Almost 6 months of CARIOCA hourly measurements of fugacity of CO_2 and temperature at 40m depth: preliminary analysis

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Context:
A region already sampled by CARIOCA during KEOPS2

November 2011-February 2012:
a CARIOCA buoy launched during KEOPS2:
a lagrangian study with measurements at 2 meters depth.

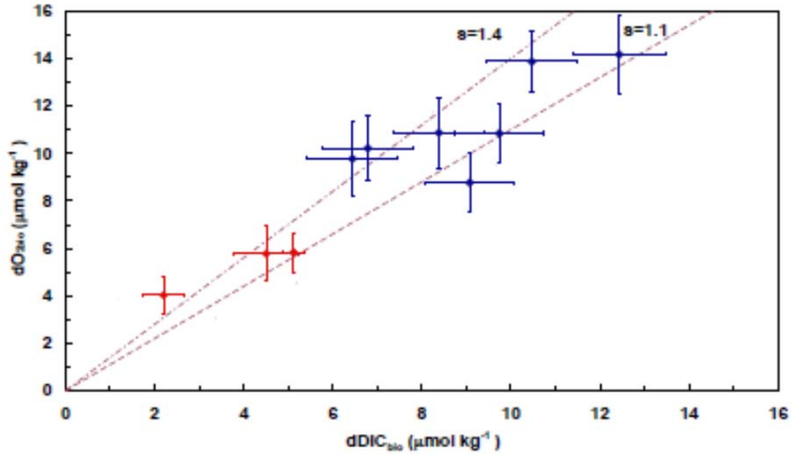
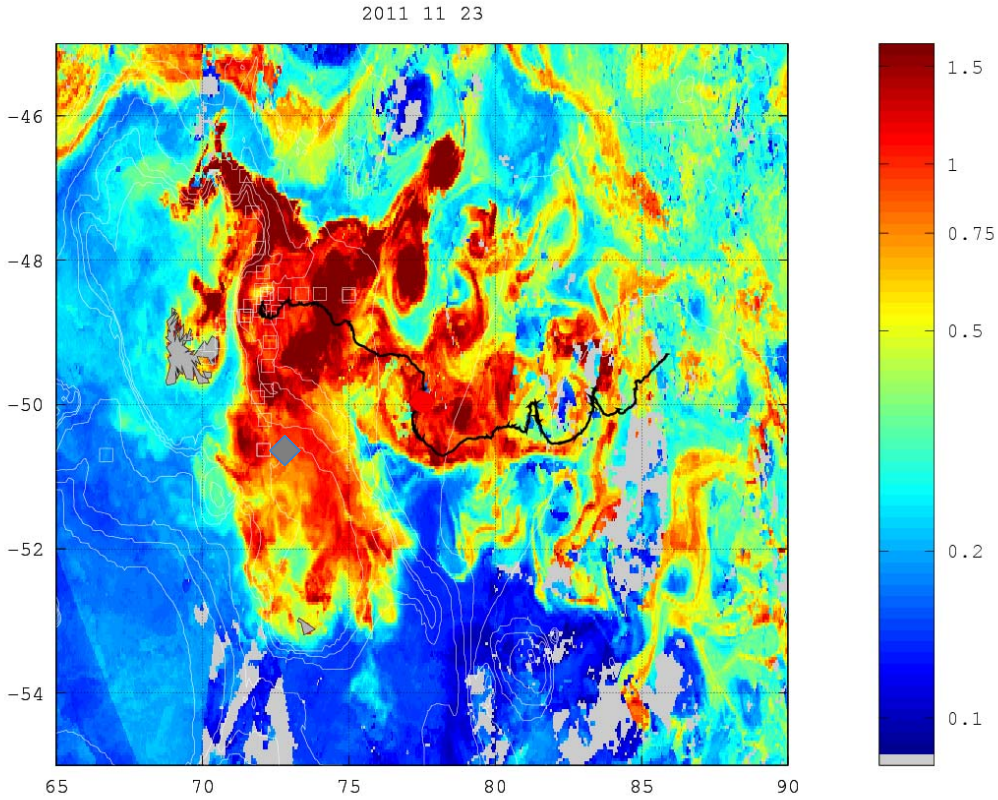


Figure 9. Changes (absolute values) of O_2 ($\mu mol\, kg^{-1}$) attributed to biological activity as a function of changes (absolute values) of DIC ($\mu mol\, kg^{-1}$) attributed to biological activity between consecutive mornings (red dots) or during the daylight period (blue dots). The two dotted lines with a slope of 1.4 and 1.1, respectively, characterize the new and regenerated production regime.



Merlivat et al. 2015

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Context:
A region already sampled by CARIOCA during KEOPS2

November 2011-February 2012:
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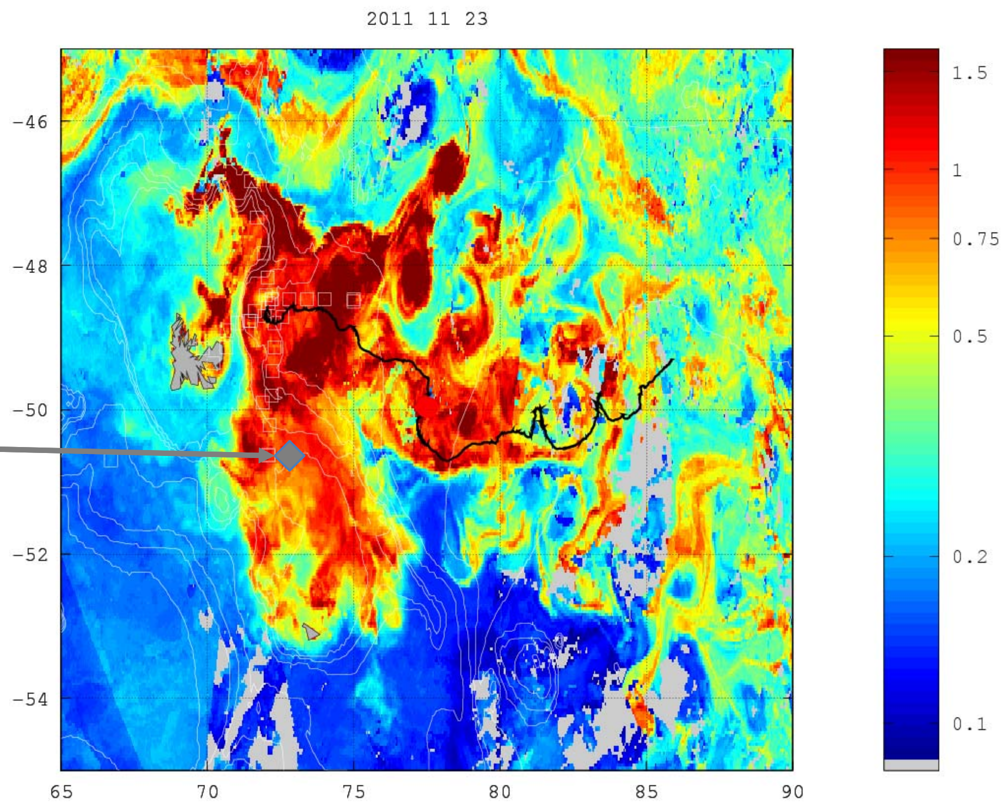
a lagrangian study with measurements at
2 meters depth.

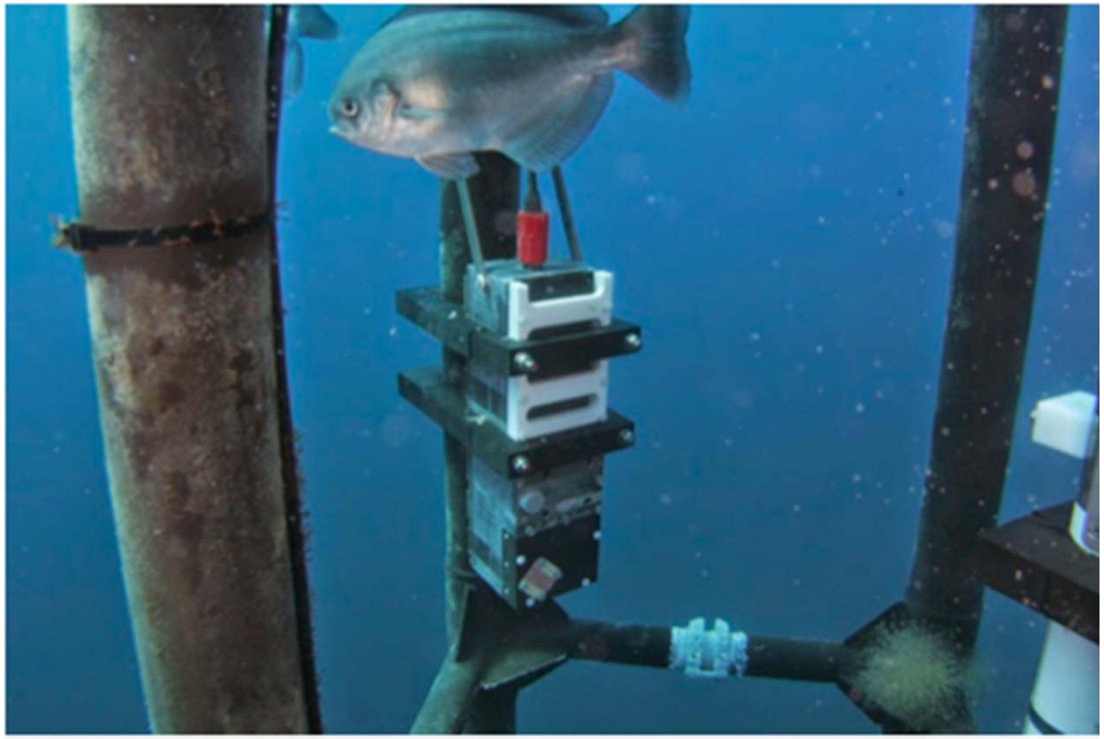
October 2016-April 2017:
SOCLIM: measurements on a mooring
at 40 meters depth.



Context:
CARIOCA sensor on SOCLIM mooring: An heritage of BIOCAREX/BOUSSOLE mooring experiment

Hourly measurements of fugacity of CO_2 , fCO_2 and temperature,T

Water intake



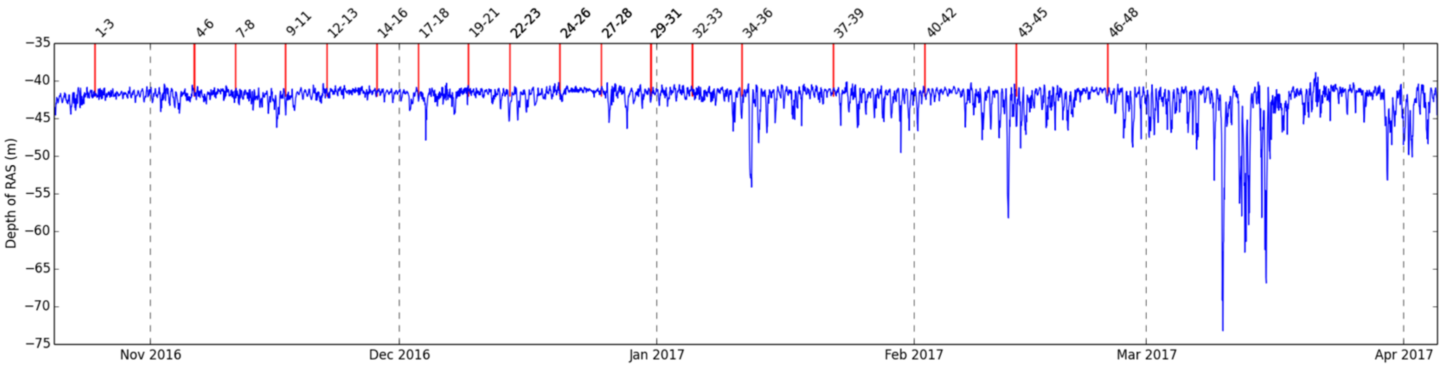
Carioca sensors on the BOUSSOLE mooring
at 3 and 10 meters- since 2013

Context

CARIOCA on SOCLIM:
a technological challenge

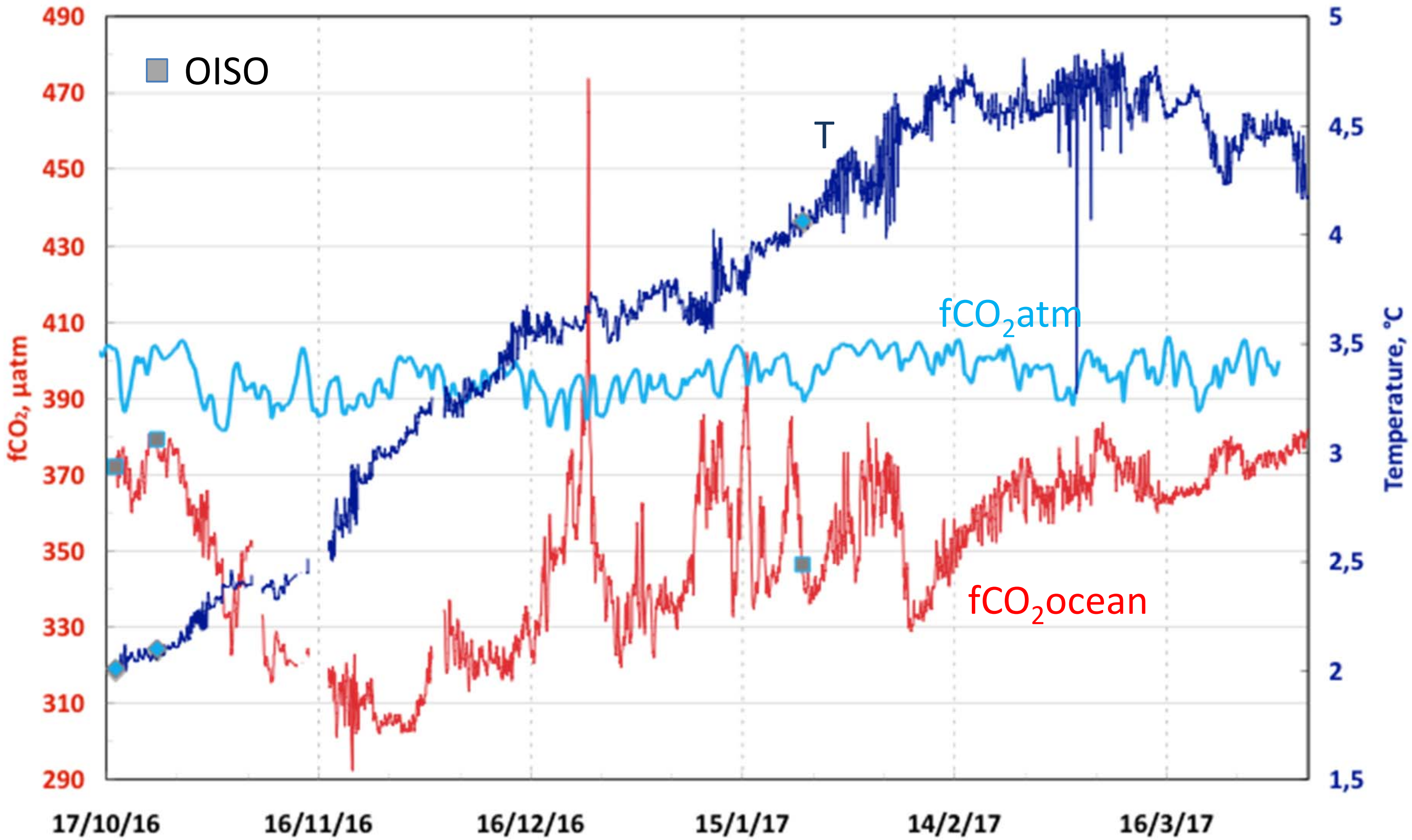
For the first time, CARIOCA sensor on a mooring at a depth close to 40 meters but up to 75 meters in March + internal waves (tides + inertial waves):
a continuous time series from October 2016 to April 2017 close to RAS

RAS Depth



S. Blain

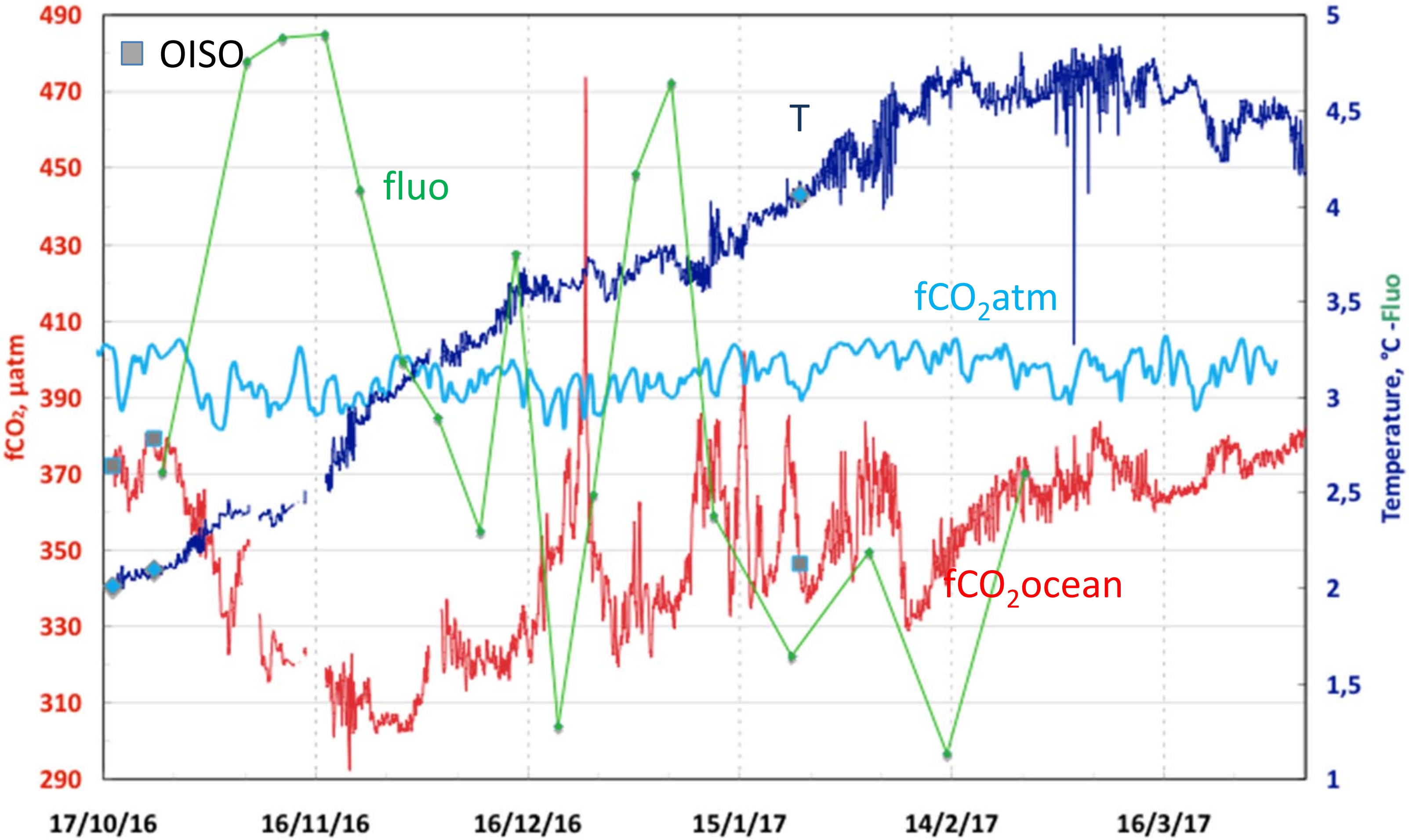
CARIOCA-SOCLIM measurements from 18 Oct 2016 to 6 April 2018



fCO2 atm (x,Crozet, December 2016, Patm from JRA v3, J.B. Sallee)
fCO2 et T OISO (st A3,40m-), used for in situ calibration of fCO_2,
(October 2016), and January 2017

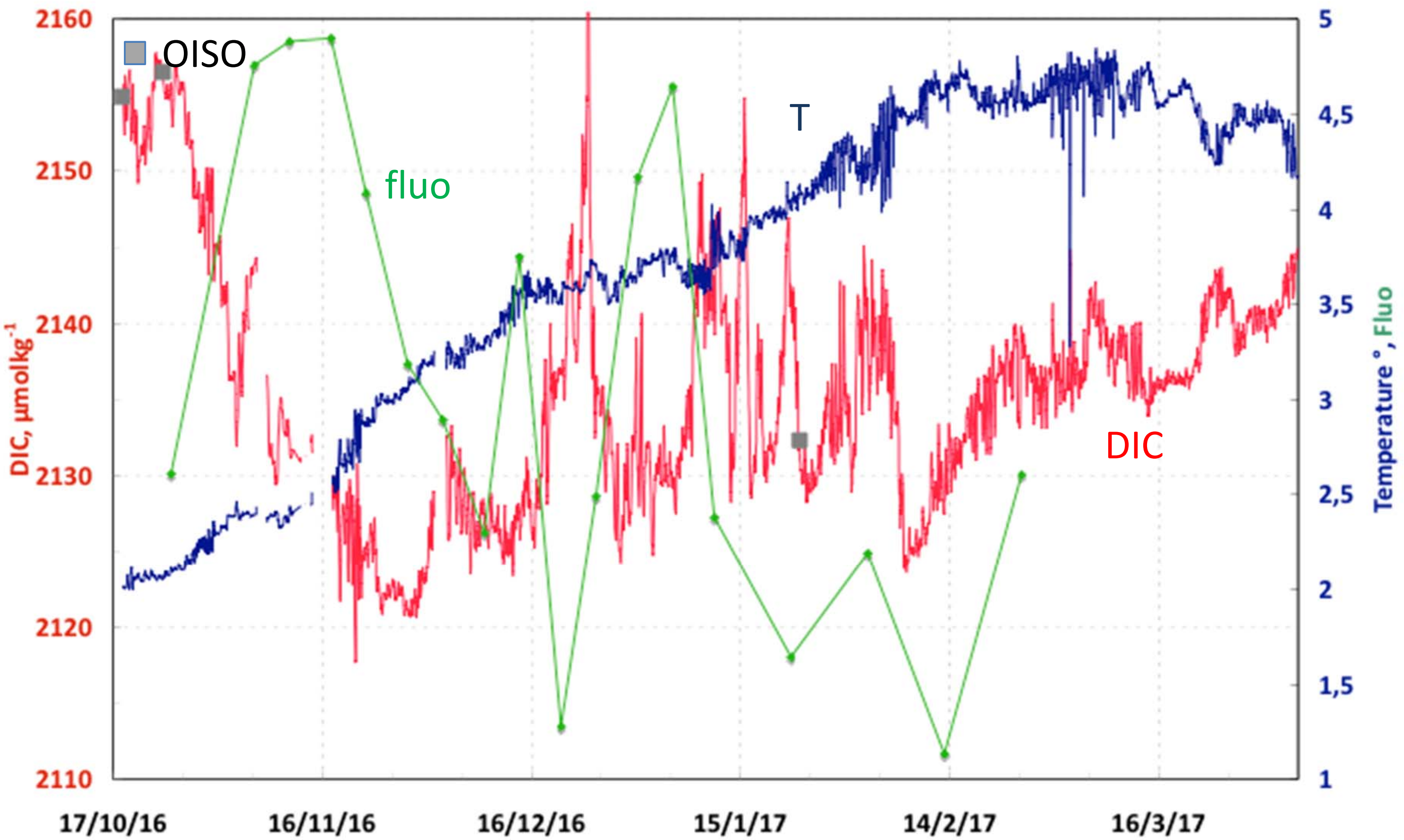
A sink for atmospheric CO2
Flux to be calculated later

CARIOCA-SOCLIM measurements from 18 Oct 2016 to 6 April 2018



+ fluo from samples collected on the RAS (S.Blain)

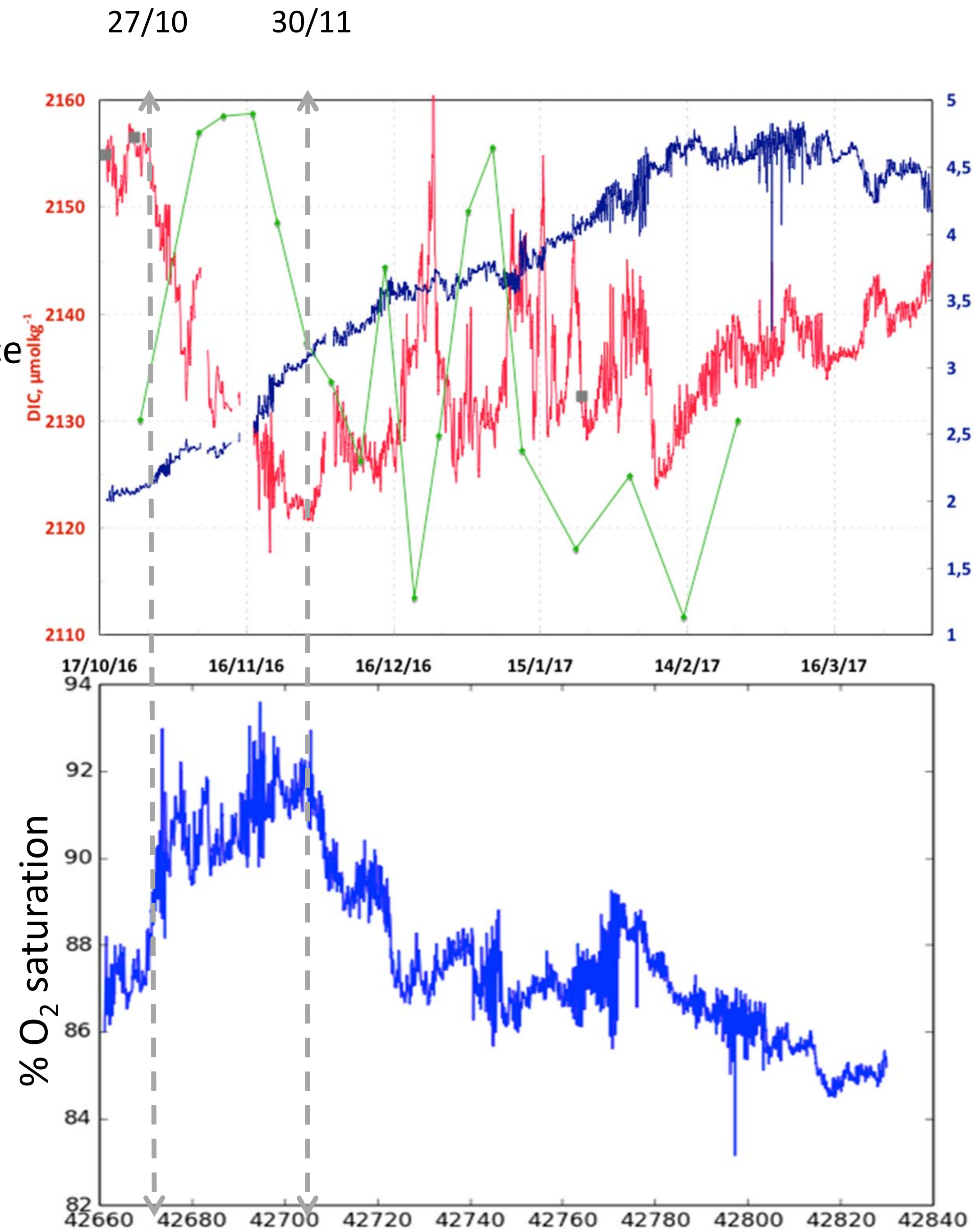
CARIOCA-SOCLIM measurements from 18 Oct 2016 to 6 April 2018



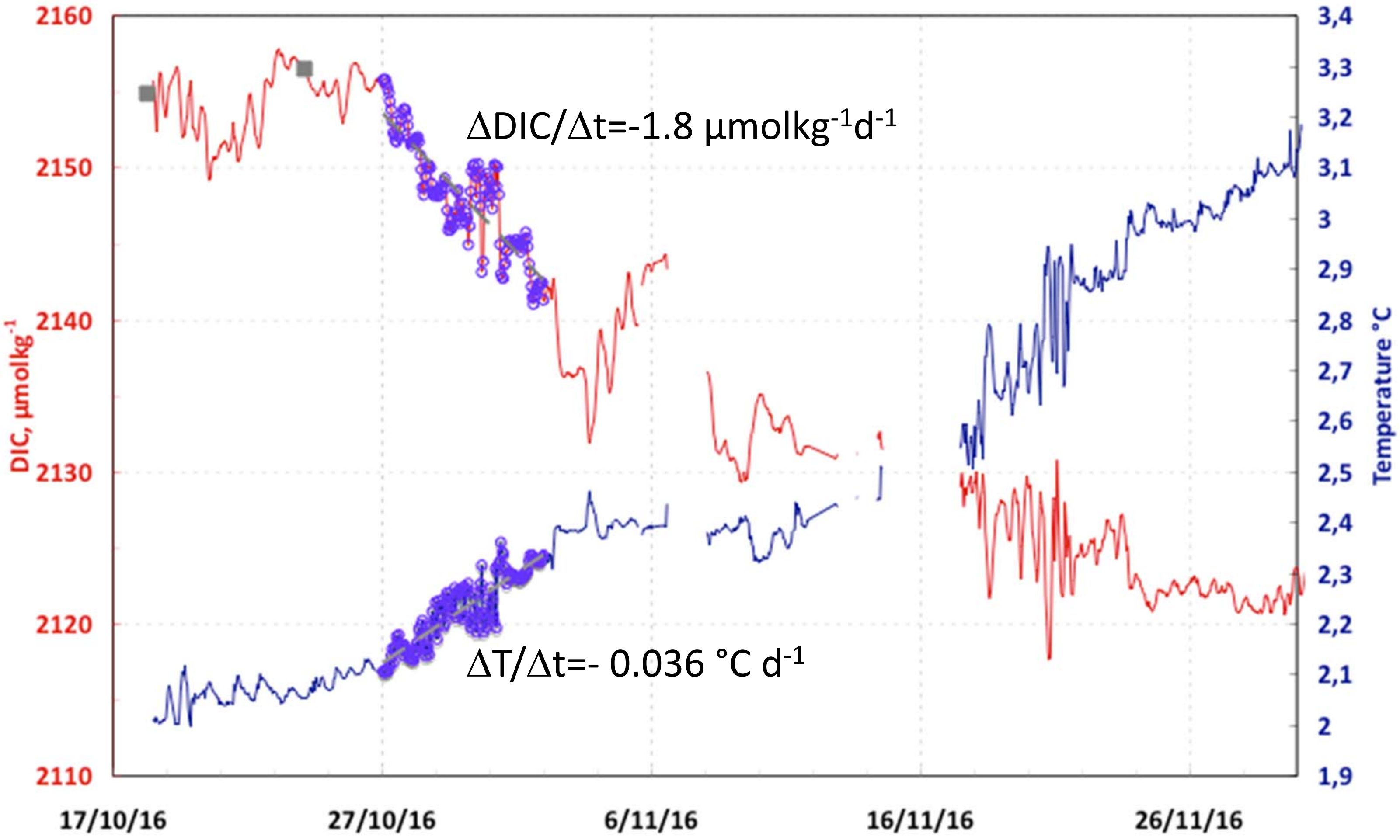
DIC calculated with the relation fCO2@2°/DIC based on the OISO data.
Future: DIC to be calculated with the salinity+ the relation Alk/sal

Large drawdown of DIC from October 27 to November 30 →signature of the onset of the bloom.

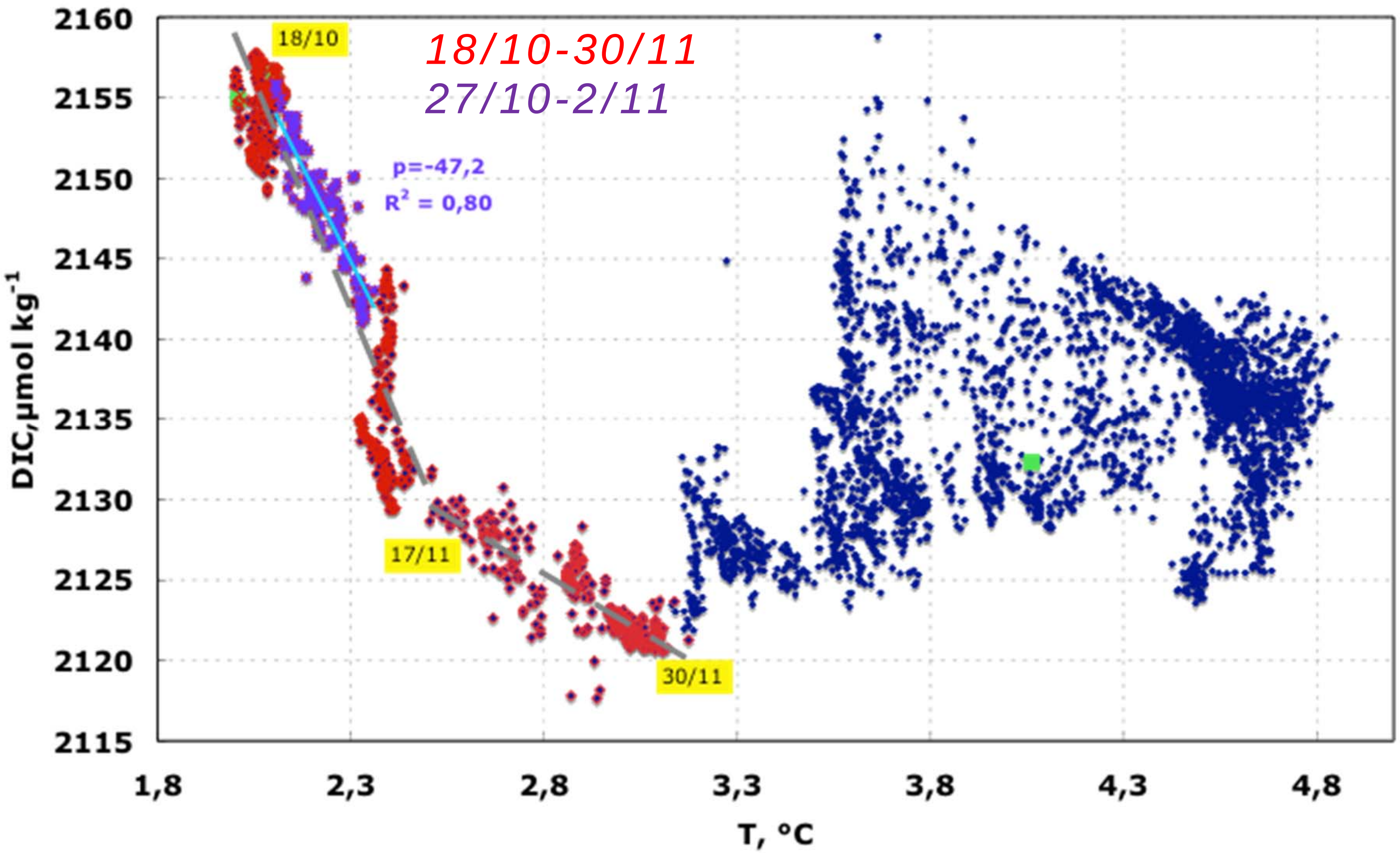
O_2 data very preliminary, not calibrated (S.Blain).
However, even qualitatively, clear evidence of a strong biological event seen by DIC, O2 and Fluo between October 27 and November 30



CARIOCA-SOCLIM Spring 2016 – Preliminary estimate of NCP

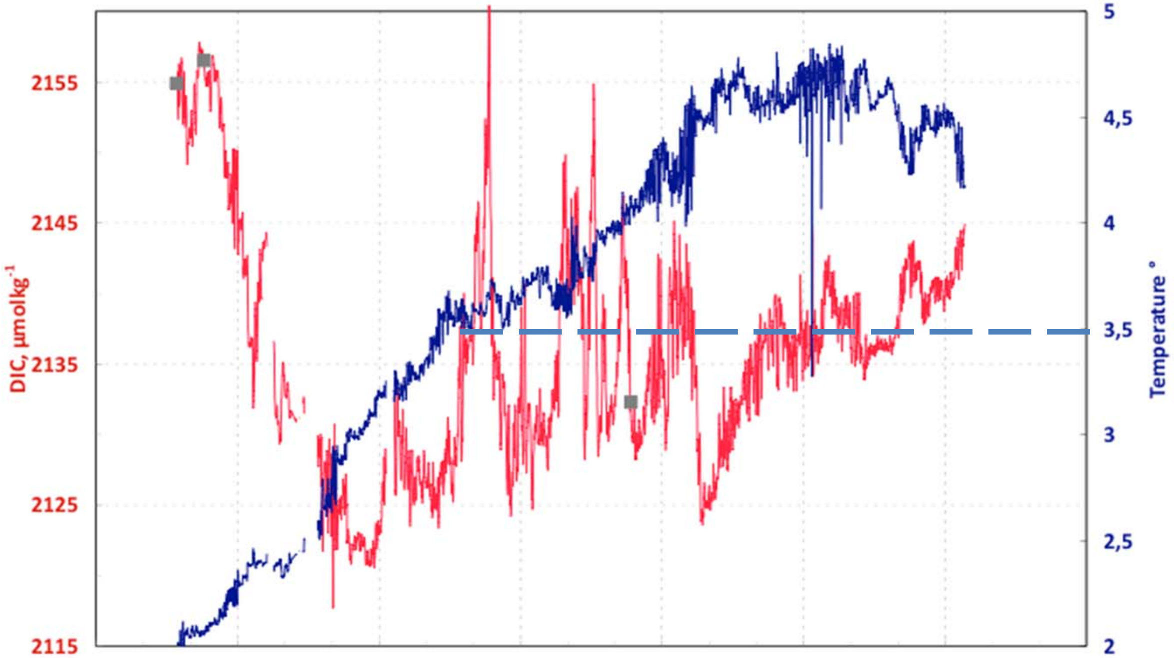


Change of DIC and T over a period of 6 days , October 27-November 2:
DIC = -1.8 µmolkg^{-1}d^{-1-}→ as MLD~110 m-→ NCP ~ 200 mmolm^{-2}d^{-1}
contribution of CO_2 air-sea flux and variability of MLD to be added in the future

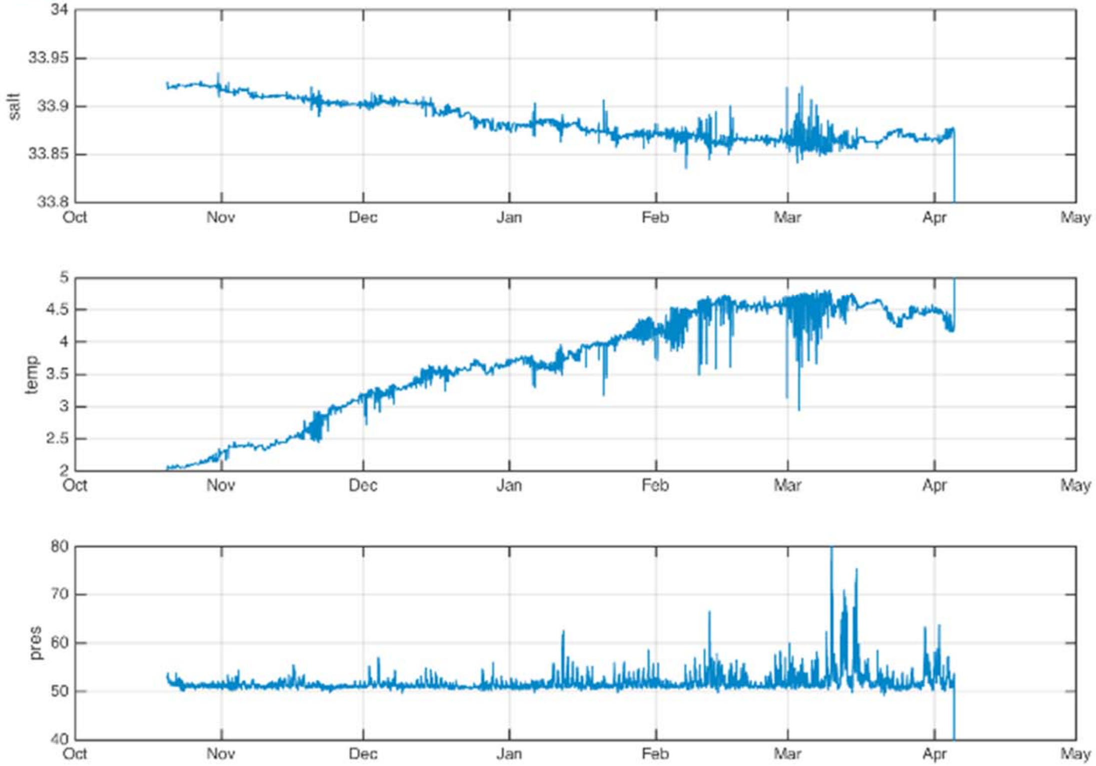


Decrease of DIC at the beginning of the warming period (October 18 - November 30):
-a very rapid change until November 17.
Onset of the bloom: MLD~110m on October 18
After November 30: signature of all processes: biology,vertical mixing, inertial waves,tide…
Evolution of MLD?

CARIOCA z~-40m



SBE 37 z~ -50m



Early March:large variability of T and S -preceedes the deepening of the mooring

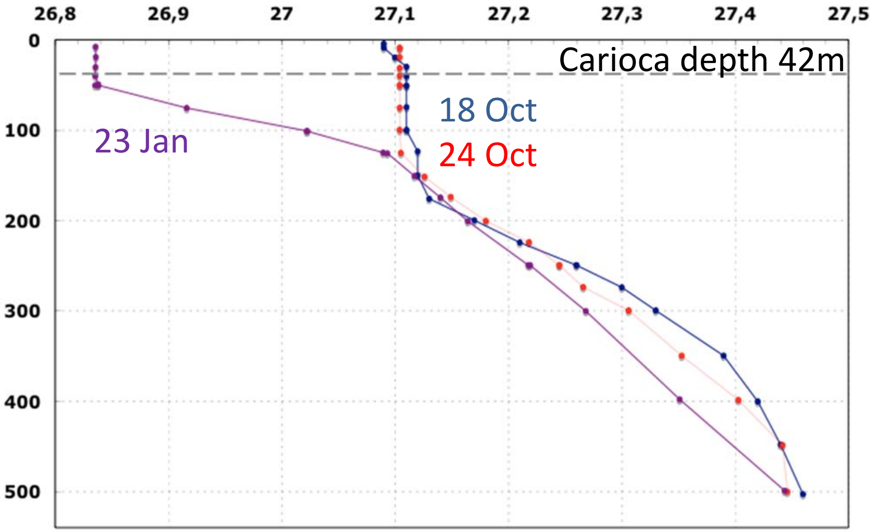
-role of internal waves

-relative changes of DIC/O2?

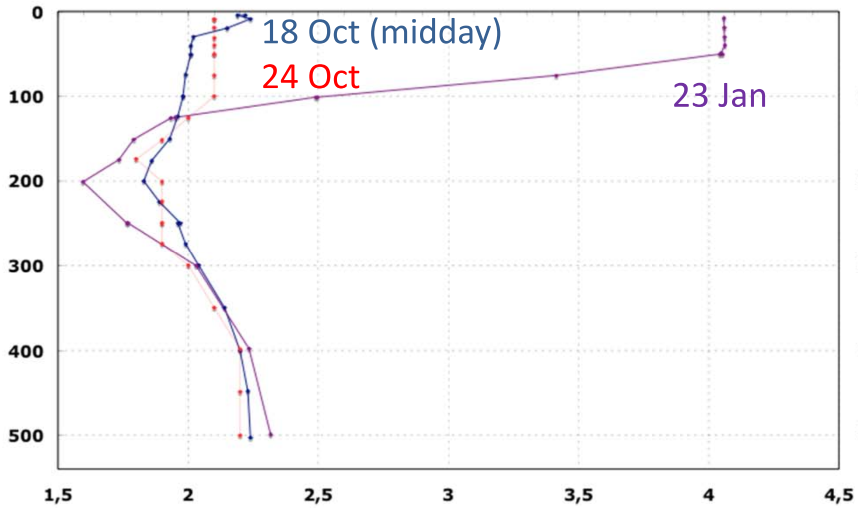
processes to be studied for the whole period

OISO Profiles = necessary tools to understand CARIOCA observations at 40 m depth

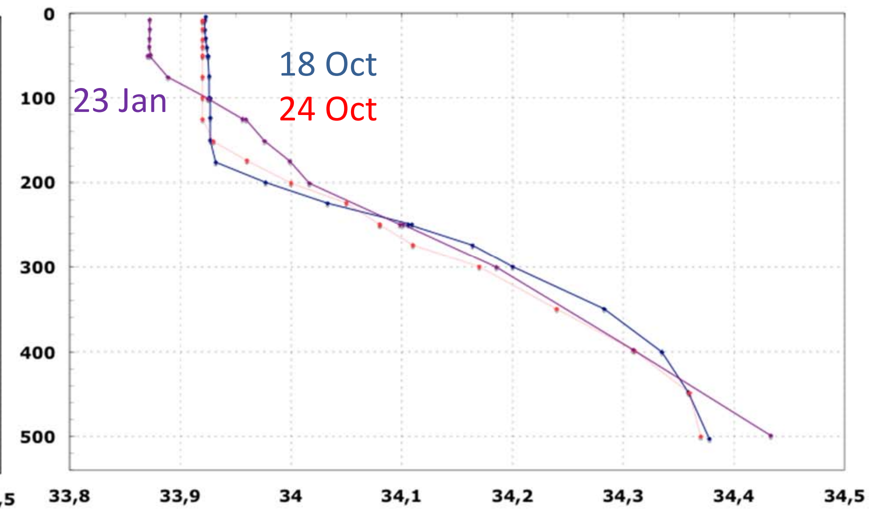
Density



MLD 24 Oct:~110m
23 Jan :~50m

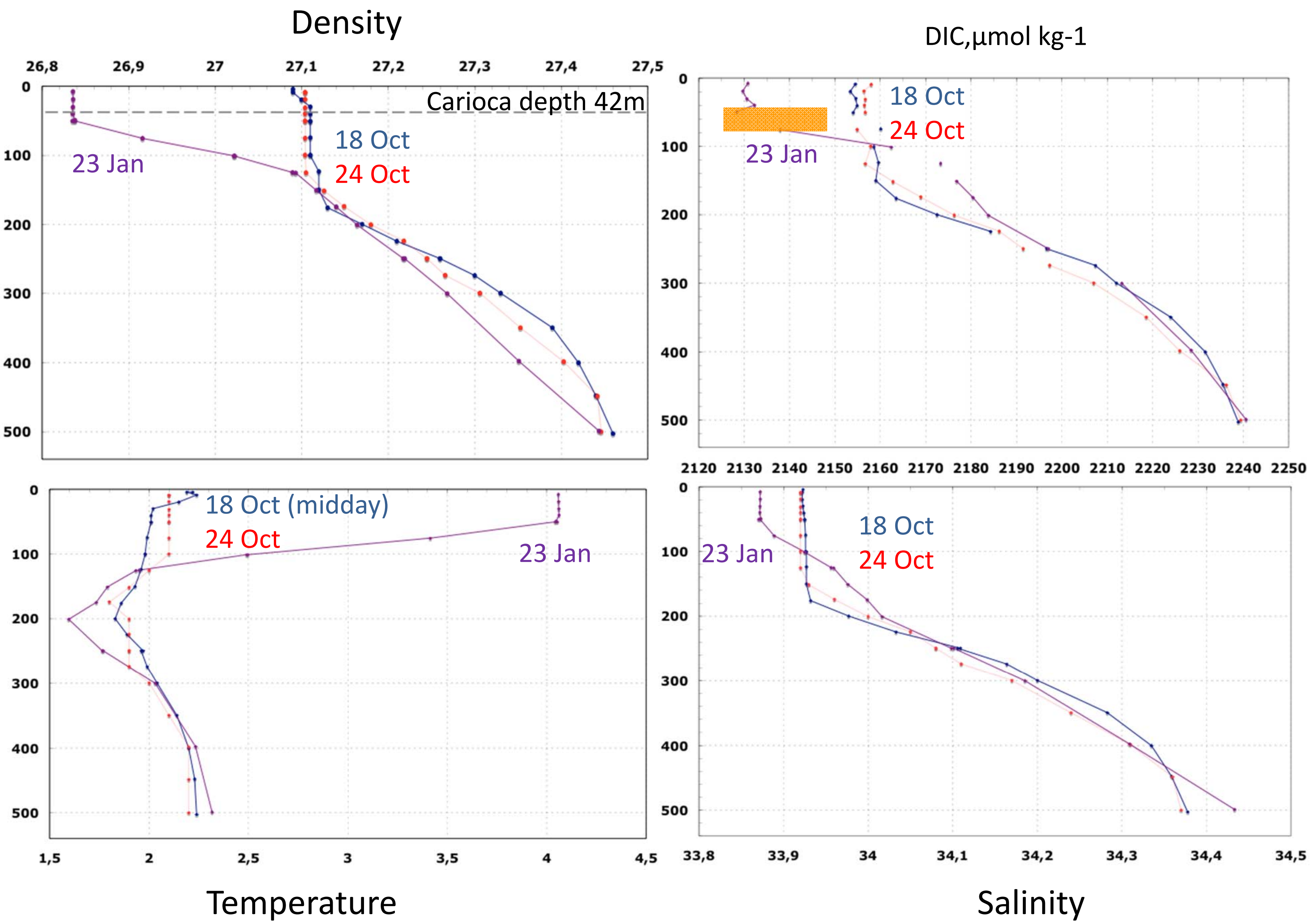


Temperature



Salinity

OISO Profiles = necessary tools to understand CARIOCA observations at 40 m depth



Conclusion and Perspectives

- ~6months of CARIOCA at ~40m depth + SOCLIM mooring measurements : monitoring of physical and biogeochemical processes
- Future focus:
  - Dynamics versus biology control of fCO_2
  - Further caracterisation of the onset of the bloom
- Future data analysis:
  - CARIOCA fCO_2 + S,T,O_2,fluo on RAS
  - Wind speed (e.g. CCMP) + vertical T,S meas. (MLD, internal waves …)

SOCLIM PLAN DU MOUILLAGE

RAS_ZOOM

Partie du mouillage lovée sur le pont pour le déploiement

PROFONDEUR VISEE	Type capteur	Numéro de série
45	T SBE56	SN 5662375-00198
50	CTD SBE37	SN 64695-9118
55	T SBE56	SN 5662375-00188
60	CTD SBE37	SN 51598-6337
65	T SBE56	SN 5662375-00199
70	T SBE56	SN 5662375-00200
75	T SBE56	SN 5662375-00201
80	T SBE56	SN 5662375-00202
85	T SBE56	SN 5662375-00204
90	CTD SBE37	SN 64695-9116
95	T SBE56	SN 5662375-00208
100	T SBE56	SN 5662375-00209
105	T SBE56	SN 5662375-00227
110	T SBE56	LOCEAN SN 126
115	T SBE56	LOCEAN SN 160
120	CTD O2 SBE37	SN 37-9792
125	T SBE56	LOCEAN SN 174
130	T SBE56	LOCEAN SN 181
135	T SBE56	LOCEAN SN 185
140	T SBE56	LOCEAN SN 190
145	T SBE56	LOCEAN SN 192
150	CTD SBE37	LOCEAN SN 39647-4321
155	T SBE56	LOCEAN SN 193
160	T SBE56	LOCEAN SN 194
165	T SBE56	LOCEAN SN 02307
170	T SBE56	LOCEAN SN 56-05883
175	T SBE56	LOCEAN SN 56-05884
180	CTD SBE37	LOCEAN SN 39647-4324
185	T SBE39	SN 3930837-1106
190	T SBE39	SN 3930837-1107
195	T SBE39 + P	SN 3948094-3250
200	T SBE39	SN 3948094-3558
210	CTD SBE37	LOCEAN SN 48169-5573
220	T SBE39	SN 3948094-3559

- Vertical T every 5m
- Vertical S every ~30m (10m close to RAS)

Extras slides

In summary:
data and tools exist to understand and interpret the observed variability of our measurements

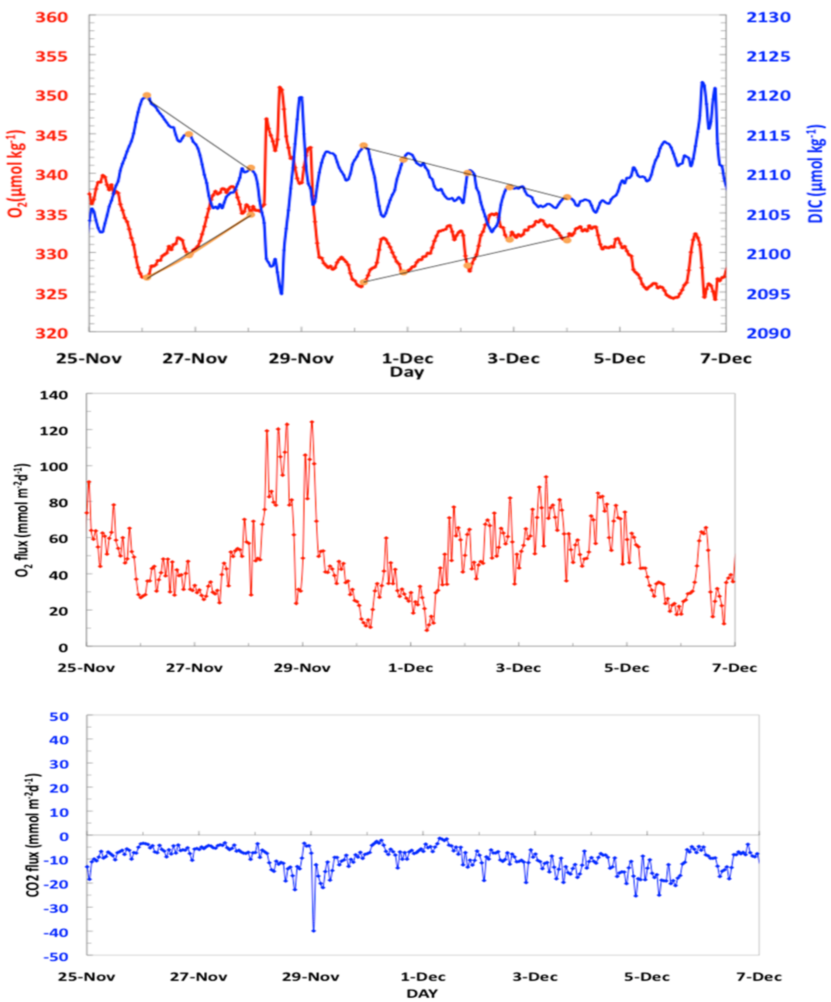
- besides Carioca data,
- salinity, oxygen on the RAS, fluorescence.
- repeated T,S profiles on the mooring line

TO BE DONE

O_2 from RAS and OISO

Quantitative estimate of NCP in the mixed layer, h, from carbon and oxygen measurements

Diel cycles of SST, O_2, DIC are observed with extrema close to sunrise and sunset➔ signature of biological processes *(see method in Boutin & Merlivat 2009)*



$$\frac{\Delta DIC_M}{\Delta t} = NCP - \frac{1}{\rho}\frac{F_{CO_2}}{h}$$

$$\frac{\Delta O_{2_m}}{\Delta t} = NCP_{O_2} + \frac{1}{\rho}\frac{F_{O_2}}{h}$$

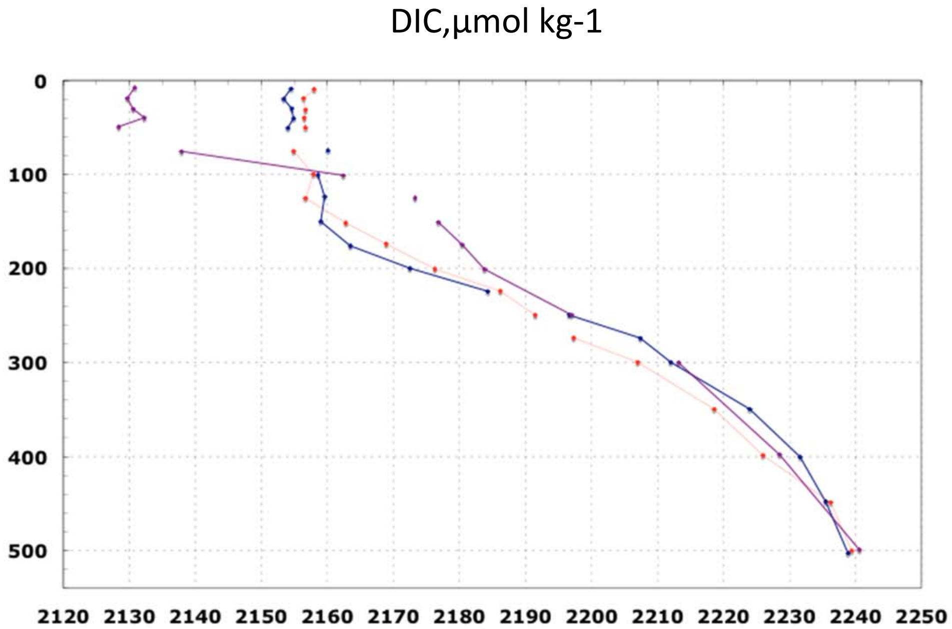
(During KEOPS 1 (D. Lefèvre):
PQ(=- NCP O_2/NCP)~1.08+/-0.86)

⬉The range of DIC_M and O_{2m} changes have similar amplitudes.
The range of the air-sea fluxes is far larger for O_2 than for CO_2.The contribution of bubbles to air-sea flux has to be taken into account for O_2.

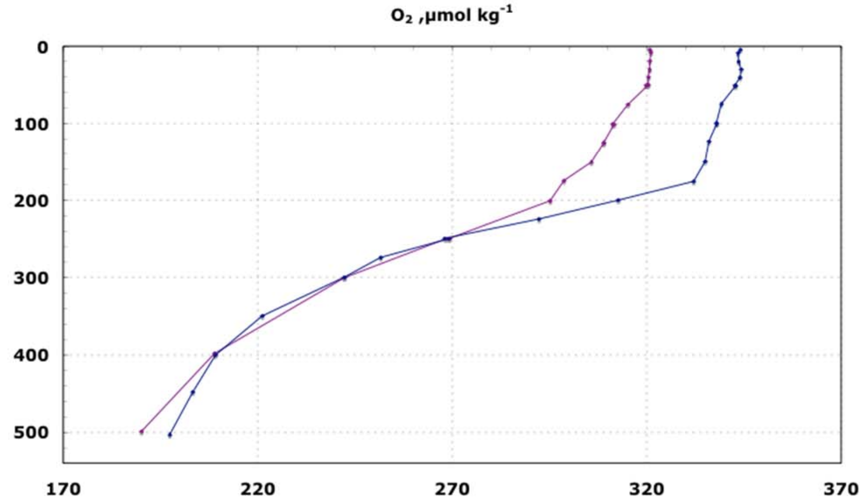
🡐note the difference between the 2 vertical scales (sign and amplitude).

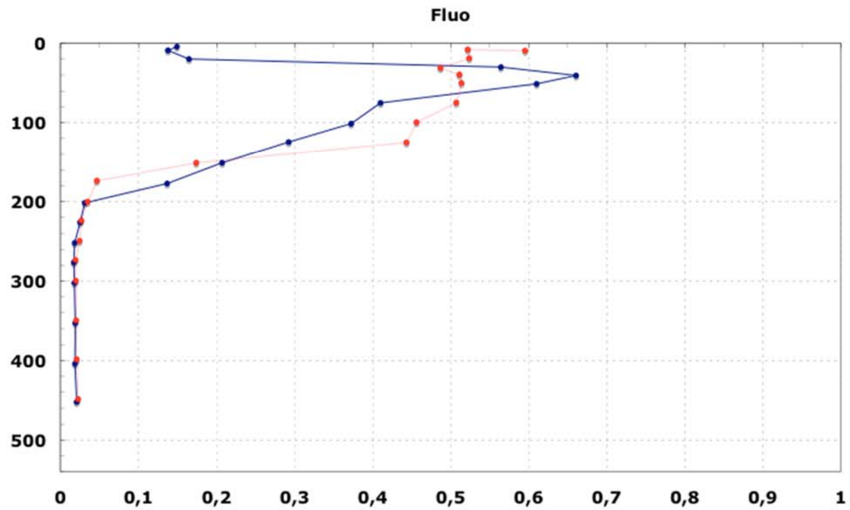
In this study, we take h=64m (climatological value-has to be specified)

Profils OISO
bleu,18/10-
rouge,24/10
- violet,23/1



Increase of DIC and decrease of O_2 with depth





SOCLIM
SOUTHERN OCEAN AND CLIMATE
FIELD STUDIES WITH INNOVATIVE TOOLS

The present proposal (SOCLIM) intends to implement a cutting-edge approach that will qualitatively and quantitatively improve the observation of the SO via pioneering in situ data acquisition.

The important process of bloom triggering has long been attributed to the seasonal vertical displacement of the mixed layer depth relative to the critical depth, as explained by Sverdrup's theory (1953).
Owing to recent technological developments and new observational approaches, this classical theory is becoming strongly challenged (Behrenfeld, 2010; Taylor and Ferrari, 2011).