Eddy induced coastal plankton community changes in a coupled numerical model of the Gulf of Lion (NW Mediterranean Sea)

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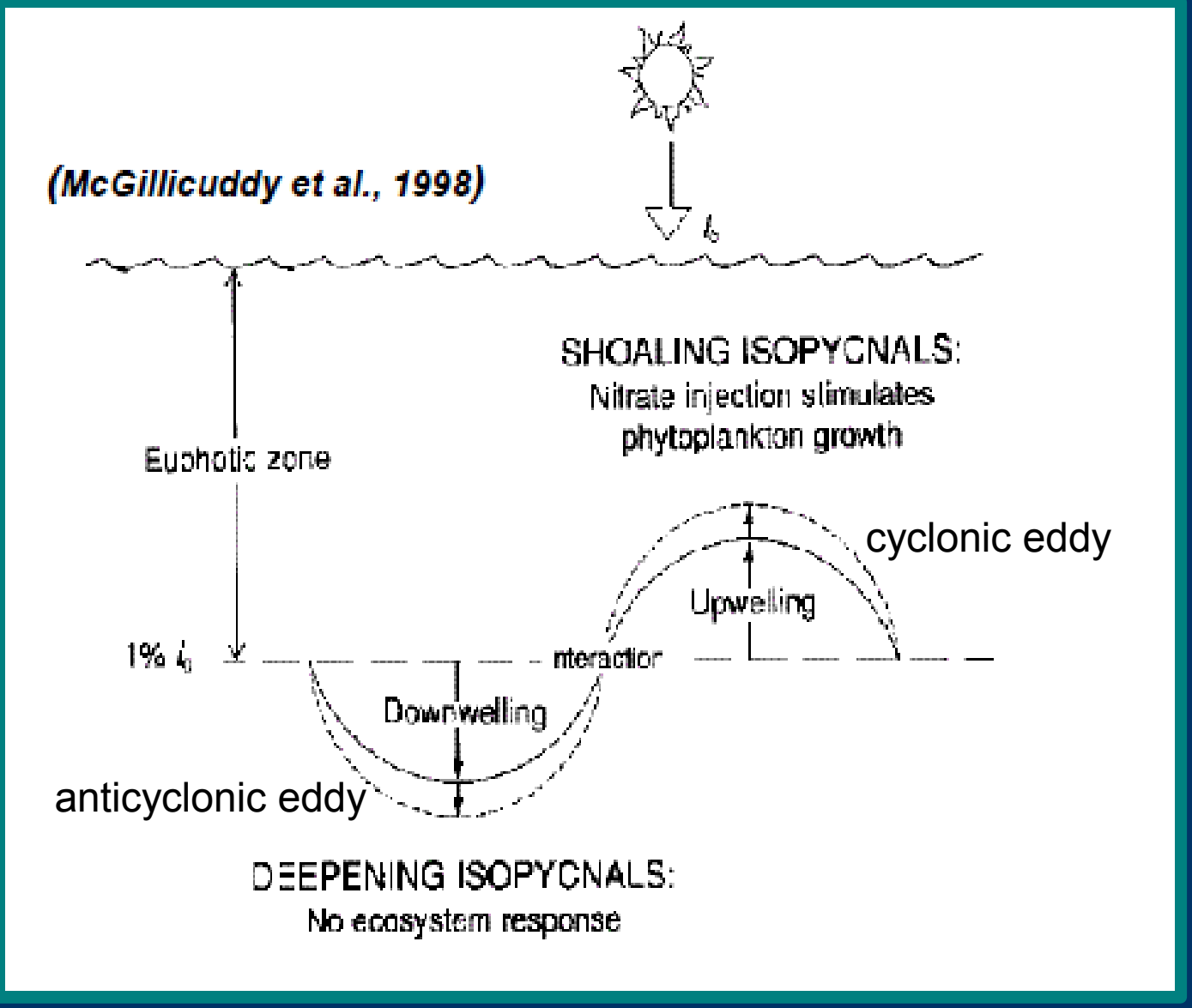
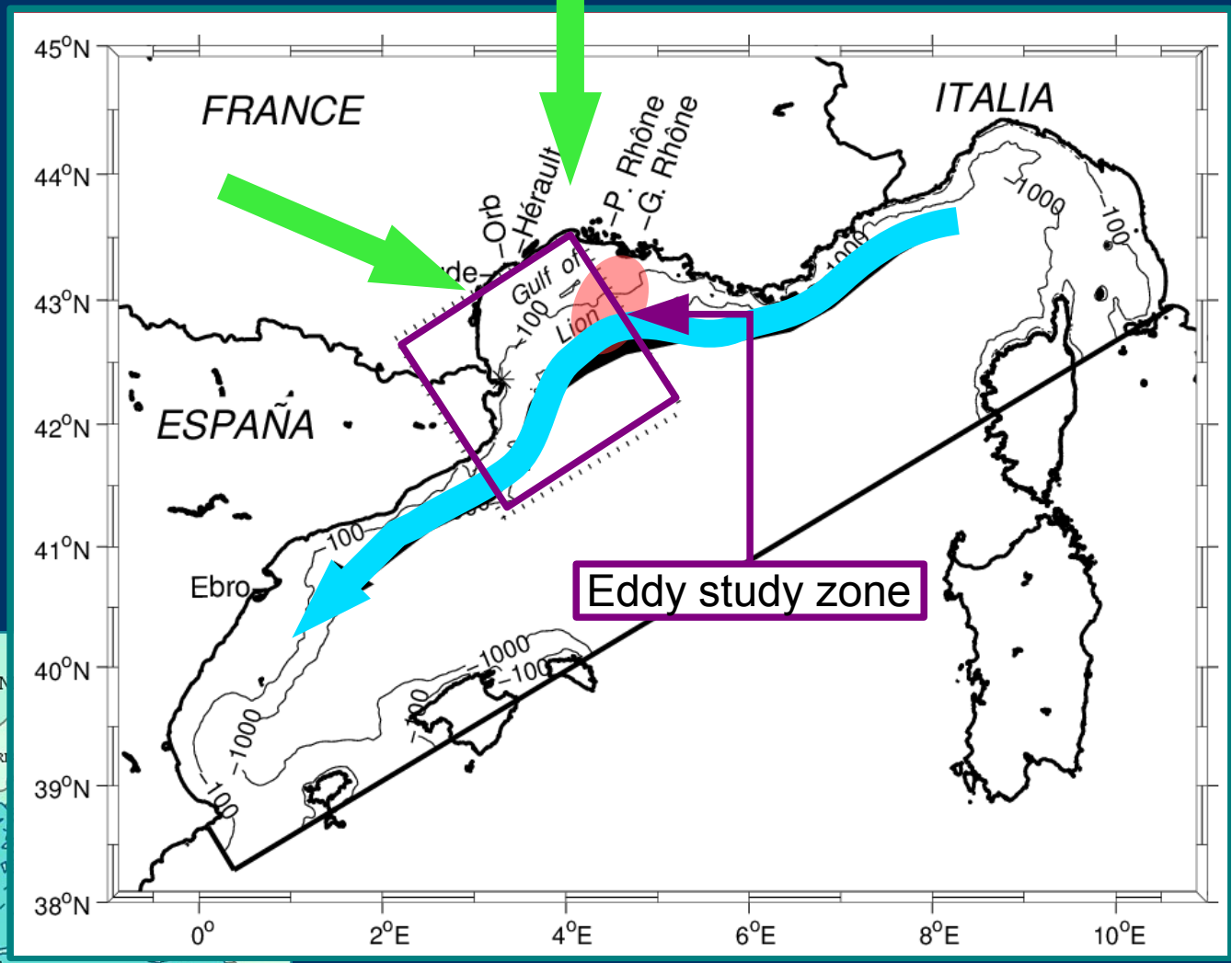
About eddies



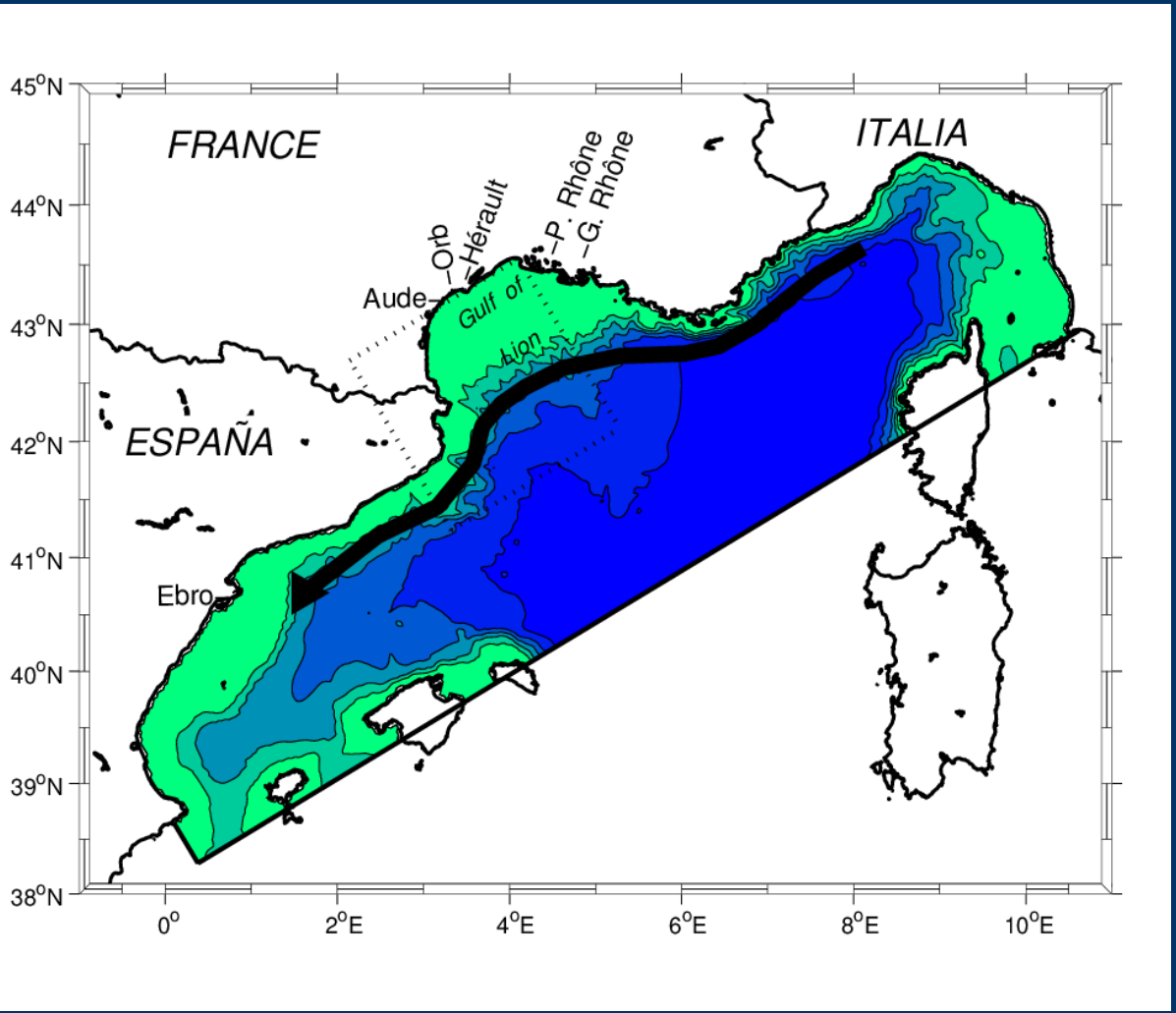
How does an anticyclonic eddy modify the coastal planktonic ecosystem?

Study Zone: Gulf of Lion, NW Mediterranean Sea

- Gulf of Lion forcings
  - Strong N & NW winds
  - Rhone River plume
  - **Northern current**



Model properties: Symphonie



Symphonie
(Marsaleix et al 2008)

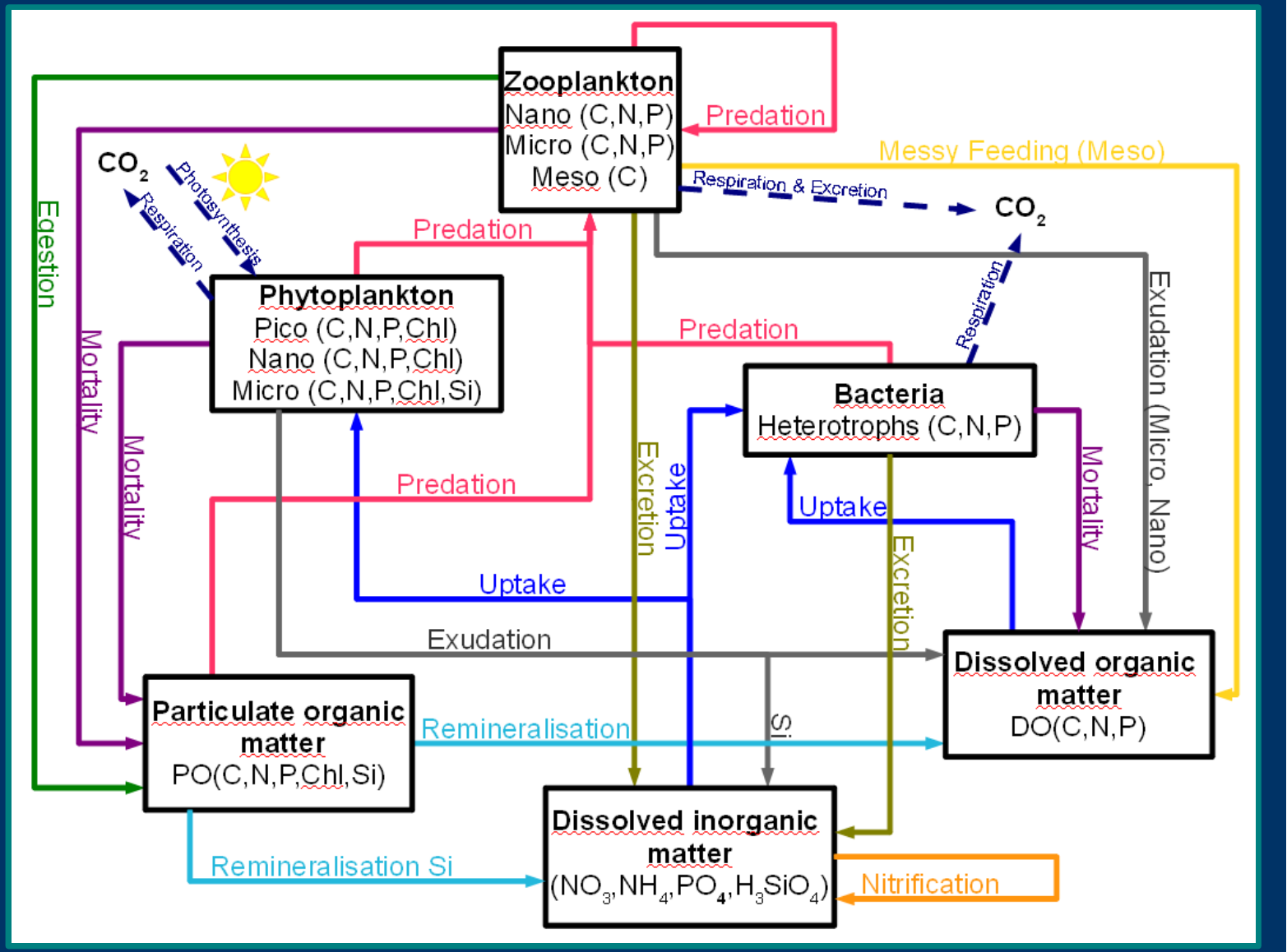
- 3D- primitive equation model
- 3 km resolution
- 40 sigma-z hybrid levels
- Open boundary conditions: OPA from MFSTEP
- Realistic river discharge rates for 6 rivers

Model properties: Eco3M

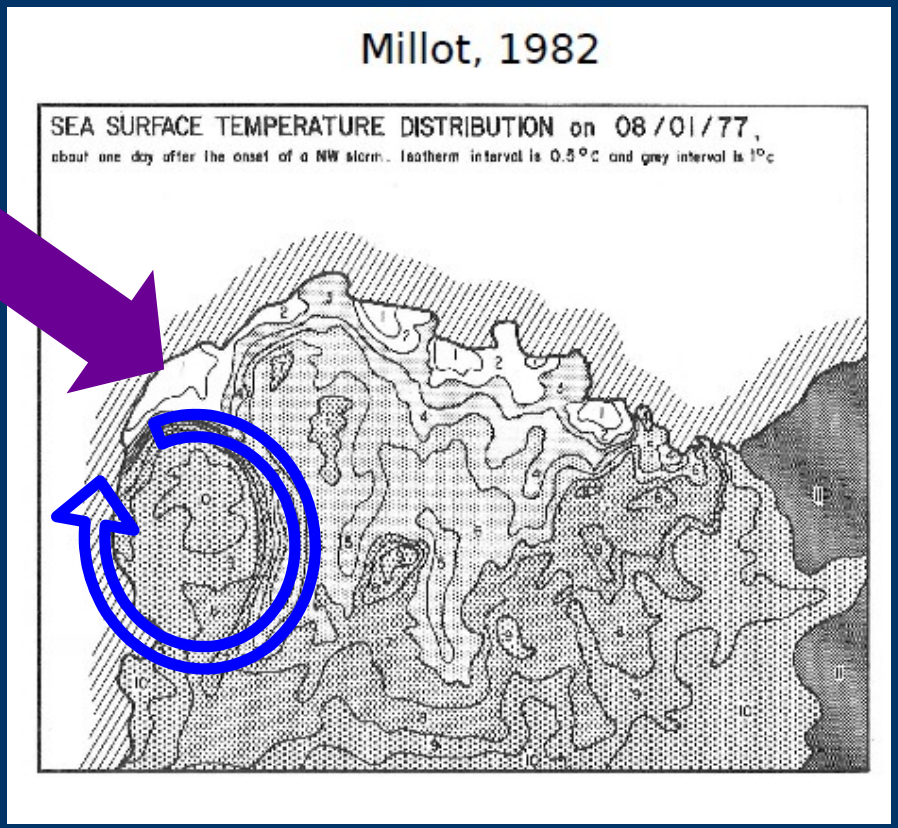
Eco3M-NWMED
(Baklouti et al 2006)

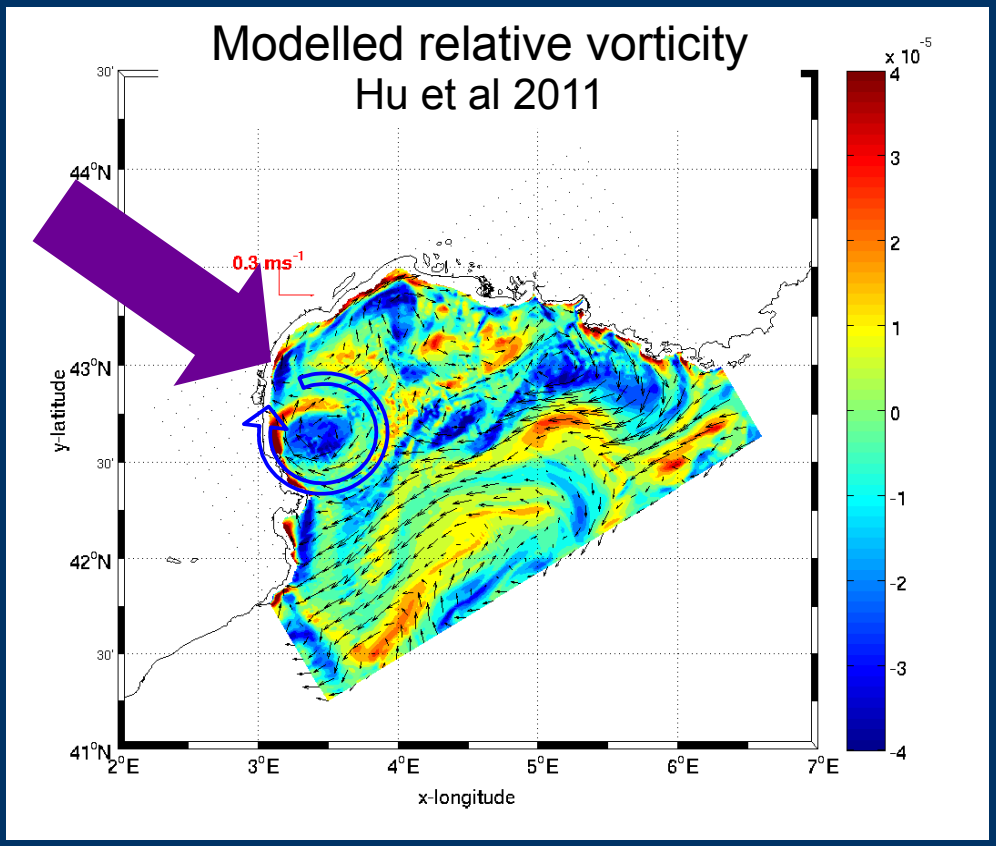
- Multi-nutrients
- Multi plankton functional types
- Non-redfieldian biomass
- C, N, P, Si, Chl

- OBC: BFM outputs
  10-day average
- Realistic river inputs of NO_3, PO_4, NH_4, and DOC



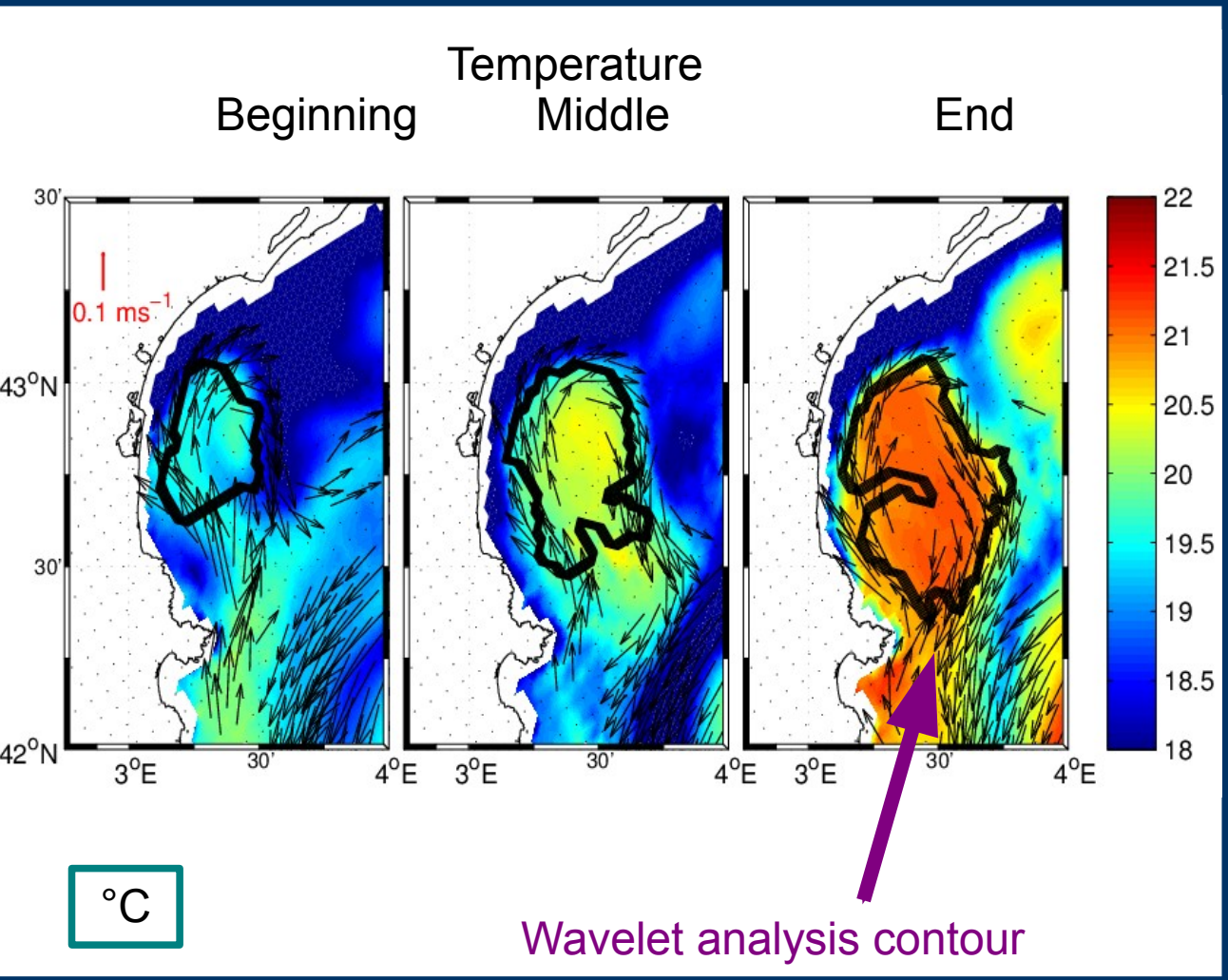
Previous work on anticyclones in Gulf of Lion





- Millot (1982) suggested AC created by strong NW winds
- Hu et al (2011) studied AC eddies from 2001-2008:
  - frequently present during stratified period
  - alimented by strong winds

Anticyclonic eddy 2001



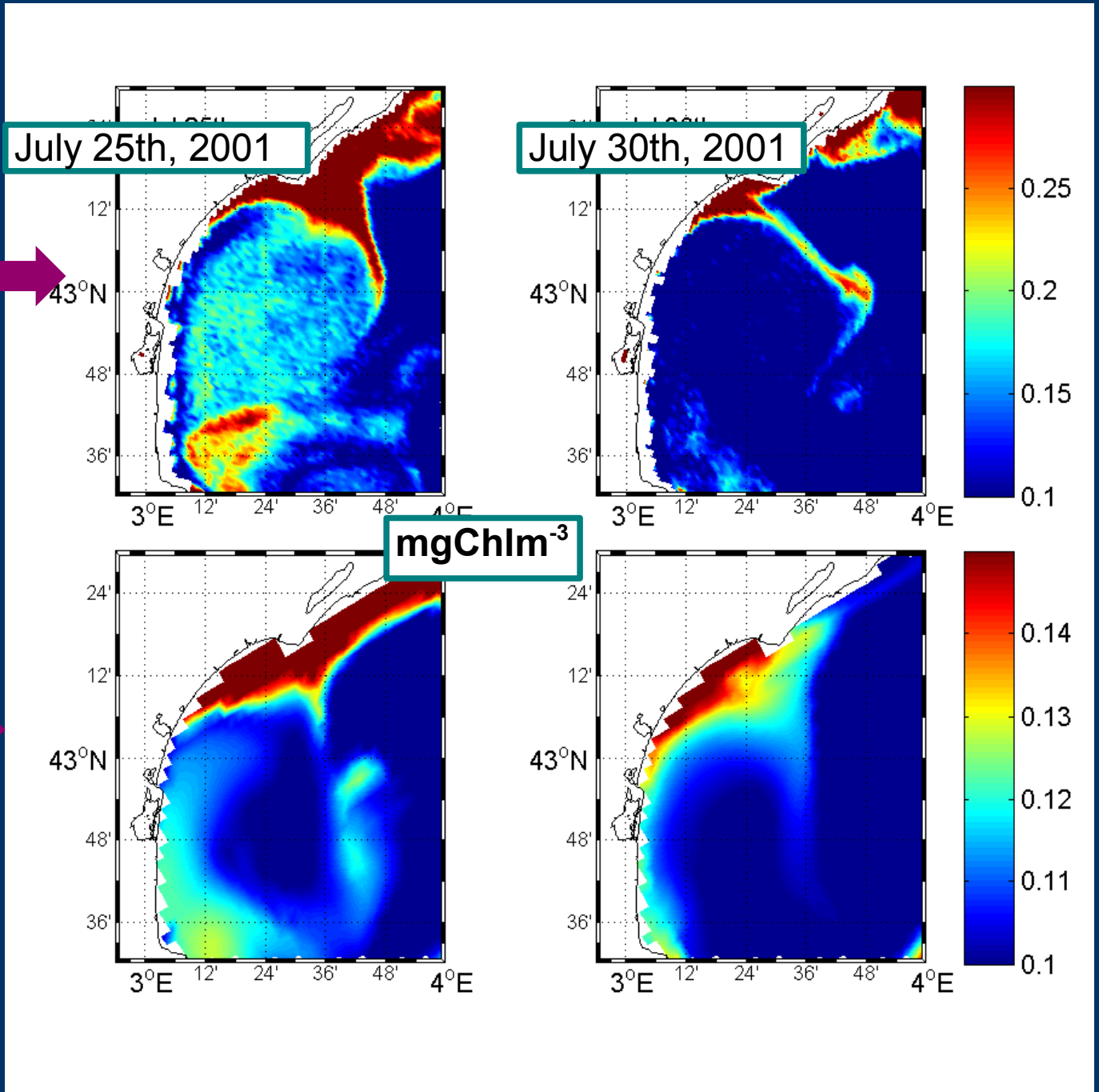
- Warm-core eddy
- July 17th – August 18th 2001
- ~40km in diameter (elliptical)

- Hu et al 2011
  - Used Symphonie model + wavelet analysis to study AC

SeaWiFS signature in total chlorophyll

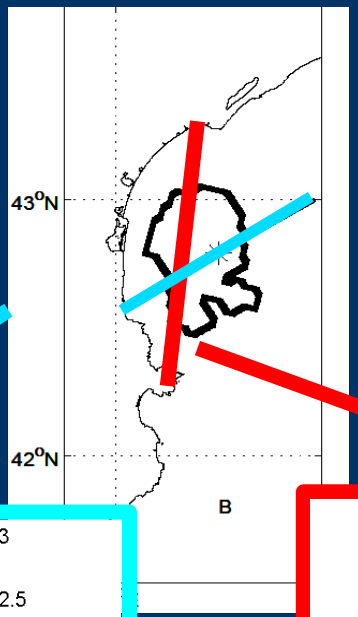
SeaWiFS

Model

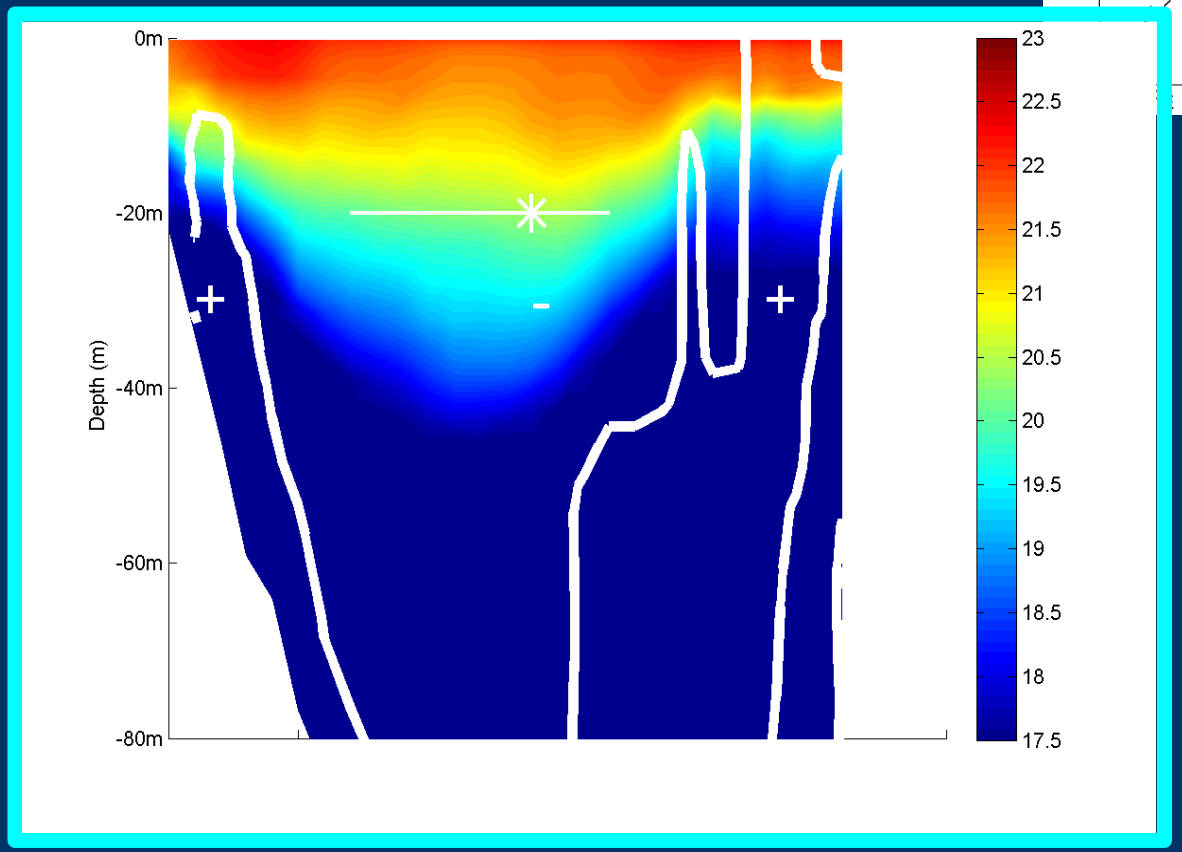


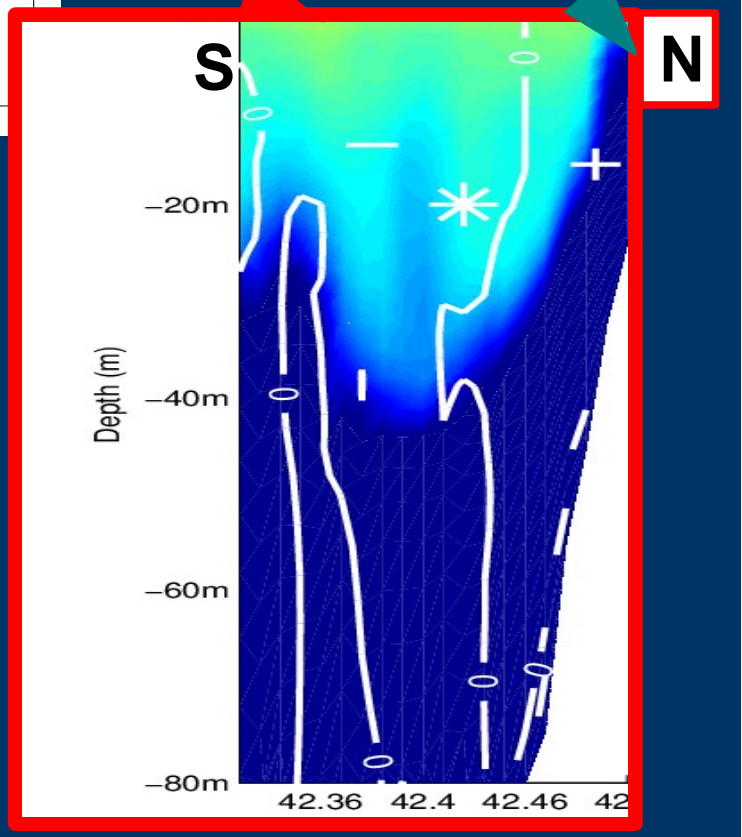
Vertical temperature patterns

- Deepening of warm surface waters
- Downwards vertical velocities

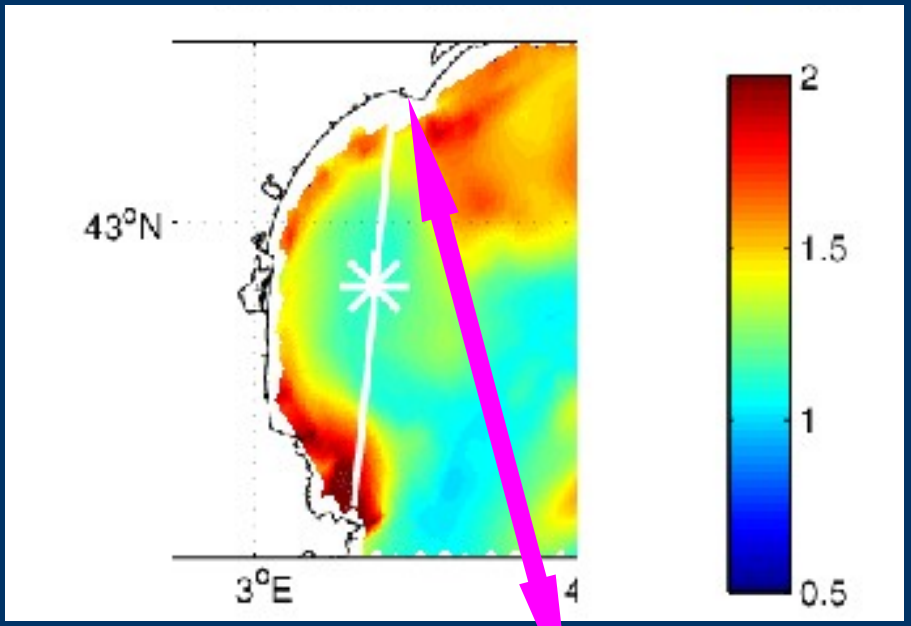


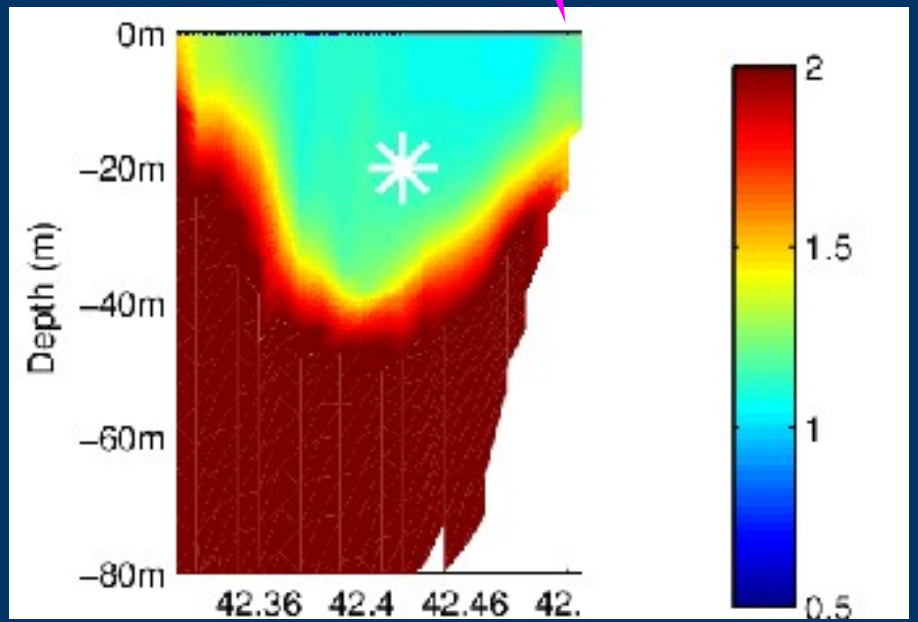
Wind-driven upwelling, upwards vertical velocities to the north of the eddy





Nutrients horizontal and vertical



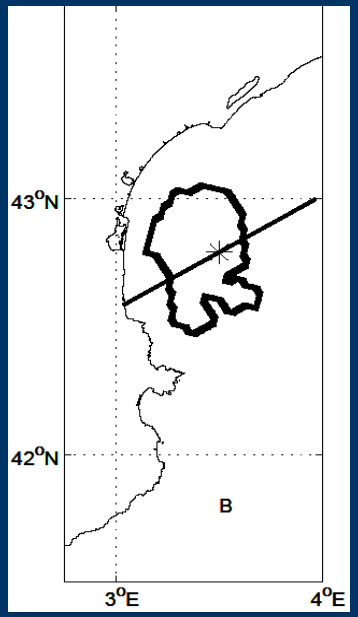


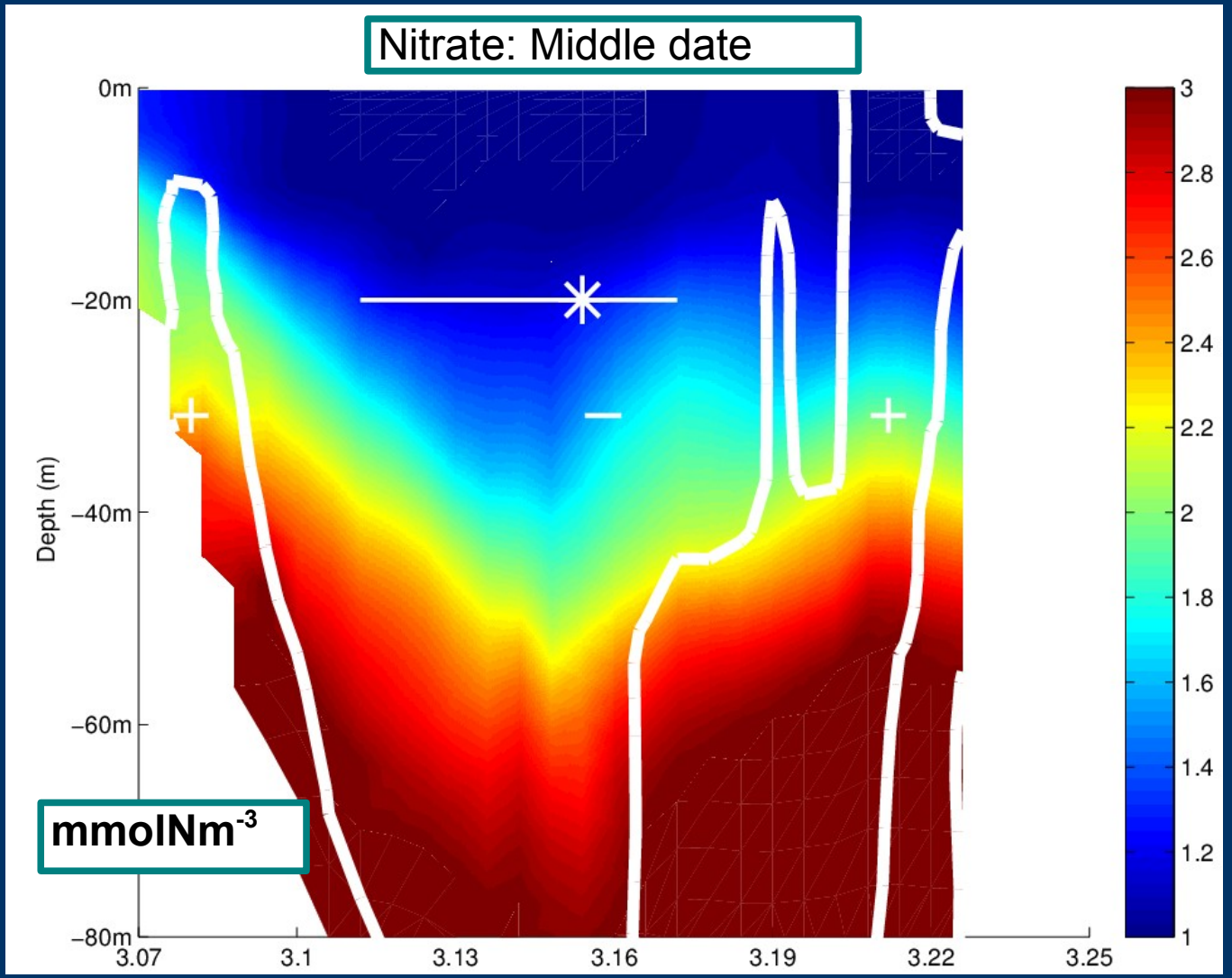
- Nitrate concentrations high near coast
- Upwelling area to the north low in nutrients
  - Already taken up by phytoplankton
- What brings nitrate to the eastern edge ?

mmolNm^{-3}

Nutrients : vertical view

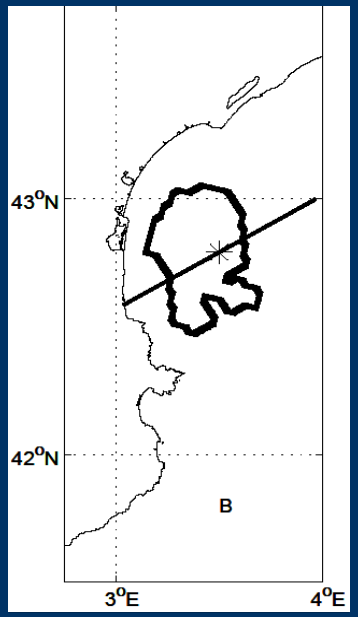
- Upwards vertical velocities on edges of eddy

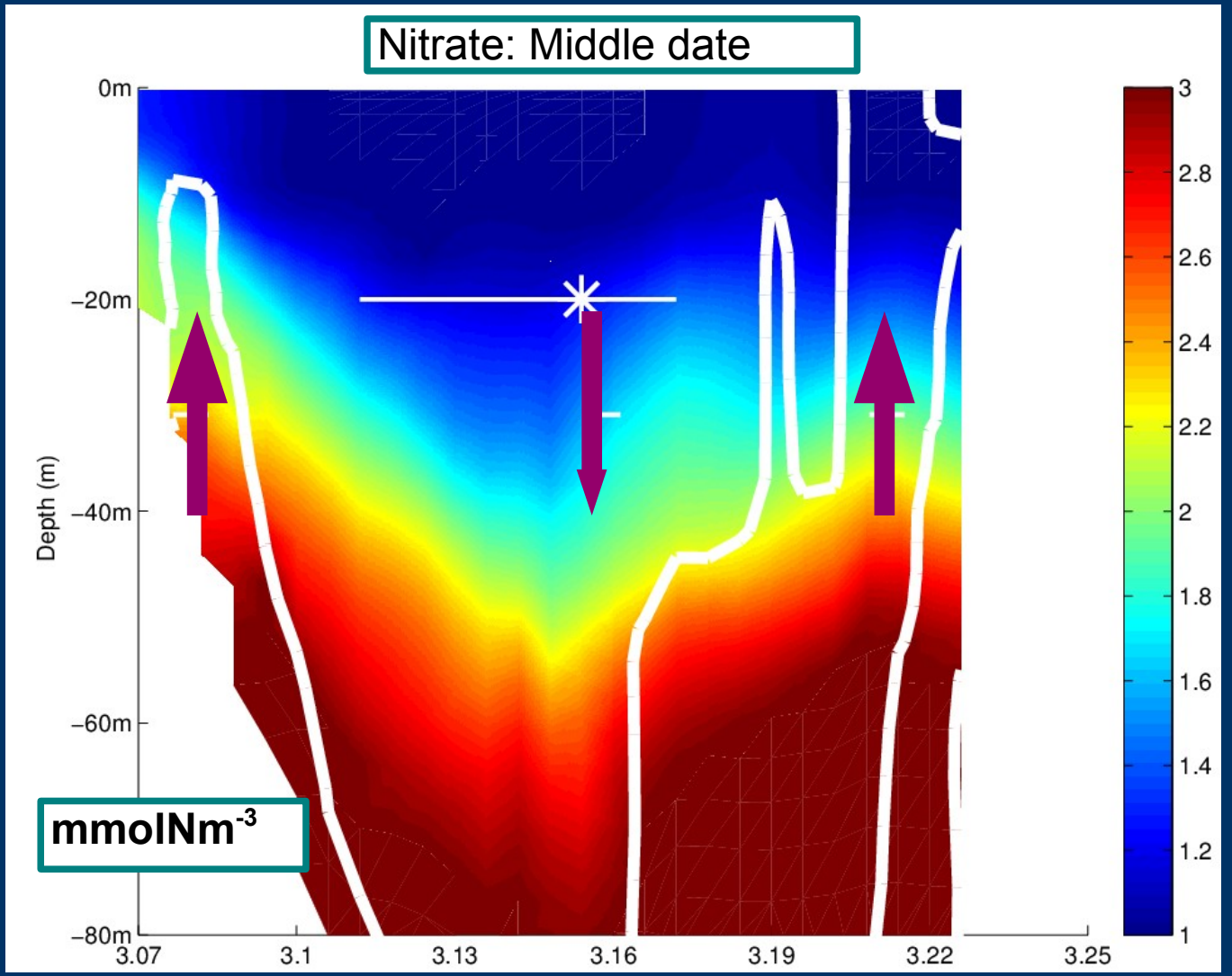




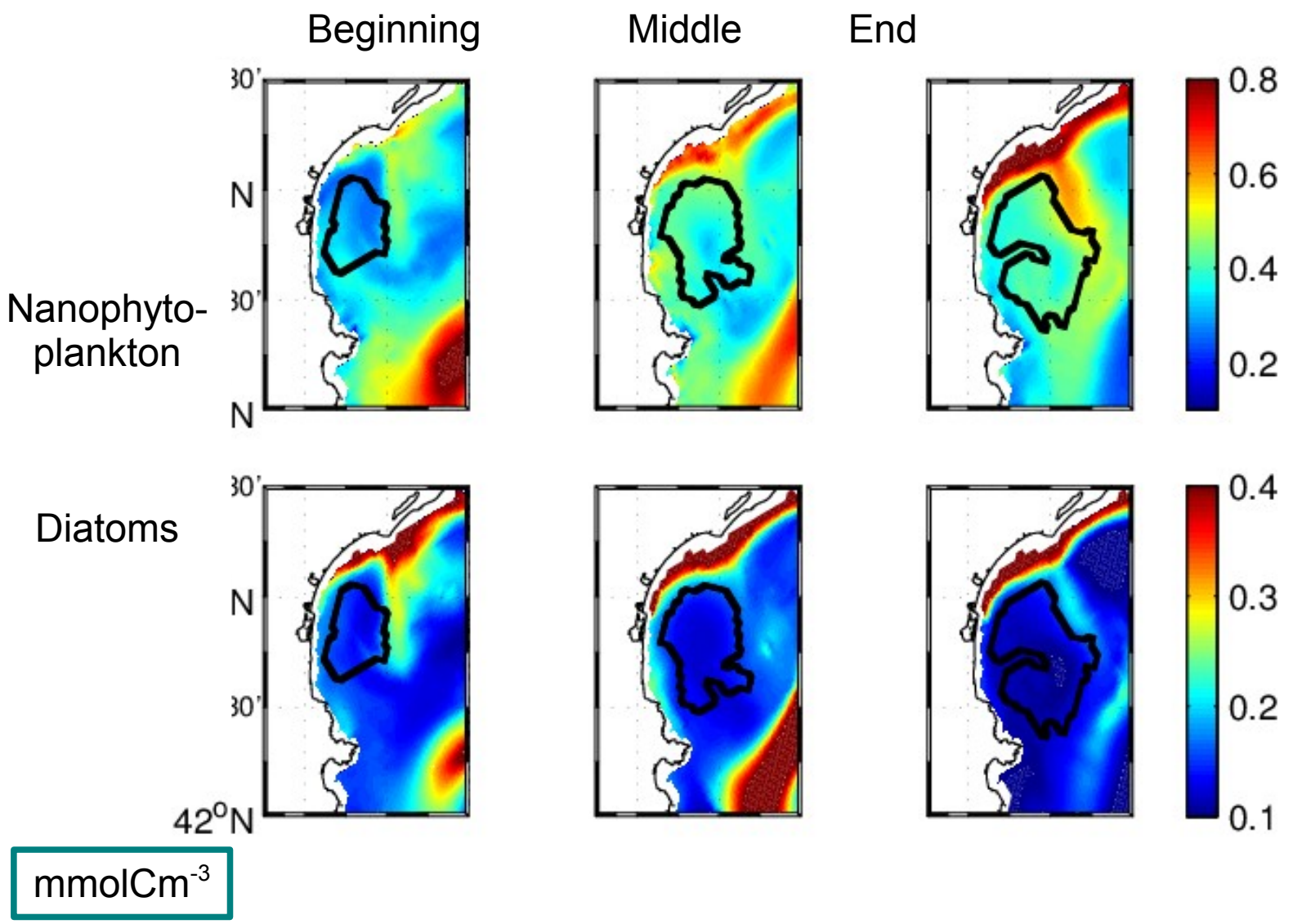
Nutrients : vertical view

- Upwards vertical velocities on edges of eddy





Response of phytoplankton



NE edge

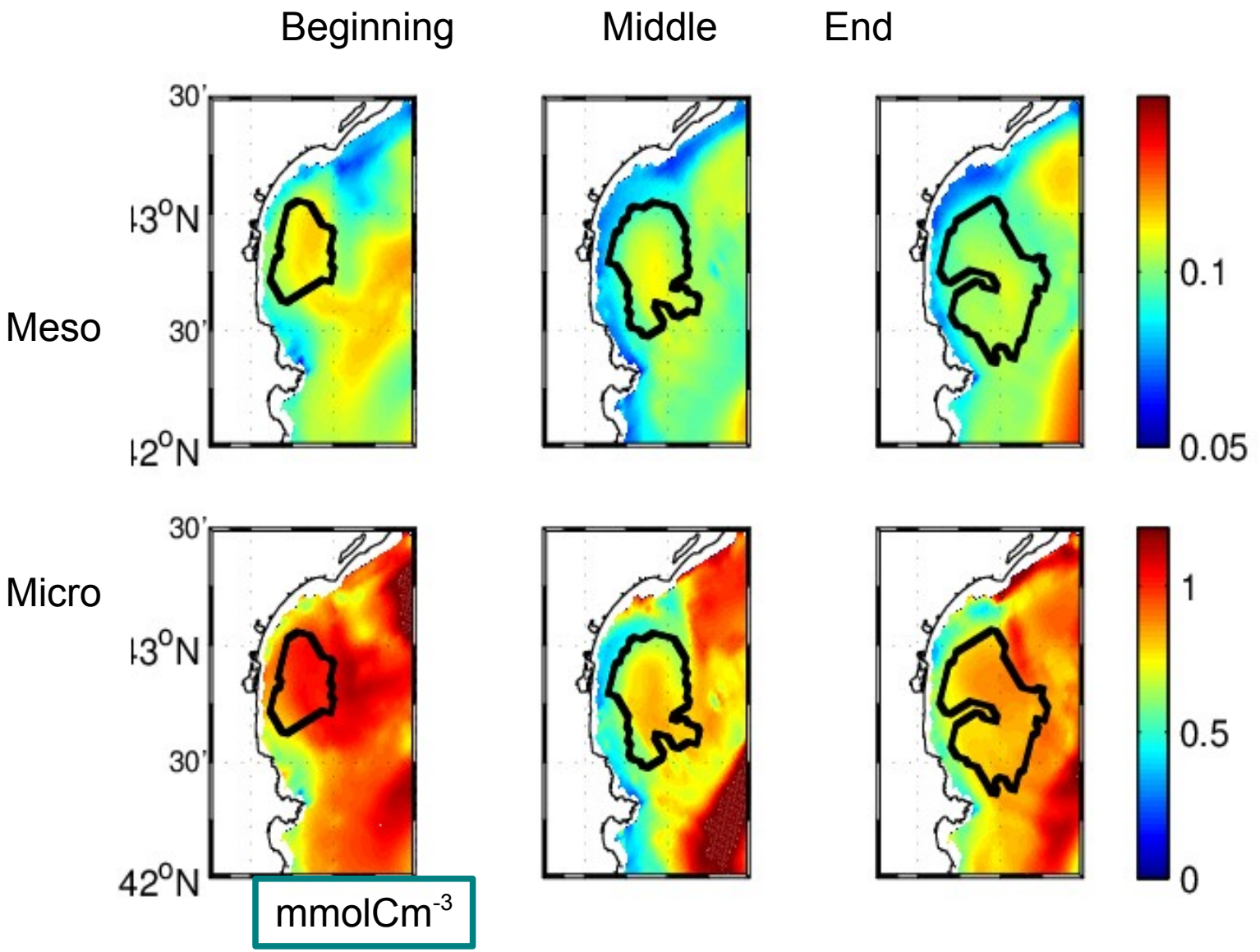
- High Phyto
- Low Nutrient

W edge

- Low Phyto
- High Nutrient

- 2-3 days for nutrients to arrive in the North

Response of Zooplankton



Coastal edge

- Low Zoo

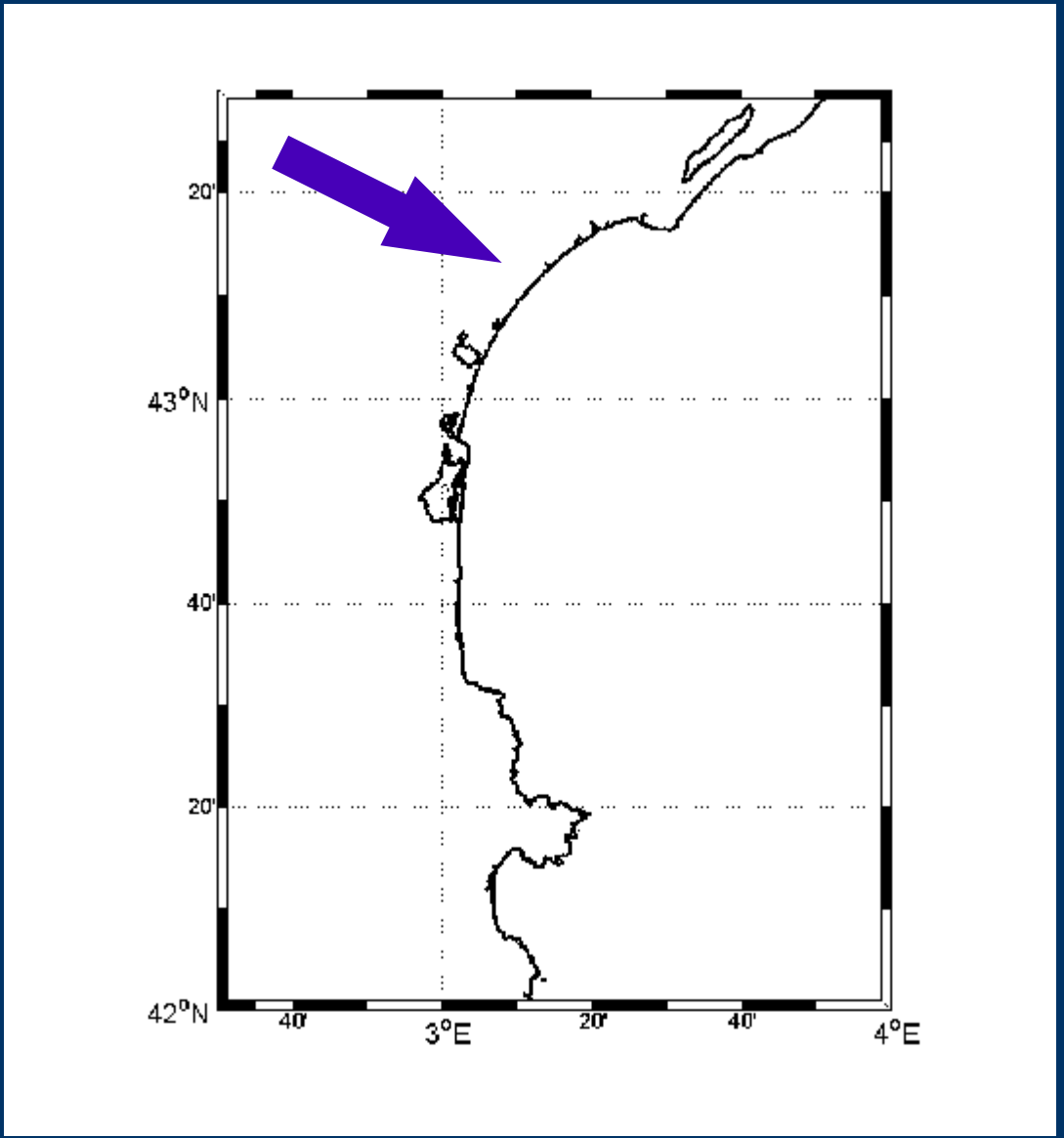
SE Edge

- High Zoo

- Grazing stops filament from completing a full rotation ?

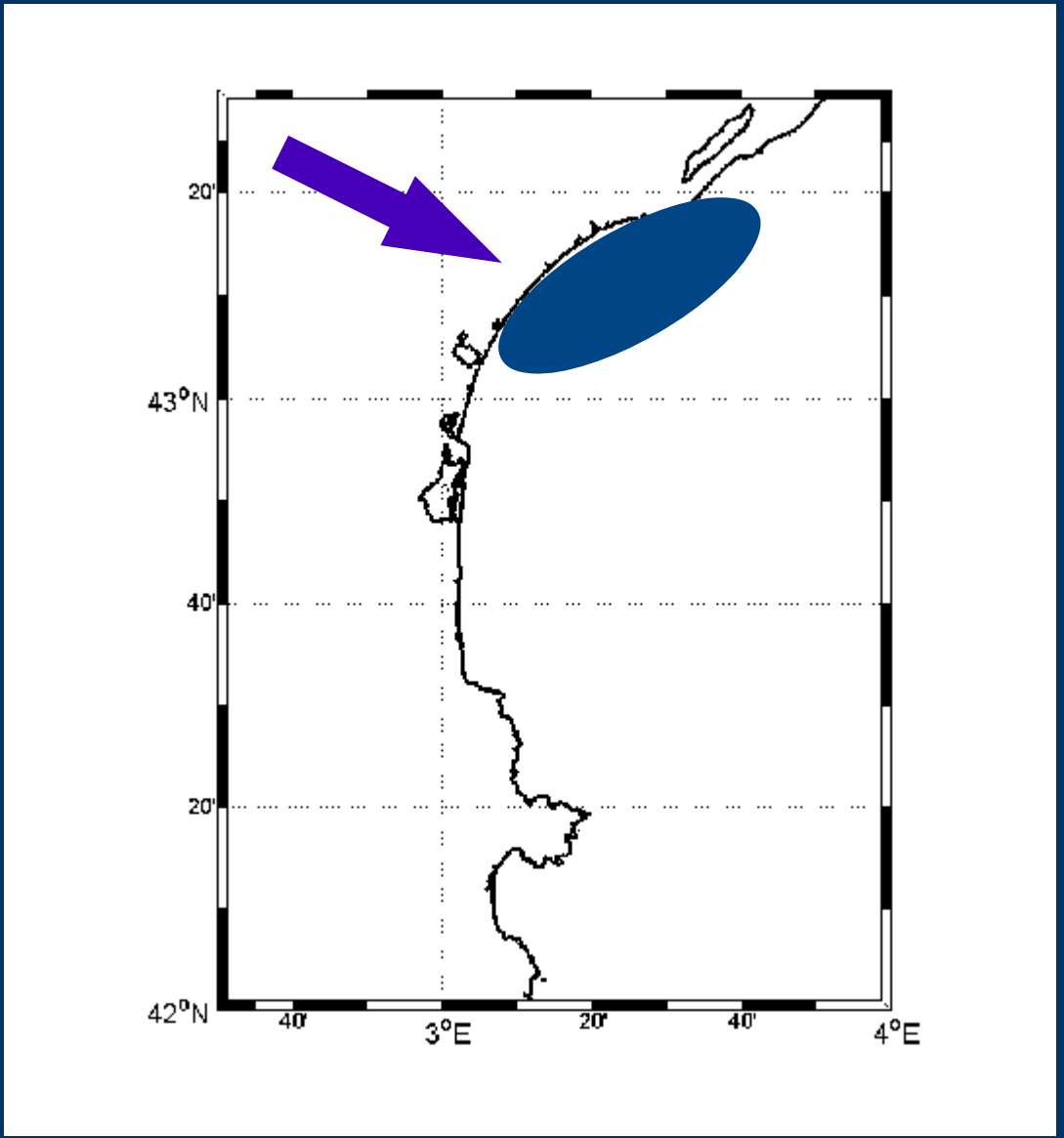
The story of this coastal AC eddy

- Strong NW wind



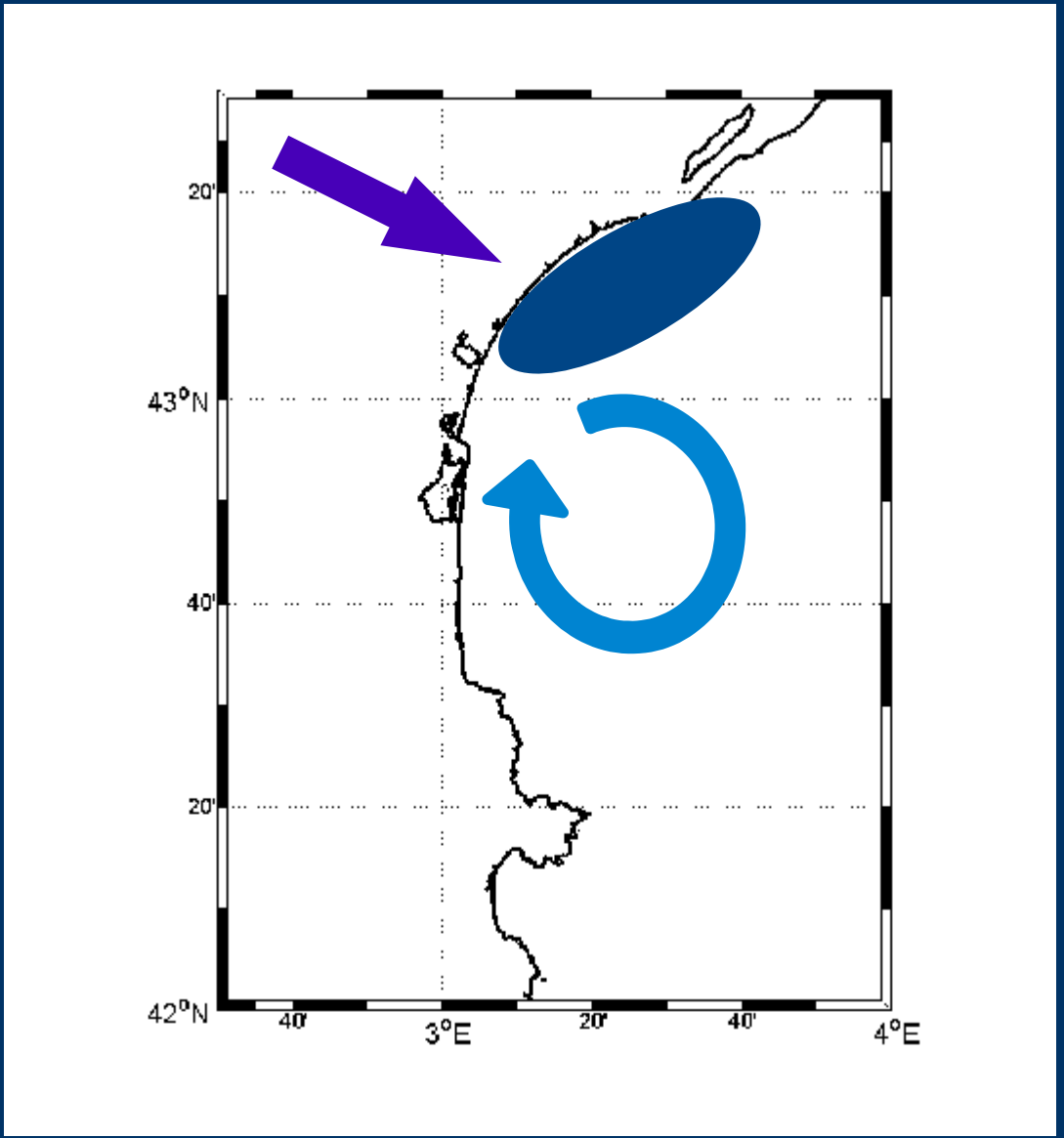
The story of this coastal AC eddy

- Strong NW wind
- Upwelling



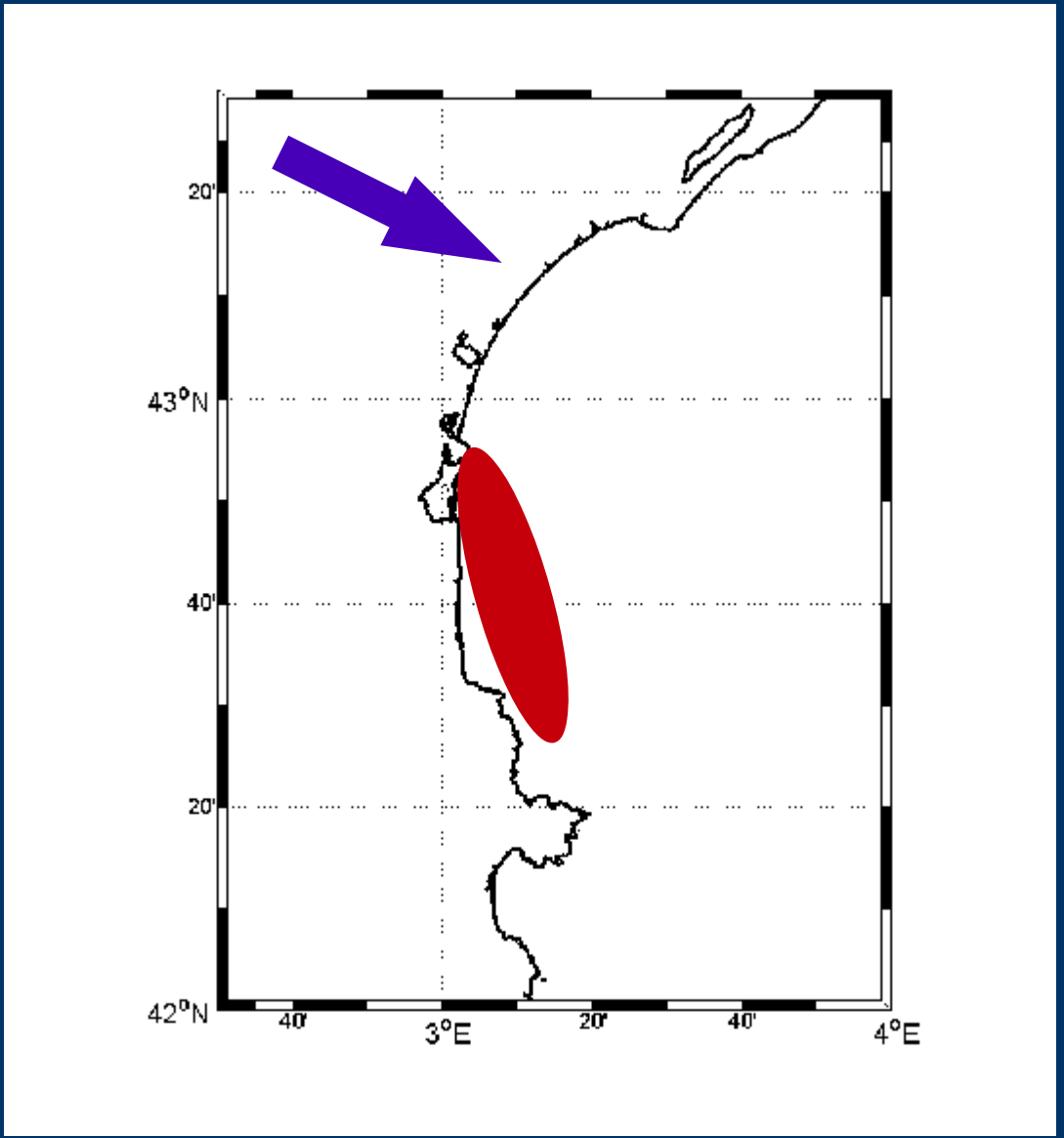
The story of this coastal AC eddy

- Strong NW wind
- Upwelling
- Anticyclonic eddy in place



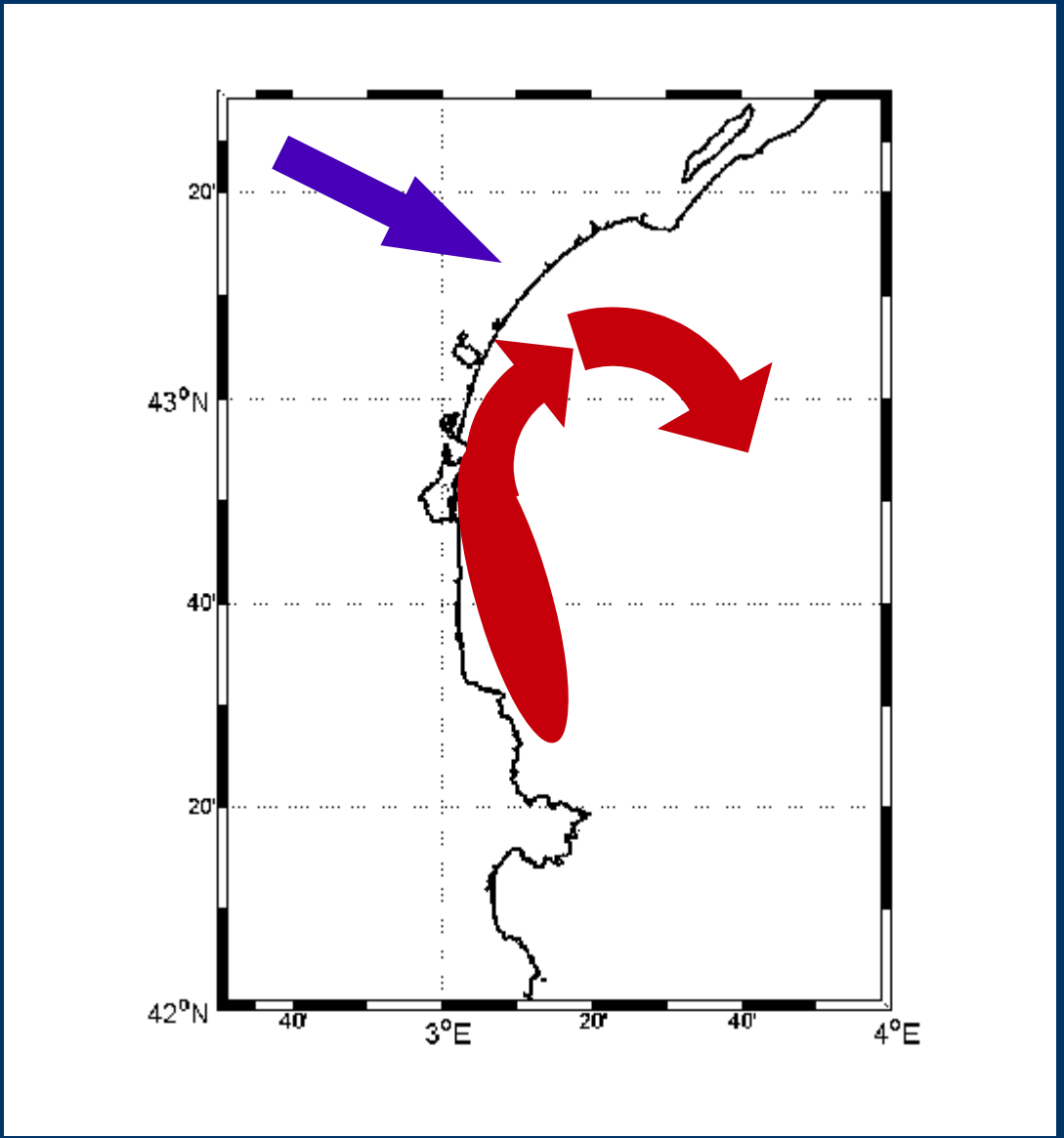
The story of this coastal AC eddy

- Strong NW wind
- Upwelling
- Anticyclonic eddy in place
- Nutrients driven up at the coast



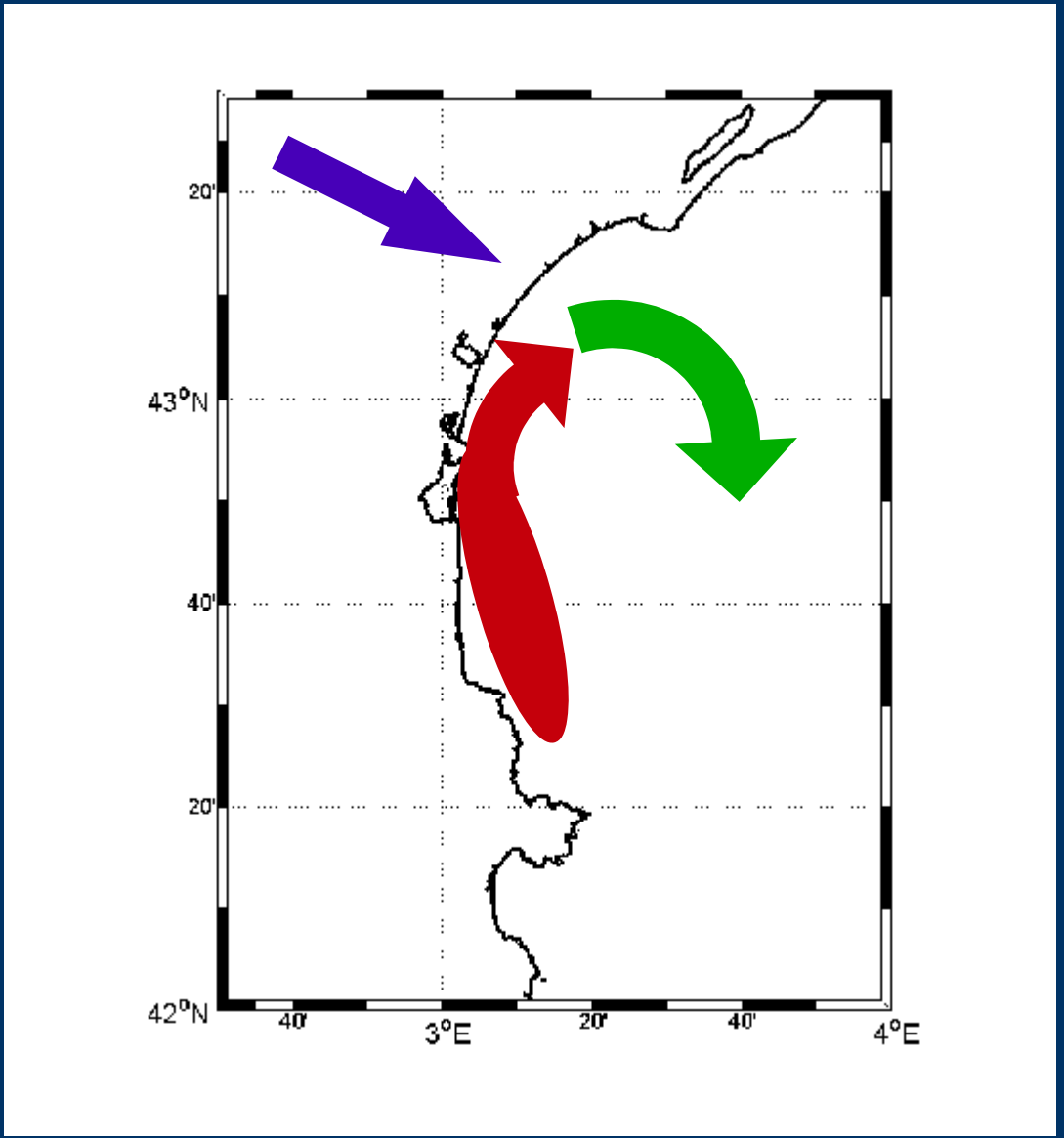
The story of this coastal AC eddy

- Strong NW wind
- Upwelling
- Anticyclonic eddy in place
- Nutrients driven up at the coast
- Nutrients advected around the eddy



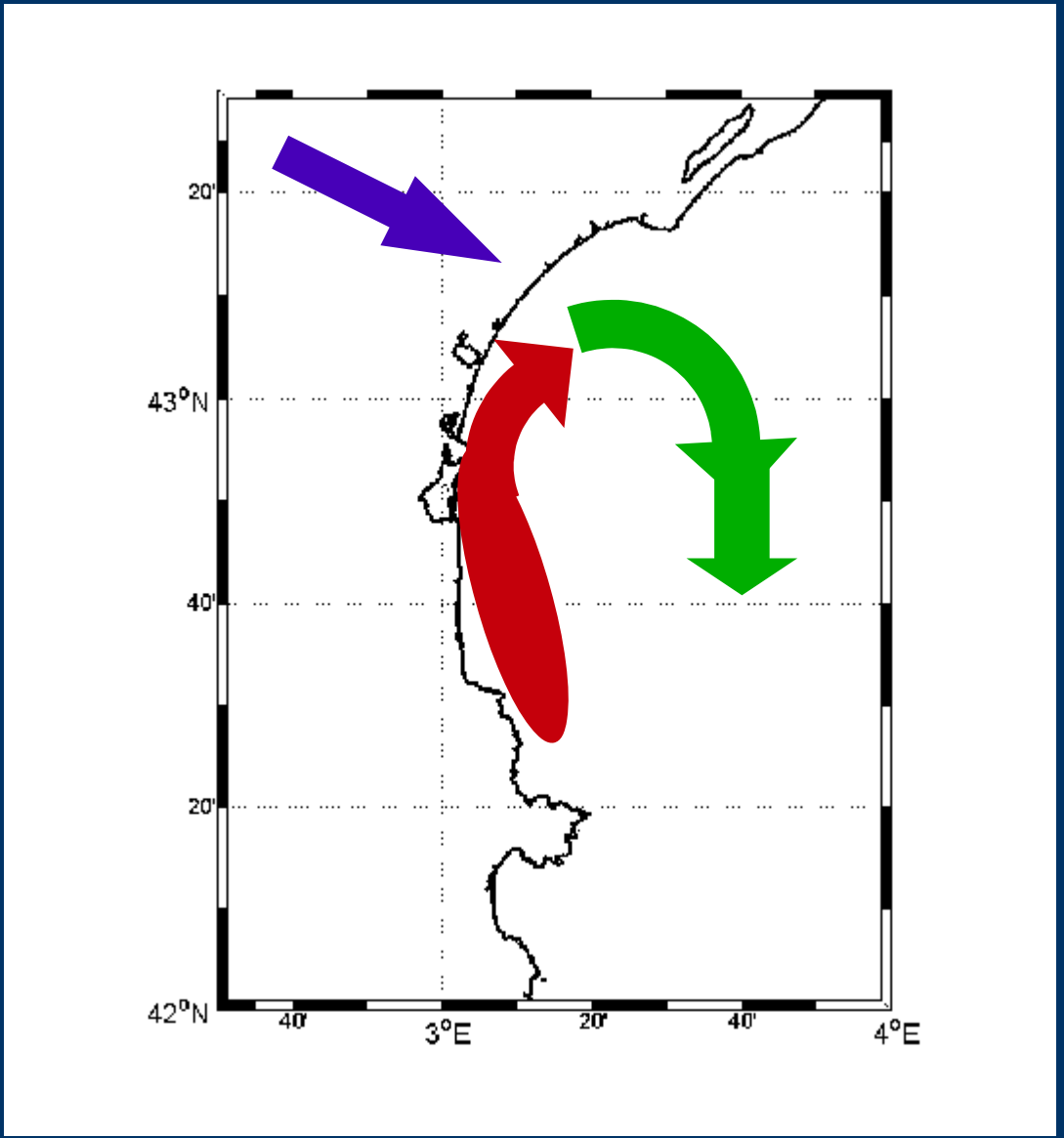
The story of this coastal AC eddy

- Strong NW wind
- Upwelling
- Anticyclonic eddy in place
- Nutrients driven up at the coast
- Nutrients advected around the eddy
- Phytoplankton development



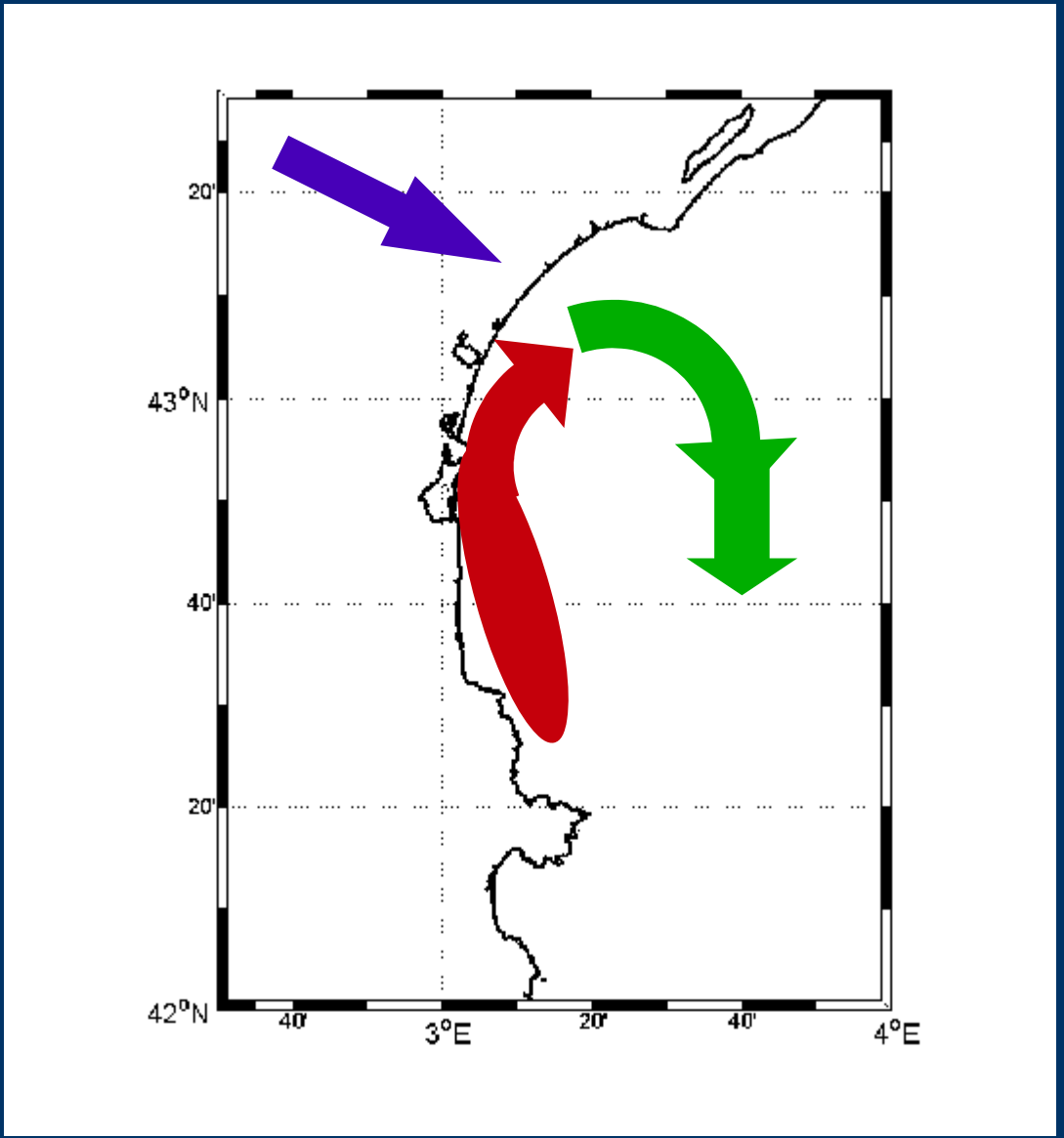
The story of this coastal AC eddy

- Strong NW wind
- Upwelling
- Anticyclonic eddy in place
- Nutrients driven up at the coast
- Nutrients advected around the eddy
- Phytoplankton development



The story of this coastal AC eddy

- Strong NW wind
- Upwelling
- Anticyclonic eddy in place
- Nutrients driven up at the coast
- Nutrients advected around the eddy
- Phytoplankton development
- End of phytoplankton development



Conclusions & Next steps

- The anticyclonic eddy acts as a transporter of phytoplankton and nutrients
  - Nutrient pumping
  - Advection
  - Phytoplankton development
  - Top-down and bottom-up control
- The planktonic ecosystem is modified by the presence of the eddy (atypical diatom development in summer)
- Next steps :
  - Study more eddies and generalize the mechanisms involved
  - Increase horizontal model resolution to 1km
- Lagrangian Transport Experiment (LATEX)
    - Nencioli this session poster, and session **NP6.1** oral Friday 9:30 room 13
    - Petrenko session OS2.1poster
    - Doglioli session OS2.1 poster