EUROPEAN COMMISSION
Executive Agency for Small and Medium-sized Enterprises (EASME)

Department A - COSME, H2020 SME and EMFF
Unit A3 - EMFF

Agreement number: EASME/EMFF/2015/1.2.1.1/SI2.709624

Project Full Name: Monitoring the Ocean Climate Change with Argo

European Maritime and Fisheries Fund (EMFF)

MOCCA

D4.2.1 Report on Real-Time processing of the MOCCA fleet

Circulation:	PU: Public
Lead partner:	Euro-Argo ERIC Central Infrastructure
Contributing partners:	BODC, Met Office, Ifremer, BSH, OGS
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Version:	1.0
Reference	D4.2.1 Report on Real-Time processing of the MOCCA fleet_v1.0.docx
Date:	15.12.2017

Euro-Argo ERIC
European Research Infrastructure
(2014/261/EU)

Document History

Version[2]	Issue Date	Stage	Content and Changes
0.1	06.06.2017	Draft	Initial document creation
0.2	08.08.2017	Draft	Revision
0.3	12.12.2017	QC	For internal quality control
1.0	15.12.2017	Final	Final version for submission

[1] As indicated in the "Technical and Scientific description of the Euro-Argo ERIC" July 2013 attached to the Euro-Argo Statutes.
[2] Integers correspond to submitted versions.

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1. INTRODUCTION

This document summarizes the activities on Real-Time (RT) processing of the MOCCA fleet. **Data processing for MOCCA floats is compliant and makes use of the Argo Data System. It is organised through Euro-Argo data centres.**

1.1. Argo Data System Overview

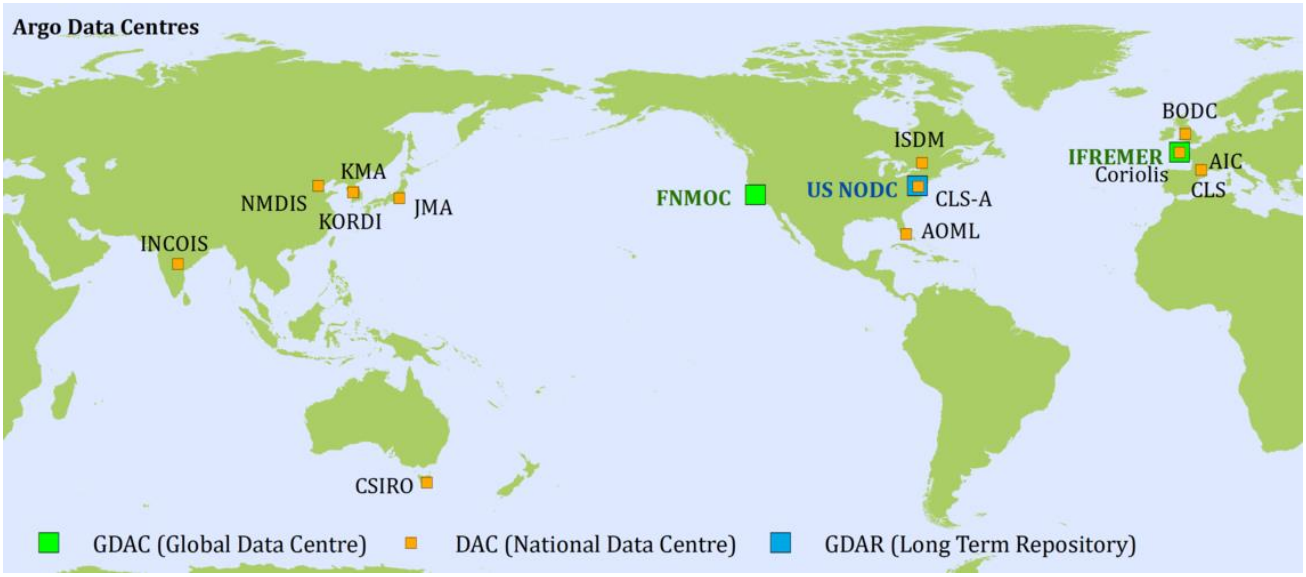

Figure 1: Argo Data System (© Argo Information Center)

The international Argo Data System is based on two Global Data Assembly Centres, a series of 11 national Data Assembly Centres and several Argo Regional Centres. Their functions are summarized below:

- **GDACs** (Global Data Assembly Centres), located at Ifremer/France and FNMOC/USA, are in charge of collecting the processed Argo data from the 11 DACs and to provide users with access to the best version of an Argo profile. Data are available, in a standard NetCDF format both on FTP and WWW. The two GDACs synchronize their database every day.

- **DACs** (Data Assembly Centres), they receive the data from the satellite operators, decode and quality control the data according to a set of 19 real time automatic tests agreed by the international Argo programme. Erroneous data are flagged, corrected where possible and then passed to the two GDACs and to the WMO GTS. The GTS data stream does not presently include quality flags and bad data and grey-listed data are not transmitted on the GTS.

- **ARCs** (Argo Regional Centres) provide wide expertise on specific geographical ocean regions in order to provide the most comprehensive data sets (including non-Argo data) of the highest quality. ARCs provide three main services: act as the delayed mode operator for "orphan" floats (i.e. float deployed by an institute that does not have a capability to perform delayed mode QC); gather the recent complementary in situ ship-based data needed for delayed mode validation; check the overall consistency of the Argo dataset in an area.

1.2. Euro-Argo Data Centres

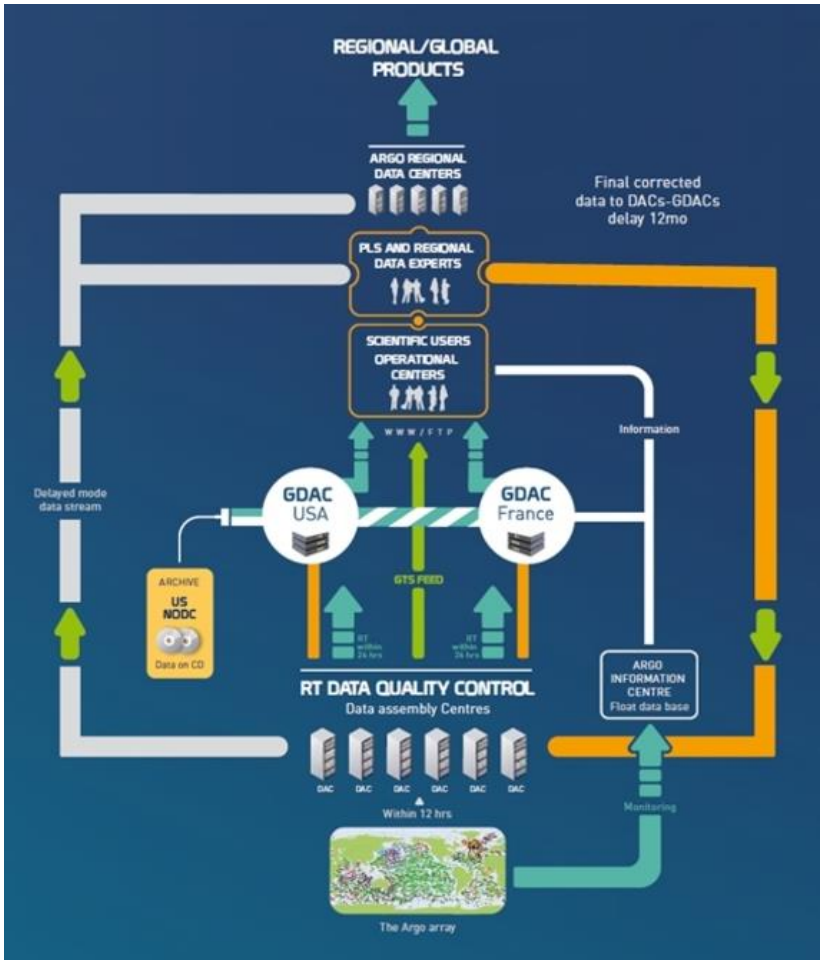

Figure 2: Argo Data Flow (© Argo Information Center)

The Euro-Argo RI plays an active role in Argo data management:

- France **(Ifremer) hosts one of the two Global Data Assembly Centres (GDAC)**
- **Two DACs are operated by France (Coriolis) and UK (BODC)**:
    - The French DAC: The French Argo Data Assembly Centre, Coriolis, which is located within Ifremer-Brest and operated by Ifremer with support of SHOM, processes float data deployed by France and from other European (Germany, Spain, Netherlands, Norway, Italy, Finland, Greece, Bulgaria) and several non-European countries (e.g. Chile, Mexico).
    - The UK DAC: The UK Argo Data Assembly Centre, which is established at BODC, processes all UK, Irish and Mauritian float data.
- Euro-Argo partners lead and contribute to three ARCs:
    - Atlantic ARC (NA-ARC): France has taken the lead in establishing the NA-ARC, which is a collaborative effort between Germany (IFM-HH, BSH), Spain (IEO), Italy (OGS), Netherlands (KNMI), UK (NOCS, UKHO), Ireland (IMR), Norway (IMR), Canada (DFO), and USA (AOML). Within the NA-ARC BSH and Hamburg University coordinate the activities in the Nordic Seas.

- Mediterranean and Black Seas ARC (Med-ARC): Italy (OGS) has taken the lead in establishing the MED-ARC, which is a collaborative effort between Greece (HCMR), Spain (IEO), France (IFREMER, UPMC/LOV), Bulgaria (IOBAS, USOF).

- Southern Ocean ARC (SOARC): UK has taken the lead in establishing the SOARC. This is a collaborative effort between BODC, CSIRO (Australia), BSH (Germany) and a representative from the SOCCOM project partners (USA).

1.3. Real-Time and Delayed-Mode processing

RT processing is carried out by DACs. Procedures flag the gross errors in the data but some subtle errors may remain like sensor drift, float trajectory problems etc. Elaborate procedures have been devised, based on statistical methods, and scientific expertise from principal investigators (PIs). The procedures are constantly assessed and updated as necessary. A minimum of 1 year of data is needed before the delayed mode processing can be performed.

2. MOCCA REAL-TIME PROCESSING

As agreed in the project Grant Agreement, MOCCA RT data processing is done by the Euro-Argo DACs (Ifremer/Coriolis, NERC/BODC jointly with the Met Office) and GDAC (Ifremer). **The number of floats is shared equally between BODC and Coriolis (75 floats each).**

BODC is currently (December 2017) processing 49 floats of which 48 were newly deployed floats during this reporting period. In total 1394 profiles were delivered for these floats in this reporting cycle. Auxiliary technical files have been delivered for all 49 floats this year in support of float monitoring. Coriolis is currently processing 72 floats.

Ifremer is also integrating all the MOCCA data into the GDAC and provide user access mode adapted to different mode of use: ftp access allowing data download for operational users, and Web access allowing data visualization, selection and extraction with specific temporal and geographical criteria specified by users.

Real-Time data processing is applied on the MOCCA fleet according the Argo standard procedures. See Argo Data Management (*http://www.argodatamgt.org/*) for further details.

The Real-Time processing phase started in May 2016 with the deployments of first floats. The processing chain developed by Ifremer is available to the Euro-Argo and Argo communities. **Ifremer/Coriolis DAC (Data Assembly Centre) implemented the chain for processing the first floats** in May 2016. In December 2016, the integration of the processing chain at BODC was complete, and **BODC processed their first MOCCA floats**.

Coriolis MOCCA floats data processing chain:
http://dx.doi.org/10.17882/45589

All MOCCA data are accessible through the Argo Global Data Centre: *ftp://ftp.ifremer.fr/ifremer/argo*
And at *http://www.ifremer.fr/argoMonitoring/floatMonitoring/632*

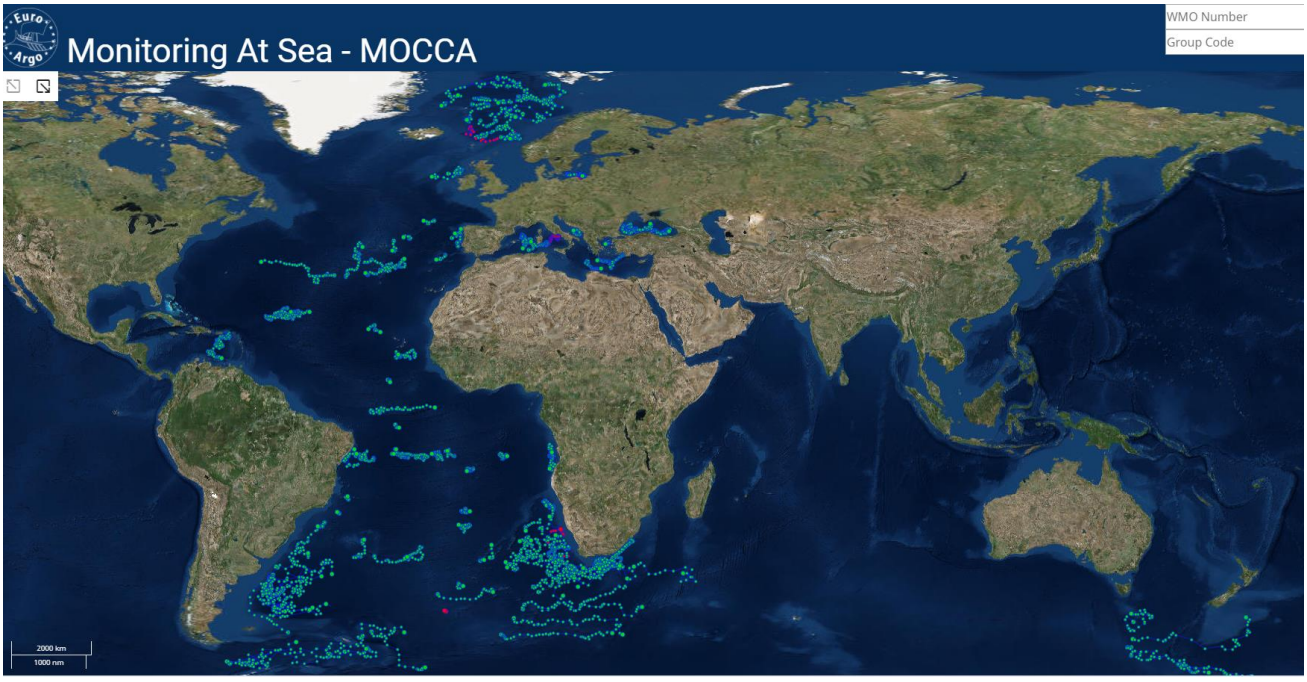

Figure 3: Positions and trajectories for all deployed MOCCA floats

2.1. Workflow

2.1.1. Ifremer/Coriolis

Coriolis internal procedures include:

- Loading of float metadata, including configuration and technical metadata, to Coriolis database for enabling automated data processing;
- Incoming data is saved to a secure archive;
- The MATLAB chain is used to process raw data, generate Argo netCDF files and apply the RTQC tests on the profiles;
- The generated Netcdf files are loaded in Coriolis database and send on the Argo GDAC;
- The Coriolis system manages generation of formats for the WMO GTS;
- Operator can change the flags if any alert is detected by the Objective analysis (run daily) by using Scoop3 software;

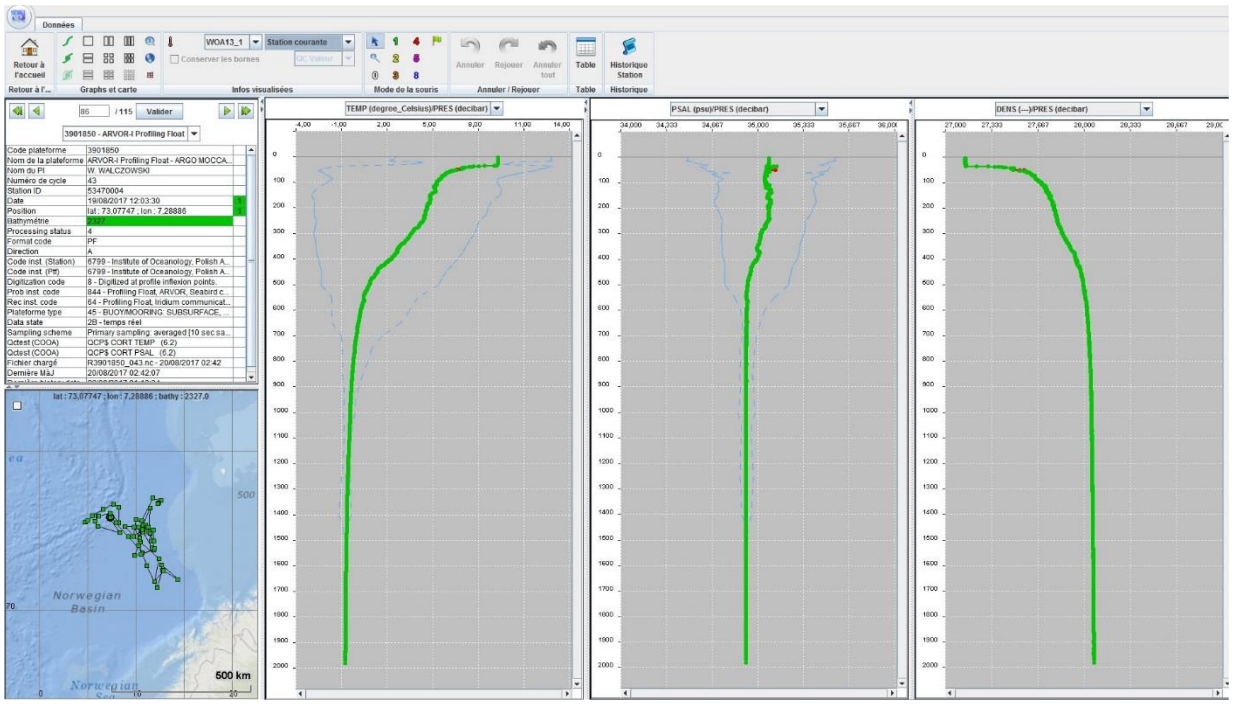

Figure 4: Scoop3 software screenshot

- Daily system monitoring is undertaken by the Coriolis Argo team to identify any processing issues and action undertaken to resolve them when they are encountered.

CO-01-01-02-02	Collecte flotteurs Argos V2 - RT					WARNING 2018-01-12T13:24:06Z
CO-01-01-08-01	Collecte flotteurs Iridium Rudics Apex - RT					OK 2018-01-12T13:50:57Z
CO-01-01-06-02	Collecte flotteurs Iridium SBD V2 - RT					UNDERWAY-LOCKED 2018-01-12T13:25:02Z
CO-01-01-09	Collecte flotteurs Nova					OK 2018-01-12T12:00:33Z
CO-01-01-11-01	Collecte flotteurs Remocean - RT					OK 2018-01-12T13:44:08Z

Figure 5: Ifremer real-time processing dashboard

2.1.2. BODC

BODC internal procedures are pretty similar and include:

- Loading of float metadata, including configuration and technical metadata, to BODC database in advance of float deployment;
- Updating final elements of deployment metadata following deployment enabling automated data processing;
- Incoming data is saved to a secure archive;
- The BODC database is used to automatically generate driver files for automated processing;
- Automated checks are performed to ensure processing is functioning correctly;
- The Coriolis processing stream deployed at BODC is used to process data and generate Argo netCDF files;
- The BODC system manages generation of formats for the WMO GTS;
- The BODC system manages delivery of netCDF files to the GDACs;
- Daily system monitoring is undertaken by the BODC Argo team to identify any processing issues and action undertaken to resolve them when they are encountered.

2.1.3. Example for a MOCCA float

As soon as a float is deployed on a scientific cruise or from a ship of opportunity, essential metadata is gathered by the Euro-Argo ERIC technical team. Then a standardized metadata deployment sheet is filled and sent to one of the DACs (Coriolis or BODC), which is used by the MATLAB processing chain.

	A	B	C	D	E	F	G	H
1		SECTION	DIM LEVEL	KEY	VALUE	DEFAULT VALUE	UNIT	SHORT NAME
2								
3	6	TITLE	1	TITLE	ARVOR			Title of the deployment file
4	6							
5	6	ARGO PROJECT INFORMATION	1	PI_NAME	Romain Cancouët			Name of the Principal Investigator of the float
6	6	ARGO PROJECT INFORMATION	1	PROJECT_NAME	MOCCA-EU			Name of the project which operates the profiling float
7	6	ARGO PROJECT INFORMATION	1	FLOAT_OWNER	Euro-Argo			The owner of the float (may be different from the data centre and operating institution)
8	6	ARGO PROJECT INFORMATION	1	OPERATING_INSTITUTION	Euro-Argo			The operating institution of the float (may be different from the float owner and data
9	6							
10	6	PLATFORM INFORMATION	1	PLATFORM_FAMILY	FLOAT			Category of instrument
11	6	PLATFORM INFORMATION	1	PLATFORM_TYPE	ARVOR			Type of float
12	6	PLATFORM INFORMATION	1	WMO_INST_TYPE	844			Instrument type from WMO code table 1770
13	6	PLATFORM INFORMATION	1	PLATFORM_MAKER	NKE			Name of the manufacturer
14	6	PLATFORM INFORMATION	1	BATTERY_TYPE	Lithium			Describes the type of battery packs in the float
15	6	PLATFORM INFORMATION	1	BATTERY_PACKS	2WILPA2234			Configuration of battery packs
16	6	PLATFORM INFORMATION	1	ARGOS_PROGRAM	6127			Argos program number
17	6	PLATFORM INFORMATION	1	FLOAT_SAIL_ID	16FR034			Float sail ID
18	6	PLATFORM INFORMATION	1	FLOAT_SERIAL_NUMBER	AL2500-16FR034			Float serial number
19	6	PLATFORM INFORMATION	1	CONTROLLER_BOARD_TYPE_PRIMARY	I535			Describes the type of controller board
20	6	PLATFORM INFORMATION	1	CONTROLLER_BOARD_SERIAL_NO_PRIMARY	C142455-0115			The serial number for the primary controller board
21	6	PLATFORM INFORMATION	1	WMO_NUMBER	3901936			Float WMO number
22	6	PLATFORM INFORMATION	1	ID_ARGOS	163468			Float Argos Id (decimal)
23	6	PLATFORM INFORMATION	1	BLUETOOTH_NUMBER	2015 09 115			Float bluetooth number
24	6	PLATFORM INFORMATION	1	FIRMWARE_VERSION	5605804			Float firmware version
25	6	PLATFORM INFORMATION	1	STANDARD_FORMAT_ID	102003			Standardised format number as described in the online reference table:
26	6	PLATFORM INFORMATION	1	MANUAL_VERSION	33-16-026			Float manual version date or number
27	6	PLATFORM INFORMATION	1	FIRMWARE_CHECKSUM	DDDF			Firmware checksum (copy of PRE_DEPLOY_FIRMWARE_CHECKSUM parameter value)
28	6	PLATFORM INFORMATION	1	CORIOLIS_DECODER_VERSION	4.52			Coriolis decoder version
29	6							
30	6	DEPLOYMENT CHECKS	1	DEPLOY_VISUAL_CHECK	OK			Comment after visual inspection of the float
31	6	DEPLOYMENT CHECKS	1	DEPLOY_BALLAST_CHECK	OK			Comment after visual inspection of the ballast
32	6	DEPLOYMENT INFORMATION	1	DEPLOY_MISSION	GOUGH			Deployment mission name (cruise name)
33	6	DEPLOYMENT INFORMATION	1	DEPLOY_SHIP	RV Agulhas II			Deployment ship name
34	6	DEPLOYMENT INFORMATION	1	DEPLOY_OPERATOR_NAME	Tahlia Henry			Name of the operator in charge of the deployment
35	6	DEPLOYMENT INFORMATION	1	DEPLOY_PROFILE_DONE	yes			CTD or XBT profile done during deployment (yes/no)
36	6	DEPLOYMENT INFORMATION	1	DEPLOY_MAGNET_REMOVAL_TIME	20/09/2017 08:05:00			Magnet removal time (dd/mm/yyyy hh:mm)
37	6	DEPLOYMENT INFORMATION	1	DEPLOY_FLOAT_INTERNAL_CHECK	OK			Comment on float internal checks (valve and pump actions, argos transmission check)
38	6	DEPLOYMENT INFORMATION	1	DEPLOY_TIME	20/09/2017 08:20:00			Deployment time (dd/mm/yyyy hh:mm)
39	6	DEPLOYMENT INFORMATION	1	DEPLOY_LATITUDE	47300			Deployment latitude (dd*mm,mm N/S or dd*mm'ss" N/S)
40	6	DEPLOYMENT INFORMATION	1	DEPLOY_LONGITUDE	13*0 W			Deployment longitude (ddd*mm,mm E/W or ddd*mm'ss" E/W)
41	6	DEPLOYMENT INFORMATION	1	DEPLOY_BUOYANCY	OK			Buoyancy description
42	6	DEPLOYMENT INFORMATION	1	DEPLOY_METHOD	By hand			Deployment method (release box, manual, expendable cardboard, etc...)
43	6	DEPLOYMENT INFORMATION	1	DEPLOY_HEIGHT	1			Deployment height (m)
44	6	DEPLOYMENT INFORMATION	1	DEPLOY_SHIP_SPEED	2.5			Ship speed (kts)
45	6	DEPLOYMENT INFORMATION	1	DEPLOY_WIND_SPEED	7			Wind speed (Beaufort)
46	6	DEPLOYMENT INFORMATION	1	DEPLOY_SEA_STATE	Very rough (4 to 6 m)			Sea state (calm, smooth, slight, moderate, rough, very rough, high, very high, phenomenal)
47	6	DEPLOYMENT INFORMATION	1	DEPLOY_BATHYMETRY	3837			Bathymetry at deployment position (m)
48	6	DEPLOYMENT INFORMATION	1	DEPLOY_NB_DAYS_UNTIL_FIRST_ASCENDING_PROFILE	2			Number of days until the first ascending profile (copy of the PM2 parameter value)
49	6	DEPLOYMENT INFORMATION	1	DEPLOY_COMMENT	Deployed on a CTD station which was a calibration cast for a			Miscellaneous comment on the deployment
50	6				VALIDATION			
51	6	SENSOR INFORMATION	1	SENSOR	CTD_PRES			Sensor name
52	6	SENSOR INFORMATION	1	SENSOR_MAKER	SBE			Sensor manufacturer
53	6	SENSOR INFORMATION	1	SENSOR_MODEL	SBE41CP			Sensor model
54	6	SENSOR INFORMATION	1	SENSOR_SERIAL_NUMBER	8503			Sensor serial number
55	6	SENSOR INFORMATION	2	SENSOR	CTD_TEMP			Sensor name
56	6	SENSOR INFORMATION	2	SENSOR_MAKER	SBE			Sensor manufacturer

Figure 6: Example of a MOCCA deployment sheet

Then the DAC processes all the incoming float data (SBD files, received from a generic email address) within a few hours after float transmission. The decoding chain generates standardised netCDF v3.1 files and submit them to the GDAC.

Index de /ifremer/argo/dac/coriolis/3901842

[répertoire parent]

Nom	Taille	Date de modification
3901842_Rtraj.nc	841 kB	04/12/2017 16:02:00
3901842_meta.nc	62.2 kB	04/12/2017 16:02:00
3901842_prof.nc	1.9 MB	04/12/2017 16:48:00
3901842_tech.nc	724 kB	04/12/2017 16:02:00
profiles/		04/12/2017 16:02:00

Figure 7: Example of MOCCA float data on the GDAC repository.

Data from the GDAC is used by operational centres like Copernicus Marine Services. It is freely available for download. Data is also imported into the Coriolis Database host by Ifremer. Each float data is available on a specific webpage.

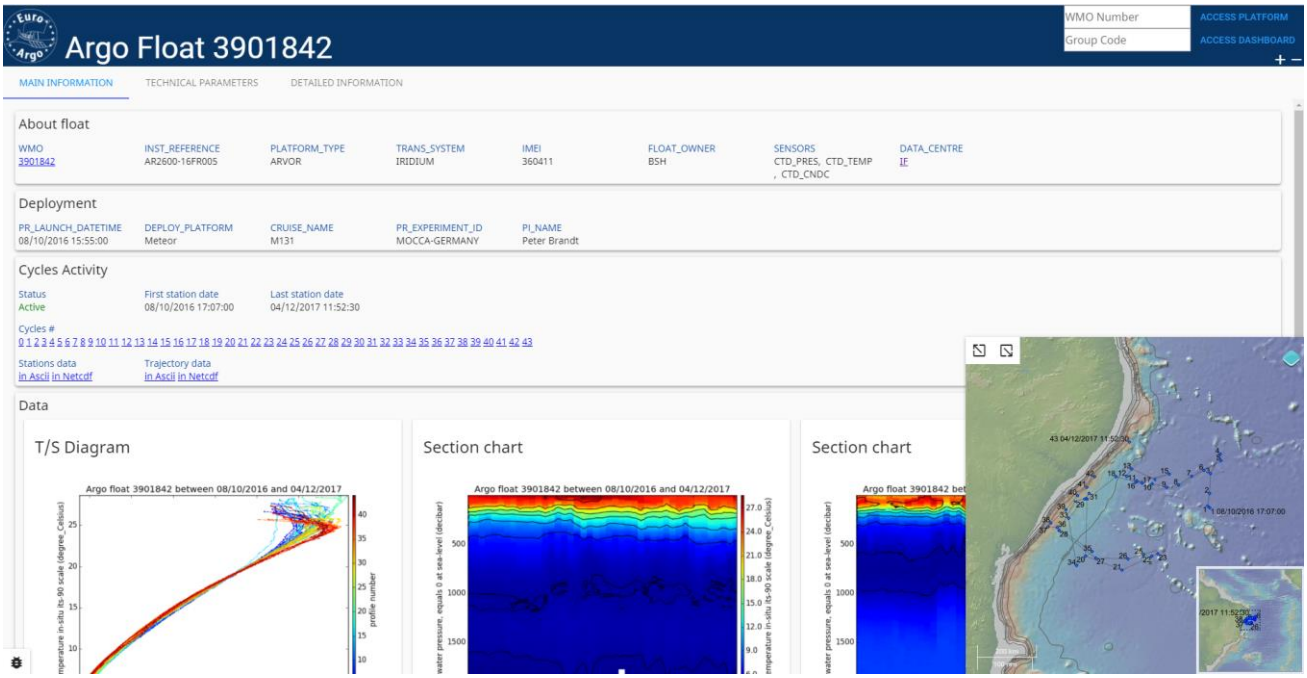

Figure 8: Example of float webpage with metadata, trajectory and oceanographic profiles displayed.
http://www.ifremer.fr/argoMonitoring/float/3901942

2.2. Indicators

To date almost 5000 CTD profiles have been collected by the MOCCA fleet. It is growing to about 500 new profiles each month.

The delay from float completing its upward profile to completion of processing at BODC is monitored within BODC and shows that for the last 3 months BODC achieved a median of 3.1 hrs and a mean of 16.6 hrs, both well within the Argo target of 24 hrs. During the final month of the reporting period BODC have improved delivery such that the median delay remains stable at 3.2 hrs and the mean has significantly improved to just 4.4 hrs.

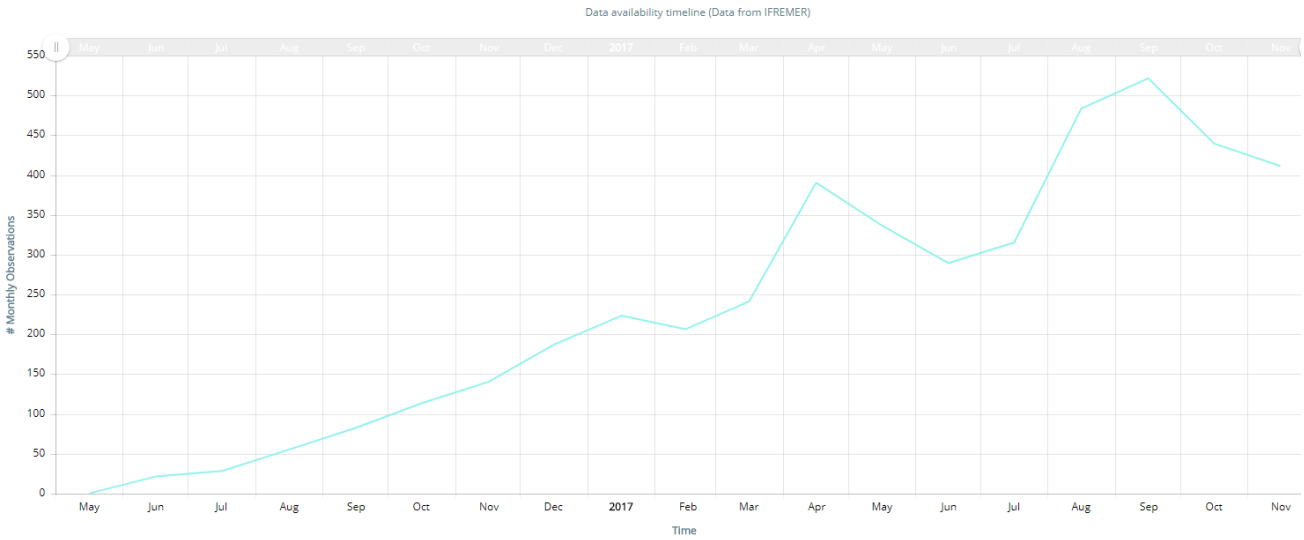

Figure 9: Number of monthly observations by MOCCA floats.

In terms of the current partition of float real-time processing, Coriolis accounts for about 2/3 and BODC about 1/3. This is expected due to the later start of RT processing by the BODC, and it will be balanced in the future as all float deployments are completed.

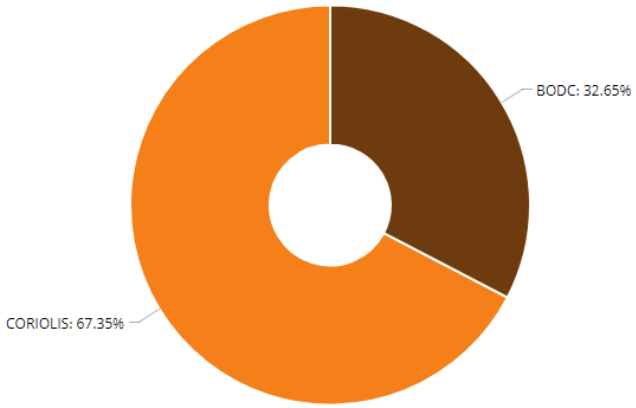

Figure 10: Observations distribution by DAC.

Most importantly, the **median delay between a float observation and its availability on the GDAC is about 3 hours**, much less than the Argo objective of 24 hours.

Figure 11: Median delays between float observations and their availability on the GDAC.

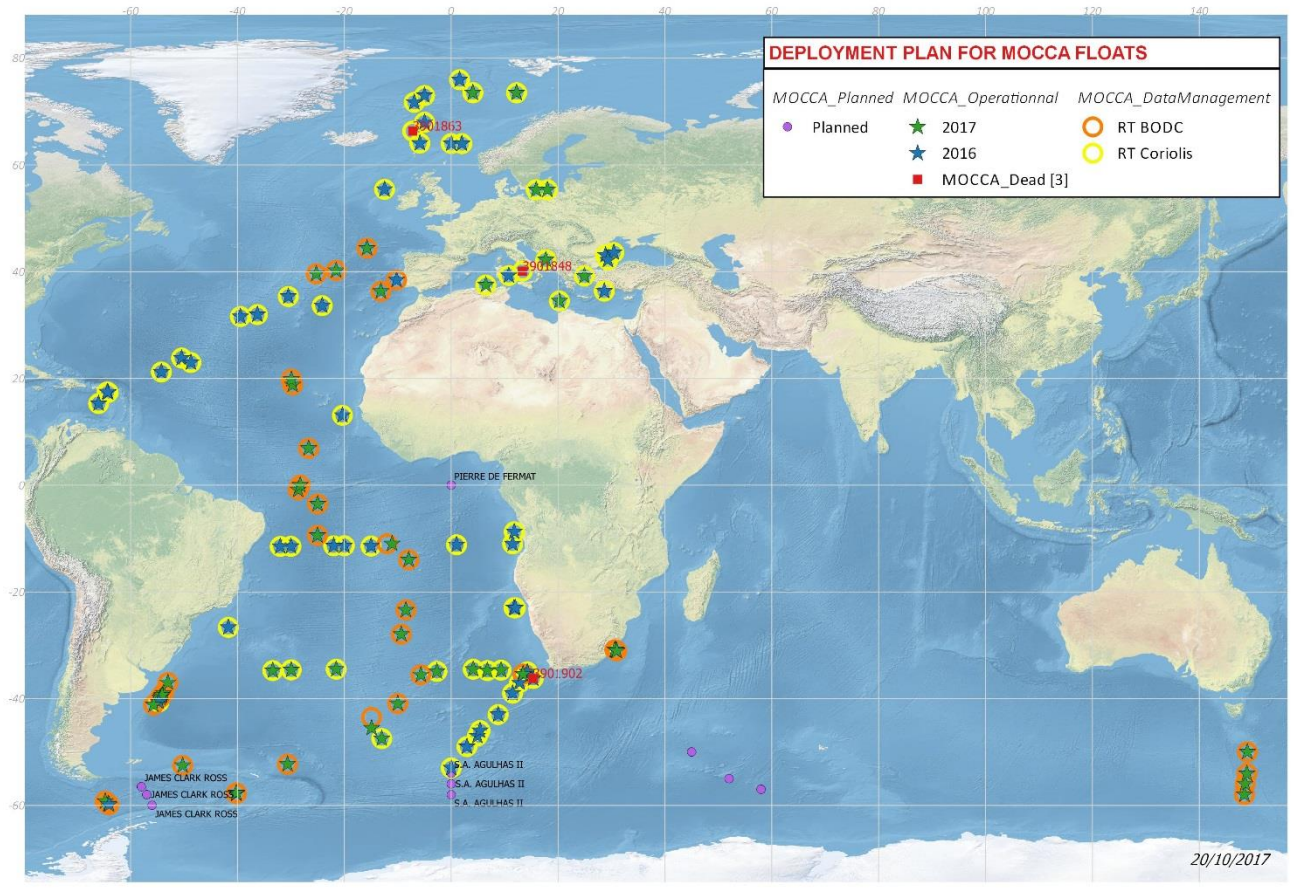

Figure 12: Geographic partition of RT processing by DAC.

2.3. Next steps

Currently 2 float software versions are used for RT processing by the different DACs. With coming and last deployments, a third version will be used but is already handled by the processing chain. No delays are therefore expected.

3. CONCLUSION

Real-Time processing of the MOCCA fleet is well underway. No particular difficulties are anticipated.