BOUSSOLE Monthly Cruise Report

Cruise 229
April 09-11, 2021

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Vessel: R/V Téthys II
(Captain: Dany Deneuve)

Science Personnel: Louis Caray Counil, Céline Dimier, Bastien Gaucher, Melek Golbol, Flavien Petit, Emilie Riquier Diamond, Judicaël Rivier and Eduardo Soto Garcia.

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Several pilot whales (genus *Globicephala*) have been observed during the cruise at the BOUSSOLE site.

BOUSSOLE project

ESA/ESRIN contract N° 4000119096/17/I-BG

April 27, 2021

Foreword

This report is part of the technical report series that is being established by the BOUSSOLE project.

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European Space Agency

Centre National d'Etudes Spatiales, France

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Cruise Objectives

Routine operations

Multiple Biospherical's C-OPS (Compact Optical Profiling System) radiometric profiles are performed at the BOUSSOLE site around solar noon, under optimal conditions: clear blue skies and flat, calm sea surface. If the sky is clear and sea conditions are reasonably calm (no whitecaps or large swell), hand held CIMEL sun photometer measurements are to be performed consecutively where possible with C-OPS profiles. If sea conditions are poor but sky is good, hand held CIMEL sun photometer measurements can be made at intervals throughout the day to measure atmospheric optical thickness. CTD deployments are required at the start and the end of the C-OPS profiling day and around noon in the longer summer days or when there is a high possibility of a satellite matchup. The CTD package also includes a Chl fluorometer. Additional instrumentation for measurement of inherent optical properties has been added from December 2011. The package includes a hyperspectral absorption meter (Hobilabs a-Sphere), a multispectral backscattering meter (Hobilabs Hydroscat-6) and a multispectral beam transmissometer (Hobilabs Gamma-4). A CTD cast including a 0.2 µm filter installed on the inlet tube of the a-Sphere is to be performed once per cruise at the BOUSSOLE site for the dissolved matter absorption measurements. This cast will be stopped at ten depths during 2 or 7 min depending on the depths in order to ensure that the integrating cavity of the a-Sphere be completely filled at each of these depths during the ascent of the CTD.

Seawater samples are to be collected, filtered and stored into liquid nitrogen for subsequent HPLC pigment and particle absorption spectrophotometric filter analysis in the lab. Three replicates samples are to be collected at surface for total suspended matter weighting in the lab.

Divers check the underwater state of the buoy structure and instrumentation, take pictures for archiving, clean the sensor optical surfaces, and then take again some pictures after cleaning. Divers also put a neoprene cap on the backscattering meter and on the transmissometers for acquiring dark measurements (started in April 2009).

In addition, water samples are to be collected at two depths (5 m and 10 m) for dissolved oxygen (DO), total alkalinity (TA) and total inorganic carbon (TC) analysis (from March 2014). The TA/TC samples will be processed by the National service for such analyses (SNAPOCO – LOCEAN in Paris). The results will allow checking the data collected by the two pCO_2 CARIOCA sensors and the two optodes installed on the buoy at 3 m and 10 m.
Water samples are to be collected at four depths for metagenomic analyses of different types of Synechococcus, cytometry and nutrients (from March 2020). This operation is part of the EFFICACY ANR project in collaboration with the *Roscoff Biological Station.* The aim is to study the distribution of different types of Synechococcus populations characterized by distinct pigmentation and adaptation to the colour of light. It includes two years of cytometry and metagenomic sampling at the BOUSSOLE site.

Further details about these operations and the data collection and processing protocols are to be found in:
Antoine, D. M. Chami, H. Claustre, F. D'Ortenzio, A. Morel, G. Bécu, B. Gentili, F. Louis, J. Ras, E. Roussier, A.J. Scott, D. Tailliez, S. B. Hooker, P. Guevel, J.-F. Desté, C. Dempsey and D. Adams. 2006, BOUSSOLE: a joint CNRS-INSU, ESA, CNES and NASA Ocean Color Calibration And Validation Activity. NASA Technical memorandum N° 2006 - 214147, 61 pp.
(http://www.obs-vlfr.fr/Boussole/html/publications/pubs/BOUSSOLE_TM_214147.pdf)

Additional operations

Seawater is to be sampled at 3 depths for micro-, nano- and pico-phytoplankton analysis by microscopy and cytometry. This operation is part of the OBOO (*From Optics to Biodiversity in the world Open Oceans: application to BGC-Argo floats*) LEFE-CYBER (*Les Enveloppes Fluides et l'Environnement – CYcles Biogéochimiques, Environnement et Ressources*) project of the *Marine optics and remote sensing group* of the *Laboratoire d'Océanographie de Villefranche (LOV).* In addition, three sensors were added to the Rosette CTD from September 2020 in the frame of this project: an Eco FLBB2 sensor that measures fluorescence (excitation at 470 nm, emission at 695 nm) and backscattering at 700 nm, an Eco 3X1M sensor that measures multispectral fluorescence (excitation at 440, 470 et 532 nm, emission at 695 nm) and an ECO V2 B206 sensor that measures chlorophyll fluorescence at 470 and 440 nm, CDOM fluorescence and backscattering at 700 nm.

Divers replaced the PCO_2 CARIOCA sensor at 3 m depth with a newly calibrated one.

The "MOOSE DYFAMED" cruise scheduled for 13th April was cancelled because of a bad weather forecasts, so their operations were performed during the BOUSSOLE cruise.

Cruise Summary

Only the first day was used for BOUSSOLE and DYFAMED operations due to bad weather forecast for the next days. The Covid-19 sanitary restrictions led us to interrupt the mission and to demobilize the material after the first day as we were uncertain to continue the operations the following days because of the bad weather forecasts and as it would have not been possible to re-embark the following days in case of improved weather conditions.
This first and single day was used for diving operations, for CTD casts with water sampling, optical profiles, CIMEL measurements, a Secchi disk at the BOUSSOLE site and for DYFAMED operations.

Friday 9 April 2021

The sea state was smooth with a light breeze to light air. The sky was blue in the morning and became hazy in the afternoon, yet the visibility was excellent. When arrived at BOUSSOLE, divers went at sea to replace the pCO2 CARIOCA sensor at 3 m depth. They also cleaned all buoy sensors and took pictures. The buoy functioning was checked on the top of the buoy. Unfortunately, the buoy was found not working and it was not possible to download data from the surface DL3 (data logger from "In-Situ Marine Optics Pty Ltd"). In the meantime, 3 CIMEL measurements and a CTD cast with water sampling were performed at the BOUSSOLE site. Then 2 CTD casts with water sampling, a Secchi disk and 3 C-OPS profiles were performed at the BOUSSOLE site before the departure to the DYFAMED site. For the CTD 02 cast, a cap was put on the backscattering meter for dark measurements and a 0.2µm filter was put on the a-Sphere absorption meter for the dissolved matter absorption measurements. This cast was stopped at 10 depths during the ascent of the CTD. A horizontal Manta net was deployed between the BOUSSOLE and DYFAMED sites and, finally, two vertical zooplankton nets and a deep CTD cast with water sampling were performed for completing MOOSE program operations before returning to the Nice harbour.

Saturday 10 April 2021

Bad weather prevented departure from the Nice harbour.

Sunday 11 April 2021

Bad weather prevented departure from the Nice harbour.

Pictures taken during this cruise can be found at:
https://photos.app.goo.gl/DUGpDn4y2c6AdSNZ8

Data from the BOUSSOLE cruises and buoy are available at:
http://www.obs-vlfr.fr/Boussole/html/boussole_data/login_form.php

Cruise Report

Friday 9 April 2021 (UTC)

People on board: Louis Caray Counil (engineer at LOV), Céline Dimier, Bastien Gaucher (diver), Melek Golbol, Flavien Petit, Emilie Riquier Diamond, Judicaël Rivier (diver) and Eduardo Soto Garcia.

0515 Departure from the Nice harbour.
0830 Arrival at the BOUSSOLE site.
0850 Diving operations (replacement of PCO_2 sensor at 3 m depth, sensors cleaning, pictures).
0855 CIMEL 01, 02, 03.
0900 Attempt of communication with the surface DL3 at the top of the buoy: failed
0900 CTD 01, 200 m with water sampling at 60, 40 and 5 m for O_2, TA/TC, TSM (BOUSSOLE program) and phytoplankton microscopy, cytometry, PIC, POC, HPLC (OBOO project).

0930 Secchi 01, 17 m.
1020 CTD 02, 400 m with water sampling at 50, 35, 20 and 5m for metagenomic, cytometry and nutrients analyses (EFFICACY project), with cap on the HS6 and a 0.2 µm filter on a-Sphere and with 2 minutes stop at 400, 150 m and 7 minutes stop at 80, 60, 50, 40, 30, 20, 10 and 5 m (BOUSSOLE program).
1220 C-OPS 01, 02, 03.
1330 CTD 03, 400 m with water sampling at 400, 200, 150, 80, 70, 60, 50, 40, 30, 20, 10 and 5m for HPLC and $a_{p.}$
1400 Departure to the DYFAMED site.
1420 Manta horizontal net (MOOSE program).
1450 Arrival at the DYFAMED site.
1500 Zooplankton nets, 100 and 200 m (MOOSE program).
1545 Deep CTD cast, 2350 m with water sampling (MOOSE 151).
1725 Departure to the Nice harbour.
2015 Arrival to the Nice harbour.

Problems identified during the cruise

- The buoy was found not working and it was not possible to download data from the surface DL3. We suspected that the problem provides from the battery. The battery will be checked and eventually replaced during a subsequent cruise.

- CTD 01: the data acquisition of the first CTD cast start at 18 m during the descent of the CTD. So, the upcast was used for the data processing instead of the downcast.

- C-OPS measurements were not optimal because the sky became hazy after the first cast with unstable surface irradiance.

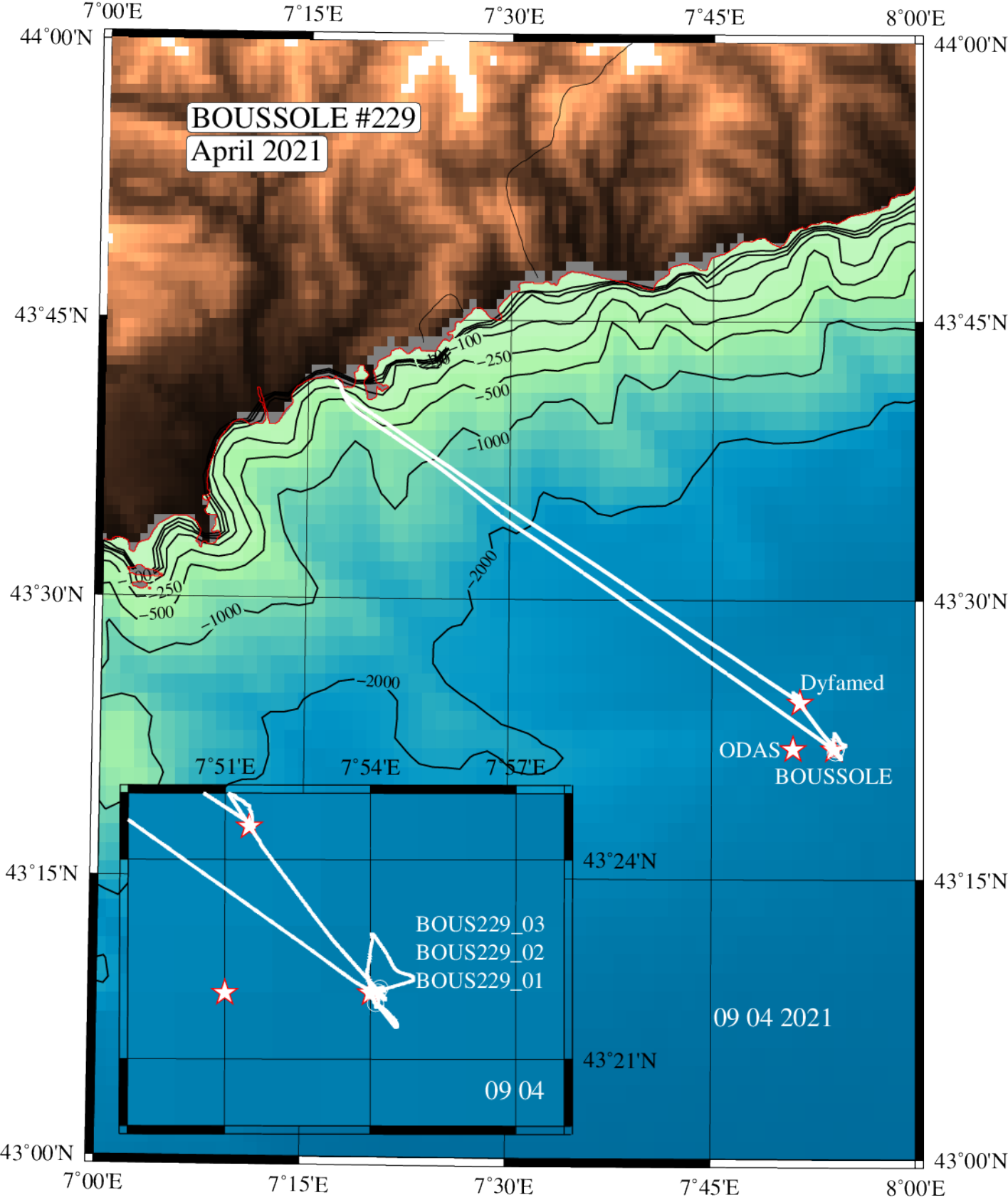
- The CTD of the IOP package could not be installed on the package with the other instruments because it was still under calibrations at SeaBird. Therefore, the IOP data will have to be synchronized in time with the main CTD for the data processing.

- There were few spikes in transmissometer data between 26 and 49 m depths during the CTD acquisitions: outliers were removed.

Appendices

Cruise Summary Table for Boussole 229

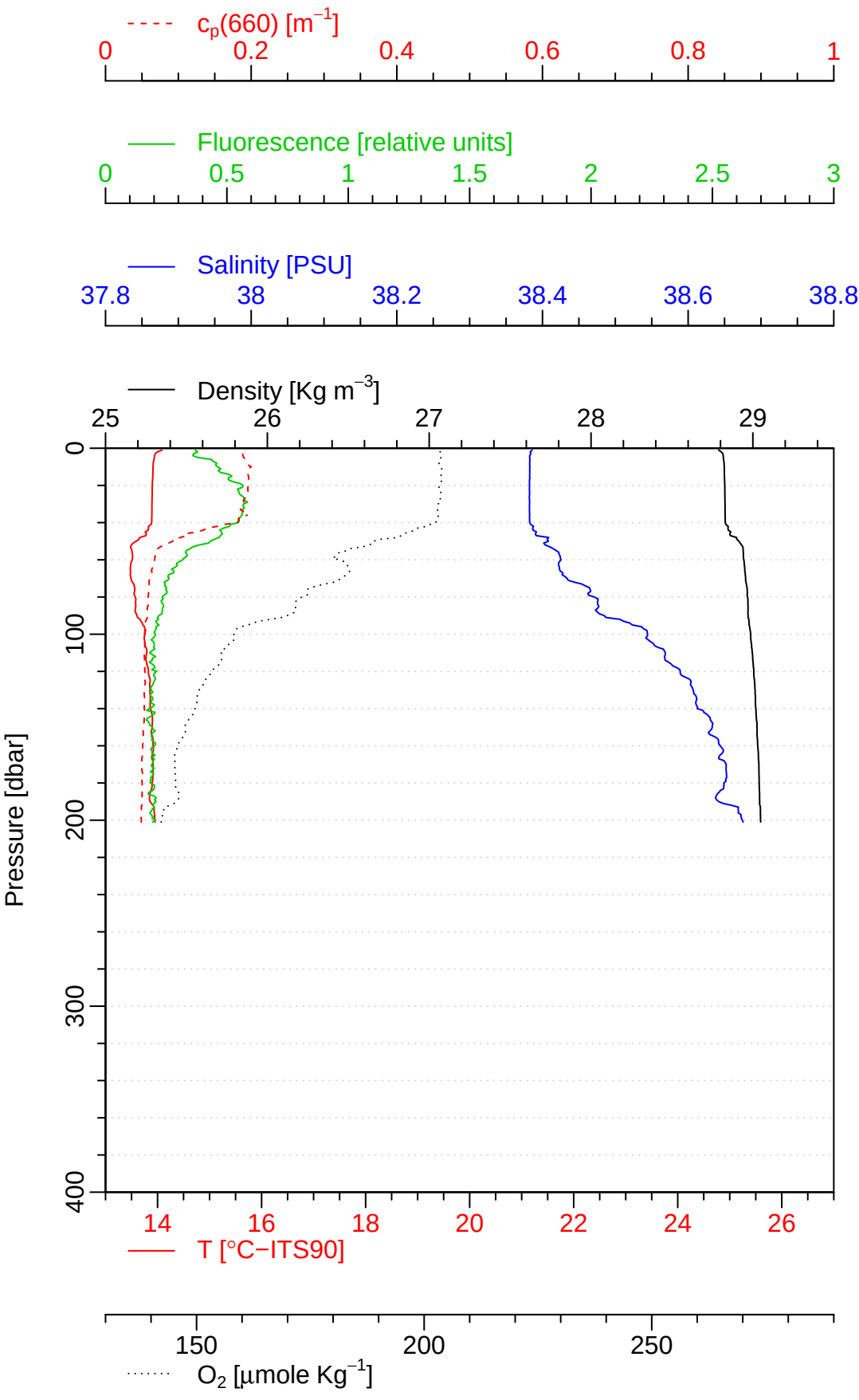
Date	Black names	Profile names	CTD notées	Other sensors	Start Time	Duration	Depth max	Latitude (N)		longitude					Weather							Sea		
	(file ext: ".raw")	(file extension: ".raw")			GMT (hour.min)	(hour.min.sec)	(meter)	(Degree)	(Minute)	(Degree)	(Minute)	Sky	Clouds	Quantity (#/8)	Wind sp. (kn)	Wind dir.	Atm. Pressure (hPa)	Humidity (%)	Visibility	T air	T water	Sea	Swell H (m)	Swell dir.	Whitecaps
09/04/21				CIMEL01	8:57	0:09:00		43	22.078	7	54.236	blue		1			1027								
				CIMEL02	9:18	0:09:00		43	22.078	7	54.236	blue		1			1027								
				CIMEL03	9:32	0:08:00		43	22.078	7	54.236	blue		1			1027								
			BOUS229_01	TSM, O_2, TA/TC & Phytofloat (HPLC, PIC, POC, Cyto, phyto)	8:59	0:13:00	200	43	22.067	7	54.196	blue		2	4.8	185	1027	51		13.5	14.09	smooth			
				Secchi 01	9:30	0:04:00	17	43	22	7	54	blue		2					excellent			smooth			
			BOUS229_02	Metagenomics, Cyto, Nutrients & a-Sphere filter & dark HS6	10:21	1:28:00	400	43	21.842	7	54.109	blue		1	3	182	1026.6	49.8		13.2	14.07	smooth			
		bou_c-ops_210409_1214_001_data.csv			12:19	0:04:39	114	43	22.121	7	53.985	blue	Cs	2	1.7	188	1025.7	46.6	excellent	14.8		smooth	0.6		no
		bou_c-ops_210409_1214_002_data.csv			12:32	0:03:22	110	43	22.314	7	53.931	cloudy (hazy)	Cs	5	1.7	188	1025.7	46.6	excellent	14.8		smooth	0.6		no
		bou_c-ops_210409_1214_003_data.csv			12:46	0:03:25	87	43	22.59	7	53.995	cloudy (hazy)	Cs	5	1.7	188	1025.7	46.6	excellent	14.8		smooth	0.6		no
			BOUS229_03	HPLC & ap	13:27	0:29:00	400	43	22.009	7	54.158	cloudy (hazy)		5	0.7	90	1025.2	48.7		13.7	14.45	smooth			
10/04/21	Bad weather																							
11/04/21	Bad weather																							



GMT 2021 May 04 16:32:25

bous229_01

Date = 09/04/2021
Heure debut [TU] = 08:59
Longitude = 007 54.196 E
Latitude = 43 22.067 N



bous229_02

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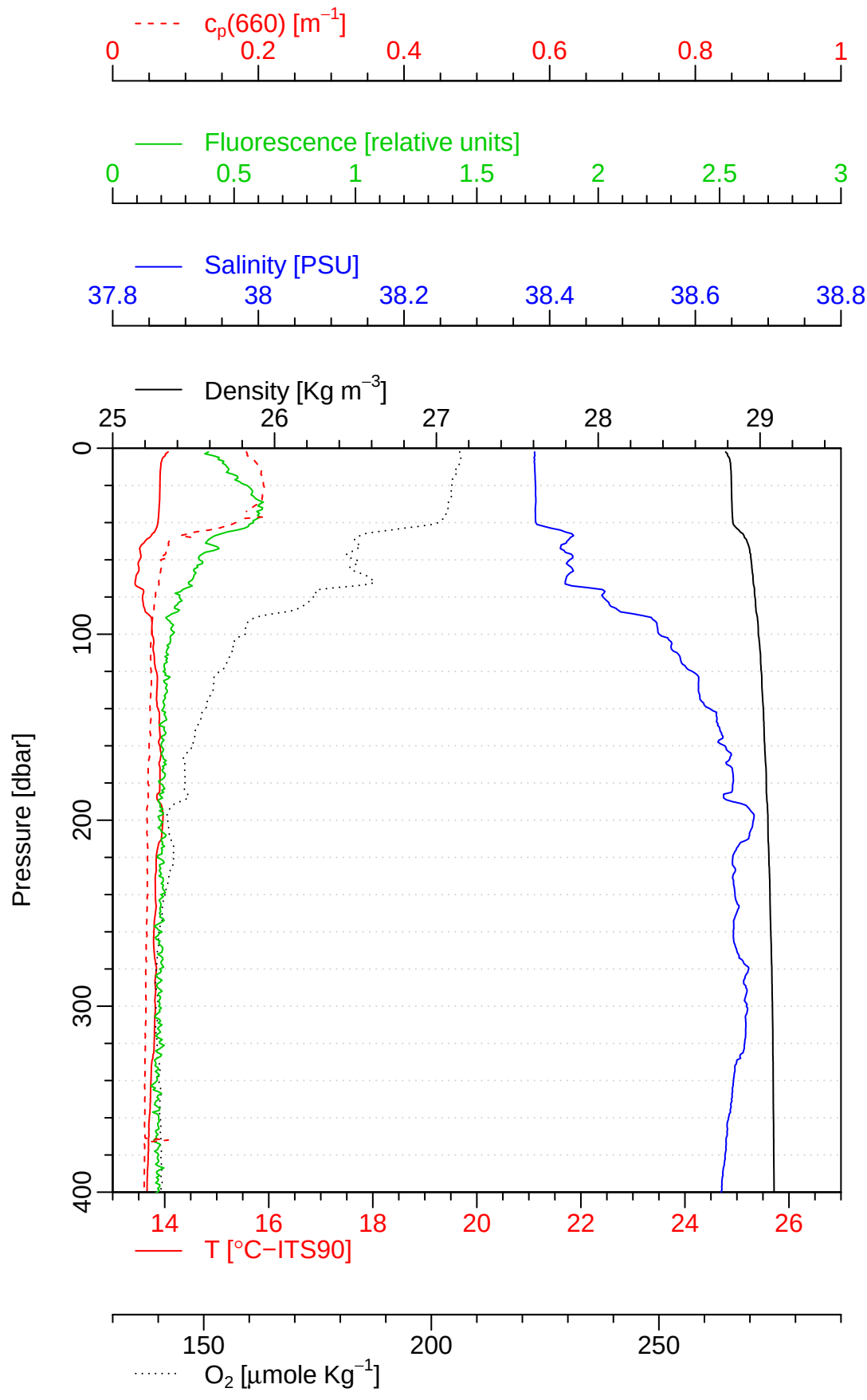
Heure debut [TU] = 10:21
Longitude = 007 54.109 E
Latitude = 43 21.842 N



bous229_03

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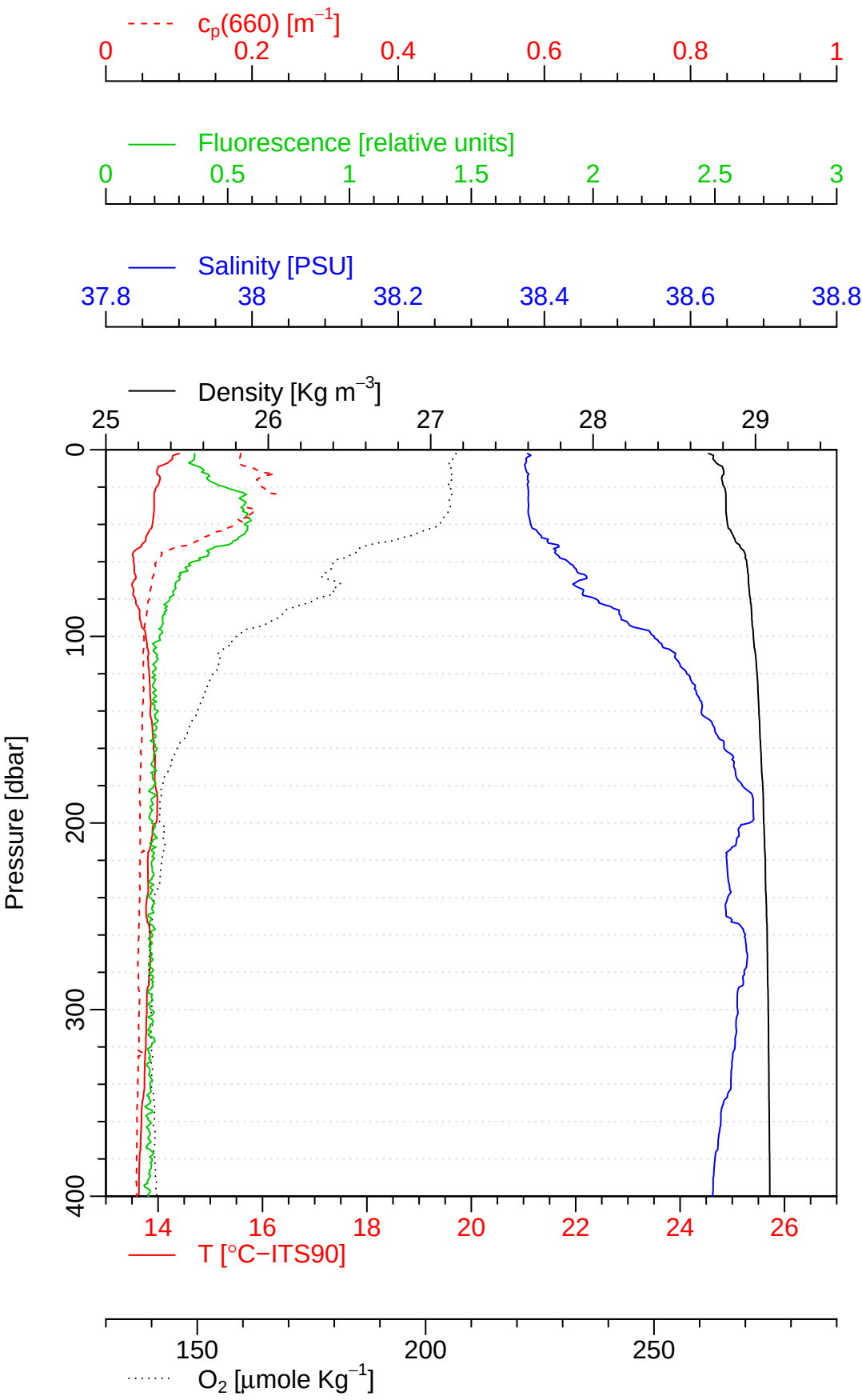
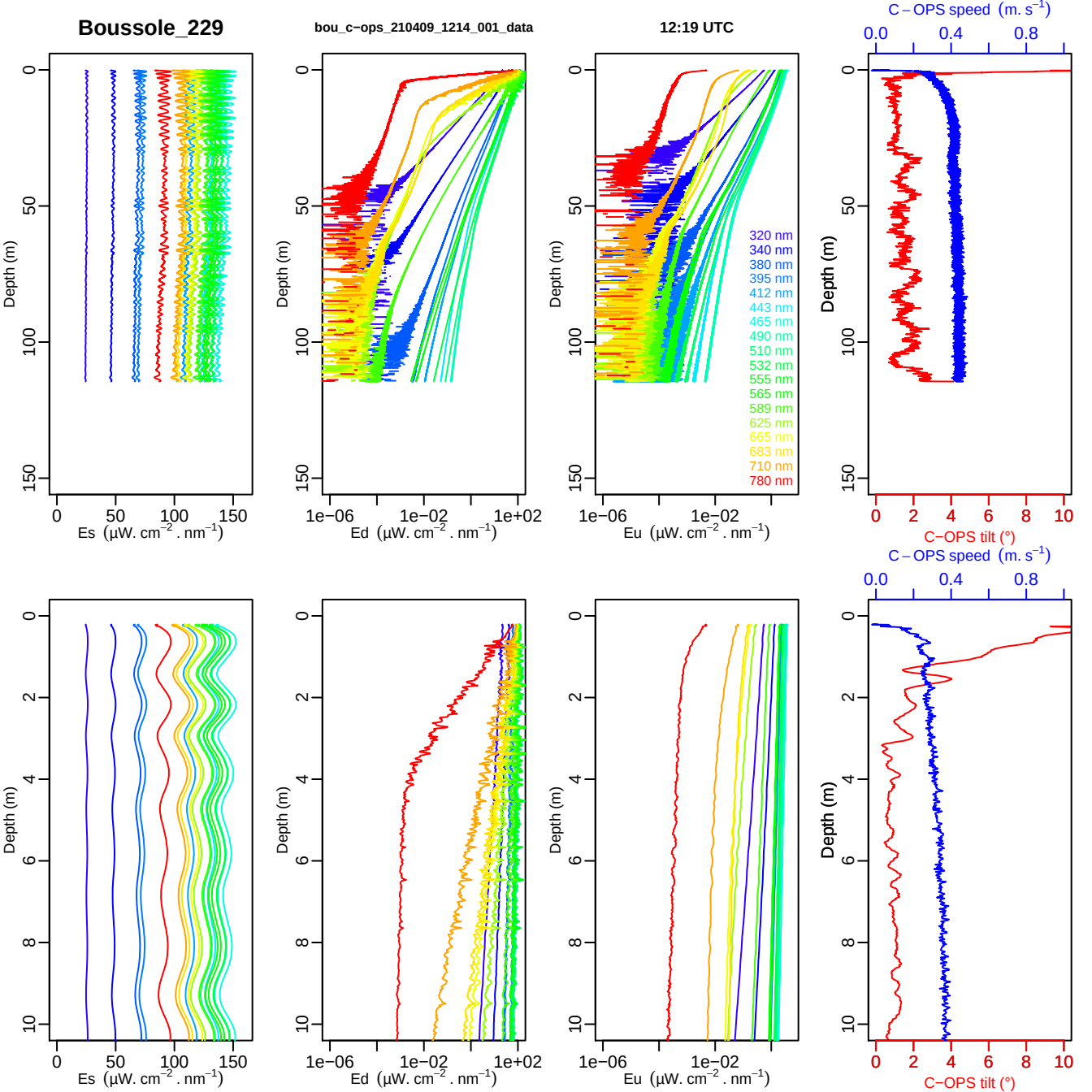
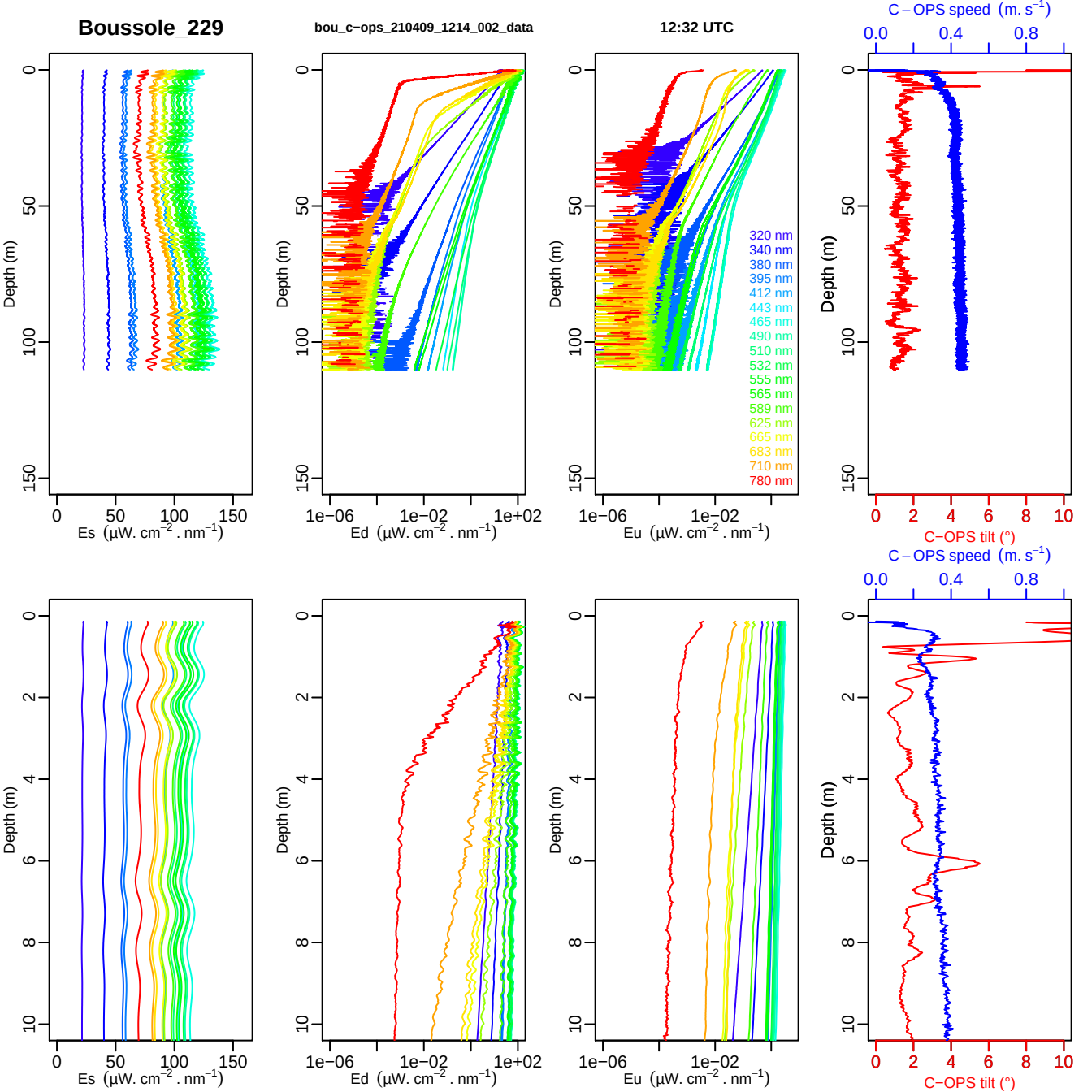
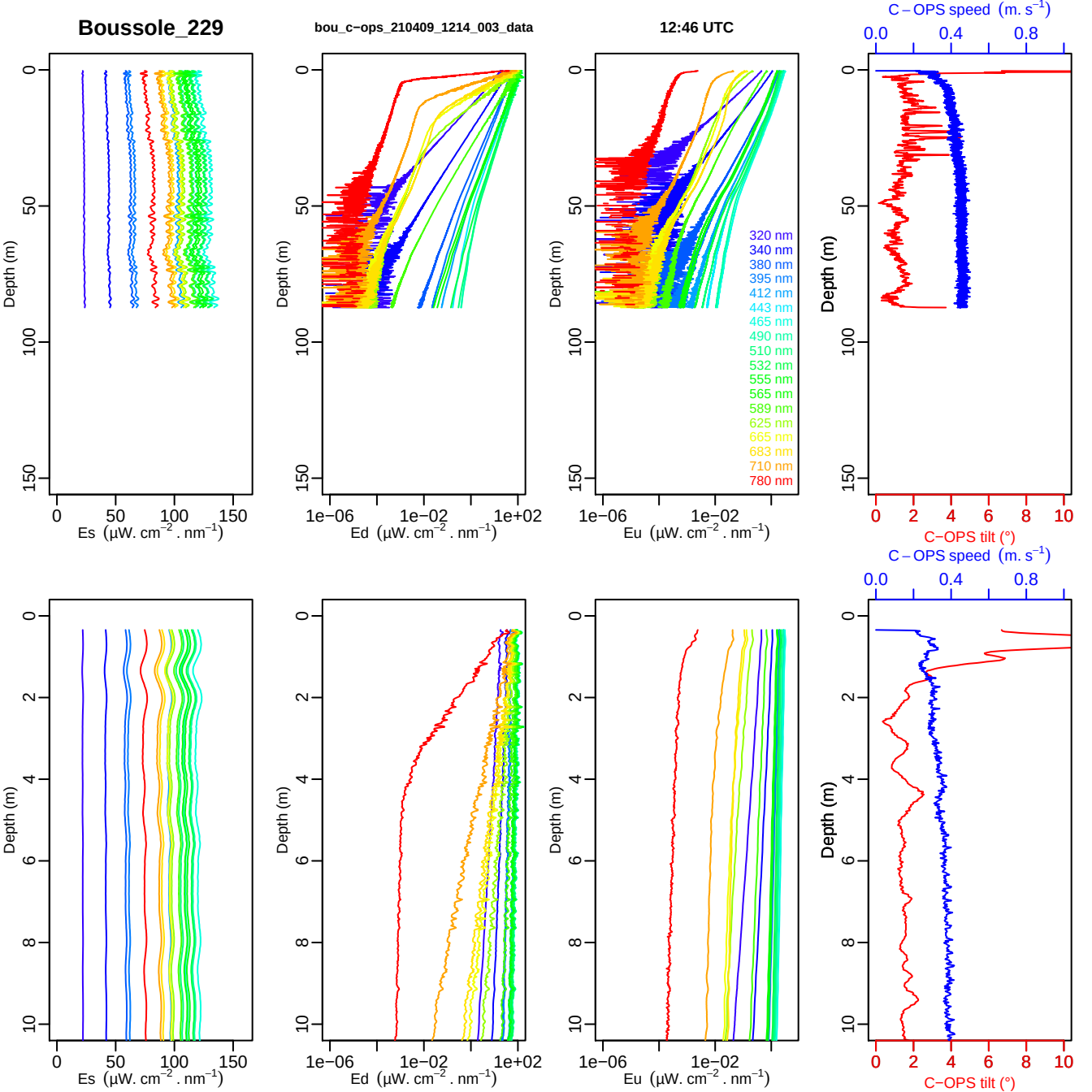
Heure debut [TU] = 13:29
Longitude = 007 54.154 E
Latitude = 43 22.009 N




Boussole_229
bou_c-ops_210409_1214_001_data
12:19 UTC
Depth (m)
Es (µW. cm⁻². nm⁻¹)
Ed (µW. cm⁻². nm⁻¹)
Eu (µW. cm⁻². nm⁻¹)
C-OPS speed (m. s⁻¹)
C-OPS tilt (°)
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm


Boussole_229
bou_c-ops_210409_1214_002_data
12:32 UTC
C – OPS speed (m. s^{-1})
0.0
0.4
0.8
Depth (m)
0
50
100
150
0
50
100
150
Es (µW. cm^{-2}. nm^{-1})
1e−06
1e−02
1e+02
Ed (µW. cm^{-2}. nm^{-1})
Eu (µW. cm^{-2}. nm^{-1})
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm
0
2
4
6
8
10
C−OPS tilt (°)


Boussole_229
bou_c-ops_210409_1214_003_data
12:46 UTC
Depth (m)
Es (µW. cm^{-2}. nm^{-1})
Ed (µW. cm^{-2}. nm^{-1})
Eu (µW. cm^{-2}. nm^{-1})
C – OPS speed (m. s^{-1})
C-OPS tilt (°)
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm