Report of the AMAZOMIX survey - Legs 1 and 2

R/V ANTEA 27/08 – 29/09, 2021

Chief Scientist Leg 1 and Leg 2: Arnaud BERTRAND, IRD/MARBEC

Report redacted aboard the R/V Antea the 29/09/2021

Outline

1. Objective of the AMAZOMIX survey

The Amazon shelf encompasses a variety of physical processes, such as fluvial inputs, coastal currents, mesoscale, filaments, tides, internal waves and upwelling, influencing nutrient concentrations, chlorophyll and suspended matter. They also affect energy, salt and heat balances; parameters that condition physical/biogeochemical interactions and ecosystem functioning, from bacteria to plankton to fish resources. In particular, internal tidal waves are very energetic in this region. They impact biogeochemical cycles via the vertical mixture induced by their dissipation or vertical movements induced by their propagation. They thus allow a significant input of nutriments into the euphotic layer enhancing primary production, as observed on the surface from watercolour data. Internal tidal waves could thus influence the biological pump and the carbon cycle. In addition, overall marine biodiversity of the region, from bacteria to fish is not well described. The connectivity of species in the tropical Atlantic is also still an open question. The Caribbean region is by far more bio-diverse than the Brazilian one. One of the hypotheses is that the Amazon plume, which can extend up to 3,000 km off the mouth, would constitute a barrier for some organisms. The Amazon Shelf is thus an ideal experimental laboratory to study the impact of physical processes on the structure and function of neritic and oceanic marine ecosystems.

In this context, the objective of the multidisciplinary AMAZOMIX survey was to study the impact of the Amazon River plume, internal tides and associated turbulent mixing, on marine ecosystem in contrasting regions off the Amazon shelf. For that purpose, the multidisciplinary AMAZOMIX project brings together physicists, biogeochemists, bioopticians and biologists. The sampling strategy consists in the simultaneous acquisition of a comprehensive set of environmental and biological compartments, including micro-organisms (bacteria, phyto and zooplankton) and higher trophic levels (micronecton, demersal and pelagic fish). AMAZOMIX is the first campaign to develop this multi-disciplinary approach off the Amazon shelf. *In situ* results will be analysed in interaction with digital tools and data, modelling (1/36°, with and without tides, 1/12° coupled) and satellite data analyses.

The survey is organized by the French Institute for Development (IRD), CNRS and CNES in France, Federal Rural University of Pernambuco (UFRPE), Federal University of Pernambuco (UFPE), Federal University of Pará (UFPA) and Federal Rural University of the Amazon (UFRA) for Brazil, and benefits from the structuring role of the International Joint Laboratory (LMI) TAPIOCA (IRD, UFPE, UFRPE). Technical services, research units and universities are associated to AMAZOMIX, of which: UMR MARBEC (University of Montpellier, IRD, Ifremer, CNRS), UMR LEGOS (CNES, CNRS, IRD, University Paul Sabatier), UMR LEMAR (UBO, CNRS, IRD, Ifremer), DT-INSU (CNRS), US IMAGO (IRD), UMR LOG (CNRS, IRD, University of Lille, ULCO), UMR MIO (University of Aix-Marseille, University of Toulon, IRD, CNRS), Federal University of Rio de Janeiro (UFRJ, Brazil), the National Brazilian Institute for Spatial research (INPE, Brazil) and the University of Porto (Portugal). The Rockland Scientific firm is also participating in the campaign as an industrial organization.

In addition to the scientists on board, AMAZOMIX includes a whole team that will remain on land. A total of about 70 Brazilian, French and other countries' researchers are involved in the campaign, which will also have a research training role for about 50 international students. AMAZOMIX is the result of a long-standing federative work based on numerous funded projects, including the TRIALTAS European project and articulated through the LMI TAPIOCA (IRD, UFPE, UFRPE). It should also be emphasized that the analysis of the data collected will be carried out jointly by the different partners and that the findings will be pooled.

The aim of this report is to resume the activities performed during the Legs 1 and 2 of the AMAZOMIX survey and to assemble in a document the main protocols.

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2. Scientific and technical staff

Table 1. List of scientific and technical staff.

Surname	Name	Nationality	Speciality	Role on-board	Institute	Status				Leg	
						Researcher	Engineer	Student.	Other.	1	2
Bertrand	Arnaud	French	Acoustics, Ecology	Chief Scientist	IRD	X				X	X
Barreto	Thaiza	Brazilian	Biology	Biology	UFRPE			X			X
Carré	Claire	French	Phytoplankton	Plankton	IRD		X			X	
Cervelli	Evan	Canadian	Oceanography	Oceanography	Rockland		X			X	
Eduardo	Leandro	Brazilian	Biology	Biology	UFRPE	X				X	
Fouilland	Eric	French	Biochemistry	Biochemistry	CNRS	X				X	
Le Ridant	Arnaud	French	Oceanography	Oceanography	CNRS		X				X
Lebourges-Dhaussy	Anne	French	Acoustics	Acoustics	IRD		X				X
Melo	Pedro	Brazilian	Zooplankton	Plankton	UFPE	X					X
Mériaux	Xavier	French	Biochemistry	Biochemistry	ULCO		X			X	
Passarone	Rafaela	Brazilian	Biology	Biology	UFRPE			X			X
Roubaud	Fabrice	French	Electronic, oceanography	Electronic, oceanography	IRD		X				X
Roudaut	Gildas	French	Acoustics	Acoustics	IRD		X				X
Rousselot	Pierre	French	Electronic	Electronic, oceanography	IRD		X			X	
Soares	Andrey	Brazilian	Biology	Biology	UFRPE			X		X	
Ternon	Jean-François	French	Biochemistry	Biochemistry	IRD	X					X
Vantrepotte	Vincent	French	Biochemistry	Biochemistry	CNRS	X				X	
Augusto de Oliveira	Felipe	Brazilian	Hydrography	Observer	Marine Brazil				X	X	X
	Total					6	8	2	1	10	10

IRD: Institut de Recherche pour le Développement, CNRS : Centre National de la Recherche Scientifique, UFRPE : Université Fédérale Rurale du Pernambouc, UFPE : Université Fédérale du Pernambouc, ULCO : Université du Littoral côte d'Opale.

3. Official and crew

Table 2. List of official and crew Leg 1.

Surname	Name	Function
SAMUEL	PIERRE	COMMANDANT
BRETAGNE	AUGUSTIN	2ND CAPITAINE
QUIBLIER	ANTOINE	LIEUTENANT
ROUSSELOT	VINCENT	CHEF MECANICIEN
GAUCHER-AUBOUR	JULIEN	2ND MECANICIEN
LE QUILLIEC	MIKAEL	MAITRE D'EQUIPAGE
DANIEL	BARGAIN	MAITRE DE MANOEUVRE
MARIE LEPOINTTEVIN	THEODORE	MATELOT-2
SCALABRIN DA SILVA	GERONIMO	MATELOT-1
FILLATRE	THOMAS	MATELOT-1
PERRENOU	JORDAN	OUVRIER MECANICIEN
CHRISTOPHE	VAILLANT	1ER CUISINIER
TOCQUET	PHILIPPE	1ER MAITRE D'HOTEL

Table 3. List of official and crew Leg 2

Surname	Name	Function
SAMUEL	PIERRE	COMMANDANT
HINGANT	CELINE	2ND CAPITAINE
QUIBLIER	ANTOINE	LIEUTENANT
PROHET	ANTOINE	CHEF MECANICIEN
GRILLON	MAXANCE	2ND MECANICIEN
LE QUILLIEC	MIKAEL	MAITRE D'EQUIPAGE
DANIEL	BARGAIN	MAITRE DE MANOEUVRE
MARIE LEPOINTTEVIN	THEODORE	MATELOT-2
SCALABRIN DA SILVA	GERONIMO	MATELOT-1
FILLATRE	THOMAS	MATELOT-1
PERRENOU	JORDAN	OUVRIER MECANICIEN
CHRISTOPHE	VAILLANT	1ER CUISINIER
TOCQUET	PHILIPPE	1ER MAITRE D'HOTEL

4. Survey design

The survey design was planned to sample:

- within and out the Amazon river plume;
- within and outside areas of generation of internal waves;
- neritic and oceanic domains.

From one station to the other, we used four strategies while collecting continuous data (acoustic, ADCP, thermosalinograph, Cytosense and fluoroprobe):

- When the distance from one station to the other was high, we followed to route.
- At one shelf-break station (Station 05), we performed a 3*0.5 nm magic rectangle over the shelf-break.
- Along long transects we performed back and forward path along transect. This option was used to compare the oceanscape along transect at different times.
- In offshore areas we stayed in fix station (facing the current at surface current speed) to obtain continuous data over time. This last option was designed to observe the passing of internal waves.

In total 14 stations have been achieved during the Leg 1 (Figure 1) and 21 stations (St 15 - St 35) during the Leg 2 (Figure 2).

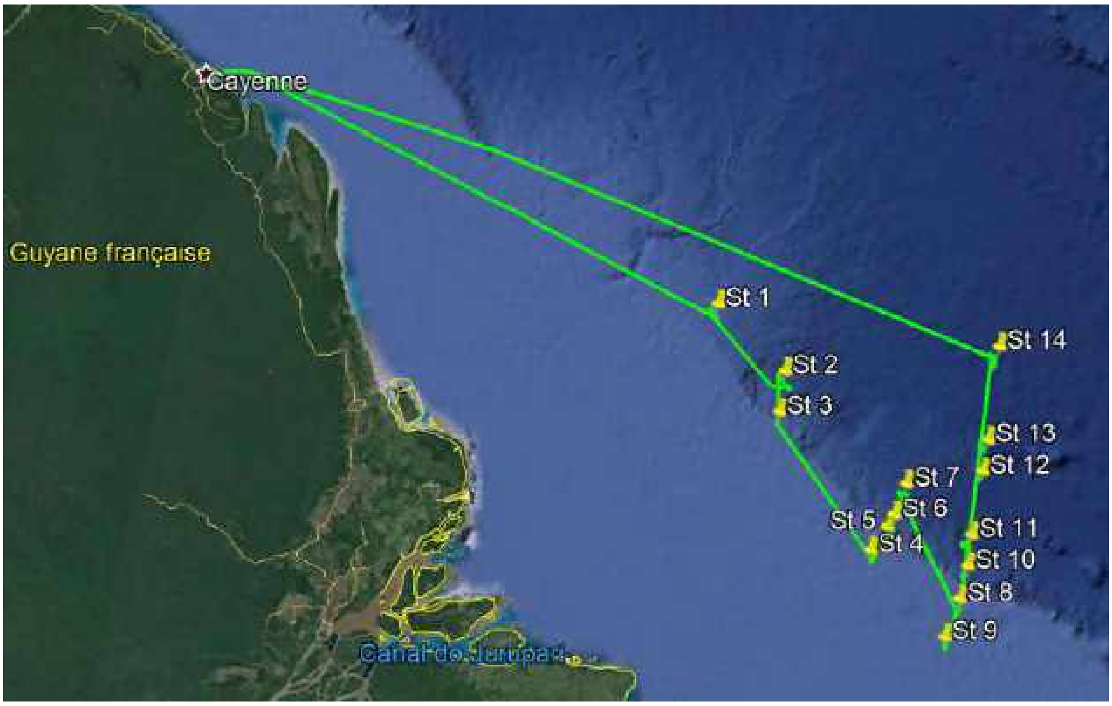

Figure 1. Amazomix survey track during Leg 1.

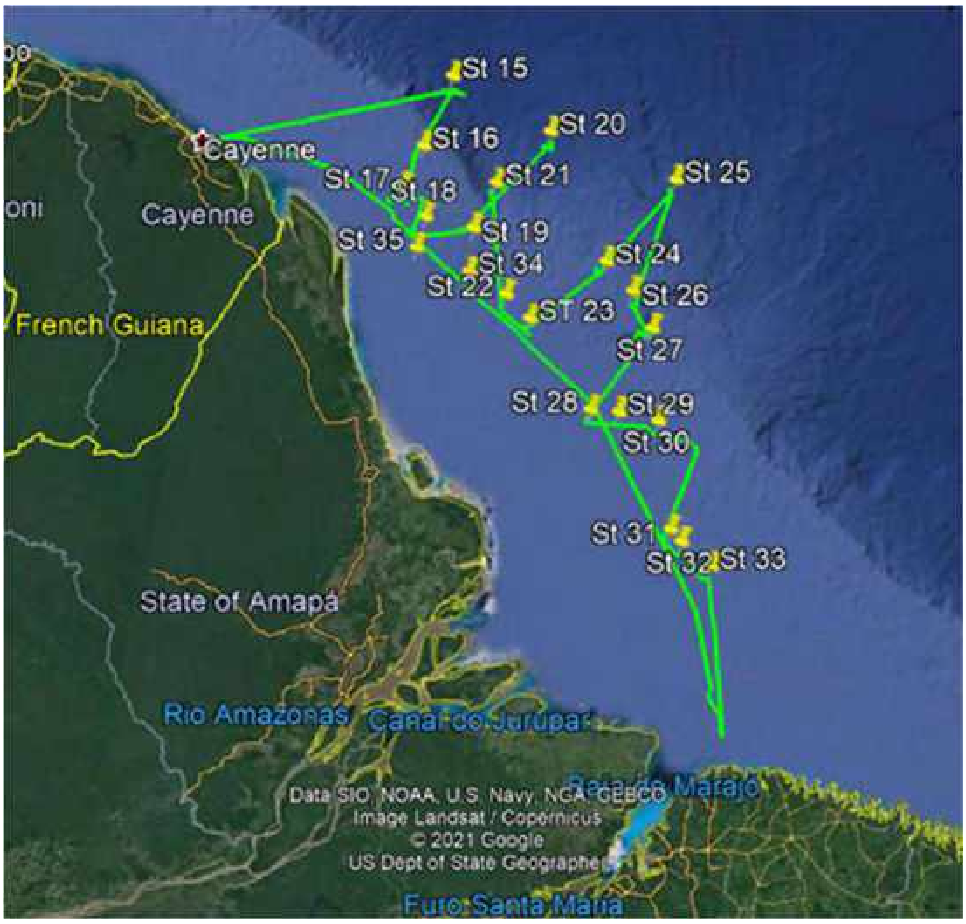

Figure 2. Amazomix survey track during Leg 2.

5. Operation mode

CINNA

Station

VMP : **VMP_01_1**

- Stationnaire – Bout au courant (PAS > ou = 0.5)
- Propre treuil – Portique AR – Poulie ouvrante sur caliorne
- Veille visuelle permanente du câble dans l'eau depuis la plage AR
- Filages en « chute libre » à la main et Virage lent
- LF Max = 1500 m

BATHYSONDE (CTD-ROSETTE) : **CTD_01_1**

- Stationnaire : Houle par l'AR ou Bout au courant
- Moonpool : MAE et MAB avec commandes sur le pont
- Filage /Virage < ou = 1 m/s
- Démarrage Bathy à 10 m puis profil
- P Immersion = Max 1000 m

CTD19 pour PAR **PAR_01_1**

- Stationnaire : CTD face au soleil (pas à l'ombre)
- Câble Hydro – Portique AR
- Filage /Virage = 1 m/s

CHALUT PELAGIQUE MICRONEKTON : **MICRO_01_1**

- Vs = pas plus de 3 nds (vitesse du chalut)
- En pêche environ 40 min, suivant détection
- LF = +/- 2.5 x P Immersion
- Filage / Virage < ou = 1 m/s

CHALUT DE FOND ROCKHOPPER : **ROCK_01_1**

- Filage : Panneau à l'eau = 4 nds : +/- 1 m/s
- Fin de filage : Ralentir jusqu'à +/- 3 nds
- En pêche +/- 5 min
- LF = 3 à 4 x Sonde

BONGO : **BONGO_01_1**

- Vs = 1.5 à 2 nds – Bout au courant
- Câble Hydro – Portique AR – avec Capteur Immersion
- Filage = 0.5 m/s et Virage = 0.3 m/s
- P Immersion = 200 m

MULTINET : **MULTI_01_1**

- Vs= +/- 2 nds – Bout au courant
- Câble Hydro – Portique AR – avec Capteur Immersion
- Filage = 0.5 m/s et Virage très lent = 0.1 / 0.2 m/s
- P Immersion = Max 240 m (suivant P déclenchement)

GRAPPE OPTIQUE : **GRAP_01_1**

- Stationnaire : Bout au courant
- Câble Hydro – Portique AR
- + câble optique à la main (LF Max = 200 m)
- 1er filage LF = 20 m puis filage à la demande
- Filage / Virage = +/- 0.3 m/s

RADIOMETRY : **RADIO_01_1**

- Stationnaire : Bout au Vent
- Radeau léger déployé à la main plage AR pendant 5 min

PHYTOPLANCTON : • Vs = +/- 1 nds – Bout au courant • Câble Hydro – Portique AR • Filage / Virage = +/- 0.3 m/s • Lf à la demande	**PHYTO_01_1**
GLIDER : • Stationnaire : Cul à la houle • Test 1 : activation à bord • MAE Zodiac • Test 2 : A l'eau avec flotteur • Largué le flotteur avant le déploiement	**GLIDER**
Opérations indépendantes des Stations : **MOUILLAGE BOUEE DERIVANTE :** **TIR SIPPICAN :**	 **DRIFTER01** **XBT01**

6. Synthesis of operations

Operation	**Number**
Thermosalinograph	Continue
SADCP (75 kHz)	Continue
Multifrequency acoustics	Continue
Cytosense	Continue: total ~40%
Fluoroprobe	Continue: total ~95%
CTD profiles (mounted on the Rosette)	71
LADCP profiles (mounted on the Rosette)	71
VMP profiles (deep/shallow)	202 (65 deep/137 shallow)
Rosette Salinity (nb of samples)	170
Rosette Oxygen (nb of samples)	172
Rosette CO_2 (nb of samples)	184
Rosette POM isotopes (nb of samples)	78
Rosette O18 (nb of samples)	47
Rosette nutrients (nb of samples)	295
Rosette total Chlorophyll (HPLC) (nb of samples)	184
Rosette Chlorophyll > 20μ (HPLC) (nb of samples)	125
Rosette Chlorophyll < 20μ (HPLC) (nb of samples)	123
Rosette Cytometry <20 μ and <1 μ (nb of samples)	154
Rosette phytoplankton > 5μ (nb of samples)	121
Rosette bacterial respiration	42
Rosette 13C uptake	42
Optical grape	46
Radiometric measurements	25
Micronektonic trawl	34
Bottom trawl	24
Bongo net hauls (successful only)	48
Multinet hauls (successful only)	33
Phytoplankton net hauls	15
Drifter releases	5
XBT casts	20
Glider deployment	1

7. Complete list of operations

Table 4. Complete list of operations performed during the survey AMAZOMIX.

Date	Time (UTC)	St.	Operation	Characteristics	Comments
28/08/2021	21:20		**Start AMAZOMIX**		
28/08/2021	22:31		Star acquisition	Start EK60 and ADCP	
28/08/2021	23:05		ADCP	Stop ADCP	Failure OSEA
29/08/2021	15:11		Drifter_1	# 300234067977540	
29/08/2021	16:22		ADCP	Restart	OSEA PC changed
30/08/2021	05:05		EK60	Stop	Computer crash
30/08/2021	05:51		EK60	Re-start EK60	
30/08/2021	12:48		XBT_1		
30/08/2021	17:53	01	Start Station_01		BD= 650 m
30/08/2021	18:08	01	~~VMP~~		Failure: pb with winch
30/08/2021	18:18	01	VMP_01_01		
30/08/2021	18:38	01	VMP_01_02		
30/08/2021	19:00	01	CTD-ROS_01_01	615 m	BD= 635 m
30/08/2021	19:45	01	ADCP	Stop	Failure OSEA
30/08/2021	20:00	01	~~CTD_PAR~~		Failure
~~30/08/2021~~	~~20:11~~	~~01~~	~~Radiometry_01_01~~		
30/08/2021	20:16	01	Grape_01_01		
30/08/2021	20:55	01	Bongo_01_01	180 m	
30/08/2021	22:08	01	Micronekton_01_01	100 - 150 m	
31/08/2021	00:20	01	End Station_01		
31/08/2021	11:04	02	Start Station_02		
31/08/2021	11:10	02	VMP_02_01		BD=1950 m
31/08/2021	12:12	02	CTD-ROS_02_01	1000 m	BD= 1950
31/08/2021	13:23	02	~~CTD_PAR~~		Failure: we abandon CTD_PAR
31/08/2021	13:43	02	Grape_02_01	120 m	GoPro for layer at 38 kHz
31/08/2021	14:11	02	Bongo_02_01	200 m	
31/08/2021	14:48	02	~~Multinet~~		Failure: mechanical problem
31/08/2021	15:17	02	Radiometry_02_01		
31/08/2021	15:26	02	End Station_02		
31/08/2021	15:28		Drifter_2		
31/08/2021	?		Fish catch		*Thunnus obesus*
31/08/2021	18:41		ADCP	Restart	
31/08/2021	19:00		ADCP	Stop	Failure
31/08/2021	19:22	03	Start Station_03		
31/08/2021	19:31	03	VMP_03_01		BD= 90 m
31/08/2021	19:35	03	VMP_03_02		
31/08/2021	19:40	03	VMP_03_03		
31/08/2021	19:55	03	Fluoroprobe	Start	
31/08/2021	19:56	03	CTD-ROS_03_01	90 m	BD= 95 m; GoPro
31/08/2021	20:41	03	Grape_03_01		
31/08/2021	21:01	03	Bongo_03_01	84 m	BD= 110 m
31/08/2021	21:26	03	XBT_2		BD= 113 m
31/08/2021	21:44	03	BottomTrawl_03_01	90 m	
31/08/2021	22:29	03	End Station_03		
01/09/2021	02:20		Drifter_3		
01/09/2021	10:12	04	Start Station_04		
01/09/2021	10:19	04	VMP_04_01		
01/09/2021	20:21	04	VMP_04_02		
01/09/2021	10:26	04	VMP_04_03		
01/09/2021	10:28	04	VMP_04_04		
01/09/2021	10:38	04	CTD-ROS_ROS_04_01	52 m	BD= 58 m, GoPro
01/09/2021	11:07	04	Grape_04_01	50 m	BD= 55 m
01/09/2021	11:29	04	~~Bongo~~		No scanmar

Date	Time (UTC)	St.	Operation	Characteristics	Comments
01/09/2021	12:01	04	Bottom-Trawl_04_01	55 m	GoPro: sand
01/09/2021	12:52	04	Bongo_04_01	~40 m	BD= 55 m
01/09/2021	13:00		Cytosense	Start	
01/09/2021	13:30	04	Bottom-Trawl_04_02	55 m	GoPro; Fish school targeted: *Decapterus sp.*
01/09/2021	14:16	04	VMP_04_05		
01/09/2021	14:18	04	VMP_04_06		
01/09/2021	14:20	04	VMP_04_07		
01/09/2021	14:23	04	VMP_04_08		
01/09/2021	14:25	04	VMP_04_09		
01/09/2021	14:35	04	CTD-ROS_04_02	51 m	BD= 56 m
01/09/2021	14:48	04	Radiometry_04_01		
01/09/2021	15:06	04	Phyto_04_01		Cable= 50 m
01/09/2021	15:15	04	End Station_04		
01/09/2021	17:40	05	Start Station_05		
01/09/2021	17:52	05	VMP_05_01		BD= 80 m
01/09/2021	17:55	05	VMP_05_02		BD=78 m
01/09/2021	17:58	05	VMP_05_03		
01/09/2021	18:11	05	CTD-ROS_ROS_05_01	70 m	BD=75 m; GoPro
01/09/2021	18:37	05	Grape_05_01	60 m	BD= 72 m
01/09/2021	18:57	05	Bongo_05_01	48 m	BD= 72 m
01/09/2021	19:28	05	Multinet_05_01		BD= 72 m
01/09/2021	20:11	05	Bottom-Trawl_05_01	72 m	GoPro
01/09/2021	21:15	05	VMP_05_04		BD= 72 m
01/09/2021	21:17	05	VMP_05_05		
01/09/2021	21:21	05	VMP_05_06		
01/09/2021	21:41	05	CTD-ROS_05_02	65 m	
01/09/2021	22:00	05	Micronekton_05_01	20 m	BD= 70 m
01/09/2021	23:20	05	End Station_05		
01/09/2021	23:34		Start MagictRec_01_01		3*0.5 nm at the shelf-break
02/09/2021	00:36		Start MagictRec_01_02		
02/09/2021	01:39		Start MagictRec_01_03		
02/09/2021	02:45		Start MagictRec_01_04		
02/09/2021	03:51		Start MagictRec_01_05		
02/09/2021	04:00		Start MagictRec_01_06		
02/09/2021	06:08		Start MagictRec_01_07		
02/09/2021	07:16		Start MagictRec_01_08		Not completed, stop at 08:00
02/09/2021	09:00	06	Start Station_06		BD= ~1200 m
02/09/2021	09:11	06	VMP_06_01		
02/09/2021	09:43	06	CTD-ROS_06_01	940 m	BD= 1100 m, Strong current: angle, we touched the bottom; sampling of sediment… Isotope analyses
02/09/2021	10:59	06	Micronekton_06_01	320 m	Myctophids and hatchetfish
02/09/2021	13:21	06	VMP_06_02		BD= 1400 m
02/09/2021	14:51	06	CTD-ROS_ROS_06_02	1000 m	
02/09/2021	15:32	06	Grape_06_01	120 m	
02/09/2021	15:55	06	Radiometry_06_01		
02/09/2021	16:08	06	VMP_06_03		
02/09/2021	17:05	06	CTD-ROS_06_03	800 m	
02/09/2021	18:16	06	Bongo_06_01	200 m	
02/09/2021	18:50	06	Multinet_06_01		
02/09/2021	19:55	06	VMP_06_04		
02/09/2021	21:50	06	Grape_06_02		
02/09/2021	22:15	06	Bongo_06_02	200 m	
02/09/2021	22:43	06	Multinet_06_02		
02/09/2021	23:43	06	~~VMP~~		Failure: not turned on
03/09/2021	00:10	06	End Station_06		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
03/09/2021	01:04		XBT_3		BD= 250 m
03/09/2021	01:04		XBT_4		BD= 100 m
03/09/2021	08:55	07	Start Station_07		
03/09/2021	09:00	07	VMP_07_01		
03/09/2021	09:38	07	CTD-ROS_07_01	1090 m	
03/09/2021	10:38	07	Micronekton_07_01	520 m	
03/09/2021	11:34	07	Sargasses		Some sargassum in surface
03/09/2021	13:05	07	VMP07_02		
03/09/2021	13:46	07	CTD-ROS_07_02	1000 m	
03/09/2021	14:58	07	Grape_07_01		
03/09/2021	15:32	07	Radiometry_07_01		
03/09/2021	15:42	07	VMP_07_03		
03/09/2021	16:40	07	CTD-ROS_07_03	1000 m	
03/09/2021	17:58	07	Bongo_07_01	200 m	
03/09/2021	18:37	07	Multinet_07_01		
03/09/2021	19:30	07	VMP_07_04		
03/09/2021	20:29	07	CTD-ROS_07_04	998	
03/09/2021	21:32	07	Grape_07_02		
03/09/2021	22:04	07	Micronekton_07_02	23 m	
03/09/2021	23:32	07	VMP_07_05		
xxxx	xxxx	07	Multinet_07_02		
04/09/2021	00:40	07	End Station_07		
04/09/2021	06:43		XBT_05		BD= 205 m
04/09/2021	07:04		XBT_06		BD= 73 m
04/09/2021	09:48	08	Start Station_08		
04/09/2021	09:53	08	VMP_08_01		
04/09/2021	09:56	08	VMP_08_02		
04/09/2021	09:59	08	VMP_08_03		
04/09/2021	10:02	08	VMP_08_04		
04/09/2021	10:05	08	VMP_08_05		
04/09/2021	10:09	08	VMP_08_06		
04/09/2021	10:24	08	CTD-ROS_08_01	74	GoPro
04/09/2021	10:47	08	Grape_08_01	65 m	GoPro
04/09/2021	11:20	08	Bottom-Trawl_08_01	75 m	GoPro
04/09/2021	12:58	08	VMP_08_07		
04/09/2021	13:02	08	VMP_08_08		
04/09/2021	13:06	08	VMP_08_09		
04/09/2021	13:10	08	VMP_08_10		
04/09/2021	13:13	08	VMP_08_11		
04/09/2021	13:17	08	VMP_08_12		
04/09/2021	13:30	08	CTD-ROS_08_02	70 m	
04/09/2021	13:58	08	Bongo_08_01	50 m	
04/09/2021	14:21	08	Phyto_08_01	50 m	
04/09/2021	14:35	08	End Station_08		
04/09/2021	17:24		Fish catch		*Coryphaena hippurus*
04/09/2021	17:30	09	Start Station_09		BD= 50 m
04/09/2021	17:35	09	VMP_09_01		
04/09/2021	17:37	09	VMP_09_02		
04/09/2021	17:39	09	VMP_09_03		
04/09/2021	17:42	09	VMP_09_04		
04/09/2021	17:45	09	VMP_09_05		
04/09/2021	17:47	09	VMP_09_06		
04/09/2021	18:00	09	CTD-ROS_09_01	45 m	GoPro
04/09/2021	18:20	09	Grape_09_01		
04/09/2021	18:52	09	Bottom-Trawl_09_01	50 m	GoPro
04/09/2021	20:20	09	VMP_09_07		
04/09/2021	20:22	09	VMP_09_08		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
04/09/2021	20:25	09	VMP_09_09		
04/09/2021	20:27	09	VMP_09_10		
04/09/2021	20:30	09	VMP_09_11		
04/09/2021	20:32	09	VMP_09_12		
04/09/2021	20:40	09	Bongo_09_01	21 m	
04/09/2021	20:55	09	End Station_09		
04/09/2021	23:35		Drifter_04		
05/09/2021	01:32		XBT_07		BD= 105 m
05/09/2021	01:36		XBT_08		BD= 250 m
05/09/2021	09:00	10	Start Station_10		
05/09/2021	09:08	10	VMP_10_01		
05/09/2021	09:45	10	CTD-ROS_10_01	1002 m	
05/09/2021	10:45	10	Micronekton_10_01	150 m	
05/09/2021	12:51	10	VMP_10_02		
05/09/2021	13:40	10	Stop all devices		Black out total
05/09/2021	13:55	10	Restart devices		
05/09/2021	14:12	10	CTD-ROS_10_02	1000 m	
05/09/2021	15:05	10	Grape_10_01		
05/09/2021	15:31	10	Radiometry_10_01		
05/09/2021	15:44	10	VMP_10_03		
05/09/2021	16:30	10	CTD-ROS_10_03	1000 m	
05/09/2021	17:37	10	Bongo_10_01	200 m	
05/09/2021	18:27	10	Multinet_10_01		
05/09/2021	19:24	10	VMP_10_04		
05/09/2021	20:15	10	CTD-ROS_10_04	1048 m	
05/09/2021	21:19	10	Grape_10_02		
05/09/2021	21:56	10	Micronekton_10_02	75 m	
05/09/2021	23:17	10	VMP_10_05		
06/09/2021	00:08	10	Multinet_10_02		
06/09/2021	00:39	10	Bongo_10_02	240 m	
06/09/2021	01:20	10	End Station_10		
06/09/2021	08:58	11	Start Station_11		
06/09/2021	09:02	11	VMP_11_01		
06/09/2021	09:33	11	Drifter_5		
06/09/2021	09:44	11	CTD-ROS_11_01	1000 m	
06/09/2021	10:40	11	Micronekton_11_01	500 m	
06/09/2021	13:15	11	VMP_11_02		
06/09/2021	14:05	11	CTD-ROS_11_02	1000 m	
06/09/2021	15:11	11	Grape_11-01		
06/09/2021	15:47	11	VMP_11_03		
06/09/2021	16:43	11	CTD-ROS_ROS_11_03	1000 m	
06/09/2021	17:52	11	Bongo_11_01	200 m	
06/09/2021	18:24	11	Multinet_11_02		
06/09/2021	19:28	11	VMP_11_04		
06/09/2021	20:10	11	CTD-ROS_11_04	1000 m	
06/09/2021	21:10	11	Grape_11_02		
06/09/2021	21:39	11	Micronekton_11_02	110 m	
06/09/2021	23:42	11	VMP_11_05		
07/09/2021	00:23	11	Multi_11_02		
07/09/2021	01:05	11	Bongo_11_02	215 m	
07/09/2021	02:08	11	Phyto_11_01	200 m (spun length)	
07/09/2021	02:10	11	End Station_11		
07/09/2021	08:54	12	Start Station_12		
07/09/2021	09:01	12	VMP_12_01		
07/09/2021	09:45	12	CTD-ROS_12_01	1000 m	
07/09/2021	10:42	12	Micronekton_12_01	240 m	Layer at depth where current flaws (crustaceans, squids and fish)

Date	Time (UTC)	St.	Operation	Characteristics	Comments
07/09/2021	13:01	12	VMP_12_02		
07/09/2021	13:44	12	CTD-ROS_12_02	1000 m	
07/09/2021	13:53	12	Radiometry_12_01		
07/09/2021	14:48	12	Grape_12_01		GoPro: observation of the layer at 38 kHz (gelatinous)
07/09/2021	15:25	12	VMP_12_03		
07/09/2021	16:11	12	CTD-ROS_12_03	1000 m	
07/09/2021	17:07	12	Bongo_12_01	200 m	
07/09/2021	17:36	12	Multinet_12_01		
07/09/2021	18:20	12	VMP_12_04		
07/09/2021	19:20	12	CTD-ROS_12_04	1000 m	
07/09/2021	19:58	12	Micronekton_12_02	50 m	Layer at 38 kHz
07/09/2021	21:30	12	VMP_12_05		
07/09/2021	22:41	12	Bongo_12_02	200 m	
07/09/2021	23:15	12	Multinet_12_02		
08/09/2021	00:20	12	Phyto_12_01	230 m (spun length)	
08/09/2021	00:50	12	End Station_12		
08/09/2021	00:55		XBT_09		
08/09/2021	08:55	13	Start Station_13		
08/09/2021	09:04	13	VMP_13_01		
08/09/2021	10:07	13	CTD-ROS_13_01	1009 m	
08/09/2021	10:41	13	Micronekton_13_01	400 m	
08/09/2021	13:00	13	VMP_13_02		
08/09/2021	13:46	13	CTD-ROS_13_02	1000 m	
08/09/2021	14:34	13	Grape_13_01		
08/09/2021	14:54	13	Radiometry_13_01		
08/09/2021	15:11	13	VMP_13_03		
08/09/2021	16:25	13	CTD-ROS_13_03	1000 m	
08/09/2021	17:13	13	Bongo_13_01	200 m	
08/09/2021	17:41	13	Multinet_13_01		
08/09/2021	18:39	13	VMP_13_04		
08/09/2021	19:22	13	CTD-ROS_13_04	1002 m	
08/09/2021	20:23	13	Grape_13_02		
08/09/2021	20:44	13	Phyto_13_01	200 m (spun length)	
08/09/2021	21:09	13	VMP_13_05		
08/09/2021	21:53	13	Micronekton_13_02	350 - 400 m	
09/09/2021	00:14	13	Multinet_13_02		
09/09/2021	01:09	13	Bongo_13_02	220 m	
09/09/2021	01:40	13	End Station_13		
09/09/2021	08:45	14	Start Station_14		
09/09/2021	08:50	14	VMP_14_01		
09/09/2021	09:32	14	CTD-ROS_14_01	1003 m	
09/09/2021	10:30	14	Glider deployment		
09/09/2021	12:17	14	Phyto_14_01	200 m (spun length)	
09/09/2021	12:50	14	VMP_14_02		
09/09/2021	13:32	14	CTD-ROS_14_02	1000 m	
09/09/2021	13:42	14	Radiometry_14_01		
09/09/2021	14:24	14	Grape_14_01		
09/09/2021	14:43	14	Radiometry_14_02		
09/09/2021	15:05	14	VMP_14_03		
09/09/2021	15:54	14	CTD-ROS_14_03	1000 m	
09/09/2021	16:49	14	Multinet_14_01		
09/09/2021	17:27	14	Bongo_14_01	200	
09/09/2021	18:05	14	VMP_14_04		
09/09/2021	18:48	14	CTD-ROS_14_04	1002 m	
09/09/2021	19:42	14	Grape_14_02		
09/09/2021	20:16	14	VMP_14_05		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
09/09/2021	21:05	14	CTD-ROS_14-05	1000 m	
09/09/2021	22:05	14	Micronekton_14_01	150 m	
09/09/2021	23:50	14	Multinet_14_02		
10/09/2021	00:50	14	Bongo_14_02	260 m	
10/09/2021	08:48	14	VMP_14_06		
10/09/2021	09:33	14	CTD-ROS_14_06	1000 m	
10/09/2021	10:26	14	Micronekton_14_02	470 m	
10/09/2021	12:48	14	Grape_14_03		
10/09/2021	13:11	14	Bongo_14_03	250 m	
10/09/2021	13:48	14	Micronekton_14_03	1200 m	
10/09/2021	18:06	14	Micronekton_14_04	260 m	
10/09/2021	17:32	14	Radiometry_14_03		
10/09/2021	18:54	14	XBT_10		
10/09/2021	18:48	14	XBT_11		
10/09/2021	20:10	14	XBT_12		
10/09/2021	20:46	14	Micronekton_14_05	1290 m	
10/09/2021	23:50	14	End Station_14		
11/09/2021	00:18		XBT_13		
11/09/2021	10:11		XBT_14		
11/09/2021	14:30		Capture fish		*Coryphaena hippurus*
11/09/2021	17:37		XBT_15		
12/09/2021	00:14		XBT_16		
12/09/2021	00:31		XBT_17		
12/09/2021	13:00		Fluoroprobe	End for Leg 1	
12/09/2021	13:00		Cytosence	End for Leg 1	Acquisition were stopped in several occasion during Leg1 due to technical problems
12/09/2021	13:38		**End Operations Leg 1**	Stop EK60, ADCP	
14/09/2021	**16:40**		**Start Leg 2**		
14/09/2021	17:42		Start operations Leg 2	Start EK60, ADCP	
15/09/2021	08:58	15	Station_15		Convergence zone with accumulation of debris, sargassum, fish and dolphin
15/09/2021	09:10	15	VMP_15_01		
15/09/2021	10:25	15	Micronekton_15_01	500 m	Pb with the LADCP so trawl before CTD-ROSETTE
15/09/2021	13:15	15	CTD-ROS_15_01	1000 m	
15/09/2021	14:21	15	Grape_15_01		
15/09/2021	14:43	15	Radiometry_15_01		
15/09/2021	15:10	15	Multinet_15_01		
15/09/2021	15:53	15	Micronekton_15_02	888 m	
15/09/2021	20:20	15	Bongo_15_01	200 m	
15/09/2021	21:32	15	Micronekton_15_03	70 then 500 m	
16/09/2021	00:27	15	Bongo_15_02	220 m	
16/09/2021	07:00		EK60, ADCP	Stop acquisition	Problem PC stop acquisition
16/09/2021	08:15		EK60, ADCP	Re-start acquisition	
16/09/2021	09:50	16	Start Station_16		
16/09/2021	10:03	16	VMP_16_01		
16/09/2021	10:06	16	VMP_16_02		
16/09/2021	10:10	16	VMP_16_03		
16/09/2021	10:23	16	CTD-ROS_16_01	90 m	
16/09/2021	10:50	16	Grape_16_01		
16/09/2021	11:09	16	Bongo_16_01	75 m	
16/09/2021	11:42	16	Multinet_16_01		
16/09/2021	12:20	16	Bottom-Trawl_16_01	105 m	GoPro
16/09/2021	13:42	16	Bottom-Trawl_16_02	100 m	GoPro
16/09/2021	15:00	16	VMP_16_04		
16/09/2021	15:03	16	VMP_16_05		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
16/09/2021	15:07	16	VMP_16_06		
16/09/2021	15:21	16	Radiometry_16_01		
16/09/2021	18:00	17	Start Station_17		
16/09/2021	18:07	17	VMP_17_01		
16/09/2021	18:09	17	VMP_17_02		
16/09/2021	18:13	17	VMP_17_03		
16/09/2021	18:25	17	CTD-ROS_17_01	65 m	Problem motor Antea we can perform any operation but trawl
16/09/2021	19:38	17	Grape_17_01		
16/09/2021	19:51	17	Bongo_17_01	60 m	
16/09/2021	20:16	17	Multinet_17_01		
16/09/2021	20:40	17	VMP_17_04		
16/09/2021	20:43	17	VMP_17_05		
16/09/2021	20:45	17	VMP_17_06		
16/09/2021	22:03	17	Bottom-Trawl_17_01	70 - 80 m	End problem motor Antea
16/09/2021	23:28	17	Bongo_17_02	60 m	
17/09/2021	00:04	17	Phyto_17_02	60 m	
17/09/2021	09:00	18	Start Station_18		
17/09/2021	09:01	18	VMP_18_01		
17/09/2021	09:03	18	VMP_18_02		
17/09/2021	09:06	18	VMP_18_03		
17/09/2021	09:19	18	CTD-ROS_18_01	65 m	
17/09/2021	10:25	18	Grape_18_01		
17/09/2021	10:45	18	Bongo_18_01	60 m	
17/09/2021	11:06	18	Multinet_18_01		
17/09/2021	11:38	18	Bottom-Trawl_18_01	75 m	Huge catch
17/09/2021	12:55	18	Radiometry_18_01		
17/09/2021	13:05	18	End Station_18		
17/09/2021	17:36	19	Start Station_19		BD= 98 m
17/09/2021	17:38	19	Radiometry_19_01		
17/09/2021	17:47	19	VMP_19_01		
17/09/2021	17:51	19	VMP_19_02		
17/09/2021	17:56	19	VMP_19_03		
17/09/2021	18:08	19	CTD-ROS_19_01	87 m	
17/09/2021	18:48	19	Grape_19_01		
17/09/2021	19:06	19	Bongo_19_01	83 m	
17/09/2021	19:30	19	Multinet_19_01		
17/09/2021	20:04	19	Bottom-Trawl_19_01	100 m	
17/09/2021	20:59	19	Bottom-Trawl_19_02	92 m	
17/09/2021	22:05	19	VMP_19_04		
17/09/2021	22:09	19	VMP_19_05		
17/09/2021	22:14	19	VMP_19_06		
17/09/2021	22:40	19	Micronekton_19_01	30 m	The trawl did not behave well
18/09/2021	00:12	19	Bongo_19_02	75 m	
18/09/2021	00:25	19	End Station_19		
18/09/2021	04:30	20	Start Station_20		Arrival in Station
18/09/2021	09:07	20	VMP_20_01		
18/09/2021	09:48	20	CTD-ROS_20_01	1008 m	
18/09/2021	10:57	20	Micronekton_20_01	450 m	
18/09/2021	13:25	20	VMP_20_02		
18/09/2021	14:11	20	CTD-ROS_20_02	1010 m	
18/09/2021	15:17	20	Radiometry_20-01		
18/09/2021	15:23	20	Grape_20_01		
18/09/2021	15:48	20	VMP_20_03		
18/09/2021	16:33	20	CTD-ROS_20_03	1009 m	
18/09/2021	17:32	20	Bongo_20_01	200 m	
18/09/2021	18:18	20	Multinet_20_01		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
18/09/2021	18:55	20	VMP_20_04		
18/09/2021	19:53	20	Grape_20_02		
18/09/2021	20:17	20	CTD-ROS_20_04	1008 m	
18/09/2021	21:15	20	VMP_20_05		
18/09/2021	22:20	20	Micronekton_20_02	62 m	
18/09/2021	23:48	20	~~Multinet_20_02~~		Failure
19/09/2021	00:14	20	Multinet_20_02		
19/09/2021	00:39	20	Bongo_20_02	220 m	
19/09/2021	03:00	20	End Station_20		Departure from Station
19/09/2021	08:10	21	Start Station_21		
19/09/2021	09:00	21	VMP_21_01		
19/09/2021	09:38	21	CTD-ROS_21_01	1008 m	
19/09/2021	10:56	21	Micronekton_21_01	310 m	
19/09/2021	13:42	21	VMP_21_02		
19/09/2021	14:19	21	CTD-ROS_21_02	1007 m	
19/09/2021	15:28	21	Grape_21_01		
19/09/2021	15:46	21	Radiometry_21_01		
19/09/2021	16:00	21	VMP_21_03		
19/09/2021	16:42	21	CTD-ROS_21_03	1008	
19/09/2021	17:36	21	Bongo_21_01	160 m	
19/09/2021	18:15	21	Multinet_21_01		
19/09/2021	18:52	21	VMP_21_04		
19/09/2021	19:37	21	CTD_21_04	1008	
19/09/2021	20:41	21	Grape_21_02		
19/09/2021	21:15	21	VMP_21_05		
19/09/2021	22:26	21	Micronekton_21_02	30 m	Many squids and some small lanternfish
20/09/2021	00:15	21	Multinet_21_02		
20/09/2021	00:48	21	Bongo_21_02	270 m	
20/09/2021	01:22	21	Phyto_21_01	200 m	
20/09/2021	01:45	21	End Station_21		
20/09/2021	09:00	22	Start Station_22		BD= 80 m, turbulence, IWs
20/09/2021	09:06	22	VMP_22_01		
20/09/2021	09:12	22	VMP_22_02		
20/09/2021	09:16	22	VMP_22_03		
20/09/2021	09:30	22	CTD-ROS_22_01	75 m	
20/09/2021	10:01	22	Grape_22_01		
20/09/2021	10:15	22	Bongo_22_01	65 m	
20/09/2021	10:29	22	Multinet_22_01		
20/09/2021	11:13	22	Bottom Trawl_22_01	82 m	
20/09/2021	12:16	22	VMP_22_04		
20/09/2021	12:25	22	VMP_22_05		
20/09/2021	12:32	22	VMP_22_06		
20/09/2021	12:42	22	CTD_22_02	76 m	
20/09/2021	13:13	22	Radiometry_22_01		
20/09/2021	13:20	22	End Station_22		
20/09/2021	17:50	23	Start Station_23		BD= 80 m, strong turbulence, IWs
20/09/2021	17:52	23	VMP_23_01		
20/09/2021	17:56	23	VMP_23_02		
20/09/2021	17:59	23	VMP_23_03		
20/09/2021	18:14	23	CTD-ROS_23_01	80 m	
20/09/2021	18:39	23	Grape_23_01		
20/09/2021	19:02	23	Bongo_23_01	63 m	
20/09/2021	19:24	23	Multinet_23_01		
20/09/2021	19:45	23	Bottom Trawl_23_01	80 m	
20/09/2021	20:48	23	VMP_23_04		
20/09/2021	20:52	23	VMP_23_05		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
20/09/2021	20:56	23	VMP_23_06		
20/09/2021	21:13	23	CTD-ROS_23_02	75 m	
20/09/2021	21:40	23	Micronekton_23_01	35 m	
20/09/2021	23:15	23	Bongo_23_02	65 m	
20/09/2021	23:34	23	Phyto_23_01	60 m	
20/09/2021	23:35	23	End Station_23		
21/09/2021	04:38	24	Start Station_24		BD= 220, Sargasses
21/09/2021	09:03	24	VMP_24_01		
21/09/2021	09:15	24	VMP_24_02		
21/09/2021	09:33	24	CTD_24_01	210 m	
21/09/2021	10:05	24	Grape_24_01		
21/09/2021	10:27	24	VMP_24_03		
21/09/2021	10:35	24	VMP_24_04		
21/09/2021	10:42	24	VMP_24_05		
21/09/2021	10:56	24	CTD-ROS_24_02	210 m	
21/09/2021	11:42	24	Bottom Trawl_24_01	220 m	The trawl did not behave well
21/09/2021	13:11	24	VMP_24_06		
21/09/2021	13:19	24	VMP_24_07		
21/09/2021	13:37	24	CTD-ROS_24_03	210 m	
21/09/2021	14:11	24	Micronekton_24_01	109 m	
21/09/2021	15:44	24	Grape_24_02		
21/09/2021	16:05	24	Radiometry_24_01		
21/09/2021	16:56	24	VMP_24_08		
21/09/2021	16:45	24	VMP_24_09		
21/09/2021	17:05	24	CTD-ROS_24_04	210 m	
21/09/2021	17:42	24	Bongo_24_01	200 m	
21/09/2021	18:12	24	Multinet_24_01		
21/09/2021	19:41	24	VMP_24_10		
21/09/2021	19:49	24	VMP_24_11		
21/09/2021	20:01	24	CTD-ROS_24_05	210 m	
21/09/2021	20:26	24	VMP_24_12		
21/09/2021	20:34	24	VMP_24_13		
21/09/2021	22:02	24	Micronekton_24_02		
21/09/2021	23:28	24	Multinet_24_02		
21/09/2021	23:51	24	Bongo_24_02	200 m	
22/09/2021	00:15	24	Phyto_24_01		
22/09/2021	00:37	24	End Station_24		
22/09/2021	06:10	25	Start Station_25		
22/09/2021	09:07	25	VMP_25_01		
22/09/2021	09:47	25	CTD-ROS_25_01	1000 m	
22/09/2021	10:59	25	Micronekton_25_01	625 m	
22/09/2021	13:18	25	Grape_25_01		
22/09/2021	13:38	25	Multinet_25_01		
22/09/2021	14:17	25	Micronekton_25_02	1200 m	
22/09/2021	17:49	25	Bongo_25_01	200 m	
22/09/2021	18:38	25	Micronekton_25_03	475 m	
22/09/2021	20:55	25	Micronekton_25_04	1300 m	
23/09/2021	~~00:18~~	25	~~Bongo_25_02~~		Failure
23/09/2021	00:36	25	Phyto_25_01	210 m	
23/09/2021	01:01	25	Bongo_25_02	215 m	
23/09/2021	01:30	25	End Station_25		
23/09/2021	10:15	26	Start Station_26		BD= 175 m
23/09/2021	10:31	26	VMP_26_01		Before IW
23/09/2021	10:39	26	VMP_26_02		During IW
23/09/2021	10:47	26	VMP_26_02		After IW
23/09/2021	11:01	26	CTD-ROS_26_01	165 m	Passage of IW
23/09/2021	11:35	26	Bongo_26_01	170 m	

Date	Time (UTC)	St.	Operation	Characteristics	Comments
23/09/2021	12:01	26	Multinet_26_01		
23/09/2021	12:56	26	Bottom Trawl_26_01	180 m	The trawl hooked the bottom, almost no catch
23/09/2021	14:14	26	Grape_26_01		
23/09/2021	14:29	26	Radiometry_26_01		
23/09/2021	14:37	26	End Station_26		
23/09/2021	18:17		XBT_18		
23/09/2021	18:40		XBT_19		
23/09/2021	18:51		XBT_20		
23/09/2021	19:20	27	Start Station_27		BD= ~600 m, Canyon
23/09/2021	19:24	27	CTD_27_01	550 m	
23/09/2021	20:17	27	VMP_27_01		
23/09/2021	20:40	27	Grape_27_01		
23/09/2021	20:57	27	Multinet_27_01		
23/09/2021	21:34	27	VMP_27_02		
23/09/2021	22:23	27	Micronekton_27_01	90-130 m	Large quantity of shrimps (large euphausiids?)
24/09/2021	00:05	27	Multinet_27_02		
24/09/2021	00:39	27	Bongo_27_01	250 m	
24/09/2021	01:07	27	Phyto_27_01	200 m	
24/09/2021	01:33	27	End Station_27		
24/09/2021	08:45	28	Start Station_28		BD= 28 m
24/09/2021	09:09	28	VMP_28_01		
24/09/2021	09:10	28	VMP_28_02		
24/09/2021	09:11	28	VMP_28_03		
24/09/2021	09:12	28	VMP_28_04		
24/09/2021	09:13	28	VMP_28_05		
24/09/2021	09:14	28	VMP_28_06		
24/09/2021	09:22	28	CTD-ROS_28_01	20 m	
24/09/2021	09:53	28	Grape_28_01		
24/09/2021	10:05	28	Bongo_28_01	15 m	
24/09/2021	10:21	28	VMP_28_07		
24/09/2021	10:22	28	VMP_28_08		
24/09/2021	10:23	28	VMP_28_09		
24/09/2021	10:24	28	VMP_28_10		
24/09/2021	10:25	28	VMP_28_11		
24/09/2021	10:26	28	VMP_28_12		
24/09/2021	10:28	28	VMP_28_13		
24/09/2021	10:29	28	VMP_28_14		
24/09/2021	10:47	28	Bottom Trawl_28_01	26 m	
24/09/2021	11:37	28	VMP_28_15		
24/09/2021	11:38	28	VMP_28_16		
24/09/2021	11:39	28	VMP_28_17		
24/09/2021	11:40	28	VMP_28_18		
24/09/2021	11:41	28	VMP_28_19		
24/09/2021	11:42	28	VMP_28_20		
24/09/2021	11:43	28	VMP_28_21		
24/09/2021	11:45	28	VMP_28_22		
24/09/2021	11:50	28	Radiometry_28_01		
24/09/2021	11:55	28	End Station_28		
24/09/2021	13:30	29	Start Station_29		BD= 52 m
24/09/2021	13:37	29	VMP_29_01		
24/09/2021	13:39	29	VMP_29_01		
24/09/2021	13:48	29	CTD-ROS_29_01	45 m	
24/09/2021	14:05	29	Bottom Trawl_29_01	58 m	The scarf of the trawl opened: reduced catch.
24/09/2021	14:59	29	Grape_29_01		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
24/09/2021	15:04	29	Radiometry_20_01		
24/09/2021	15:18	29	Bongo_29_01	23 m	64 µm damaged → for qualitative analyses only
24/09/2021	15:43	29	VMP_29_04		
24/09/2021	15:46	29	VMP_29_05		
24/09/2021	15:49	29	VMP_29_06		
24/09/2021	15:53	29	End Station_29		
24/09/2021	18:30	30	Start Station_30		BD= 68 m
24/09/2021	18:37	30	VMP_30_01		
24/09/2021	18:41	30	VMP_30_02		
24/09/2021	18:50	30	CTD-ROS_30_01	66 m	
24/09/2021	19:15	30	Grape_30_01		
24/09/2021	19:26	30	Bongo_30_01	60 m	
24/09/2021	19:52	30	Bottom Trawl_30_01	68 m	
24/09/2021	20:36	30	Bottom Trawl_30_02	70 m	
24/09/2021	21:29	30	VMP_30_03		
24/09/2021	21:33	30	VMP_30_04		
24/09/2021	21:56	30	Multinet_30_01		
24/09/2021	22:18	30	Bongo_30_02	62 m	
24/09/2021	22:26	30	Phyto_30_01	63 m	
24/09/2021	22:37	30	End Station_30		
25/09/2021	09:00	31	Start Station_31		BD= 32 m
25/09/2021	09:07	31	VMP_31_01		
25/09/2021	09:08	31	VMP_31_02		
25/09/2021	09:10	31	VMP_31_03		
25/09/2021	09:11	31	VMP_31_04		
25/09/2021	09:13	31	VMP_31_05		
25/09/2021	09:23	31	CTD-ROS_31_01	25 m	
25/09/2021	09:41	31	Grape_31_01		
25/09/2021	09:59	31	Bongo_31_01	17 m	
25/09/2021	10:08	31	Phyto_31_01	17 m	
25/09/2021	10:24	31	VMP_31_06		
25/09/2021	10:26	31	VMP_31_07		
25/09/2021	10:27	31	VMP_31_08		
25/09/2021	10:28	31	VMP_31_09		
25/09/2021	10:30	31	VMP_31_10		
25/09/2021	10:41	31	Grape_31_02		
25/09/2021	10:51	31	Bottom Trawl_31_01	32 m	
25/09/2021	11:35	31	Bottom Trawl_31_02	34 m	
25/09/2021	12:14	31	Radiometry_31_01		
25/09/2021	12:21	31	VMP_31_11		
25/09/2021	12:23	31	VMP_31_12		
25/09/2021	12:24	31	VMP_31_13		
25/09/2021	12:26	31	VMP_31_14		
25/09/2021	12:27	31	VMP_31_15		
25/09/2021	12:33	31	End Station_31		
25/09/2021	13:35	32	Start Station_32		BD= 38 m
25/09/2021	13:37	32	VMP_32_01		
25/09/2021	13:39	32	VMP_32_02		
25/09/2021	13:40	32	VMP_32_03		
25/09/2021	13:49	32	CTD-ROS_32_01	30 m	
25/09/2021	14:04	32	Bottom Trawl_32_01		
25/09/2021	15:01	32	Grape_32_01		
25/09/2021	15:11	32	Radiometry_32_01		
25/09/2021	15:23	32	Bongo_32_01	25 m	
25/09/2021	15:41	32	VMP_32_04		
25/09/2021	15:43	32	VMP_32_05		

Date	Time (UTC)	St.	Operation	Characteristics	Comments
25/09/2021	15:45	32	VMP_32_06		
25/09/2021	15:50	32	End Station_32		
25/09/2021	18:20	33	Start Station_33		BD= 45 m
25/09/2021	18:22	33	VMP_33_01		
25/09/2021	18:23	33	VMP_33_02		
25/09/2021	18:25	33	VMP_33_03		
25/09/2021	18:35	33	CTD-ROS_33_01	40 m	
25/09/2021	18:55	33	Grape_33_01		
25/09/2021	19:05	33	Phyto_33_01	33 m	
25/09/2021	19:19	33	Bottom Trawl_33_01	42 m	
25/09/2021	20:08	33	VMP_33_04		
25/09/2021	20:10	33	VMP_33_05		
25/09/2021	20:12	33	VMP_33_06		
25/09/2021	20:15	33	End Station_33		
26/10/2021	11:43		Start transfer samples		Transfer of biological samples. Not an easy task…
26/10/2021	12:26		End transfer samples		
26/10/2021	15:00		Meeting with Tara		
27/10/2021	13:30	34	Start Station_34		BD= 75 m
27/10/2021	13:34	34	Grape_34_01		
27/10/2021	13:47	34	Radiometry_34_01		
27/10/2021	13:58	34	End Station_34		
27/10/2021	17:58	35	Start Station_35_01		
27/10/2021	18:01	35	Grape_35_01		
27/10/2021	18_10	35	Radiometry		
27/10/2021	18:16	35	End Station_35		
28/09/2021	10:50		**End Operations Leg 2**	Stop EK60, ADCP	

8. Thermosalinograph

Termperature and salinity data have been acquired continusly from a thermosalinograph SBE21 (Figure 3Figure 3. Sea surface salinity and temperature during the Leg 1 (left panels) and Leg 2 (right panels) of the AMAZOMIX survey.).

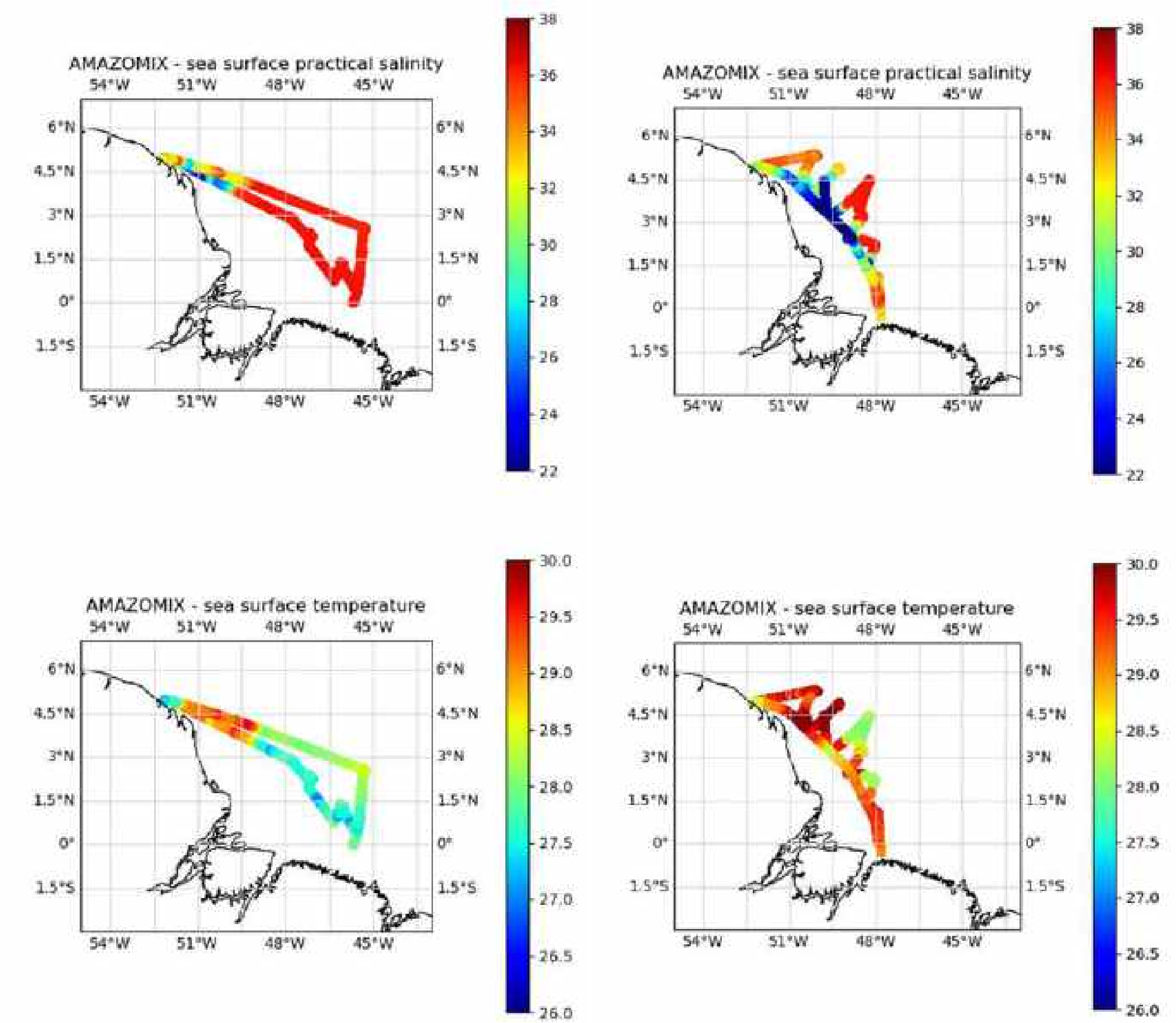

Figure 3. Sea surface salinity and temperature during the Leg 1 (left panels) and Leg 2 (right panels) of the AMAZOMIX survey.

9. VMP

To characterise highly turbulent environments down to 1000 m depth we used a vertical microstructure profiler (VMP). The turbulence measurement (resolution: ~2 mm) is used to deduce the rate of energy dissipation within water masses. The more stratified the water mass, the less turbulence there will be.

AMAZOMIX Deployment Statistics:

- 33 stations sampled
- 202 operations completed (65 >100 m, 137 <100 m)
- Combined length of all profiles 42,480 m

9.1. VMP-250-TE Overview and Design

The VMP-250-Tidal Energy (TE) is a special configuration of the VMP-250 originally created to measure turbulence at Tidal Energy (TE) development sites. These sites typically have strong currents (>2 m/s) and high levels of dissipation (>1x10^-5 W/kg). They are typically found in tidal channels in shallow waters (hundreds of meters or less). The VMP-250-TE uses a 2.4 kg weight collar to increase the fall speed of the VMP from standard speed of 0.7 m/s to 1.4 m/s. To compensate for the increased fall speed the sample rate is increased from 512 Hz to 1024 Hz. To ensure the strong levels of dissipation do not cause signals to be saturated, the gain of the shear probes is reduced by a factor of 10. The VMP-250-TE has a depth rating of 1000 dBar. The VMP-250 uses x2 velocity shear probes and x2 FP07 Thermistors to collect microstructure turbulence data. For data processing purposes, the VMP must have a consistent, uninterrupted fall speed. Vibrations, such as those created by a tight tether, or from loose components, will create coherent vibrations that must be removed from the shear probe signals so they are not confused with turbulence signals. For these reasons, the VMP must be deployed using a slack tether to decouple the VMP from the motion of the ship and prevent the tether from being tight during the downward profile.

9.2. Deployment site categorisation

It was very fortunate that the VMP-250-TE was used on the Amazomix because the North Brazil Current proved to be a challenging deployment location with high current speeds (up to 4 nots in surface) and strong levels of turbulence. The VMP was deployed at 33 stations that can be put into 3 categories.

I. Shallow (‘short’) Stations: These stations were typically 100 m depth or less. These stations typically had strong currents and high levels of turbulence.

II. Shelf break / near the shelf: These stations were in depths of 600 m to 2000 m depth. Located on the shelf break or past the shelf but still near it. These sites contained strong currents at the surface and through the entire water column. Strong shear was also present, meaning the current speed was not uniform throughout the water column.

III. Far from shelf: These stations were farther from the shelf in 1500 m to 4000 m depth. The upper 300 m to 400 m of water had strong currents and shear with strong turbulence signals present but not as strong as locations close to the shelf. Below 300 m to 400 m there was little to no current and shear and low turbulence signals.

9.3. VMP deployment methods by site type

A specific VMP configuration and deployment method was developed for each site type. The VMP configurations were primarily to modify the fall speed of the VMP with a secondary consideration of reducing vibrations as much as possible. The deployment methods were determined by the depth of the profile as well as how fast the VMP required the rope tether to be deployed (Figure 4). The crew of the Antea as well as the Official VMP Team (scientists; Figure 5) were instrumental in developing unique deployment methods for the specific sites.

Figure 4. More than 1000 m of rope tether flakes out on deck of Antea before a deep VMP profile.

Figure 5. Official VMP Team, Leg 1.

I. Shallow Stations (Figure 6 and Figure 7): The VMP was configured to have x1 2.4 kg weight collar and x4 long brushes. The resulting fall speed was typically a little less than 1.2 m/s, however there was some minor decrease in fall speed across the length of the profile. The fall speed of 1.2 m/s was used with the Distance = Speed X Time calculation to determine how many seconds to deploy the VMP to reach a target depth. The target depth was chosen to be a safe distance from the bottom, typically 5 m, but sometimes less if the operator was feeling confident. The deployment method included flaking out enough rope tether on the deck for the length of the profile. Typically 1.5 X Target Depth is a sufficient length of tether. The VMP was deployed by hand at with crew standing by to make more rope available if needed. Recovery was by hand. It is very important to start pulling the rope back as soon as the desired fall time has been reached so that the VMP does not continue to fall due to the slack tether and impact the bottom. Typically the person deploying the VMP will hold the tether and quickly walk to the back of the deck and the pull in ~10 m. Then they will continue to pull in the rest of the tether by hand or another person will begin to assist; using the winch at this time is also acceptable. It does not take long to collect 1 profile in shallow locations, so typically 3 to 6 profiles were collected at each of these stations.

a. One 2.4 kg weight collar
b. Four long brushes

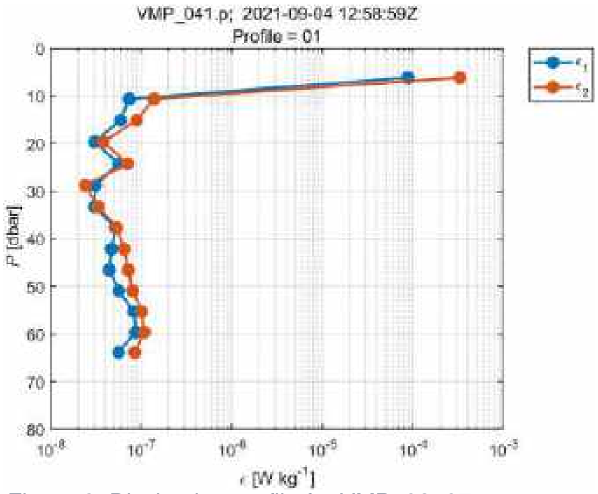

Figure 6. Dissipation profile for VMP_08_07.

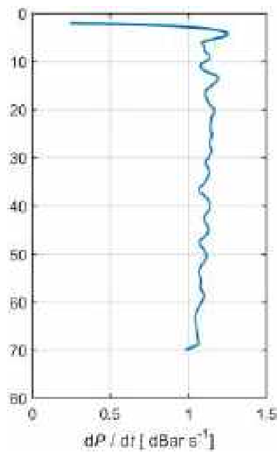

Figure 7. VMP fall speed with one weight collar and four long brushes for VMP_08_07.

II. Shelf break / near the shelf (Figure 8 and Figure 9): Due to the currents and mid water column shear on or near the shelf break, the VMP fall rate quickly decreased when using the standard VMP-250-TE configuration and the desired depth was not achieved. In a few extreme cases, the VMP only descended to 200 m or 300 m even when 1500 m of tether was deployed. To combat this situation extra weight was added to the VMP. An additional 2.4 kg weight collar was added and the number of brushes was reduced to 1 long brush. In this configuration the VMP accelerated to 2.1 m/s and then began to degrease fall speed until 0.7 m/s and sometimes as low as 0.2 m/s depending on the intensity of the shear and currents. The best deployment method for this site type is to flake out as much line as possible on the deck before the deployment. This way the person deploying the VMP by hand can quickly access rope tether to throw into the water. It is possible to flake out up to 1000 m on the deck of the Antea, however this requires 15 to 20 min to prepare before the deployment. Typically, the crew would flake out as much line as possible within the preparation time available, once the VMP was deployed, extra space on the deck was filled with flaked line ensuring that the tether was easily accessible, and no tangles would occur. At locations of this site type with this configuration, it is still very unlikely that the VMP will go beyond the depth rating of 1000 m with the amount of tether available (1560 m). The maximum depth reached was 908 m. On these sites it is very important that the ship go as slow as possible, ideally 0.5 knots relative to the current (sometimes that means 2.5 knots backwards relative to ground).

a. Two 2.4 kg weight collar
b. One long brush

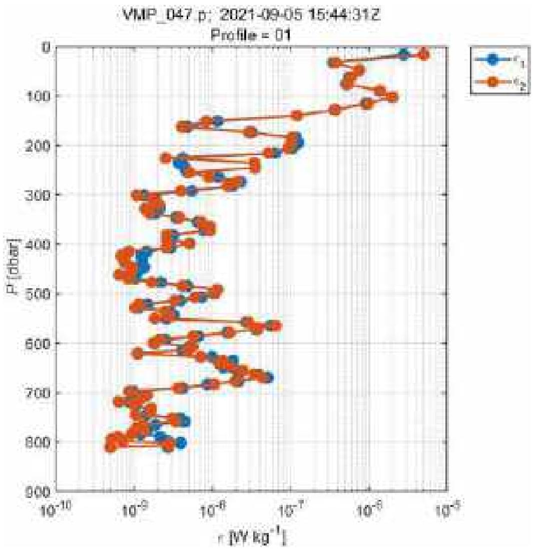

Figure 8. Dissipation profile for VMP_10_03.

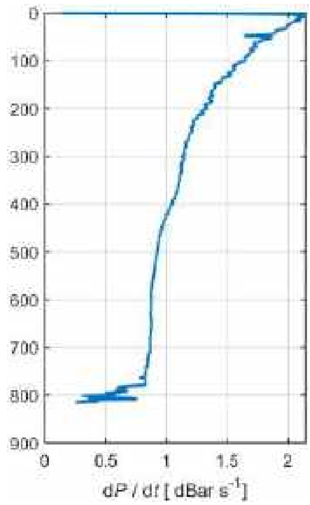

Figure 9. VMP fall speed with two weight collars and one long brush for VMP_10_03.

III. Far from Shelf: When the VMP is no longer decreasing speed across the entire profile it is most likely best to reduce the fall speed of the VMP. Reducing the fall speed of the VMP has the benefit of improving data quality due to reduced vibrations. Faster speeds typically create stronger coherent vibrations felt by the VMP and shear probes. Strong vibrations generated by the rope tether and brush are acceptable when there is a large turbulence signal, however with weaker currents and lower turbulence signals it is best to reduce the fall rate. This can impact total depth achieved. If it is important to go as deep as possible or if data quality is only a concern in the lower half of the profile it may be best to use configuration B at this site type. In this configuration the second weigh collar was removed and 1 (Figure 10) or 2 (Figure 11) long brushes used. In the case of Leg 1, mostly 2 long brushes. With 1 long brush this resulted in an initial fall speed of 1.55 m/s decreasing to 0.5 m/s below the currents. With x2 long brushes the initial fall speed was 1.4 m/s decreasing to 0.6 m/s or less below the currents. The deployment method was the same as type B, however the VMP was falling slower so it was possible to be more relaxed when preparing the tether on the deck while the VMP was falling. Again, the speed of the ship is important and can impact the depth achieved and how fast the tether must be deployed. Slower ship speeds will allow for less rope to be used and the VMP to achieve deeper depths.

   a. One 2.4 kg weight collar
   b. One or two long brushes

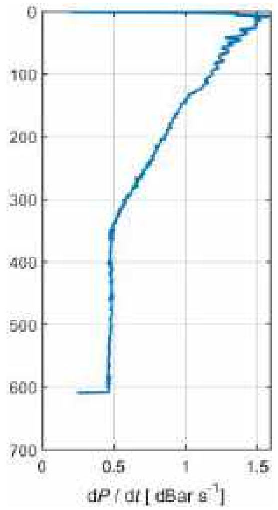

Figure 10. VMP fall speed with one weight collar and one long brush for VMP_14_06.

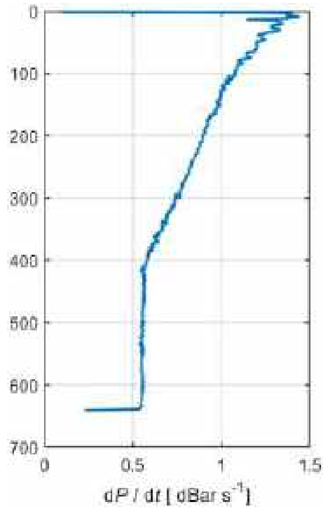

Figure 11. VMP fall speed with one weight collar and two long brushes for VMP_14_02.

10. SADCP

ADCP data (75 kHz) have been recorded continuously during the survey (see EK60 echousounder section for problem in the acquisition). Settings have been adjusted to the bottom depth (< and > 150 m deep); see below for the configurations.

10.1. Configuration for shallow waters (< 150 m)

```
;----------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    default
; Setup type:    High resolution, short range profile(broadband)
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 25/01/2013
;----------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for broadband single-ping profile mode (WP), 40 (WN) 4 meter bins (WS),
; 8 meter blanking distance (WF), 390 cm/s ambiguity vel (WV)

;WN : Sets the number of depth cells over which the ADCP collects data.
WN040

;WP - Broad Bandwidth Profiling Pings Per Ensemble
; When using VmDas, the typical setup will use single ping (WP1) when
; doing Broad Bandwidth profiling
WP1
```

```
;WS : Selects the volume of water for one measurement cell
; Broad Bandwidth Profiling Depth Cell Size
; n = 200 to 3200 cm for 75kHz systems.
WS400

;WF : Broad Bandwidth Profiling Blank after Transmit
; Default  WF800 75kHz
WF800

; WV :Broad Bandwidth Profiling Ambiguity Velocity
WV390

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)
; If BP = zero, the ADCP does not collect bottom-track data
BP000
BX12000

; output velocity, correlation, echo intensity, percent good
WD111100000

; One and a half seconds between bottom and water pings
TP000100

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1000001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA04529

; Set transducer depth (decimeters)
ED00030

; Set Salinity (ppt)
ES0

; Synchro esclave
cx1,0

; save this setup to non-volatile memory in the ADCP
CK
CS
```

10.2. Configuration for offshore waters (> 150 m)

```
;--------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    default
; Setup type:    Low resolution, long range profile(narrowband)
;
; NOTE:  Any line beginning with a semicolon in the first
;        column is treated as a comment and is ignored by
;        the VmDas software.
;
; NOTE:  This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 25/01/2013
;--------------------------------------------------------------------------/
```

```
; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), forty-five (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF)

;WP - Broad Bandwidth Profiling Pings Per Ensemble
; If WP = zero, the ADCP does not collect broadband profile data
WP0

;NN - Narrow Bandwidth Profiling Number of Profile Depth Cells
NN080

;NP - Narrow Bandwidth Profiling Pings Per Ensemble
NP00001

;NS - Narrow Bandwidth Profiling Depth Cell Size
NS0800

;NF - Narrow Bandwidth Profiling Blank after Transmit
NF0800

; No bottom track ping (BP),
; Set maximum bottom search depth to 1200 meters (BX)
BP000
BX12000

; output velocity, correlation, echo intensity, percent good
ND111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000150

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1000001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA04529

; Set transducer depth (decimeters)
ED00030

; Set Salinity (ppt)
ES0

; Synchro esclave
cx1,0

; save this setup to non-volatile memory in the ADCP
CK
```

10.3. SADCP preliminary results

Preliminary SADCP results (Figure 12 and Figure 13) illustrate the presence of the strong North Brazil Current (NBC).

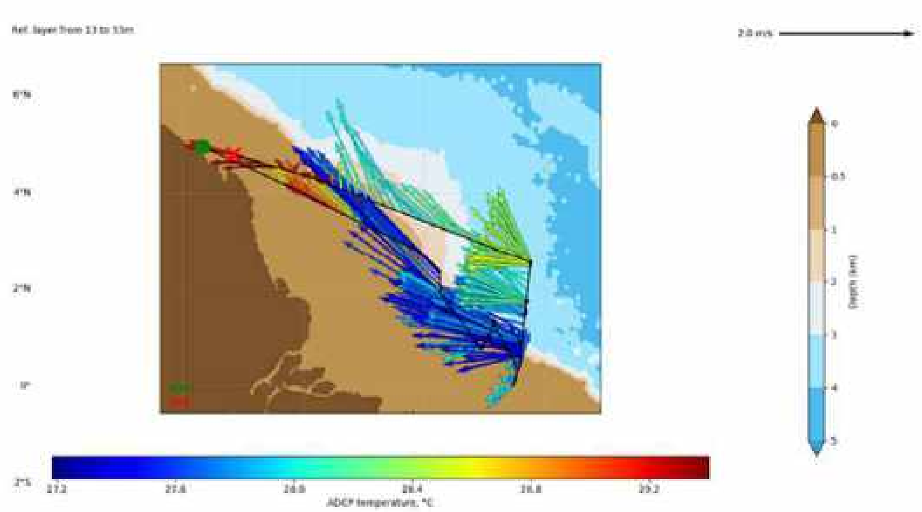

Figure 12. Surface currents (layer 13 – 53 m) during the first Leg of the AMAZOMIX survey.

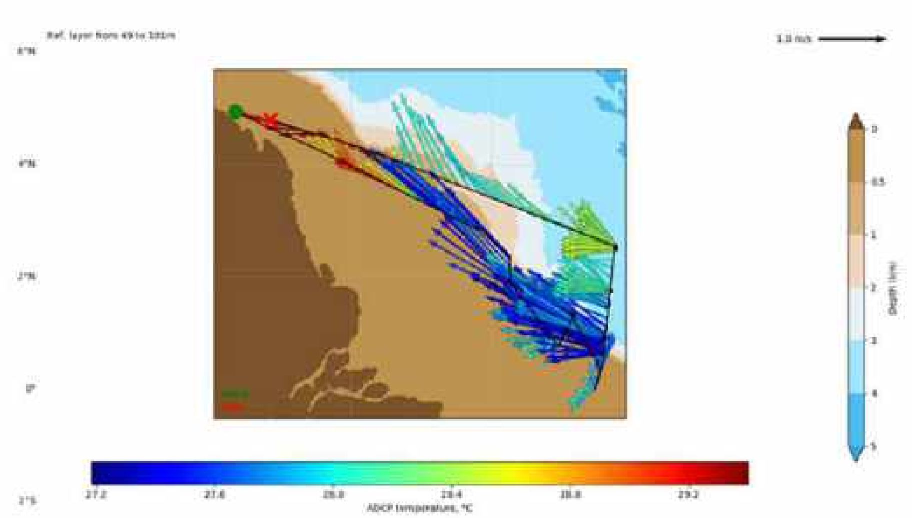

Figure 13. Near-surface currents (layer 49 – 101 m) during first Leg of the AMAZOMIX survey.

11. LADCP

Two LADCPs RDI 300 kHz were mounted on the Rosette, one looking down (S/N 12818) and one looking up (S/N 24085). LADCP profiles (Figure 14Figure 14. Example of a series of LADCP profiles during the long Station 14 with the evolution of zonal (upper plot) and meridional (lower plot) along time.) were thus performed simultaneously to CTDO profiles (SBE911+). The compass of both LADCP were calibrated in the LOPS platform in February 2021.

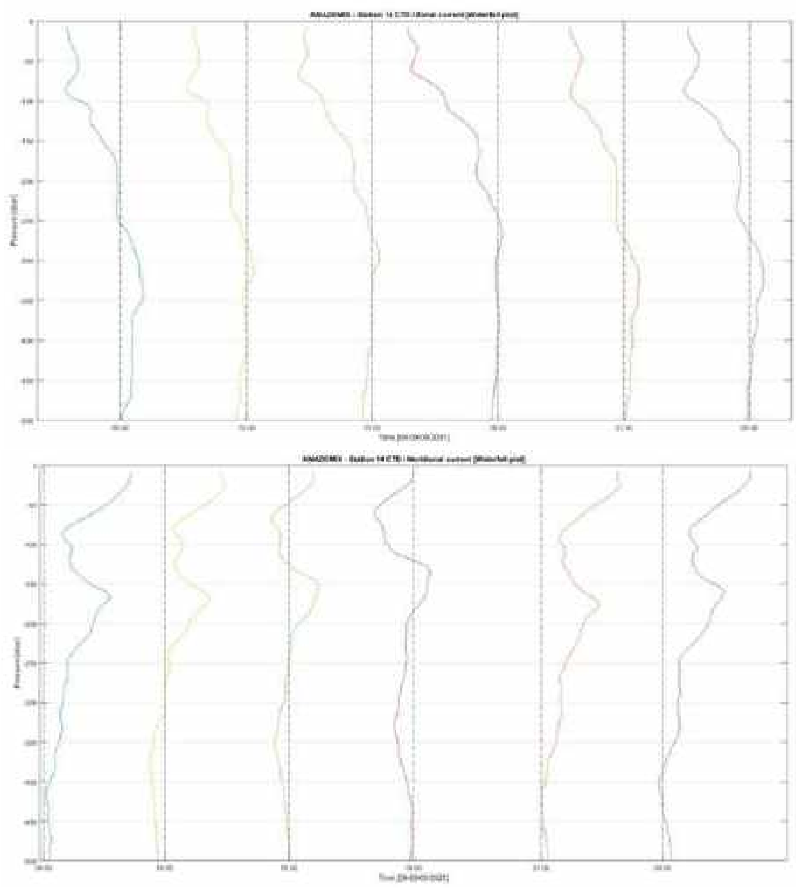

Figure 14. Example of a series of LADCP profiles during the long Station 14 with the evolution of zonal (upper plot) and meridional (lower plot) along time.

12. CTD profiles

A total of 71 CTDO profiles (SBE911+) have been performed. The structure of the vertical profiles were highly variable according to (i) the influence or not of the Amazon plume (Figure 15), and (ii) the passage of internal waves (Figure 16).

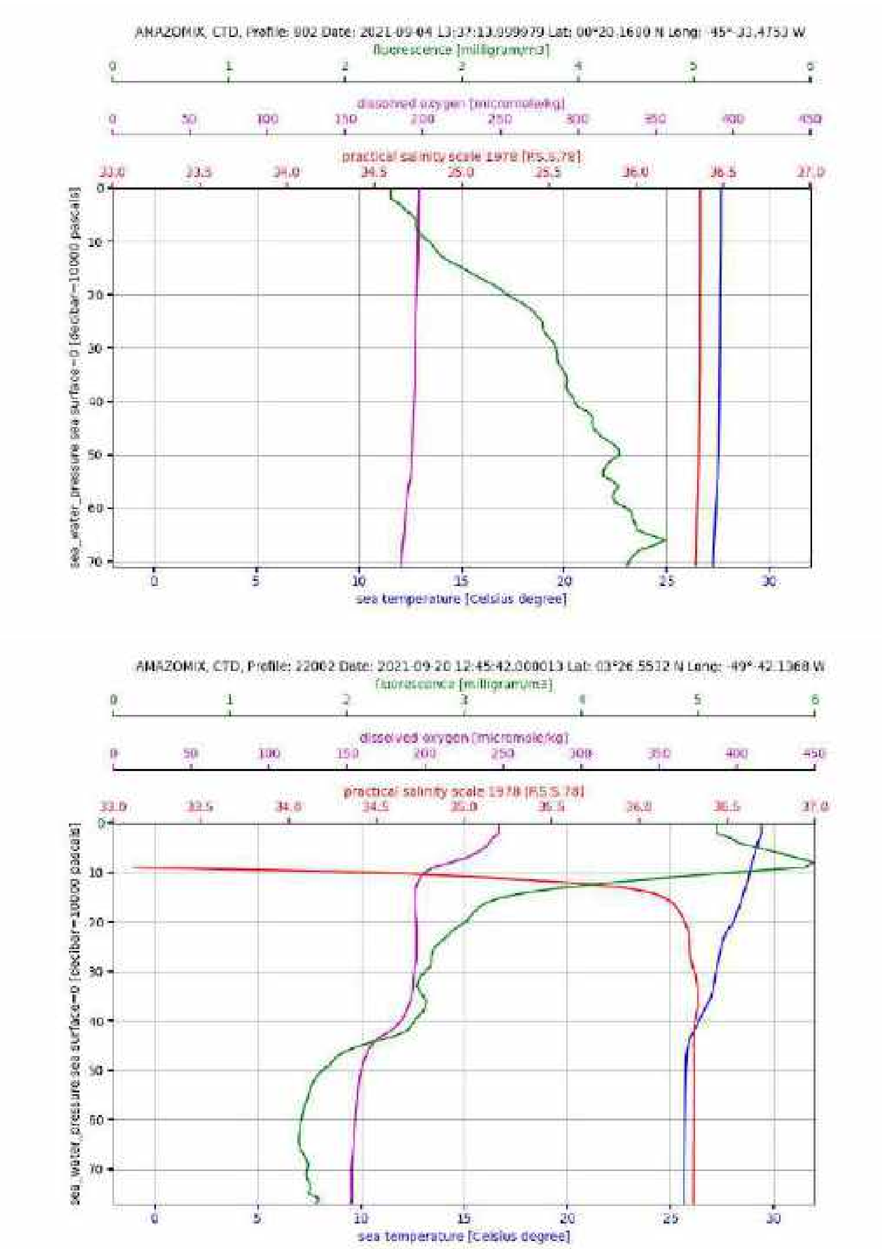

Figure 15. Example of shallow CTDO profiles out (upper plot) and within (lower plot) the Amazon plume.

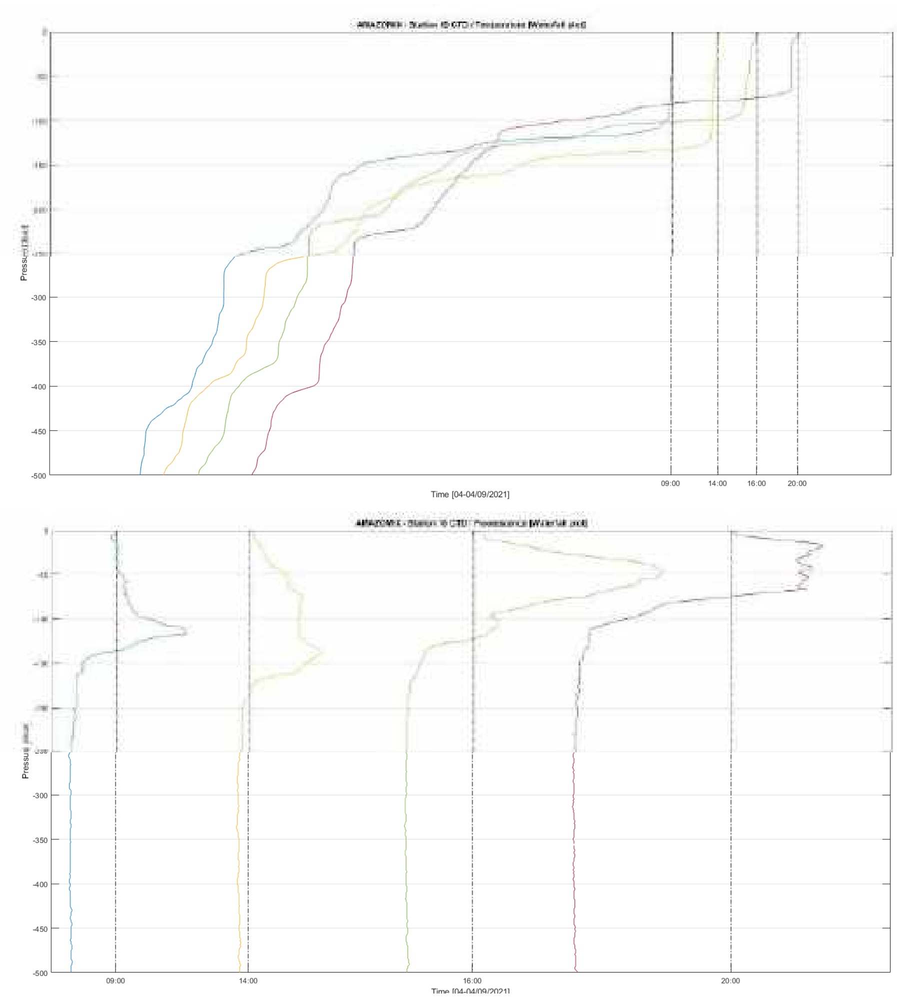

Figure 16. Example of four sequential profiles of temperature (upper plot) and fluorescence (lower plot) at Station 10 (04/09/2021, 00°38 N, 045°29 W).

13. CTD 19 profiler

Additionally to the CTDO SBE911+ mounted in the rosette the use of a CTD19 was planned to record PAR in the blind zone of the CTD rosette (shadow of the R/V due to the use of the moon pool). Unfortunately, the CTD19 had a failure that could not be fixed aboard and could not be used.

14. Rosette

A rosette equiped with 11 Niskin bottles have been used during the hydrological profiles to sample water down to 1000 m deep.
Water was collected to mesure the following elements (Table 5):
- Dissolved oxygen (for CTD calibration – analyse onboard);
- Salinity (for CTD calibration – analyse onboard)
- Nutriments (nitrate, phosphate, silicate) ;
- Particulate organic matter (POM)
- Stables isotopes on POM
- Pigments > and < 20 µm (for further HPLC measurements);
-phytoplankton flora;
- Nano-, pico-phytoplankton and bacteria abundance (cytometry);
- Isotopes on oxygen (O^{18});

- CO_2 (total dissolved inorganic carbon DIC and total alkalinity AT – to be analysed at the SNAPO-CO_2, LOCEAN, Paris);
- Microbial respiration;
- Primary productivity: C^{13} uptake rate.

Table 5. Detail of parameters sampled on the Rosette at each depth (protocol adapted according to the stations, i.e., some measures were not performed at all station/depth (e.g. O^{18}) and O_2/S were not measured at all sampling depths).

Depth (m)	Nº of bottle	Parameter
1000	1	Nutriments, O_2/S, POM, CO_2, O^{18}
750	1	Nutriments, O_2/S, CO_2, O^{18}
500	1	Nutriments, O_2/S, POM, CO_2, O^{18}
250	1	Nutriments, O_2/S, CO_2, O^{18}
Inf (lower Fluo)	1	Nutriments, O_2/S, CO_2, O^{18}, Pigment HPLC, Phyto ident, Phyto and Bacteria abundance
Intermediate 2 fluo		Nutriments, O_2/S, CO_2, O^{18}, Pigment HPLC, Phyto ident, Phyto and Bacteria abundance
Deep clholorophyll maximim (DCM)	3 (am) 2 (pm)	Nutriments, O_2/S, POM, CO_2, O^{18}, Pigment HPLC, Phyto ident, Phyto and Bacteria abundance, primary production, microbial respiration
Intermediate 1 fluo	1	Nutriments, O_2/S, CO_2, O^{18}, Pigment HPLC, Phyto ident, Phyto and Bacteria abundance
Surface	2 + bucket	Nutriments, O_2/S, POM, CO_2, O^{18}, Pigment HPLC, Phyto ident, Phyto and Bacteria abundance, primary production, microbial respiration

Water samples were collected and processed as decribed in Figure 17.

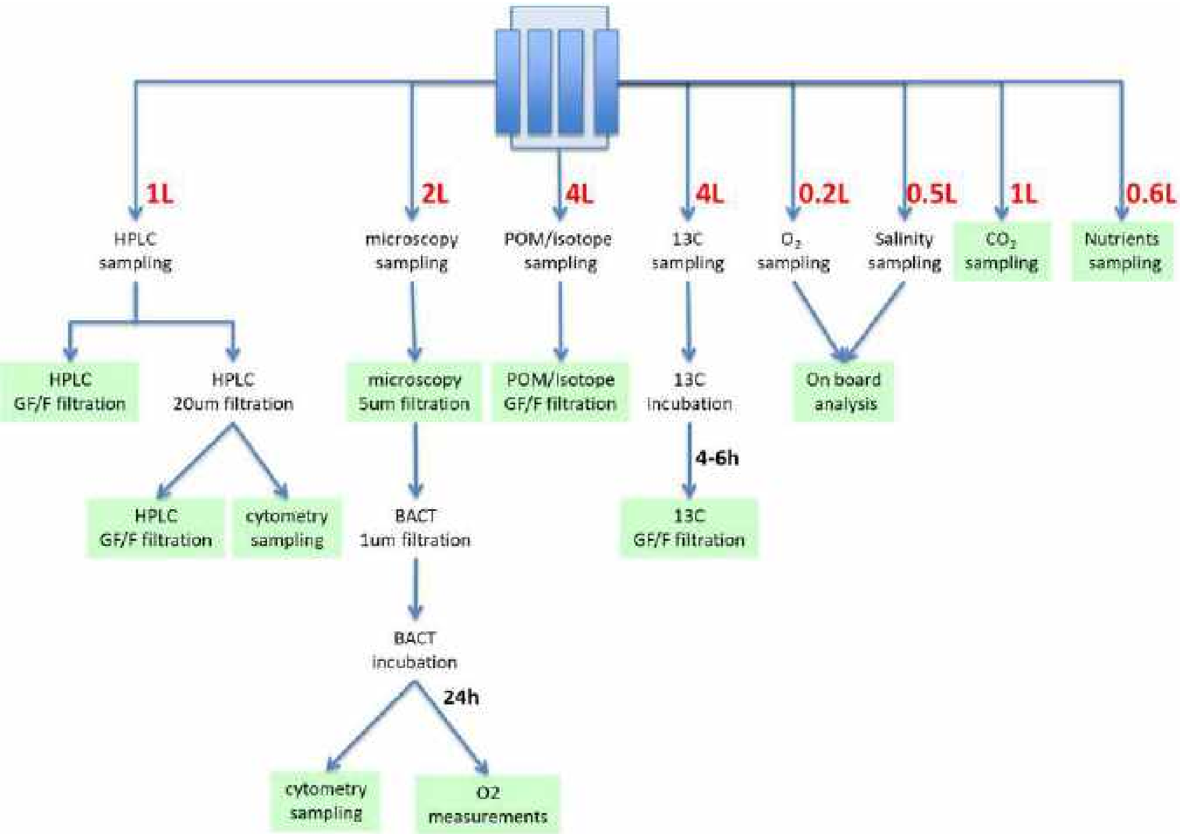

Figure 17. Protocol to process water samples from the rosette.

- Oxygen and salinity samples were taken at different depth levels, at each station according to classical methods. The sampling strategy was designed to provide *in situ* reference data for the CTD sensor calibration. Samples were analysed onboard.

- Nutrients samples were collected at each sampling depth in 30 ml Nalgen vials and stabelised in an oven at 80°C during 2h30 (pasteurization).

- Samples for CO_2 measurements (DIC and AT) were stored in 500 ml glass bottles and poisonned with 300 µl HgCl2. They were kept at room temperature until analysis at the laboratory.

- Samples for O^{18} were stored in 30 ml brown glass bottles and stored at room temperature. Six profiles for O^{18} measurements have been taken during the cruise in different water mass types (open ocean stations, coastal stations, Amazone plume stations).

- Particulate organic matter (POM) samples were taken by filtration on GF/F 47 mm pre-carbonized fiters. A large volume of water (up to 8 L for clear water) was filtered in order to get enough material for the determination of carbon and nitrogen stable isotopes content by mass spectrometry (at the laboratory). Filters were dried in an oven (60°C during 48h) and kept at room temperature until the isotopic measurement.

- For phytoplanktonic pigments, seawater was filtered on GF/F 25 mm filters just after collection. Depending on the sample load, 500 ml to 1 L of water was filtered for each sample. Filters were then kept at low temperature (-20°C during the cruise then -80°C). Pigments will be measured at the laboratory (IMAGO, Brest) by high pressure liquipd chromatograhy (HPLC). Pigments are measured on "raw samples" ("HPLC tot" without pre-filtration) and on water filtered at 20µm ("HLPC 20µ" and "HPLC fract" for the >20µm and the <20µm size classes).

- Samples for bacterial diversity measurement by flow cytometry were kept from filtered water (<20 µm and <1 µm) in cryotubes (1.6 ml of water + 80 µl formalin) and stored in liquid nitrogen. They will be kept at -80°C during the transport to the laboratory. Bacterial communities will be counted by flux cytometry. Their diversity will be described by sequencing.

- Bacterial respiration was measured on samples taken at the same depth (surface and DCM) as for primary production assessment. Aliquots (30 ml) of filtered (<1 µm) water sample were stored in black tanks at a constant temperature (28°C) for 24 hours. Oxygen content was regularly measured (every 5 minutes) within the tanks using a dedicated oxygen sensor.

- Primary production was assessed by measuring carbon incorporation (C13 stable isotope) within 1 L sample bottles paced in an incubation box (filled by a continuous flow of surface water to maintain stable temperature) for 4 to 6 hours. The incubation box was exposed to sunlight. Bottles were either clear bottles (for surface samples) or covered with light filters (for DCM samples) in order to reproduce *in situ* PAR (photosynthetic active radiation) given by the CTD sensor. After the incubation time (Tf), samples were filtered on GF/F 25 mm pre-carbonated fliters, and their C13 content (mass spectrometry measurement at lab) will be compared to a reference C13 content obtained by the filtration of a no-incubation reference sample (T0). Filters were dried (24h in an oven at 60°C) then kept at room temperature.

- Samples for phytoplankton identification and abondance (Phyto-ID, from Niskin bottles) were taken by filtration of 1 L to 2 L of seawater on 5µm filters. Fliters were kept in plastic bottles with 30ml of the filtered seawater and 600 µl of lugol). They were stored in a normal freezer 4°C. All taxonomic data (phytoplankton was also sampled with a 20 µm net) will be made available on an interactive database (http://data.oreme.org/plankton/phytoplankton_home) gathering observations on phytoplankton communities from project developed in France and other countries. This database is a tool facilitating the identification of phytoplankton species is connected with the WormS (World register Marine Species) basis.

15. Cytosense and fluoroprobe

To continuously map phytoplankton distribution we used a Cytosense associated with a Fluoroprobe BBE benchtop probe (Figure 18). The Cytosense continuously measures the abundance of pico-nanophytoplankton at the surface, while the BBE captures the pigment wavelengths of the major phytoplankton families as well as the "yellow" particles present in the water.

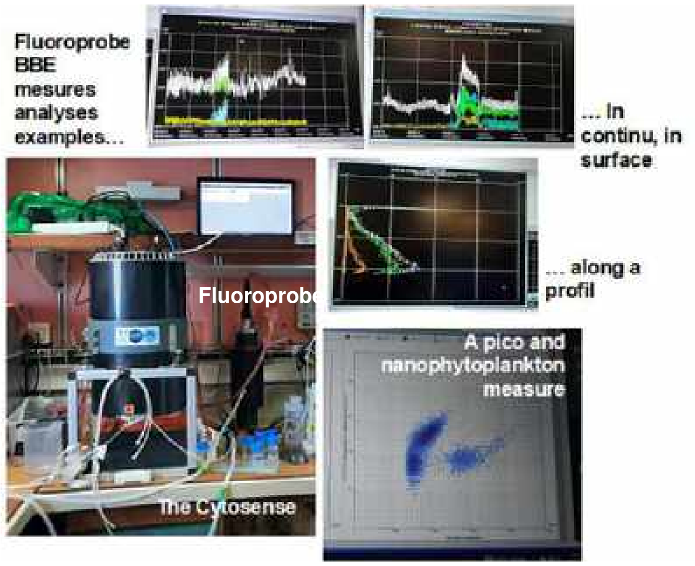

Figure 18. Fluoprobe and Cytosense in the dry lab.

The CytoSense (Figure 19) allows detecting particles over a large size-range (from submicron to 1.5 millimetres in diameter). Its laser detects different fluorescence wavelengths:

- Dark red fluorescence: the main emission band of chlorophyll
- Orange fluorescence: allows to distinguish species containing accessory pigments such as erythrins and phycobilins.
- Yellow/green fluorescence: typical of some ciliates and cysts and sometimes of cells undergoing lysis (such as after being ingested by zooplankton) - also useful for artificial fluorescent staining of cellular components, DNA, etc.
- Blue fluorescence.

Sensors detect different morphological criteria:

- Curvature detector: by distinguishing across the width of the flow cell the position of the particle in the flow cell can be known or, with longer particles, how they are curved.
- Polarised light sensor: some plankton species polarise light in a certain direction. We have developed a special sensor to measure this polarisation.

A camera is fitted to the instrument to photography the cells in order to identify phytoplankton groups for example. The images are coupled with individual laser scans to allow further analysis. Unfortunately the Cytosense camera did not work well. In addition, the Cytosense faced a number of technical issues and could not be used continuously but only ~40% of the time.

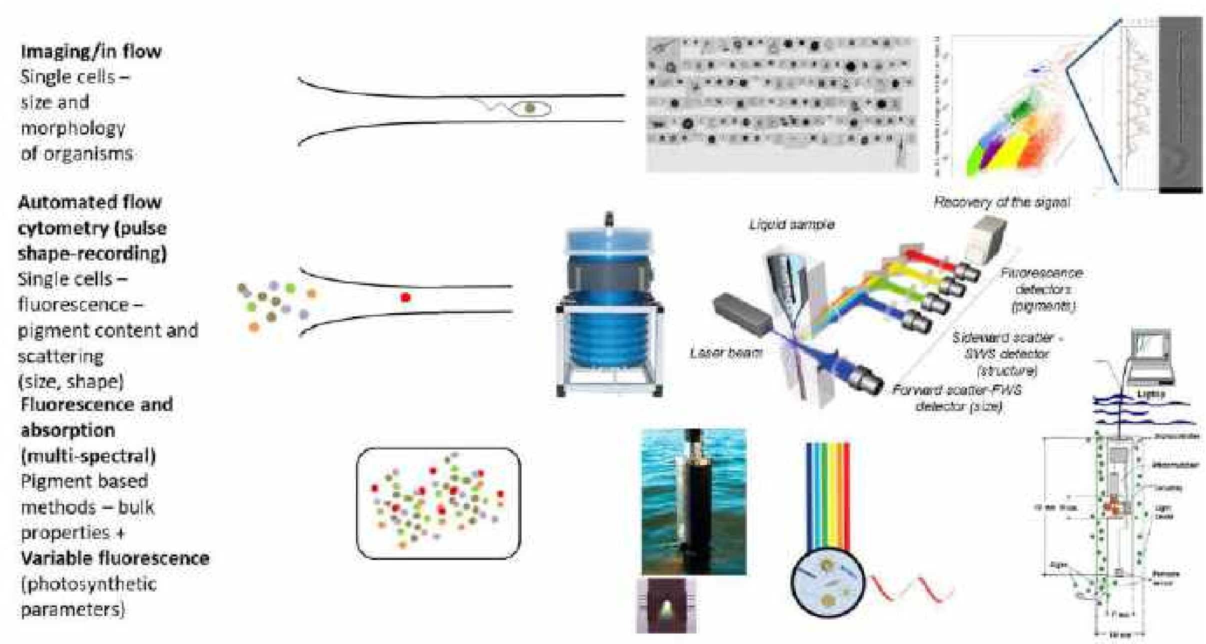

Figure 19. Cytosense to observe phytoplankton in vivo, in situ and in near real time.

16. Radiometric measurements

Radiometric measurements were performed using two TRIOS hyperspectral radiometers (310-950 nm, each 3 nm). One reference sensor, located on the top of the boat measures the downwelling light. The second, placed on a floating structure, measures the upwelling light field at the sea surface (Figure 20). These two spectra are used to compute the remote sensing reflectance (Rrs), the ocean colour input parameter also measured by OCR satellites. This spectra allows (i) the validation of the ocean colour data gathered from different satellites (MODIS, VIIRS, Sentinel-3) after atmospheric correction, and (ii) the validation/development of bio-optical models needed for estimating a variety of optical/biogeochemical parameters (e.g. Inherent Optical Properties: absorption and scattering, biogeochemical parameters; Chla, SPM, POC, CDOM, DOC, pCO2) from the ocean colour signal. These parameters are measured in parallel on discrete samples or from *in situ* optical sensors (see next section).

Figure 20. Radiometric measurements.

17. Optical measurements (optical grape)

A variety of optical instruments were mounted on a common frame (optical grape; Figure 21) equipped with its own CTD for the acquisition of a set of parameters providing the following information:

- At the sea surface: particle size distribution (PSD) and particles scattering properties; parameters not measured from discrete samples (rosette). This surface information is useful for algorithm (development) validation.
- Along vertical profile (classically down to 120 m): quantitative and qualitative information on the particulate (PSD, zooplankton and particles scattering properties), coloured dissolved matter distribution, the phytoplankton total chlorophyll_a and the specific biomass of major phytoplankton groups, and the underwater light field. These information are important to complement the ocean colour observation which are available at the sea surface, only.

Nephelometer BB9-Wetlabs

Nephelometer SC6-IMO

Fluoroprobe Bioneff

Laser Granulometer LISST 1000-X (Sequoia)

Fluorometer ECO3 WETLABS

Figure 21. The optical grape.

17.1. Particle size distribution

The Laser Granulometer LISST 1000-X (Sequoia) measures the vertical distribution of the particle size distribution (PSD) between 2 and 500 µm. These measurements will be complementary to parameters acquired by other sensors (UVP6, Backscattering sensors).

17.2. UVP6

The Underwater Vision Profiler (UVP) is holding a light source and a camera designed to study particles and zooplankton distribution simultaneously and to quantify them in a known volume of water.

17.3. Scattering properties

Particles backscattering properties were measured at different wavelengths through two complementary nephelometers (Figure 21; BB9-Wetlabs; 488, 510, 532, 595, 650, 676, 715, 765, 865 nm, SC6-IMO: 413, 443, 490, 550, 594, 659 nm, 4 Hz). This Inherent Optical Property (IOP) of the seawater provides quantitative information on the particulate matter pool (e.g. proxy for POC estimation) being also a source of information on particulate matter size and origin (slope of the backscattering spectra).

17.4. Coloured dissolved organic matter fluorescence (Wetlabs)

The fluorometer (ECO3 WETLABS) measures the Fluorescence Dissolved Organic Matter (FDOM), a proxy for monitoring the vertical distribution of the dissolved organic matter. This profile will be put in parallel with the Coloured Dissolved Organic Matter (CDOM) absorption spectra measured from discrete sampling form the Rosette. CDOM is a major component acting on inwater light availability and also a proxy for estimating the concentration of the Dissolved Organic Carbon from space.

17.5. In-water spectral light profiles

The in-water light filed was measured with a radiometer at seven wavelengths (411, 443, 490, 511, 560, 620, 664 nm, 4 Hz) in the visible along vertical profiles. This profile will be used to compute the downwelling light attenuation coefficient (Kd, m^{-1}) that allows describing the light environment corresponding to the different water masses sampled. This information will be put in parallel with the biological (primary production) or ecological data gathered during the cruise.

17.6. Fluoroprobe

A highly sensitive Bionef fluorometer was used to estimate the phytoplankton total chlorophyll a and the specific biomass of major phytoplankton groups (green algae, blue-green/ cyanobacteria, diatoms, cryptophytes). This fluoroprobe thus allows studying the distribution phytoplankton community along the vertical scale.

18. Glider

On September 09/09/2021 at 10:30 UTC, a Slocum Crate Glider has been deployed (Figure 22). This glider is equipped of physical (pressure, conductivity, temperature) and biogeochemical (fluorescence, oxygen, Fluorescence Dissolved Organic Matter, optical backscattering) sensors. The objective of the Glider is to sample the hydrography off the continental shelf in the propagation path of internal waves from the position of Station 14 where a mooring will be deployed (southern yellow triangle in Figure 23) and the position of the second mooring (southern yellow triangle in Figure 23).

Figure 22. Glider deployment.

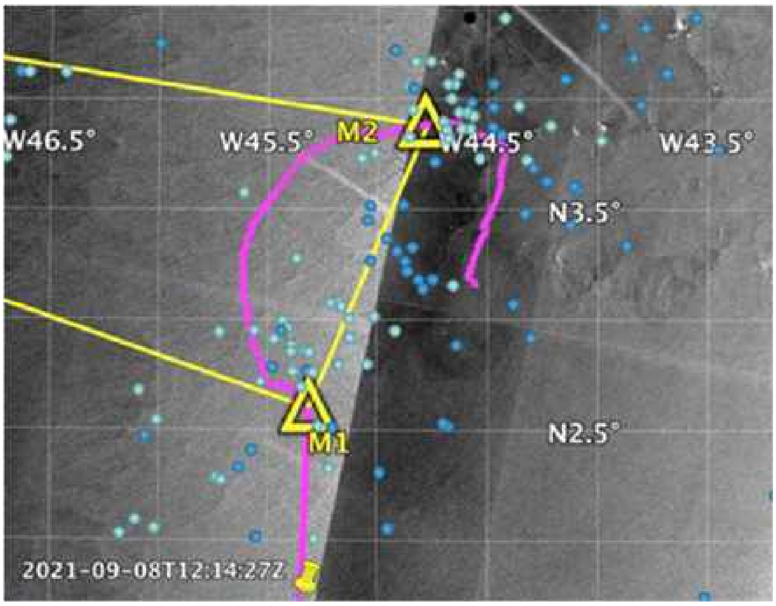

Figure 23. Glider track (pink solid line) until Sept. 28, 2021 (the yellow pin shows the starting position) overlapped on a SAR image showing the propagation of internal waves. The yellow triangles show the position of the moorings to be deployed during the Leg 3, the yellow solid line indicates the survey track of the Leg 3.

19. Multifrequency acoustic data

Multifrequency acoustic data have been continuously acquired during the survey (Stations included) using an EK60 at 38, 70, 120 and 200 kHz.

19.1. Echosounder calibration

The echosounders were calibrated prior to the survey, in Morgat the 14/04/2021 during the ESSTECH2021 mission in April 2021 in Morgat. The results of this calibration are summarised below.

	38kHz	70kHz	120kHz	200kHz
Pulse s	**512µs**			
Ping interval	0.4			
Max power W	1000	750	200	90
Rms beam	0.29	0.81	0.44	0.31
Rms polynom	**0.23**	**0.7**	**0.42**	**0.24**
Transd,_gain	**24.21**	**26.57**	**26.78**	**25.96**
Sa corr. dB	-0.55	-0.46	-0.37	-0.34
Fsc_Athw °	6.98	6.22	6.4	6.31
Fsc_alg °	6.82	6.34	6.15	6.27
Athw offset °	0.01	0.01	0.07	-0.03
Alg offset °	0	-0.12	-0.07	0.1

	38kHz	70kHz	120kHz	200kHz
Pulse length	**1024µs**			
Ping interval	0.4			
Max power W	1000	750	200	90
Rms beam	0.3	0.69	0.26	0.19
Rms polynom	**0.29**	**0.63**	**0.23**	**0.14**
Transd,_gain	**24.25**	**26.33**	**26.73**	**25.76**
Sa corr. dB	-0.57	-0.34	-0.33	-0.25
Fsc_Athw °	7.14	6.62	6.39	6.3
Fsc_alg °	7.16	6.27	6.27	6.49
Athw offset °	0.04	-0.07	0.06	0.05
Alg offset °	-0.11	-0.27	-0.01	0.14

19.2. Configuration OSEA

The EK60 echosounders were synchronized with the ADCP. The EK60 echosounders were the "master" of the synchronisation and the ADCP was in "slave" mode. During LEG 1, until 31/08/2021 at 18:40, the synchronisation was carried out with the OSEA V4.1 software and the following configuration: dynamic mode with trigger of the master EK60 and the slave ADCP with 50% delay on the ping interval (Figure 24).

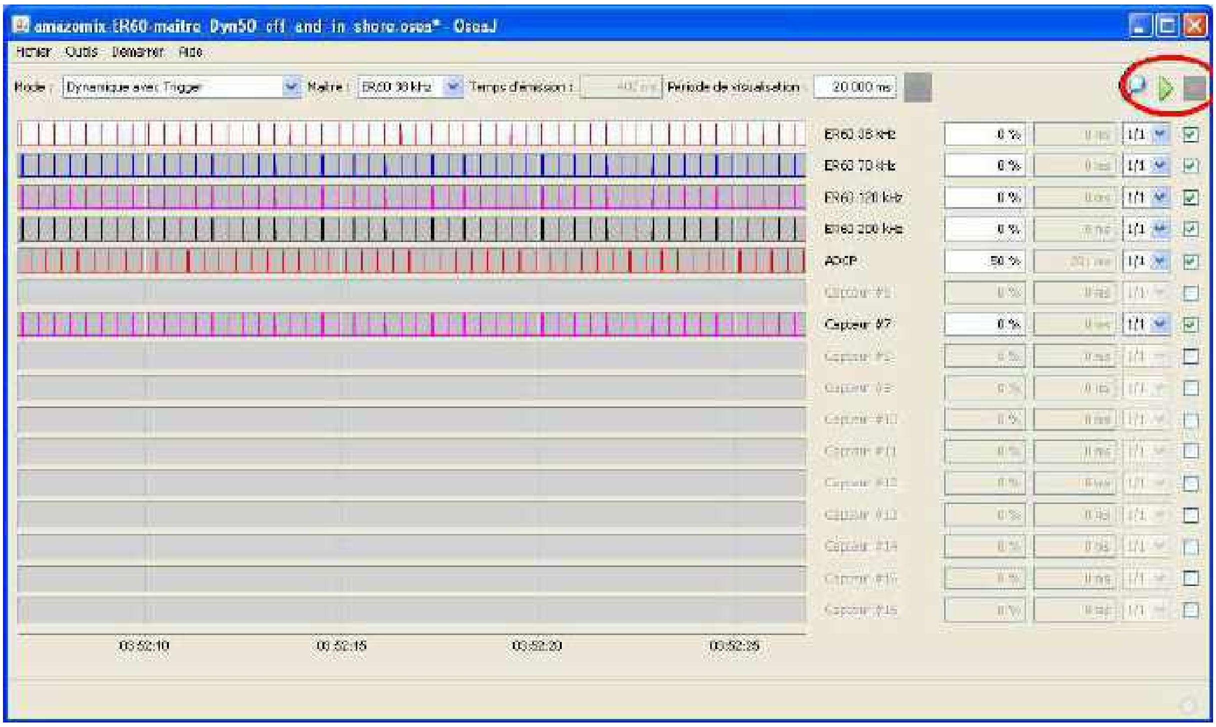

Figure 24. Configuration of OSEA V4.1 software to synchronise the echosounders and the ADCP.

Due to problems with the OSEA system and the associated computer, after 31/08/2021 at 18:40 the synchronization was done via a function generator. The EK60 was still the master and the ADCP was still the slave but without any delay on the ADCP ping interval. OSEA system was changed during the stop over between Leg 1 and Leg 2.

19.3. Acquisition ER60

The EK60 sounders were in continuous acquisition throughout the cruise. However, three crashes, without explanation, occurred (30/08 5:50; 04/09 07:00; 16/09/21 06:54) and the acquisition was not turned on, generating corrupted acquisition files and therefore probably unusable (~2 hour of missing acquisition).

The pinging parameters were as follows for the entire duration of the mission:

	38 kHz	70 kHz	120 kHz	200 kHz
Pulse length (µs)	1024	1024	1024	1024
Power (W)	1000	750	250	90

The acquisition parameters were set by the bathymetry of the site and followed the following table:

Bottom Depth range (m)	ER60 Minimum ping interval (s)	RAW files ARCHIVE RANGE (m)	Max bottom detection (m)
0-100	0.3	100	
0-150	0.4	150	
0-250	0.65	250	
0-500	1.25	500	
>500	2.1	800	no

Echograms revealed the presence of a variety of internal waves at varying scale from high (Figure 25) to lower (Figure 26) frequencies.

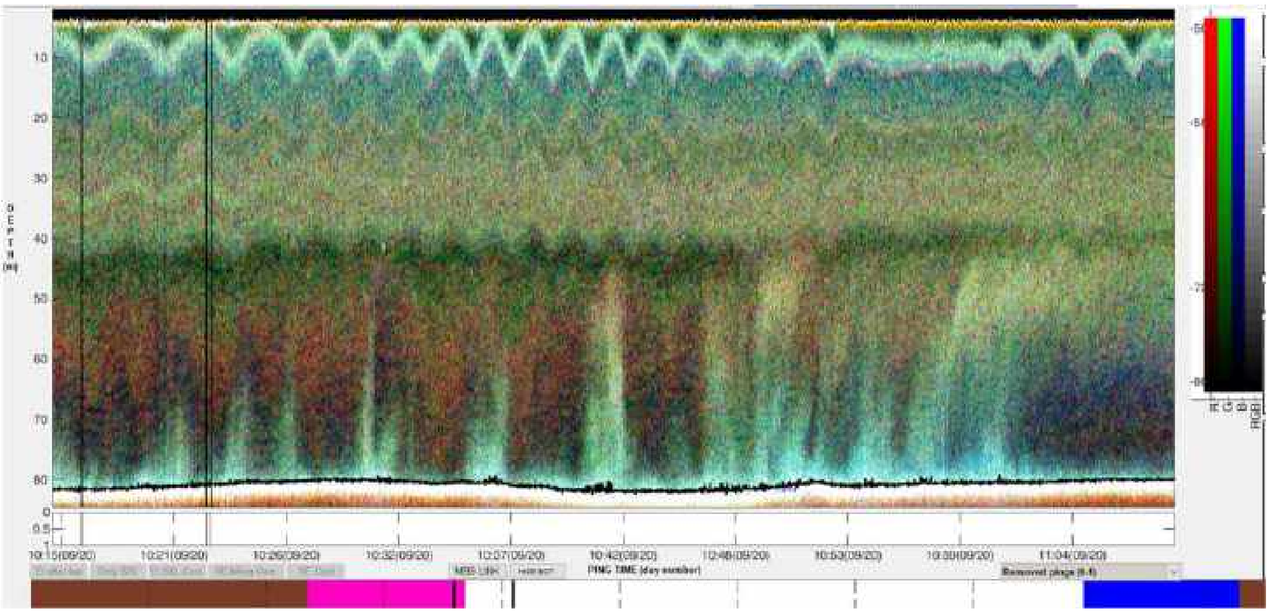

Figure 25. Example of composite RGB representation of acoustic data acquired at Station 22 revealing the passage of high-frequency internal waves.

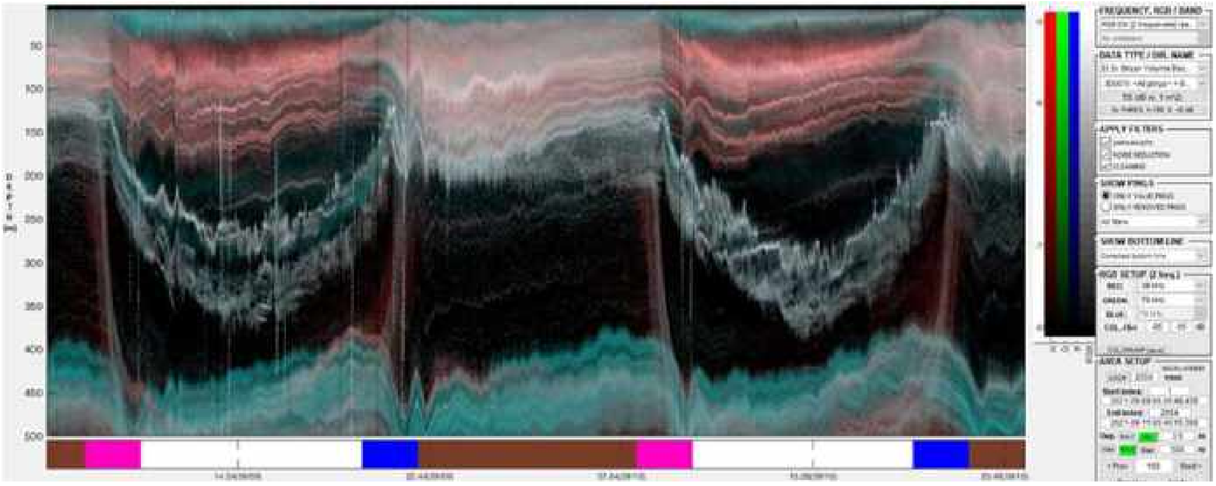

Figure 26. Example of composite RGB representation of acoustic data acquired during 48 h at Station 14 revealing the passage of internal waves.

20. Phytoplankton net

In addition to samples from the Rosette. Fifteen phytoplankton samples were collected using a 20 µm mesh-size phytoplankton net (Figure 27).

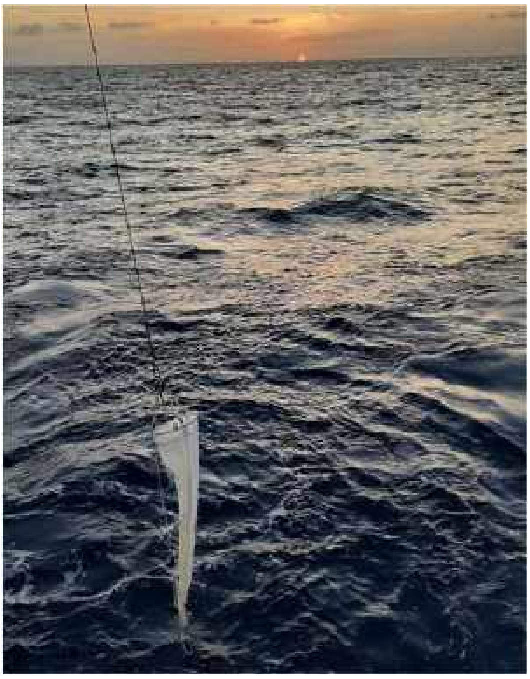

Figure 27. Phytoplankton net.

21. Zooplankton

Zooplankton was sampled using a bongo with two mesh-size (64 and 120 µm) and a Multinet (5 closing nets, 300 µm) allowing for five size-classes of zooplankton:

AMAZOMIX: 5 Size-classes

- Size-class A, Bongo 64 µm: 50 to 100 µm
- Size-class B, Bongo 120 µm: 100 to 200 µm
- Multinet 300 µm, Size-class C: 200 to 500 µm
- Multinet 300 µm, Size-class D: 500 to 1000 µm
- Multinet 300 µm, Size-class E: > 1000 µm

Balance of zooplankton sampling:

	Nb hauls	Taxonomy	Isotopes	Genetic	Enzyme
Multinet	33	126	118	22	-
Bongo 64 µm	48	48 (*3 qualit.)	48	-	46 (*1 qualit.)
Bongo 120 µm		48	48	-	48
Total	**81**	**207**	**214**	**22**	**94**

21.1. Bongo net

In total 48 hauls of Bongo have been achieved. Sampling of two size-classes:
Size-class A: Bongo 64 µm: 50 to 100 µm
Size-class B: Bongo 120 µm: 100 to 200 µm

Objective: taxonomy and microplastics, isotopes and enzymes

Sampling strategy:

- One oblique tow 200 m to the surface in deep waters or from the bottom to surface in shallow waters.

Samples from each net (64 µm, 120 µm) were cut in three fractions: Taxonomy (50%), Isotopes (25%) and Enzymes (25%) (Figure 28):

- The fraction for taxonomy and microplastics was placed in 500 ml pot and fixed in formaldehyde 4% for further biomass, taxonomic and microplastic analyses. Pots were labelled with one tag inside and by pasting another one outside. Pot were closed with parafilm and then kept outside of the lab, in large boxes in the dark.
- The fraction for enzymes was put in two 1.5 ml Eppendorf microtubes (make a small hole in the Eppendorf), frozen with liquid nitrogen and stored at -80ºC. Each microtube was labelled with specific tag (created with labeller).
- The fraction for stable isotope analysis was passed on plankton sieve collector column. The sample form the 64 µm was passed on a 64 – 100 µm column and only the 64 µm size-class was kept. The sample form the 120 µm was passed on a 100 – 200 µm column and only the 100 µm size-class was kept. These samples were kept in brown acetone clean glass vials with self-sealing cap. These vials were labelled with specific tag (created with labeller) and frozen at -20ºC.

Note that to clean plankton sieve collectors:

- for a given sample, use sea water;
- between samples, use fresh water (and alcohol).

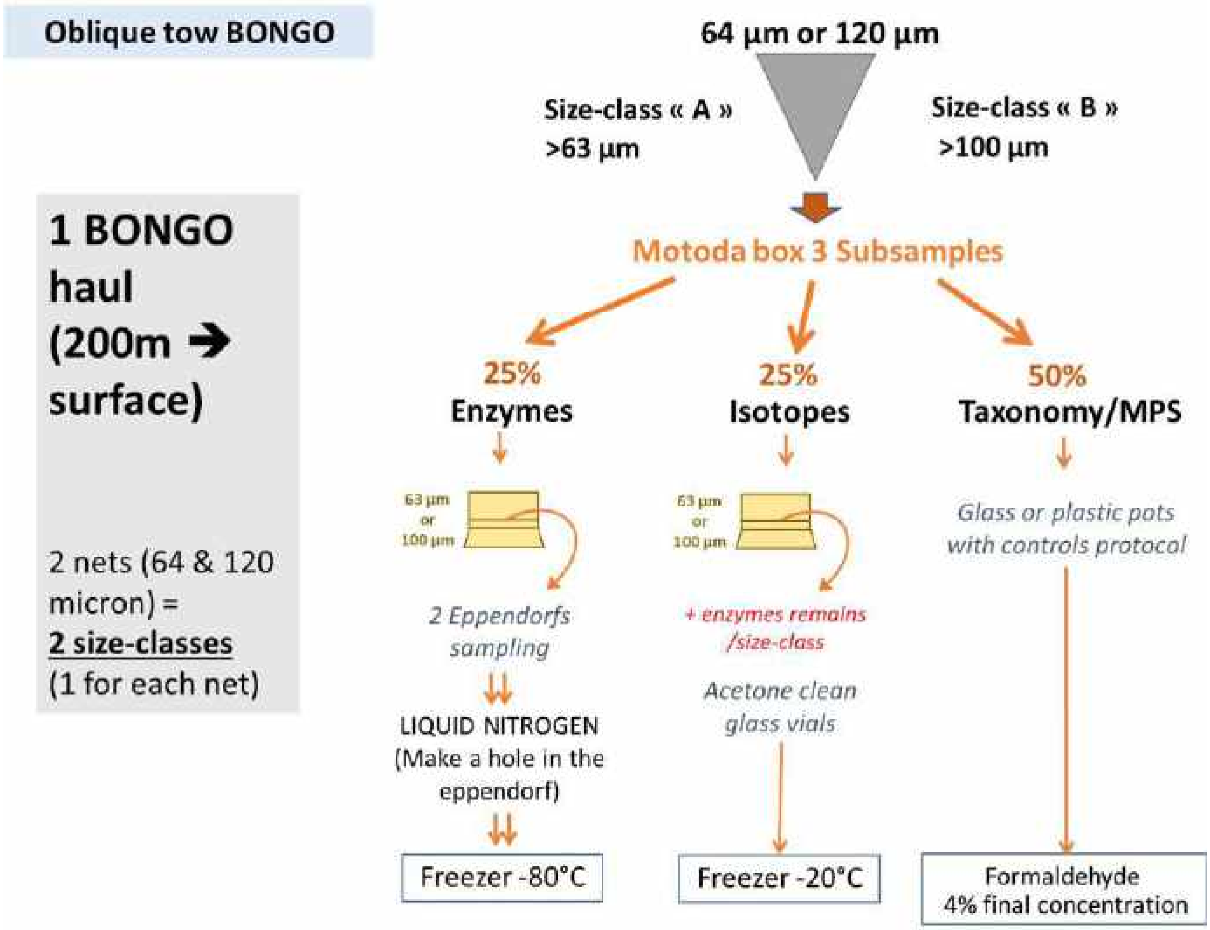

Figure 28. Protocol for bongo tows.

21.2. Multinet

In total 33 hauls of multinet (five closing nets with a mesh size of 300 µm) have been achieved. Sampling of three size-classes:

- Size-class C, Multinet 300 µm: 200 to 500 µm
- Size-class D, Multinet 300 µm: 500 to 1000 µm
- Size-class E, Multinet 300 µm: > 1000 µm

Objective: taxonomy and microplastics, isotopes and genetics

Sampling strategy: in all cases, one oblique tow ~200 m to the surface (from the bottom to surface in shallow waters).

Classically the multinet was used this way (Figure 30):

- Deep-water stations: 5 closing nets → 0 or 1 downward (integrative)+ 4 or 5 upward (stratified)
- Shallow-water stations: 3 closing nets → 0 or 1 downward (integrative)+ 2 or 3 upward (stratified)

See Multinet protocol for its programming or connected mode operation

The sampling depth strata are determined according to the thermohaline structure and the presence of sound scattering layers (SSL) (Figure 29).

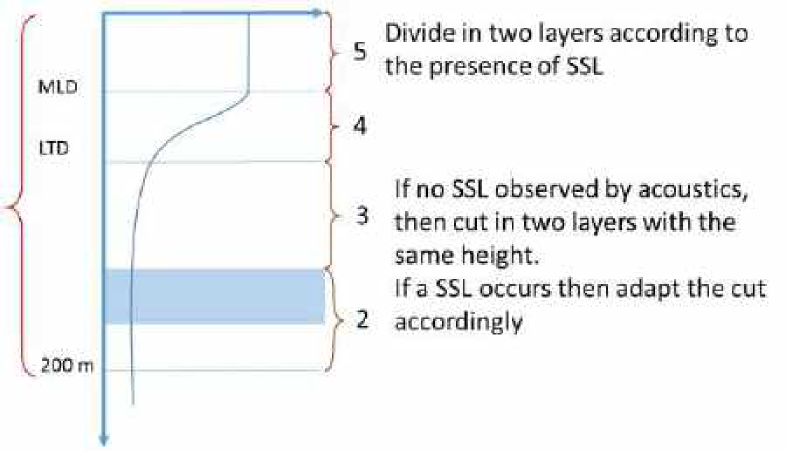

Figure 29. Determination of the vertical layers to be sampled with the multinet. Note that the first net can be 'integrative' from the surface to ~200 m or fifth layer.

Two kind of hauls were preformed:

I. Sampling by depth layer only (Figure 30and Figure 31). Samples from each net were cut in two fractions: Taxonomy and microplastics (50%) and Isotopes (50%).

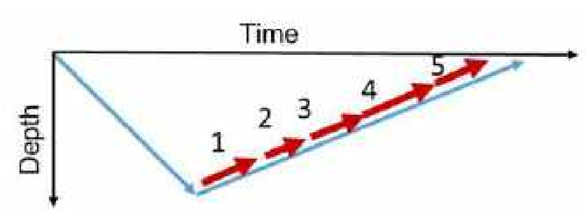

Figure 30. Protocol for closing the nets of the multinet, by depth layer only.

- The fraction for taxonomy and microplastics was placed in 500 ml pot and fixed in formaldehyde 4% for further biomass, taxonomic and microplastic analyses. Pots were labelled with one tag inside and by pasting another one outside. Pot were closed with parafilm and then kept outside of the lab, in large boxes in the dark.
- The fraction for stable isotope analysis was passed on a plankton sieve collector column (200 - 500 - 1000 µm). These samples were kept in brown acetone clean glass vials with self-sealing cap. These vials were labelled with specific tag (created with labeller) and frozen at -20ºC.

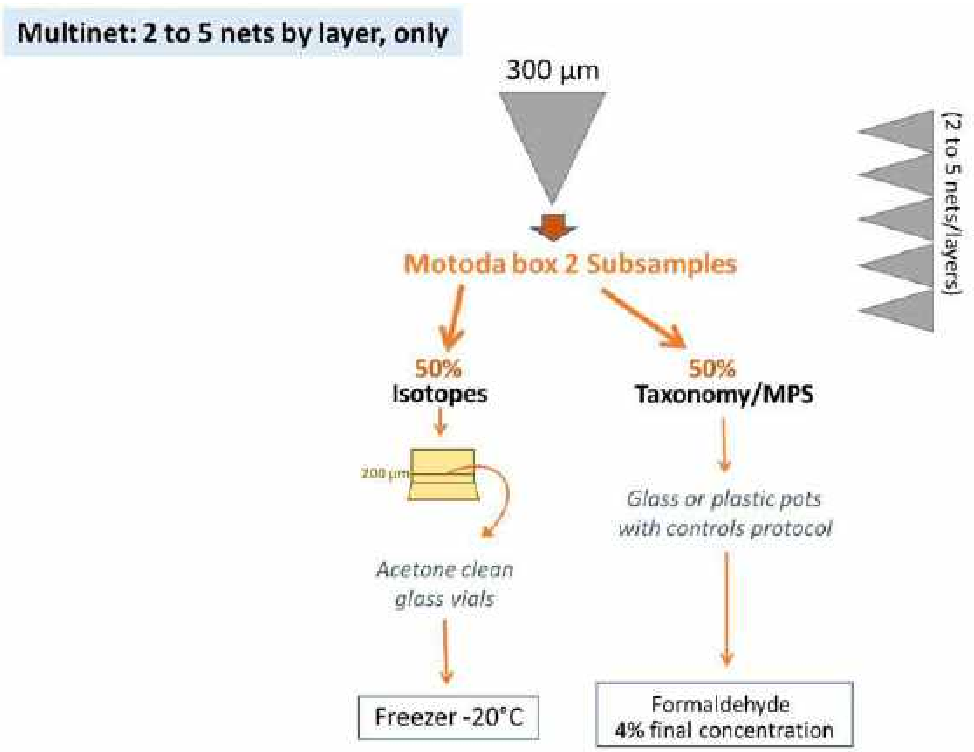

Figure 31. Protocol for processing multinet samples from tows with sampling by vertical layers, only.

II. Sampling with one integrative net (first net) from the surface to ~200 m and 2 to 4 nets by layer (Figure 32 and Figure 33). The samples by layer were processed following the protocol above described. The sample from the integrative net was fixed in pure ethanol for further genetic analyses.

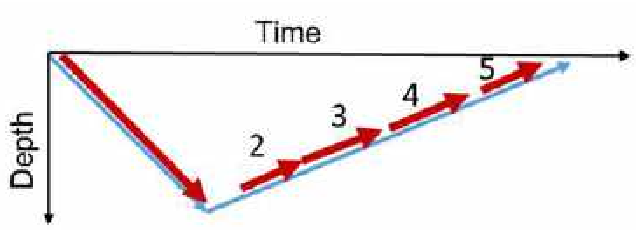

Figure 32. Protocol for closing the nets of the multinet, with one integrative net plus nets by depth layer.

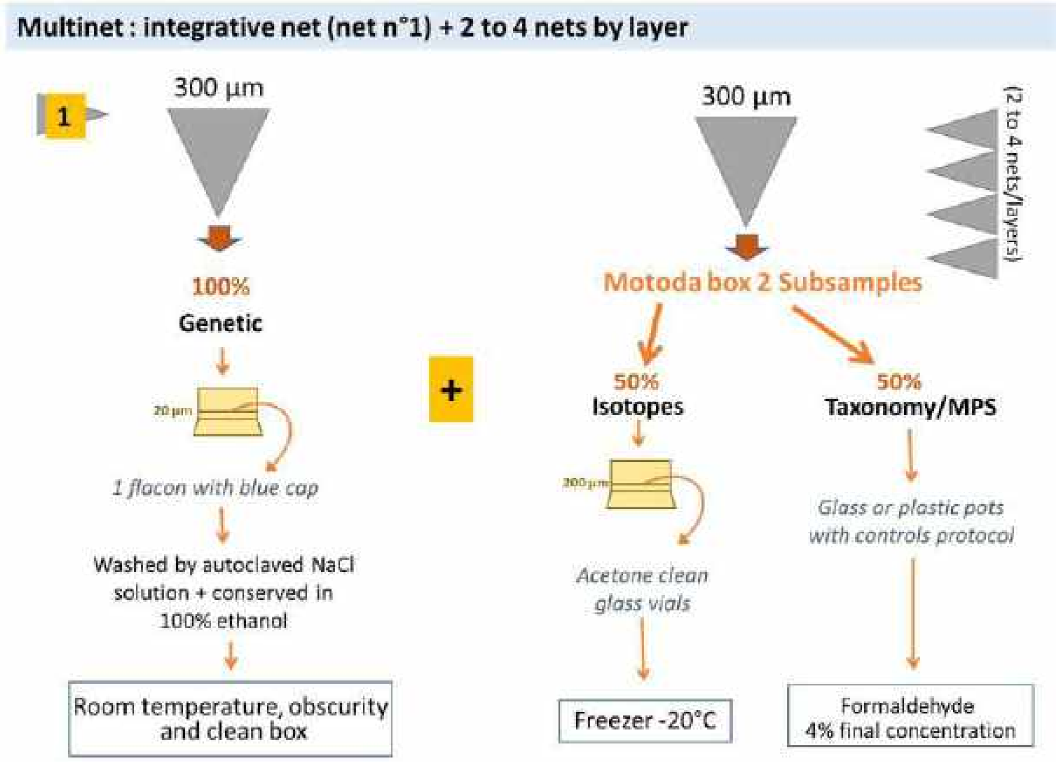

Figure 33. Protocol for processing multinet samples from tows with one integrative net plus nets by vertical layers.

Note that to clean plankton sieve collectors:

- for a given sample, use sea water;
- between samples, use fresh water (and alcohol).

22. Trawl

22.1. Protocol

To sample bentho-demersal and pelagic communities, two trawls have been used during the Amazomix survey:

- a bottom trawl 'Rockhopper'(body mesh: 40 mm, cod-end mesh: 25 mm) (Figure 34).
- a micronekton trawl (body mesh: 40 mm, cod-end mesh: 10 mm) (Figure 35).

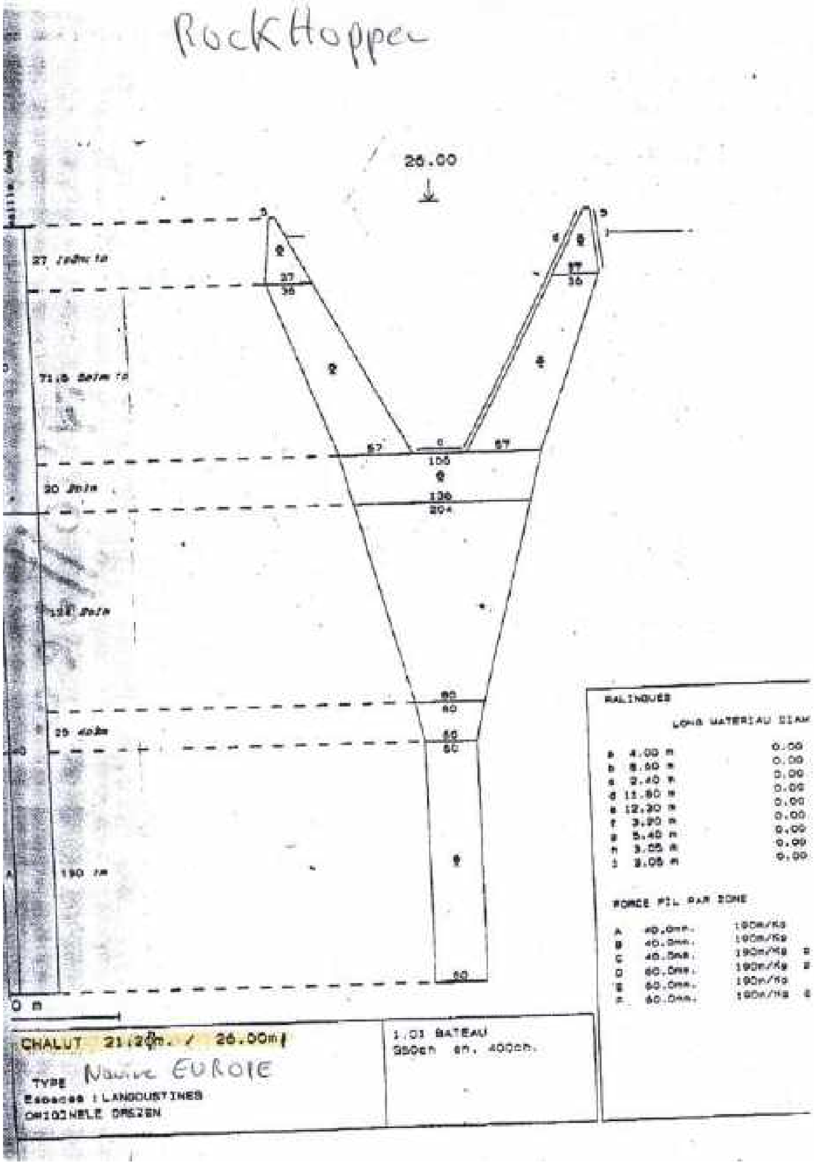

Figure 34. Characteristics of the Rockhopper bottom trawl.

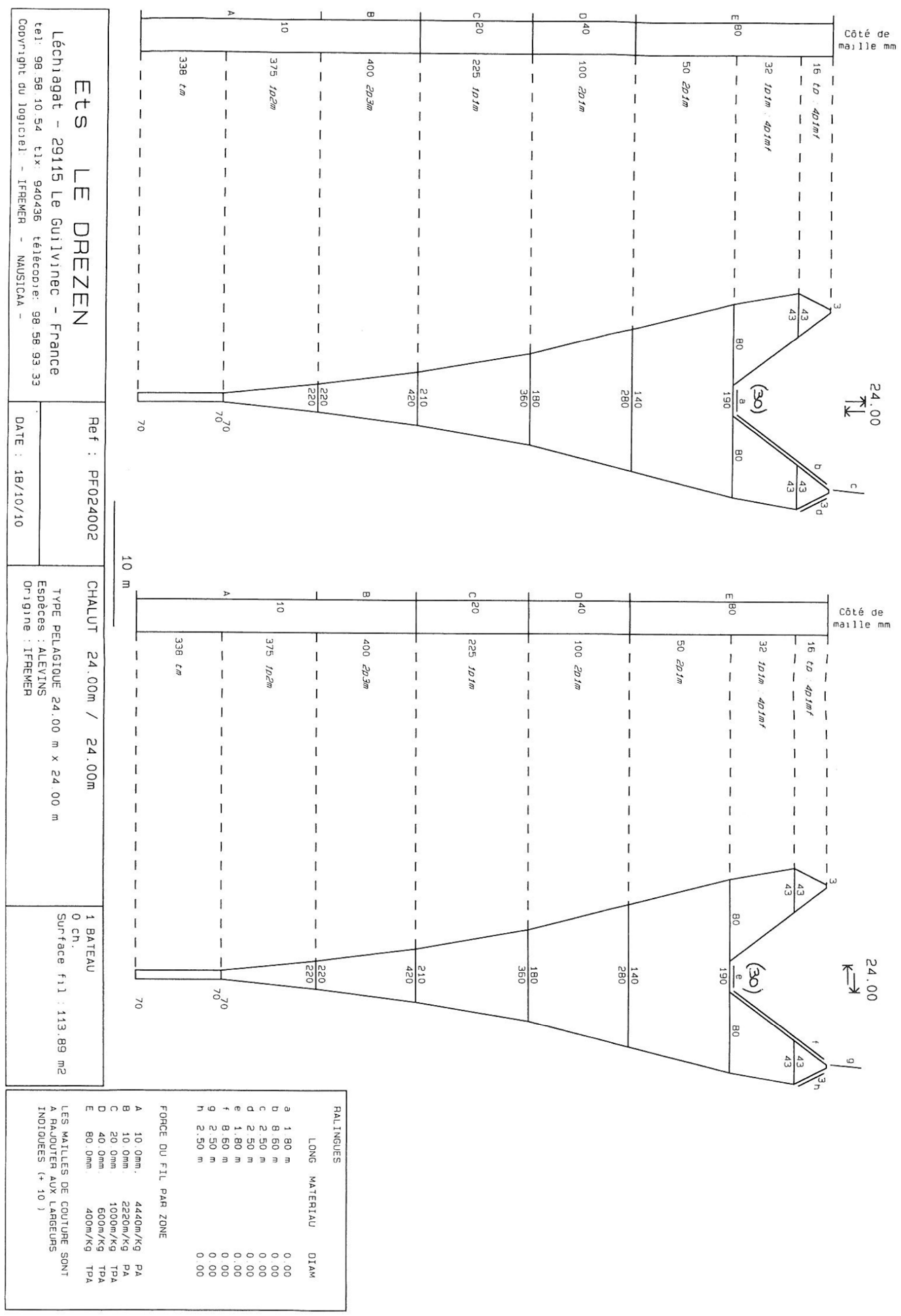

Figure 35. Characteristics of the micronektonic pelagic trawl.

After the capture, organisms were first separated into large groups (e.g., fish, crustaceans, molluscs, gelatinous), more sensible species were immediately kept in refrigerated water to maintain their morphological structures. Organisms captured with the micronekton trawl were maintained in refrigerated water during this operation. In the wet lab, organisms were then identified to the lowest possible taxonomic degree (usually by order or family) according to ad hoc taxonomic literature.
After identification, individuals were weighed and counted, the total length of the largest and smallest individuals was also measured. Individuals of the different species/groups were photographed with their respective track numbers.

Organisms captured with the bottom and pelagic trawl were fixed for further isotope, genetic and taxonomic (and biological) analyses (Figure 36).

For further isotope analysis, small fish and other groups were stored in plastic packages and subsequently frozen (10 individuals when available). Large fish were individually weighed and measured. Then samples of muscle tissue from the region below the dorsal fin were removed and subsequently frozen, and the specimens were preserved in formaldehyde 4%. Among these individuals (small fish, large fish and other groups), five samples of muscle tissue were doubled for genetic analysis and kept frozen.

For taxonomy, small fish and other groups were frozen. When molluscs and crustaceans were very abundant a subsample was sorted and frozen. For large fish, when available, around 30 individuals of different size classes were preserved in formaldehyde 4%. Sponges were preserved in two different ways: frozen and preserved in alcohol 100% for further chemical and genetic analyses.

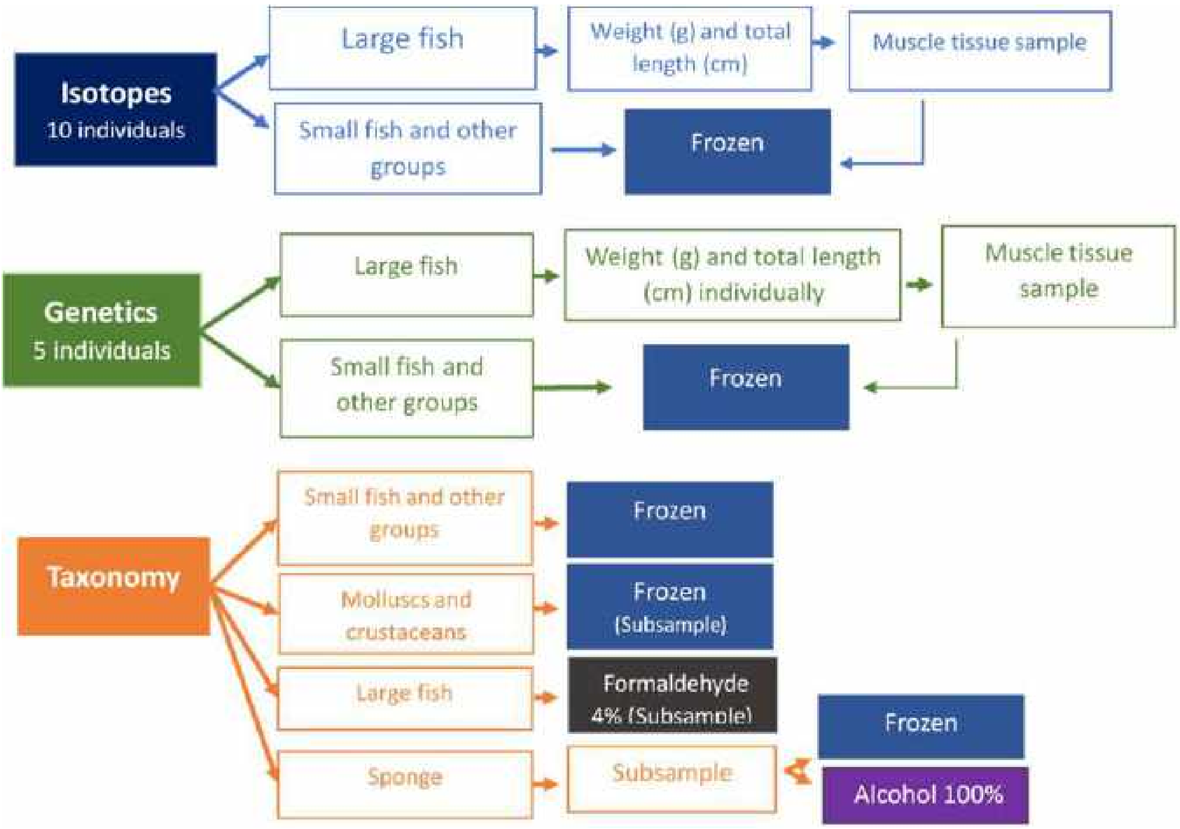

Figure 36. Protocol for organisms captured with the bottom and pelagic trawls.

22.2. Preliminary results

Twenty-four hauls have been performed with the bottom trawl during AMAZOMIX above the continental shelf. A large variety of taxa (>125 since the identification could not be performed at the species level for all taxa) have been captured including fish (93), crustaceans (14), echinoderms (5) and sponges (5) (Figure 38; Figure 37). These catches corresponded to a total of ~1.800 kg of organisms (Figure 39). About 1300 kg of sampled organisms were frozen and 120kg of material was formalized. In addition, more than 350 samples of muscle tissue were stored for isotopes, genetics, and other analyses.

Figure 37. Example of catches from the bottom trawl.

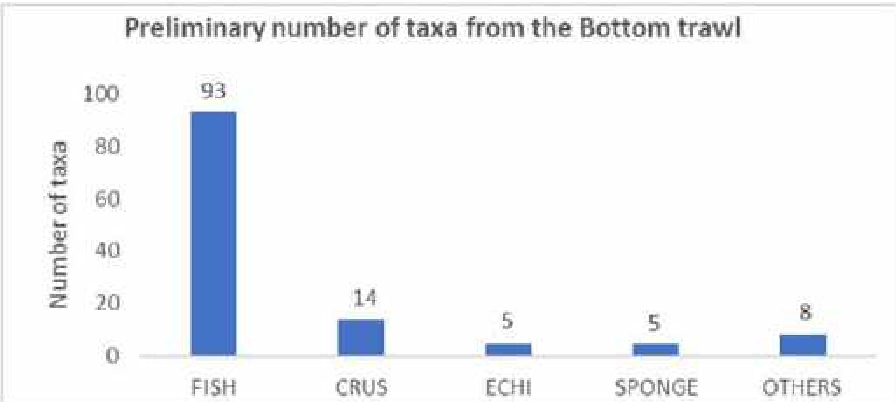

Figure 38. Preliminary number of taxa caught with the bottom trawl.

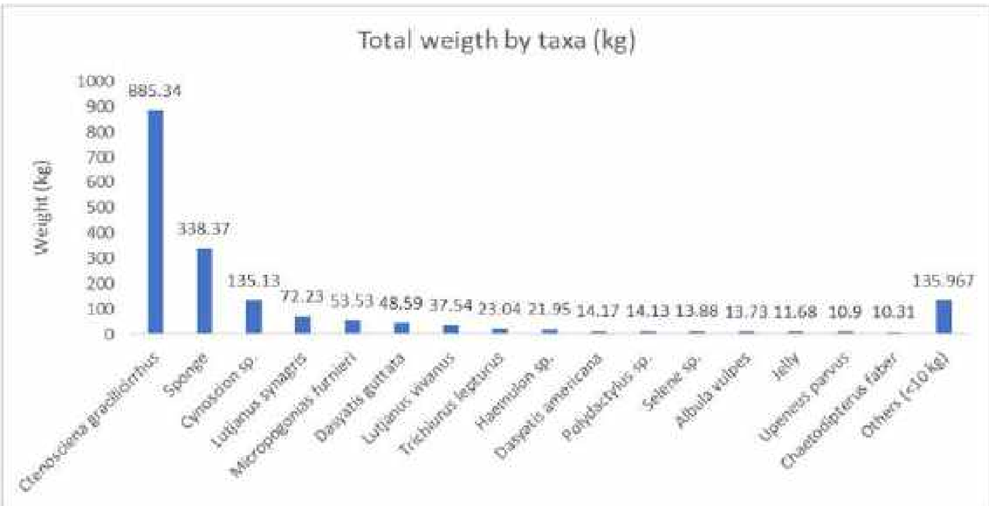

Figure 39. Total weight by taxa caught with the bottom trawl.

In total, 34 hauls have been performed with the Micronekton net between the surface and ~1300 m deep. A Wildlife Computer temperature depth recorder (TDR) was fitted on the trawl to continuously record the depth and temperature along the hauls. The TDR was fitted on the CTDO in Station 25 (1000 m) to be calibrated.

A large variety of taxa (>187 since the identification could not be performed at the species level for all taxa) have been captured (Figure 40; Figure 41) including fish (148), crustaceans (15) or mollusc (12). These catches corresponded to a total of ~100 kg (Figure 42).

Figure 40. Example of catch from the micronektonic trawl.

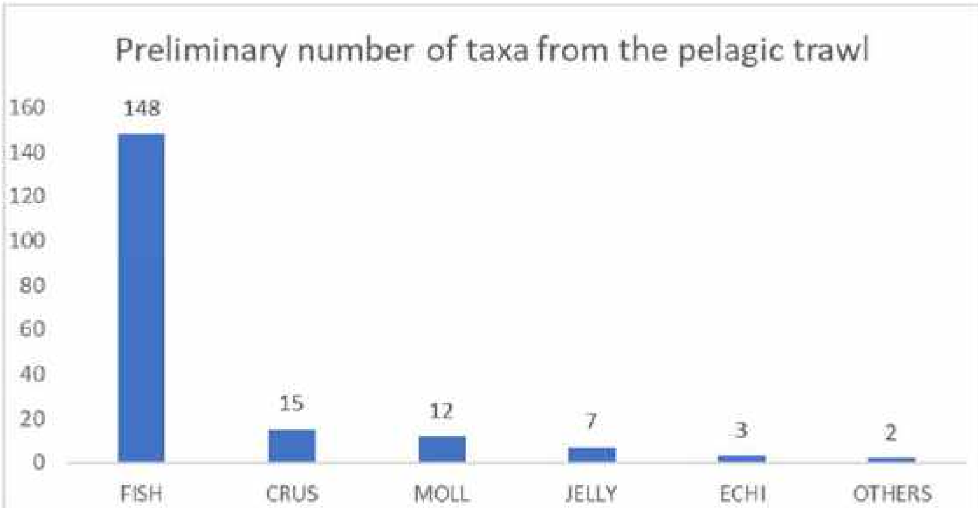

Figure 41. Preliminary number of taxa caught with the micronekton trawl.

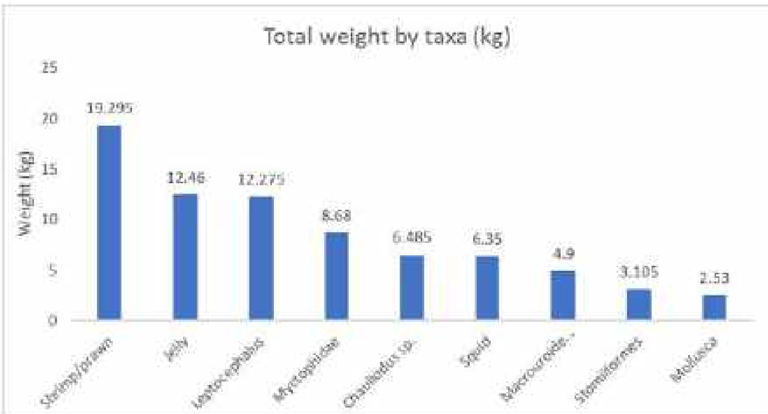

Figure 42. Total weight by taxa caught with the micronekton trawl.

23. Videos

Video cameras (GoPro 5 and 9) have been fitted on the bottom trawl (Figure 43), the optical grape (Figure 44) and the rosette (Figure 45). A total of 20 underwater videos have been recorded. This relatively low number is inherent to the turbidity in shallow water. In addition, a variety of videos recorded the different operations at sea.

Figure 43. Example of image capture from the camera mounted on the bottom trawl.

Figure 44. Example of image capture from the camera mounted on the grape with the observation of gelatinous organisms.

Figure 45. Example of image capture from the camera mounted on the rosette.

24. The team!

We would like to warmly acknowledge the officers and crew of the R/V ANTEA.
They did an amazing job to ensure the success of the AMAZOMIX survey!
You are Amazing!
Merci! Obrigado! Thank you!

Figure 46. Officers and crew of the R/V ANTEA.

Figure 47. The Amazomix team, Leg 1

Figure 48. The Amazomix team, Leg 2.