



# Comparative time series analyses in the English Channel

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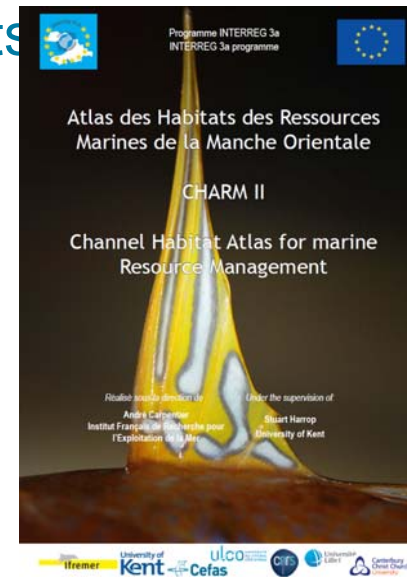
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# CHARM 3

- ⚡ Funded by EU Interreg programme
- ⚡ Channel integrated Approach to marine Resource Management
- ⚡ phases 1 & 2: multidisciplinary approach to marine living resource management
- ⚡ assessment of key marine species and their habitats in the *eastern* Channel
- ⚡ develop management tools to predict human impacts
- ⚡ Product: Channel Habitat Atlas (2009)
- ⚡ Phase 3: western Channel & **plankton** added

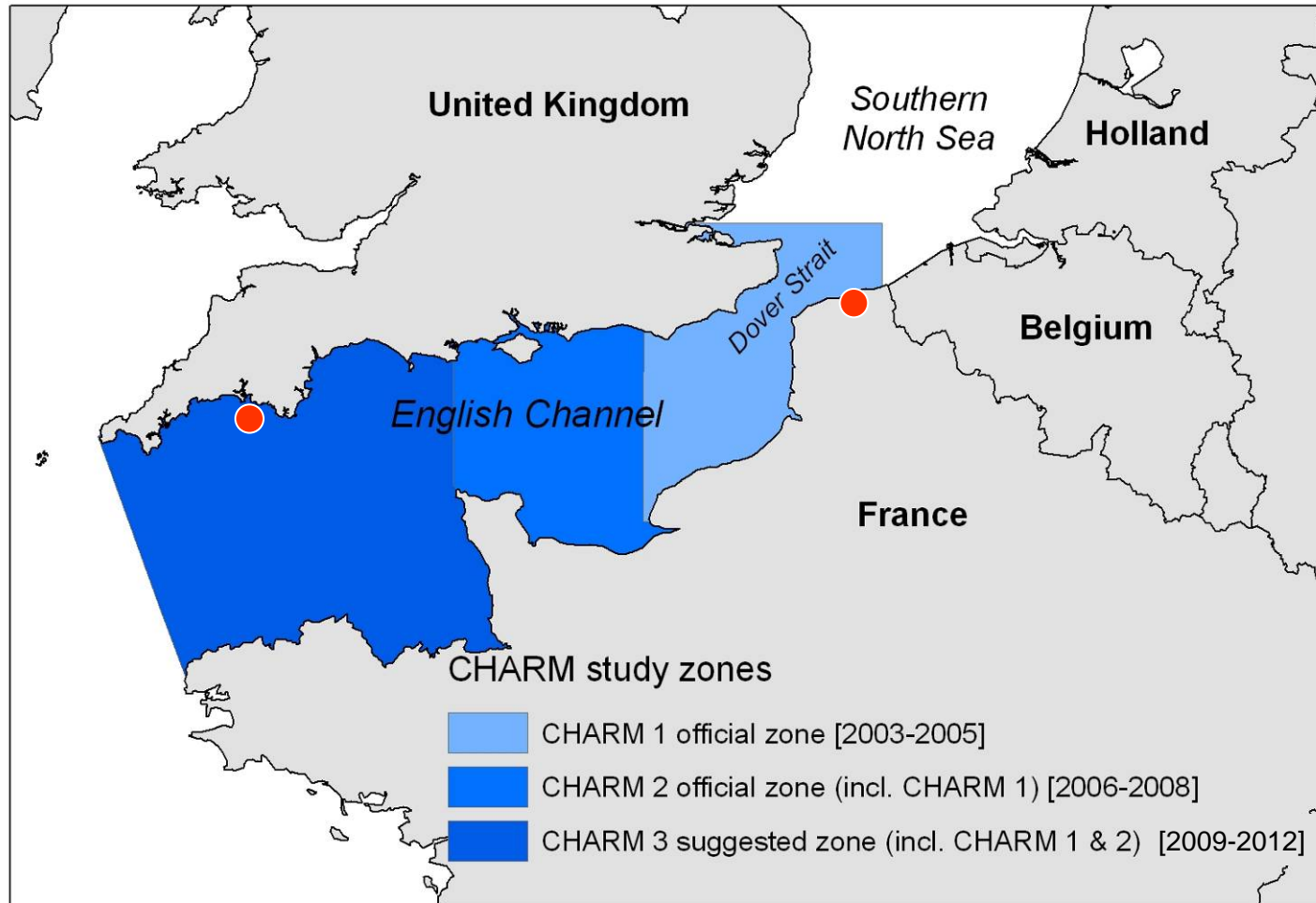


# Action 2.1: multimetric food web index

- ❧ inventory of planktonic taxa, based on historical data sets
  - *IFREMER coastal network surveys/sea campaigns, Gravelines time series, PML time series, CPR data (SAHFOS)*
- ❧ phyto- and zooplankton phenologies
- ❧ timing of life cycles along longitudinal gradient(s)
- ❧ defining dominant, common and accessory phyto- and microzooplankton species
- ❧ Trophic relationships & food web index
- ❧ mapping functional groups of zooplankton



# The CHARM area



# Two long-term sampling stations

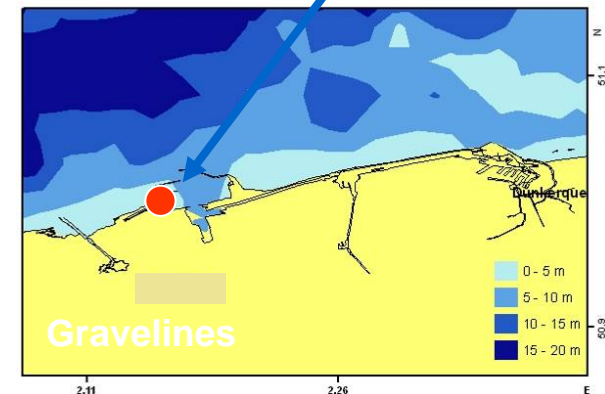
## 🌊 Plymouth: L4

- Western Channel
- 50 m depth
- Estuary influence (rivers Tamar & Plym)
- Gateway to the Celtic Sea and North Atlantic



## 🌊 Gravelines

- Eastern Channel
- 7 m depth
- Harbour influence
- Gateway to the North Sea
- Entrance of a nuclear power plant (non-impact site)



# What's available?

## L4

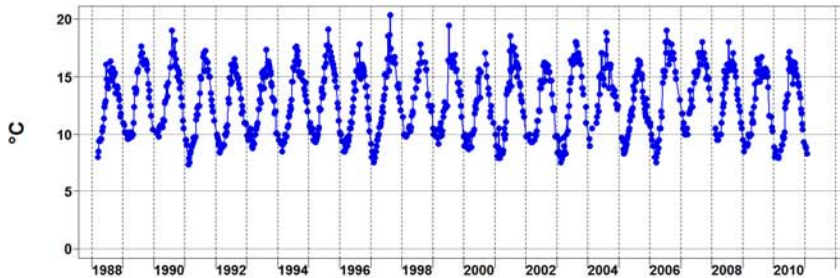
- 🌊 Weather
- 🌊 SST
- 🌊 Nutrients since 2000
- 🌊 Chlorophyll
- 🌊 Phytoplankton composition
- 🌊 Zooplankton species

## Gravelines

- 🌊 Weather
- 🌊 SST
- 🌊 Nutrients (some years)
- 🌊 Chlorophyll
- 🌊 Phytoplankton composition
- 🌊 Zooplankton species

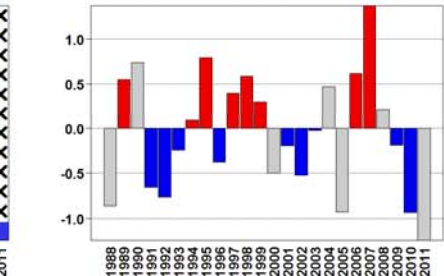
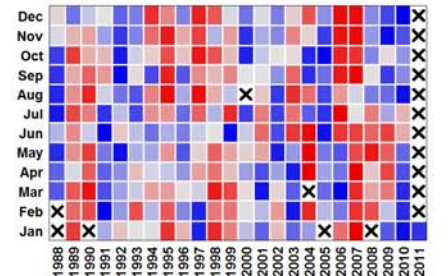
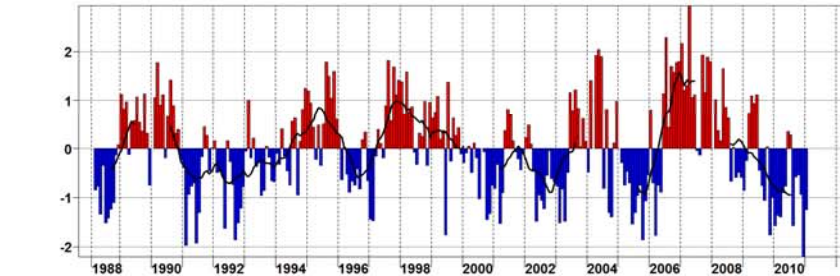
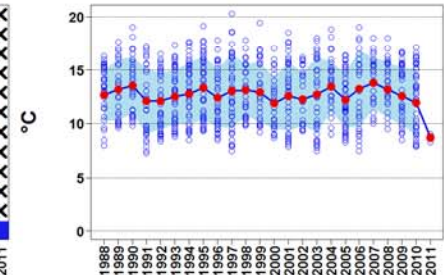
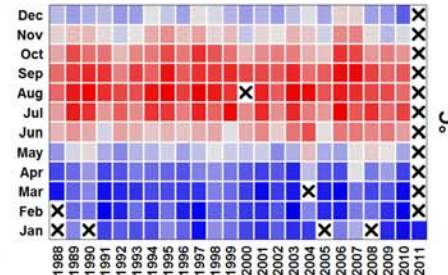
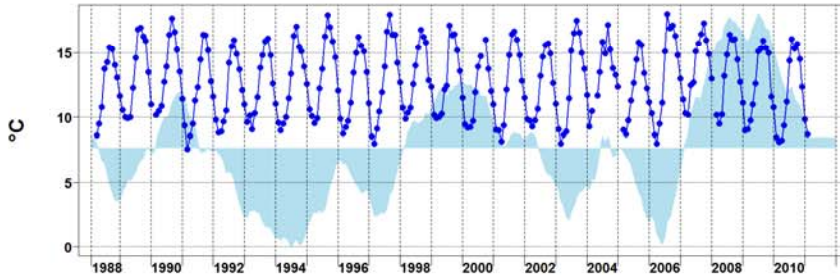
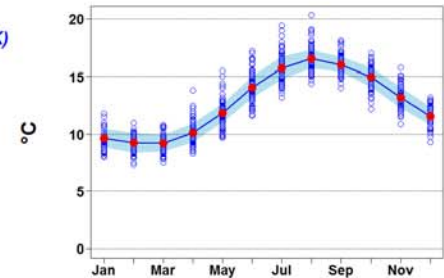


# The data sets



Variable: **Sea Surface Temperature**  
 Location: **L4 station (Western Channel - UK)**  
 Period: **1988-2011**  
 Number of samples: **1006**

Min: **7.3**  
 Max: **20.3**  
 Average: **12.85**  
 SD: **2.83**  
 Median: **12.9**  
 Unit: **°C**



- ⚡ R-package developed by Damien Eloire
- ⚡ Grey bars = years with missing data

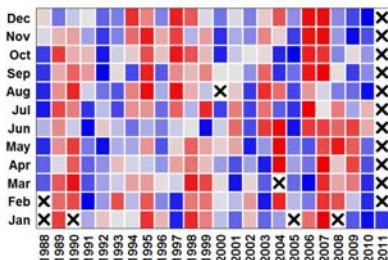
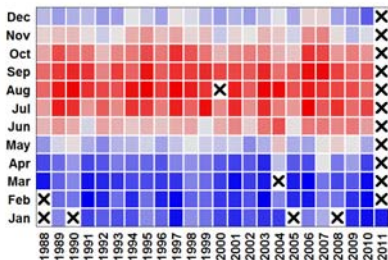
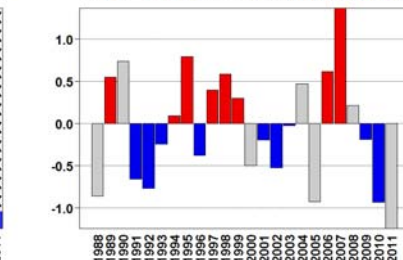
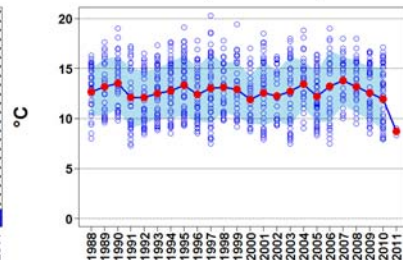
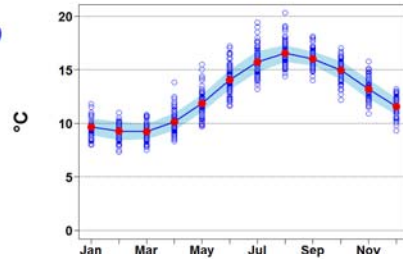


# SST

## L4

Variable: **Sea Surface Temperature**  
 Location: **L4 station (Western Channel - UK)**  
 Period: **1988-2011**  
 Number of samples: **1006**

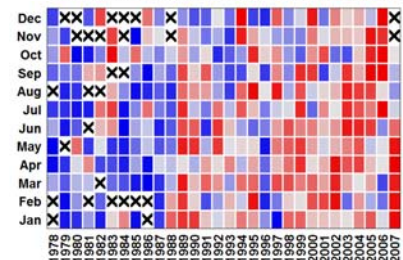
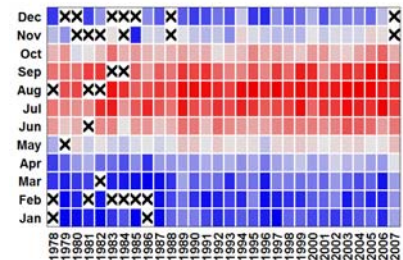
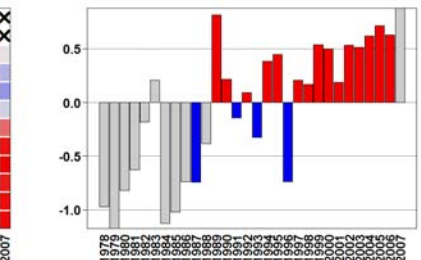
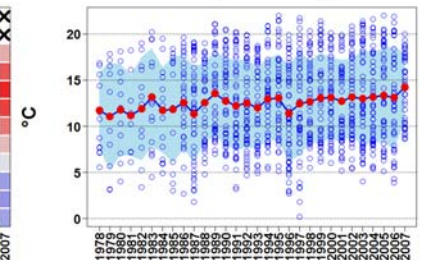
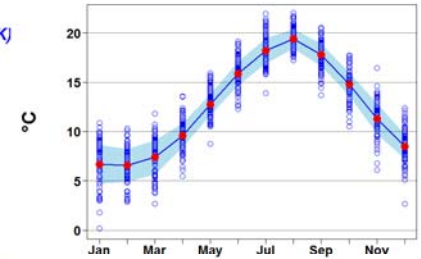
Min: **7.3**  
 Max: **20.3**  
 Average: **12.85**  
 SD: **2.83**  
 Median: **12.9**  
 Unit: **°C**



## Gravelines

Variable: **Sea surface temperature**  
 Location: **Gravelines (Eastern Channel - UK)**  
 Period: **1978-2007**  
 Number of samples: **1308**

Min: **0.2**  
 Max: **22**  
 Average: **12.77**  
 SD: **4.74**  
 Median: **12.6**  
 Unit: **°C**



- Temperature oscillations Grav > L4
- Strong warming (Grav) since 1970's (shift in anomalies in 1988)



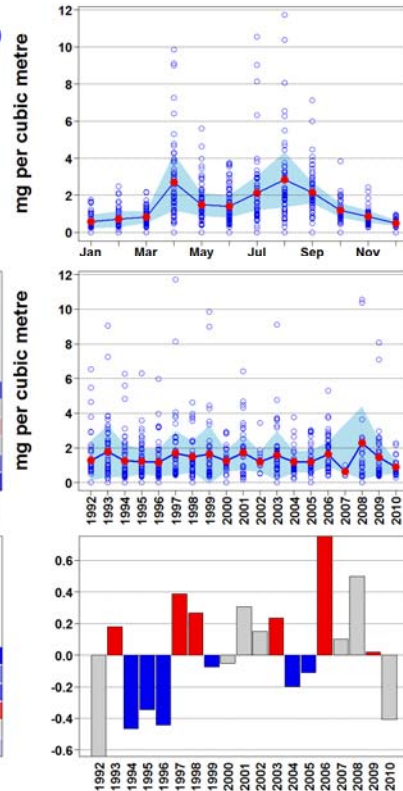
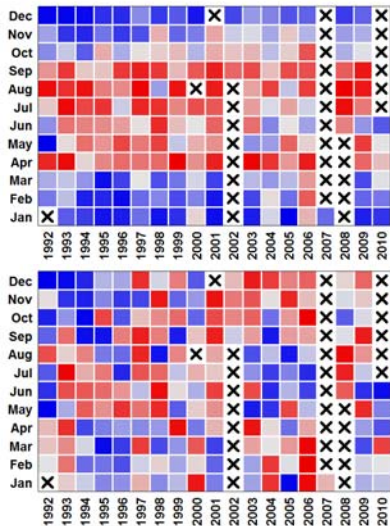


# Chlorophyll

## L4

Variable: **Chlorophyll**  
 Location: **L4 station (Western Channel - UK)**  
 Period: **1992-2010**  
 Number of samples: **709**

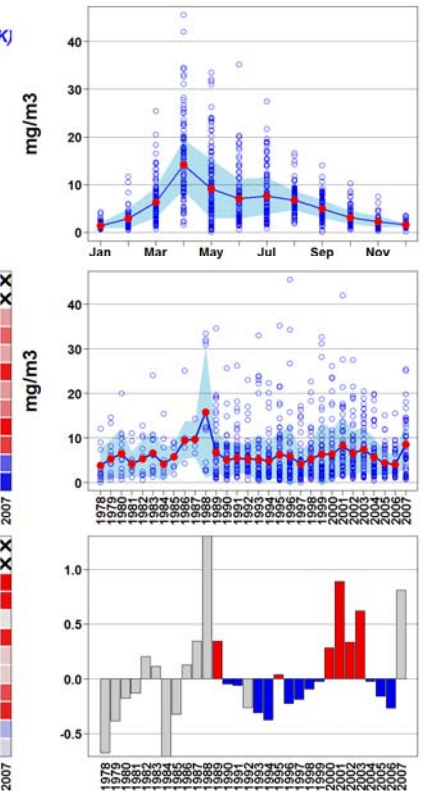
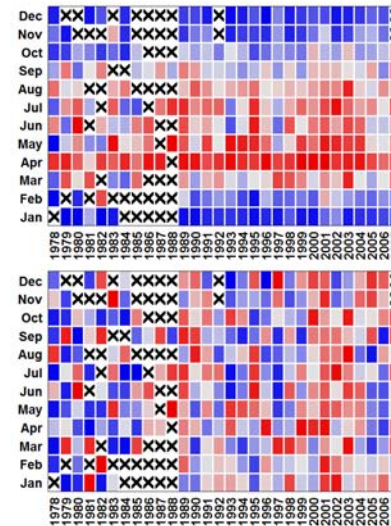
Min: **0**  
 Max: **11.72**  
 Average: **1.47**  
 SD: **1.46**  
 Median: **1.02**  
 Unit: **mg per cubic metre**



## Gravelines

Variable: **Chlorophyll**  
 Location: **Gravelines (Eastern Channel - UK)**  
 Period: **1978-2007**  
 Number of samples: **1080**

Min: **0.05**  
 Max: **45.57**  
 Average: **6.2**  
 SD: **6.05**  
 Median: **4.3**  
 Unit: **mg/m3**



🌊 L4 = 2 peaks vs. Grav = 1 peak

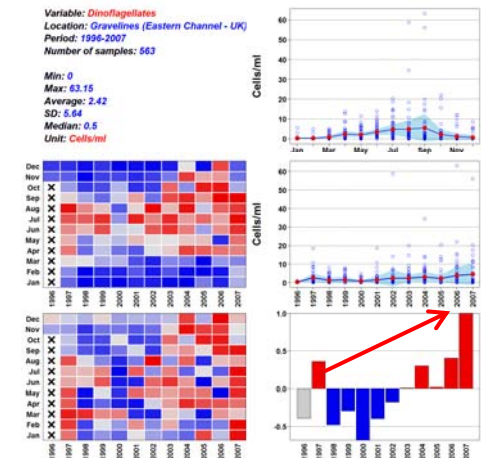
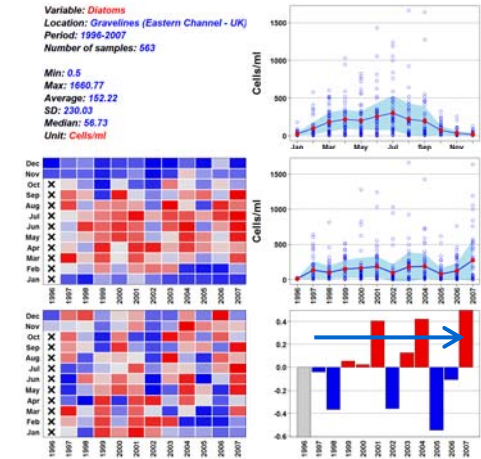
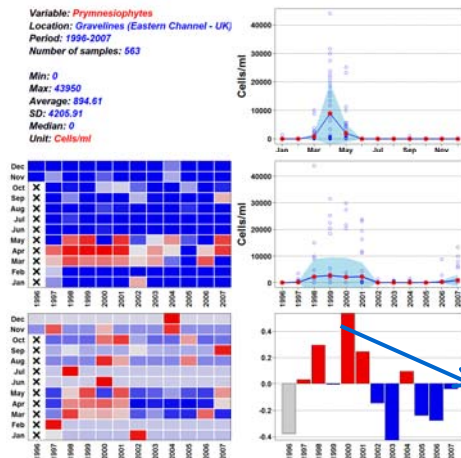
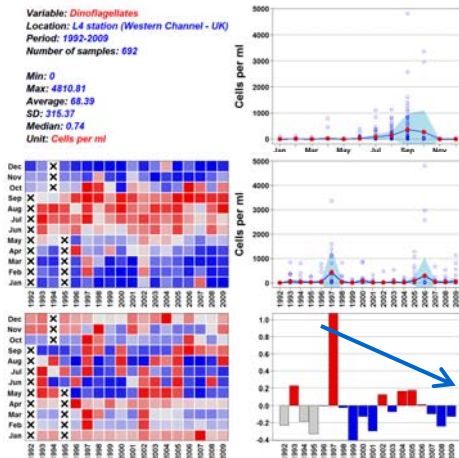
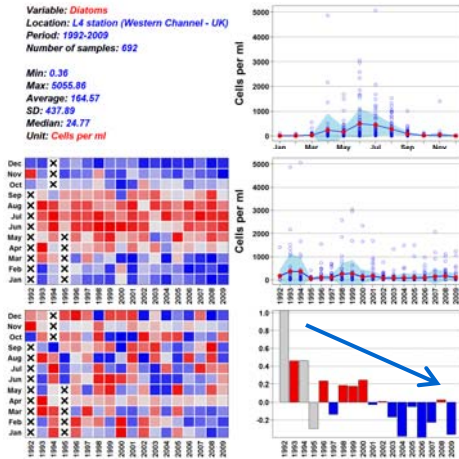


# Phytoplankton

## L4

## Gravelines

- ⊘ Diatoms: season Grav > L4
- ⊘ Dinos: L4 >> GRAV
- ⊘ *Phaeocystis* blooms: negative trend in Grav, irregular at L4 since 2005

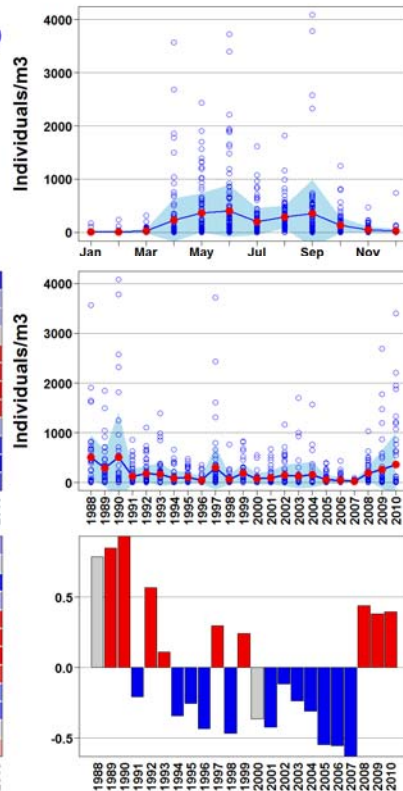


# Acartia clausi

## L4

Variable: **Acartia clausi**  
 Location: **L4 station (Western Channel - UK)**  
 Period: **1988-2010**  
 Number of samples: **1001**

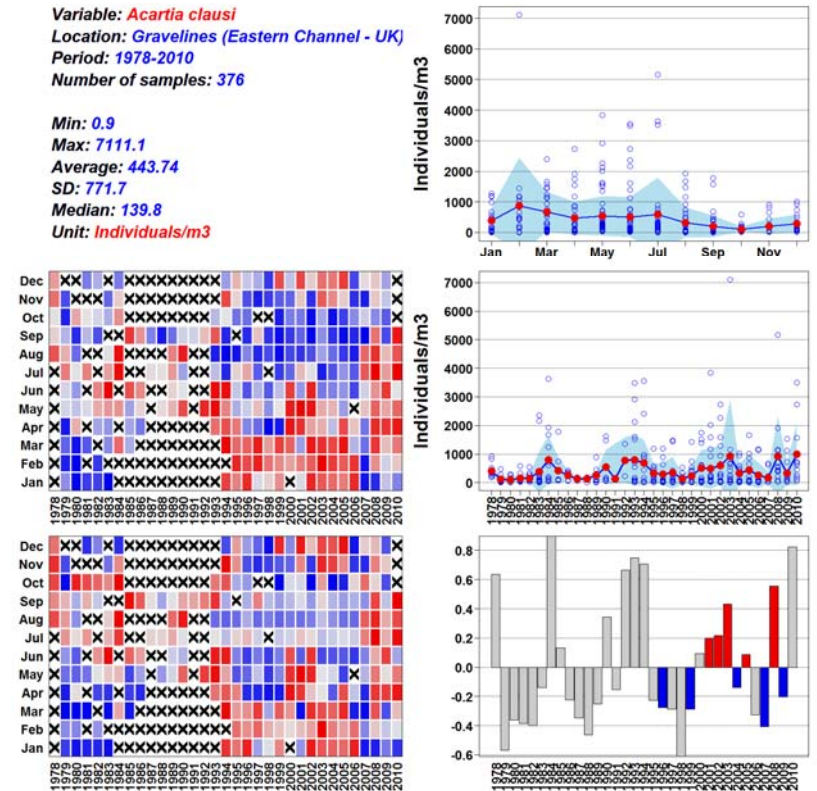
Min: **0**  
 Max: **4083.5**  
 Average: **189.49**  
 SD: **415.52**  
 Median: **42.1**  
 Unit: **Individuals/m3**



## Gravelines

Variable: **Acartia clausi**  
 Location: **Gravelines (Eastern Channel - UK)**  
 Period: **1978-2010**  
 Number of samples: **376**

Min: **0.9**  
 Max: **7111.1**  
 Average: **443.74**  
 SD: **771.7**  
 Median: **139.8**  
 Unit: **Individuals/m3**



- ⚡ Grav peaks earlier than L4
- ⚡ More abundant in cool years at L4



# Temora longicornis

L4

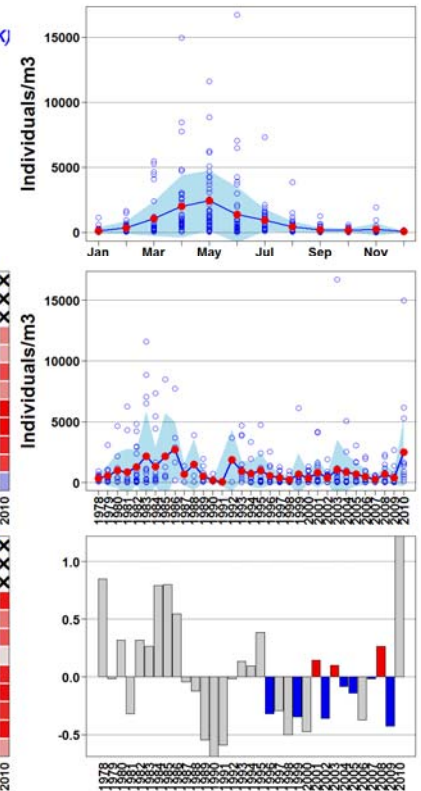
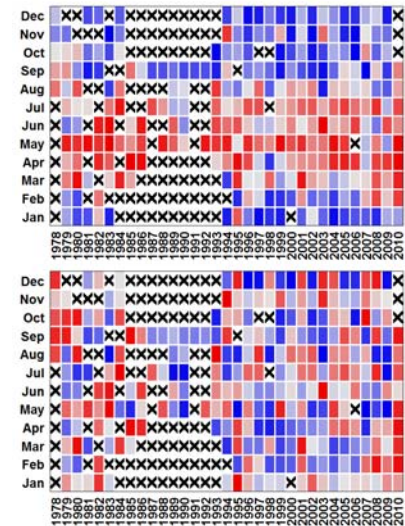
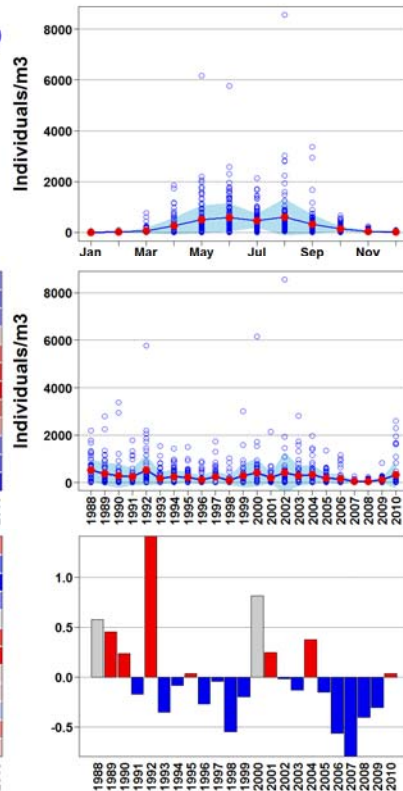
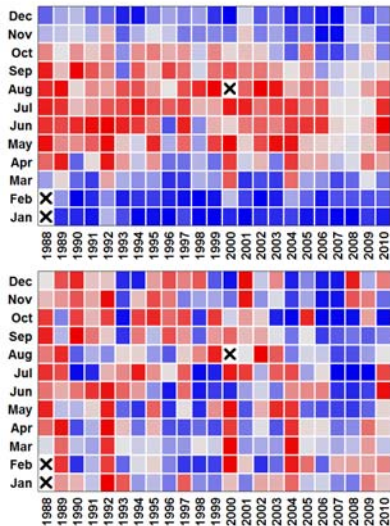
Gravelines

Variable: **Temora longicornis**  
 Location: **L4 station (Western Channel - UK)**  
 Period: **1988-2010**  
 Number of samples: **1001**

Min: **0**  
 Max: **8562.14**  
 Average: **273.95**  
 SD: **567.85**  
 Median: **67.4**  
 Unit: **Individuals/m3**

Variable: **Temora longicornis**  
 Location: **Gravelines (Eastern Channel - UK)**  
 Period: **1978-2010**  
 Number of samples: **376**

Min: **1.9**  
 Max: **16711.1**  
 Average: **947.47**  
 SD: **1889.72**  
 Median: **269.6**  
 Unit: **Individuals/m3**



- Spring peak in Grav vs bimodal seasonal cycle at L4
- Negative anomalies 2005-10 at L4 during warmest years, but not in Grav

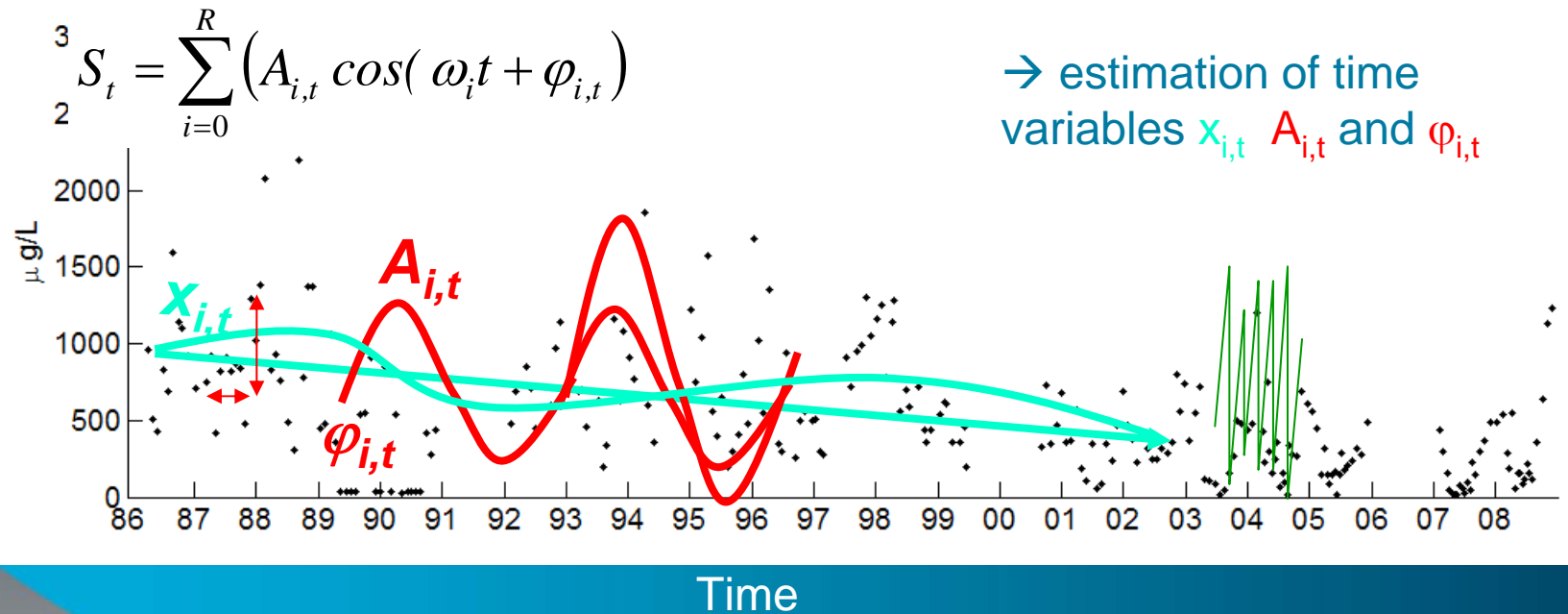


# DHR: dynamic harmonic regression



$$y_t = T_t + S_t + e_t$$

data = Trend + Seasonality + error



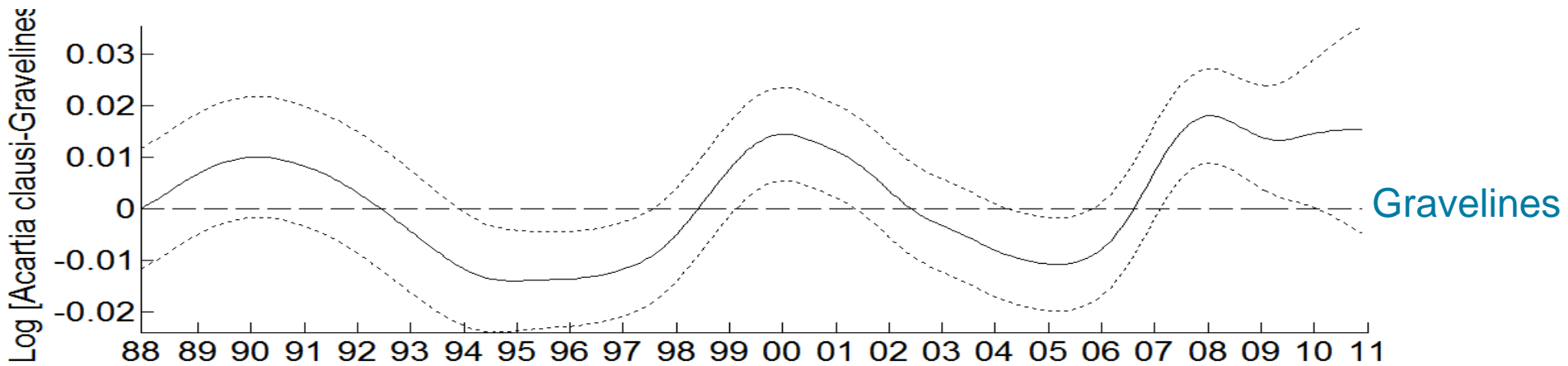
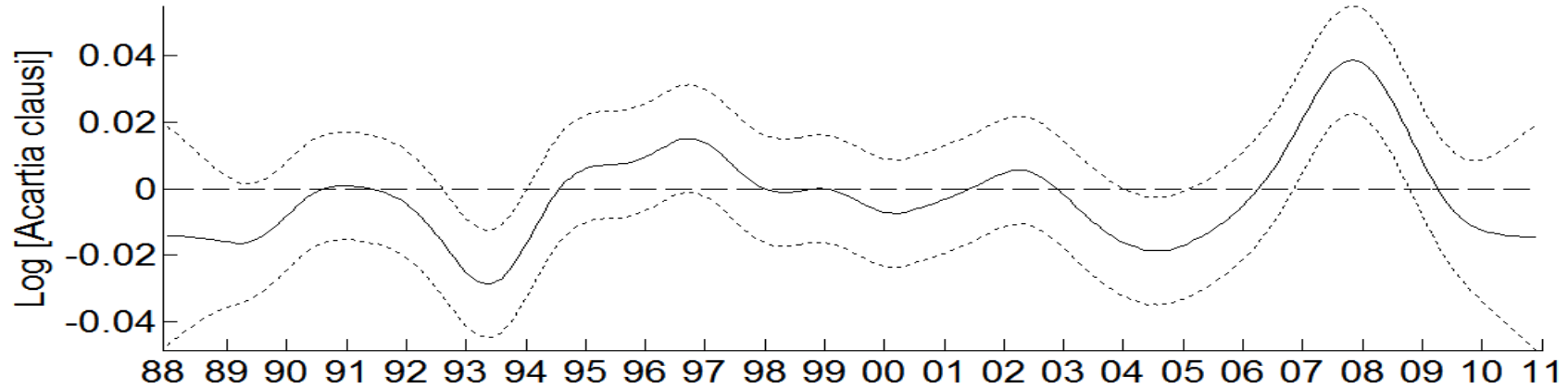
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Today 14:30, S5-7198

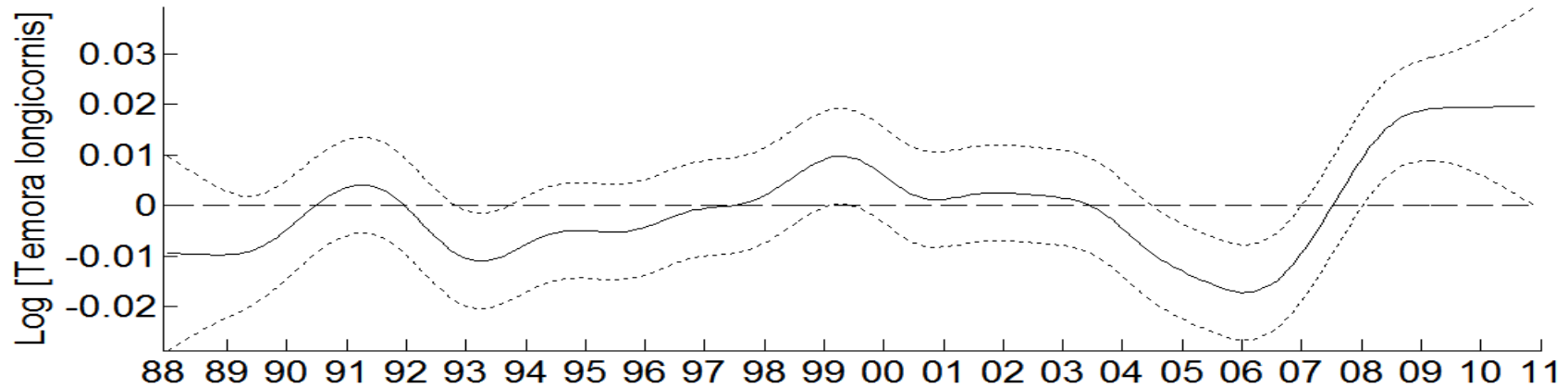
“Long-term and interannual variability  
of zooplankton at a coastal station in  
the Western English Channel”



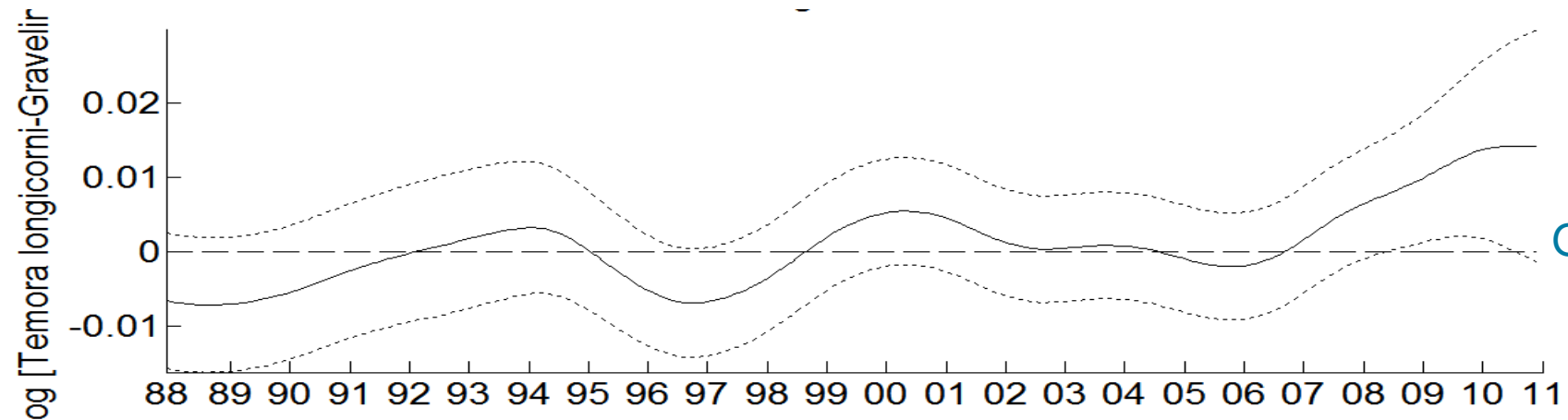
# DHR: *Acartia clausi*



# DHR: *Temora longicornis*



L4



Gravelines





# Conclusions:

- Stronger temperature oscillations at Gravelines
- Strong warming trend since 1970's
- 2 phyto blooms (L4) vs 1 (Grav)
- Very different abundances of dinoflagellates (L4 >> Grav) - why?
- Strong *Phaeocystis* blooms (both) with a negative trend in recent years (absent at L4 in some years)
- Acartia* peaks earlier in Grav (winter/spring) than at L4
- Temora* peaks earlier in Grav and has a bimodal seasonal distribution at L4



# Outlook:

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- ⚡ Analyse nutrient data and correlations with phytoplankton
- ⚡ Add *Pseudocalanus* data
- ⚡ Apply time series model to determine similarities in trend slopes
- ⚡ Run statistics on model outputs to detect significant correlations
- ⚡ Combine eastern and western data sets with CPR data across the Channel



# Acknowledgements

