New in situ estimates of carbon biological production rates in the Southern Atlantic Ocean from CARIOCA drifter measurements

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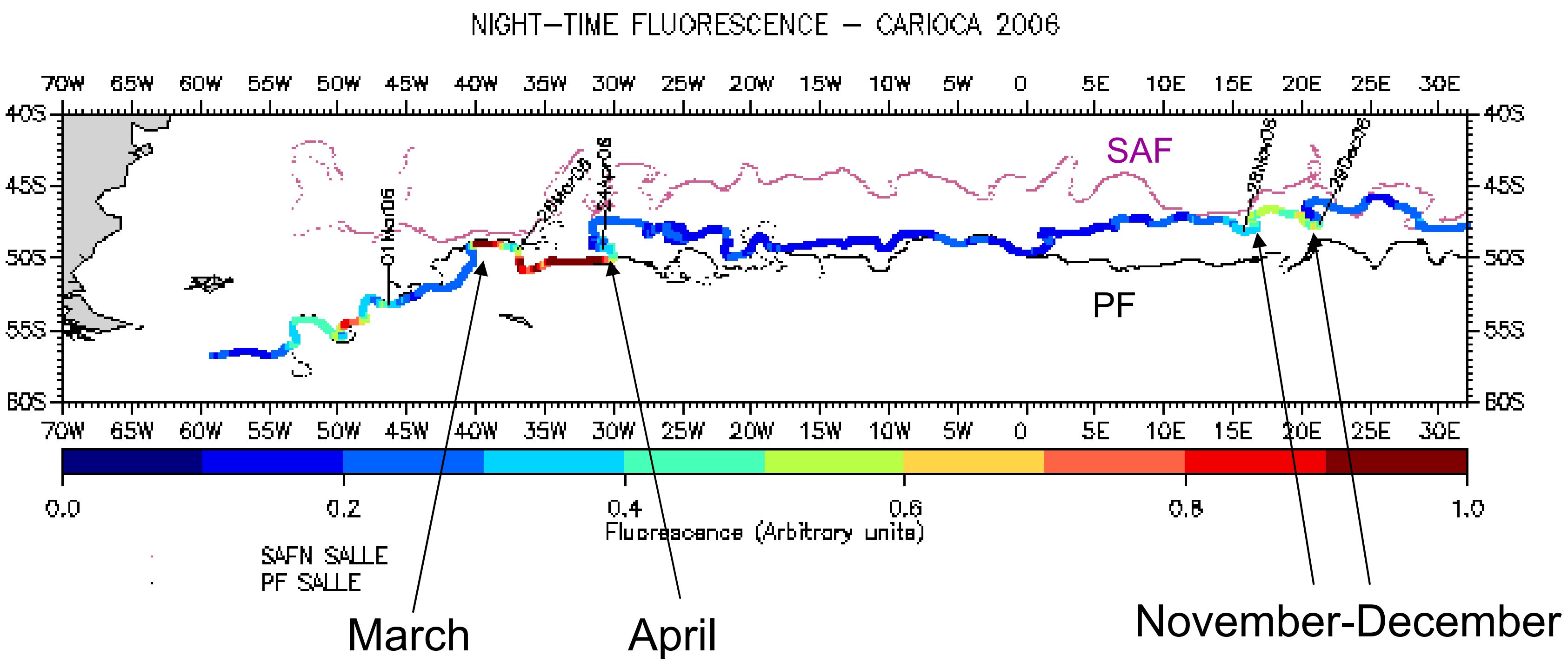
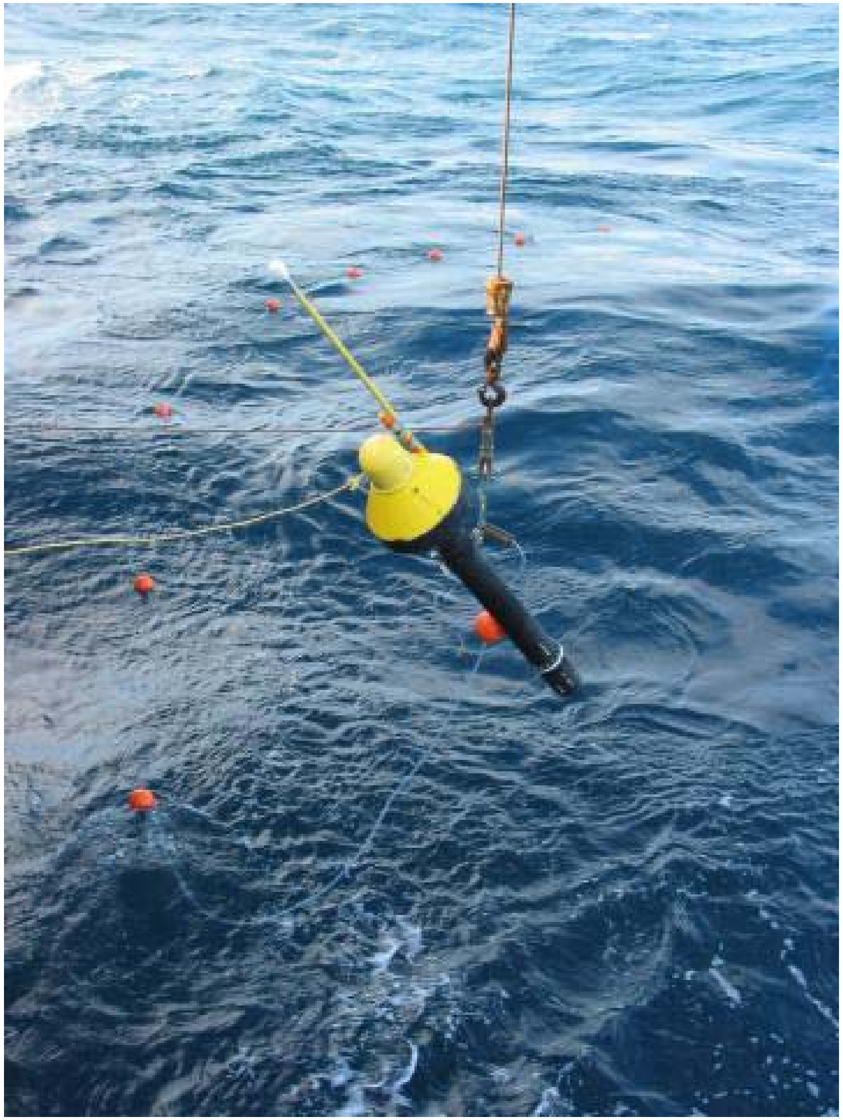


(Boutin et Merlivat, GRL, 2009, in press)

CARIOCA drifters

- Ocean measurements at 2m depth:
  - –CO_2 ocean fugacity: fCO_2 (accuracy <3µatm)
  - –SST
  - –SSS
  - –Fluorescence
- Atm. measurements of:
  - –Wind speed
  - –Atm. Pressure
- Trajectory influenced by :
  - –15m depth currents

Duration: about 1 year



PARAMETERS DERIVED FROM CARIOCA HOURLY MEASUREMENTS

Dissolved Inorganic Carbon (DIC): deduced from fCO_2, SST and SSS :
(assuming Alkalinity /SSS relationship (Lee et al, 2006) and carbonic acid dissociation constants (Lueker et al. 2000))

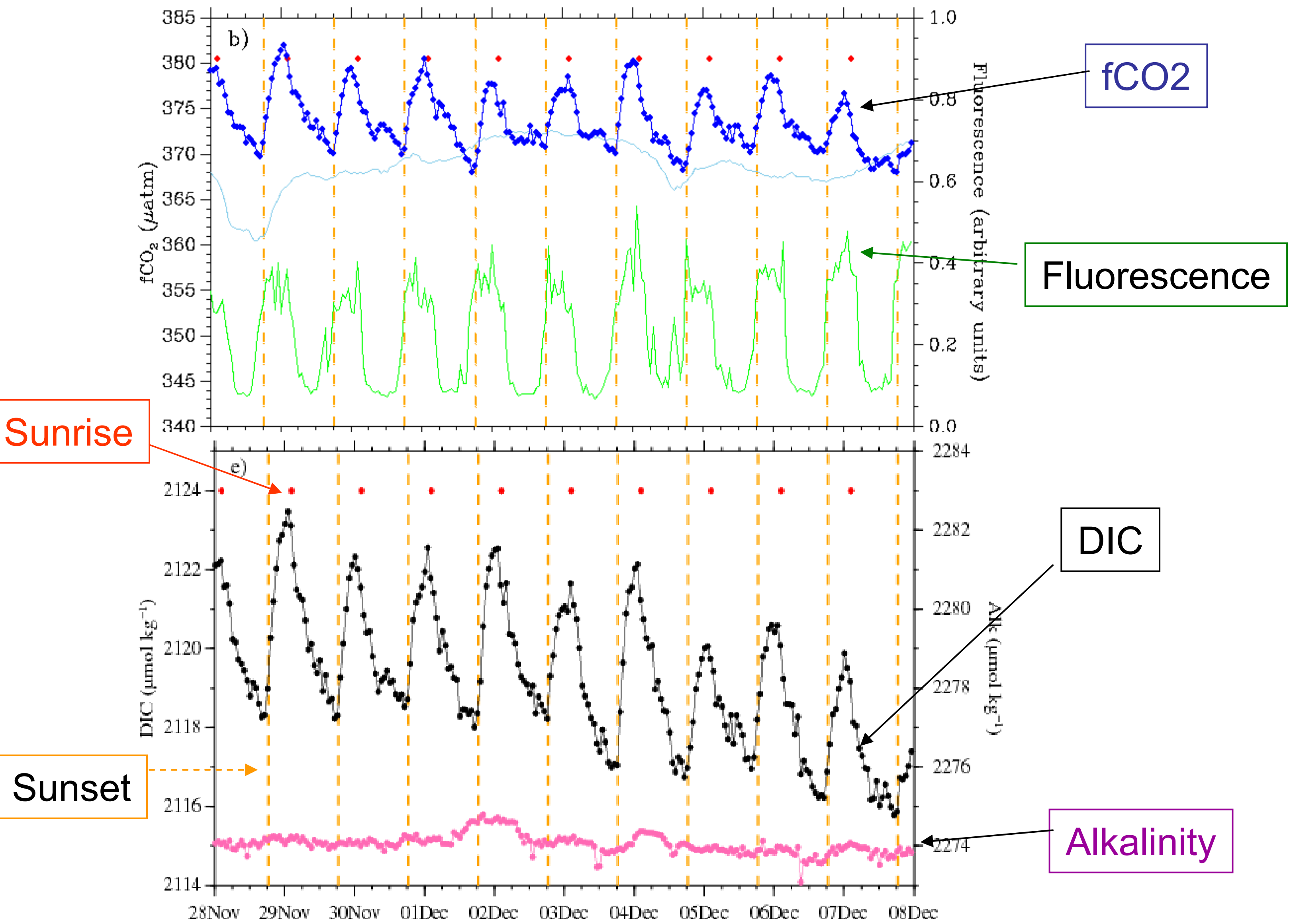
⇒Relative precision of DIC coming from fCO_2 precision ~1.5µmol/kg;
⇒Absolute precision of DIC coming from Alk uncertainty: ~ 9.3µmol/kg

Air-sea CO_2 flux: $F=K\,(fCO_2^{ocean} - fCO_2^{air})$

K from Wanninkhof (1992) rel. ($K \alpha U^2$); U from QuikSCAT wind speeds (maps of K available at: *ftp.ifremer.fr*)

fCO_2^{air} deduced from air measurements of CO_2 concentration at Macquarie island

Observations: during some periods, diurnal variation of DIC (min at sunset, max sunrise) together with significant fluorescence and almost constant alkalinity



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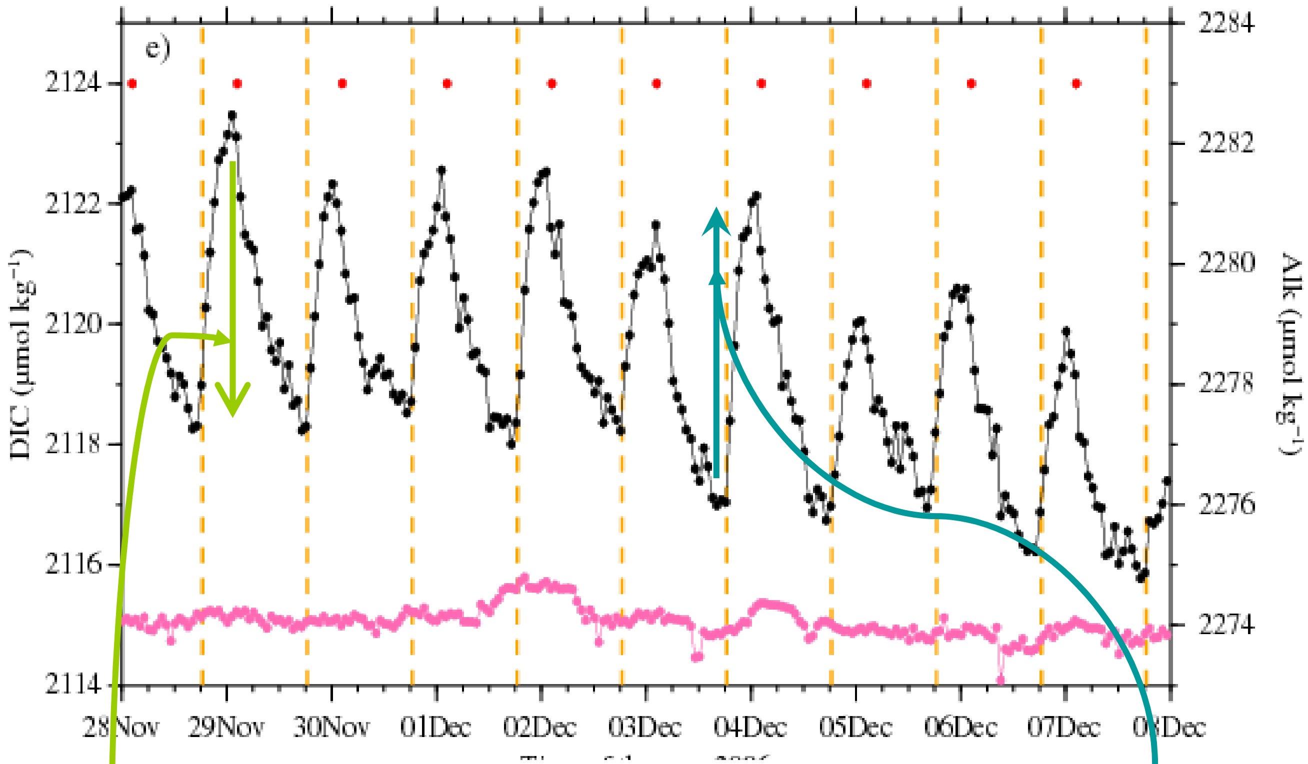
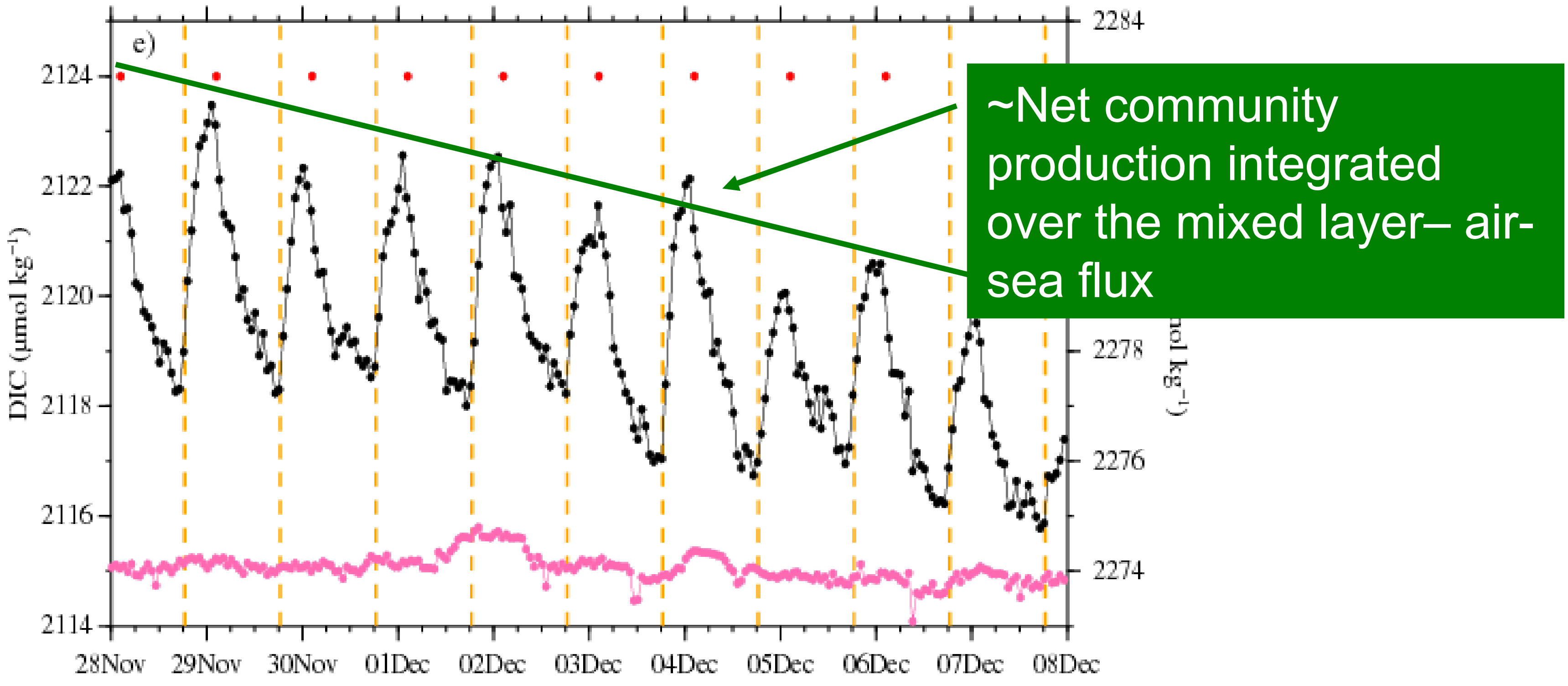
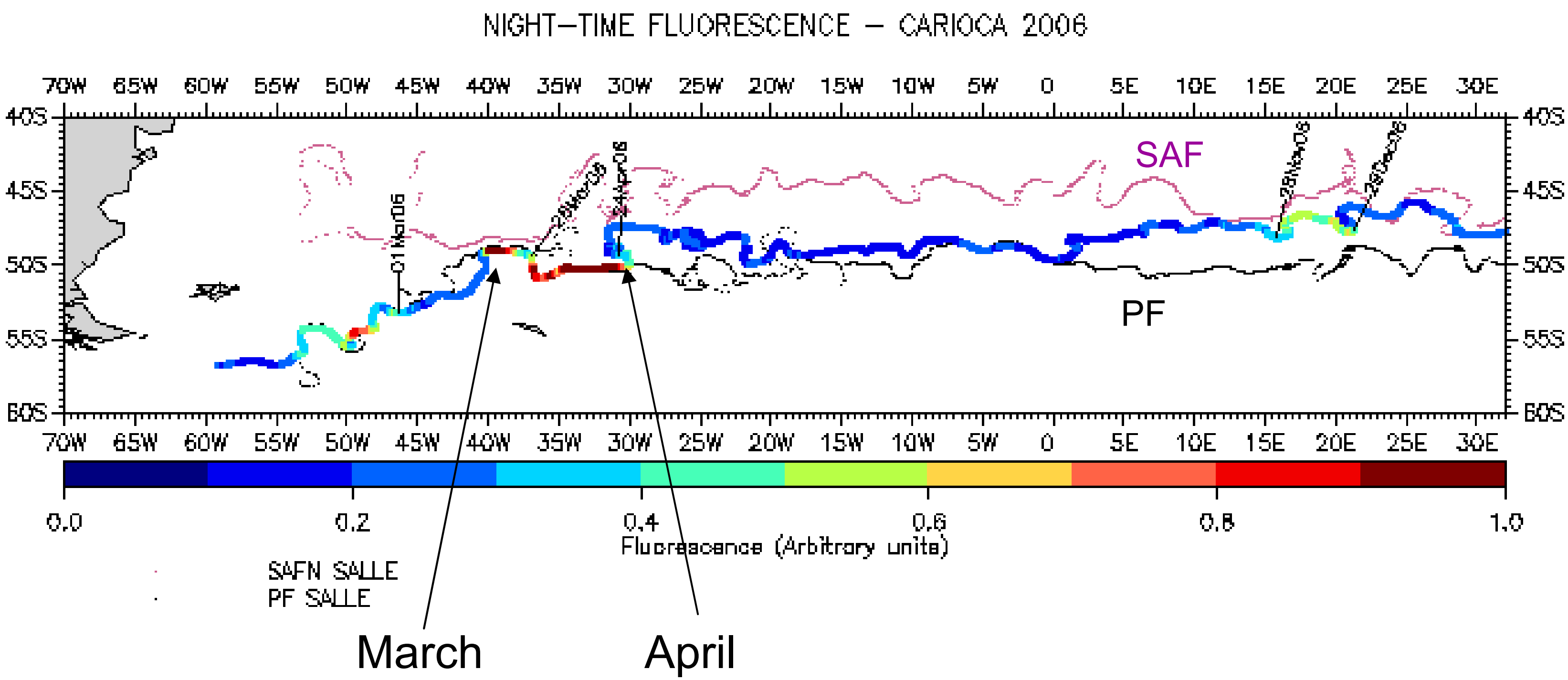


During daylight, decrease of DIC due to Net Community Production at 2m – air-sea CO2 flux

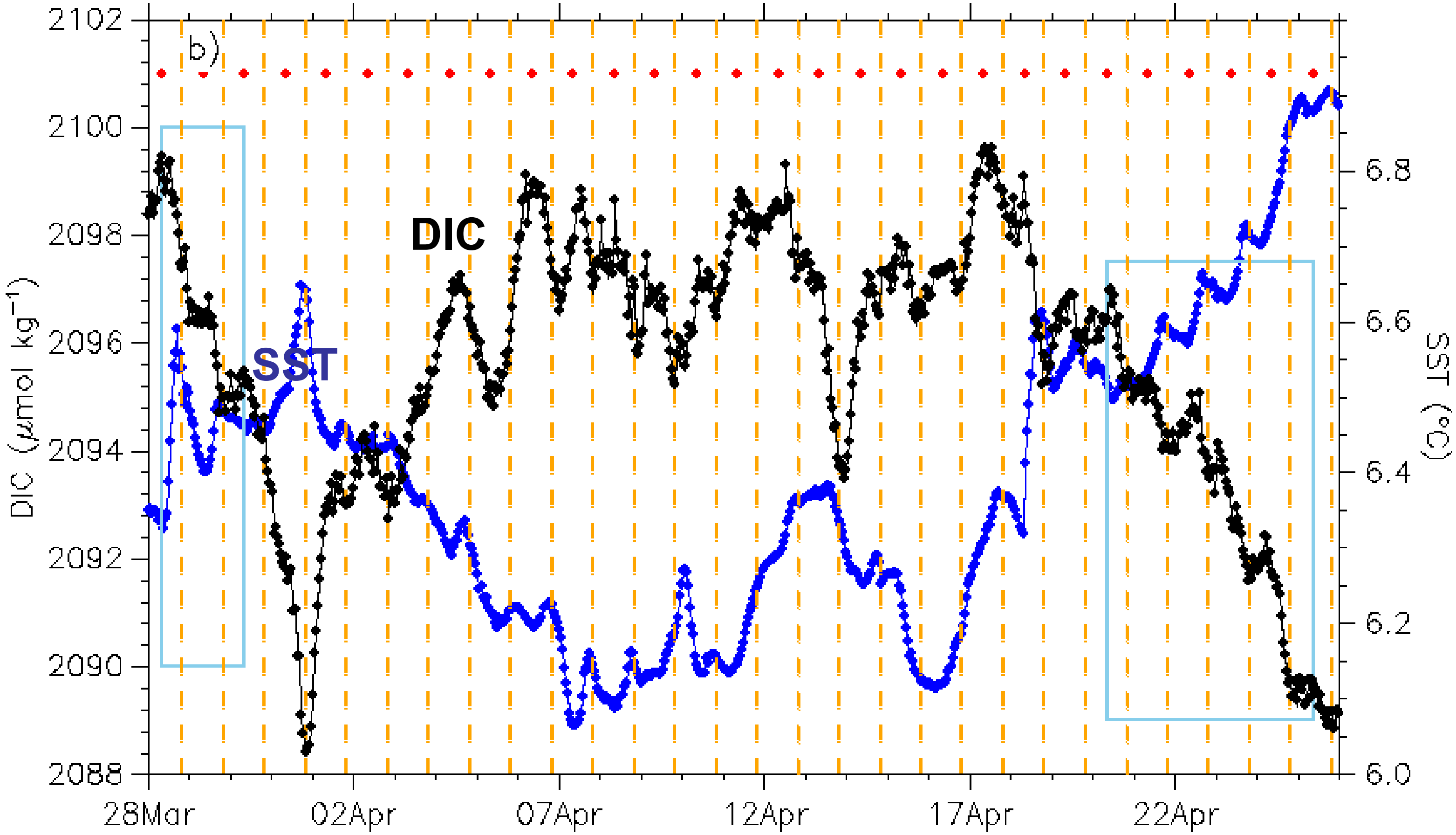
During nightime, increase of DIC due to diurnal mixing + respiration => at the end of the night DIC mixed over the mixed layer

Observations: during some periods, diurnal variation of DIC (min at sunset, max sunrise) together with significant fluorescence and almost constant alkalinity

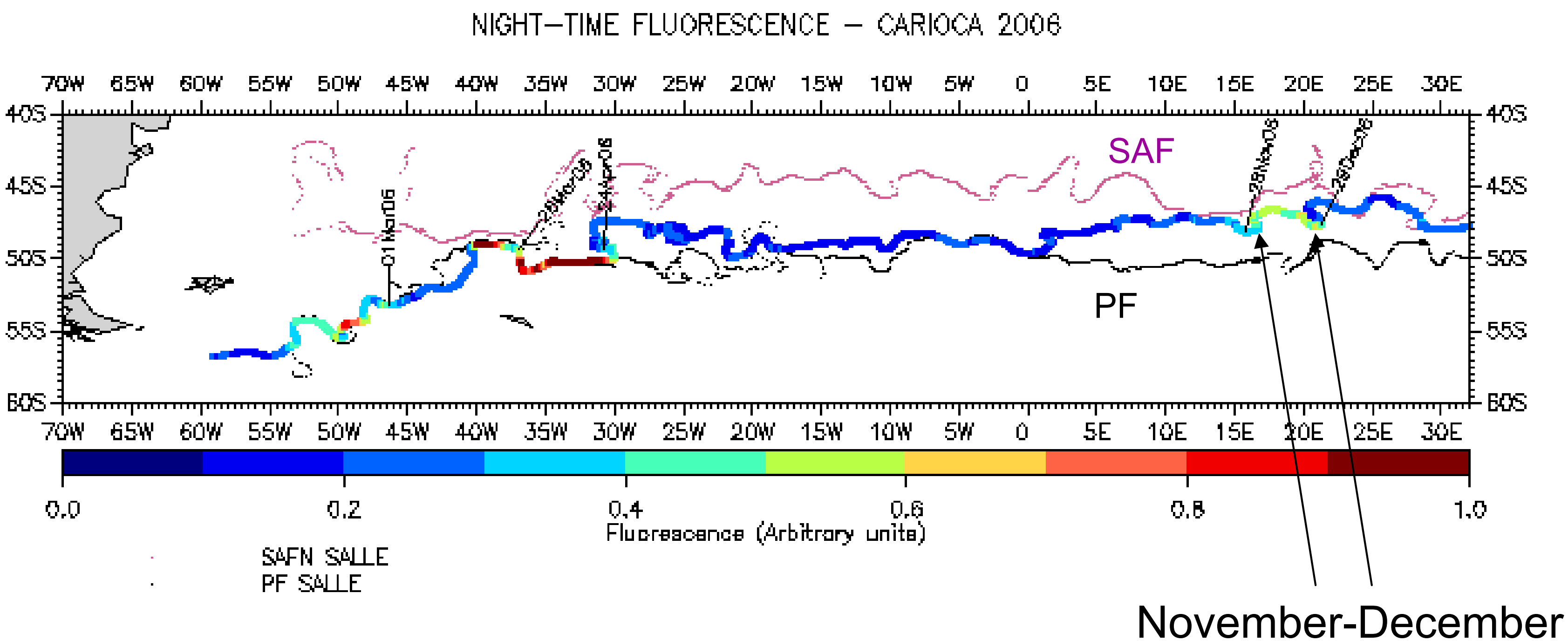



NIGHT-TIME FLUORESCENCE – CARIOCA 2006
70W 65W 60W 55W 50W 45W 40W 35W 30W 25W 20W 15W 10W 5W 0 5E 10E 15E 20E 25E 30E
40S 45S 50S 55S 60S
SAF
PF
0.0 0.2 0.4 0.6 0.8 1.0
Fluorescence (Arbitrary units)
SAFN SALLE
PF SALLE
March
April

Selection (by eye) of time periods with DIC diurnal cycles in phase with sun cycle, no Alk variation, significant fluorescence signal

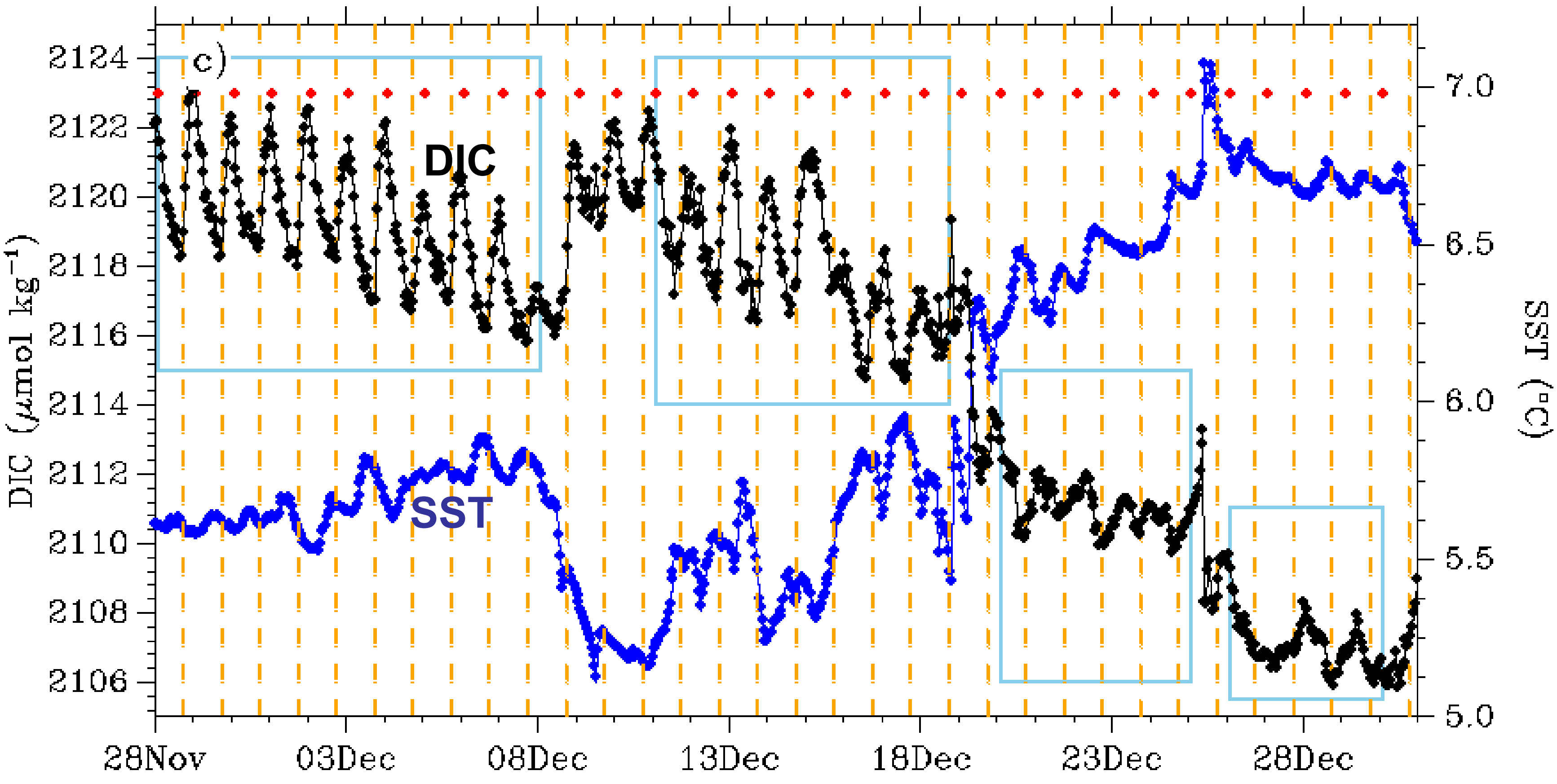


In Fall, in the wake of South Georgia island, large NCP at 2m during daylight period but ~ no increase during nightime => maximum of productivity probably takes place deeper than 2m



NIGHT-TIME FLUORESCENCE – CARIOCA 2006
70W 65W 60W 55W 50W 45W 40W 35W 30W 25W 20W 15W 10W 5W 0 5E 10E 15E 20E 25E 30E
40S
45S
50S
55S
60S
SAF
PF
0.0
0.2
0.4
0.6
0.8
1.0
Fluorescence (Arbitrary units)
SAFN SALLE
PF SALLE
November-December

Selection (by eye) of time periods with DIC diurnal cycles in phase with sun cycle, no Alk variation, significant fluorescence signal



In Spring, in the PZ close to 20°E, NCP integrated over the mixed layer smaller than NCP at 2m during daylight period

diurnal DIC cycles often associated with SST diurnal cycle and SST increase (warm layer)

Summary of NCP derived from CARIOCA measurements

Time period 2006	Area (mean)	No of days	$(C_M-C_m)_{d-1}$ µmol kg^{-1}	ΔC/Δt µmol kg^{-1}d^{-1}	p	q	F mmol m^{-2}d^{-1}	h m	NCP µmol kg^{-1} d^{-1}	Integrated NCP mmol m^{-2}d^{-1}	$NCP_{daylight}$ µmol kg^{-1} d^{-1}
1-4 Mar.	53.1°S-46.0°W	3	2.07±0.25	2.87±0.13	0.56	0.54	2.99	40	2.94± 0.13	118 ±5	2.23± 0.25
14-16 Mar	52.0°S-42.5°W	2	2.50±0.40	2.35±0.15	0.52	0.46	2.90	40	2.42± 0.15	97 ±6	2.65± 0.40
28-30 Mar..	49.6°S-37.0°W	2	1.70±0.10	1.95±0.25	0.48	0.48	3.76	20	2.04± 0.25	41±5	1.88± 0.10
20-25 Apr.	49.3°S-30.3°W	5	1.58±0.53	1.36±0.08	0.43	0.43	4.25	60	1.43± 0.08	86 ± 5	1.76± 0.53
28Nov. 7 Dec.	47.8°S-16.4°E	9	4.35±0.63	0.33±0.07	0.65	0.66	2.03	80	0.35± 0.07	28 ± 6	4.48± 0.63
11-18 Dec.	46.8°S-18.0°E	7	3.78±0,92	0.59±0.21	0.66	0.56	0.45	85	0.59± 0.21	50 ± 18	3.81± 0.92
20-25 Dec.	47.3°S-20.3°E	5	1.85±0.79	0.43±0.28	0.66	0.56	0	85	0.43± 0.28	37± 24	1.85± 0.79
26-30 Dec.	47.7°S-21.2°E	4	2.60±0.20	0.60±0.25	0.66	0.59	0	85	0.60± 0.25	51± 21	2.60± 0.20

Fall-Wake of South Georgia island

Spring – PZ 20°E

Summary

CARIOCA measurements provide in situ estimates of ocean biological production rates. Order of magnitudes similar to Lefèvre et al. (DSR2, 2008) study.

Main advantages :

- it is non-intrusive,
- compared for instance to the O2 /Argon method, the contribution of air-sea flux is small with respect to biological rates.
- it provides NCP integrated over MLD