COMPARISON OF COASTAL VERSUS MID-BASIN BLACK SEA ECOSYSTEM PROCESSES

Barış Salihoğlu

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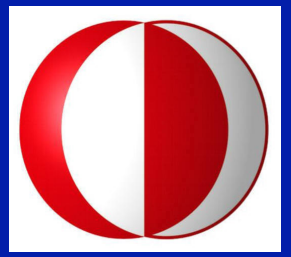

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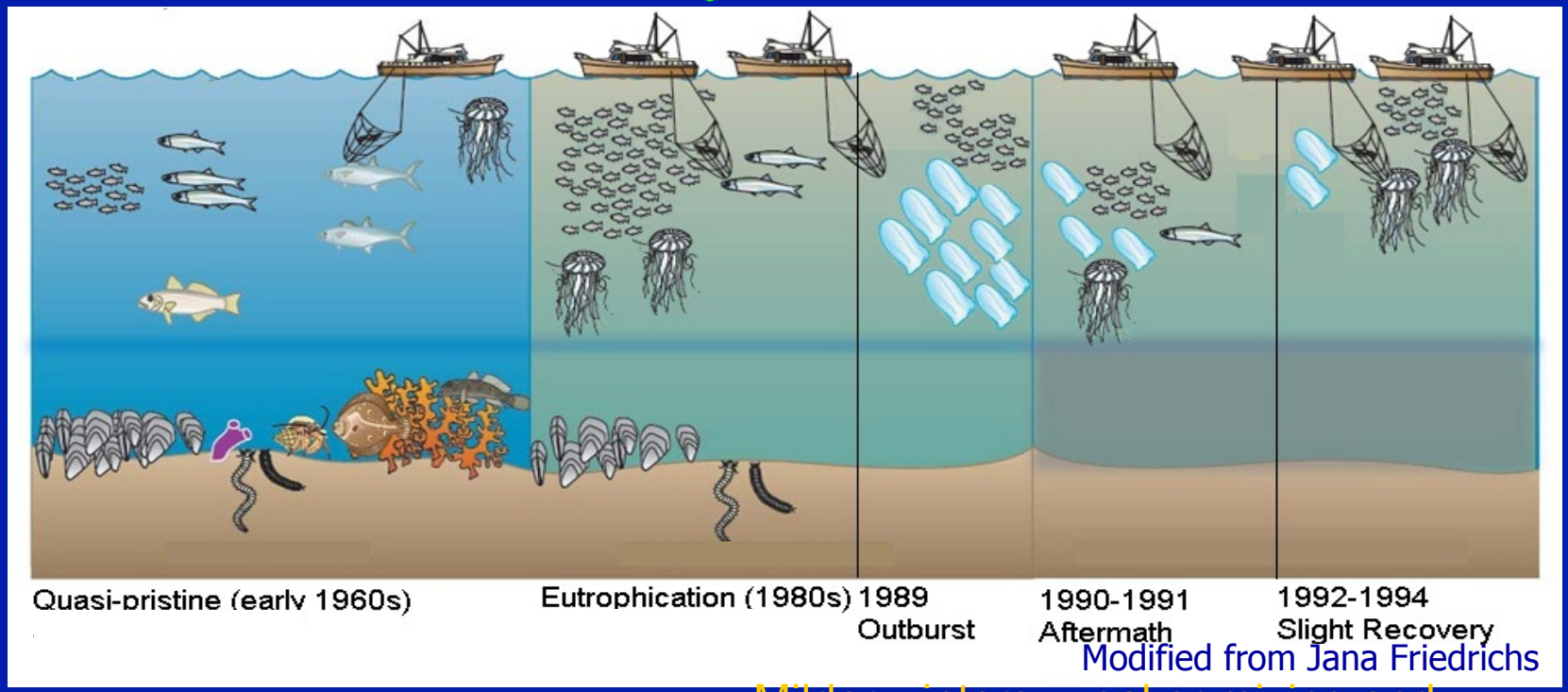
Talk outline:

- **Background on the status of the Black Sea**
- **Research motivation**
- **Model**
- **Results** (Northwestern Shelf vs Eastern Black Sea)
- **Summary and outlook**

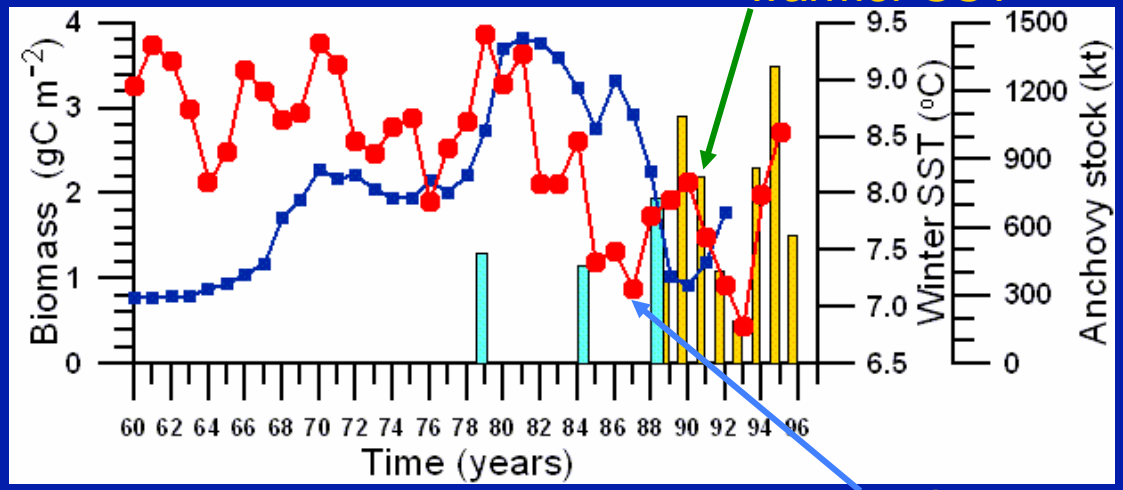
Research area: The *Black Sea*

Black Sea ecosystem transformations



Modified from Jana Friedrichs

Milder winters, weaker mixing and warmer SST



Severe winters (+ NAO)
more intense mixing, colder SST

Black Sea as a case study

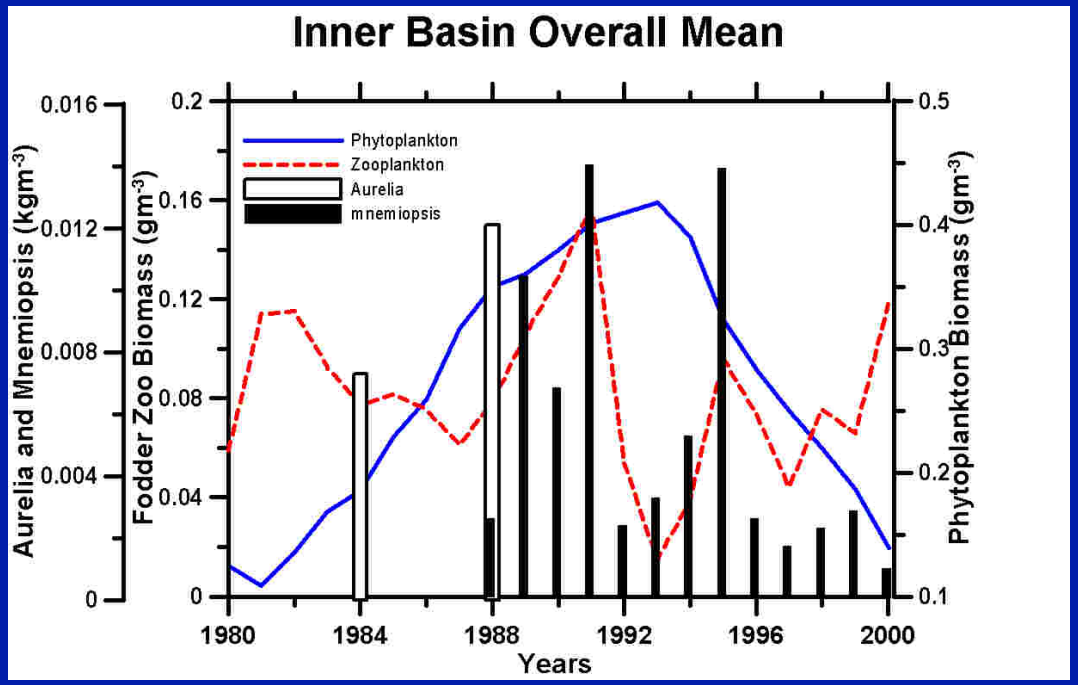
The Black Sea has been over exploited for decades...
- Over fishing, eutrophication, and invasion by alien invasive species have resulted in dramatic shifts in ecosystem structure and severe environmental degradation.

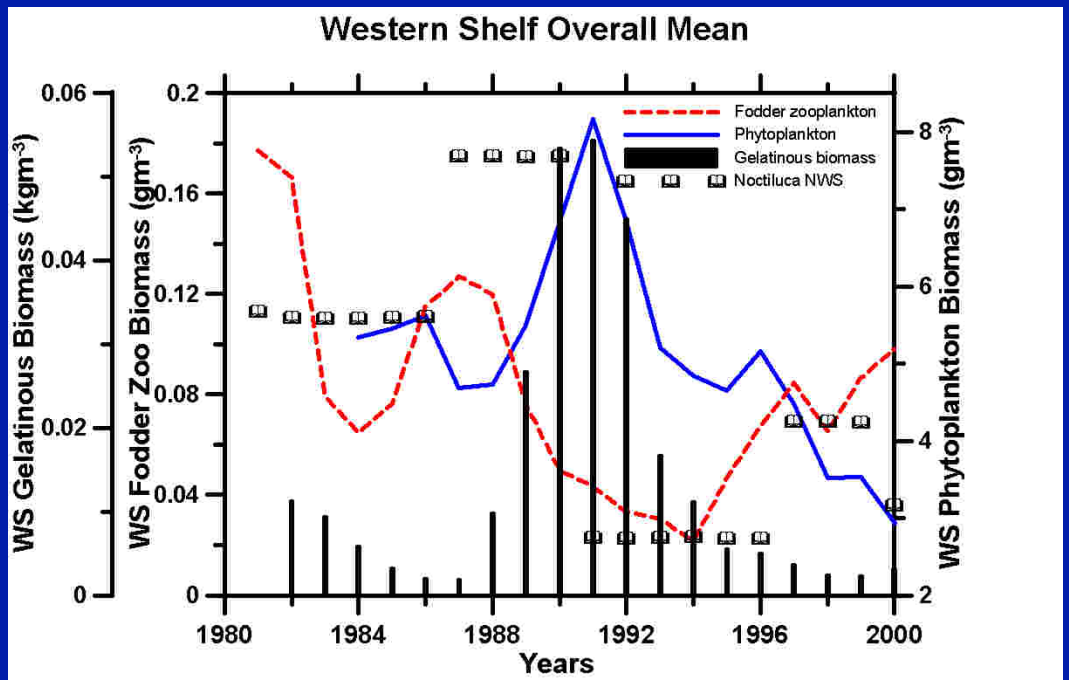
Opportunity now to assess modelling capacity with regard to each of these environmental pressures, in combination with changing climatic forcing.

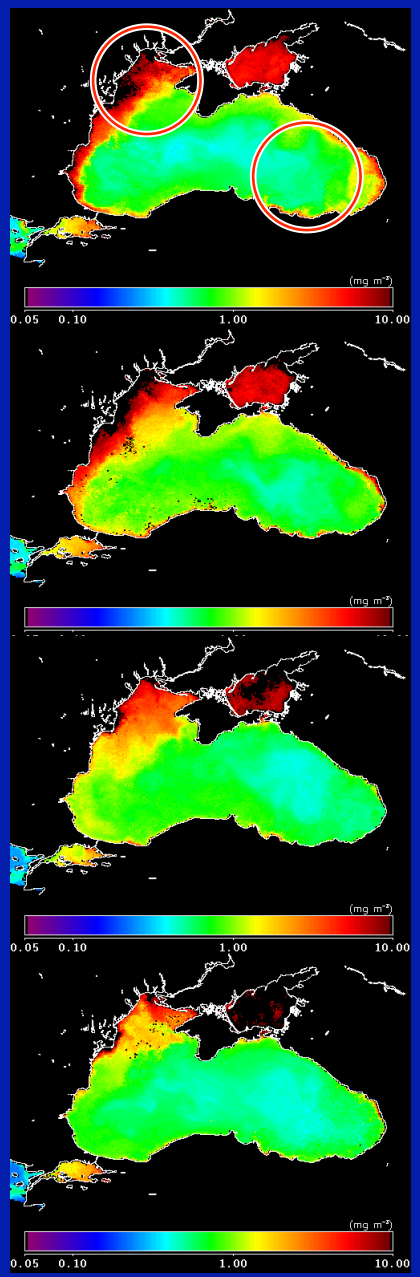
Property	Pristine (<1970)	Eutrophication (1975-1992)	Post -eutrophication (1993-2005)
DIN	1 µM	8 µM	7 µM
SiO_4	35-45 µM	20-25 µM	20-25 µM
PO_4	< 2 µM	3-8 µM	< 2 µM
Phytoplankton	< 3.0 g m^{-3}	10-20 g m^{-3}	~5 g m^{-3}
Trophic zooplankton	250 mg m^{-3}	75-150 mg m^{-3}	50-100 mg m^{-3}
Aurelia+Mnemiopsis	50 mg m^{-3}	up to 3000 mg m^{-3}	< 500 mg m^{-3}
Total fish catch	15 x 10^3 tons	5-15 x 10^3 tons	2 x 10^3 tons
% share of piscivores fish	40-50	30-15	< 10

Table: Approximate values of major ecosystem properties during three different regimes of the north-western Black Sea.

Inner basin vs Nortwestern shelf







May

June

July

Aug

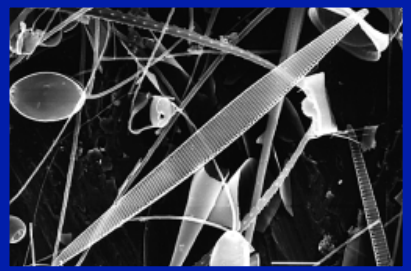
Research motivation:

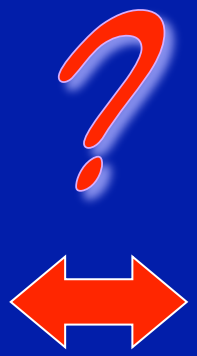
The Black Sea ecosystem was substantially modified due to concurrent effects of intense:

- Eutrophication,
- Overfishing,
- Invasive species (outburst of gelatinous macrozooplankton *Mnemiopsis leidyi*),
- Climatic variations.

Main focus:

- Interactions between lower and higher trophic levels after the end of 1980s.
- How these interactions control coastal and open basin ecosystems?
- Impact on the seasonal cycle, PP and export.



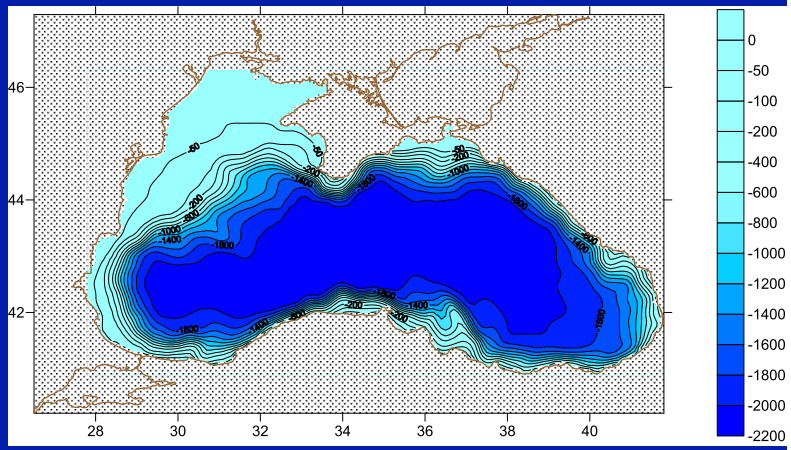

Technical details of physical model

Princeton Ocean Model (pom2k)

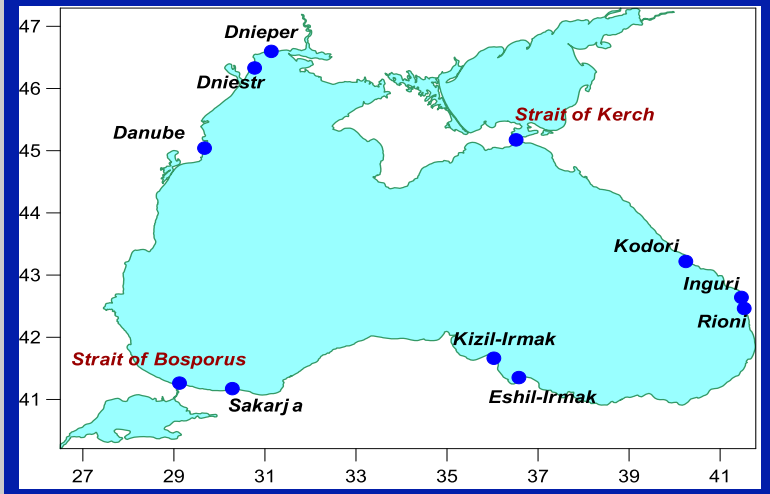
- Horizontal grid ~ 5km regular array
- Vertical grid: 26 sigma levels, compressed towards upper 200 m
- Initialisation: Spun up from climatology using atmospheric climatological forcing
- Forcing:

- Atmospheric forcing (6-hours data) (ERA40 or SXG)
- Climatic river input (9 in total)
- Straits discharges (Bosporus/Kerch)

- Data assimilation:
  - Optimal Interpolation of temperature and salinity deviations from climatic mean onto model grid at monthly time scales (1971-1992)
  - Altimetry SSH anomalies assimilated into model as temperature and salinity (1992-2001)



Black Sea model domain



Rivers and straits included in model

Technical details of ecosystem model

BIMS_ECO, BIMS_CIR (Oguz et al, 2001)

- Pelagic food web model
- Nutrient cycling
- Vertical grid extends to 200 m (26 z-levels with 2 m resolution near the surface and 20 m near the lower boundary).
- Horizontal grid as in Circulation model.

Model compartments

Tropic level-0

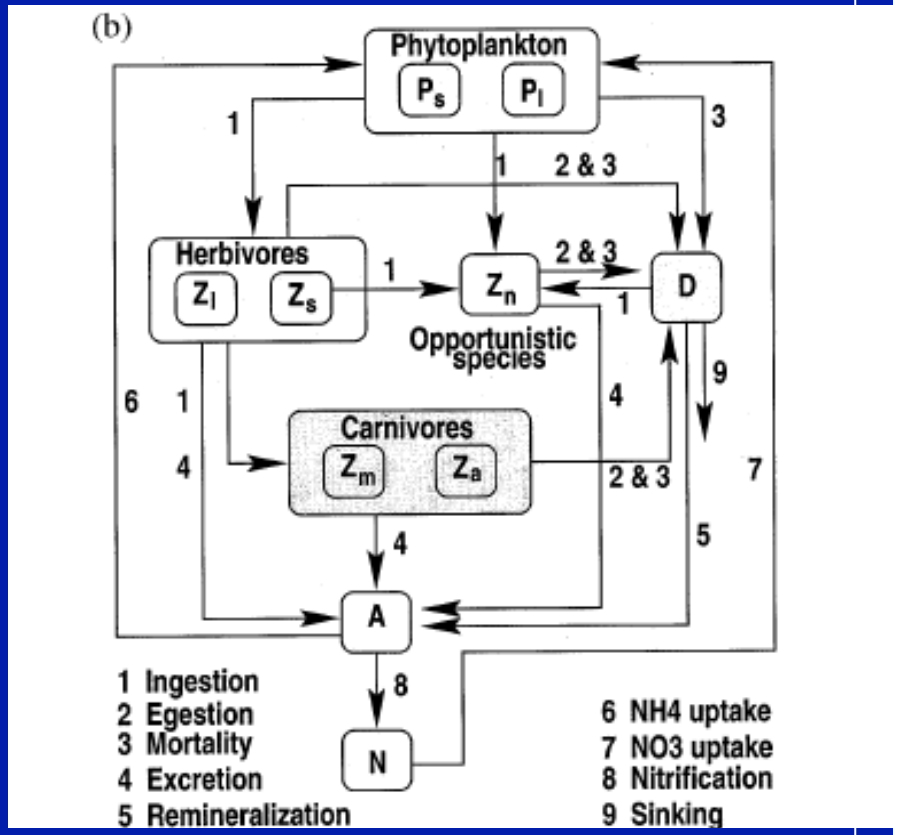
N - nitrate
A – ammonium
DON- Dissolved inorganic nitrogen
D - Labile pelagic detritus

Tropic level-1

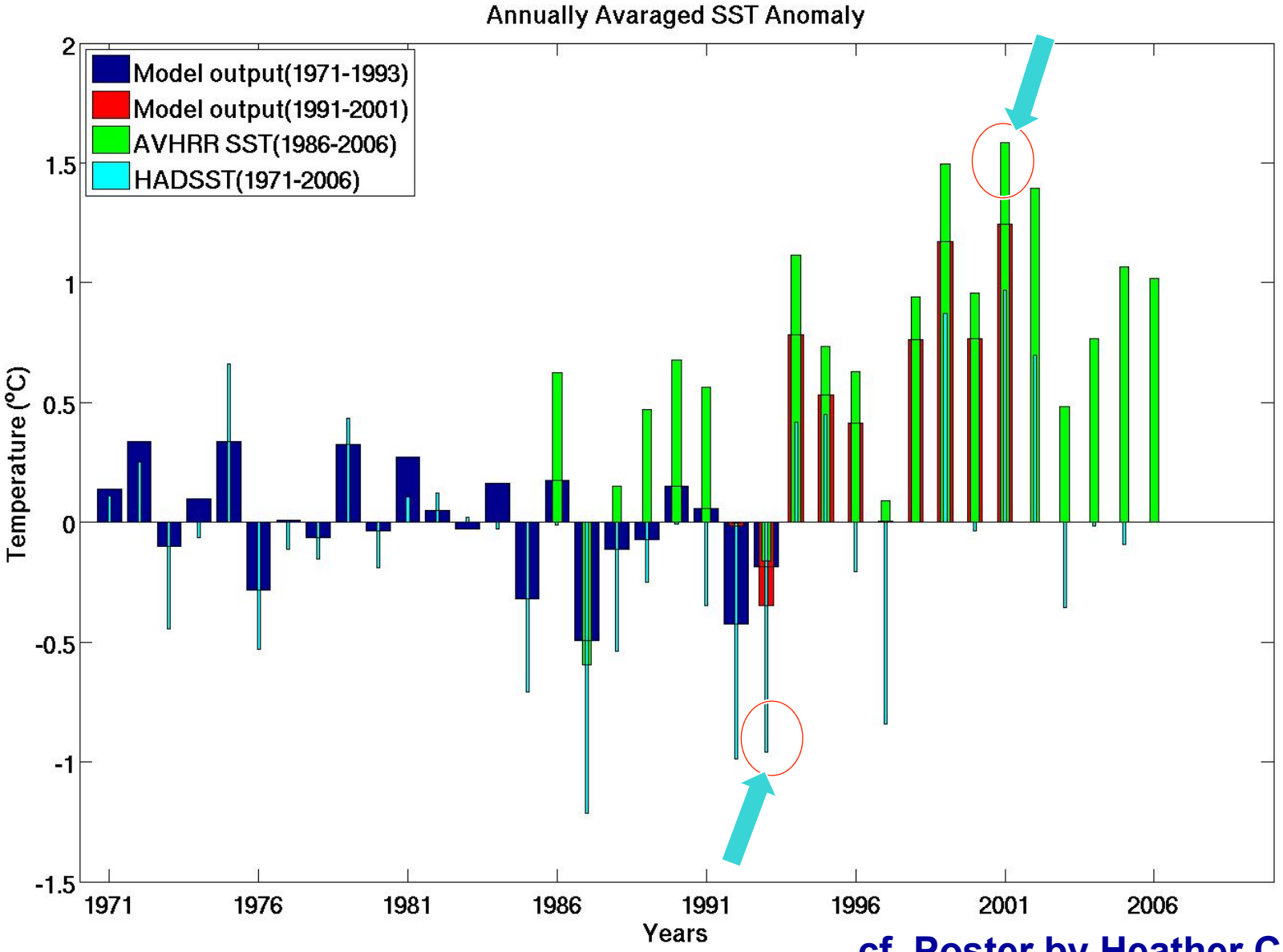
Ps - small (<10 μm) phytoplankton
Pl – large (> 10 μm) phytoplankton

Tropic level-2

Zs – microzooplankton
Zl – mesozooplankton
Zn - opportunistic heterotrophic dinoflagellate *Noctiluca scintillans*
Za - gelatinous carnivore *Aurelia aurita*
Zm- gelatinous carnivore *Mnemiopsis leidyi*

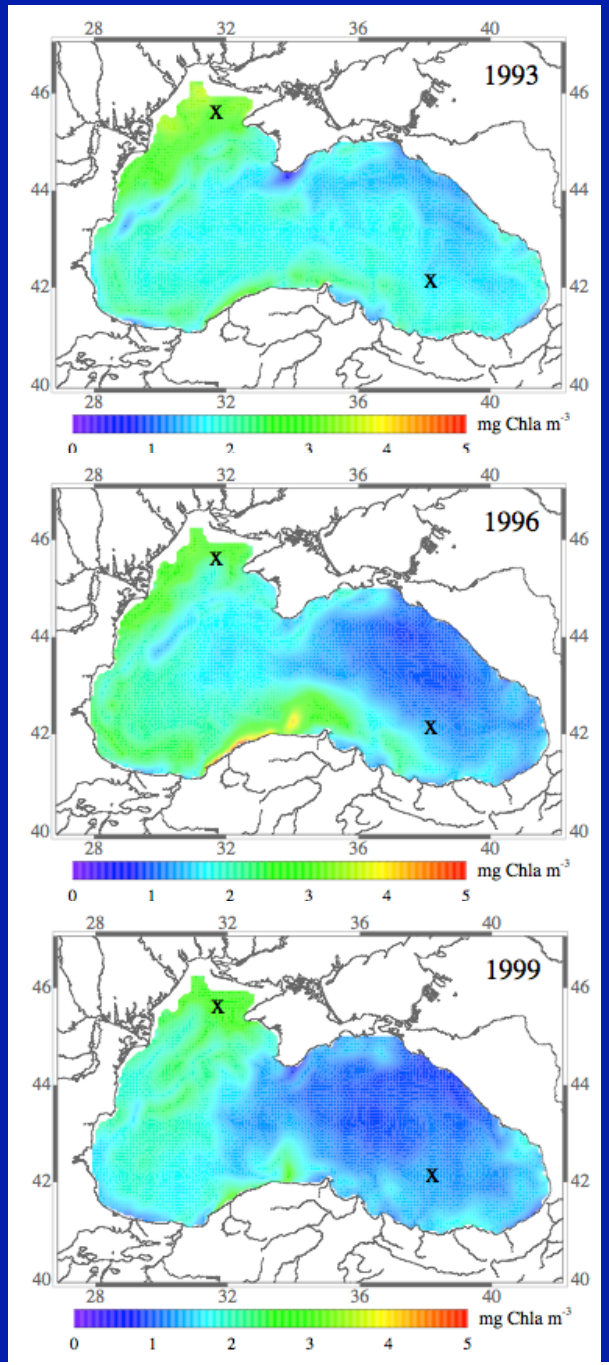


Temperature variability



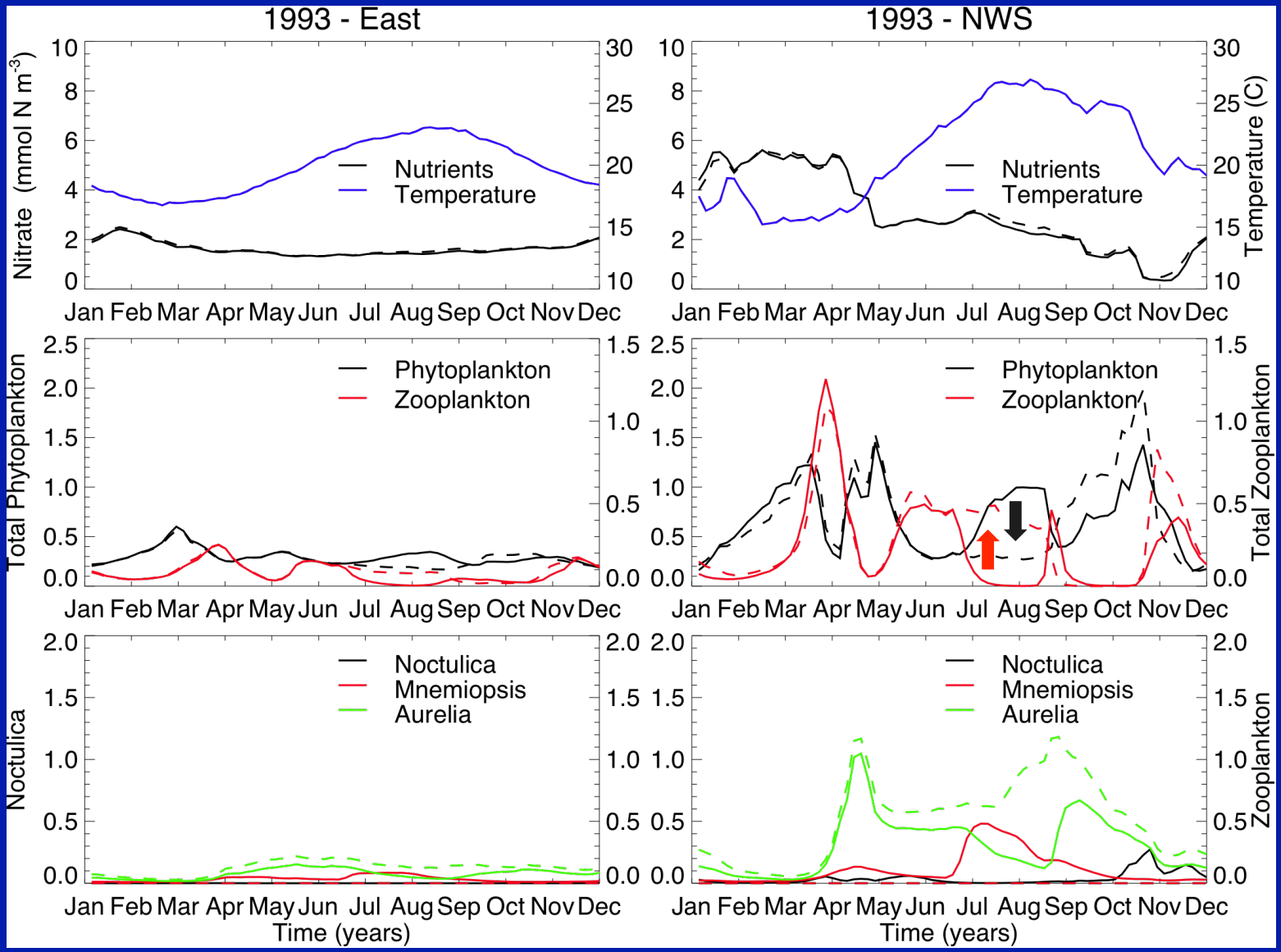
cf. Poster by Heather Cannaby

Model results



Mid-basin versus coastal ecosystem

Cold year



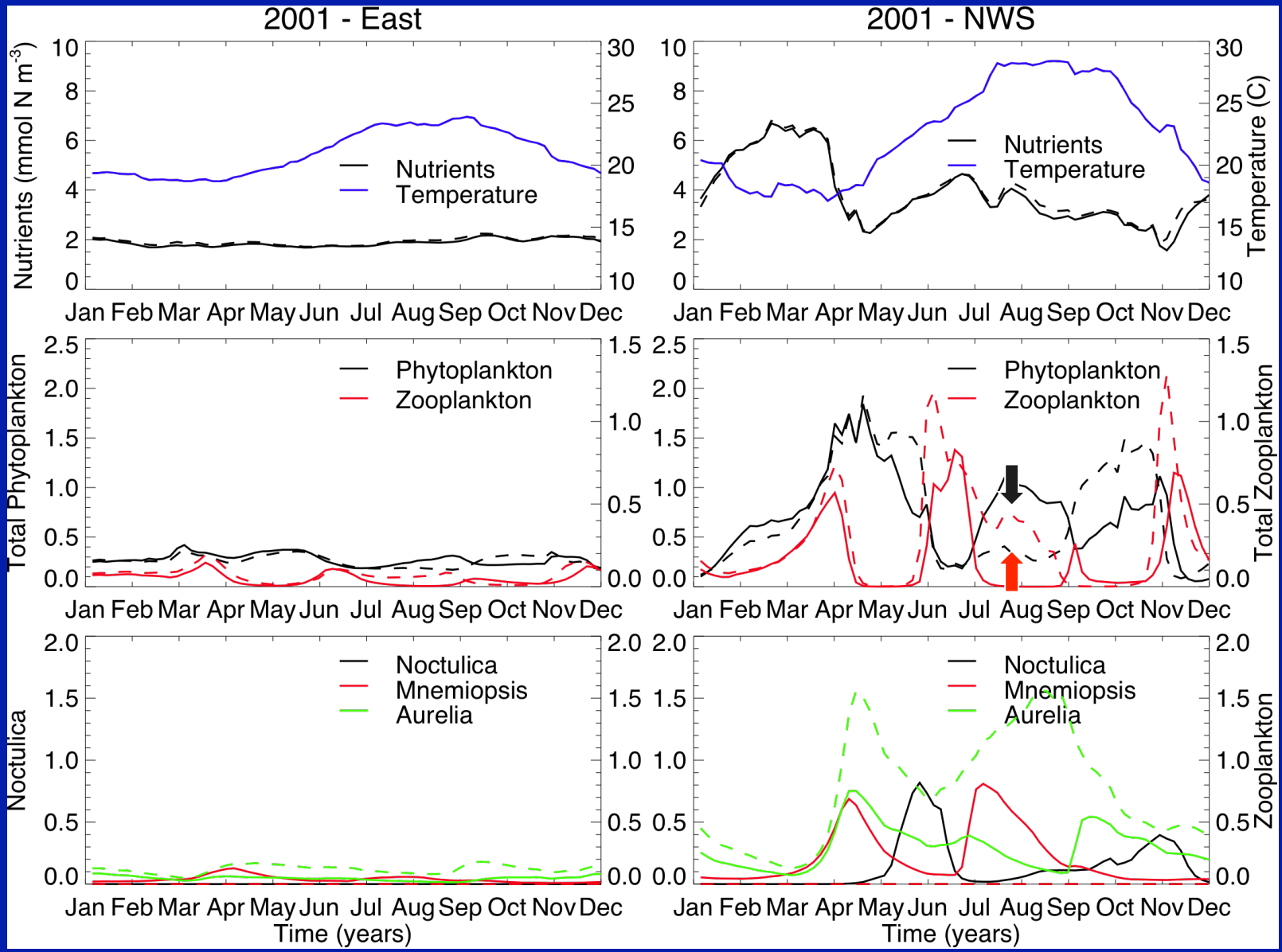
Mid Basin

Shelf

- – – without Mnemiopsis

Mid-basin versus coastal ecosystem

Warm year



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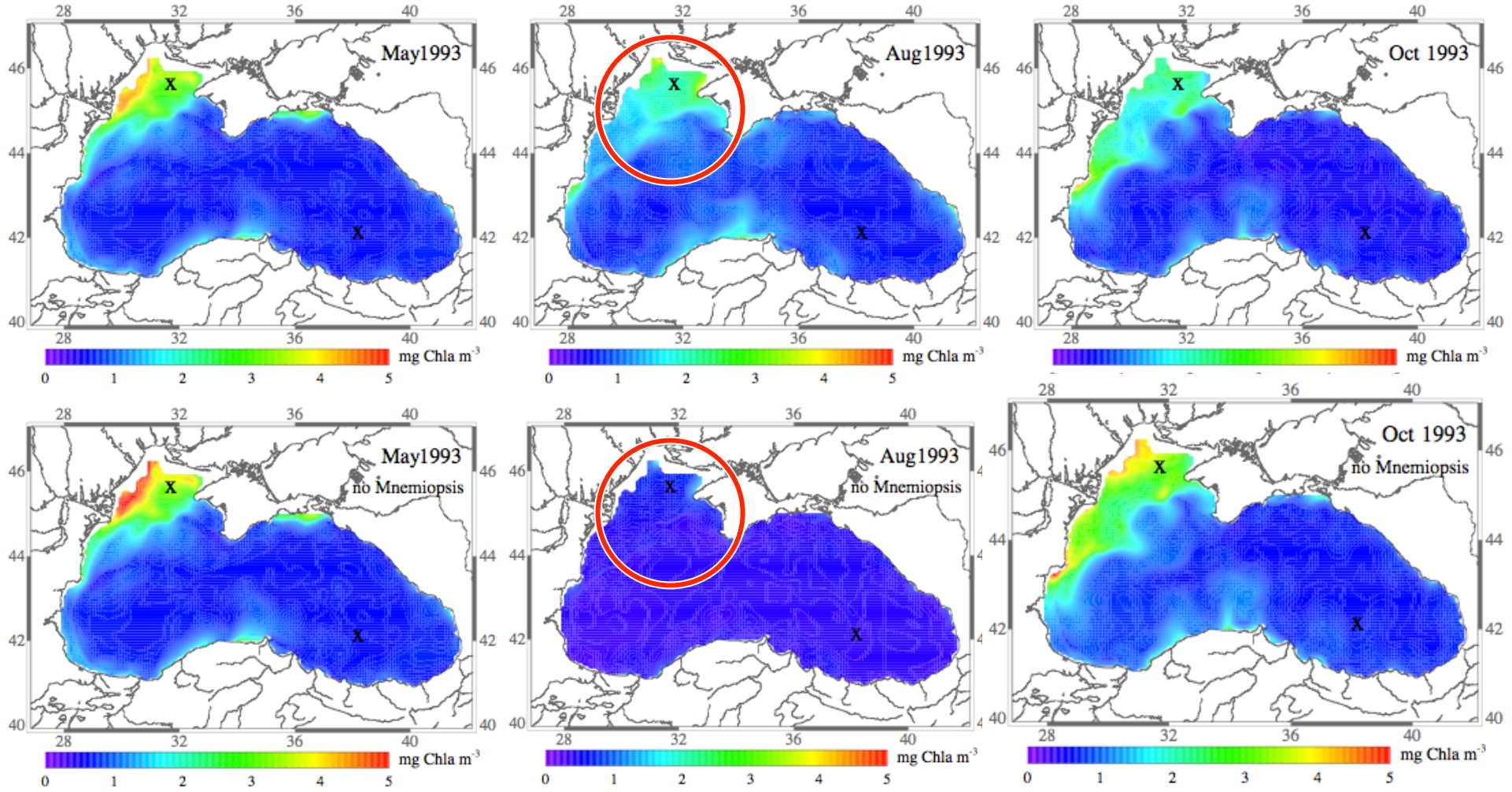

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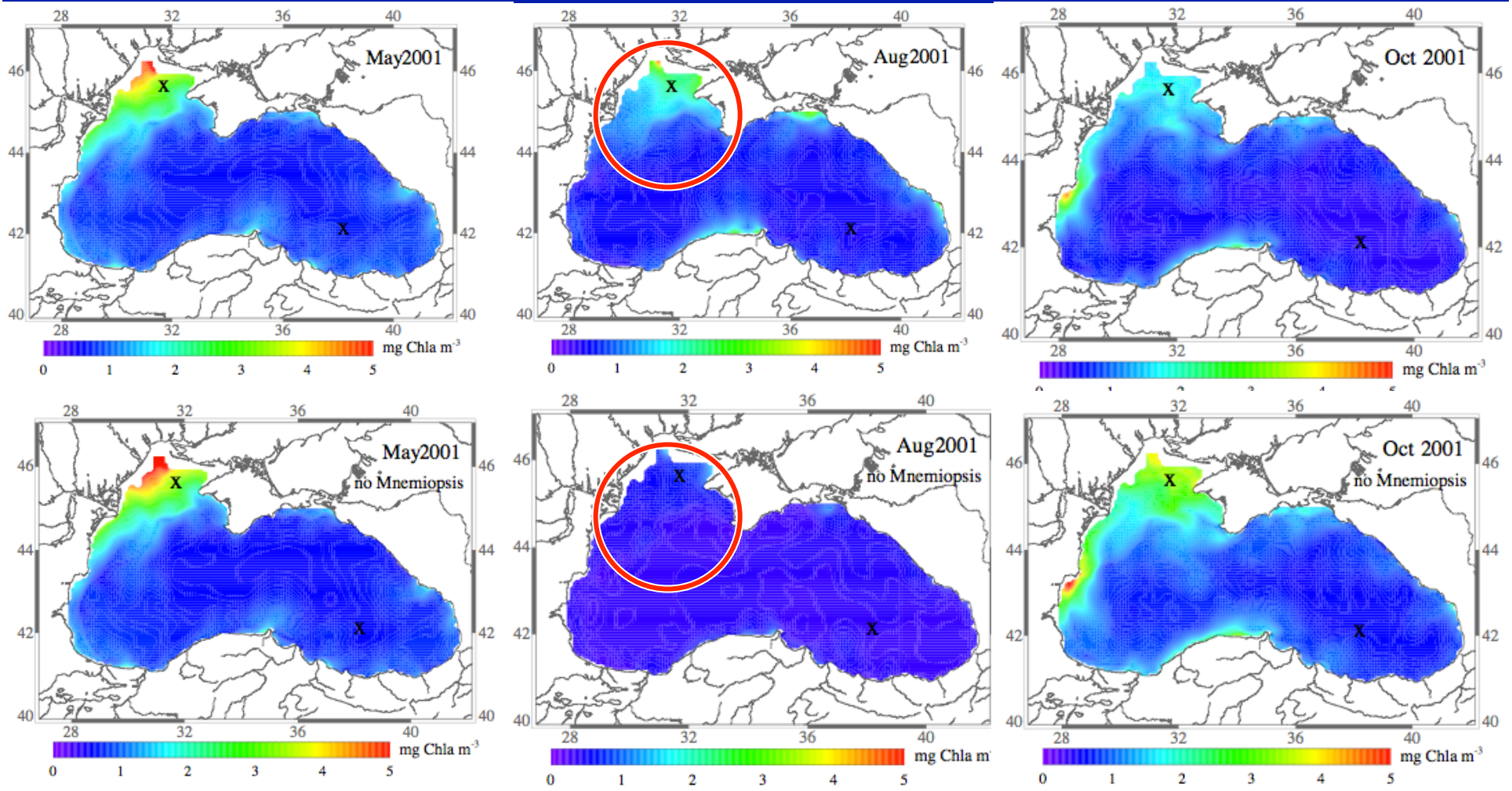

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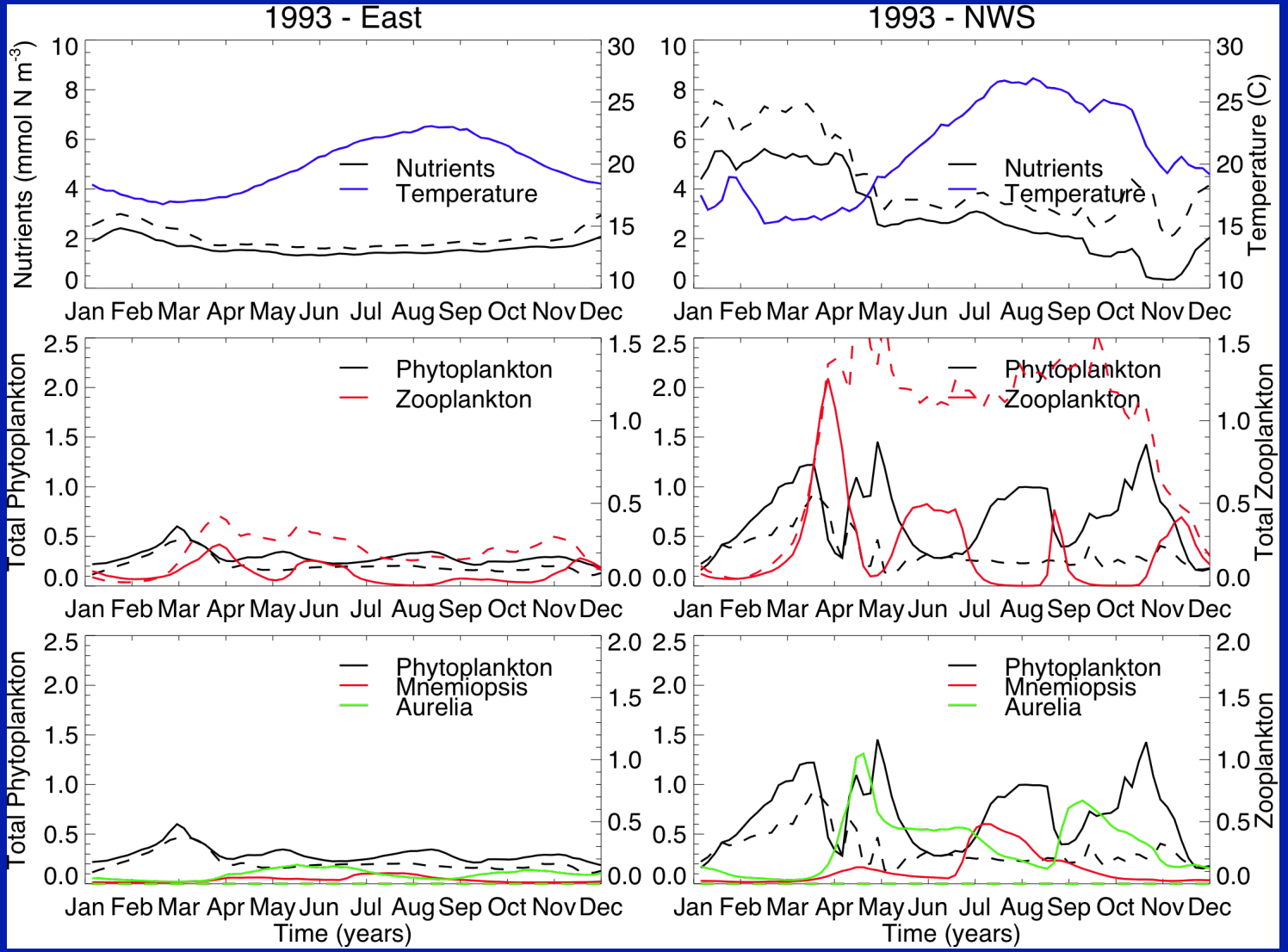

- — — without Mnemiopsis and Aurelia

Mid-basin versus coastal ecosystem

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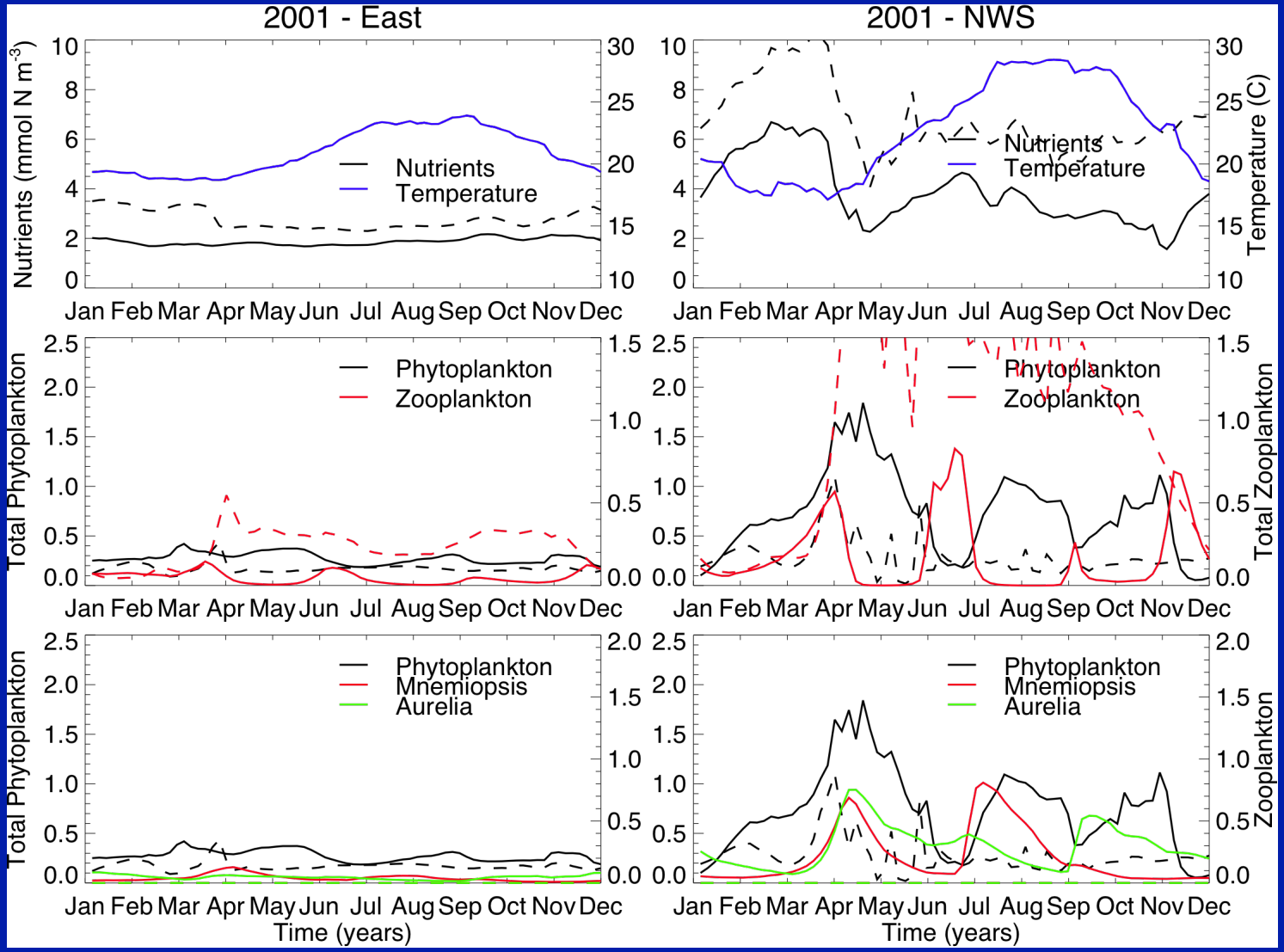


- – – without Mnemiopsis and Aurelia

Conclusions

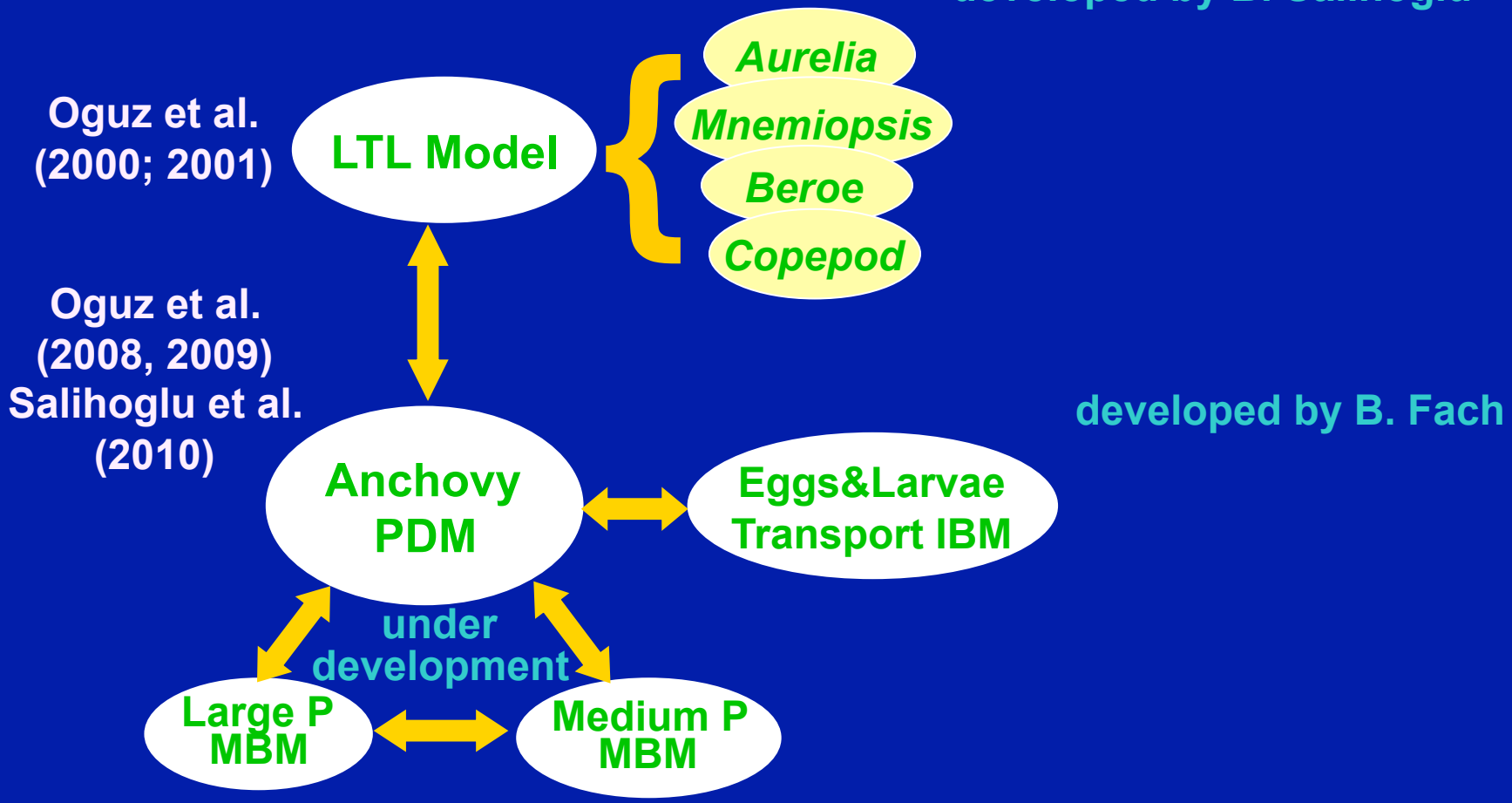
- Because of high biomass of the invasive ctenophore *Mnemiopsis leidyi*, longer periods of phytoplankton blooms occur in the coastal areas compared to the open basin.
- Severe regulation of the ecosystem by the upper levels of the food chain.
- Three consecutive maxima of phytoplankton biomass (spring, summer, autumn) occur in the coastal waters.
- The summer phytoplankton increase is a new element in the annual cycle of the ecosystem.
- Carbon export decreases 5-6% when *Mnemiopsis* is removed and up to 35-40% when all jellyfish are removed from the system.

Outlook:

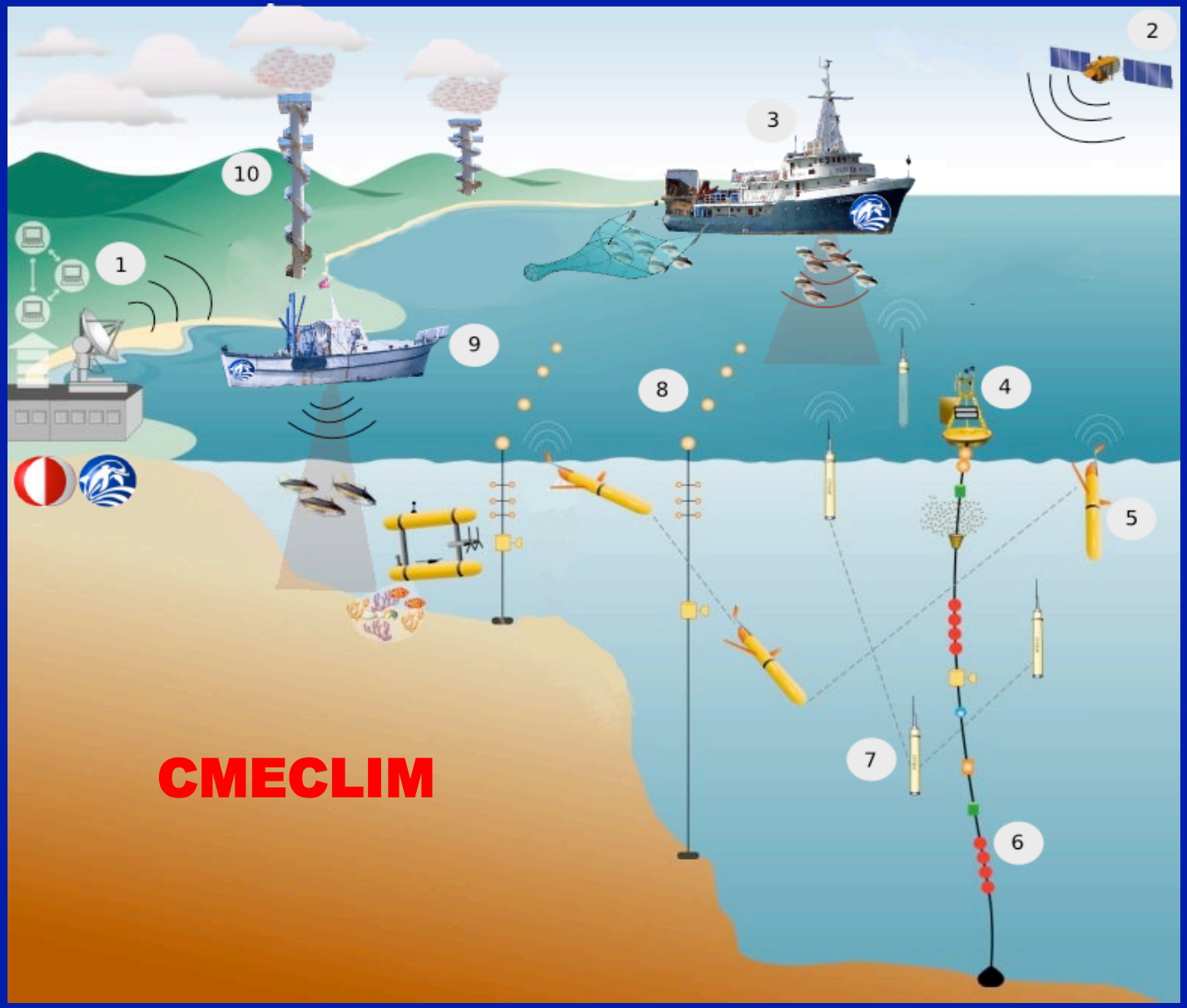
Black Sea Ecosystem Modeling and Forecasting

Black Sea Integrated Modelling System (BIMS)

Zooplankton Population Dynamics Models (PDMs)
developed by B. Salihoglu



CENTER FOR MARINE ECOSYSTEMS AND CLIMATE RESEARCH



Better monitoring of the Black Sea

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THANK YOU!