Inter-annual variations over a decade of primary production of the Mediterranean seagrass *Posidonia oceanica*

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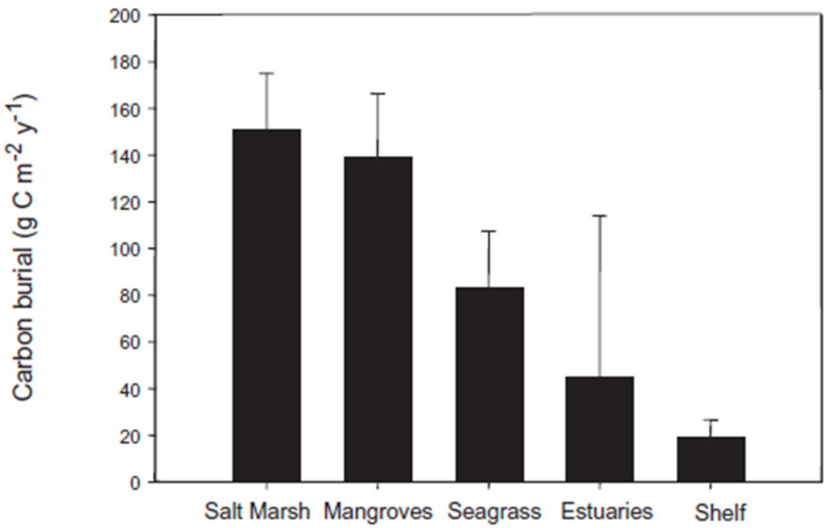
Motivation

Seagrasses are:
1. Hot spots of carbon production and burial



	Carbon burial (TgC yr^{-1})
Vegetated coastal systems	
Mangroves	24
Salt marshes	60
Seagrasses	27
Continental shelf	99
Deep ocean sediments	6

Duarte et al. (2005) Biogeosciences 2:1-8

Motivation

Seagrasses are:

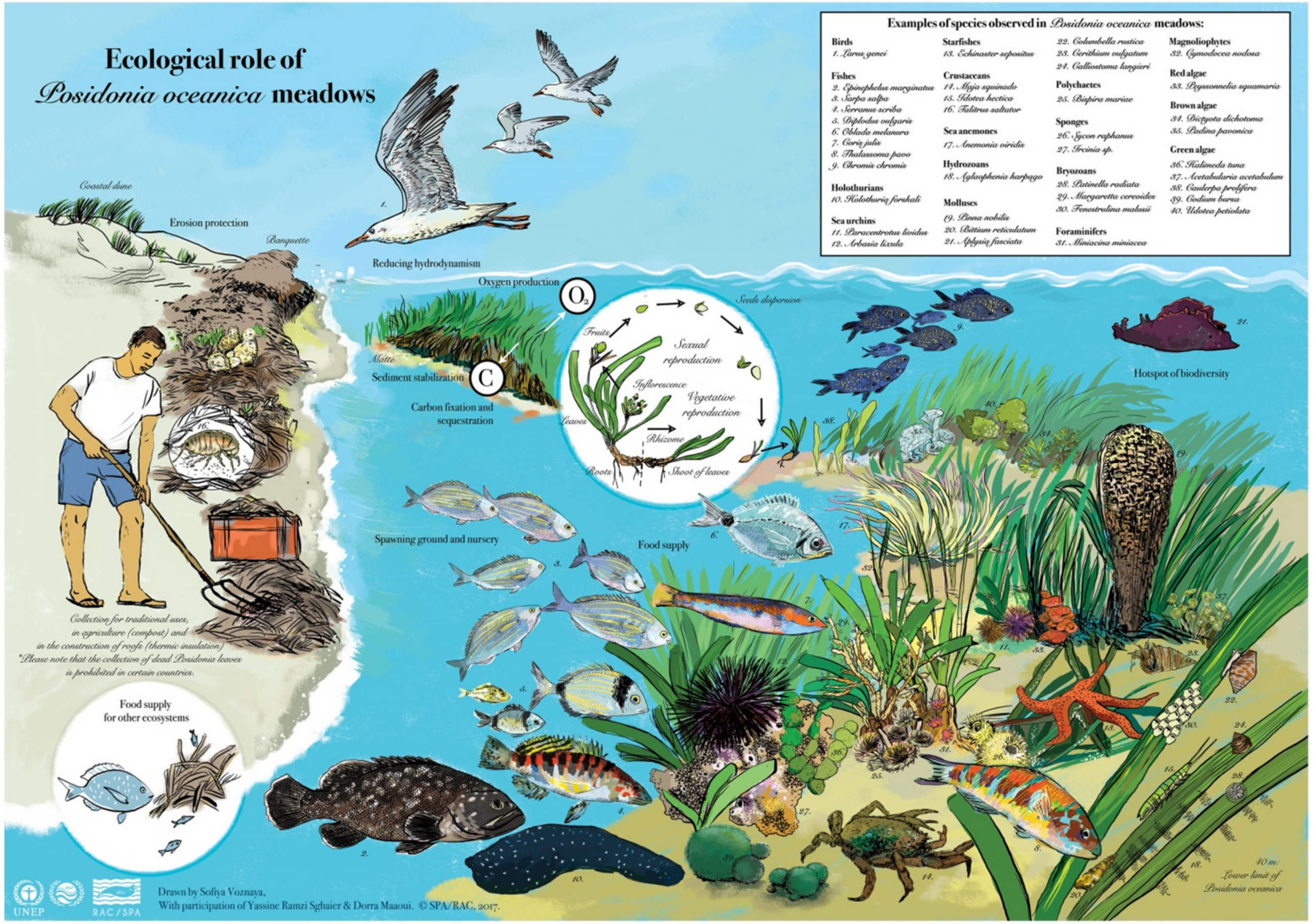
1. Hot spots of carbon production and burial

2. Hot spots of biodiversity

Motivation

Seagrasses are:

1. Hot spots of carbon production and burial
2. Hot spots of biodiversity
3. Providers of diverse ecosystems functions, services, and goods



Motivation

Seagrasses are:

1. **Hot spots of carbon production** and burial
2. Hot spots of biodiversity
3. Providers of diverse ecosystems functions, services, and goods

Does gross primary production (GPP) of *Posidonia oceanica* fluctuate inter-annually ?

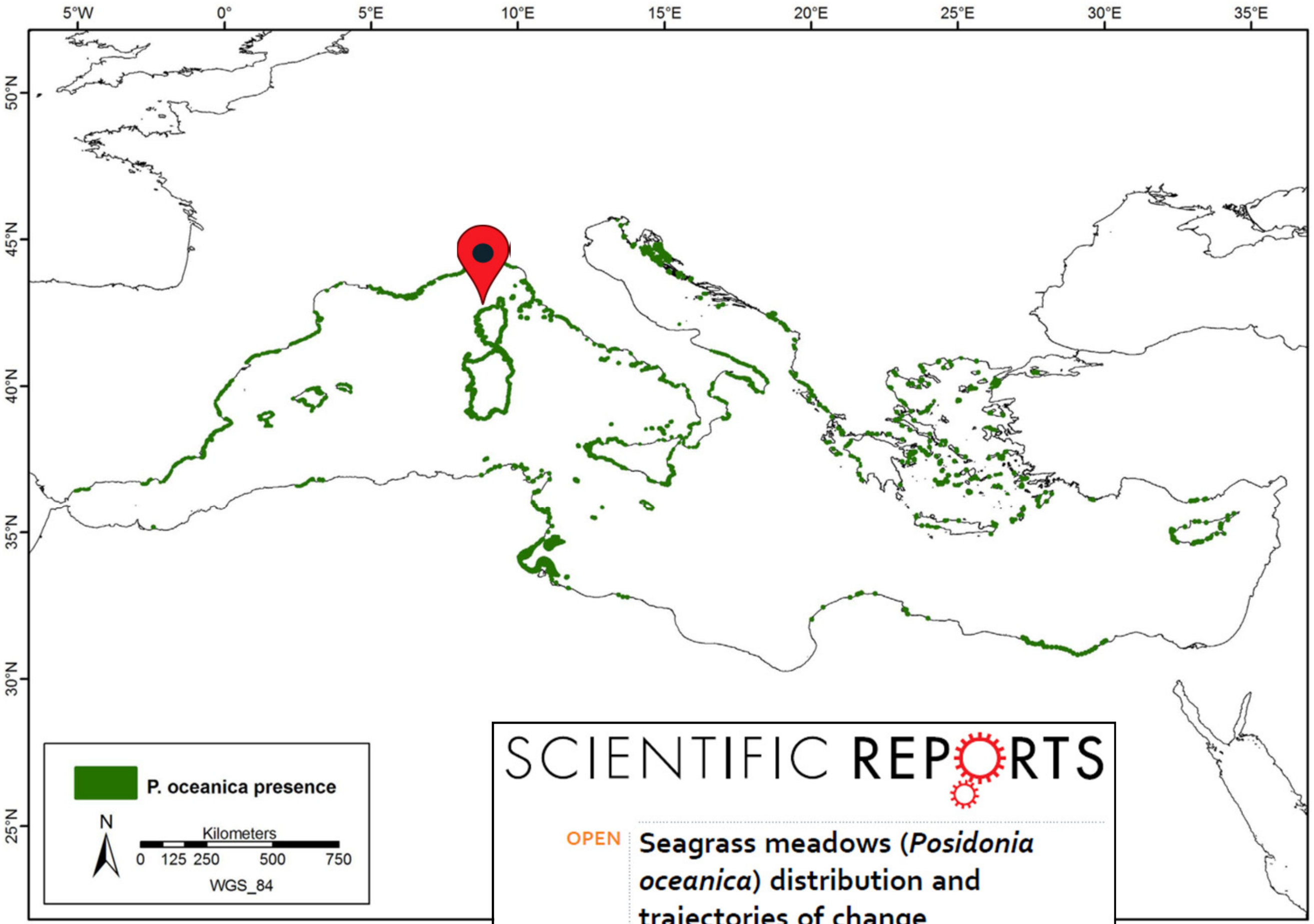
Is GPP of *P. oceanica* increasing or decresing in the Mediterranean Sea ?

Motivation

Posidonia oceanica (Linnaeus) Delile 1813

- Angiospermae (terrestrial origin)
- endemic to the Mediterranean
- most abundant seagrass in the Mediterranean
- present from shore to ~40 m depth
- habitat for a large biodiversity
- long-living but very slow-growing
- vulnerable
- threatened (mechanical damage, light limitation from eutrophication)
- meadows declining

Methods



SCIENTIFIC REPORTS

OPEN

Seagrass meadows (*Posidonia oceanica*) distribution and trajectories of change

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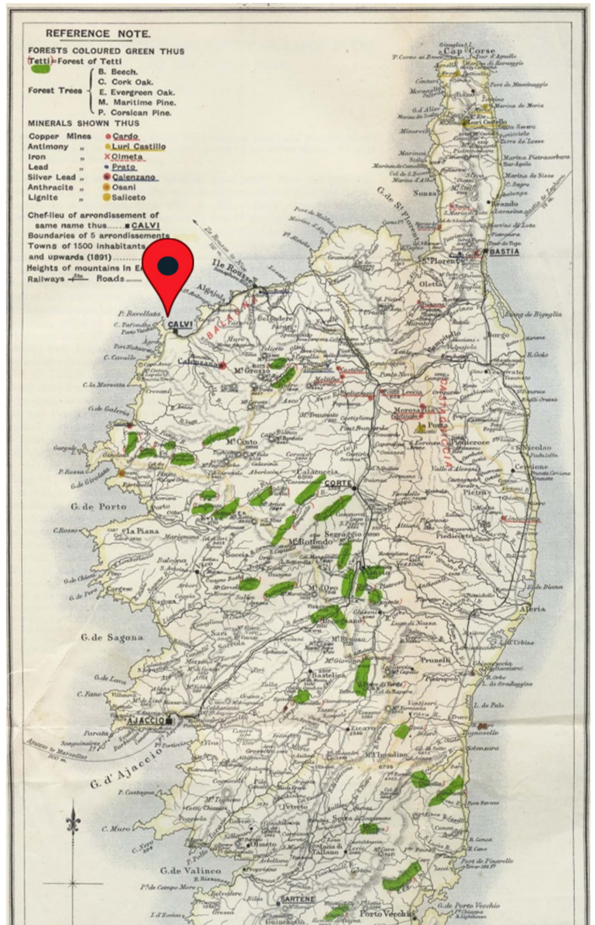
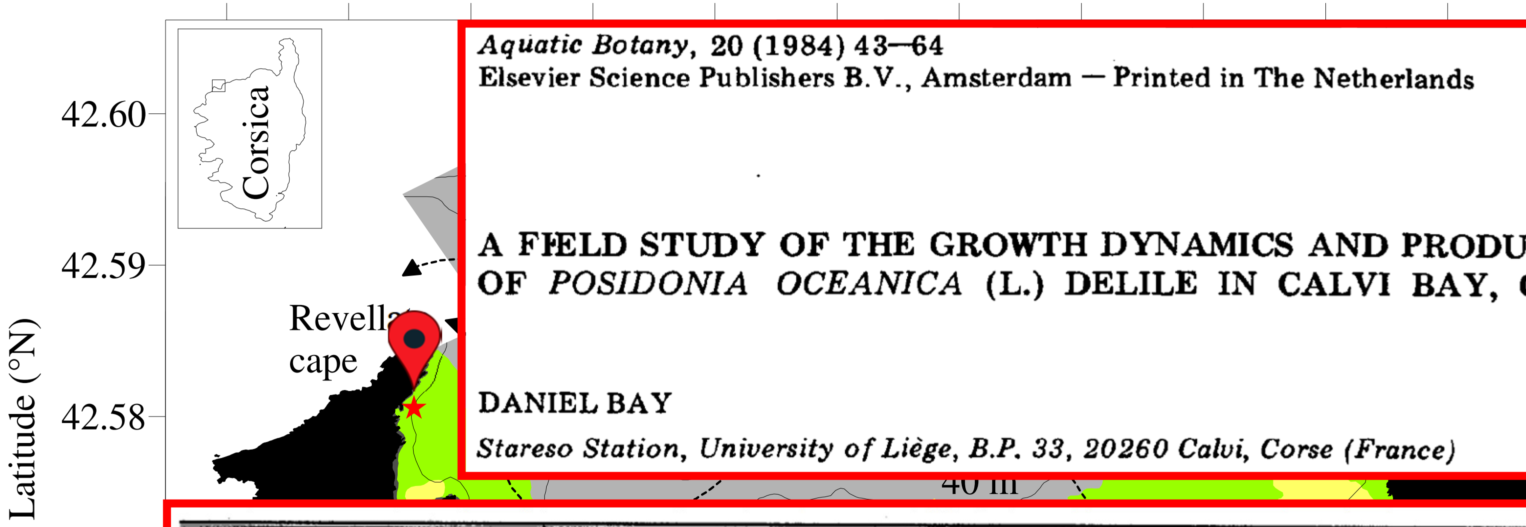
Luca Telesca[1], Andrea Belluscio[2], Alessandro Criscoli[2], Giandomenico Ardizzone[2], Eugenia T. Apostolaki[3], Simonetta Fraschetti[4], Michele Gristina[5], Leyla Knittweis[6], Corinne S. Martin[7], Gérard Pergent[8], Adriana Alagna[9], Fabio Badalamenti[9], Germana Garofalo[5], Vasilis Gerakaris[10], Marie Louise Pace[11], Christine Pergent-Martini[8] & Maria Salomidi[10]



Methods



Aquatic Botany, 20 (1984) 43—64 43
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

A FIELD STUDY OF THE GROWTH DYNAMICS AND PRODUCTIVITY OF *POSIDONIA OCEANICA* (L.) DELILE IN CALVI BAY, CORSICA

DANIEL BAY

Stareso Station, University of Liège, B.P. 33, 20260 Calvi, Corse (France)

Vol. 38: 197–199, 1987	MARINE ECOLOGY – PROGRESS SERIES Mar. Ecol. Prog. Ser.	Published June 18

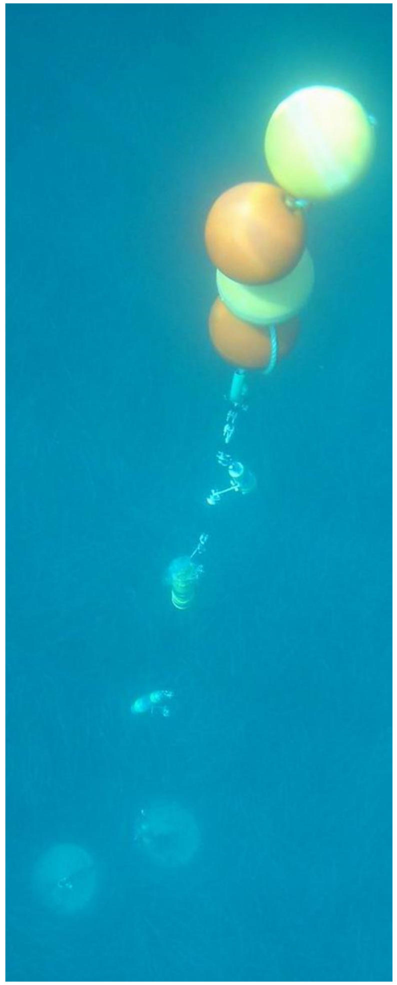
NOTE

Seasonal variation of the diel carbon budget of a marine macrophyte ecosystem

M. Frankignoulle & J. M. Bouquegneau

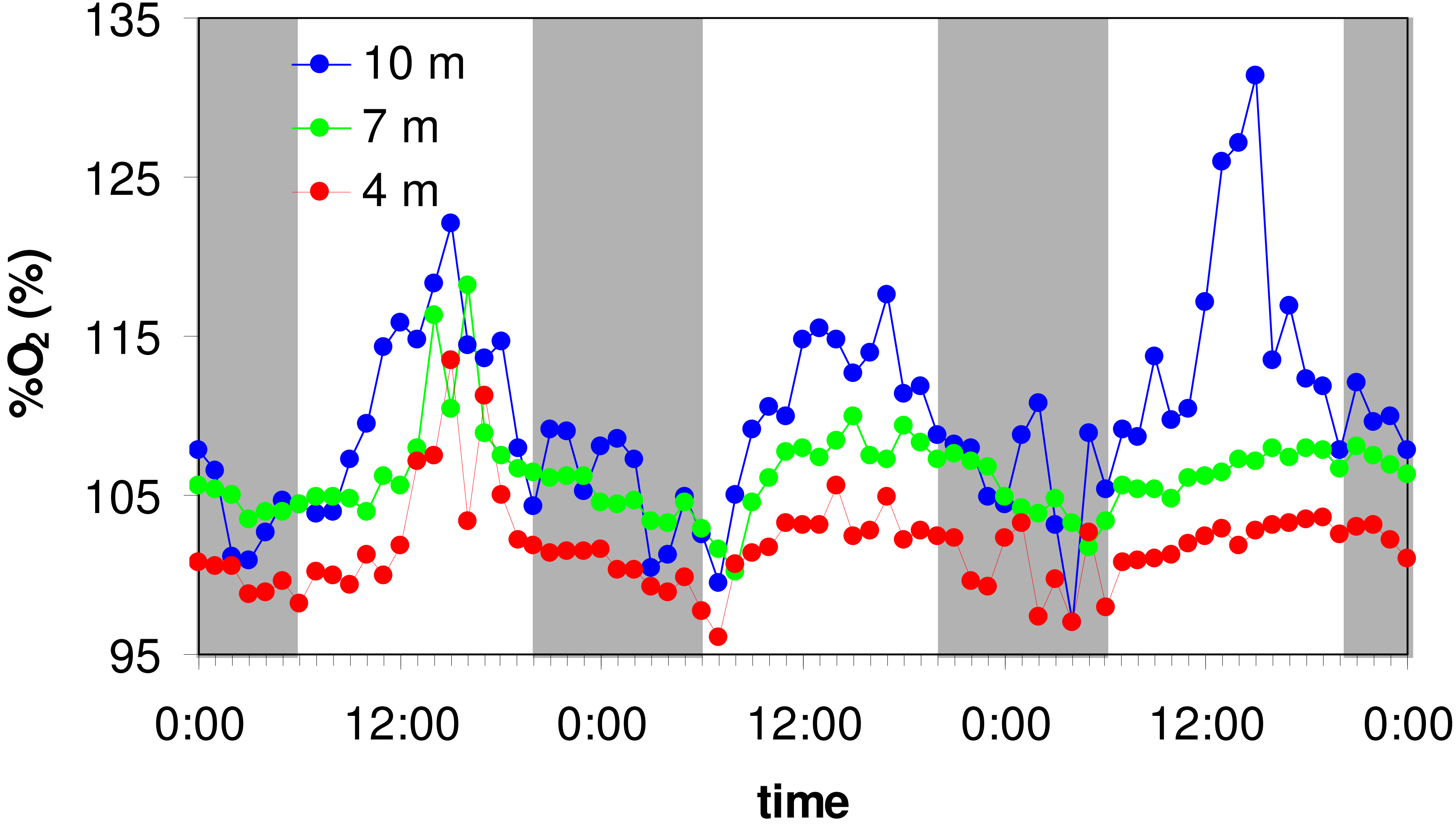
Laboratory of Oceanology, University of Liège, B-4000 Liège (Sart-Tilman, B6), Belgium

Methods



Aanderaa optodes 3835
Fluorometer
Salinometer

Results

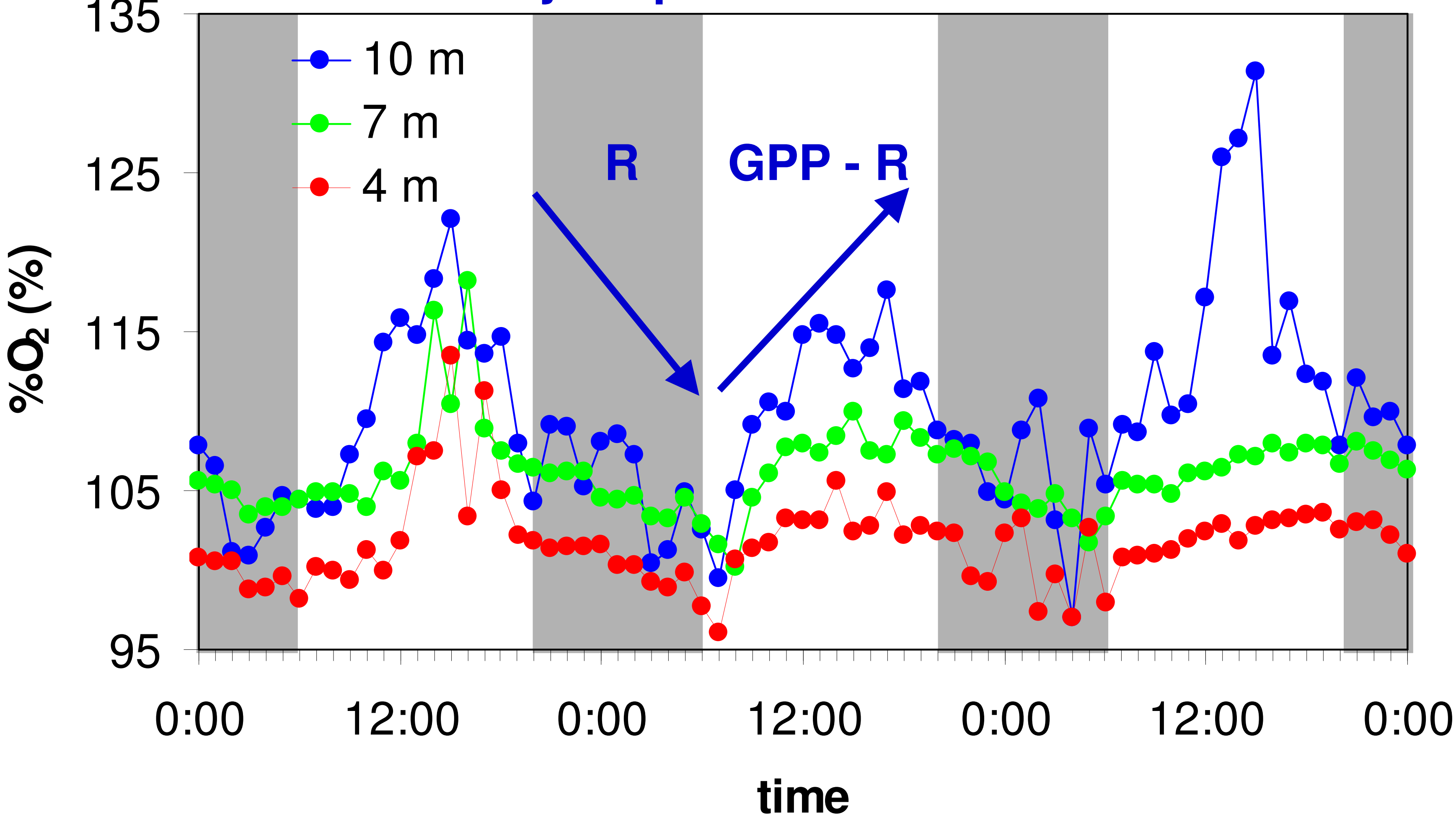


Higher O_2 at 10m
Higher daily amplitude of O_2 10m

} **Effluence of Posidonia biology**

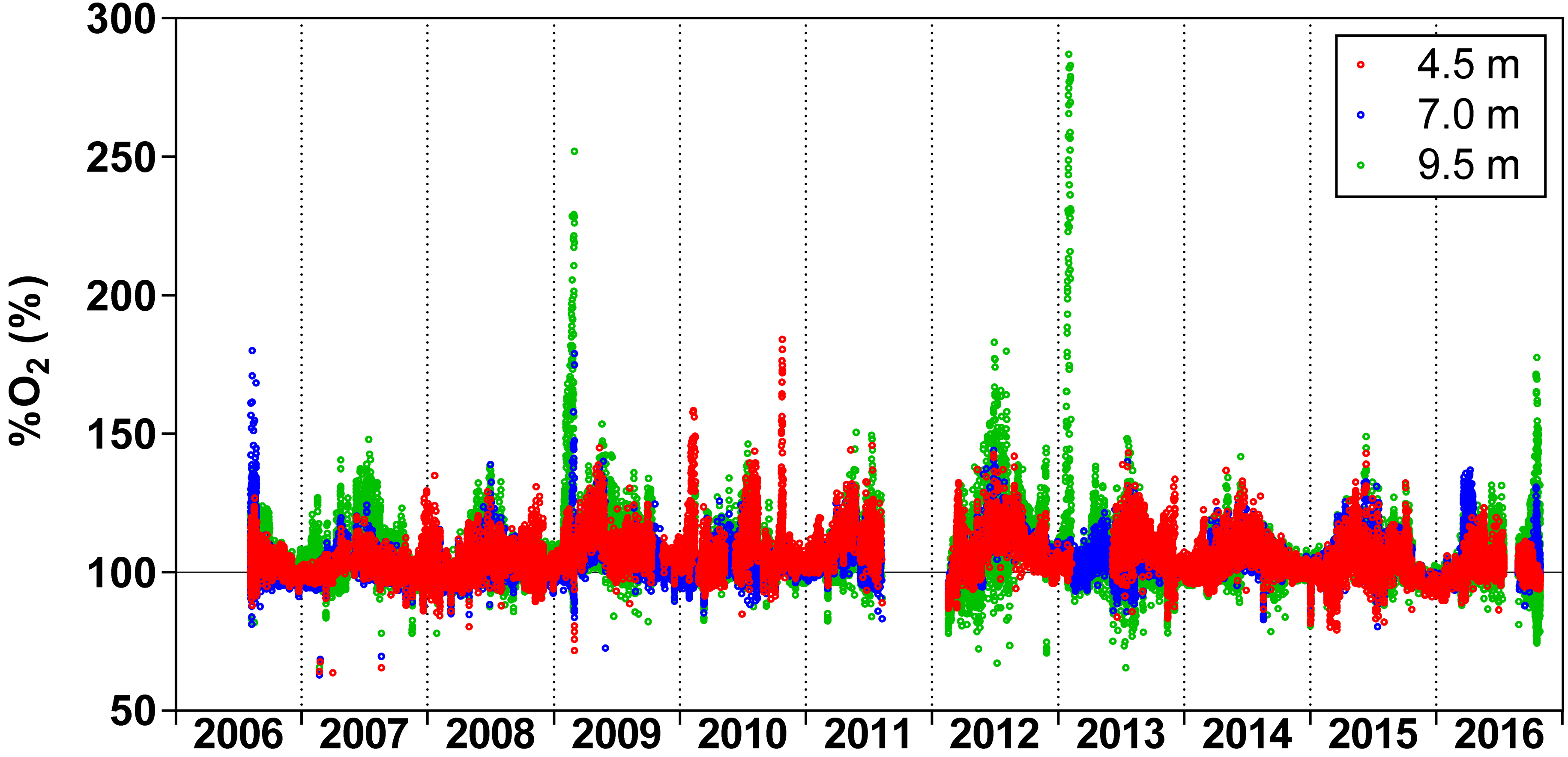
Results

GPP = Gross primary production
R = Community respiration



Higher O_2 at 10m
Higher daily amplitude of O_2 10m
} **Effluence of Posidonia biology**

Results

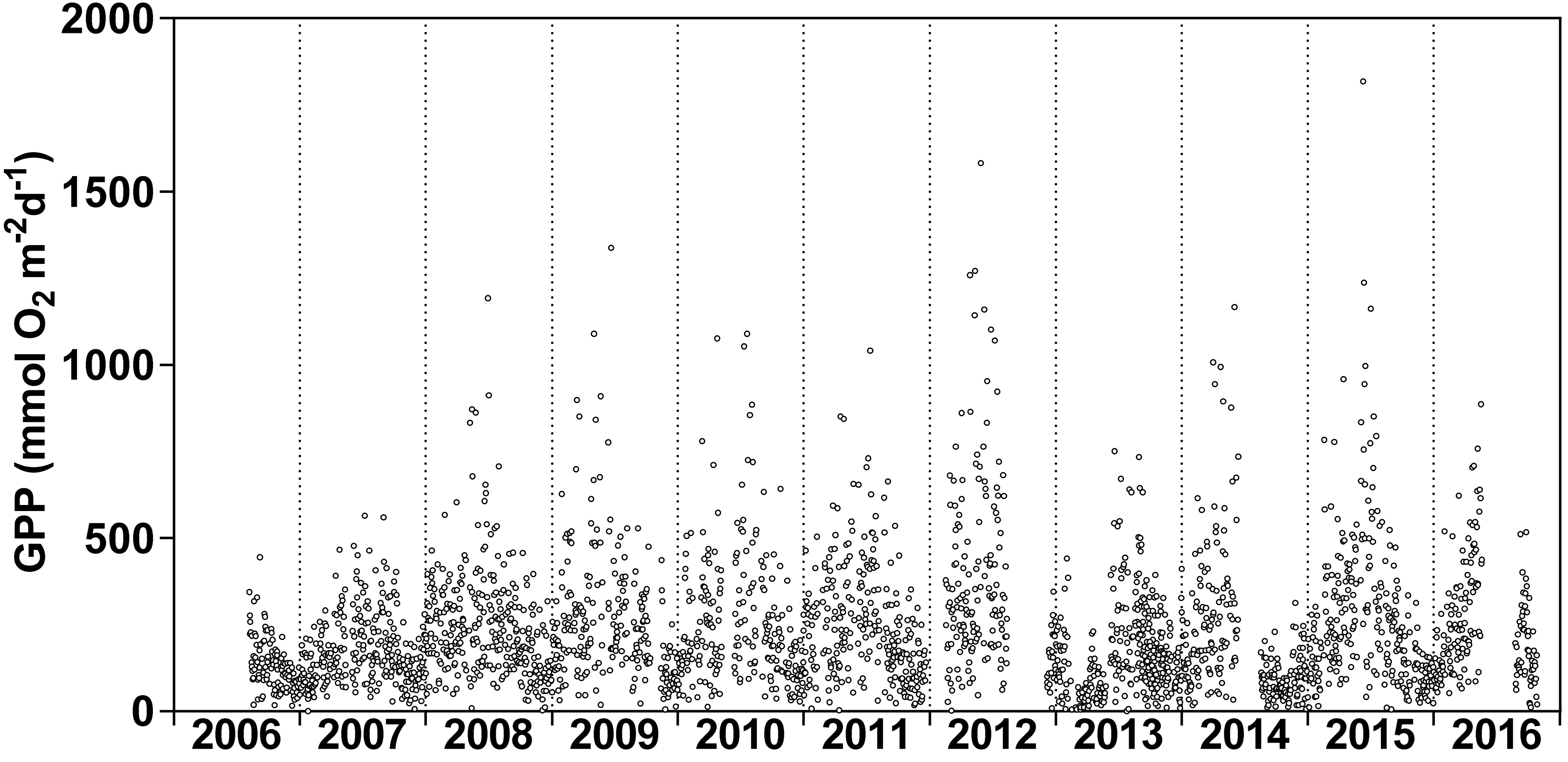


***n*~81,900 at each depth**

Average %O_2 = 104%

Net autotrophic Community

Results

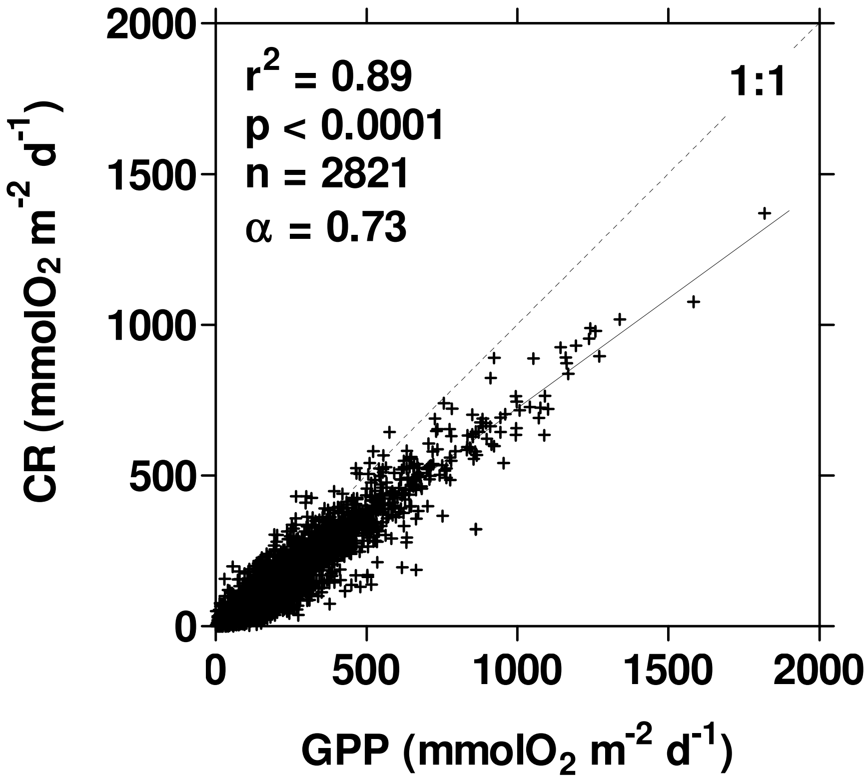


***n*=2821**

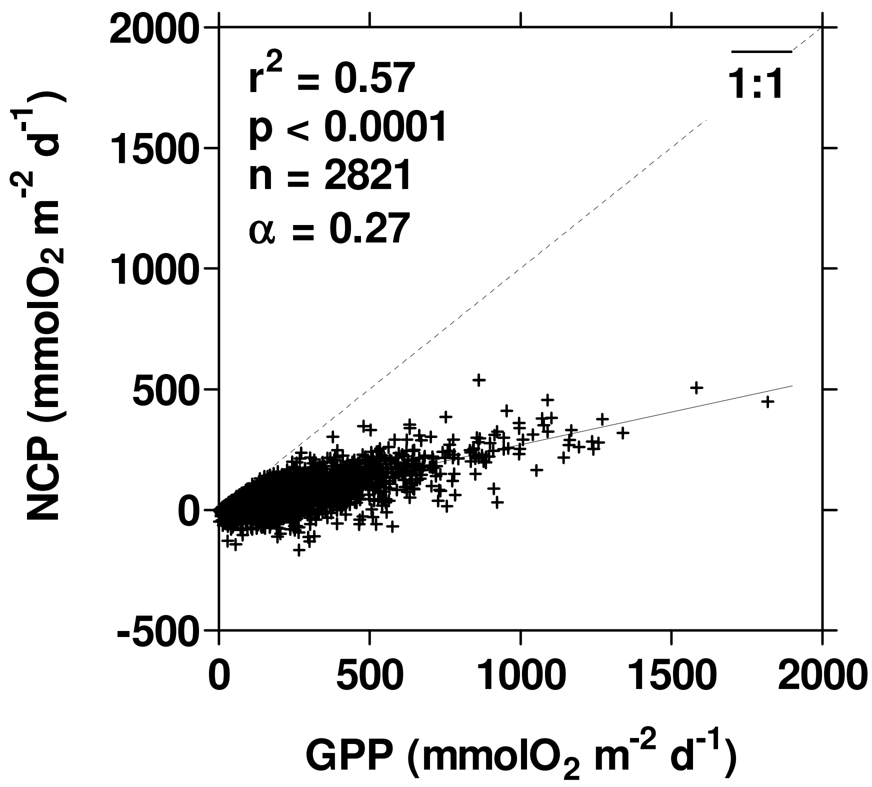
Range = 0.4 and 1818 mmol O_2 m^{-2} d^{-1}

Results

Community Respiration



Net Community production

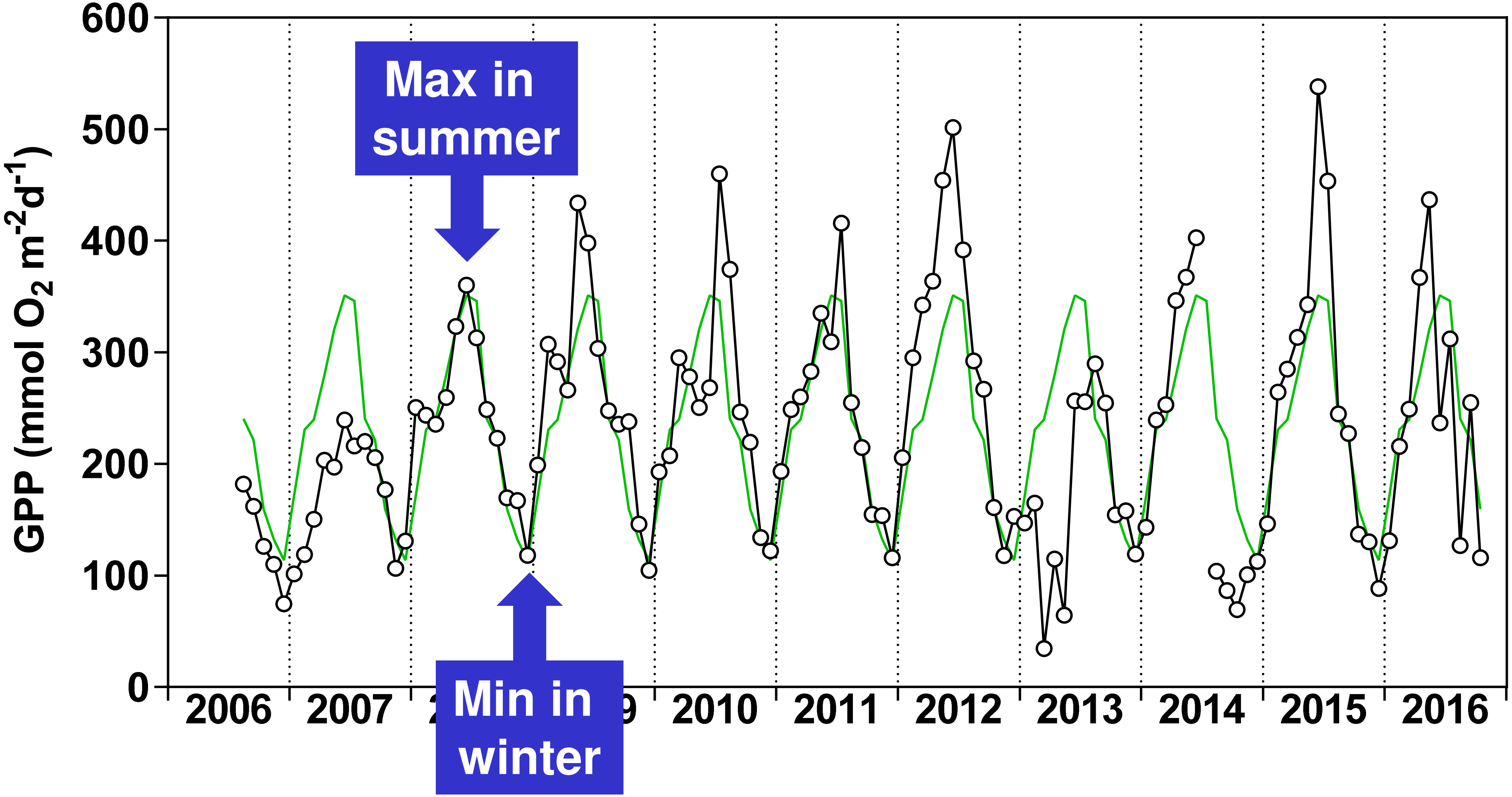


CR < GPP
Net autotrophic Community

NCP = 23 molO_2 m^{-2} yr^{-1}
on average

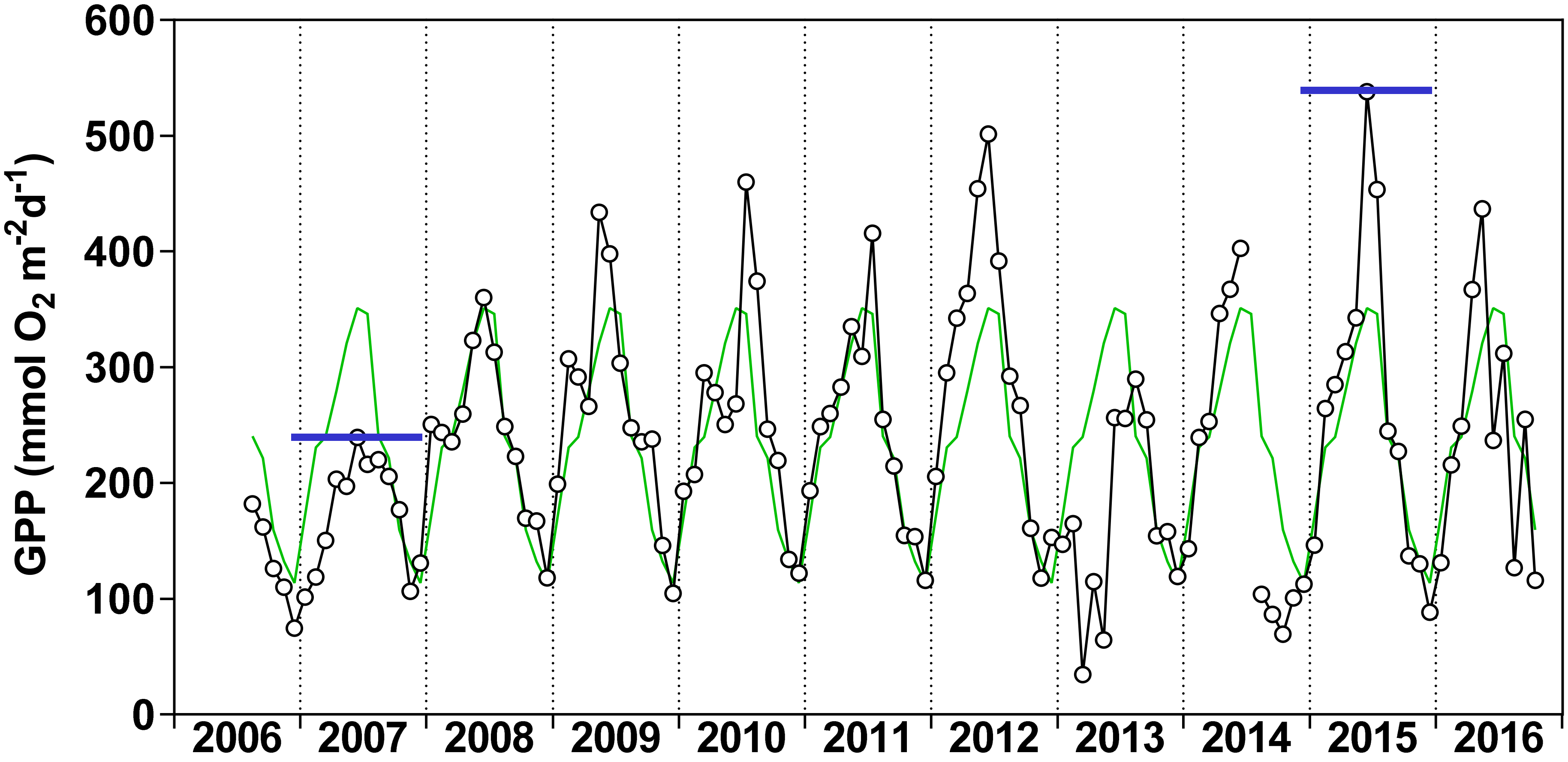
Results

Distinct seasonal pattern

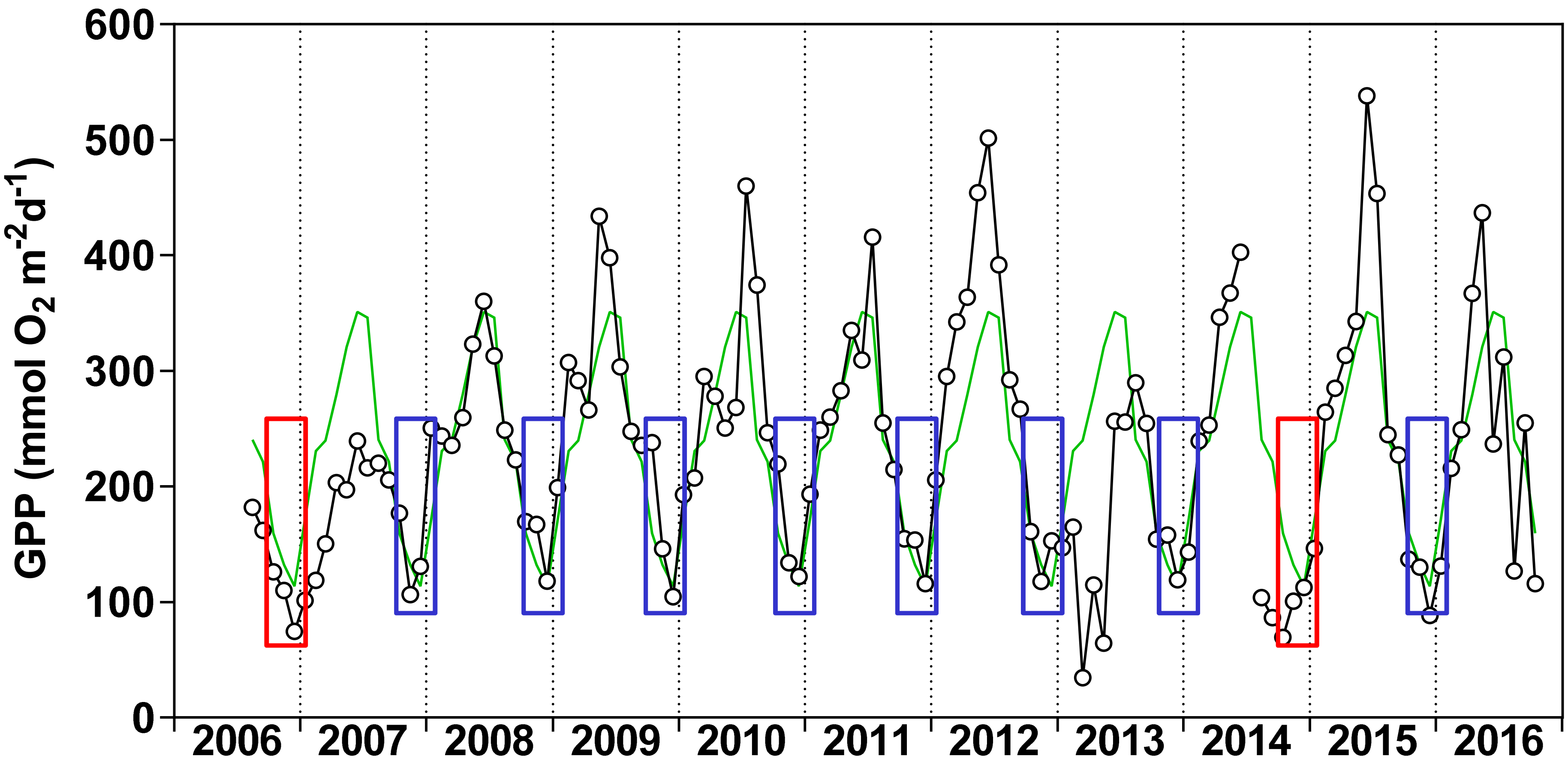


Results

Distinct inter-annual variations



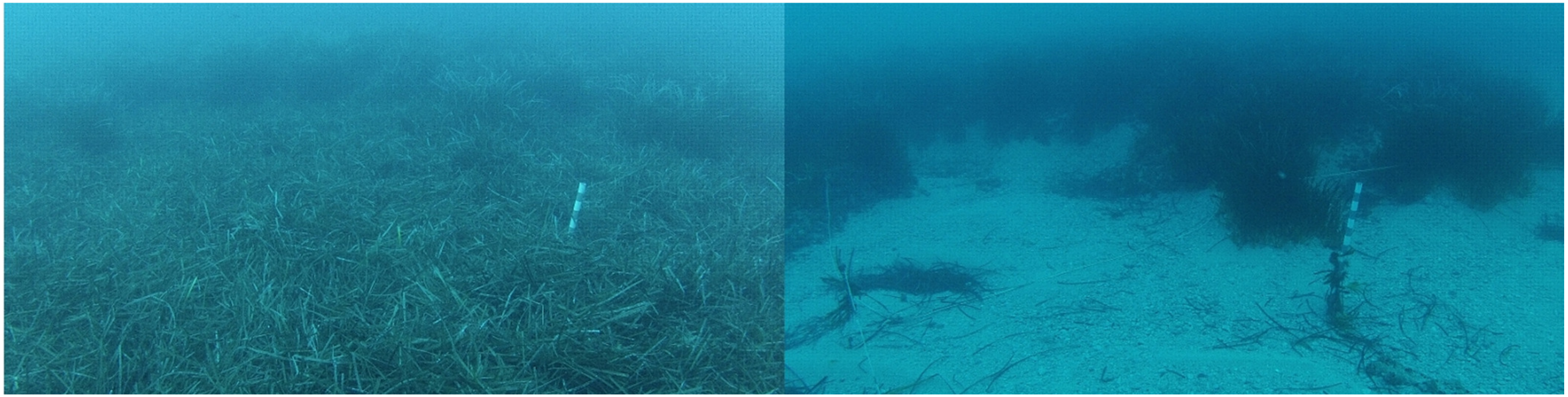
Results



Sept-Jan = repeatable

Except winters 2006-2007 & 2014-2015

Results



meadow + *Posidonia* litter
(end of summer)

Meadow clear of litter
(winter and start of next cycle)

→

Fall & winter storms

"Normal" year.
GPP by benthic sciaphile flora starts as soon as litter is cleared

Photo credit: Lepoint G.

Results

meadow + *Posidonia* litter
(end of summer)

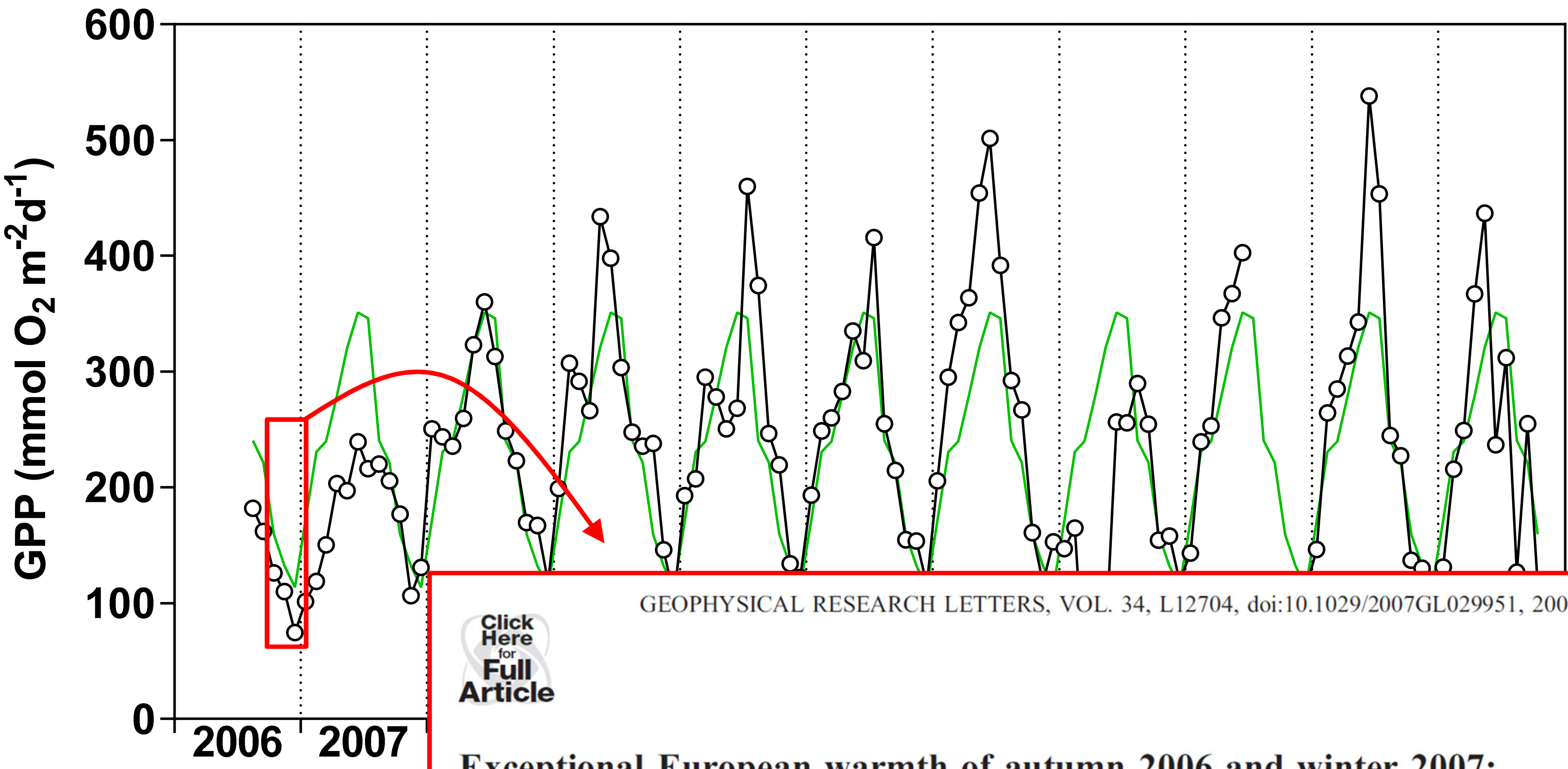
meadow + *Posidonia* litter
(winter and start of next cycle)

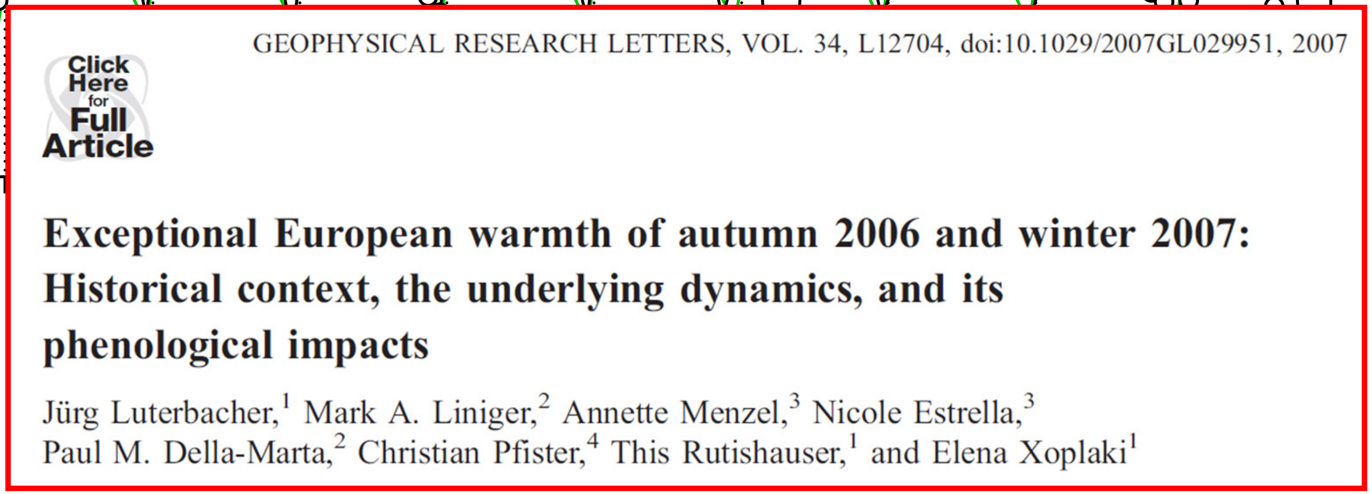
~~Fall & winter storms~~

"No storm" year.
GPP by benthic sciaphile flora does not occur (occultation)

Photo credit: Lepoint G.

Results




GEOPHYSICAL RESEARCH LETTERS, VOL. 34, L12704, doi:10.1029/2007GL029951, 2007

Click Here for Full Article

Exceptional European warmth of autumn 2006 and winter 2007: Historical context, the underlying dynamics, and its phenological impacts

Jürg Luterbacher,[1] Mark A. Liniger,[2] Annette Menzel,[3] Nicole Estrella,[3] Paul M. Della-Marta,[2] Christian Pfister,[4] This Rutishauser,[1] and Elena Xoplaki[1]

Results

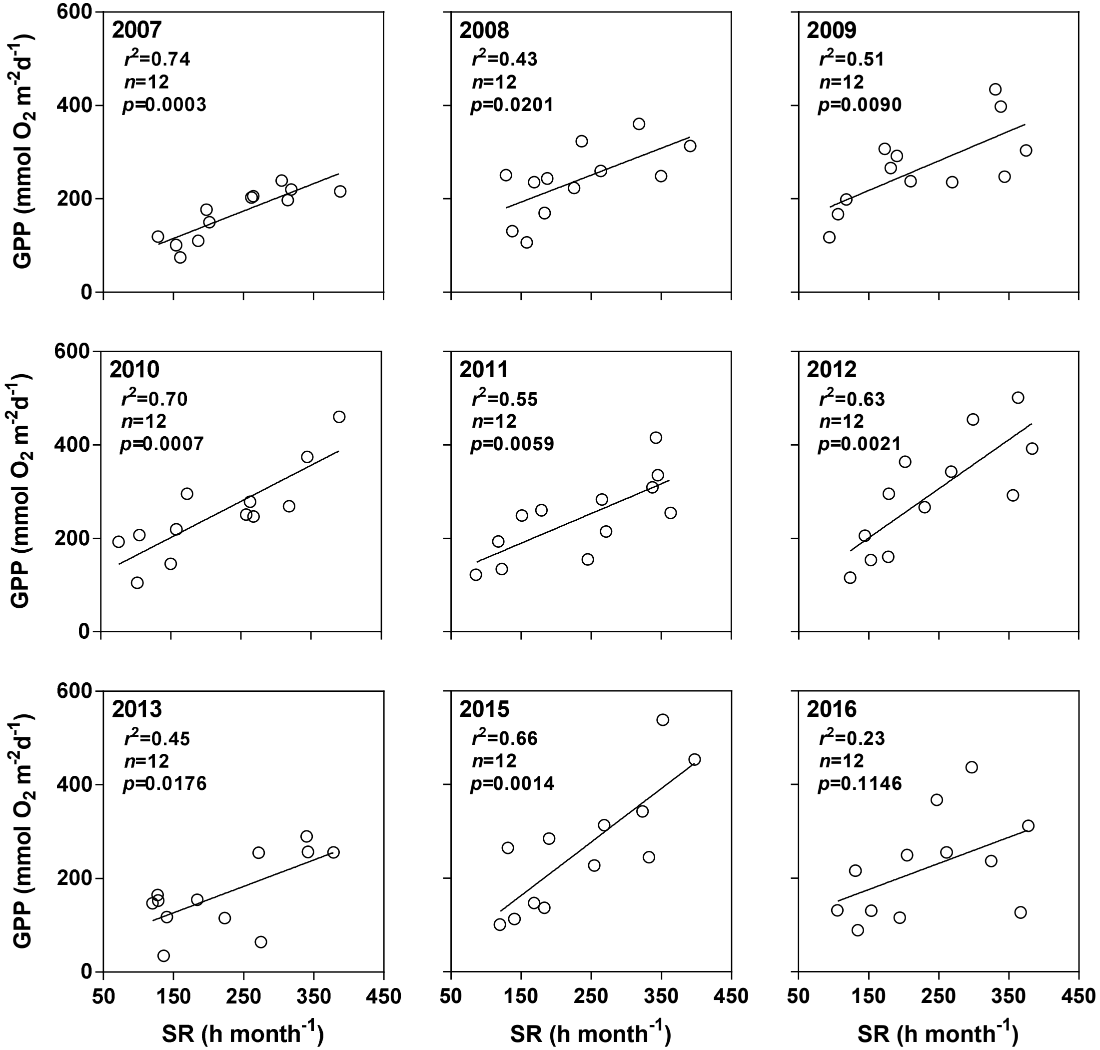
Analysis of inter-annual variability from February-August

& Solar radiation
& Sea surface temperature (SST)
& Chlorophyll-a
& Wind speed
& Precipiation

Results

Analysis of inter-annual variability from February-August

& Solar radiation



Results

Analysis of inter-annual variability from February-August

& Solar radiation
& Sea surface temperature (SST)
& Chlorophyll-a
~~& Wind speed~~
~~& Precipiation~~

Results

Analysis of inter-annual variability from February-August

February and March:

GPP = -6 + 0.0553 x Solar radiation + 3.08 x Chlorophyll-a
$(r=0.87 > r_{crit(0.95,\ n=9)}=0.44)$

Positive correlation with Chlorophyll-a
≠ phytoplanktonic contribution to GPP
= winter nutrient inputs increase both planktonic and benthic production

Results

Analysis of inter-annual variability from February-August

February and March:

GPP = -6 + 0.0553 x Solar radiation + 3.08 x Chlorophyll-a
($r=0.87 > r_{crit(0.95,\ n=9)}=0.44$)

April:

GPP = 29 - 0.061 x solar radiation + 4.33 x Chlorophyll-a
- 0.31 x Sea Surface Temperature
($r=0.90 > r_{crit\ (0.95,\ n=9)}=0.44$)

Negative relationship with SST and Solar radiation:

during this period high SST and high solar radiation
= early stratification
= lower nutrient inputs (from mixing)

Results

Analysis of inter-annual variability from February-August

February and March:

GPP = -6 + 0.0553 x Solar radiation + 3.08 x Chlorophyll-a
($r=0.87 > r_{crit(0.95,\ n=9)}=0.44$)

April:

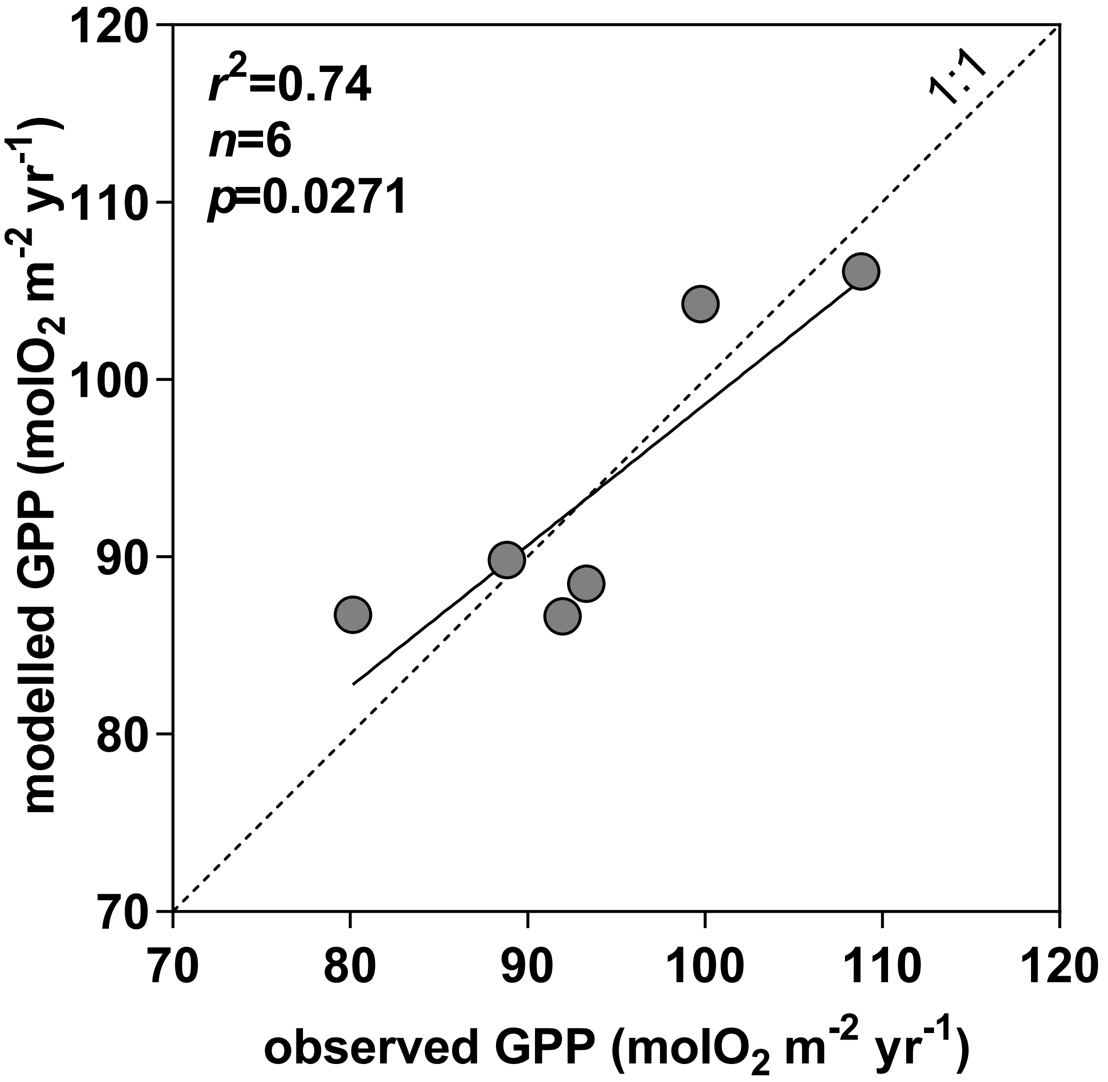
GPP = 29 - 0.061 x solar radiation + 4.33 x Chlorophyll-a
- 0.31 x Sea Surface Temperature
($r=0.90 > r_{crit\ (0.95,\ n=9)}=0.44$)

May to August:

GPP = -287 + 0.052 x solar radiation
+ 11.93 x sea surface temperature
($r=0.93 > r_{crit\ (0.95,\ n=9)} = 0.44$)

Results

Combination of GPP models for each period allows to predict annual GPP



Conclusions

Does gross primary production (GPP) of *Posidonia oceanica* fluctuate inter-annually ?

Yes, annually from 61 to 108 $molO_2$ m^{-2} yr^{-1}.
Mostly related to solar radiation, modulated by temperature and nutrient inputs.

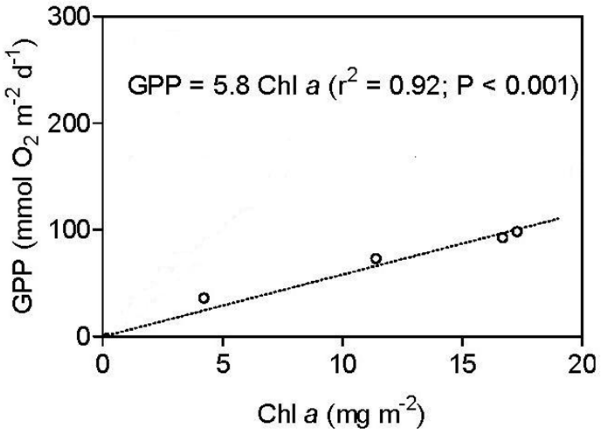
Is GPP of *P. oceanica* increasing or decresing in the Mediterranean Sea ?

I don't know.
But at our study site, GPP was stable from 2006 to 2016.


Funded by
Fonds National de la Recherche Scientifique (FNRS)
Photo credit: Miche

Q&A

Planktonic versus benthic GPP ?



→ Chl *a* from our fluorometer → (very) rough estimate of planktonic GPP

GPP = f (Chl *a*)
Bay of Palma (Mallorca)
Gazeau et al. (2005)

01 August 2006 - 01 August 2007:

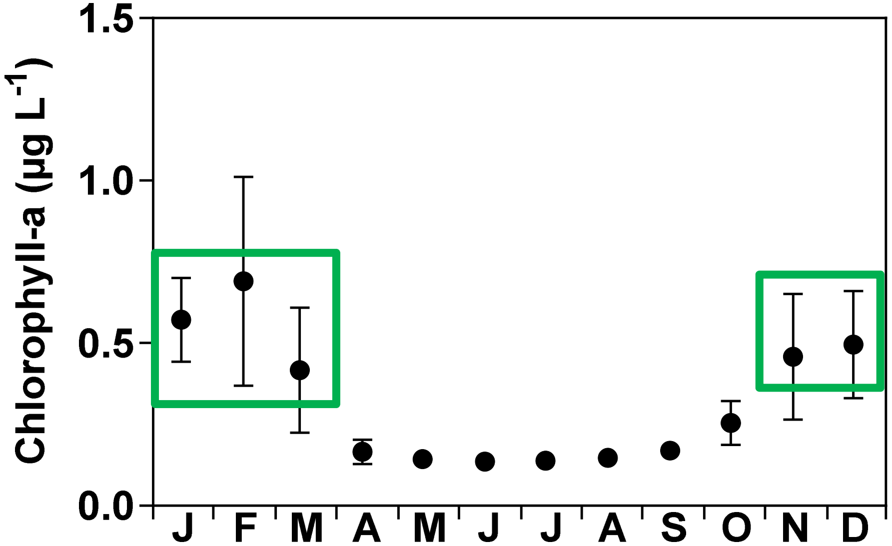
calculated planktonic GPP
range ~0.0 to 92.6 mmol O_2 m^{-2} d^{-1},
average 4.5 mol O_2 m^{-2} yr^{-1}.

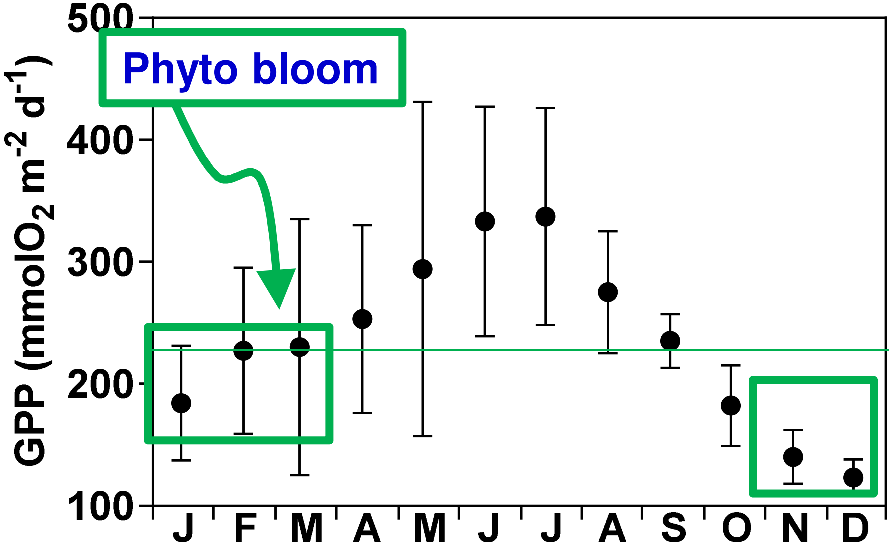
community GPP
range 0.4 to 564.6 mmol O_2 m^{-2} d^{-1}
average 56.9 mol O_2 m^{-2} yr^{-1}

Planktonic compartment contributes <10% of community GPP on an annual scale in this specific community at this depth.

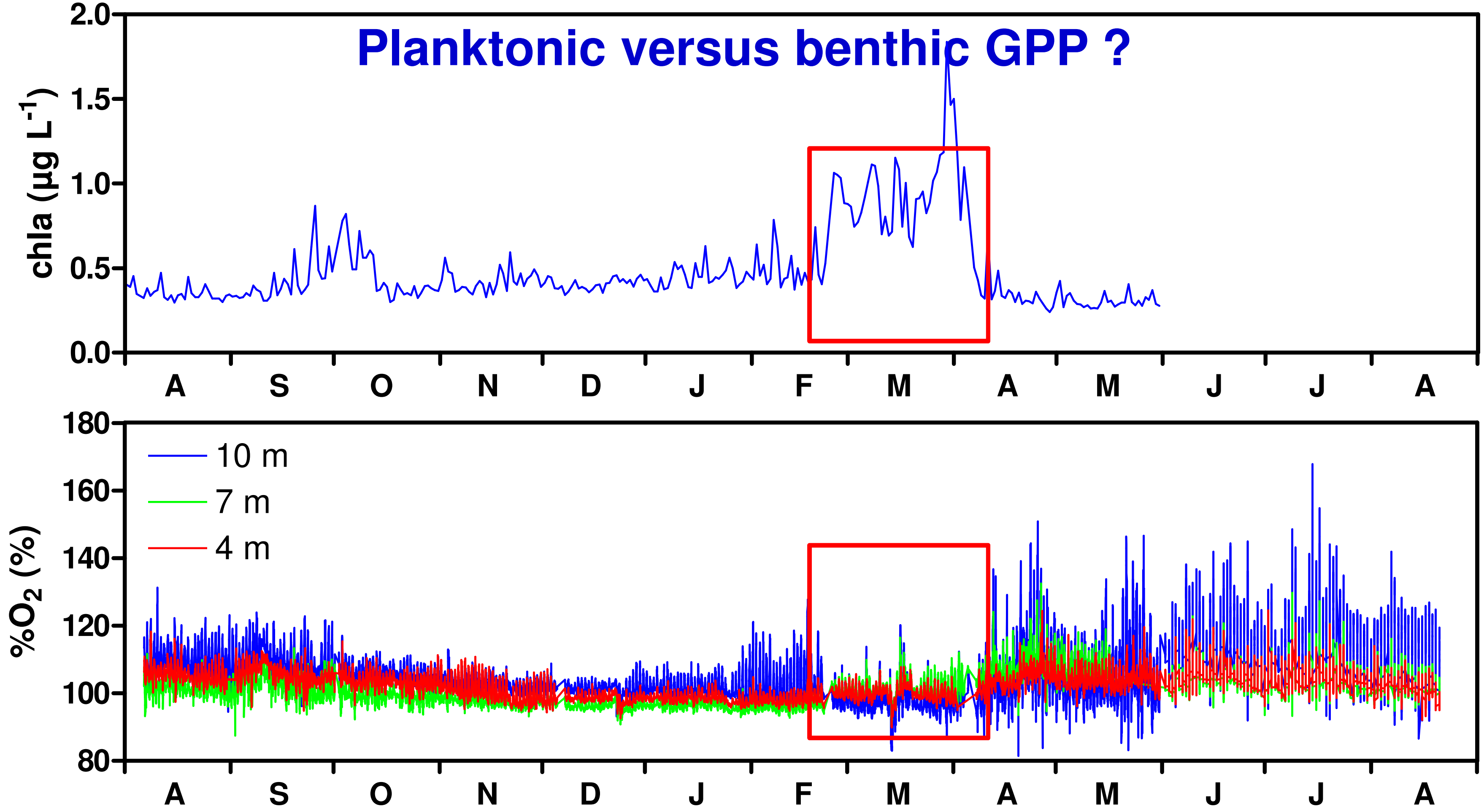
Q&A

Planktonic versus benthic GPP ?



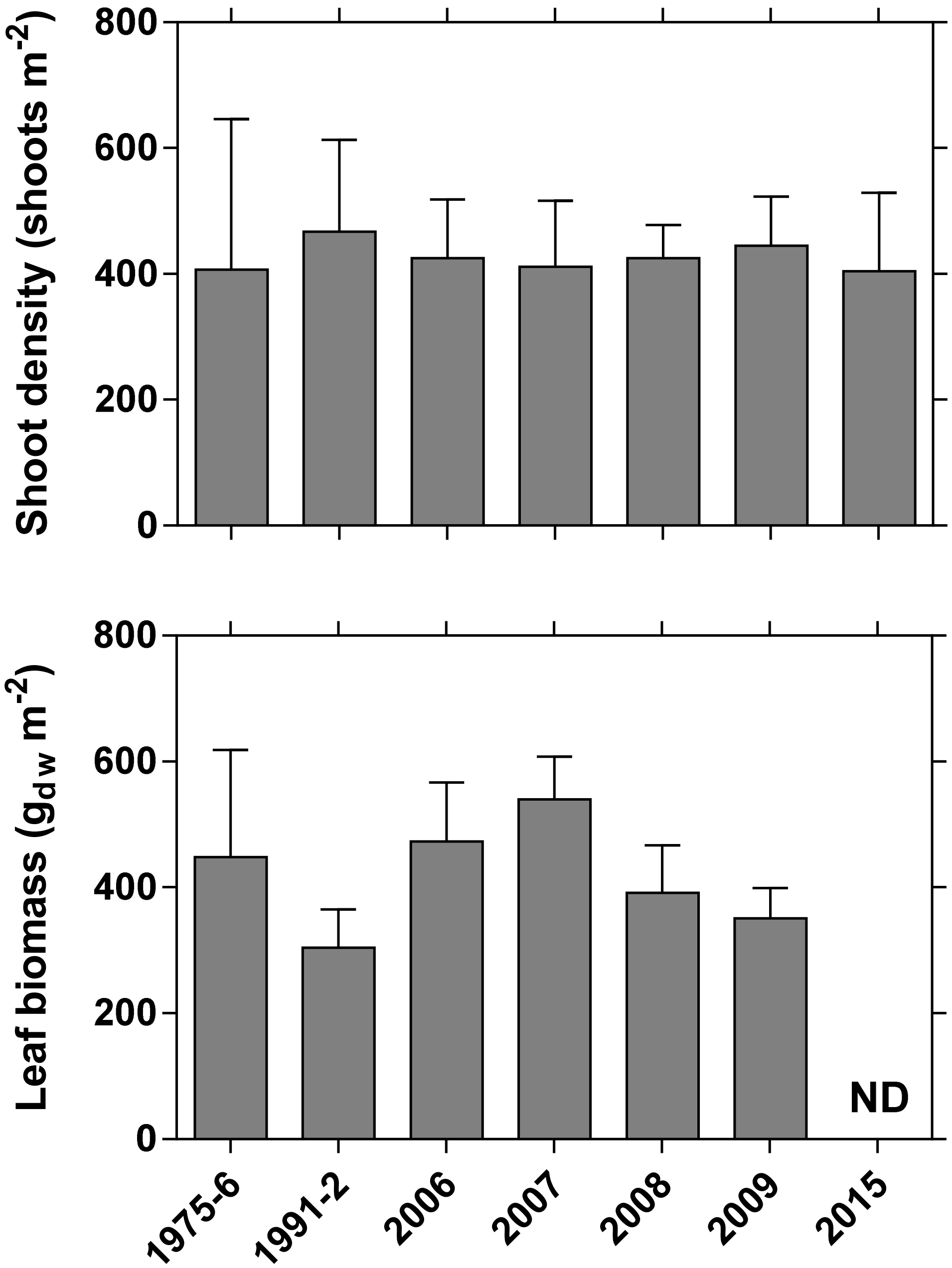


Q&A

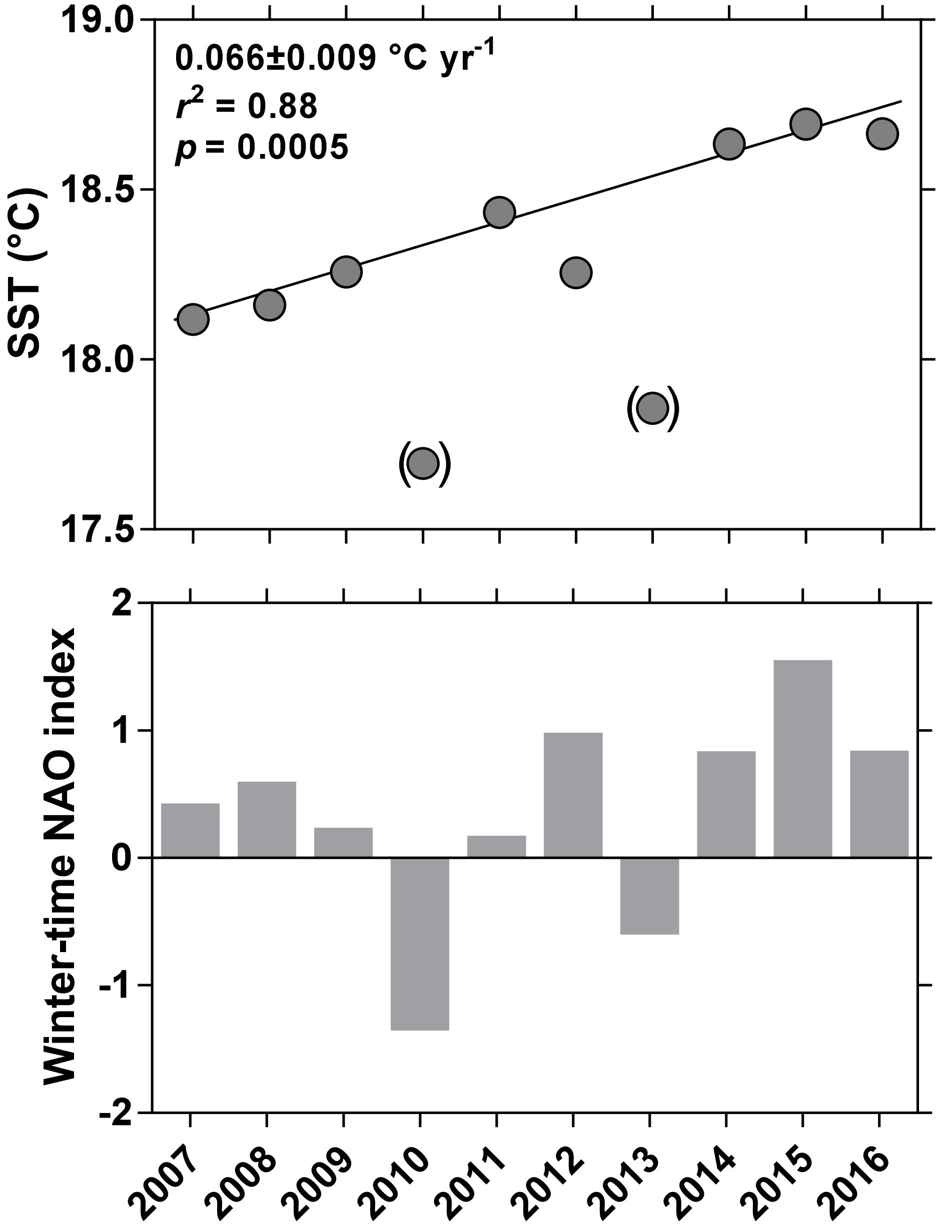


= phytoplankton bloom => shading effect on Posidonia

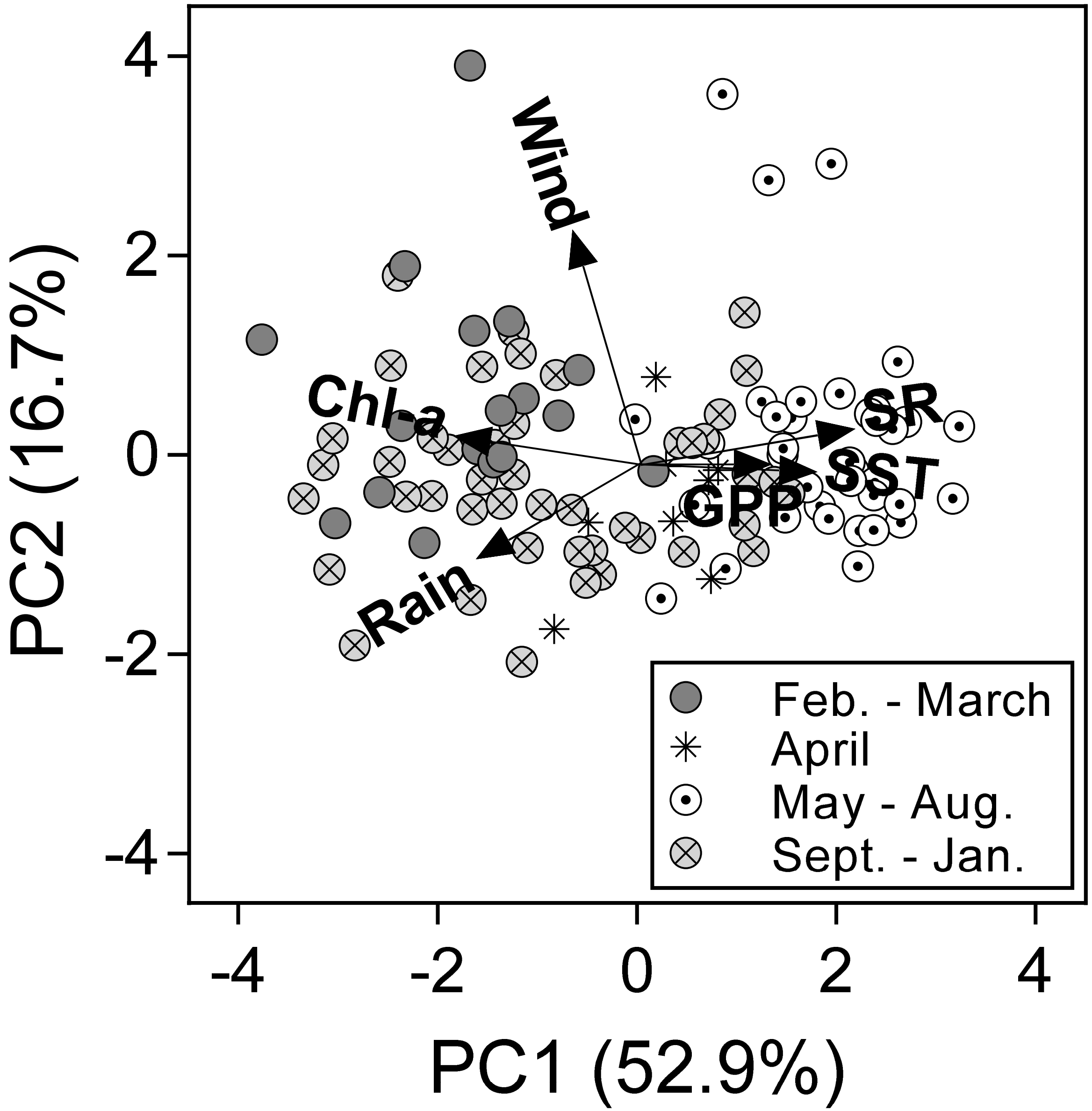
Q&A


Shoot density (shoots m-2)
0
200
400
600
800
Leaf biomass (gdw m-2)
0
200
400
600
800
ND
1975-6
1991-2
2006
2007
2008
2009
2015

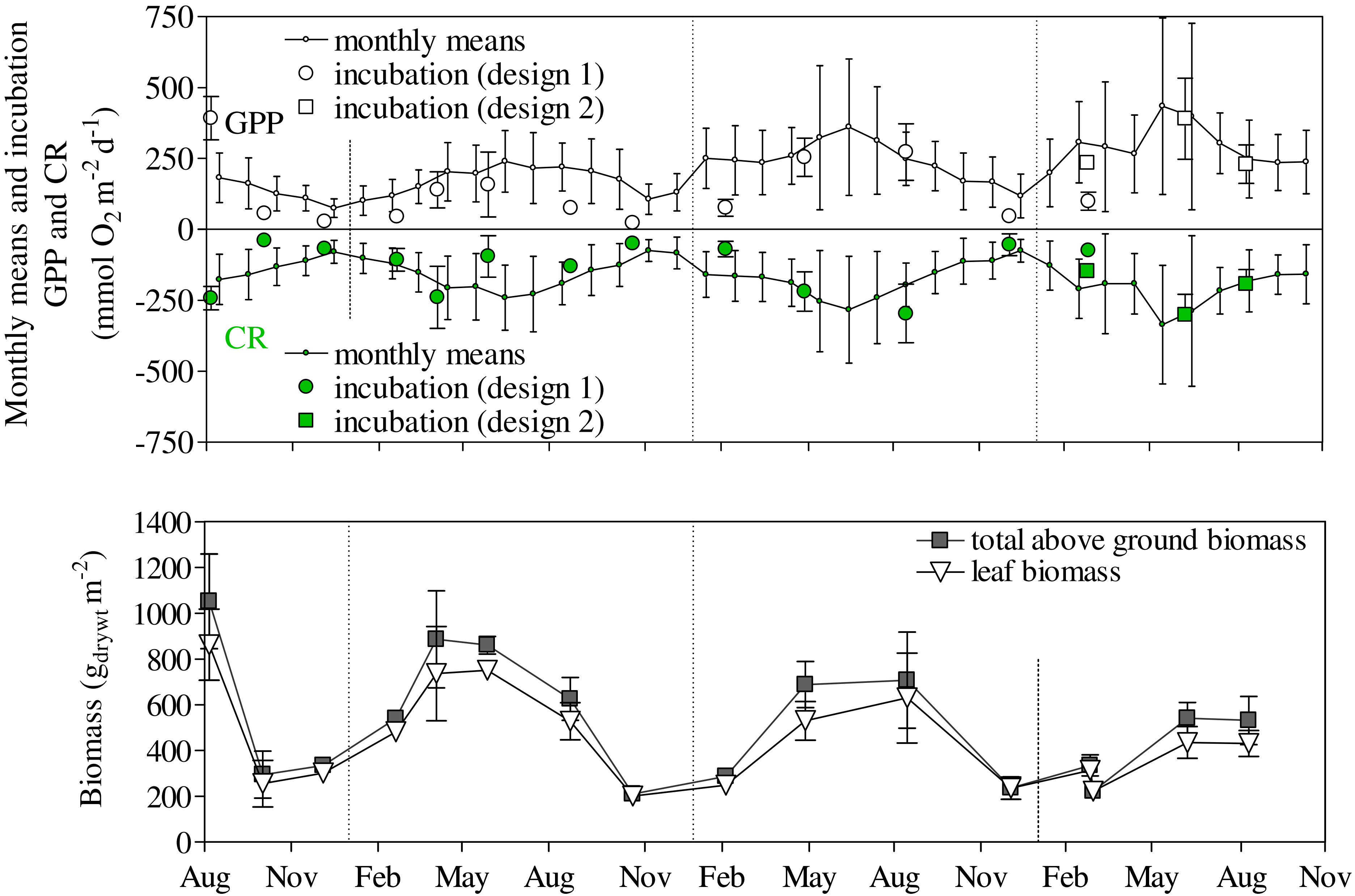
Q&A


19.0
18.5
18.0
17.5
SST (°C)
0.066±0.009 °C yr-1
r2 = 0.88
p = 0.0005
2
1
0
-1
-2
Winter-time NAO index
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

Q&A


Wind
Chl-a
SR
SST
GPP
Rain
Feb. - March
April
May - Aug.
Sept. - Jan.
PC2 (16.7%)
PC1 (52.9%)
4
2
0
-2
-4
-4
-2
0
2
4

Q&A


Monthly means and incubation GPP and CR (mmol O2 m-2 d-1)
750
500
250
0
-250
-500
-750
GPP
monthly means
incubation (design 1)
incubation (design 2)
CR
monthly means
incubation (design 1)
incubation (design 2)
Biomass (gdrywt m-2)
1400
1200
1000
800
600
400
200
0
total above ground biomass
leaf biomass
Aug
Nov
Feb
May
Aug
Nov
Feb
May
Aug
Nov
Feb
May
Aug
Nov

Q&A

Limnol. Oceanogr., 57(1), 2012, 347–361

doi:10.4319/lo.2012.57.1.0347

Seasonal and interannual variations of community metabolism rates of a *Posidonia oceanica* seagrass meadow

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Abstract

We report gross primary production (GPP), community respiration (CR), and net community production (NCP) over a *Posidonia oceanica* meadow at 10 m in Corsica (Bay of Revellata) based on the open water O_2 mass balance from a data set of hourly measurements with an array of three O_2 optodes deployed from August 2006 to October 2009. The method was checked by comparison with discrete measurements of metabolic rates derived from benthic chamber incubations also based on the diel change of O_2. This comparison was satisfactory and actually highlights the potential caveats of benthic incubation measurements related to O_2 accumulation in small chambers leading to photorespiration and an underestimation of GPP. Our data confirmed previous *P. oceanica* meadows GPP and CR values, strong seasonal variations, and net autotrophy. High-resolution data revealed strong interannual variability, with a decrease of GPP by 35% and NCP by 87% during 2006–2007 characterized by a mild and less stormy winter compared with 2007–2008 and 2008–2009. *P. oceanica* meadows are then expected to decrease export of organic carbon to adjacent communities (decrease of NCP), since a decrease in frequency and intensity of marine storms is expected in the future in the Mediterranean Sea as a result of a northward shift of the Atlantic storm track.