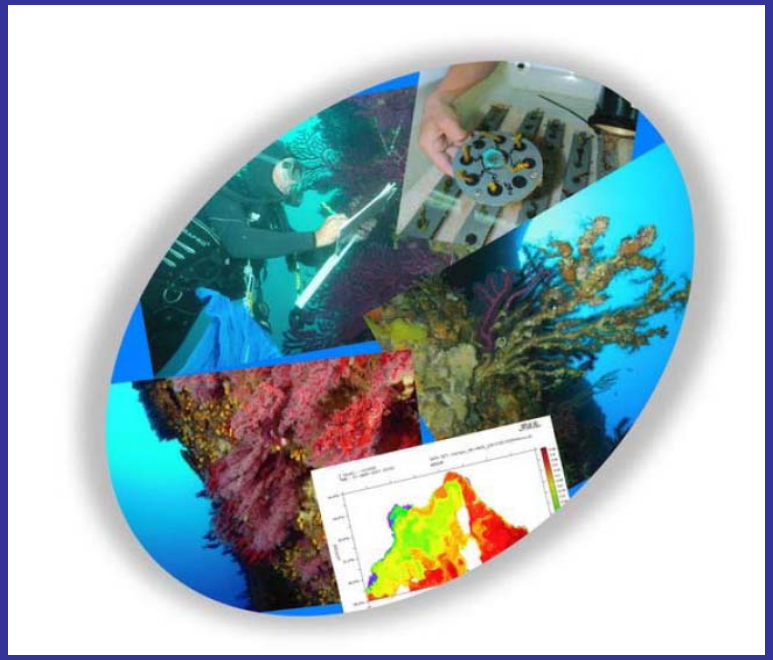
NW Mediterranean sea model toward the study of the climate change impacts on the coastal ecosystems

I. Pairaud, *P. Garreau, N. Bensoussan, J. Garrabou, V. Faure*



ClimCares project
2011-2013

Warming of the NW Mediterranean coastal waters

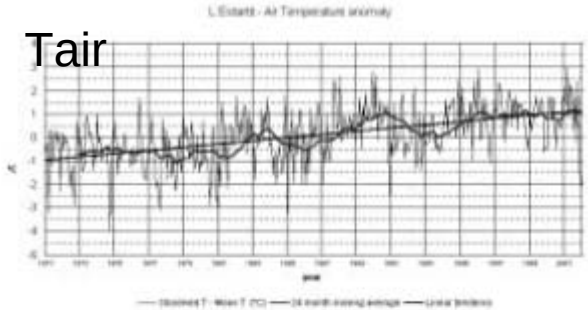


Fig. 3. Air Temperature anomaly (observed minus average) series (1971-2001) with tendencies: 24 month running average and linear.

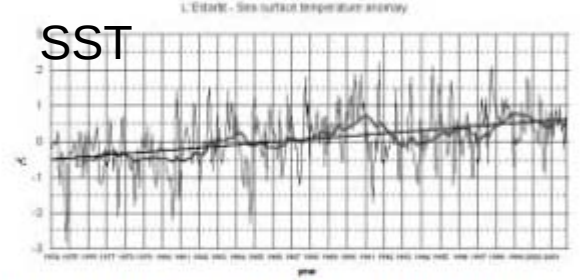


Fig. 4. Sea Surface Temperature anomaly series (1974-2001) with tendencies as in Fig. 3.

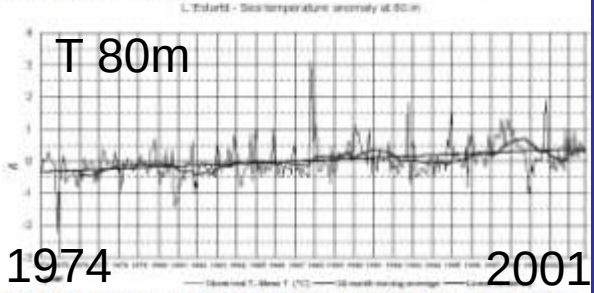


Fig. 5. Sea Water Temperature anomaly series at 80 m depth (1974-2001) with tendencies as in Fig. 3.

From Salat et Pascual, CIESM, 2002

SST warming of ~ 1.1ºC in 27 years (0.7°C at 80m)

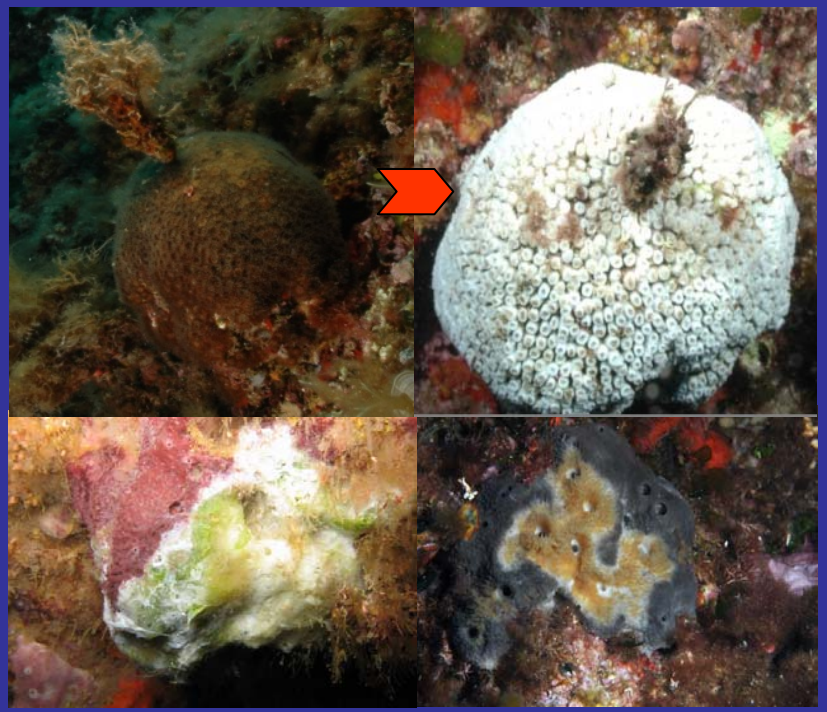
IMPACT OF WARMING: Mass mortality events in the NW Mediterranean

2 mass mortality events:
1999 and 2003 summers

About 30 benthic species affected

Large geographic scale affected

Linked to temperature anomalies



What will be the impacts of warming on the Mediterranean biodiversity?

- What is the expected warming?
- What will be the species/populations more affected by the warming?
- Can the species/population cope with the expected environmental shift?
- Are there warming hot-spots within the NW Mediterranean?
- Where should we focus our management and conservation efforts?

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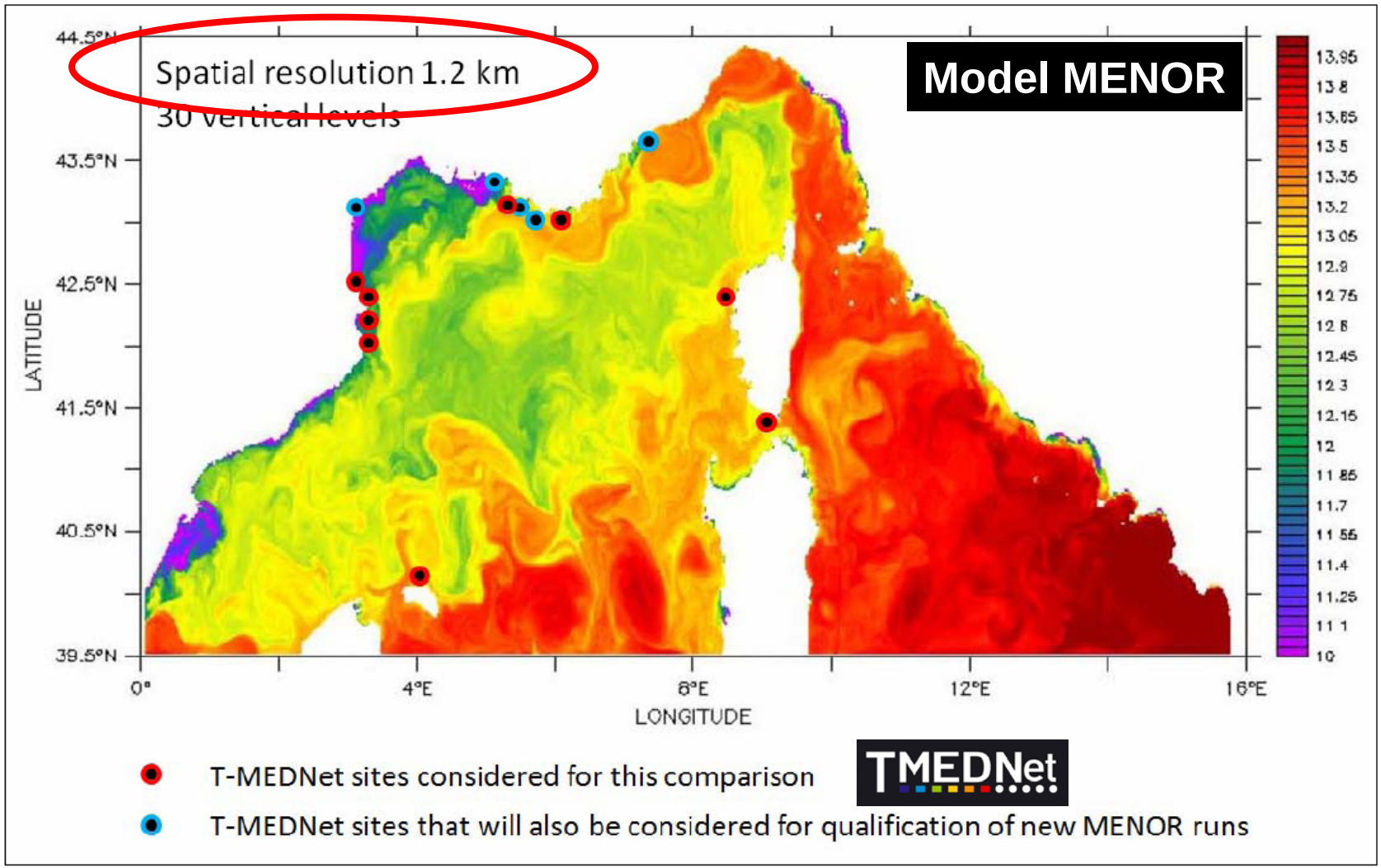
ClimCares will contribute providing information on:

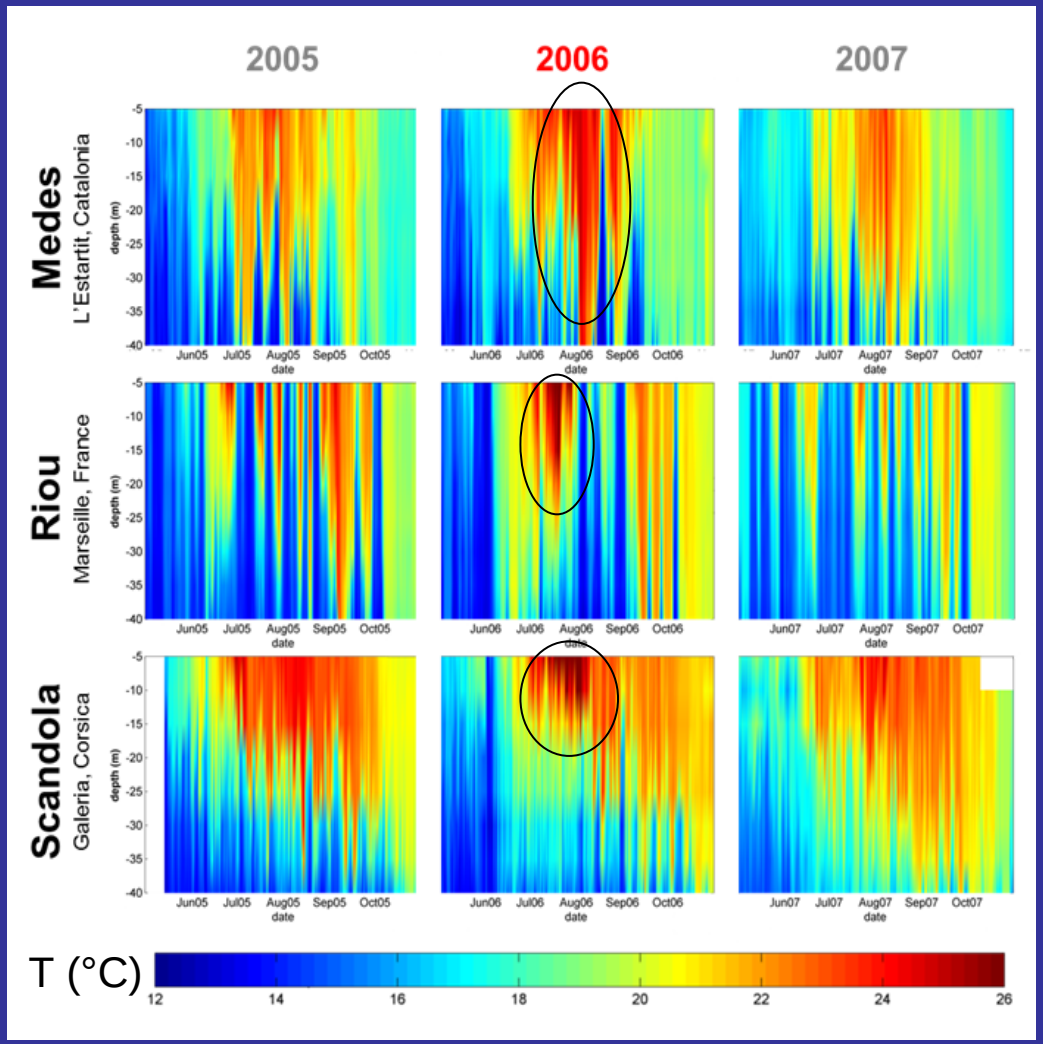
1. Expected warming for NW Mediterranean coastal areas
2. Response of target species to temperature stress (coralligenous)

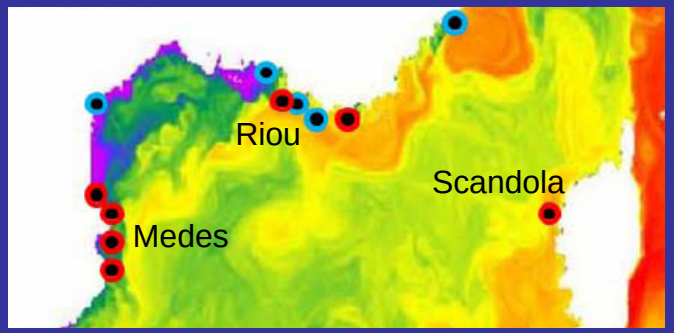
Use of models: Understanding of the last 10 years and Simulation of potential warming by the end of XXIst century

Modelling of warming events: Model vs observations of temperature over 2001-2011



Example of available time series for validation from TMedNet



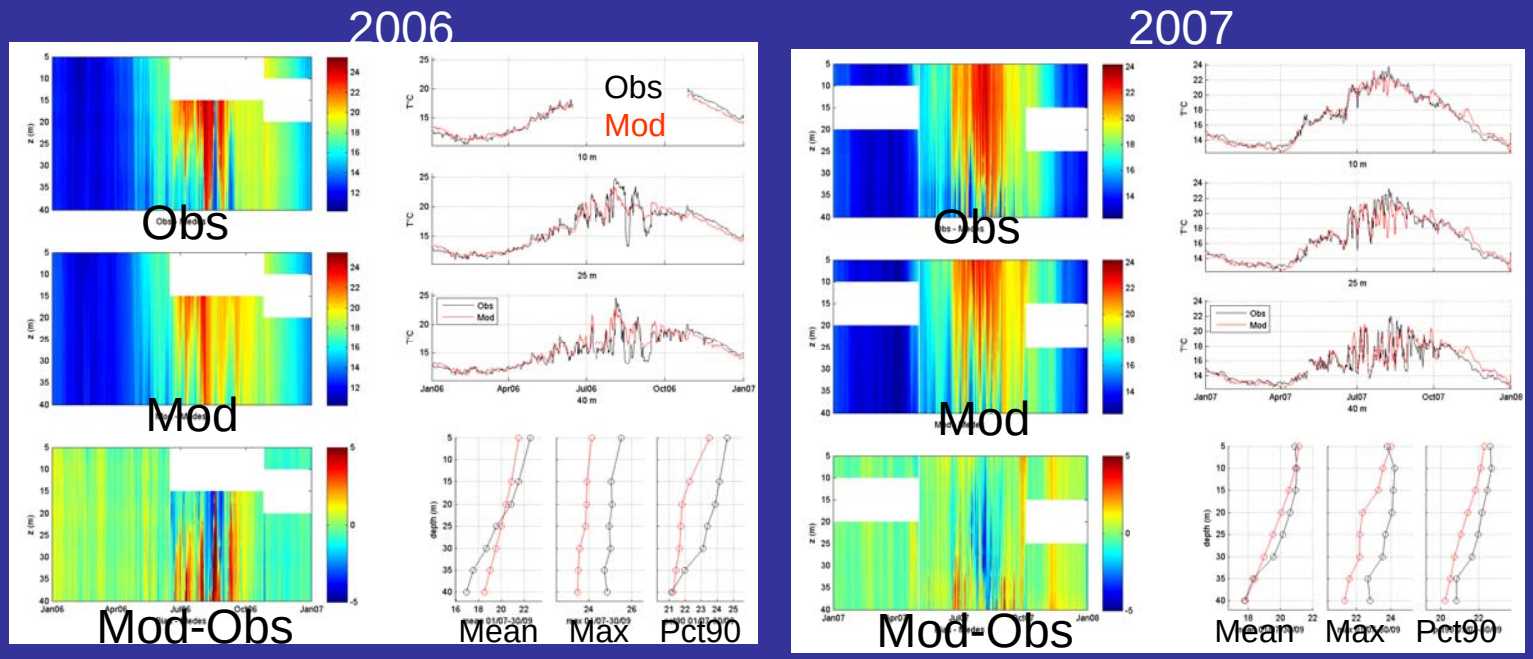


Differences between sites in summer:

- Warming at Medes -> Cooling at Riou (upwelling under NW winds)
- Cooling at Medes (upwelling) -> warming at Riou
- Higher T at Scandola more marked in 2005 and 2007

Identification of heat waves in 2006 (reaching about 10-15m depth at Riou)

Comparison between model and observations (Medes)



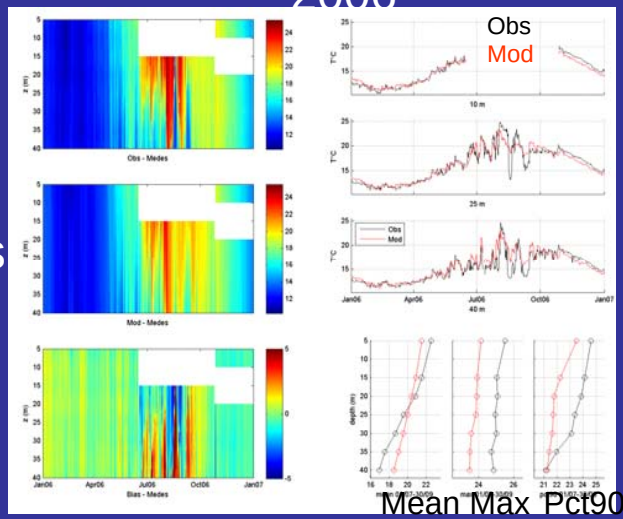
- Good seasonal and interannual variability
- Underestimation of extreme temperature events

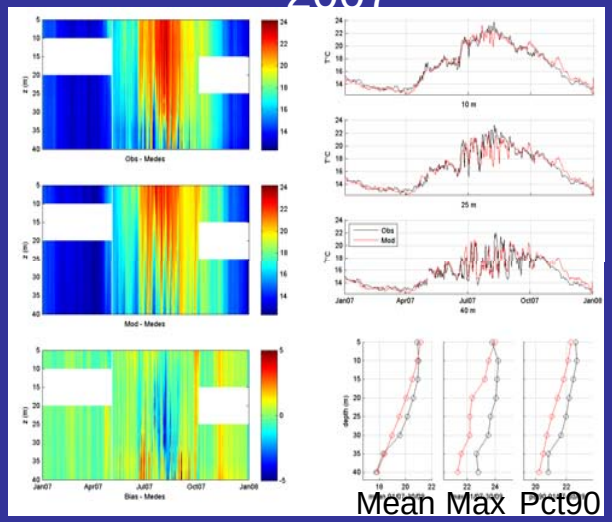
Comparison between model and observations (Medes & Riou)

2006

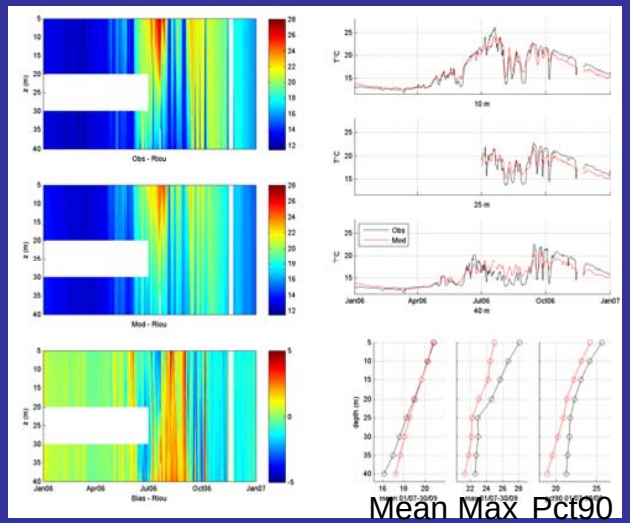
2007

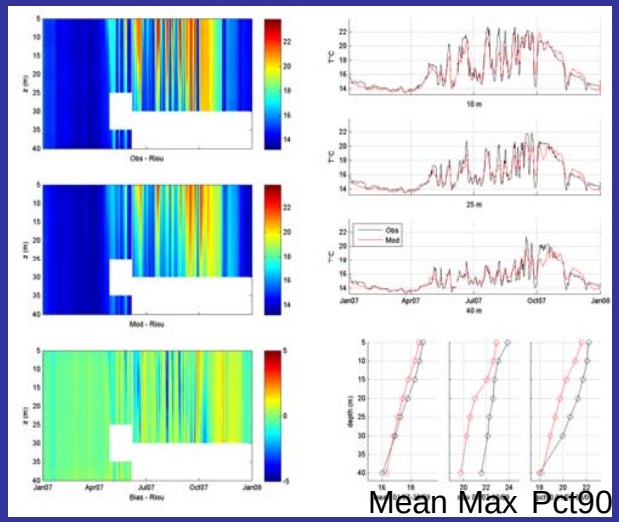
Medes





Riou





The model:

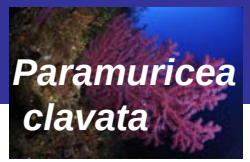
- reproduces the observed processes
- shows less T variablility than the data
- underestimates extreme heat events

Biological responses to warming

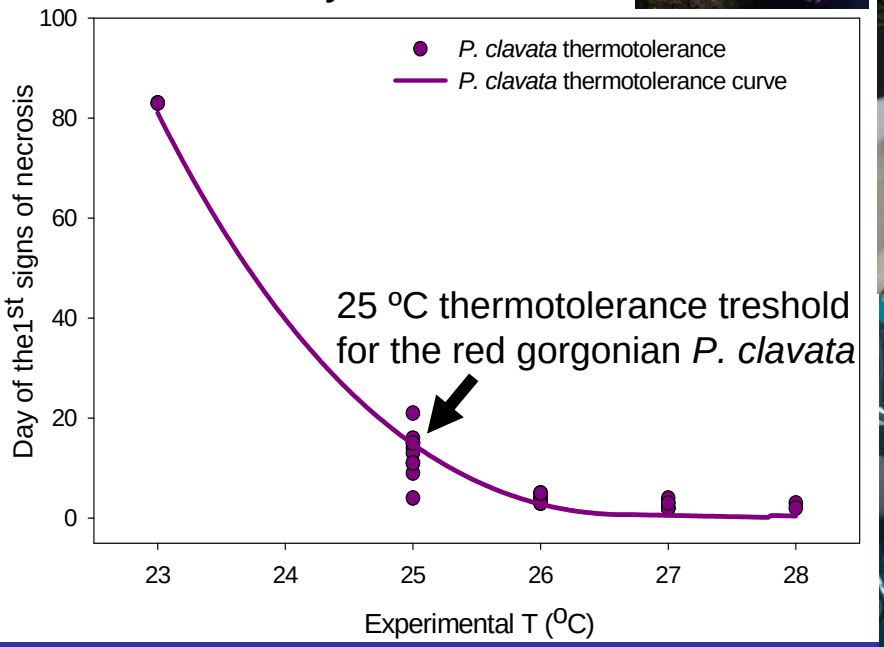
Field surveys & literature

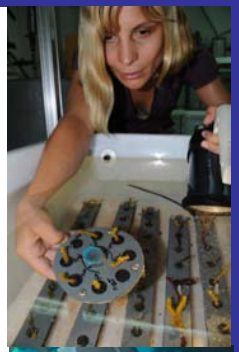
↓

Thermotolerance functions



From field surveys & literature





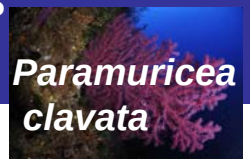
Mortality : 2 cases

1- T>23°C over a long period

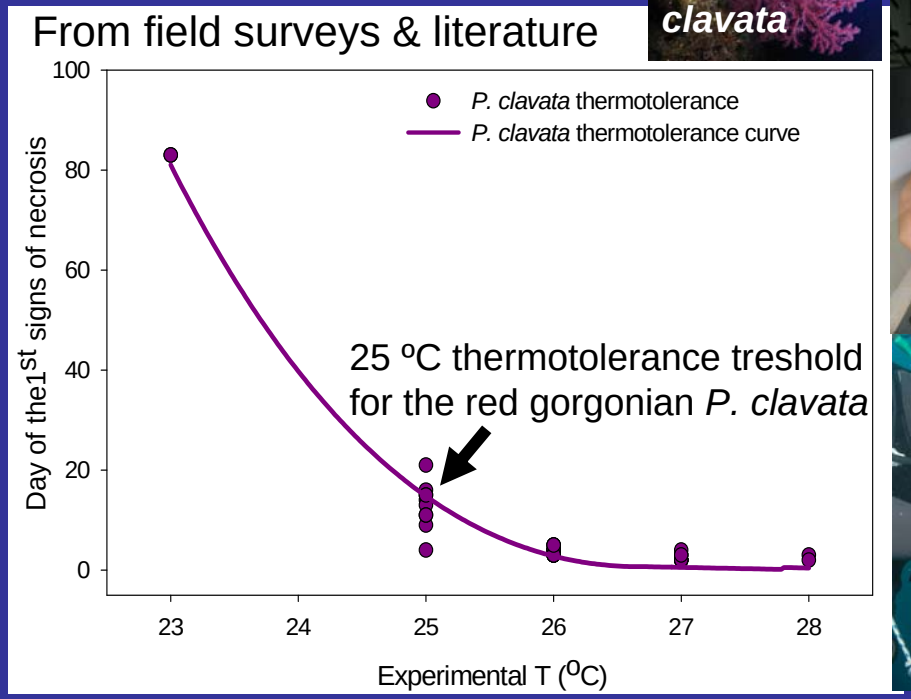
2- short periods with T> 25°C

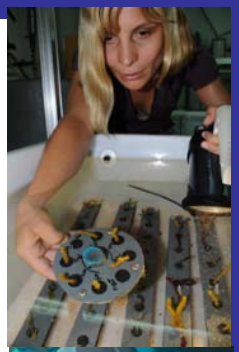
Biological responses to warming

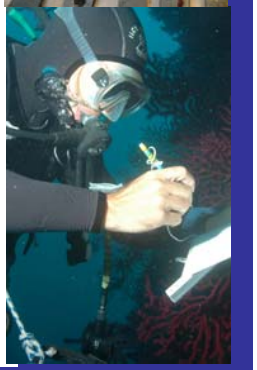
Thermotolerance functions



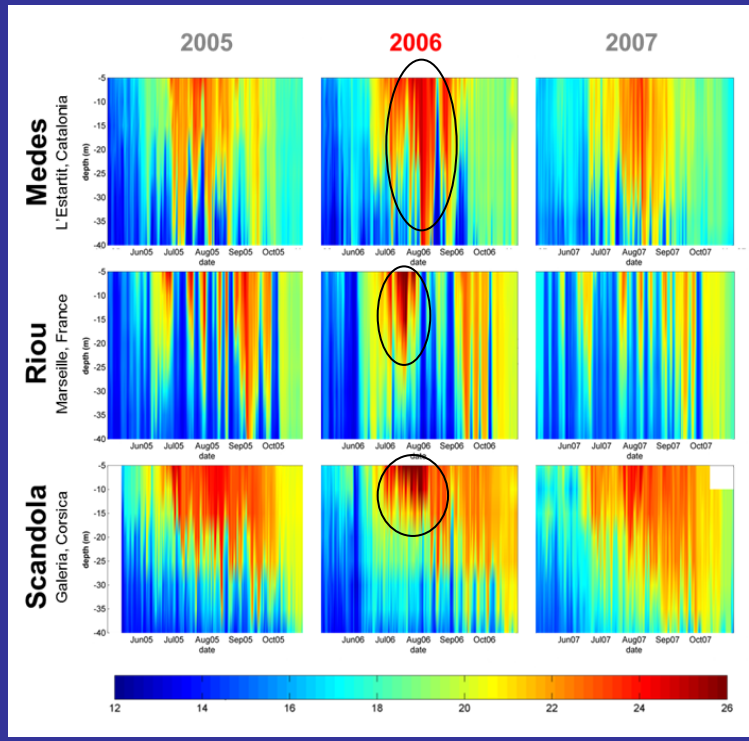
From field surveys & literature







2006 warming events



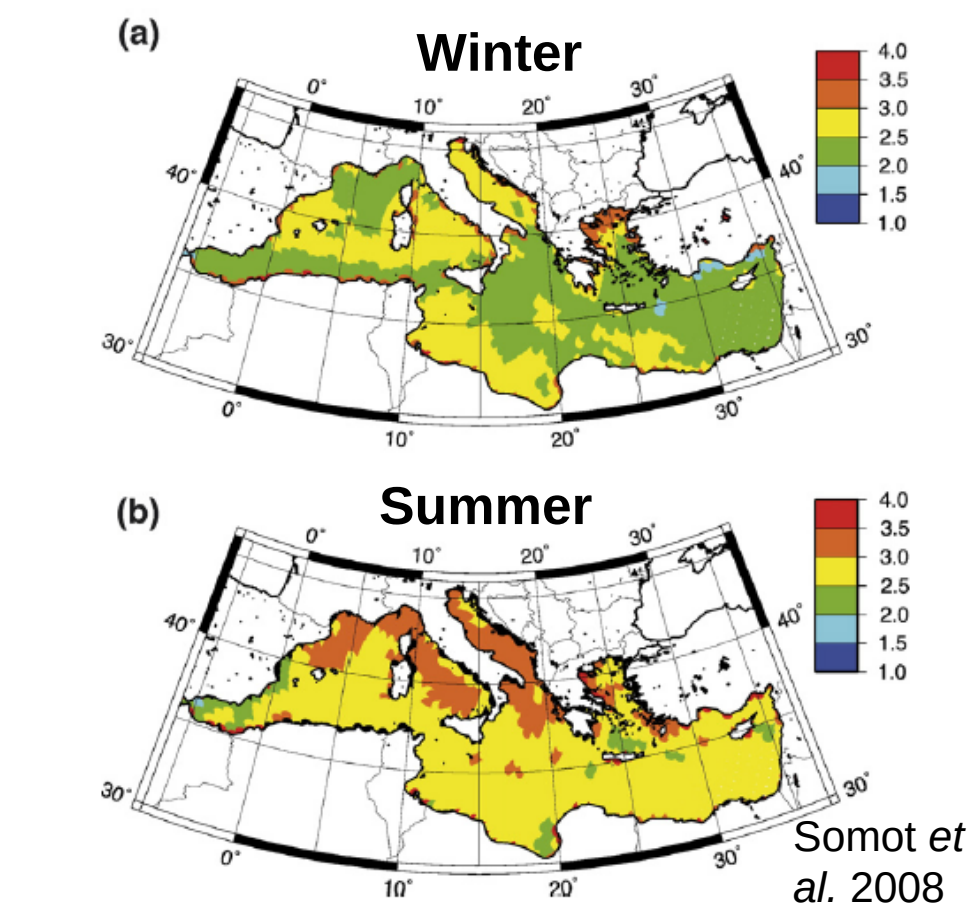
Mortality : 2 cases
1- T>23°C over a long period
2- short periods with T> 25°C

⇨ 2006 mortality events :

Medes (case 1), Scandola (case 2)

Future work: Modelling potential warming by the end of XXIst century

Mediterranean Warming simulation 2070-2099 / 1961-1990 under IPCC-A2 scenario



Somot *et al.* 2008

Overall about +3 °C by 2099

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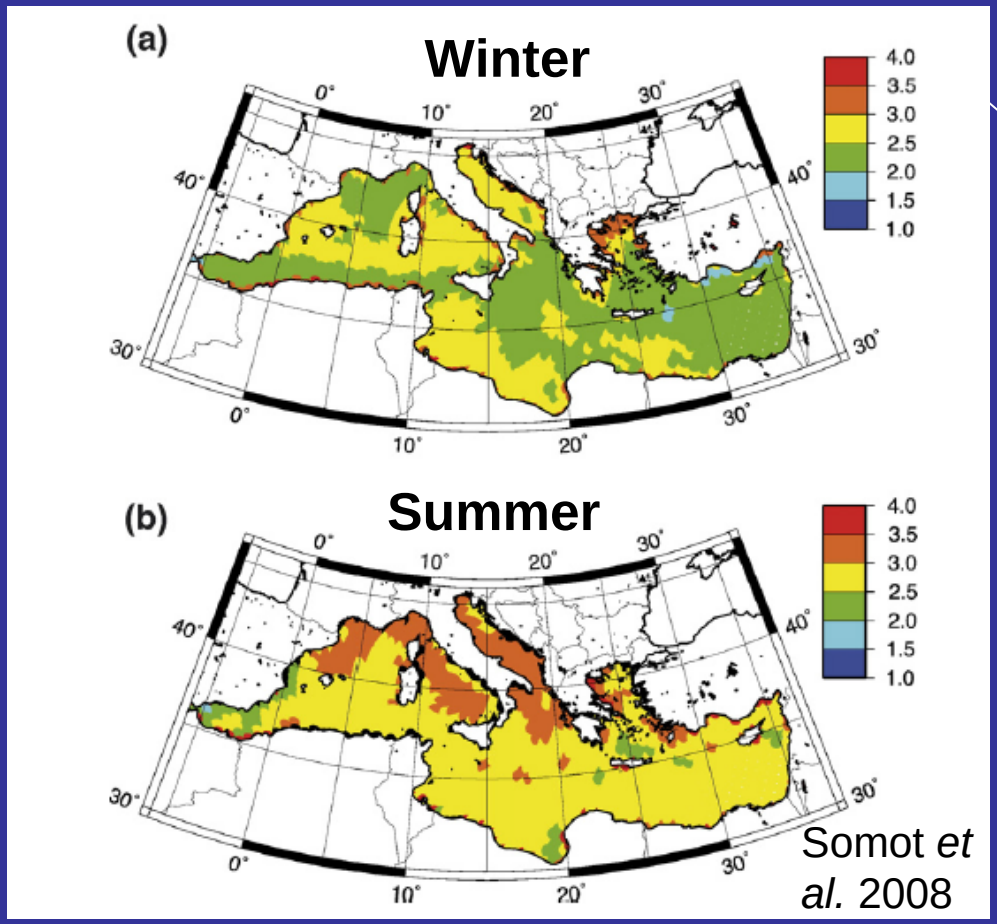
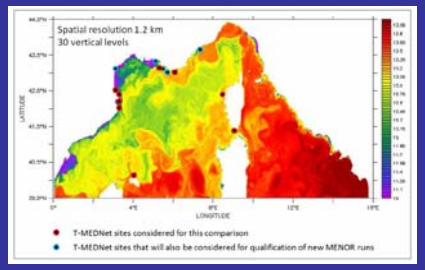


Overall about +3 °C by 2099

Ocean & atmosphere forcing for MENOR

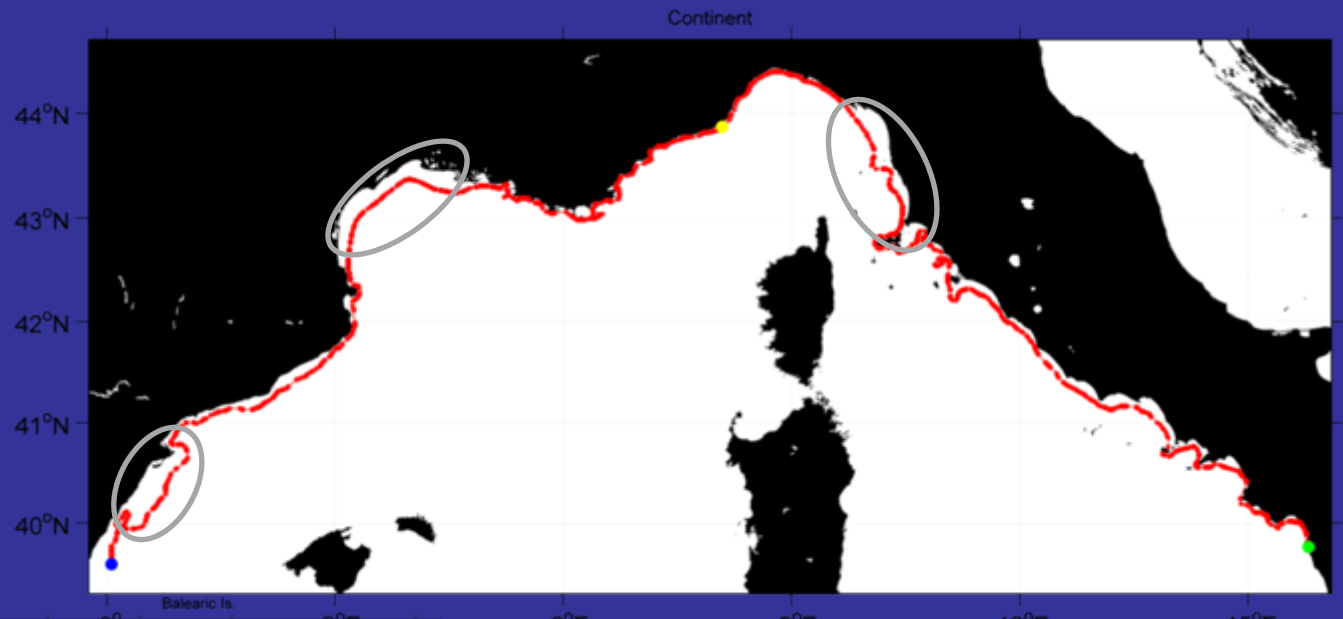


Collaboration with S. Somot (Meteo-France, CNRM-GAME)

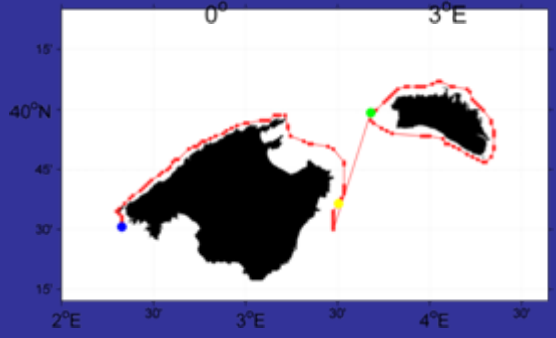
Extreme scenarios at regional scale

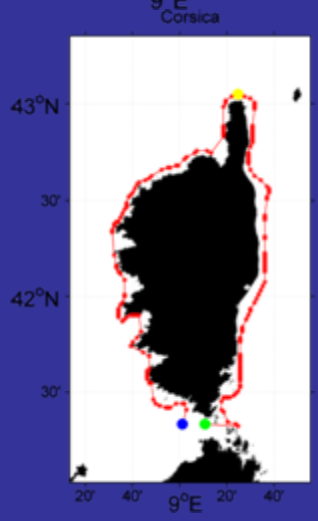
Assessment of potential impact of warming at NWMed basin scale from simulations

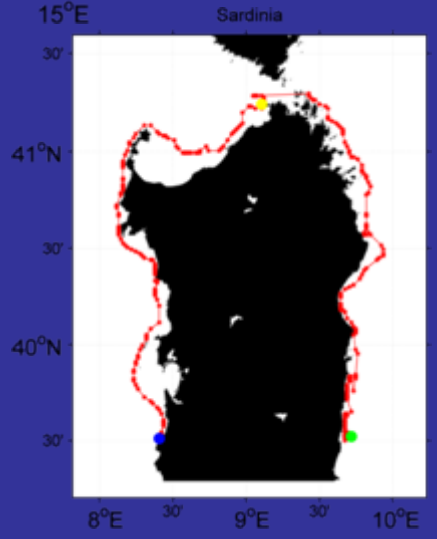
Evolution of Temperature profiles along the coast



Data extraction was conducted along 60m and 20m isodepths for better insight on benthic conditions in shallow areas (large continental shelves)



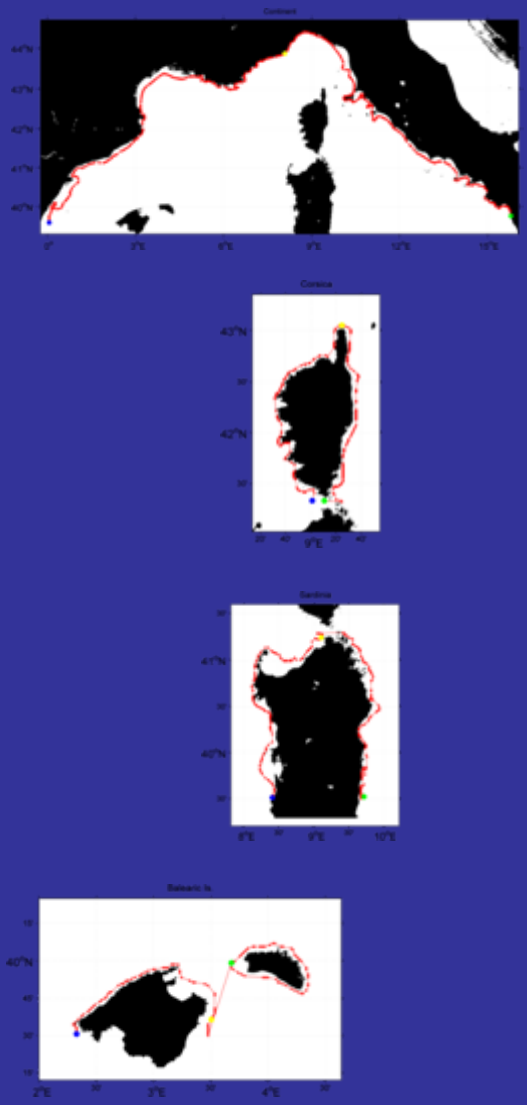


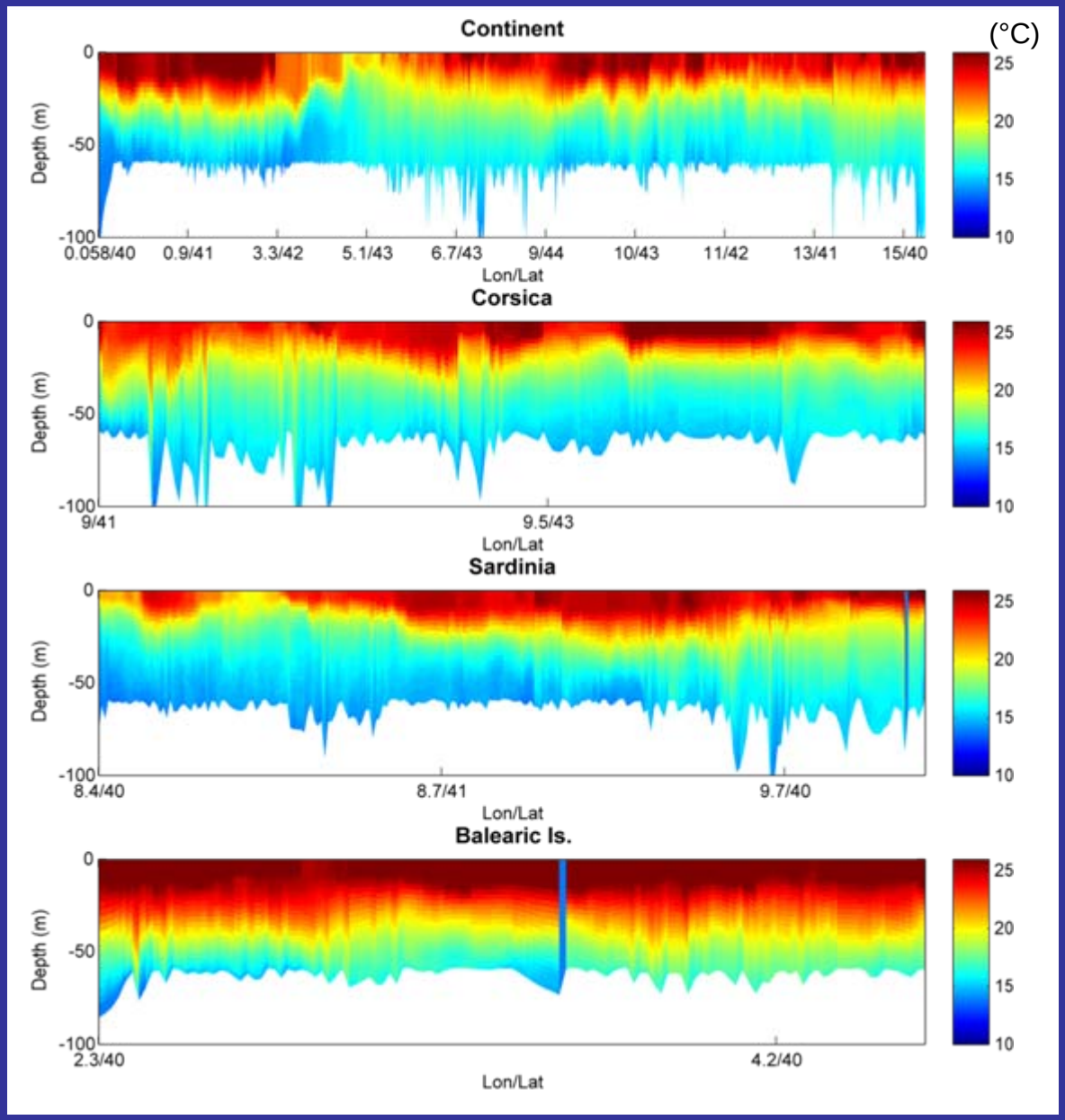


- Beginning
- Middle
- End

of extractions

T along NWM coasts on 15 august 2010

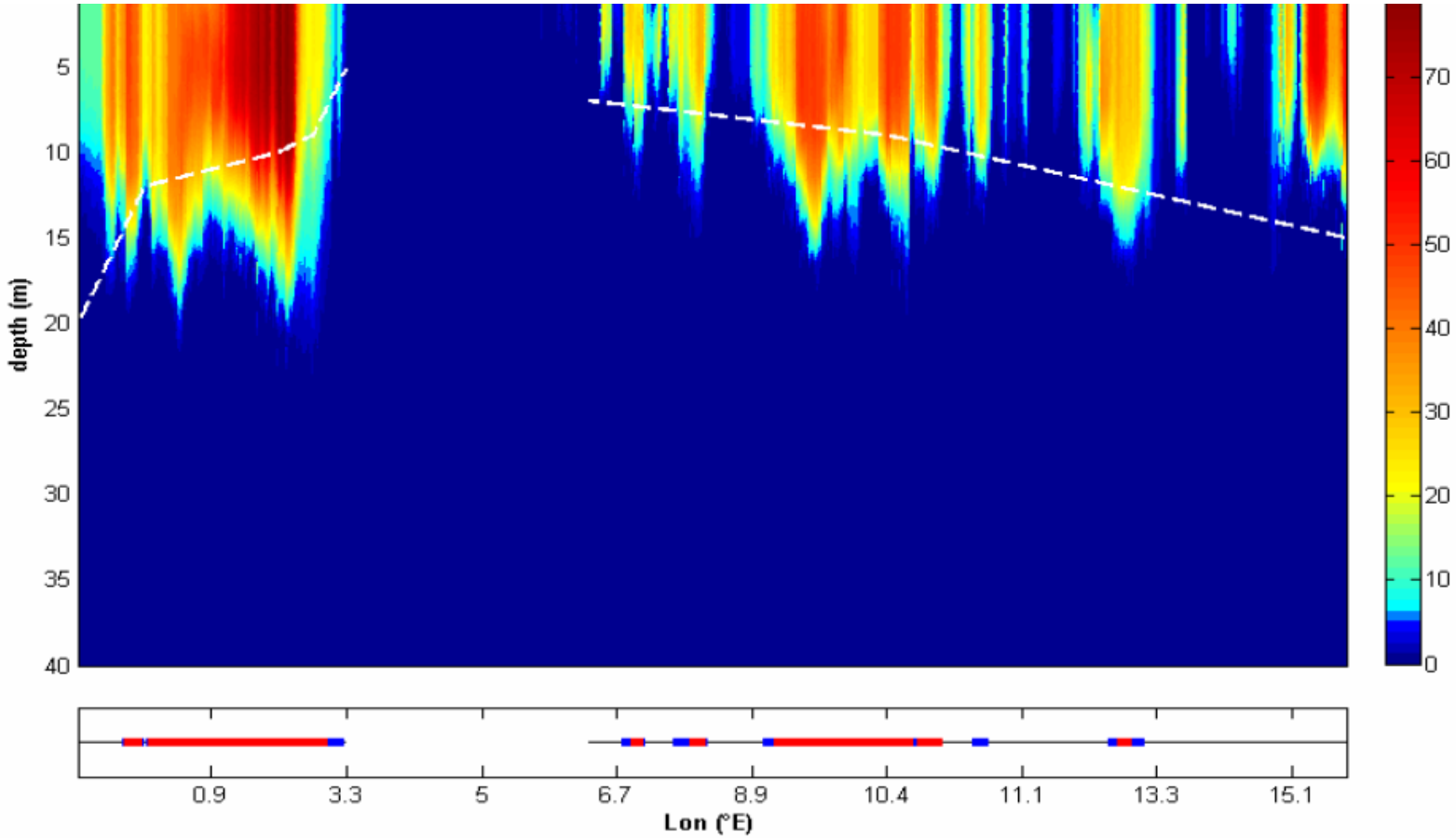




Assessment of potential impact of warming in NWMed from simulations

Number of days above 25 ºC for the year 2010

current upper distribution limit of target species (Clavata)



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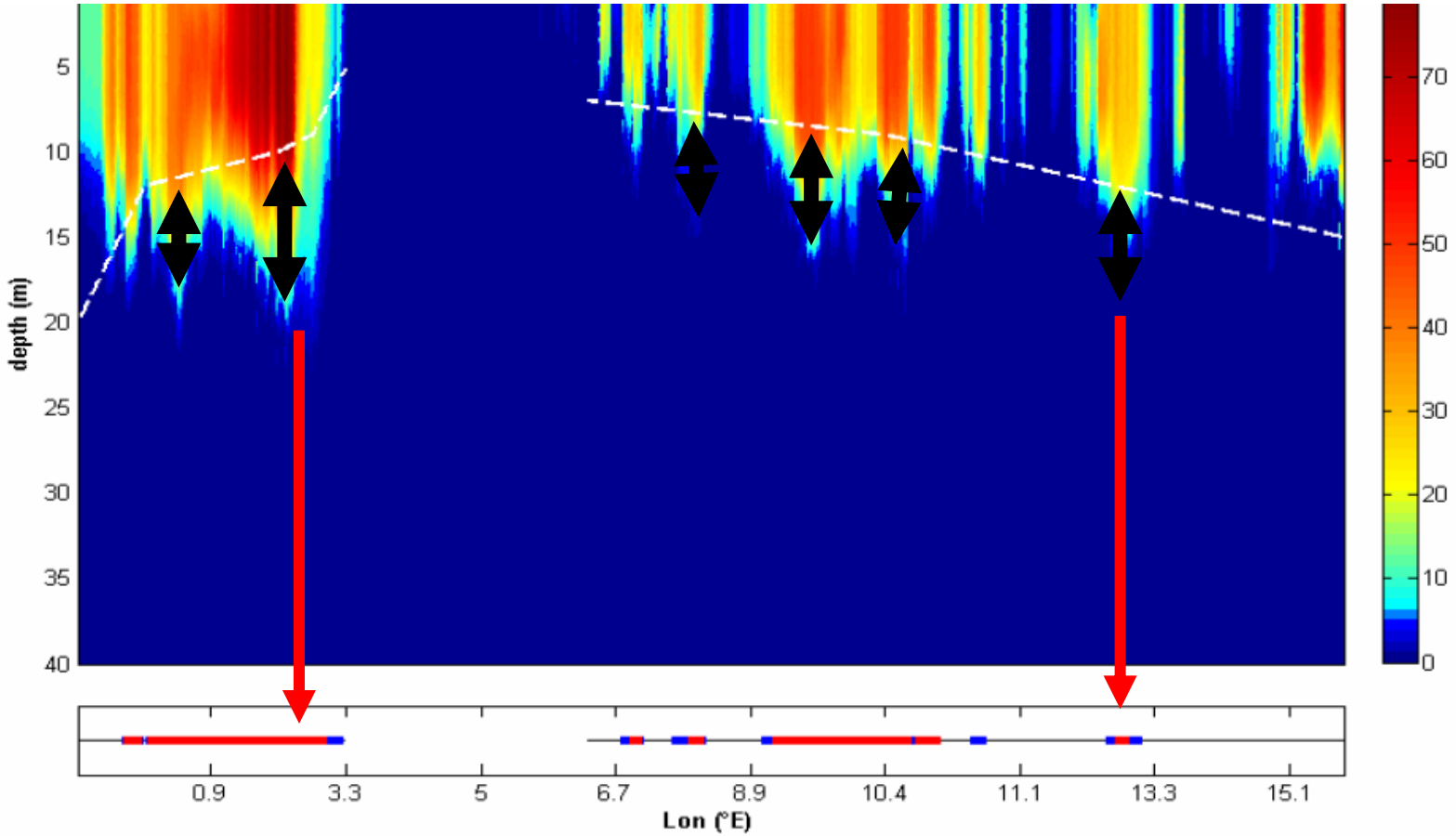
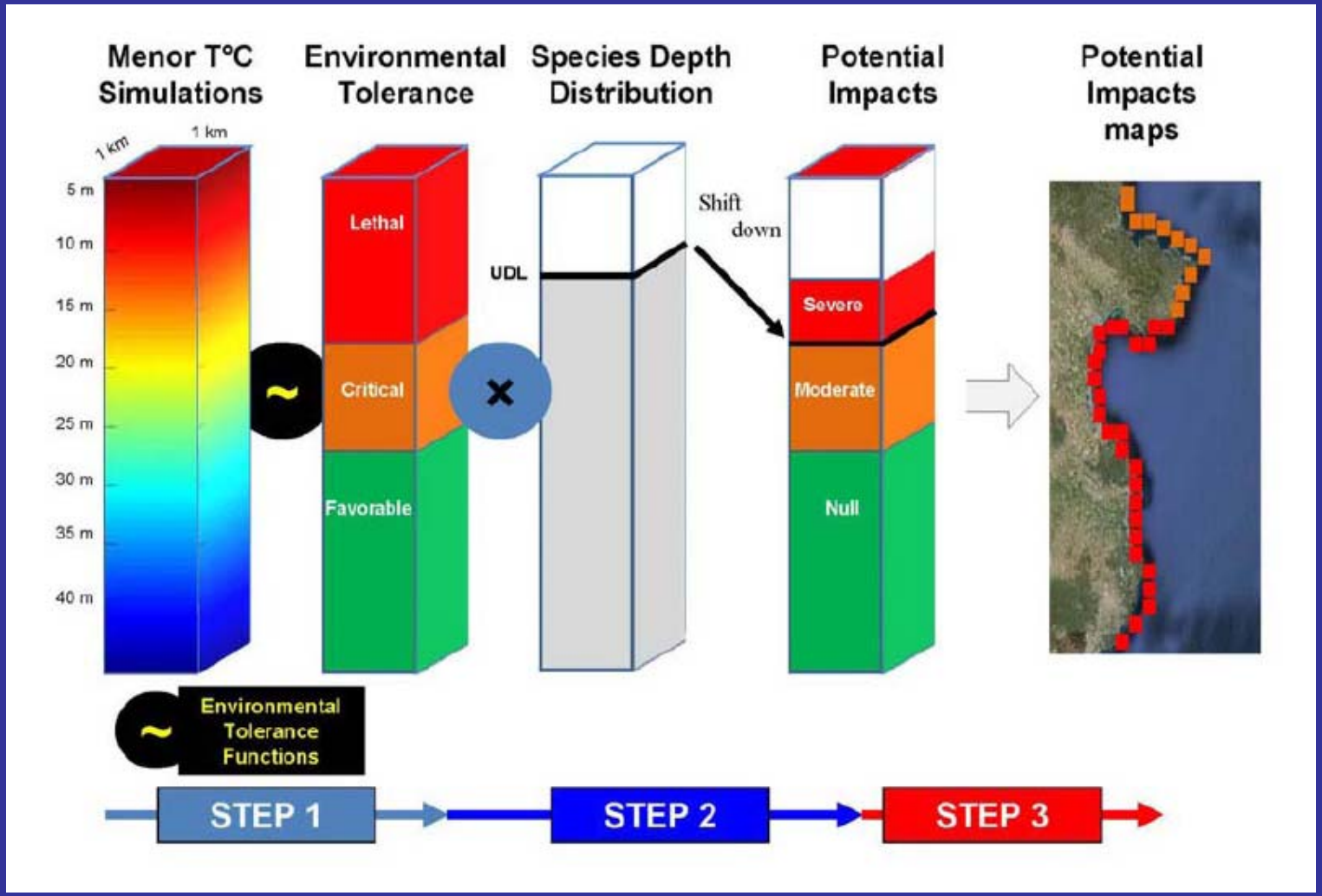


Number of days above 25 ºC at the end of the XXIst century

⇨ Prediction of sensitive areas to be monitored

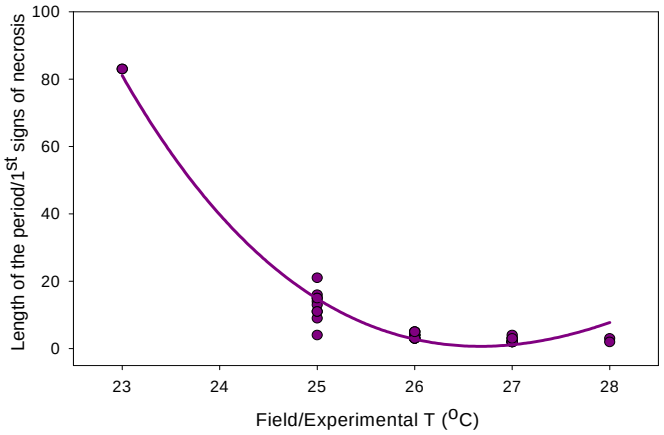
CONCLUSION


Menor T°C Simulations
Environmental Tolerance
Species Depth Distribution
Potential Impacts
Potential Impacts maps
1 km
1 km
5 m
10 m
15 m
20 m
25 m
30 m
35 m
40 m
Lethal
Critical
Favorable
UDL
Shift down
Severe
Moderate
Null
Environmental Tolerance Functions
STEP 1
STEP 2
STEP 3

WHAT'S NEXT?

The focus was on the impacts on coralligenous communities.

BUT the same procedure can be applied to other species and/or biological processes



Some examples:
-Arrival of alien species
-Reproductive cycles
-Larval development
-Acidification

Towards a global view on the expected biological impacts of warming in the NW Mediterranean Sea