50th International Liege Colloquium on Ocean Dynamics

Long-term studies in oceanography, 28th May to 1st June 2018

Interaction between climate forcing and plankton communities in a pristine NW Mediterranean site, the Bay of Calvi (Corsica) : a long term study

Anne GOFFART[1]*, Jean-Henri HECQ[1], Yoann BALDI[2], Amandine COLLIGNON[1], Sylvain COUDRAY[2], Françoise MARCO-MIRALLÈS[2], Pierre LEJEUNE[3]

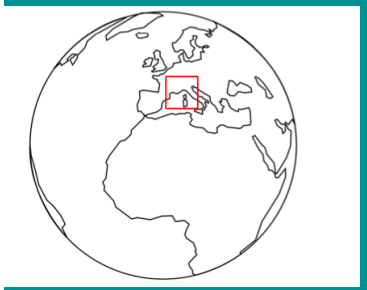
*[1] University of Liège, Belgium, [2] IFREMER, [3] STARESO, * A.Goffart@uliege.be*

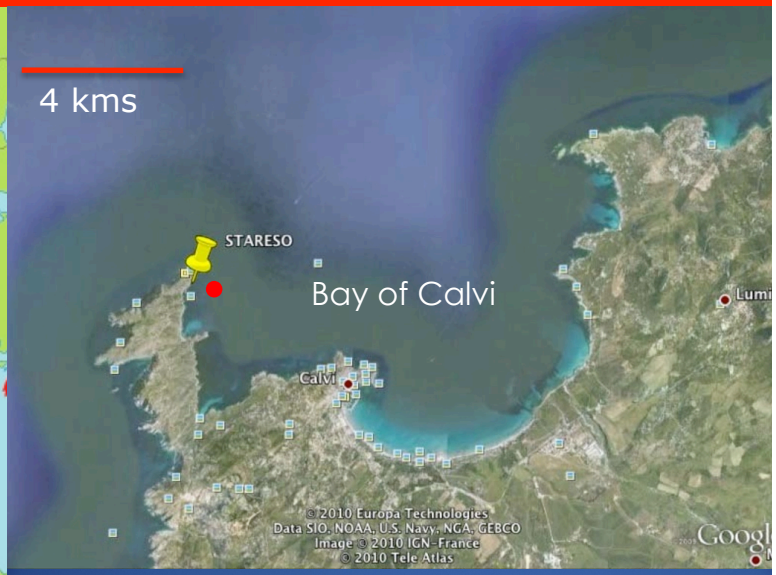
31 05 18

Objectives

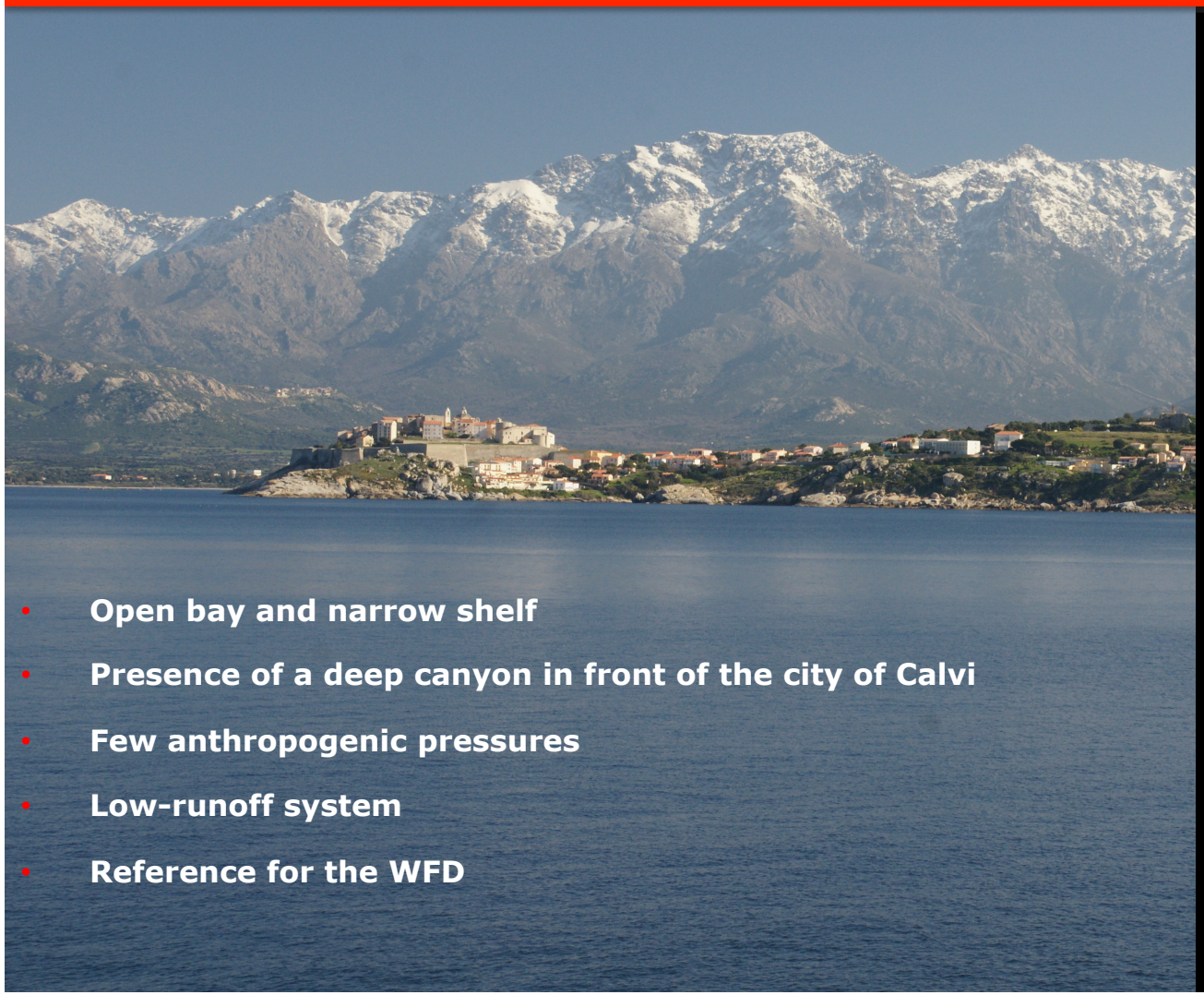
- **To synthesize a long-term high-resolution study of environmental variables and surface plankton dynamics performed over the last four decades in a pristine NW Mediterranean coastal zone;**
- **To understand mechanisms controlling the interannual variability of phytoplankton bloom in a context of climate change;**
- **To detect trends, if any.**

The studied area : the Bay of Calvi, Corsica, Western Mediterranean

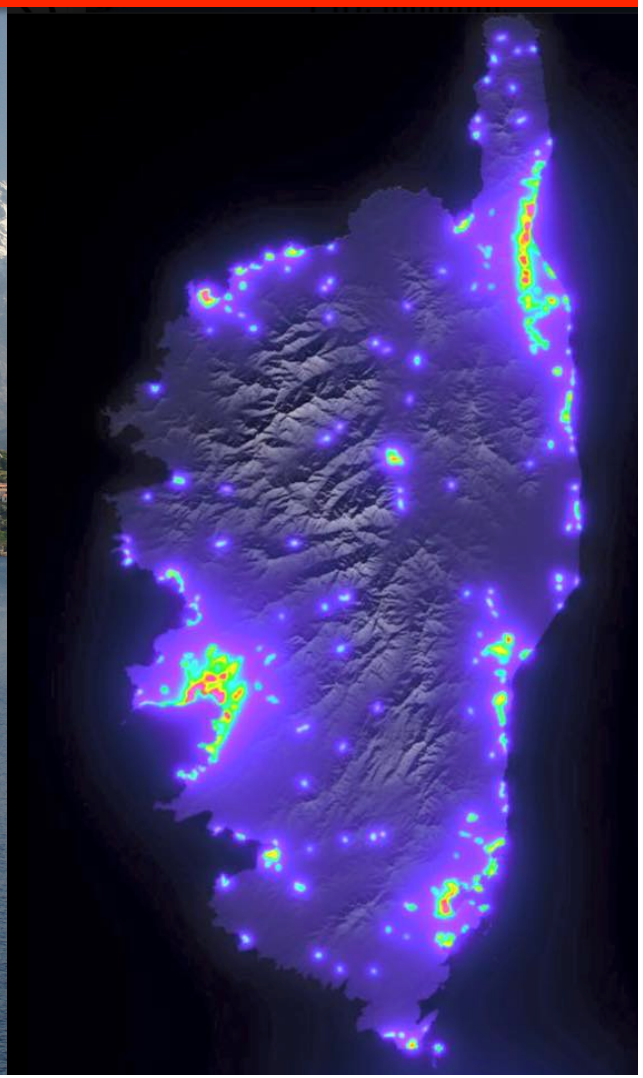




The studied area : the Bay of Calvi, Corsica, Western Mediterranean



- **Open bay and narrow shelf**
- **Presence of a deep canyon in front of the city of Calvi**
- **Few anthropogenic pressures**
- **Low-runoff system**
- **Reference for the WFD**



Long-term time series (surface data, 1979-)

Water temperature and wind

- Continuous from 1979

Total chlorophyll *a*

- From 1979, with interruptions until 2005, continuous from 2006

Nutrients

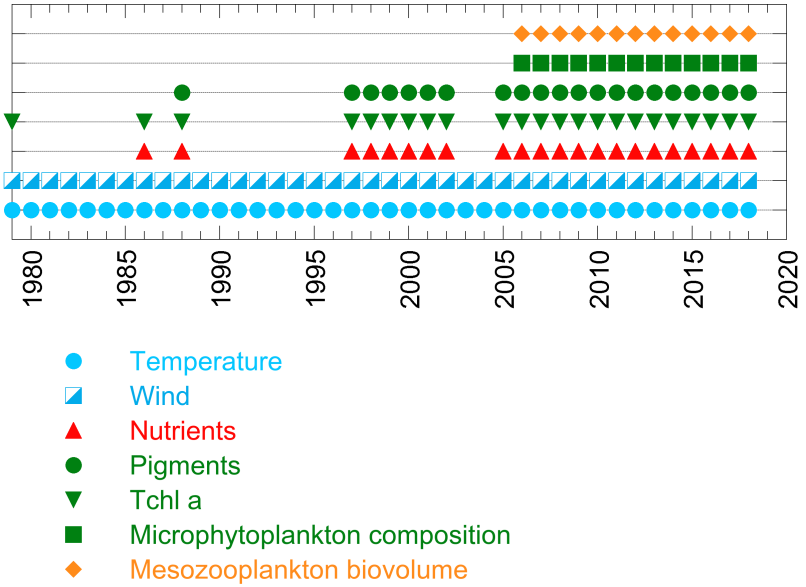
- From 1986, with interruptions until 2005, continuous from 2006

Phytoplankton pigments

- From 1988, with interruptions until 2005, continuous from 2006

Microphytoplankton composition and mesozooplankton biovolume

- Continuous from 2006
- Main zooplankton groups in some years.

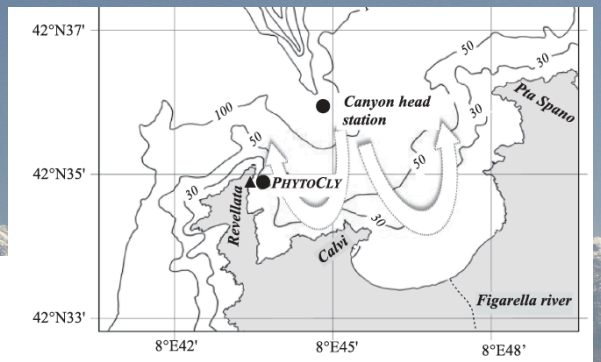


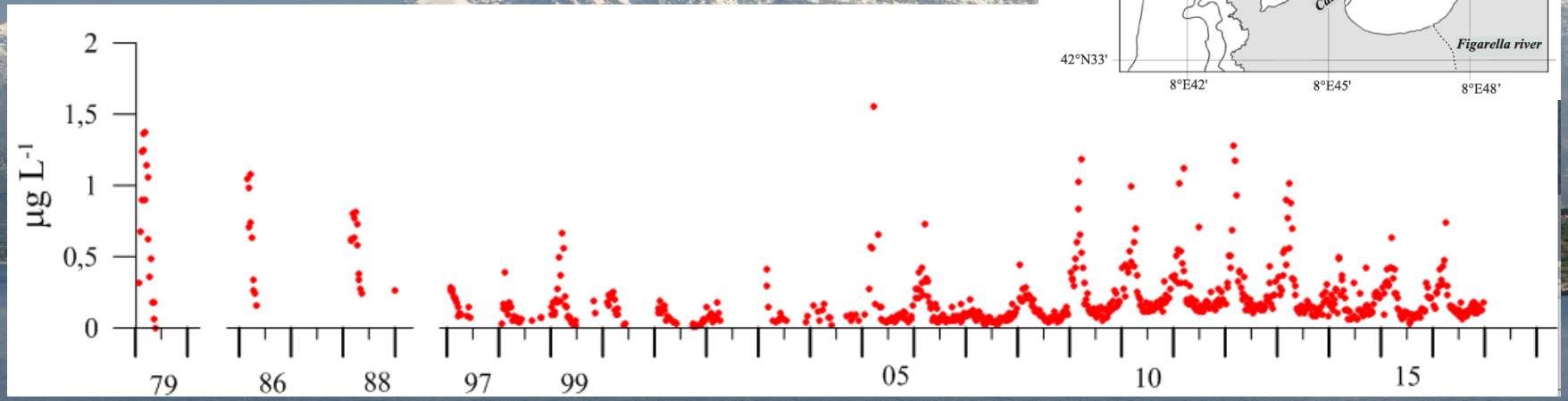
High sampling frequency :

- **Phytoplankton and nutrients : daily to biweekly**
- **Zooplankton : weekly.**

Long-term time series (surface data, 1979-)

- **Sampling at a fixed site (PHYTOCLY)**



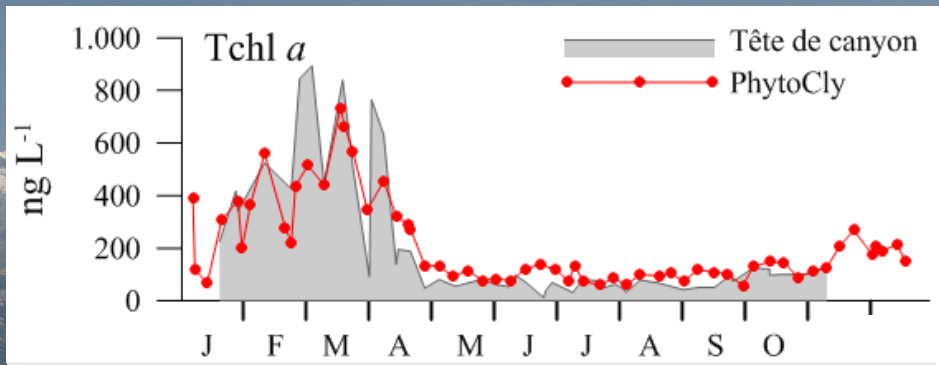


Subsurface Tchl *a* time series at the PHYTOCLY site, 1979 - 2016

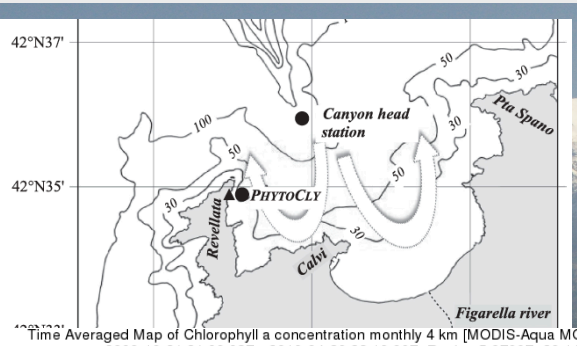
IGMETS International Group for Marine Ecological Time Series
Analysis and synthesis of global marine ecological changes as seen through biogeochemical and plankton time series.

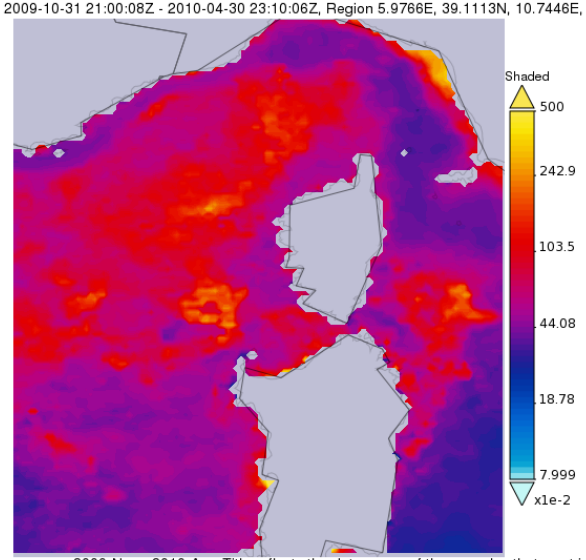
Long-term time series (surface data, 1979-)

- **Sampling at a fixed site (PHYTOCLY)**
- **Phytoplankton observations in the Bay of Calvi are pertinent at the scale of the western coast of Corsica**



Subsurface Tchl *a* at the PHYTOCLY site and at the Canyon head station, 2015.

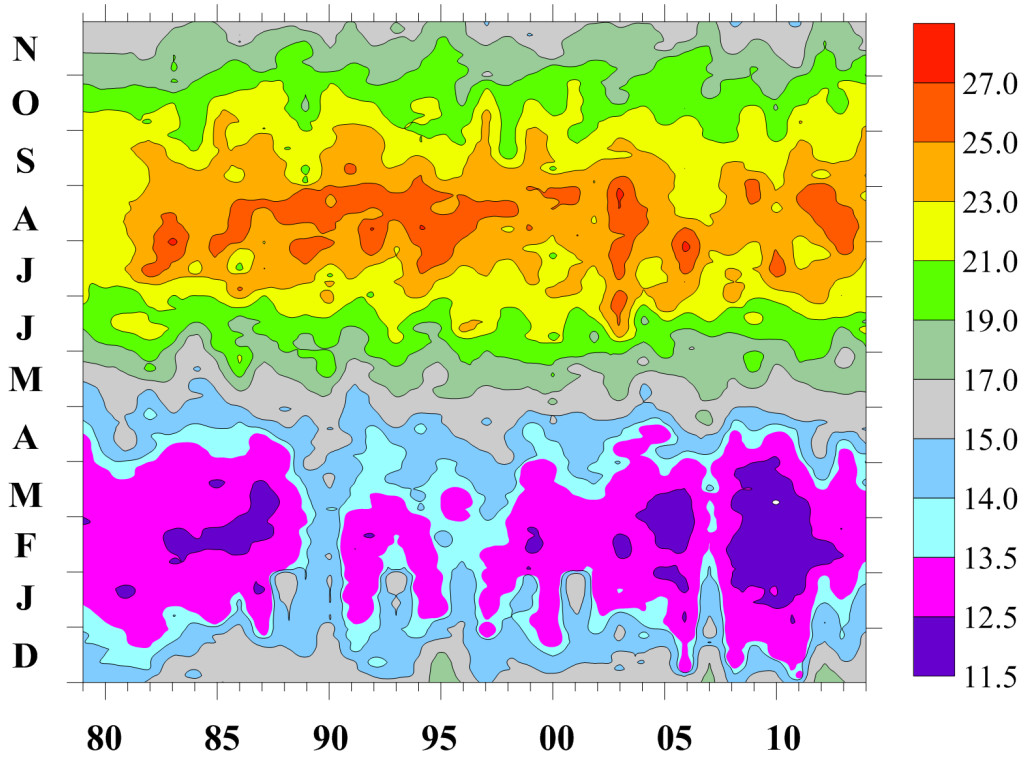




Time averaged map of Tchl *a* (Modis-Aqua, 4 km), 31/10/2009 - 30/04/2010

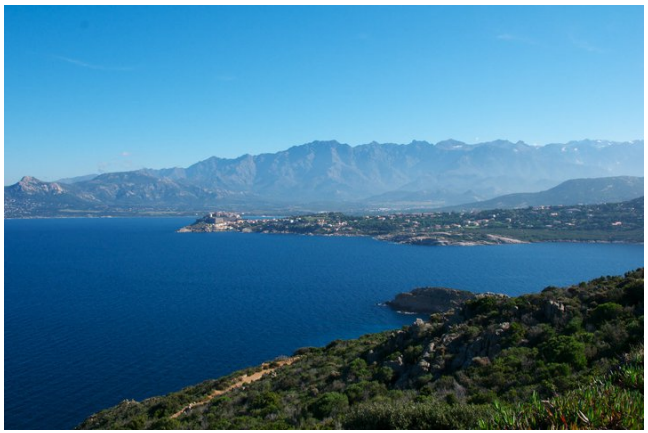
High seasonal and interannual variability in environmental variables

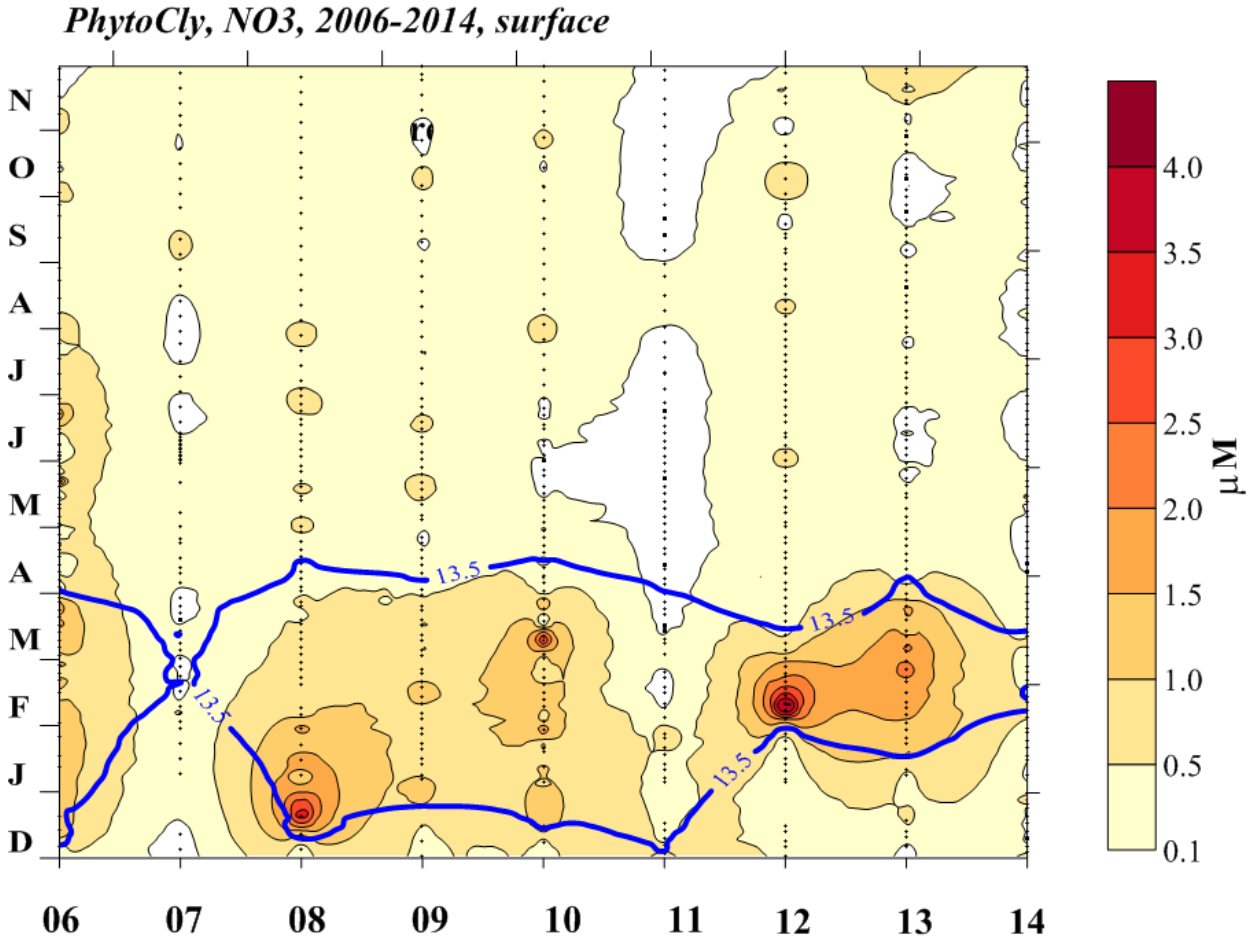
High seasonal and interannual variability in environmental variables



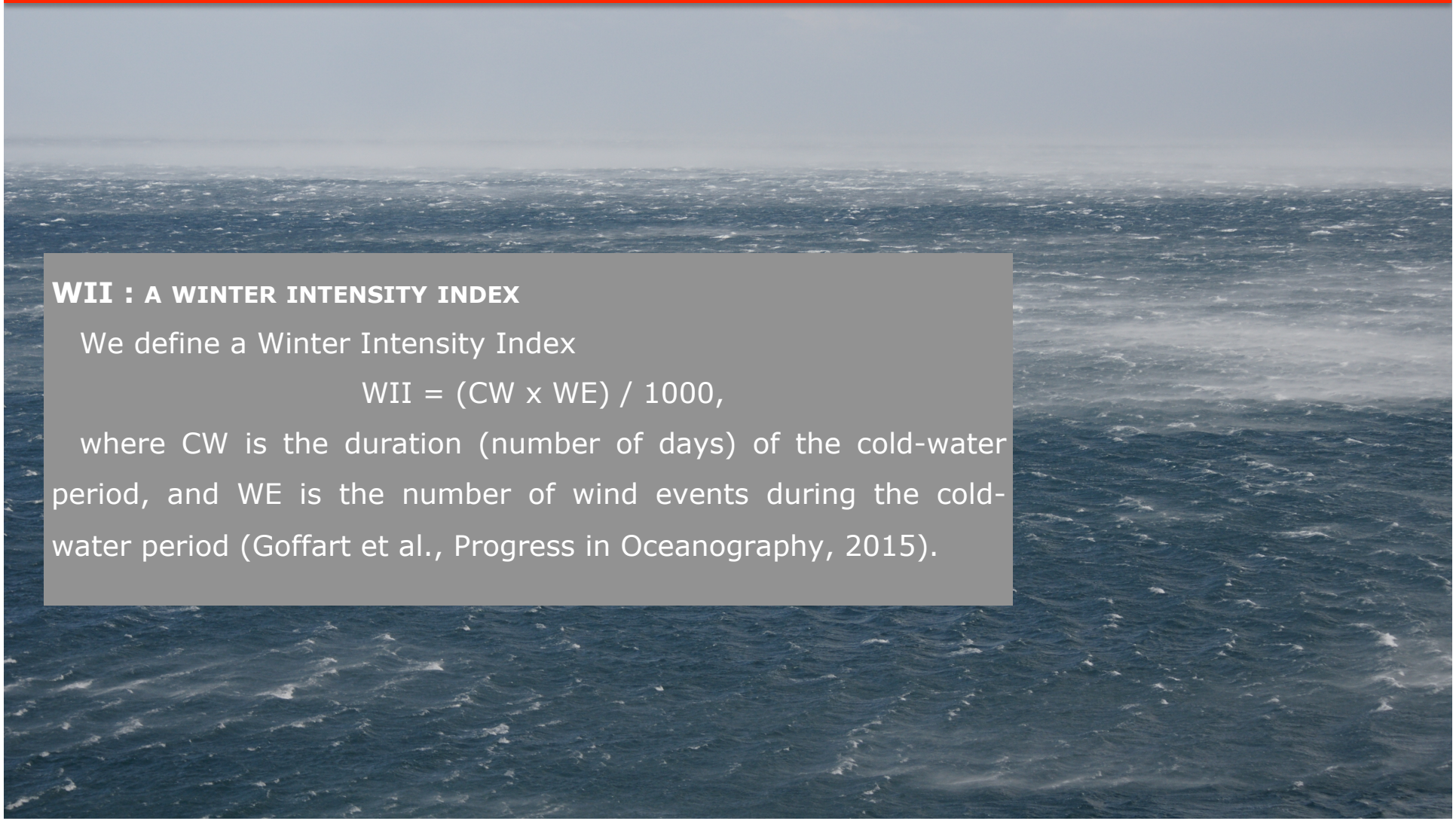
Temporal changes in subsurface temperature in the Bay of Calvi (1979-2014)

High seasonal and interannual variability in nutrient concentrations





Winter intensity index (WII)



WII : A WINTER INTENSITY INDEX

We define a Winter Intensity Index

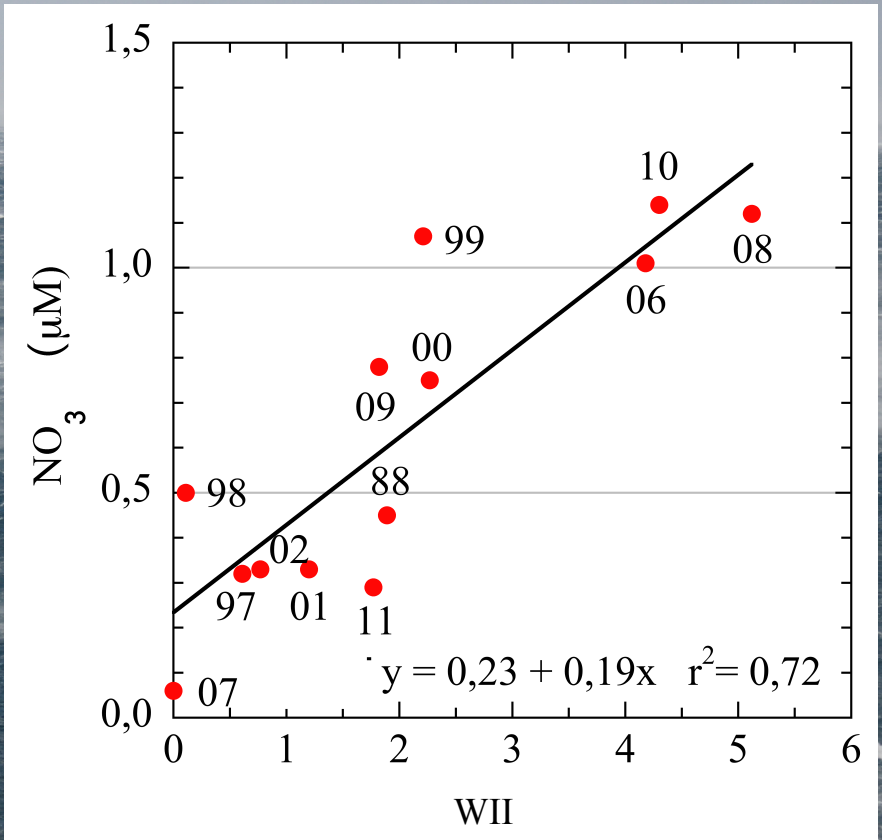
$$WII = (CW \times WE) / 1000,$$

where CW is the duration (number of days) of the cold-water period, and WE is the number of wind events during the cold-water period (Goffart et al., Progress in Oceanography, 2015).

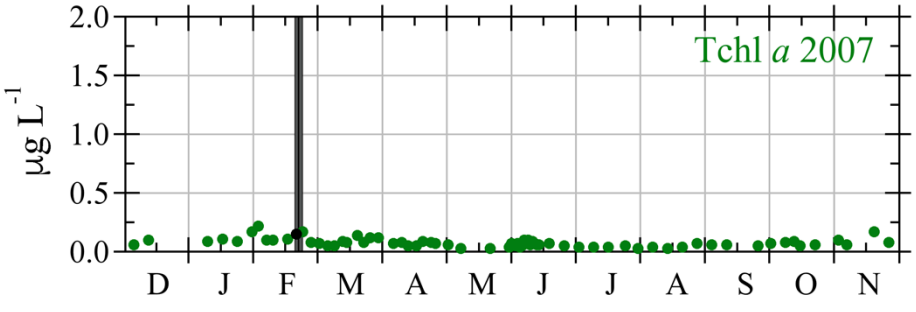
Control of winter-spring nutrient enrichment by WII

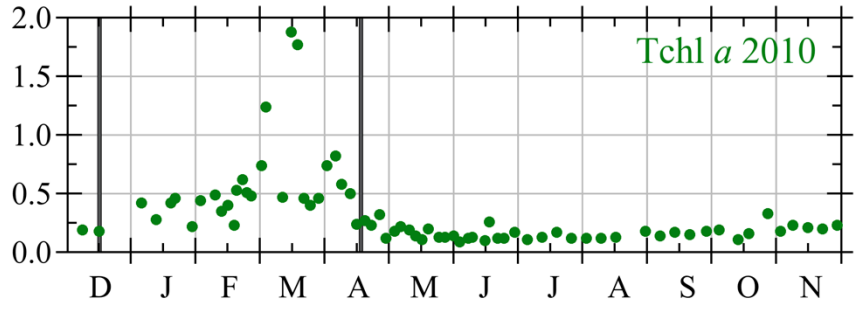
NUTRIENTS VS WII DURING THE COLD-WATER PERIOD

The plots of nitrate averaged over the cold-water periods as function of WII show highly significant relationships (Goffart et al., 2015, Progress in Oceanography).

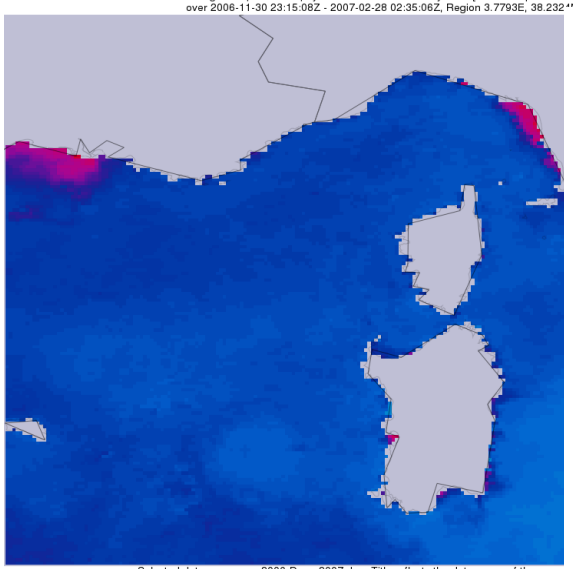


High seasonal and interannual variability in phytoplankton biomass



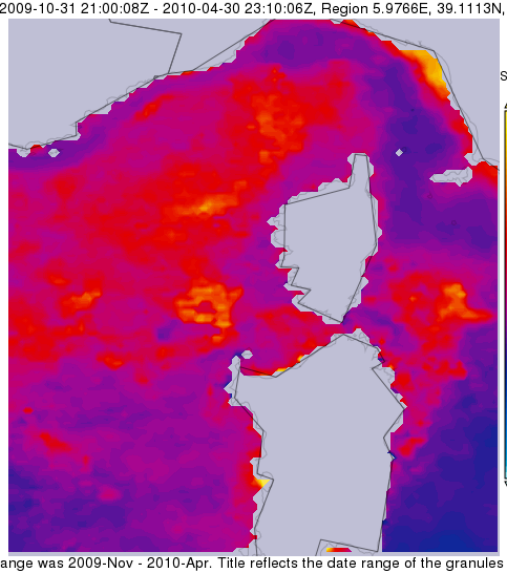


Time Averaged Map of Chlorophyll a concentration monthly 4 km [MODIS-Aqua MODISA_L3m_CHL v2014]
over 2006-11-30 23:15:08Z - 2007-02-28 02:35:06Z, Region 3.7793E, 38.232



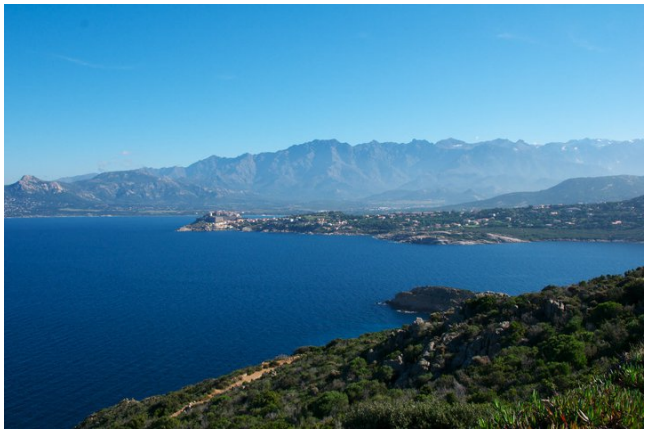
- Selected date range was 2006-Dec - 2007-Jan. Title reflects the date range of the granu

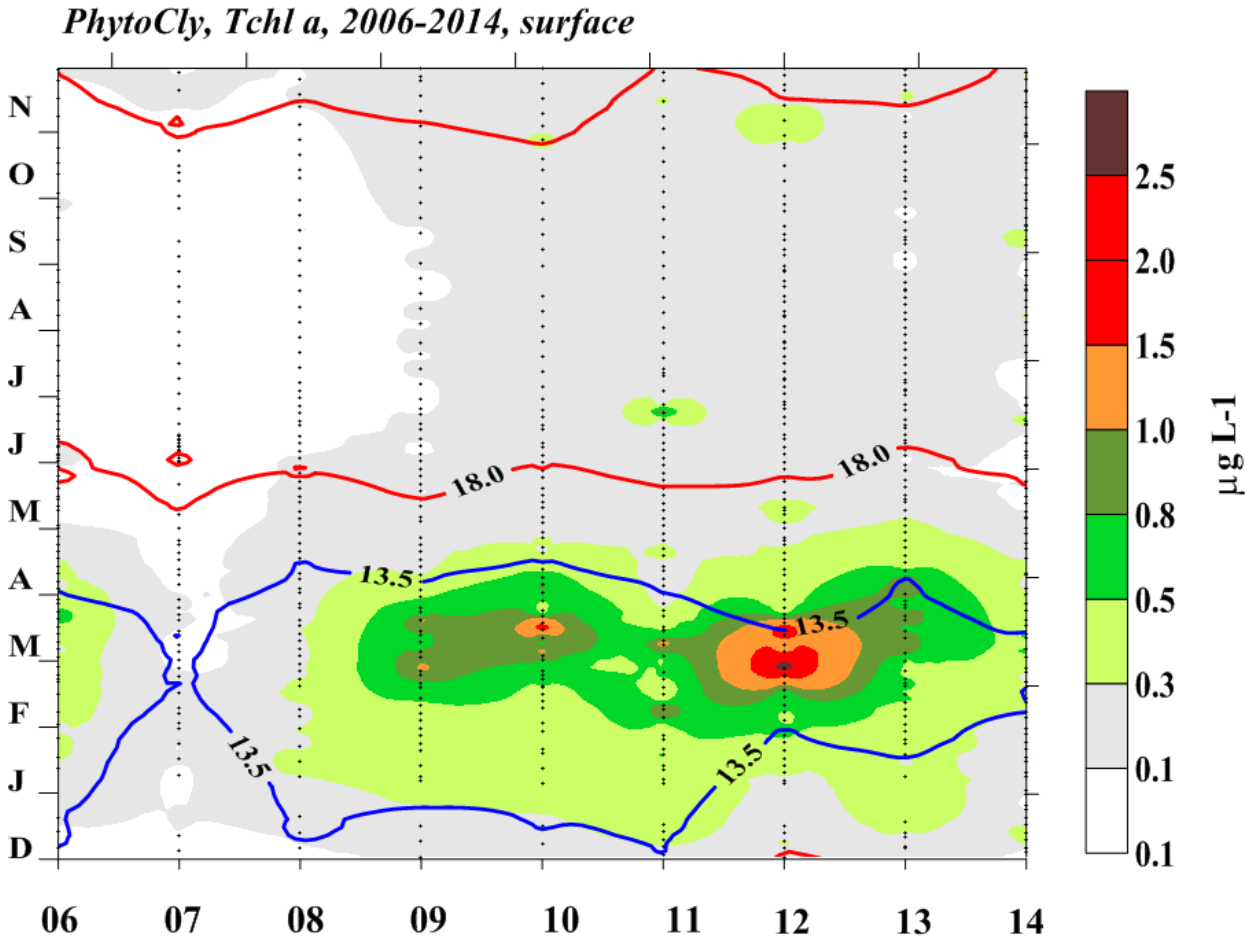
over 2009-10-31 21:00:08Z - 2010-04-30 23:10:06Z, Region 5.9766E, 39.1113N, 10.7446E, 44.3188N



- Selected date range was 2009-Nov - 2010-Apr. Title reflects the date range of the granules that went into making this result.

High seasonal and interannual variability in phytoplankton biomass



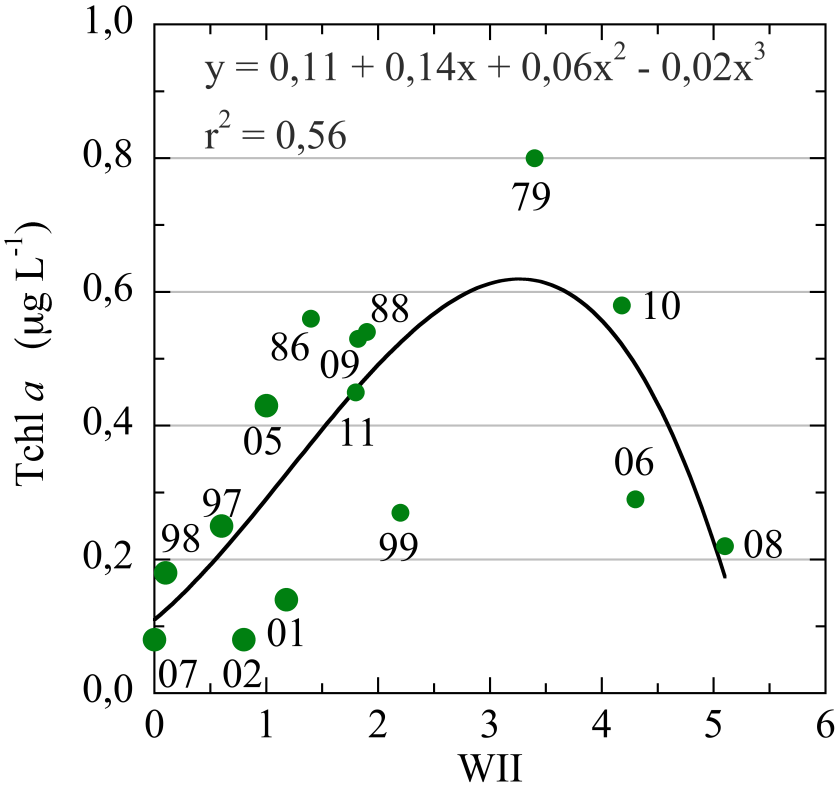


Control of winter-spring phytoplankton biomass by WII

TCHL *a* VS WII DURING THE COLD-WATER PERIOD

The plots of Tchl *a* averaged over the cold-water periods as function of WII show highly significant relationships (Goffart et al., 2015, Progress in Oceanography).

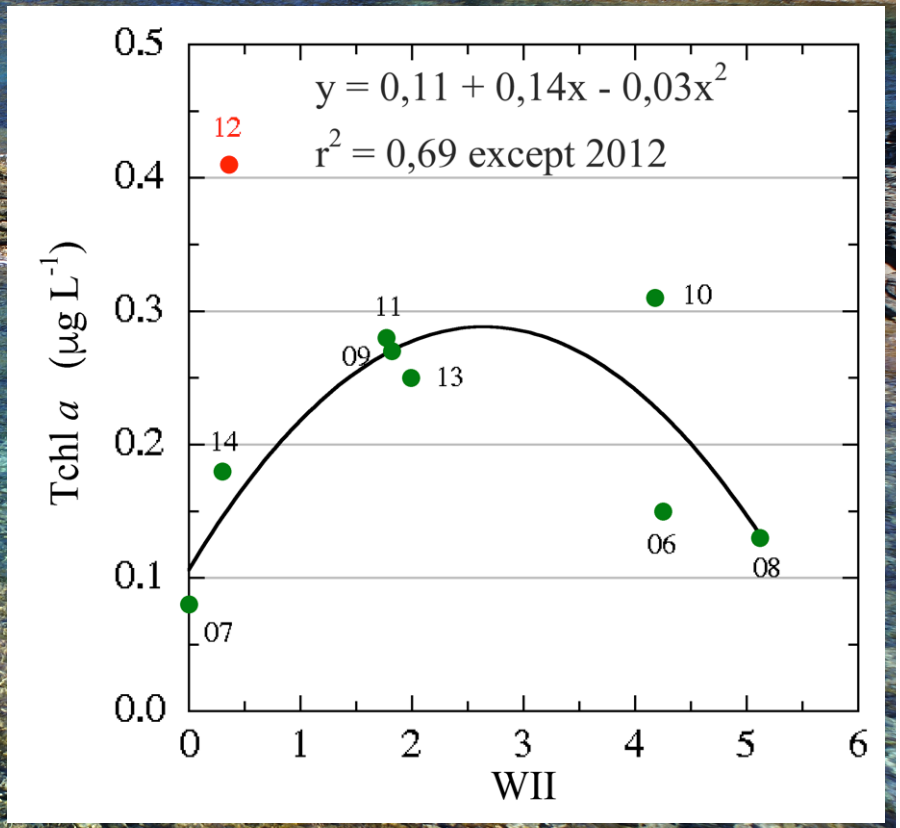
According to WII, the trophic character of the Bay of Calvi ranges from very oligotrophic (*i.e.* subtropical regime) to mesotrophic (*i.e.* temperate regime). A third regime is observed during severe winters characterized by specific wind conditions, when Mediterranean "high nutrient – low chlorophyll" conditions occur.



Control of annual phytoplankton biomass by WII

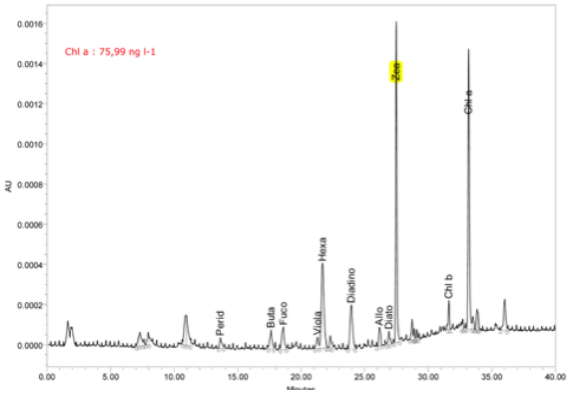
MEAN ANNUAL TCHL *a* VS WII

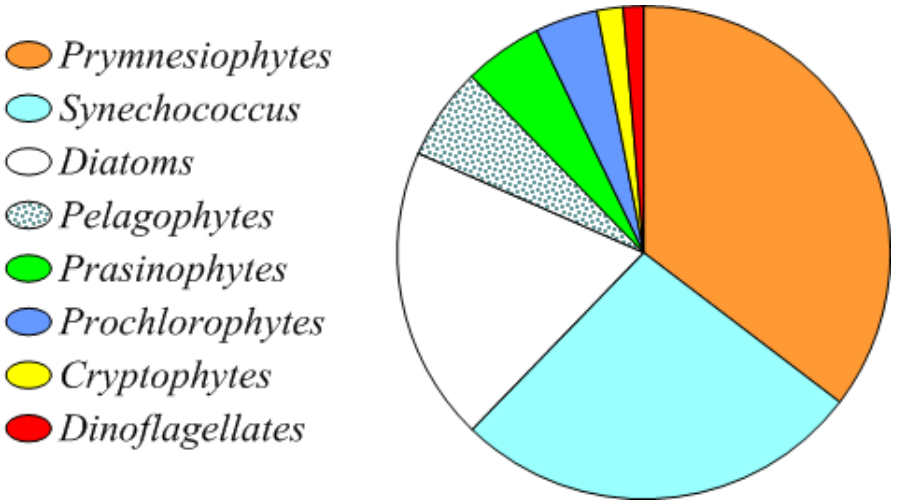
When phytoplankton was sampled over the entire year, strong positive correlations are observed between WII and annual mean concentrations, except in 2012.



Control of phytoplankton composition by WII

- **Overall, prymnesiophytes, cyanobacteria and diatoms are the dominant groups**
- **Prymnesiophytes and cyanobacteria are present all over the year**

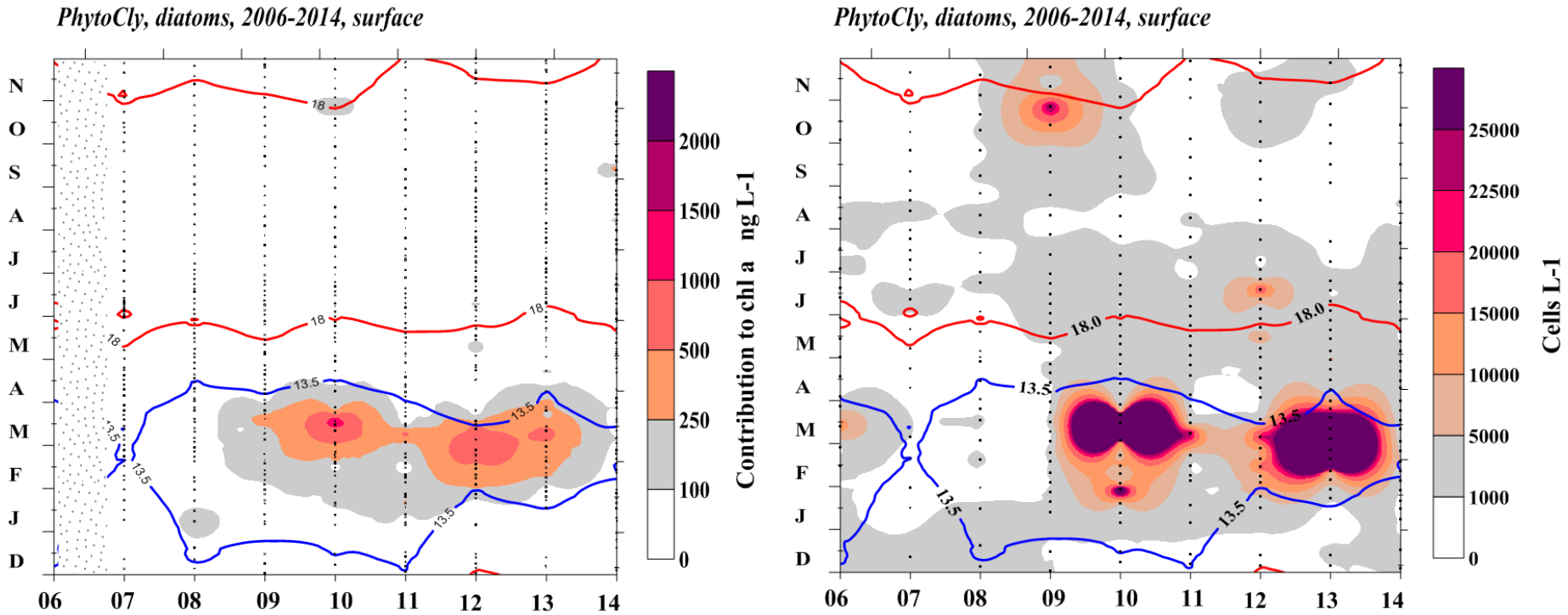




Relative contribution (%) of each phytoplankton group at the PHYTOCLY station (2012 - 2015, pigments + CHEMTAX)

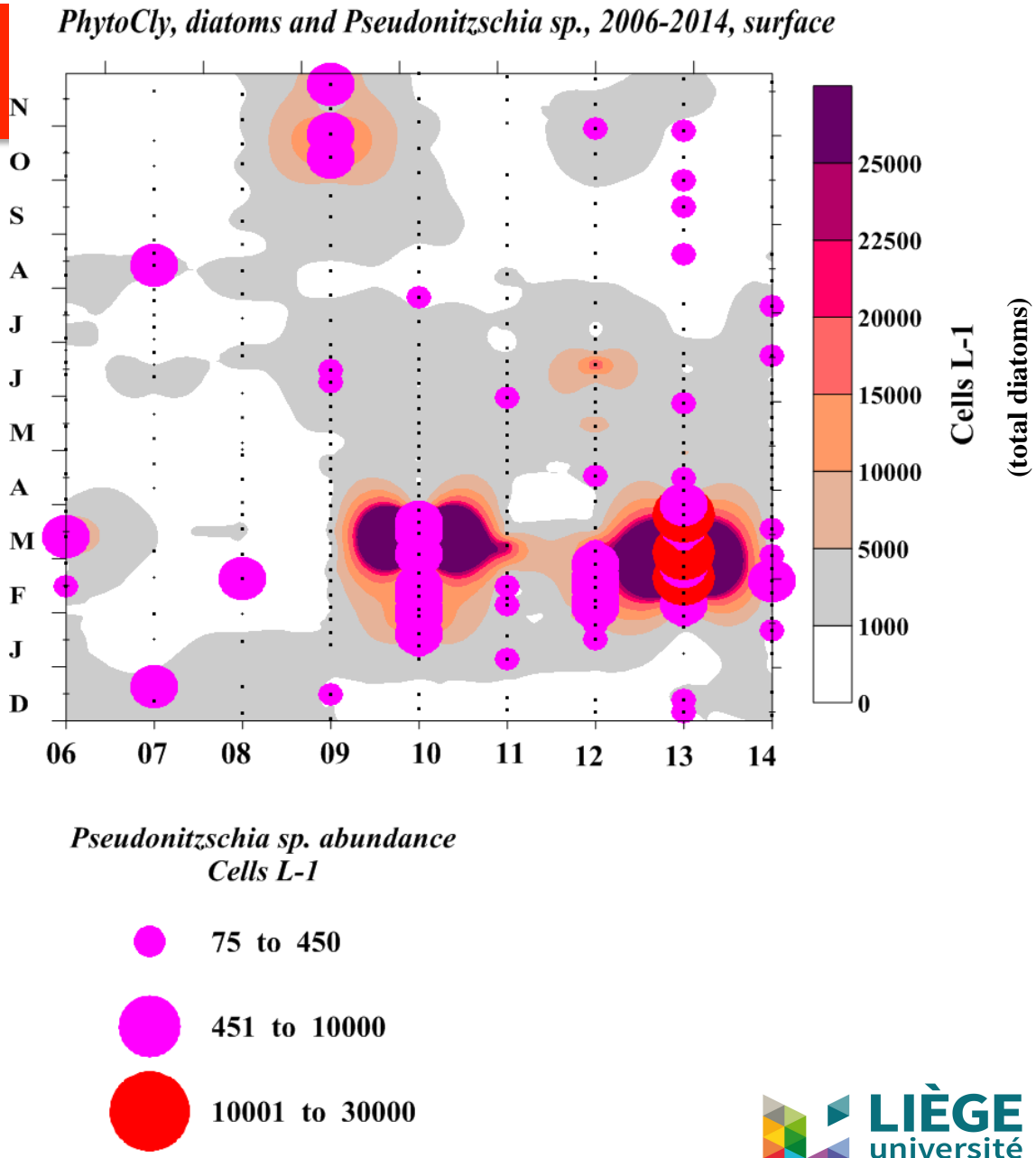
Control of phytoplankton composition by WII

- **Diatoms develop only during the cold-water periods**

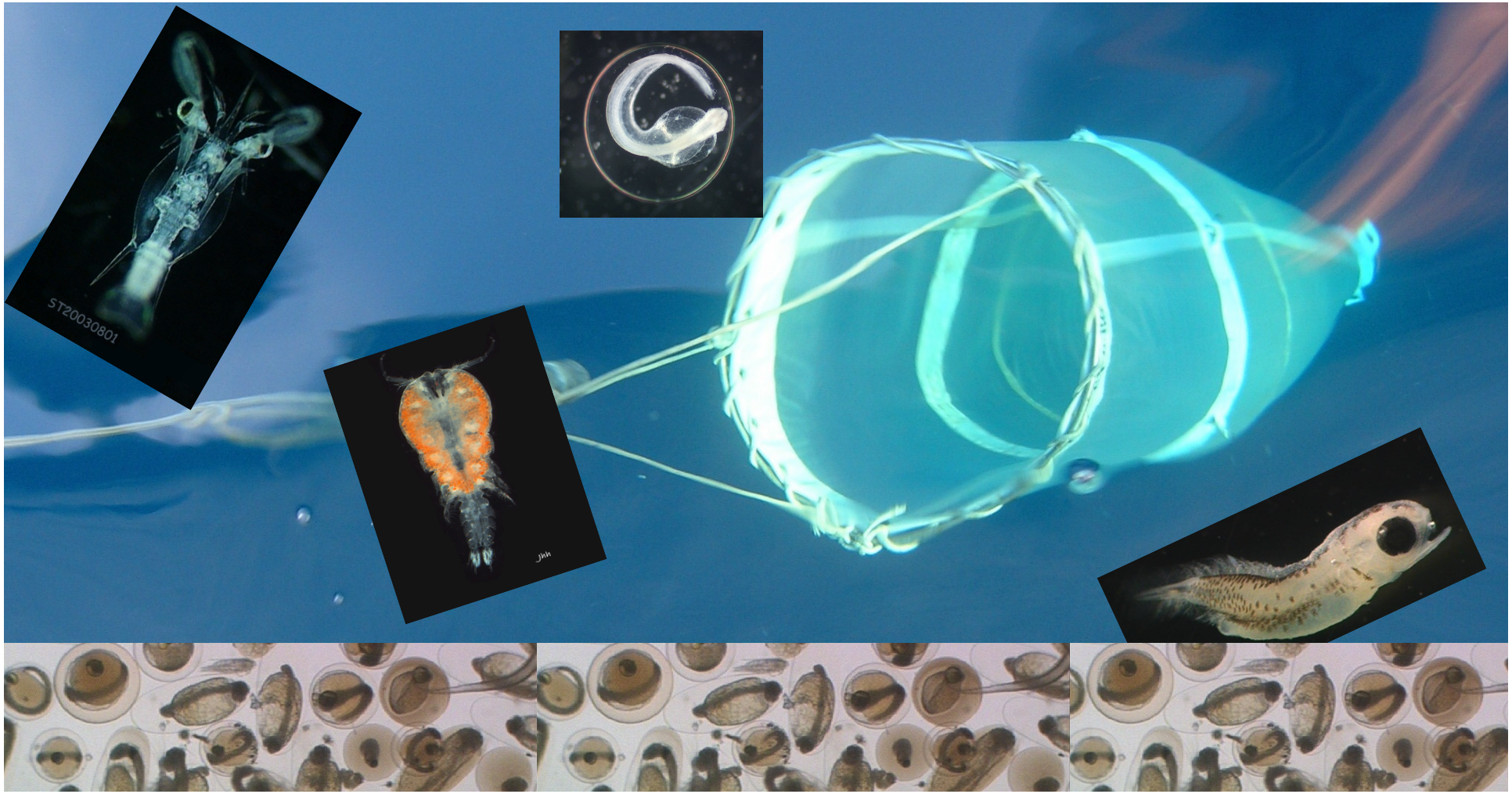


Our study is consistent with the report that, when occurring, diatoms peaks were added to the initial phytoplankton groups instead of replacing them (Barber & Hiscock 2006)

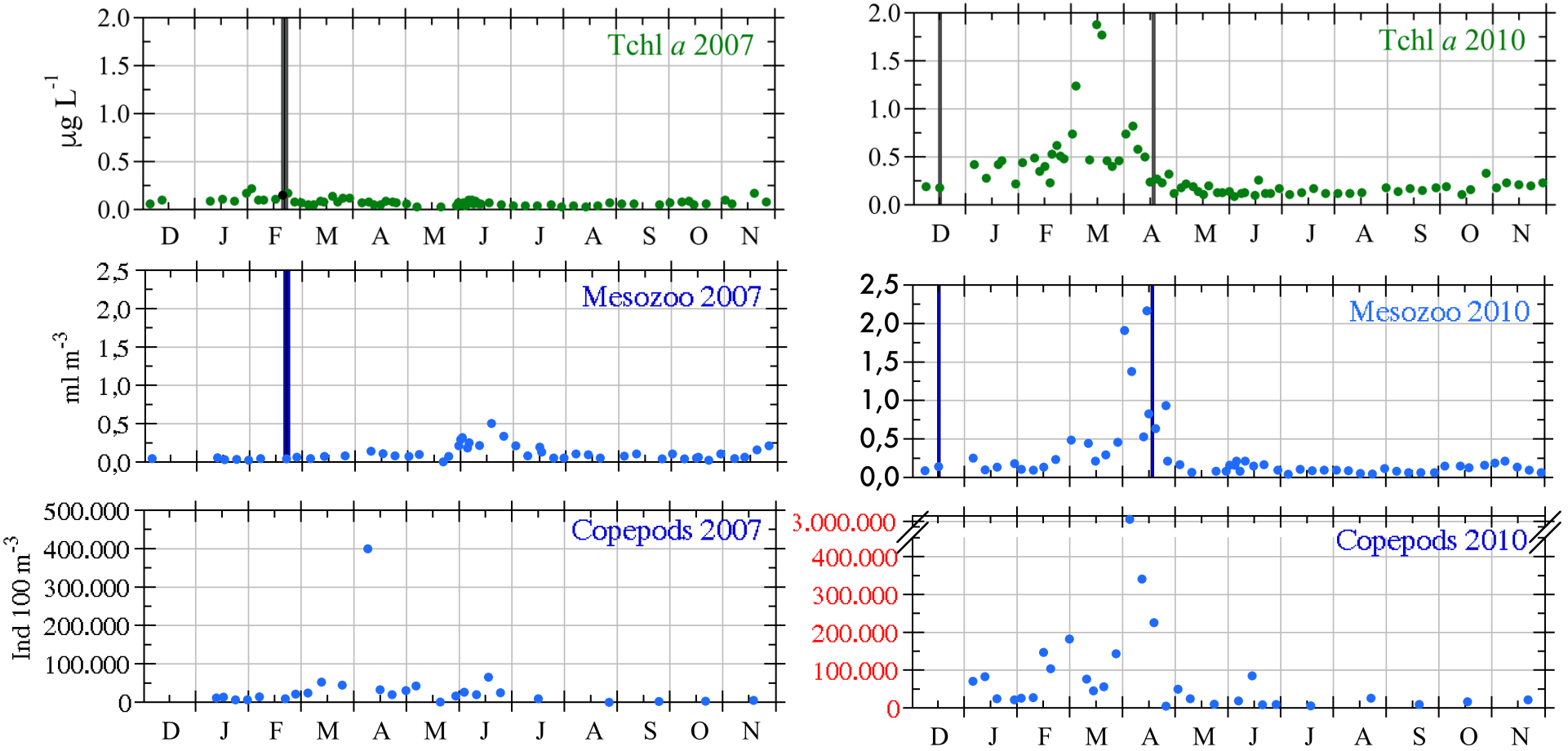
Pseudonitzchia sp.



High seasonal and interannual variability in zooplankton

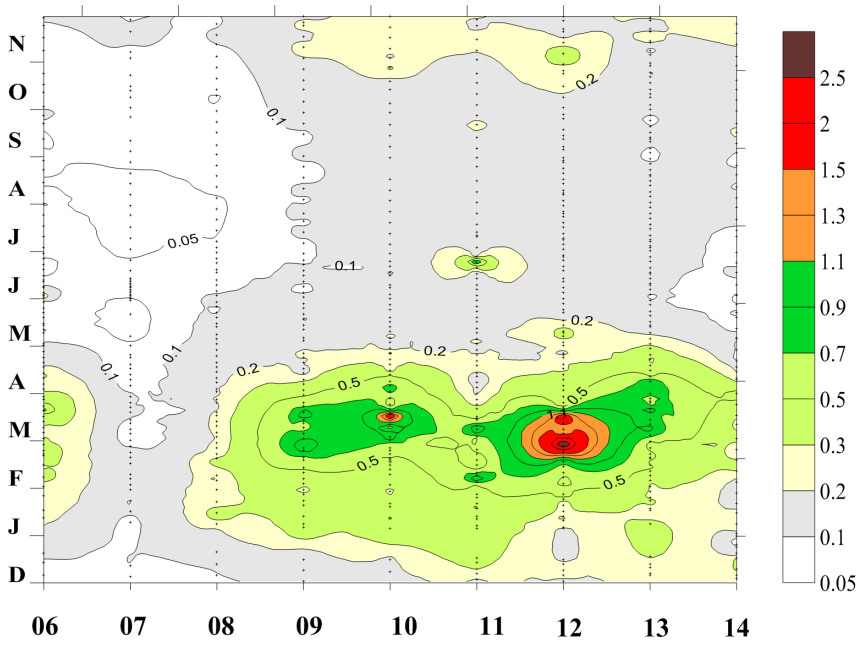


High seasonal and interannual variability in zooplankton

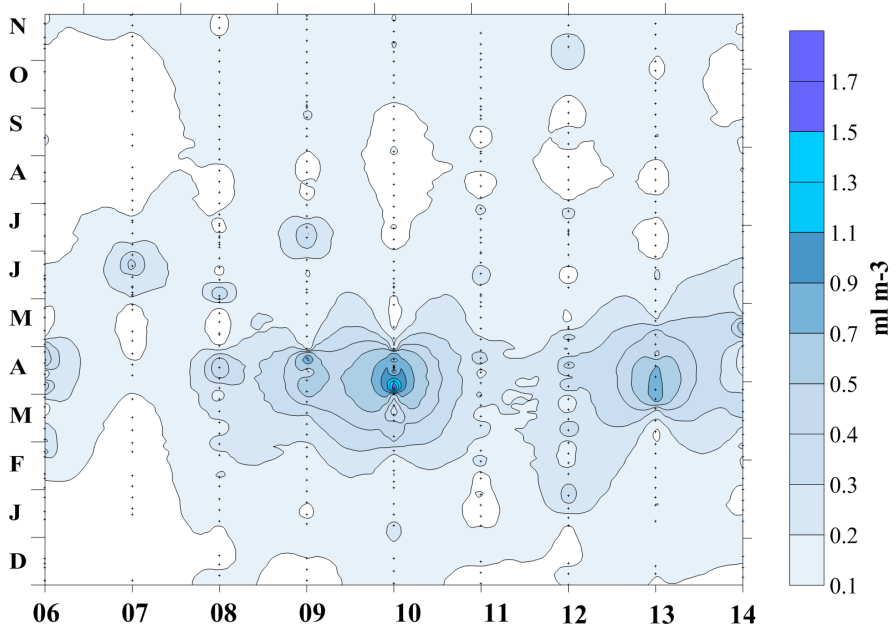


Control of plankton composition by winter intensity

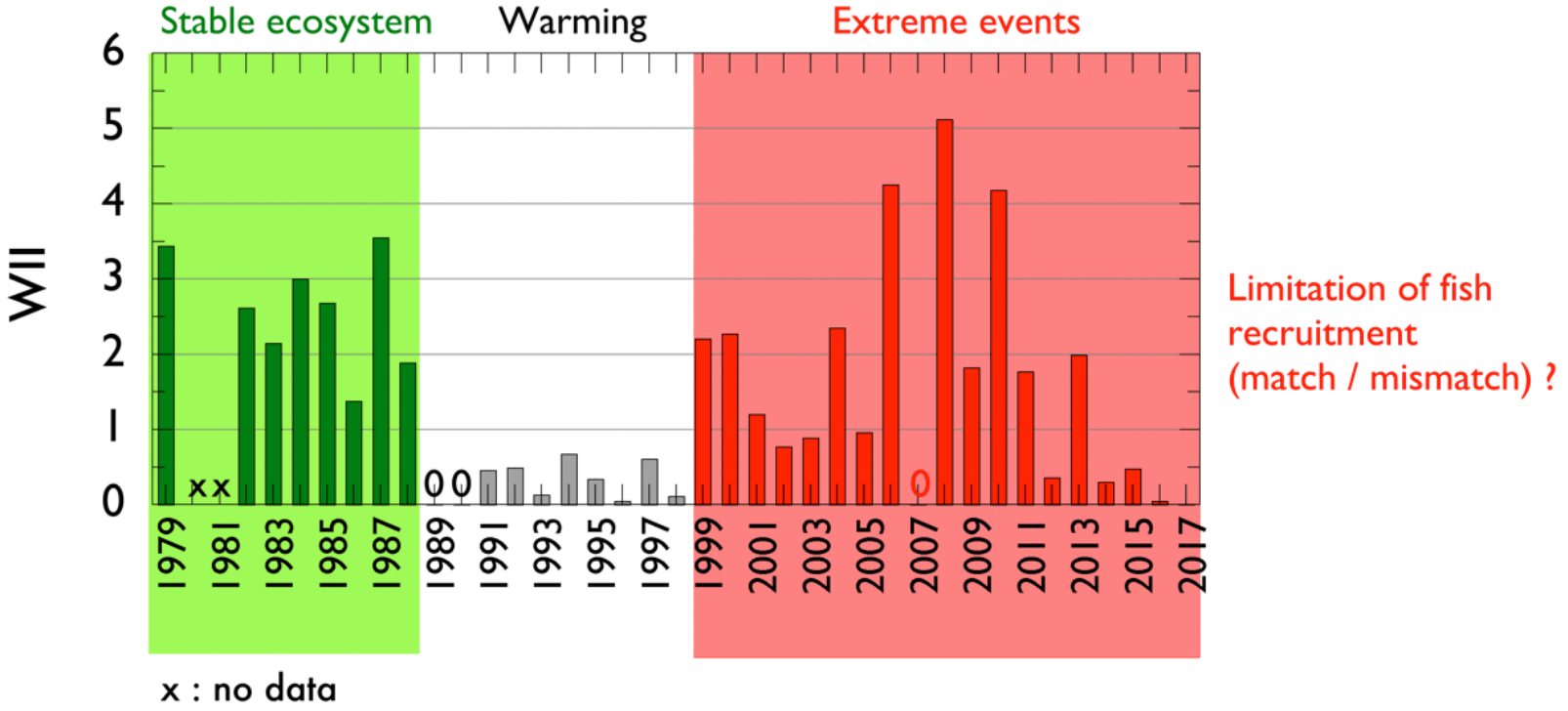
PhytoCly, Tchl a, 2006-2014, surface



Bay of Calvi, mesozooplankton, 2006-2014, surface



Trends in WII ?



Limitation of fish recruitment (match / mismatch) ?

Concluding remarks

- **Winter intensity is a key driver of plankton dynamics over the year.**
- **The Bay of Calvi has undergone regime shifts (*i.e.* sudden, substantial and temporally persistent changes) in the late 1980s and in the late 1990s.**
- **Extreme WII values were observed in two consecutive winters during the last decade (2007 and 2008, respectively).**
- **There is a need to maintain long-term time series observations coupled with with satellite information (*e.g.* regionalization of phytoplankton composition).**


LIÈGE
université
Thank you for your attention !