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Trends in the size of mesozooplankton during the last 25 years at A Coruña (N Spain)

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Introduction:

- size of plankton decreases with warming

- reduction in size of planktonic prey will induce changes in food web structure and dynamics:
  small phyto -> small zoo -> small planktivores
  small plankton remains -> less sedimentation

- upwelling regions may display different trends because of reduced or no warming

Hypothesis:

- small zooplankton increase
- large zooplankton decrease
- warming and reduced upwelling favours small zooplankton

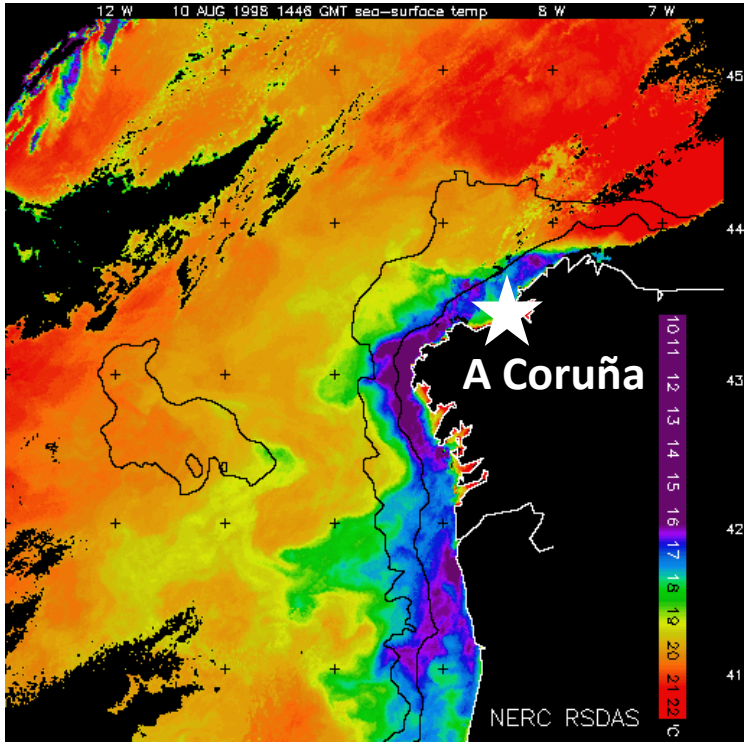
Objectives:

- to analyze changes in the mean size of mesozooplankton and variations in abundance of taxonomical groups of different size

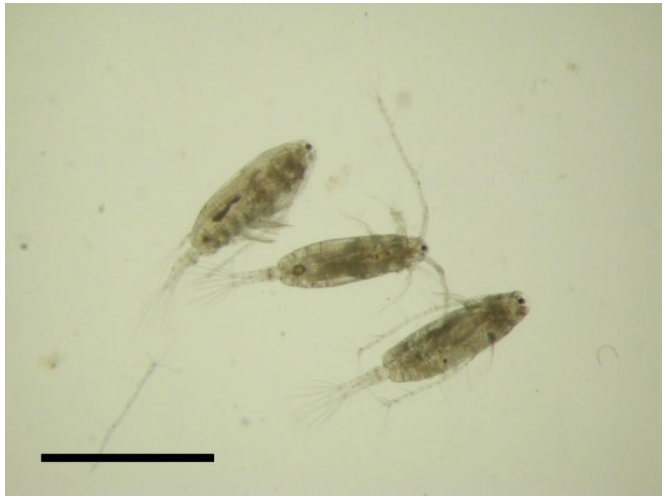
- to relate changes in size and abundance to changes in temperature and upwelling intensity

Methods:

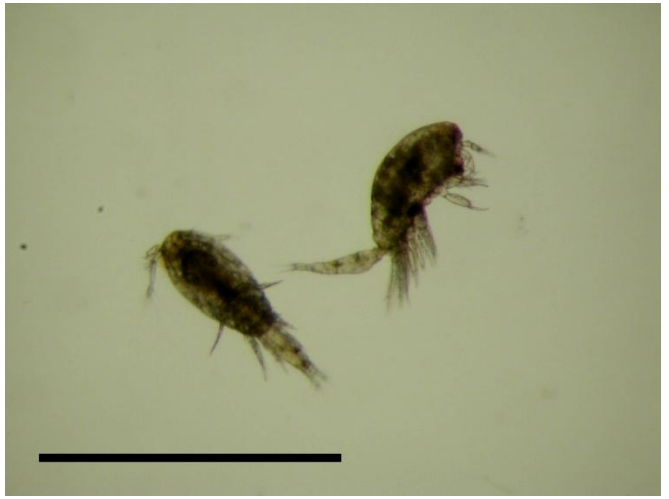
Mesozooplankton time-series from A Coruña (St. 2, RADIALES) 1988-2013
(detailed species identification: 1994-2013)



http://www.seriestemporales-ieo.com/



Acartia clausi



Oncaea media

Paraeuchaeta hebes

Candacia armata

Bar length = 1 mm

Methods:

sampling

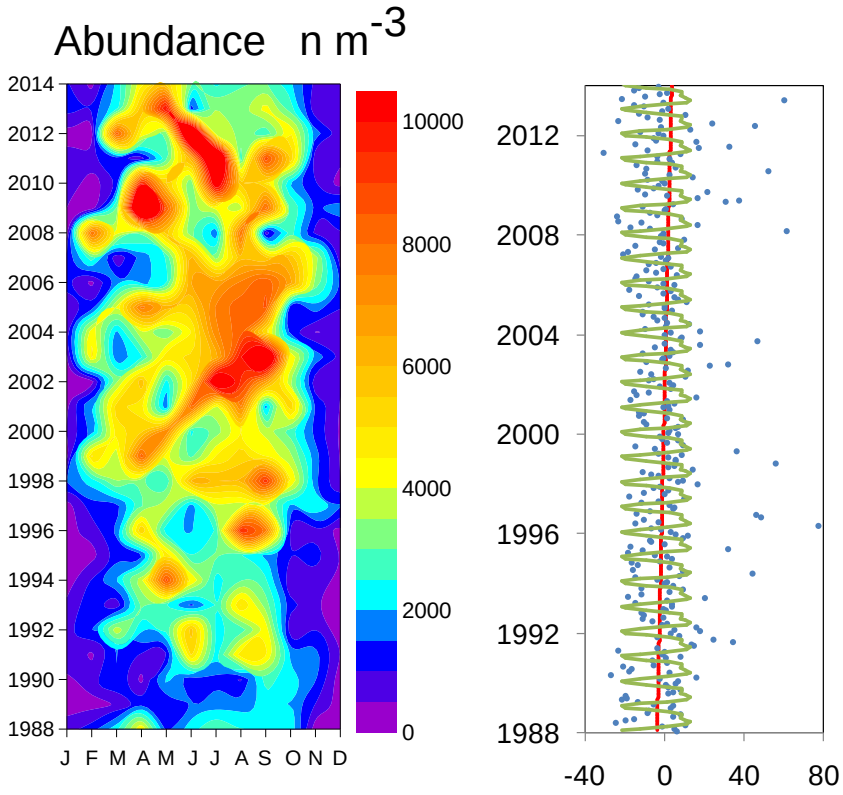
- Sampling: Bongo net, double-oblique tows, 200 µm mesh
- Total biomass: dry weight
- Abundance: steromicroscope counts, taxonomical groups (or species)
- SST: CTD casts
- Upwelling index: Ekman transport (http://www.indicedeafloramiento.ieo.es/)

statistics

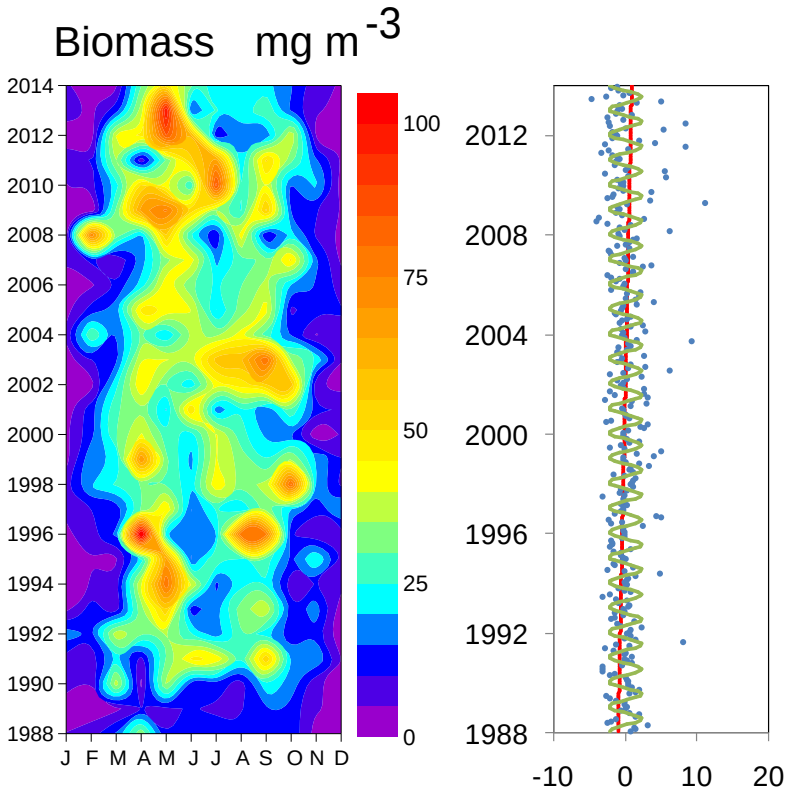
- Small: body length < 1 mm (Cladocera, Copepoda: *Acartia*, *Oithona*, *Oncaea*)
- Large: body length > 1 mm (Appendicularia, Euphausiacea, Copepoda: Calanoida, *Temora longicornis, Candacia armata*, *Paraeuchaeta*, *Centropages*)
- Ratios:
  - Copepoda small:total
  - mean body weight = biomass:abundance
- series analysis:

$$Y_t = \bar{y} + LT[y_t] + SC[y_t] + R[y_t] + \varepsilon_t$$

Total abundance and biomass

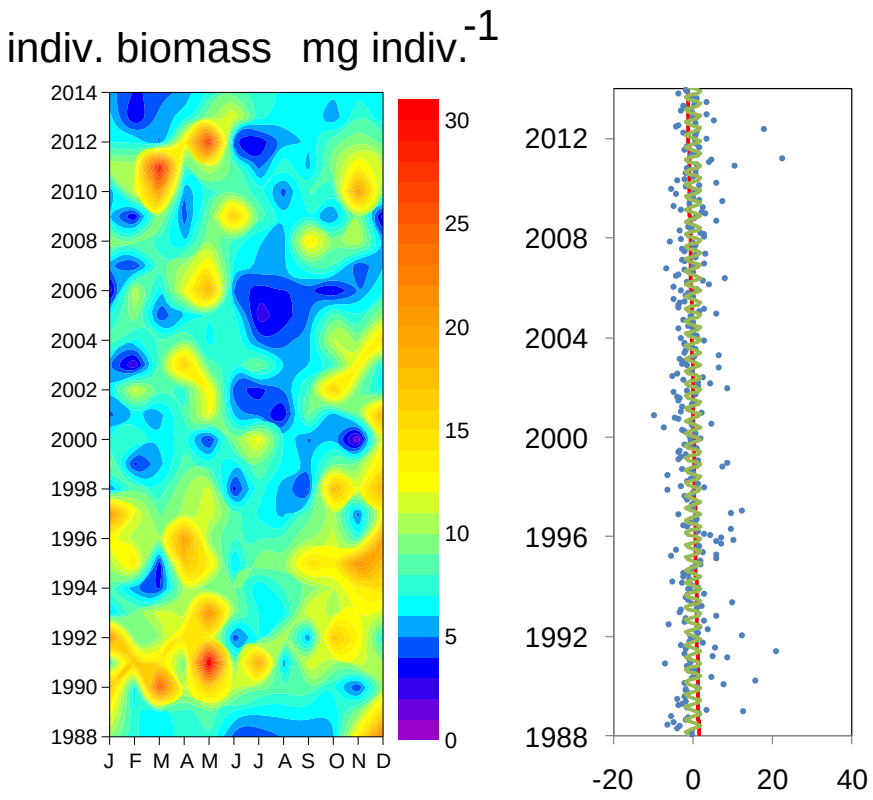


+ trend



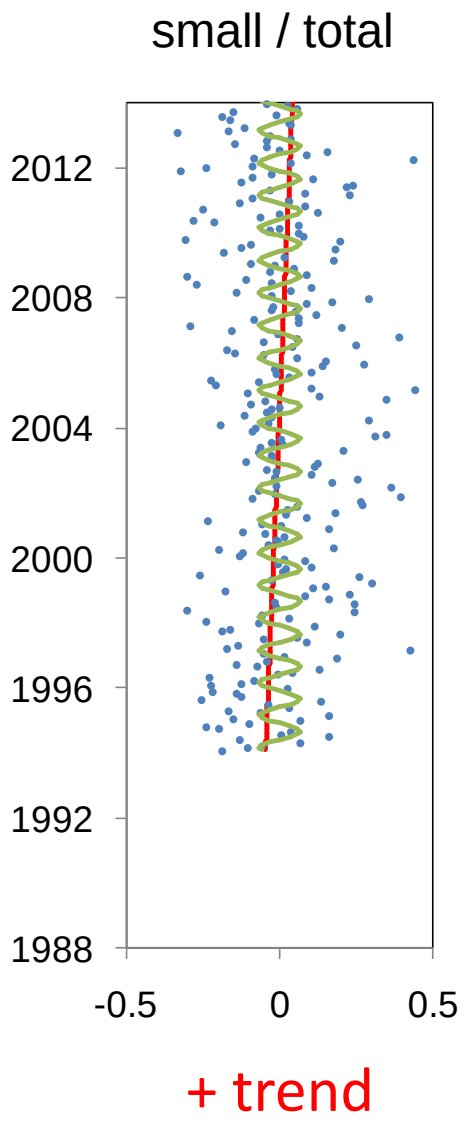
+ trend

Mean individual biomass

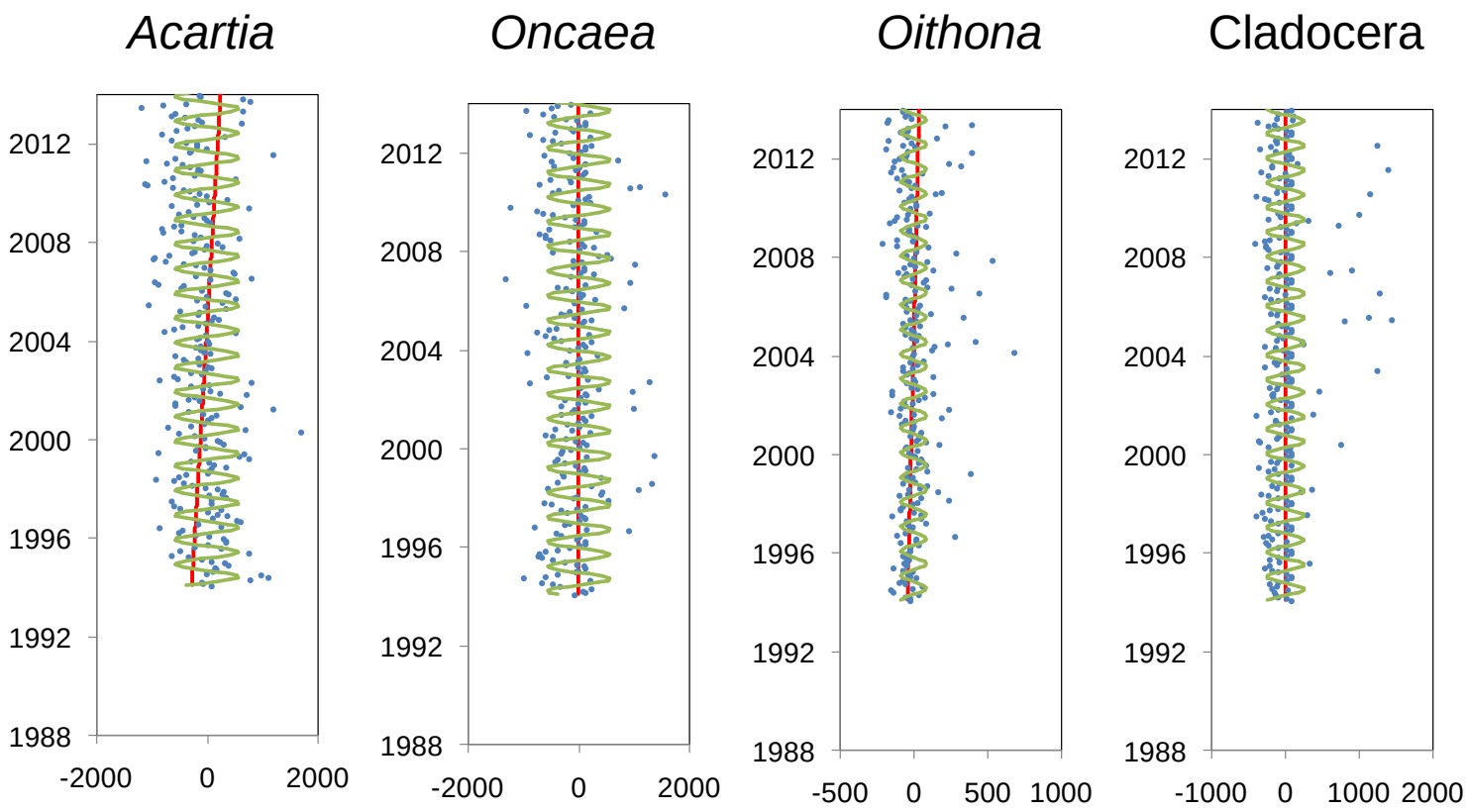


- trend

Copepoda

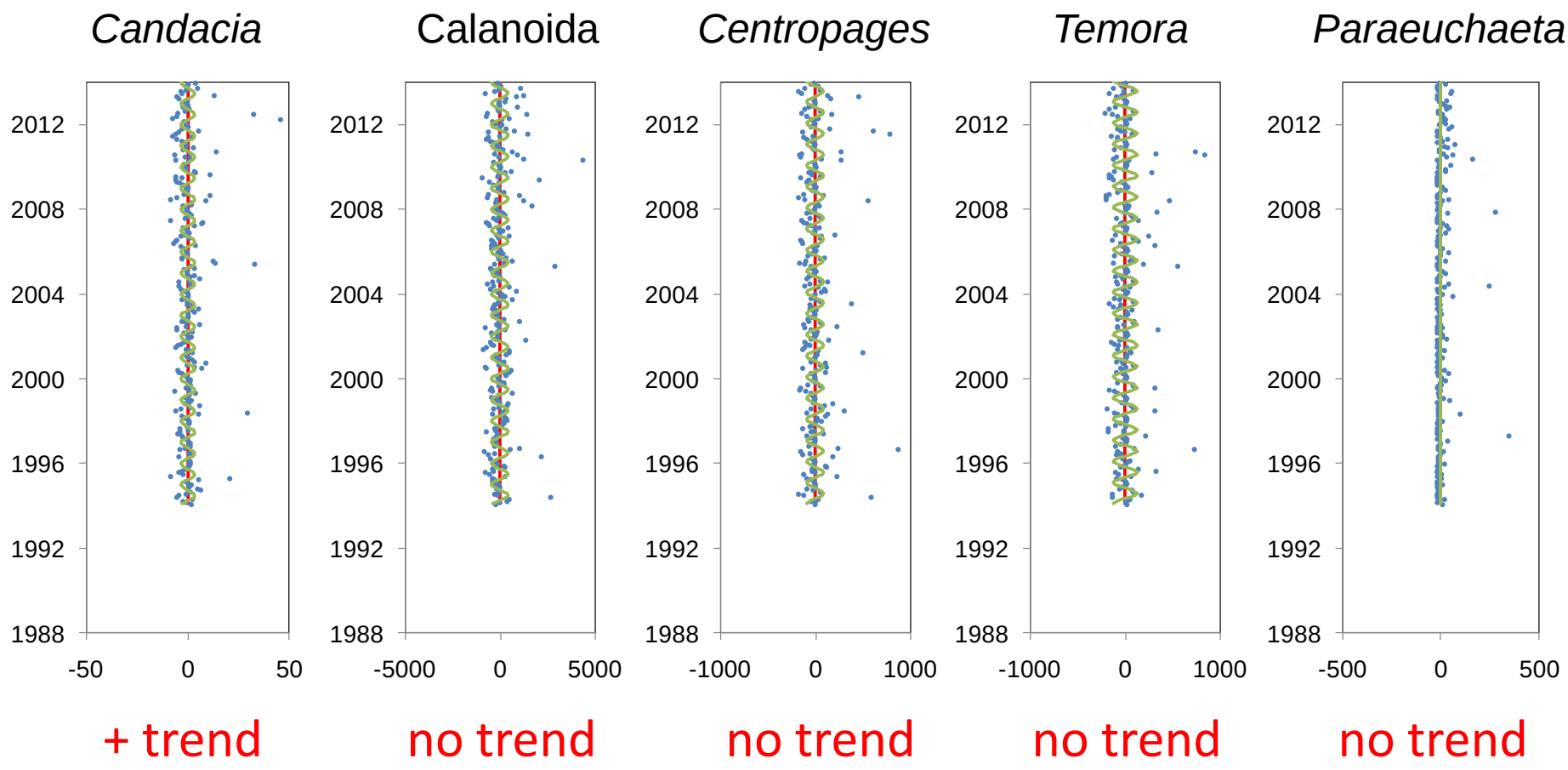


Small (< 1 mm)

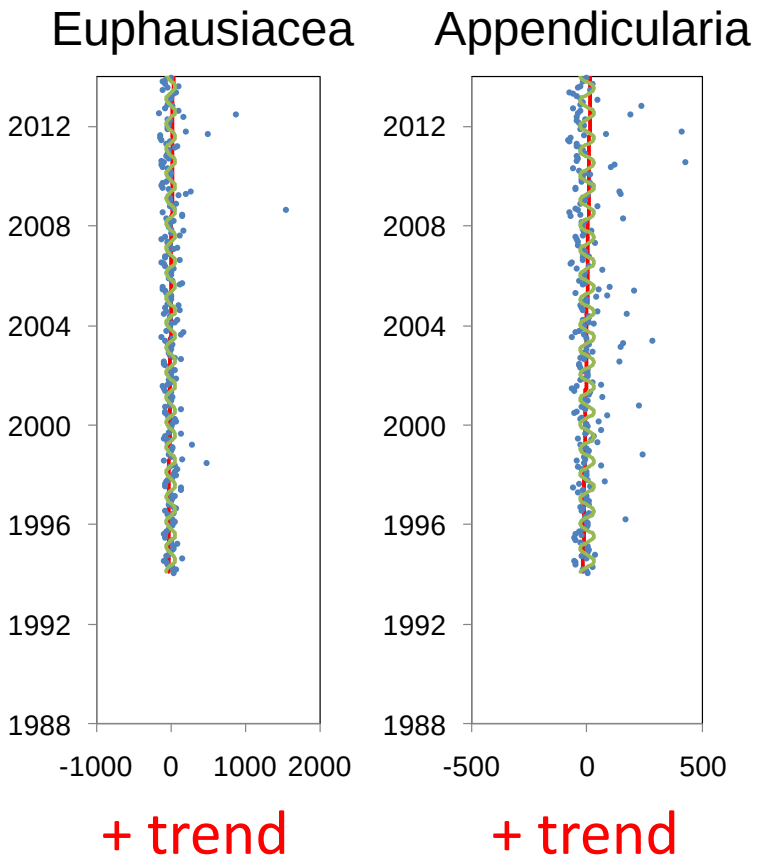


+ trend | no trend | + trend | no trend

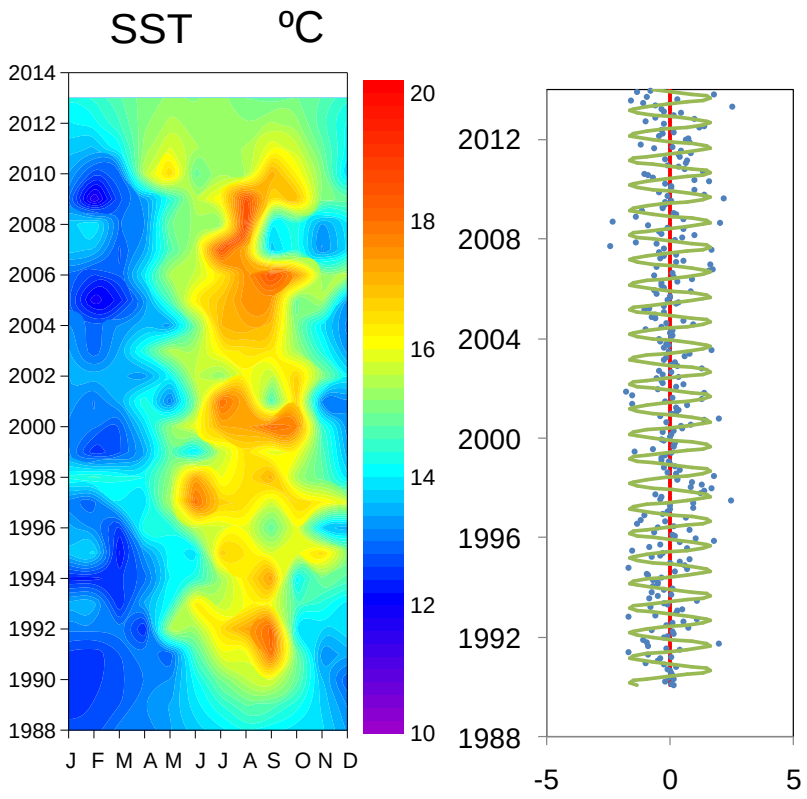
Large copepods (> 1 mm)

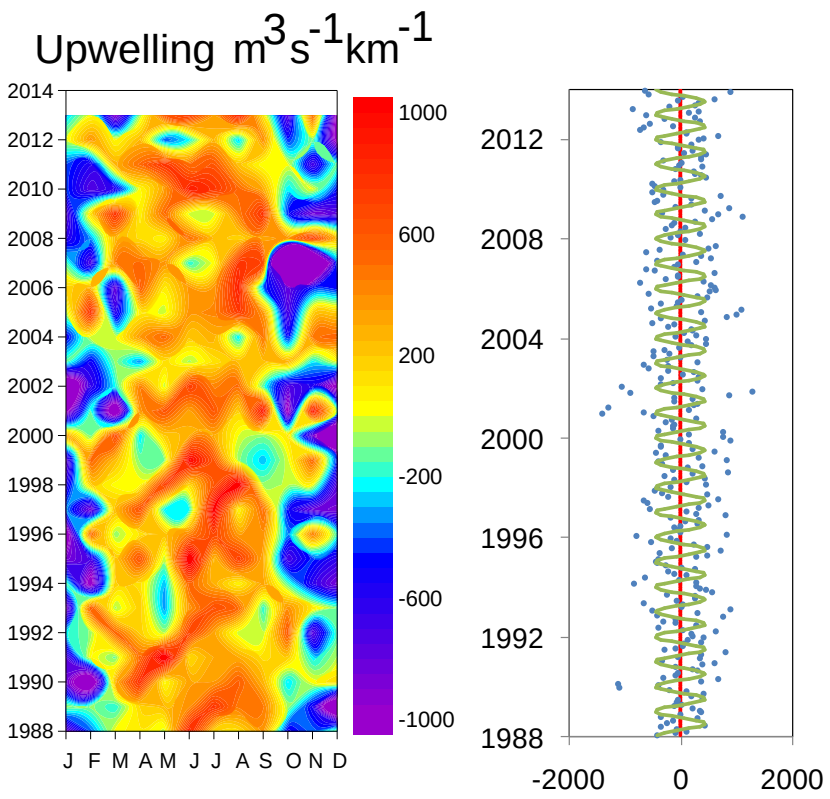


Other large species (> 1 mm)



SST and upwelling





no trend

no trend

+0.01ºC yr^{-1}

-2.23 m^3 s^{-1} km^{-1} yr^{-1}

Significant trends

Trend	variable	Ho (small increases)	Ho (large decreases)	Ho (SST increases)
Decreasing	biomass/indiv.	decrease		
Increasing	Total abundance	increase		
	Total biomass	increase		
	Acartia (small)	increase		
	Oithona (small)	increase		
	Appendicularia (large)		increase	
	Candacia (large)		increase	
	Euphausiacea (large)		increase	
	index small Cop / total	increase		
No trend	Cladocera (small)	NO		
	Oncaea (small)	NO		
	Calanoida (large)		NO	
	Paraeuchaeta (large)		NO	
	Temora (large)		NO	
	Centropages (large)		NO	
	UI			NO
	SST			NO

Crosscorrelations with upwelling and SST

		UI r	UI lag	SST r	SST lag
	SST	-0.242	0		
	Abundance	-0.127	6		
	Biomass	0.113	2	-0.163	1
	Biomass	0.108	6		
	Biom/indiv			-0.126	4
small	*Acartia*	0.147	5	-0.189	5
small	*Acartia*			-0.231	7
small	Oithona			-0.160	5
large	Appendicularia			n.s	
large	*Candacia*			n.s	
large	Euphausiacea			0.161	0
	Small/Total	0.141	3	-0.228	0

effect UI

effect warming

unexplained

lag in months

Conclusions

Support of Ho = decrease in body size:

- overall decreasing trend in the average individual biomass
- increase in the ratio small : total copepods
- increase in the dominance of some small copepods (*Acartia*, *Oithona*)
- increase in total biomass and abundance

but

- no trend in other small species (Cladocera, *Oncaea*)
- increase in the dominance of some large species (Appendicularia, Euphausiacea, *Candacia*)

Effects of warming and upwelling:

- no trend in SST or upwelling
- dominant effect of upwelling over warming on mesozooplankton changes delayed between 2 and 6 months