BOUSSOLE Monthly Cruise Report

Cruise 244
July 10-12, 2022

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Vessel: R/V Téthys II
(Captain: Arnaud Behoteguy)

Science Personnel: Lou Andres, Matthieu Bressac, Cyril Debost, Emilie Diamond-Riquier, Céline Dimier, Inès Leferme, Louis Petiteau, Judicaël Rivier, Paco Stil and Vincenzo Vellucci

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The *R/V Téthys II* at the vicinity of the BOUSSOLE buoy.

BOUSSOLE project

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

June 23, 2022

Foreword

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

BOUSSOLE is funded and supported by the following Agencies and Institutions

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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), handheld CIMEL sun photometer measurements are to be performed consecutively where possible with C-OPS profiles. If sea conditions are poor but sky is good, handheld 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 replicate 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).

Projects-specific operations

In addition, water samples are to be collected at 5 m depth for dissolved oxygen (DO), total alkalinity (TA) and total inorganic carbon (TC) analysis (from March 2014) and pH analysis (from October 2021). The TA/TC samples will be processed by the National service for such analyses (SNAPOCO – LOCEAN in Paris). The DO and pH samples will be analysed in the *Institut de la Mer de Villefranche* by the MOOSE team. The results will allow checking the data collected by the pCO_2 CARIOCA sensors, the optode and the pH sensor installed on the buoy at 3 m.
Water samples are to be collected at four depths for metagenomic analyses of different types of Synechococcus, cytometry and nutrients (from March 2020). Additional samples for cytometry analyses are to be collected at ten depths during the BOUSSOLE CTD sampling (from November 2021). These operations are 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, nutrients and metagenomics 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

For logistical reasons, some of the BOUSSOLE operations were performed during the DYFAMED cruise (first day) and some of the DYFAMED operations were performed during the BOUSSOLE cruise (second and third days).

Data were downloaded from the SeapHOx sensor installed on the buoy at 3 m depth for the MOOSE program via the communication cable on the top of the buoy. It combines a pH sensor with a Sea-Bird SBE37 MicroCAT CTD+DO sensor.

A drifting mooring line RESPIRE was deployed the first day during the MOOSE-DYFAMED cruise and recovered the last day during the BOUSSOLE cruise in the frame of the SEAMER project of the *Laboratoire de Villefranche-sur-Mer.*

The Meteo-France buoy located in the DYFAMED site was not well functioning and worked intermittently, so we have been asked to check the state of the buoy.

Cruise Summary

The first day was planned for MOOSE-DYFAMED cruise but some of the BOUSSOLE operations were performed like maintenance on the top of the buoy, CTD with water sampling, C-OPS profiles, a Secchi disk. This day was also used to deploy the drifting mooring line and to check the Meteo-France buoy. The second day was used for diving operations, for maintenance on the top of the buoy, for CTD cast with water sampling and for MOOSE operations (Manta horizontal net and triple zooplankton vertical nets). The last day was used for maintenance on the top of the buoy, for a Secchi disk, for CTD cast with water sampling, for C-OPS profiles and for the recovery of the RESPIRE drifting mooring line.

Sunday 10 July 2022

The sea state was smooth with a light breeze to light air. The sky was blue and the visibility was excellent. During the previous deployment of the BOUSSOLE buoy which took in June 30th, the Junction Box was not switched on and the cap of the Es sensor on the top of the buoy was forgotten on the instrument. So, when arrived at BOUSSOLE, this cap was removed and the Junction Box was switched on. The surface sensor was not heard working on the top of the buoy. Then, a CTD cast with water sampling, 3 C-OPS profiles and a Secchi disk were performed at the BOUSSOLE site. Then, the RESPIRE drifting mooring line was deployed and a deep CTD cast with water sampling was performed at the DYFAMED site for the MOOSE program. Finally, the state of the surface of the Meteo-France buoy was checked before returning to the Nice harbour: nothing was reported except a broken solar panel.

Monday 11 July 2022

The sea state was smooth and there was no wind. The sky was blue and the visibility was excellent. When arrived at BOUSSOLE site, divers went at sea to clean the buoy sensors and to check if there was still bubbling from the battery (bubbling was seen during the previous deployment in June). Bubbling was still on, unfortunately divers lost the ventilation valve key which permit to screw the valve, however they were able to screw the valve by hand, stopping the bubbling.
The seapHOx communication cable was bring and affixed on the top of the buoy and seapHOx data were downloaded. The functioning of the buoy was checked on the top of the buoy but it appeared that the buoy was not working: no noise came out of the surface sensor. So, the dark measurements were not performed. Then, 2 CTD with water sampling were performed at the BOUSSOLE site. The first cast (CTD 02) was performed with a 0.2µm filter 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.
Then a Manta horizontal net was performed in the way to DYFAMED site and 2 triple zooplankton vertical nets were performed at the DYFAMED site for the MOOSE program before returning to the Nice harbour.

Tuesday 12 July 2022

The sea state was smooth with a light air. The sky was blue and the visibility was good. Firstly, buoy functioning was checked on the top of the buoy: the surface sensors did not turn on. After that, the surface DL3 Wi-Fi was switched on with an external battery and a connection was got. The only data file available (starting after deployment) was downloaded. Then the surface DL3 was reconnected to the buoy cable and the surface instrument turned on with a correct functioning.
Then a Secchi disk, 2 CTD casts with water sampling and 3 C-OPS profiles were performed at the BOUSSOLE site. Unfortunately, IOP package was not available because the batteries of the IOP package were discharged and it was too late to recharge them. Finally, the RESPIRE drifting mooring line was recovered before returning to the Nice harbour.

Pictures taken during this cruise can be found at:
https://photos.app.goo.gl/D4XHrkDXSBwuRiAY9

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

Cruise Report

Sunday 10 July 2022 (UTC)

People on board: Lou Andres (student), Matthieu Bressac, Emilie Diamond-Riquier, Louis Petiteau and Paco Stil.

0630 Departure from the Nice harbour.
0950 Arrival at the BOUSSOLE site.
0955 Maintenance on the top of the buoy: removing of Es cap, switching on the Junction Box.
1030 CTD 01, 400 m with water sampling at 290, 175, 80, 70, 60, 50, 40, 30, 20, 10 and 5 m for HPLC, a_p, TA/TC, DO and pH.
1120 C-OPS 01, 02, 03.
1220 Secchi 01, 26 m.
1230 Departure to the RESPIRE drifting mooring line deployment site.
1245 Deployment of the RESPIRE drifting mooring line.
1310 Departure to the DYFAMED site.
1330 Arrival at the DYFAMED site.
1350 CTD MOOSE 165, 2350 m with water sampling (MOOSE program).
1535 Departure to the Meteo-France buoy site.
1545 Arrival at the Meteo-France buoy site: buoy checking.
1615 Departure to the Nice harbour.
1920 Arrival at the Nice harbour.

Monday 11 July 2022 (UTC)

People on board: Lou Andres, Cyril Debost, Céline Dimier, Inès Leferme (student), Judicaël Rivier and Paco Stil.

0525 Departure from the Nice harbour.
0830 Arrival at the BOUSSOLE site.
0845 Diving operations: cleaning and tightening of the screw of the battery.
Buoy functional checking.
SeapHox data downloading.
1005 CTD 02, 400 m with water sampling at 5 m for TSM (with 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).
1200 CTD 03, 400 m with water sampling at 400, 200, 150, 80, 70, 60, 50, 40, 30, 20, 10 and 5 m for HPLC and a_p.
1245 Manta horizontal net.
1320 Zooplankton triple vertical nets x 2 (100 and 200m).
1345 Departure to the Nice harbour.
1700 Arrival to the Nice harbour.

Tuesday 12 July 2022 (UTC)

People on board: Lou Andres, Inès Leferme (student), Louis Petiteau, Paco Stil and Vincenzo Vellucci.

0530 Departure from the Nice harbour.
0850 Arrival at the BOUSSOLE site.
0900 Maintenance on the top of the buoy: data downloading, battery and functional checking.
0930 Secchi 02, 28m.
1020 CTD 04, 400 m with water sampling at 60, 44, 20 and 5 m for metagenomics, nutrients and cytometry.
1050 Attempt of recharging IOP package batteries.
1125 CTD 05, 400 m with water sampling at 400, 200, 150, 80, 70, 60, 50, 44, 30, 20, 10 and 5 m for HPLC, a_p, TSM and cytometry.

1215 C-OPS 04, 05, 06.
1300 Departure to the RESPIRE drifting mooring line site.
1400 Recovery of the RESPIRE drifting mooring line.
1420 Departure to the Nice harbour.
1715 Arrival to the Nice harbour.

Problems identified during the cruise

- Problems appeared in the BOUSSOLE C-OPS EdZ radiometer (S/N #152) during the previous cruise. So, it was sent to the manufacturer for repair. The EdZ radiometer was replaced with the one shared among the marine optics and remote sensing group at LOV (S/N #182). So, the configuration of the C-OPS is different: there were some differences between EdZ and EuZ wavelengths.

- The cable of the IOP package battery was not disconnected during the night by mistake, so the batteries discharged and there were no IOP data acquisition the last day due to the lack of battery. The backscattering dark measurements of the IOP package could not be performed.

- There was no blank for the TSM filtration of the second day (CTD 02).

- The CIMEL photometer did not work. Unfortunately, it is not possible to send at the manufacturer for maintenance because of its obsolescence.

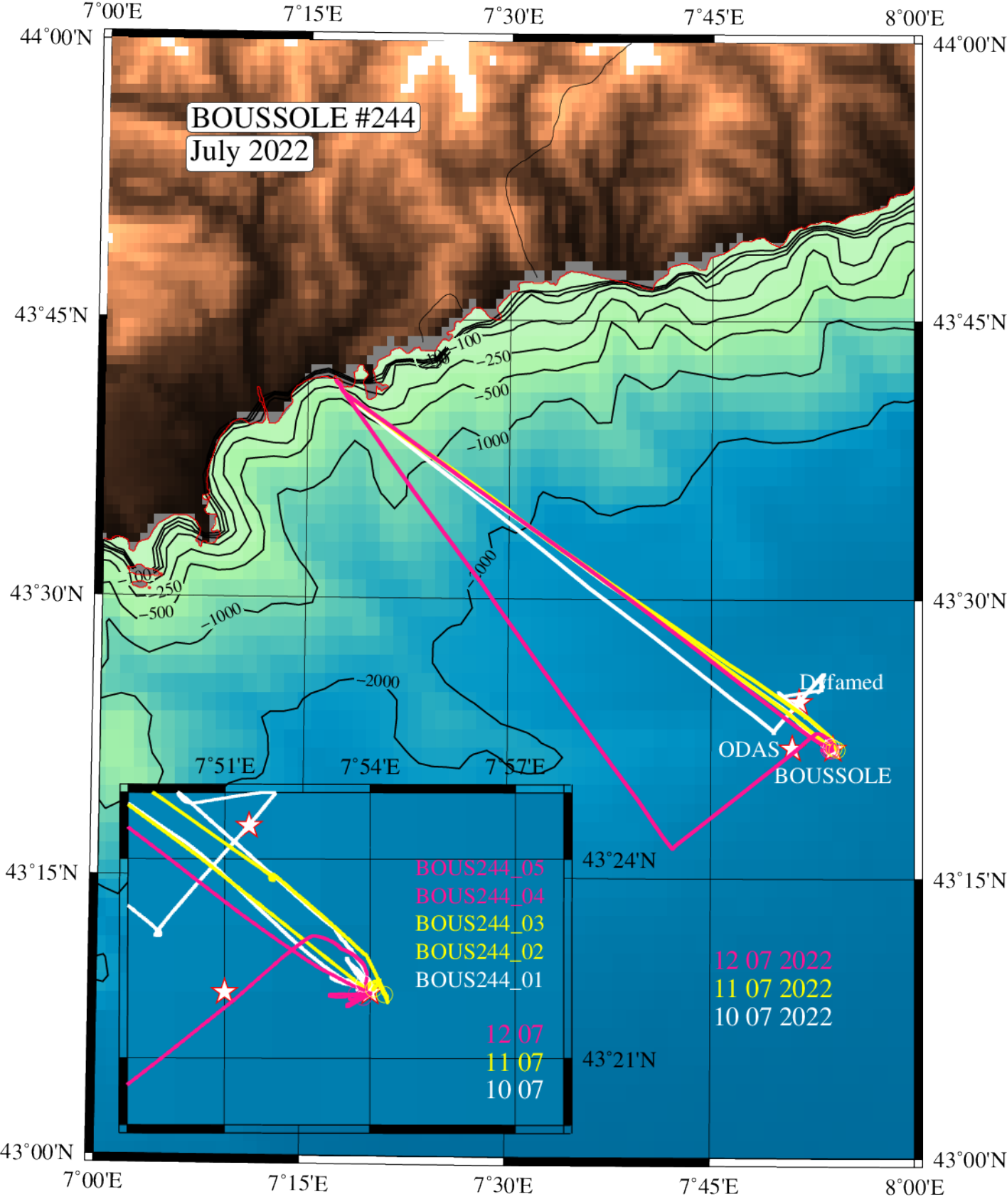
- The ship fluorometer is out of service. It is not repairable because of its obsolescence. It will be replaced during the works planned on the R/V *Téthys* in 2023.

- The second day during the diving, the functioning of the buoy was checked at the top of the buoy but the surface sensor was not heard working. So, the dark measurements on the buoy were not performed. The last day, surface sensor was not heard working too. After that, the surface DL3 Wi-Fi was switched on with an external battery and a connection was got. The only data file available (starting after deployment) was downloaded. Then the surface DL3 was reconnected to the buoy cable and the surface instruments turned on. Then stopped after the acquisition and restarted at the nominal schedule, i.e. a correct functioning. After verification of the downloaded datafile, it appeared that the buoy had worked continuously, on a nominal schedule, for about 5 days before entering sleeping mode due to low voltage. Instruments did not all work all of the time, however this is normal behaviour due to decreasing battery voltage. In summary, the buoy battery was ok (no leak) and capable to recover after discharge. It is not clear why the surface DL3 did not restart after battery recovery.

Appendices

Cruise Summary Table for Boussole 244

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
10/07/22			BOUS244_01	HPLC, ap, O_2, TA/TC, O2 & pH	10:34	0:42:00	400	43	22.121	7	53.874	blue		1	4.3	100	1015.9	68		26	25.50	smooth			
		bou_c-ops_220710_1031_001_data.csv			11:29	0:03:17	78	43	22.32	7	53.750	blue	Ci	1	1.8	310	1016	68	excellent	27.3		smooth	0.3		no
		bou_c-ops_220710_1031_002_data.csv			11:50	0:03:32	81	43	22.241	7	53.933	blue	Ci	1	1.8	310	1016	68	excellent	27.3		smooth	0.3		no
		bou_c-ops_220710_1031_003_data.csv			12:02	0:03:51	93	43	22.561	7	53.670	blue	Ci	1	1.8	310	1016	68	excellent	27.3		smooth	0.3		no
				Secchi 01	12:20	0:04:00	26	43	22	7	54	blue		0					excellent			smooth			
11/07/22			BOUS244_02	TSM	10:03	1:32:00	400	43	22.047	7	54.075	blue		1	0.2	36	1017	64.5		26.4	25.30	smooth			
			BOUS244_03	HPLC & ap	11:58	0:32:00	400	43	21.961	7	54.303	blue		1	0.2	149	1016	61.1		27	25.60	smooth			
12/07/22				Secchi 02	9:30	0:04:00	28	43	22	7	54	blue		1					good			smooth			
			BOUS244_04	Metagenomics, cyto & nutrients	10:16	0:14:00	100	43	21.92	7	53.861	blue		1	0.8	292	1014	70		26.5	26.00	smooth			
			BOUS244_05	HPLC, ap, TSM & cyto	11:22	0:3900	400	43	21.969	7	53.721	blue		1	2.1	150	1019	71		27	26.10	smooth			
		bou_c-ops_220712_1207_004_data.csv			12:28	0:03:48	94	43	22.497	7	53.756	blue	Cu	3	1	341	1019	64.6	good	27.5		smooth	0.2		no
		bou_c-ops_220712_1207_005_data.csv			12:40	0:03:56	98	43	22.643	7	53.418	blue	Cu	3	1	341	1019	64.6	good	27.5		smooth	0.2		no
		bou_c-ops_220712_1207_006_data.csv			12:51	0:02:41	65	43	22.796	7	53.088	blue	Cu	3	1	341	1019	64.6	good	27.5		smooth	0.2		no



GMT 2022 Oct 06 16:07:46

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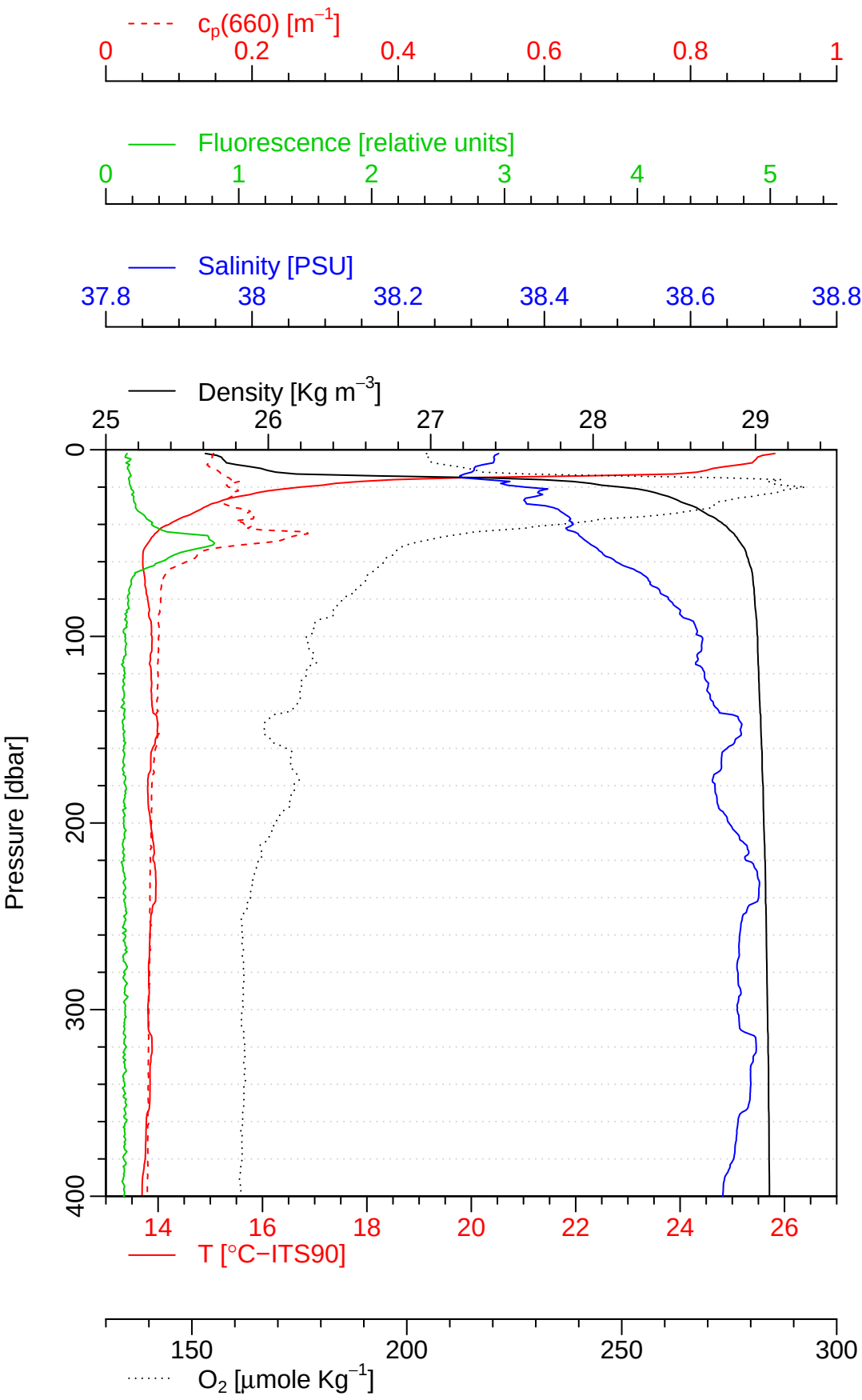
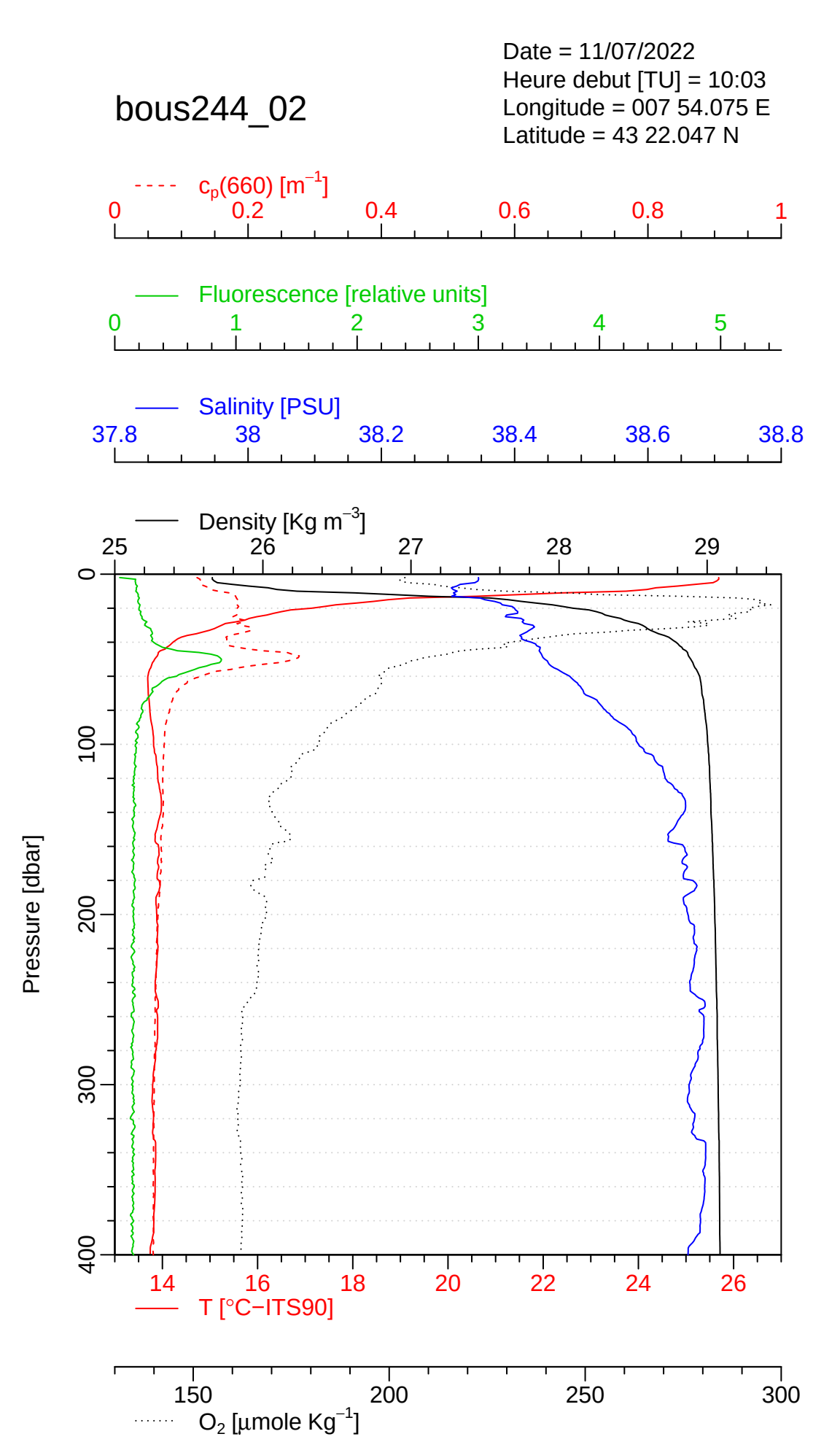
Latitude = 43 22.121 N




bous244_02
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Heure debut [TU] = 10:03
Longitude = 007 54.075 E
Latitude = 43 22.047 N
cp(660) [m−1]
0
0.2
0.4
0.6
0.8
1
Fluorescence [relative units]
0
1
2
3
4
5
Salinity [PSU]
37.8
38
38.2
38.4
38.6
38.8
Density [Kg m−3]
25
26
27
28
29
Pressure [dbar]
0
100
200
300
400
14
16
18
20
22
24
26
T [°C−ITS90]
150
200
250
300
O2 [µmole Kg−1]

bous244_03

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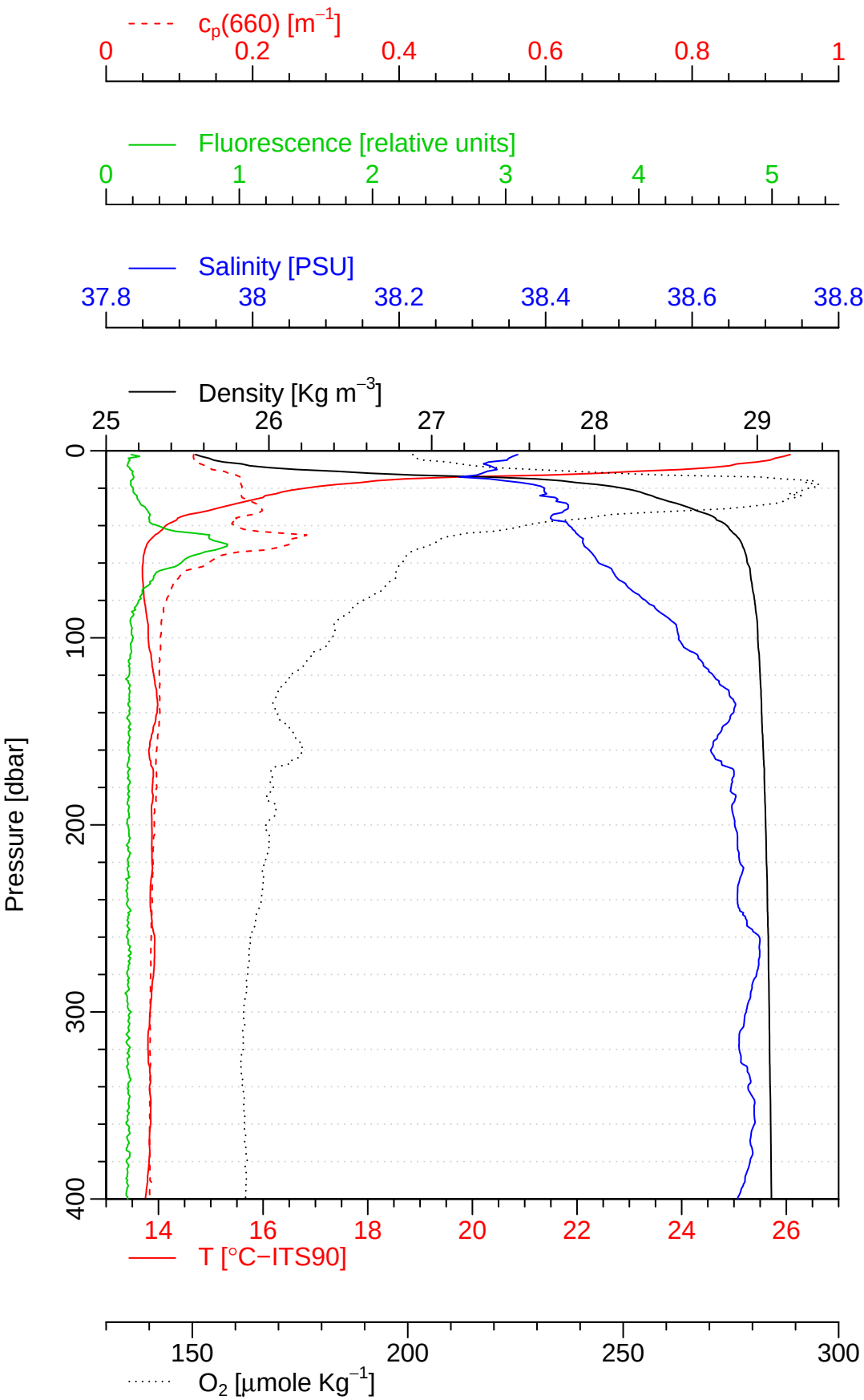
Longitude = 007 54.303 E
Latitude = 43 21.961 N



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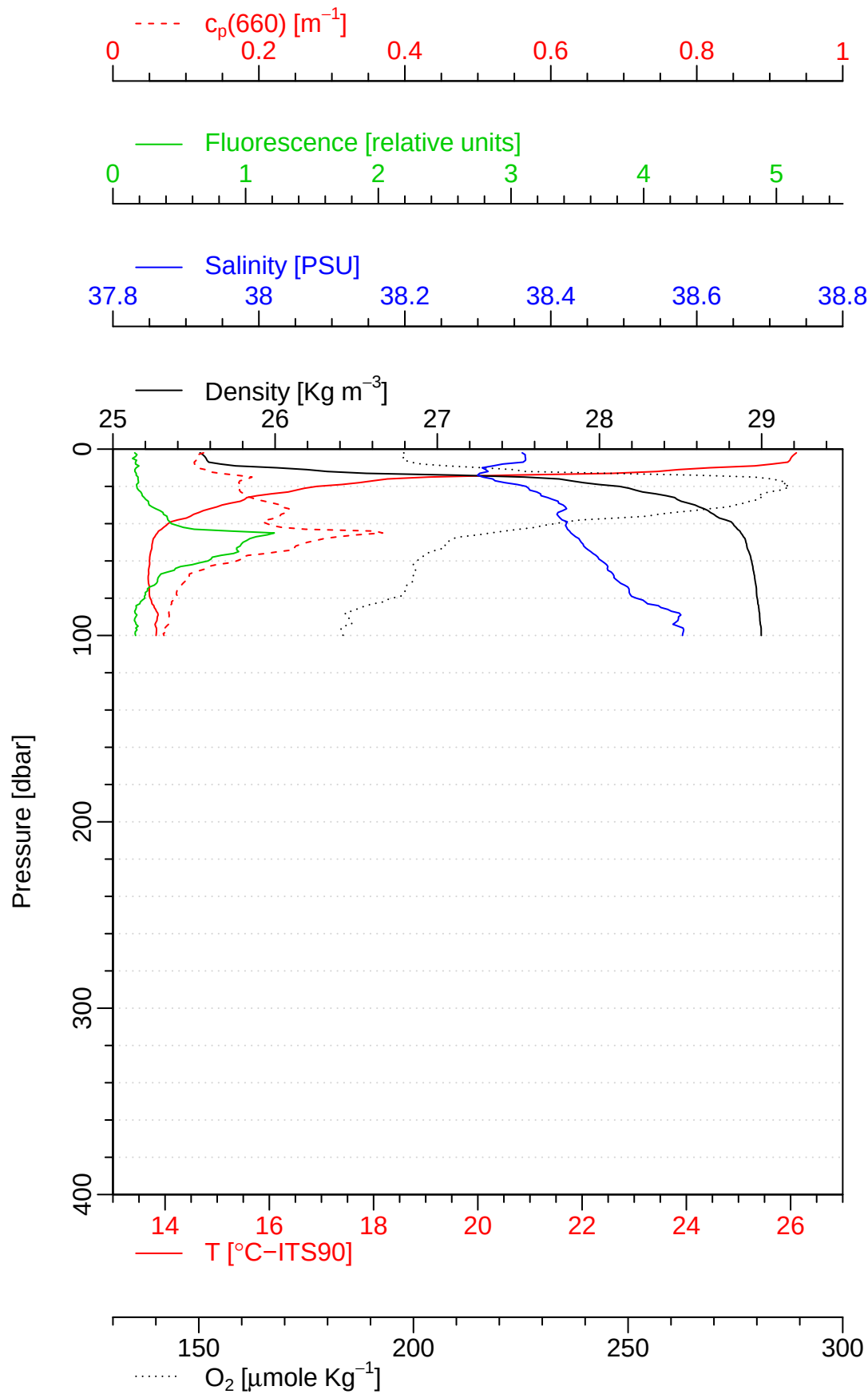

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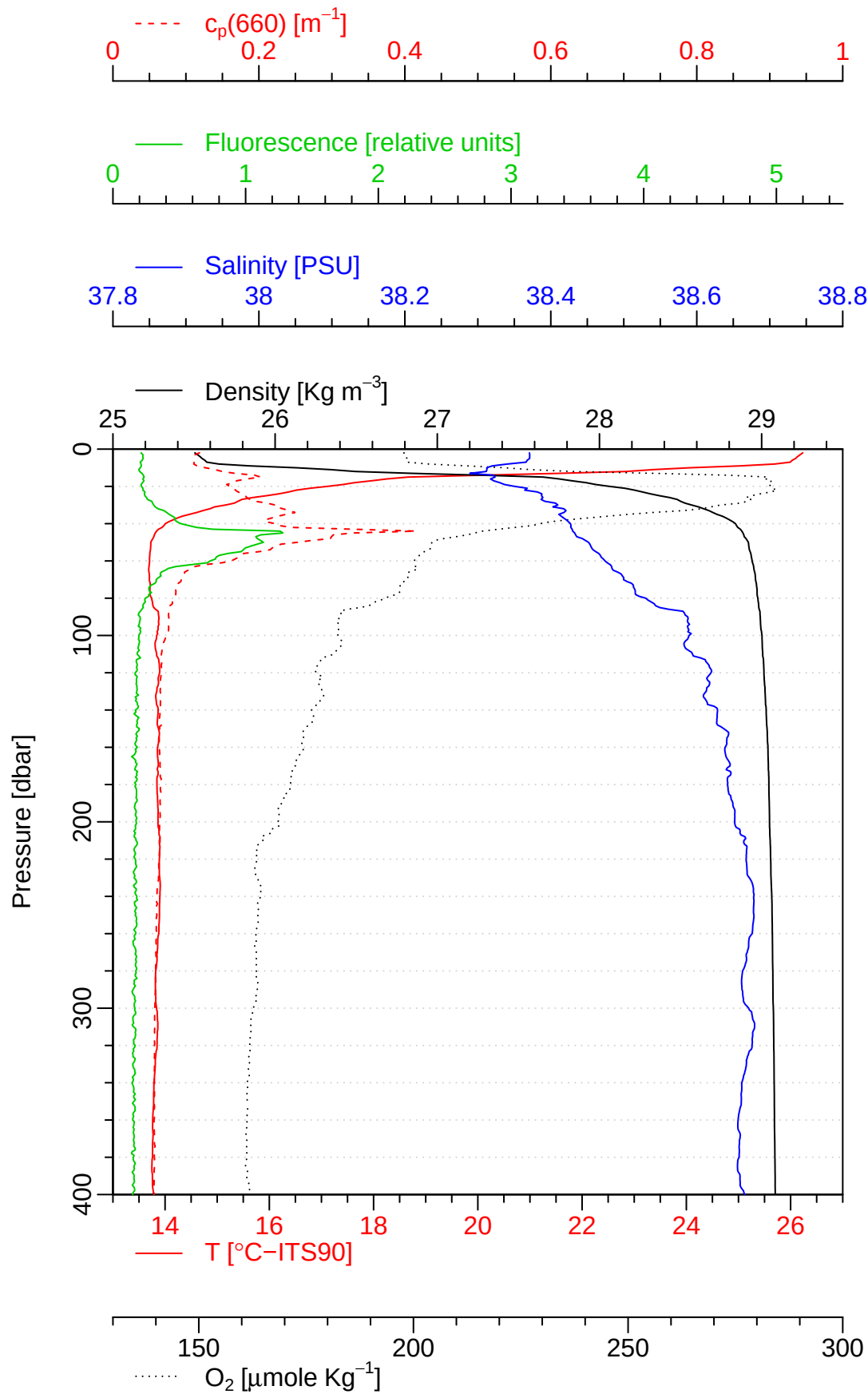

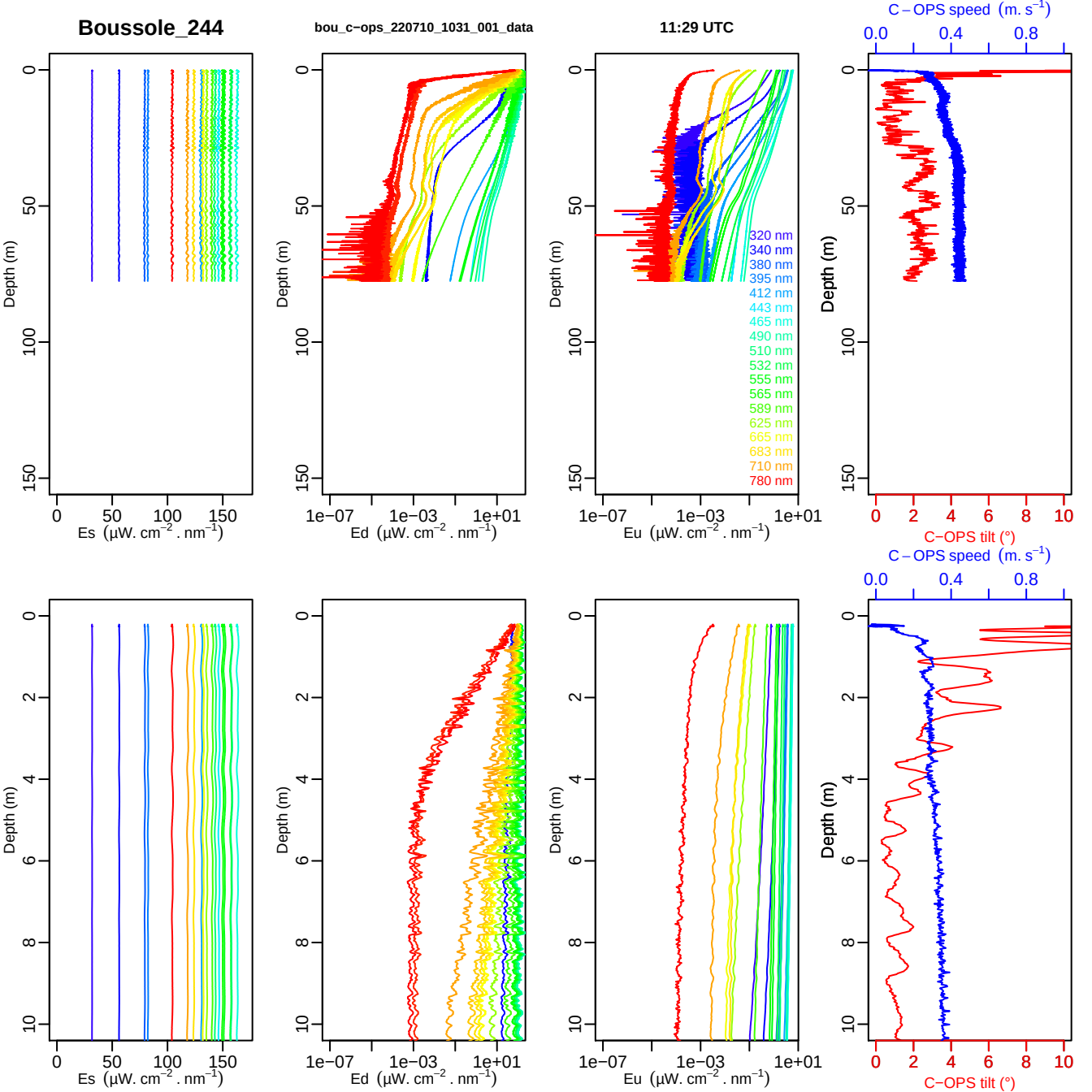
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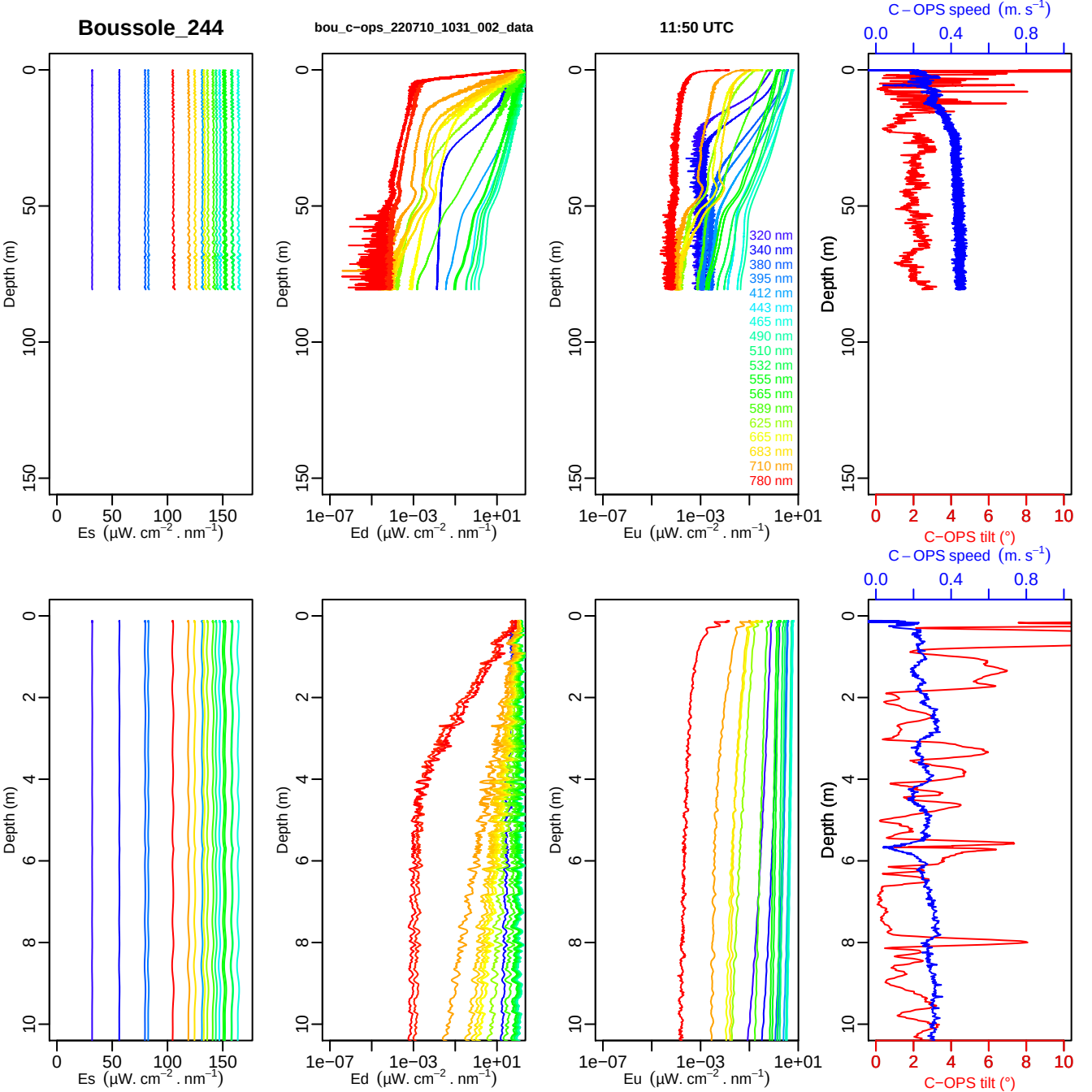
Es (µW. cm⁻². nm⁻¹)
Ed (µW. cm⁻². nm⁻¹)
Eu (µW. cm⁻². nm⁻¹)
C-OPS speed (m. s⁻¹)
C-OPS tilt (°)
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm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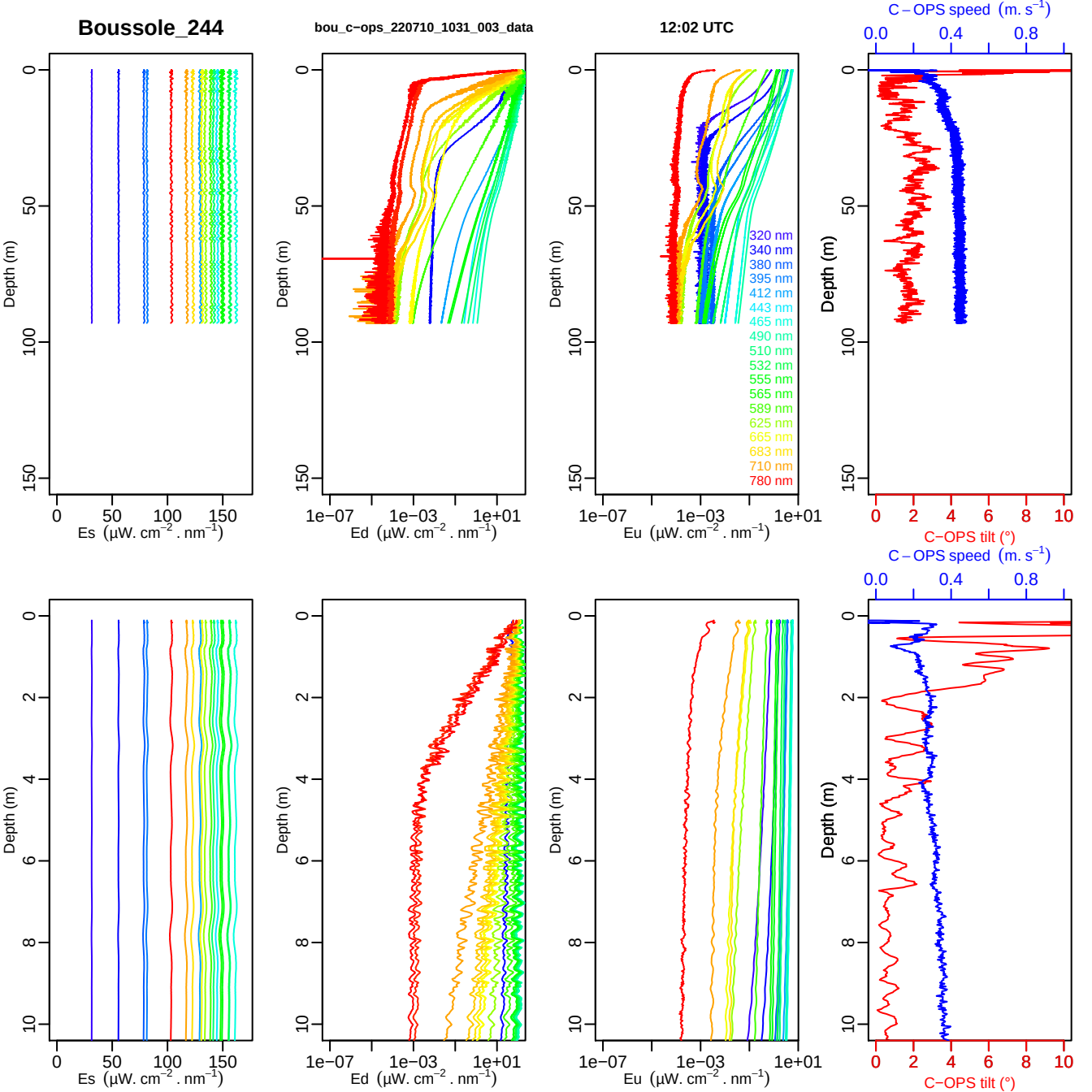
Ed (µW. cm⁻². nm⁻¹)
Eu (µW. cm⁻². nm⁻¹)
C – OPS speed (m. s⁻¹)
C-OPS tilt (°)
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm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C – OPS speed (m. s^{-1})
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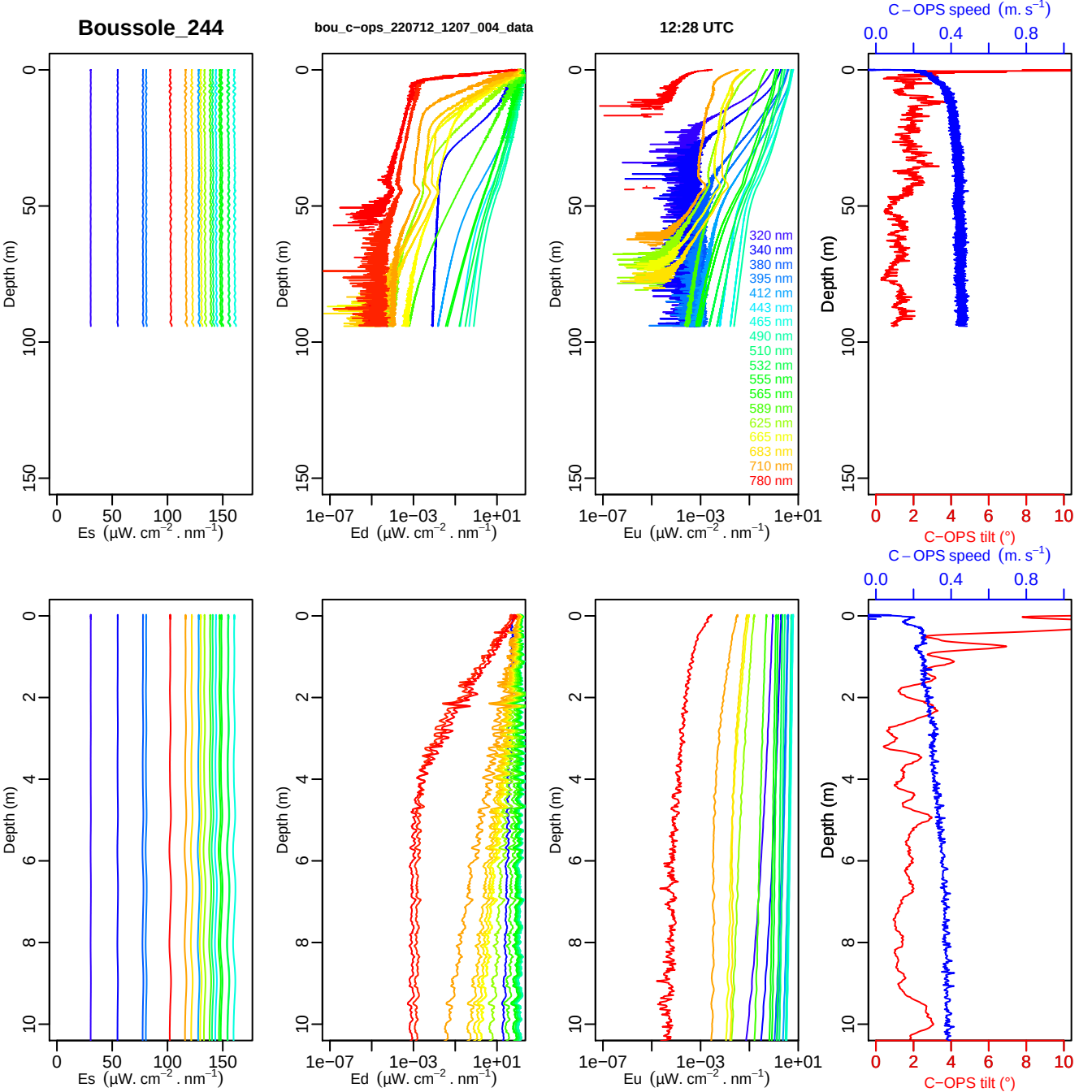
0.4
0.8
Depth (m)
0
50
100
150
0
50
100
150
Es (µW. cm^{-2}. nm^{-1})
1e−07
1e−03
1e+01
Ed (µW. cm^{-2}. nm^{-1})
Eu (µW. cm^{-2}. nm^{-1})
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm
0
2
4
6
8
10
C−OPS tilt (°)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0.8
Depth (m)
0
50
100
150
Es (µW. cm^{-2}. nm^{-1})
Ed (µW. cm^{-2}. nm^{-1})
Eu (µW. cm^{-2}. nm^{-1})
1e−07
1e−03
1e+01
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
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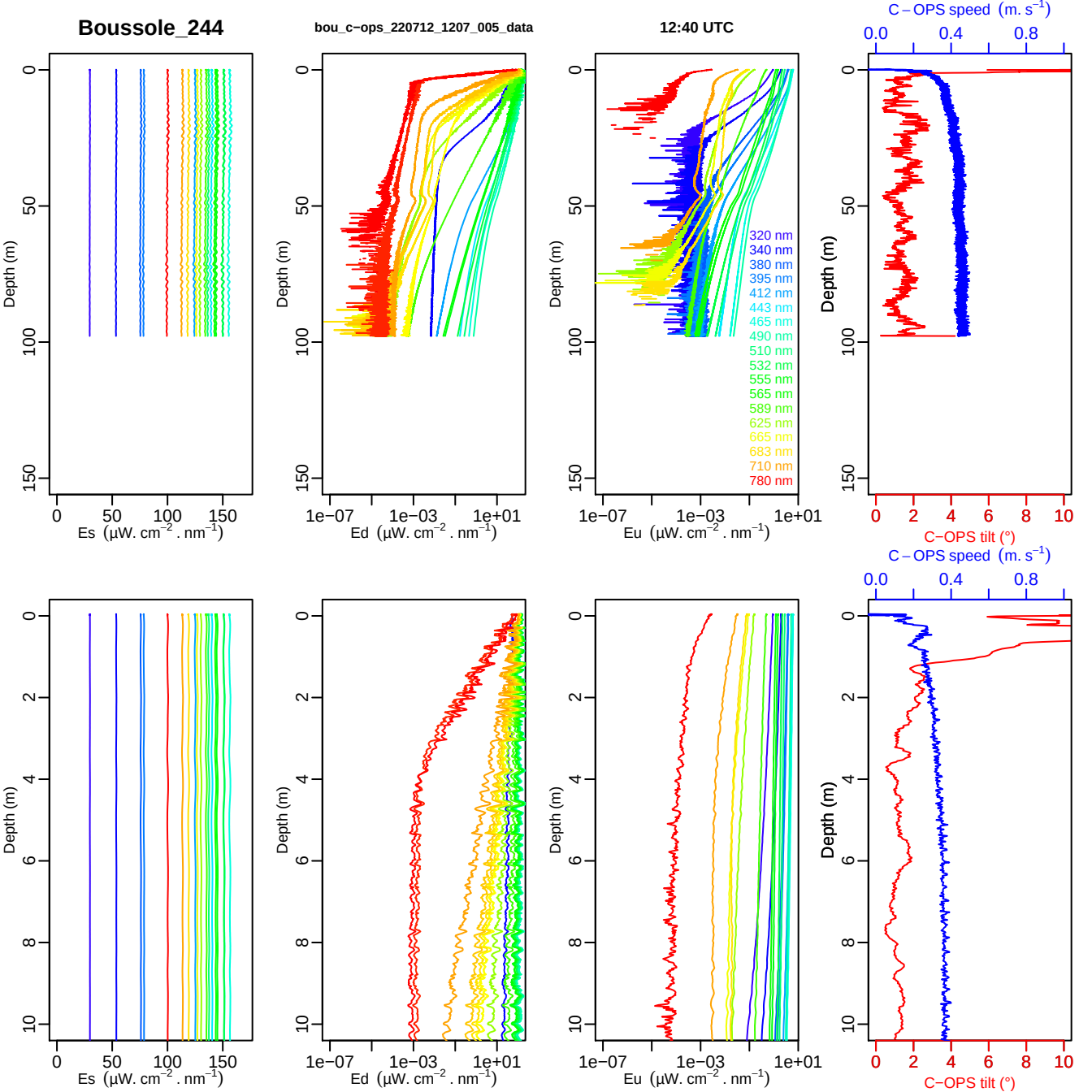
780 nm
C−OPS tilt (°)
0
2
4
6
8
10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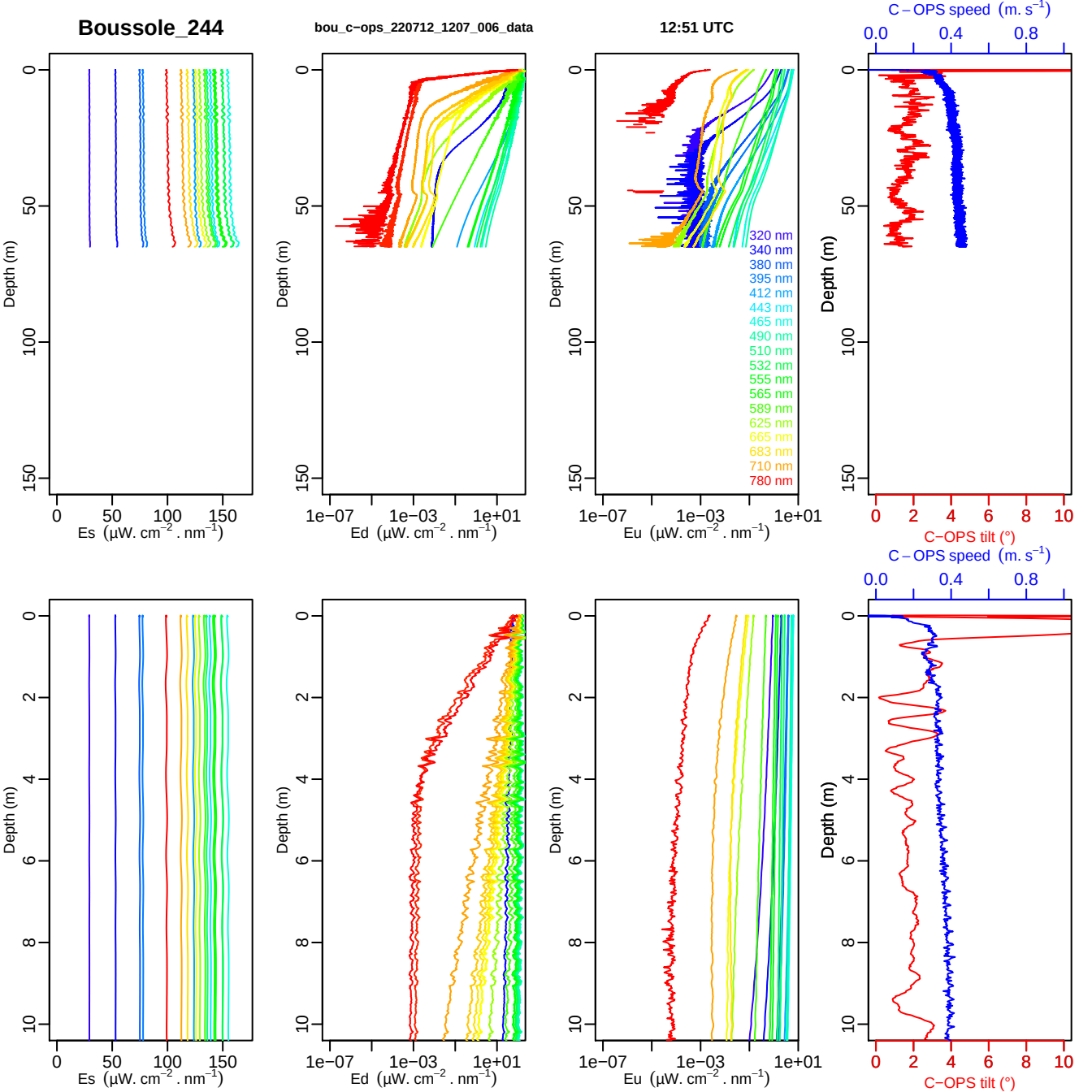
Eu (µW. cm⁻². nm⁻¹)
C – OPS speed (m. s⁻¹)
C-OPS tilt (°)
320 nm
340 nm
380 nm
395 nm
412 nm
443 nm
465 nm
490 nm
510 nm
532 nm
555 nm
565 nm
589 nm
625 nm
665 nm
683 nm
710 nm
780 nm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Ed (µW. cm⁻². nm⁻¹)
Eu (µW. cm⁻². nm⁻¹)
C-OPS speed (m. s⁻¹)
C-OPS 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