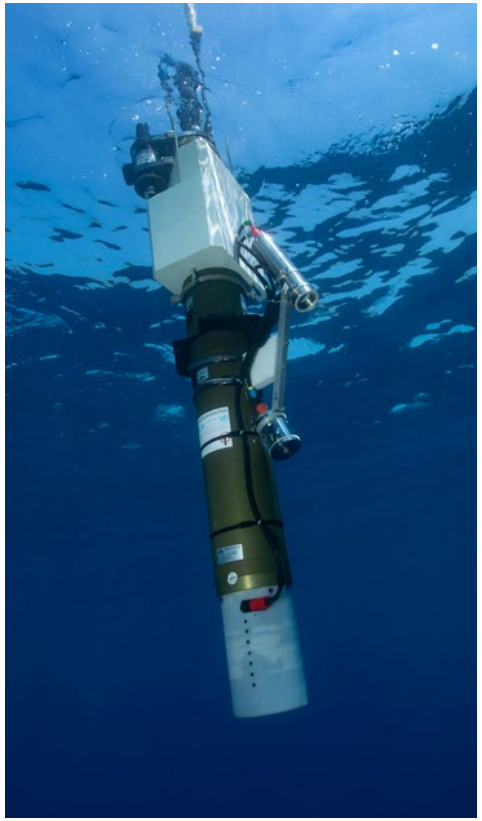


Data validation & exploration of changes in vertical dynamics

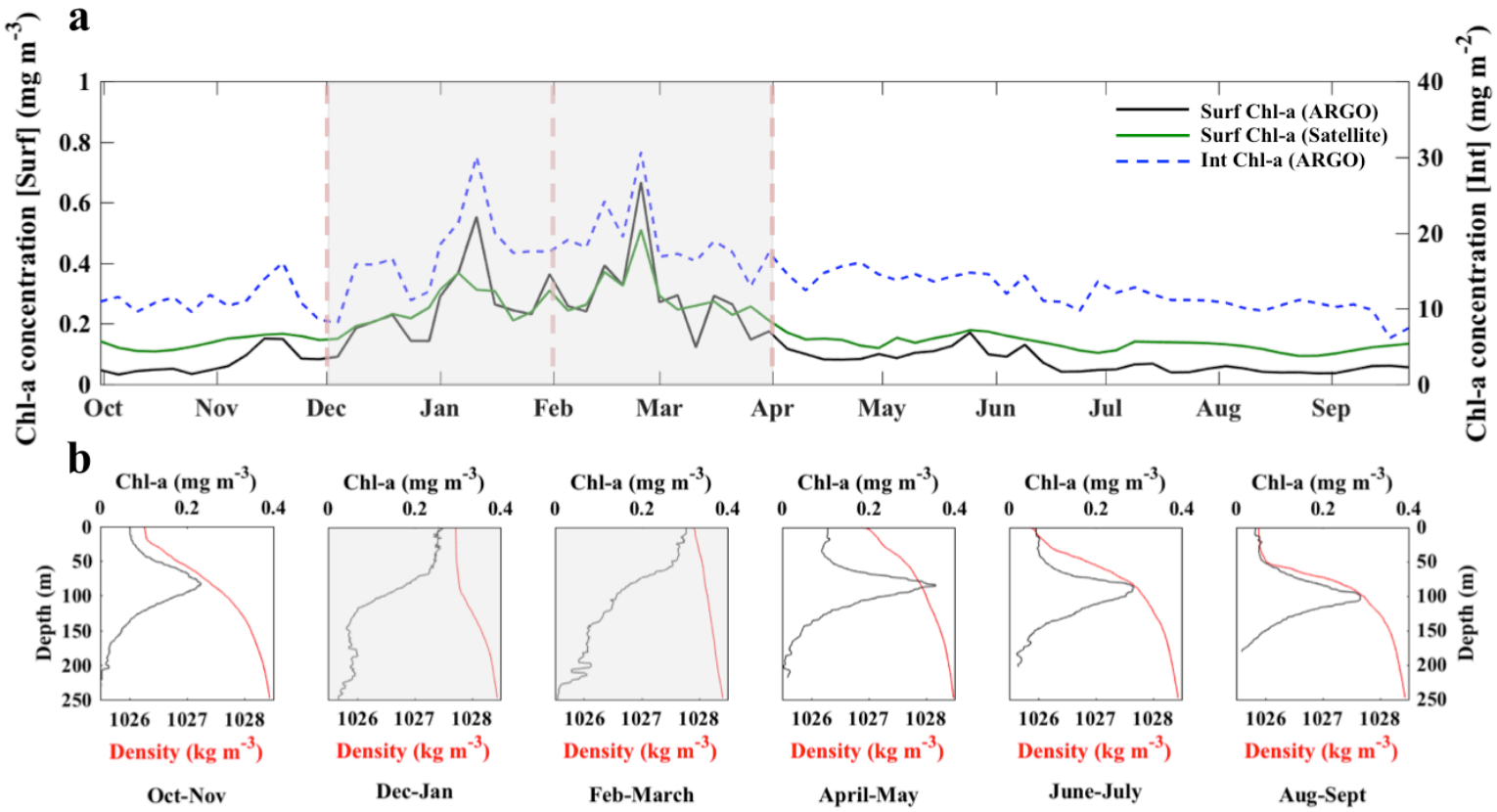


Gittings et al. (2019b)

Additional Contemporary Ocean Platforms



Data validation & exploration of changes in vertical water column dynamics



Gittings et al. (2019b)