Ingesting, validating, long-term storage and access of Flow Cytometery (FCM)

SeaDataCloud

Marseille, from 21 to 22 March 2018

Soumaya LAHBIB

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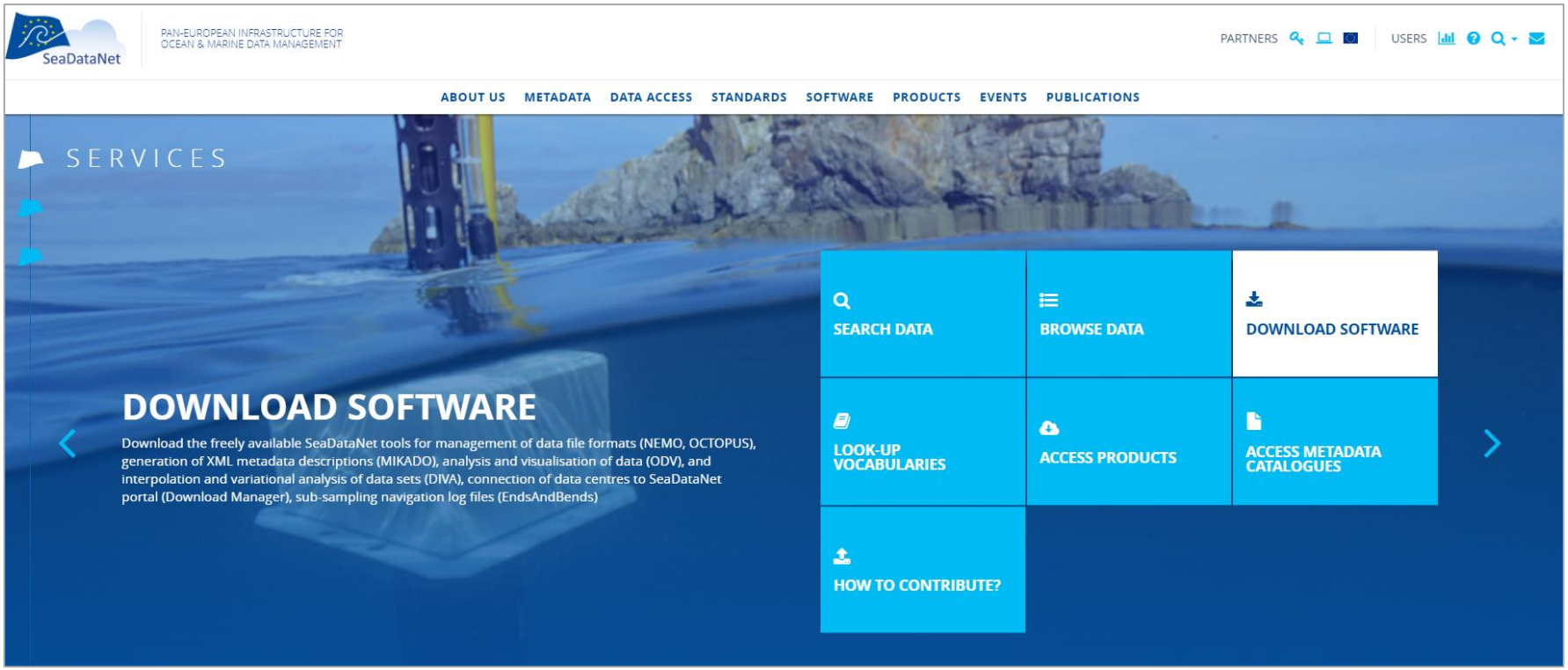
Portal with standards, tools, and services, both for users and data centers

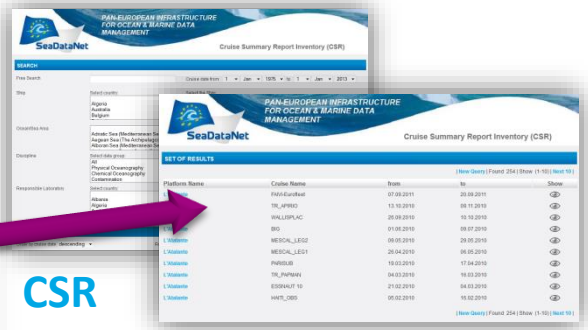


www.seadatanet.org

SeaDataNet metadata directories

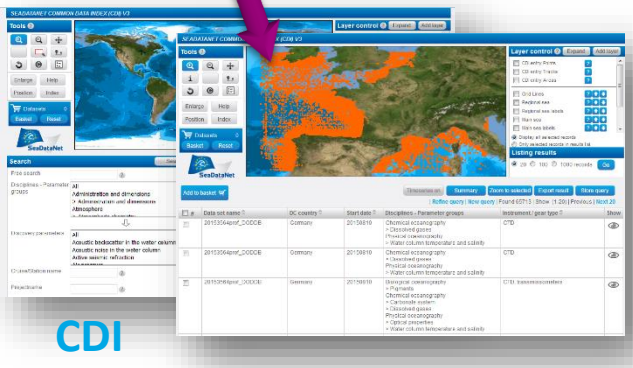
EDMO **Organisations**

EDMERP
Projects

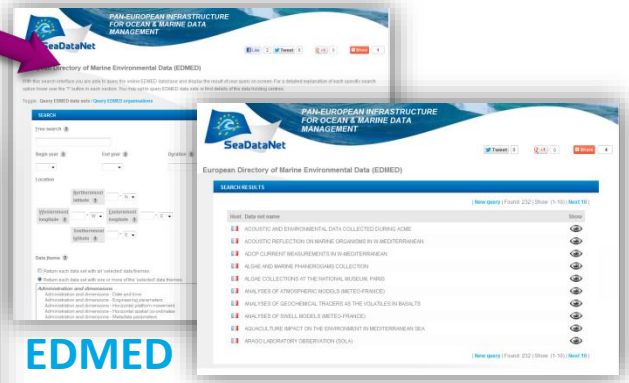


CSR
Research cruises

EDIOS
Observing programmes

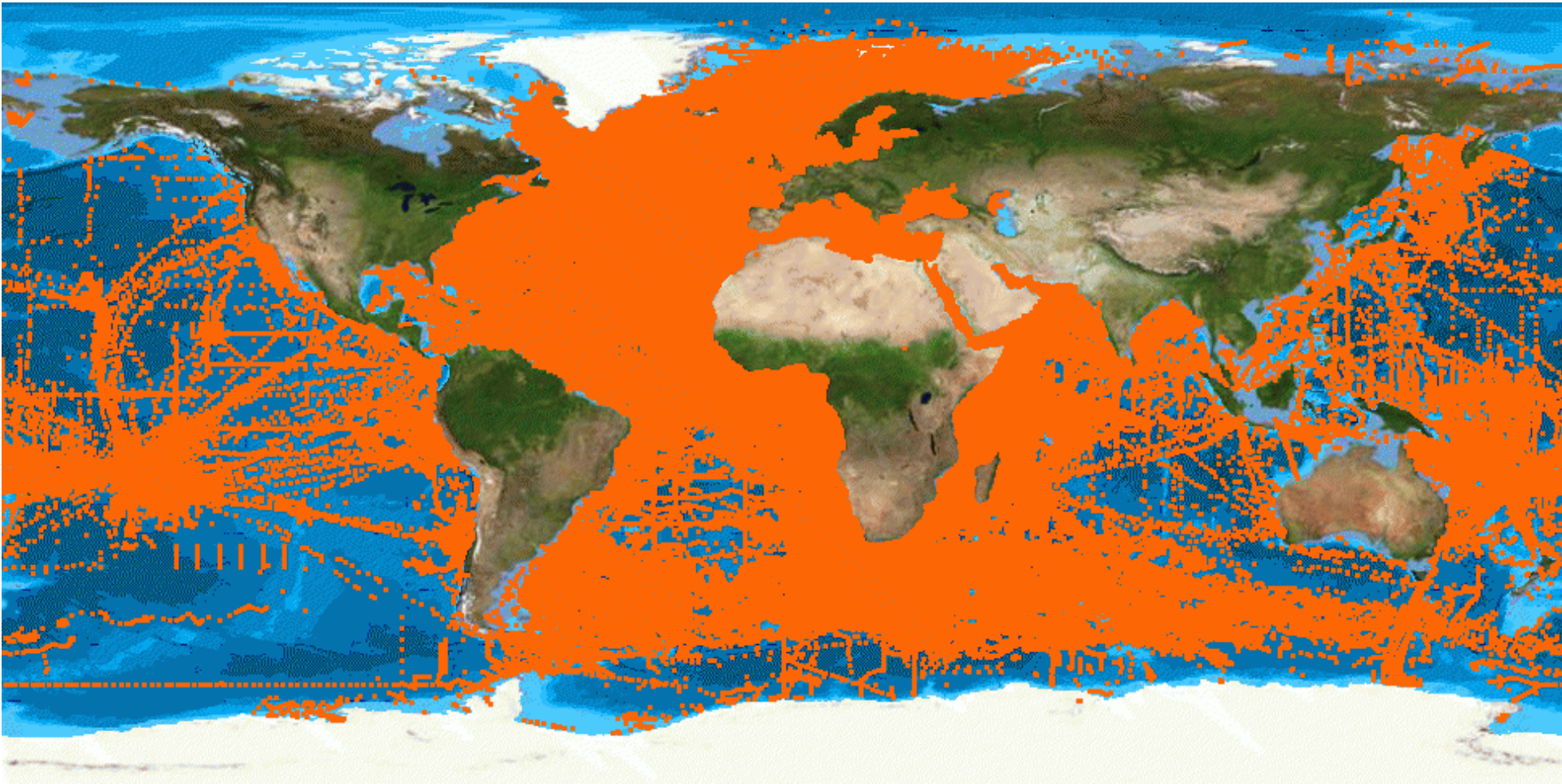


CDI



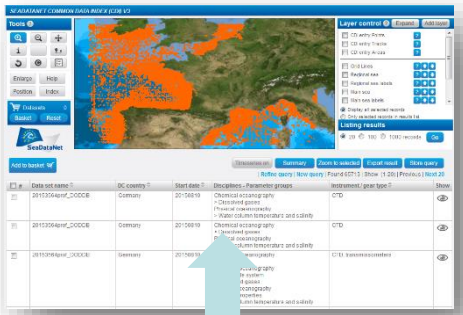
EDMED
Data sets

CDI service for discovery



2.10 million *CDI entries from* ***34*** *countries for physics, chemistry, geology, geophysics, bathymetry and biology; from* ***1805 to 2018****;* ***86%*** *unrestricted or under SDN License*

Aggregated collection



Data discovery and access

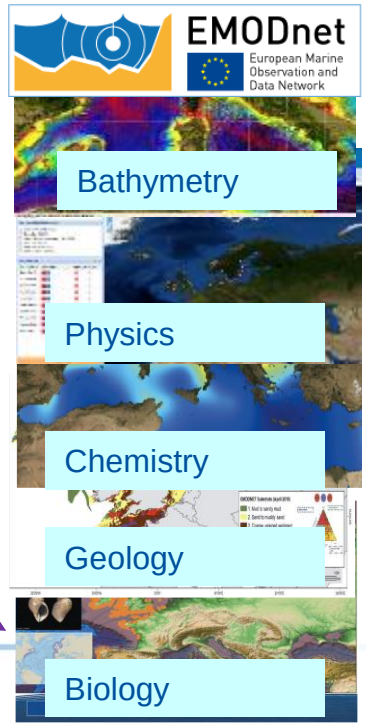
Regional subsets

SeaDataNet

> 110 data centres

NODCs; HOs; GEOs; BIOs; ICES; PANGAEA

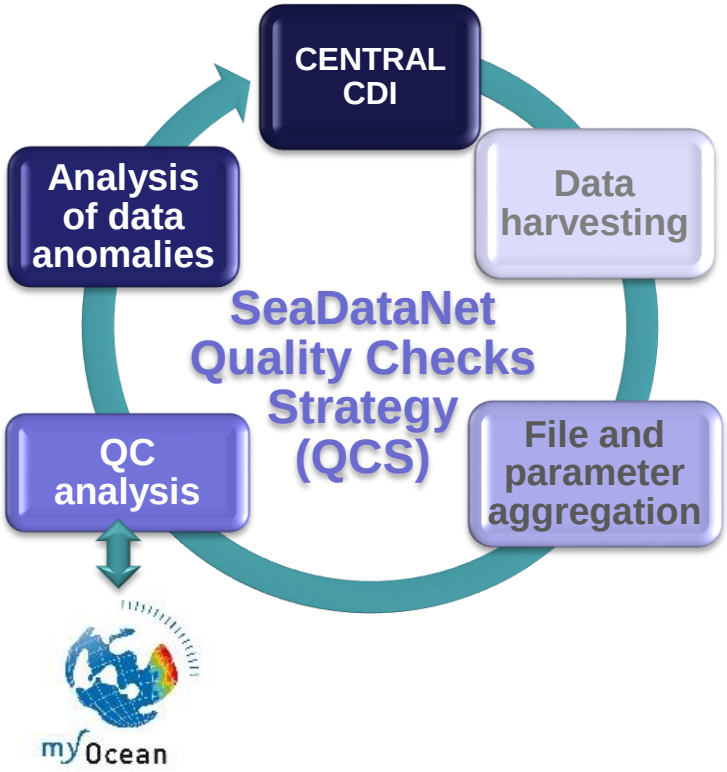
Thematic portals

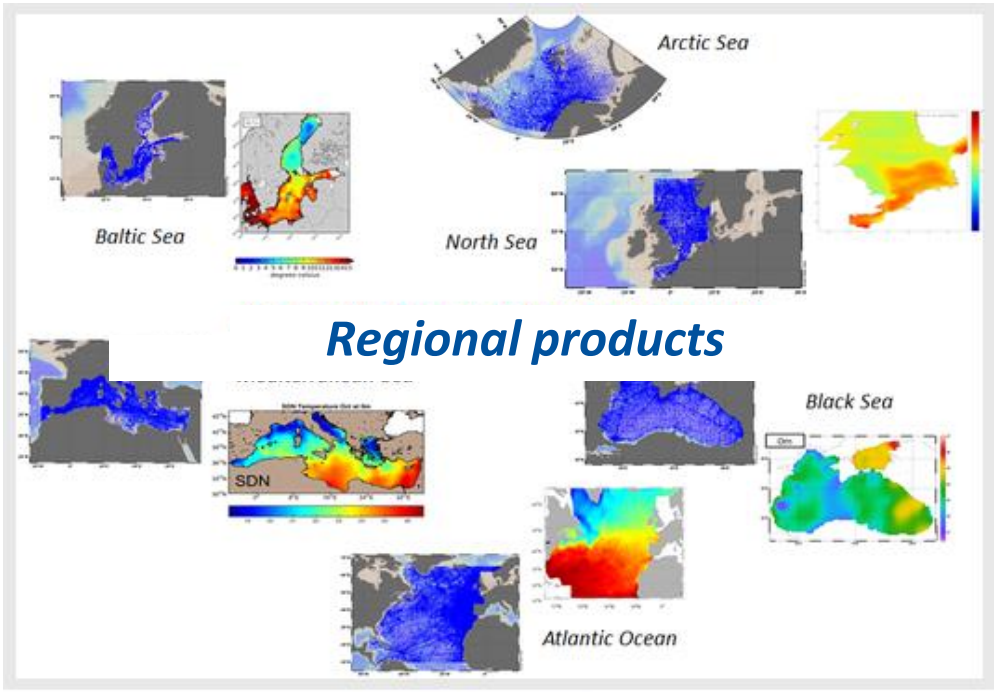


≈ 600 European data originators

CDI Data Discovery and Access service

SeaDataNet products



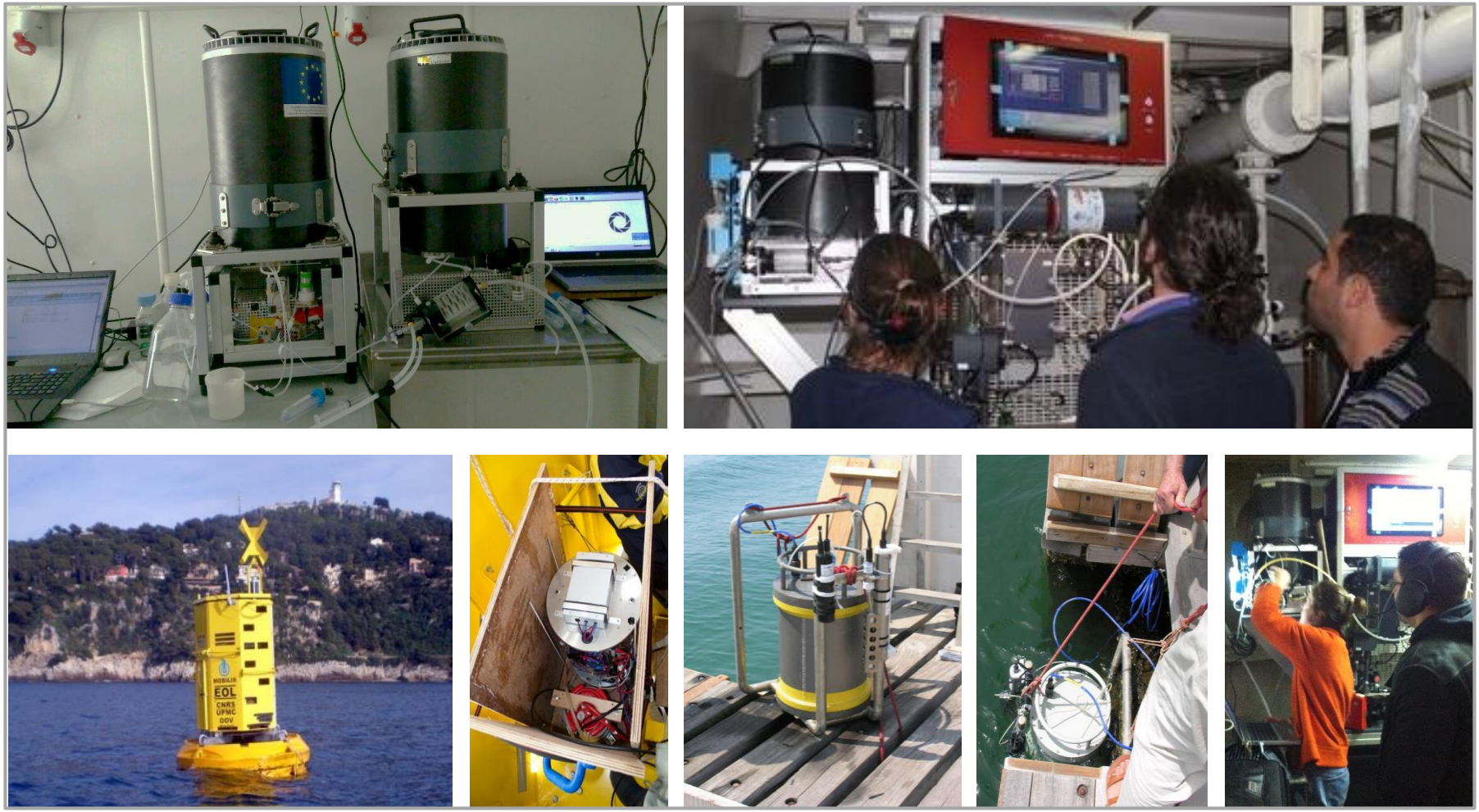


Aggregated datasets and climatologies

Improvement of the data quality

Copernicus Marine Environmental Monitoring Service (**CMEMS**)

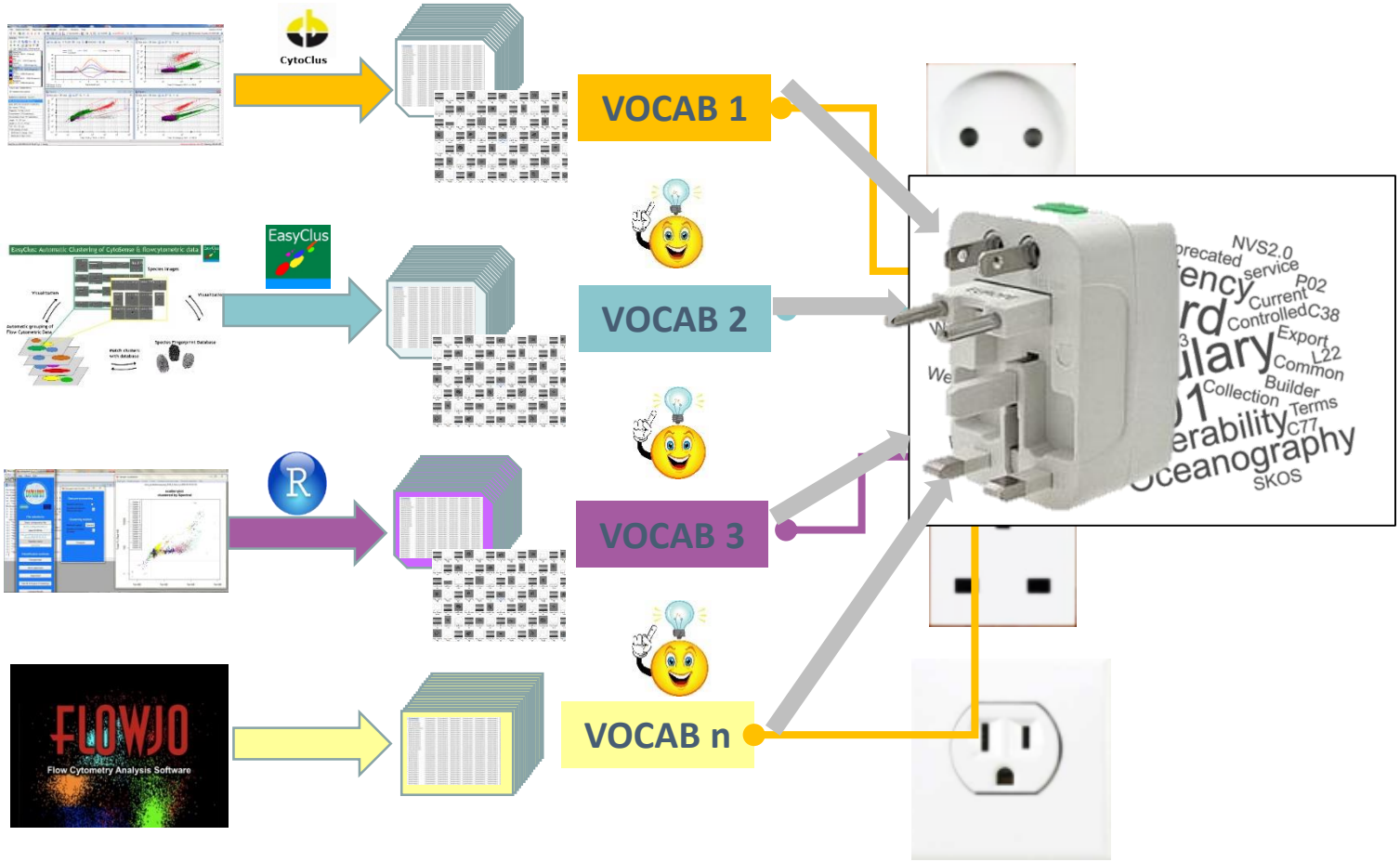
Application to FCM data



FCM Tools

VOCABULARY HETEROGENEITY
(Parameters, Cluster names, Unit, etc.)

COMMON VOCABULARY



FCM Tools

VOCABULARY HETEROGENEITY
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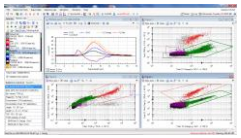
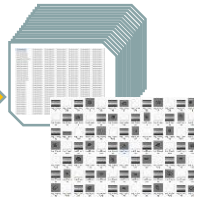
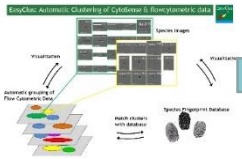


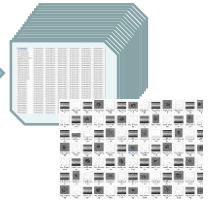
CytoClus



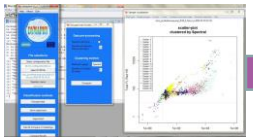
VOCAB 1



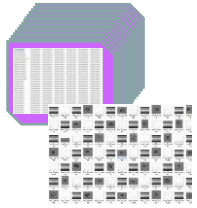
EasyClus



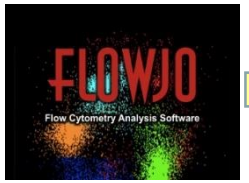
VOCAB 2



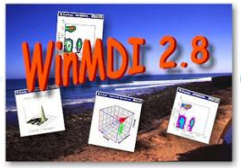
R

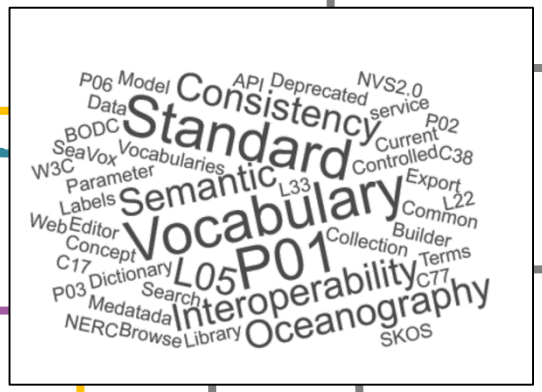


VOCAB 3



VOCAB n





SeaDataNet

EMODnet
European Marine Observation and Data Network

OBIS
OCEAN BIOGEOGRAPHIC INFORMATION SYSTEM

Other ISO Portals

I. FCM Common Vocabulary

1. Analysis of the existing FCM Common vocabulary

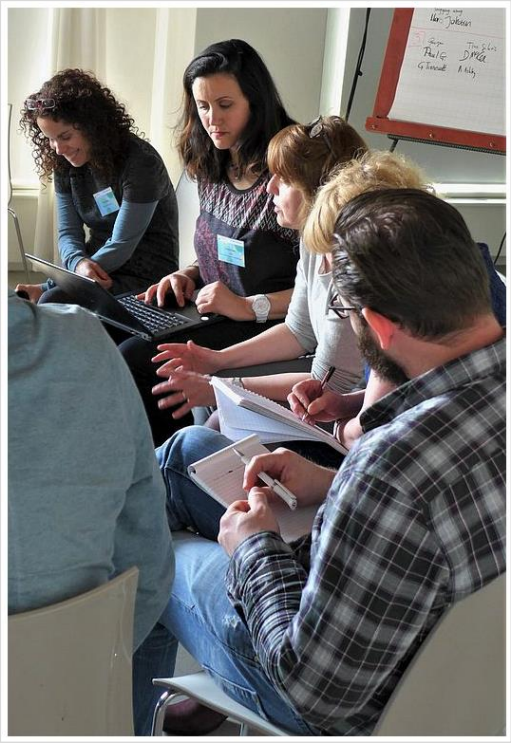
2. Captured parameters (Cefas, MIO, RWS, ULCO and VLIZ)

3. Setting up FCM common vocabulary

4. FCM Questionnaire

1. Analysis of the existing Common vocabulary

Cytobuoy Meeting, March 2017→ Parallel session – Harmonisation of flow cytometry use and data (protocol, standardisation, definition of functional types, quality control)



→ 34 FCM codes existed in the BODC VS

P01 (BODC Parameter Usage Vocabulary) -existing vocabulary for flow cytometry

conceptid	preflabel	modified	altlabel	definition	Deprecate Y/N	FCM Community Feedback
PYPKAFB1	Abundance of Bacteria (ITIS: 202421: WoRMS 6) [Subgroup: group PSB1 autotrophic] per unit volume of the water body by flow cytometry	4/17/2016 15:50:07	Bact_PSB1_auto	Number of particles resolved as photosynthetic bacteria cells from the uncharacterised cluster PSB1 in a unit volume of any body of fresh or salt water determined by flow cytometry analysis of unstained samples.		Prochlorochocus they don't know what it is. It is not clear we need to separate syno and proclo and give definition for each one: difference by size and pigment.
PYPKAFB2	Abundance of Bacteria (ITIS: 202421: WoRMS 6) [Subgroup: group PSB2 autotrophic] per unit volume of the water body by flow cytometry	4/17/2016 15:50:07	Bact_PSB2_auto	Number of particles resolved as photosynthetic bacteria cells from the uncharacterised cluster PSB2 in a unit volume of any body of fresh or salt water determined by flow cytometry analysis of unstained samples.		Synechococcus (1 - 2 um)
P18318A9	Abundance of Bacteria (ITIS: 202421: WoRMS 6) [Subgroup: heterotrophic; high nucleic acid cell content] per unit volume of the water body by flow cytometry	4/17/2016 15:50:07	Abund_BE006316	Number of particles resolved as heterotrophic bacteria cells from the high nucleic acid content cluster (HNA) in a unit volume of any body of fresh or salt water determined by flow cytometry analysis of samples stained with a nucleic acid-specific fluorescent dye, and subtraction of cyanobacteria cell count if present.		Not concerned
ADI07845	Abundance of Dinoflagellates (ITIS: 9873: WoRMS 19542) [Size: <20um Subgroup: autotrophic] per unit volume of the water body by flow cytometry	2/22/2016 14:44:37	ADino<20um_FC	Number of particles <20um identified as most likely small dinoflagellates in a unit volume of any body of fresh or salt water determined by flow cytometry analysis of unstained samples.		How can you define them by FCM??
P200A00Z	Abundance of Dinoflagellates (ITIS: 9873: WoRMS 19542) per unit volume of the water body by flow cytometry	2/18/2016 15:18:01	P200A00Z	This code was updated on 18-feb-2016 so that the name Dinoflagellates is used instead of Pyrrophycophyta in the preferred label field. The vernacular term 'dinoflagellates' maps to Pyrrophycophyta in the ITIS taxonomy and Dinophyceae in the WoRMS taxonomy. In the		not agree and not clear
PU00A02A	Abundance of eukaryote picophytoplankton per unit volume of the water body by flow cytometry	4/17/2016 15:50:07	UndifEuPicoPhytAbund	Number of particles resolved as photosynthetic eukaryote cells in the picoplankton size range in a unit volume of any body of fresh or salt water determined by flow cytometry analysis of unstained samples.		not agree and not clear

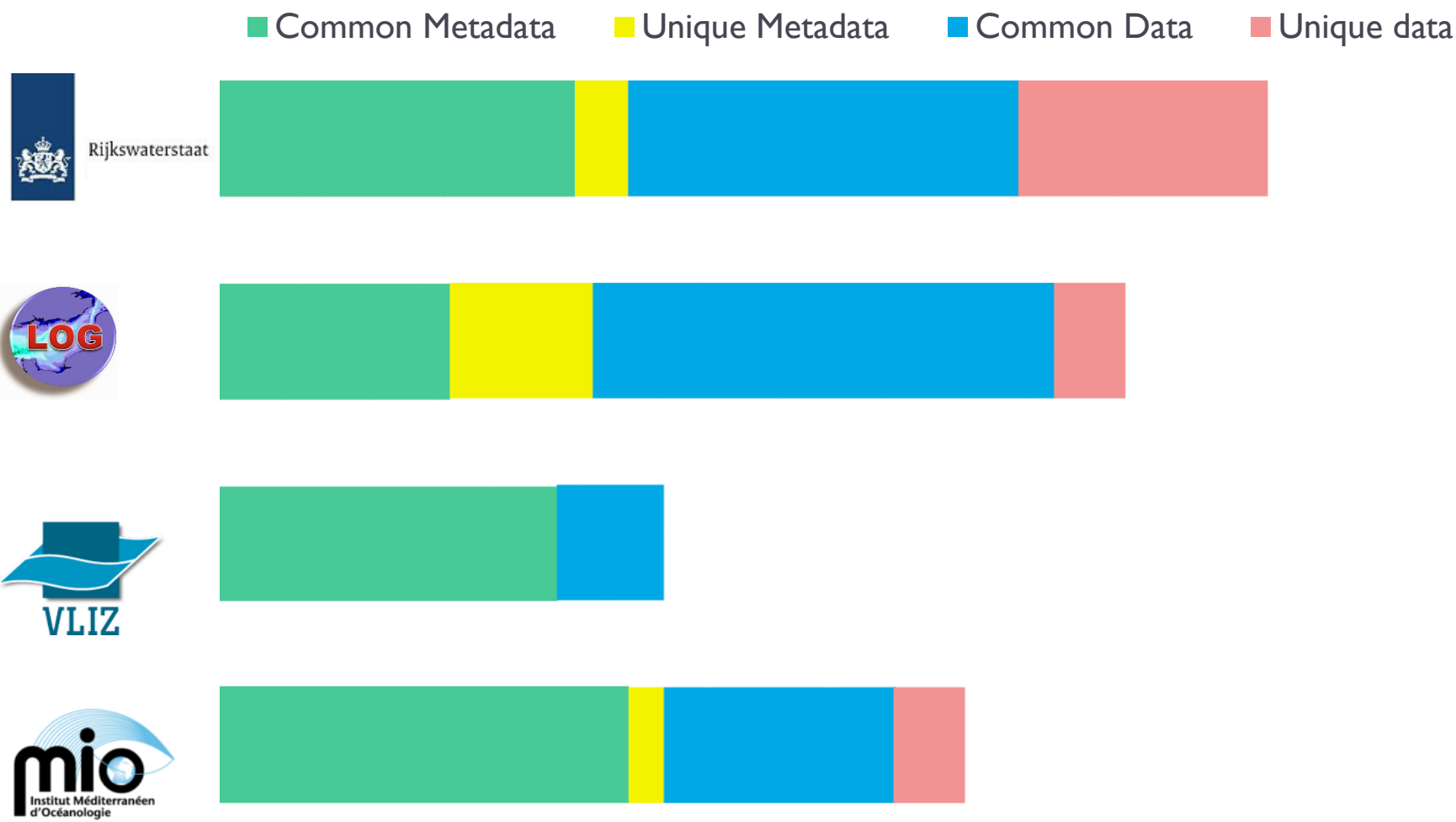
1. Analysis of the existing Common vocabulary

Cytobuoy Meeting, March 2017➔ Parallel session – Harmonisation of flow cytometry use and data (protocol, standardisation, definition of functional types, quality control)

➔ 34 FCM codes existed in the BODC VS

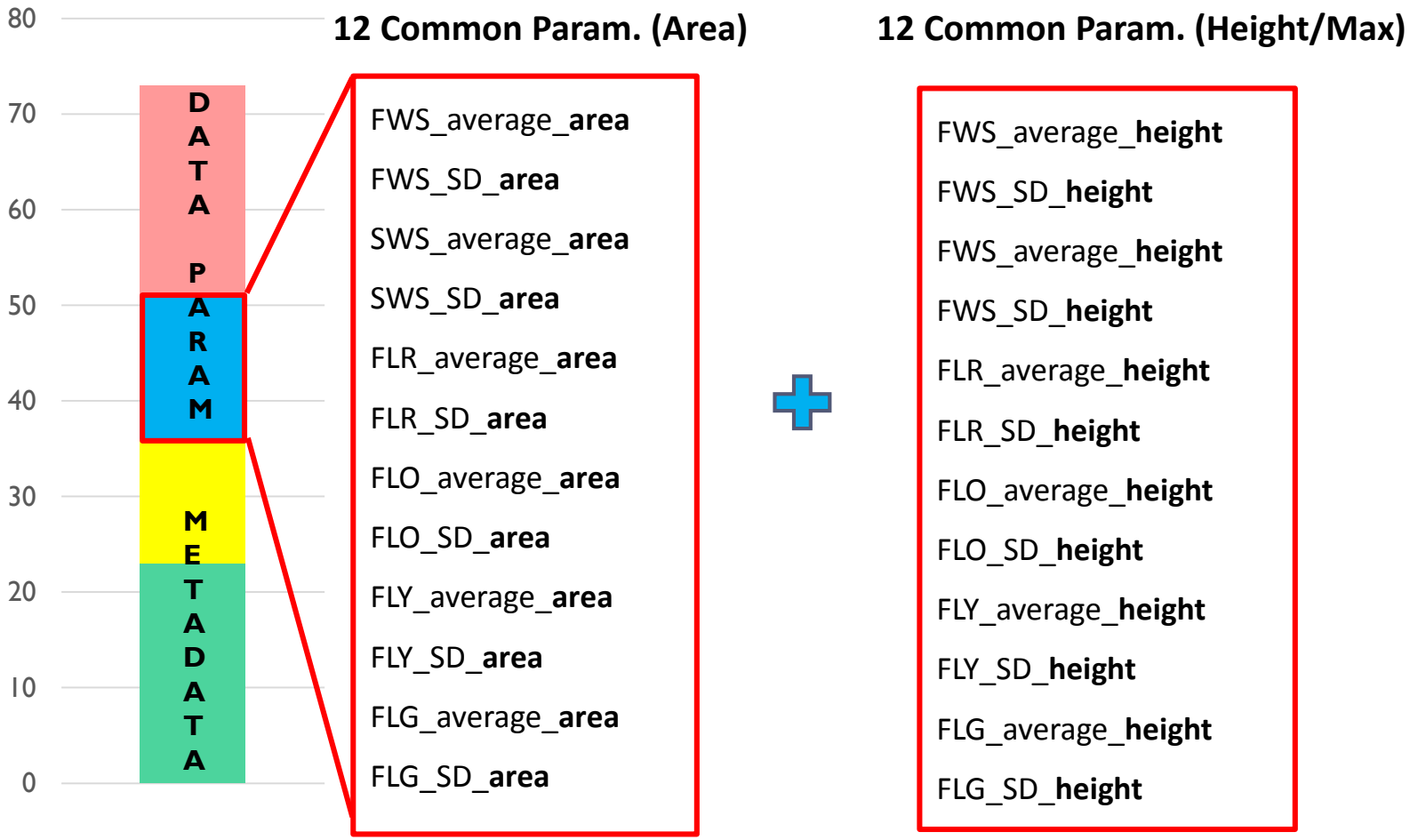
- Some codes are good
- Redundancy
- Definitions are not clear for FCM users and difficult to understand

2. FCM captured parameters



P01 (BODC PARAMETER USAGE VOCABULARY)

→ 24 Captured Common Data paramters sent to BODC



Common Metadata Unique Metadata Common Data Unique data

3. Setting the FCM Standardized Common Vocabulary

- Semantic model (BODC)

Chemical model	Biological model	Physical model
Measurement Substance Measurement matrix relationship Matrix Matrix subcomponent	Measurement Organism Name Organism Specifics Measurement matrix relationship Matrix Matrix subcomponent Method	Measurement Statistical Physical entity Measurement matrix relationship Matrix Method
Concentration of carbon (total inorganic) {TCO2} per unit mass of the water body [dissolved plus reactive particulate phase]	**Abundance** of Bacteria (ITIS: 202421: WoRMS 6) [Subgroup: heterotrophic] per unit volume of the water body by automated flow cytometry	**Area** mean of Forward light scatter pulse per cluster from the water body by flow cytometry

Area

Mean of

Forward light scatter pulse

per cluster from the

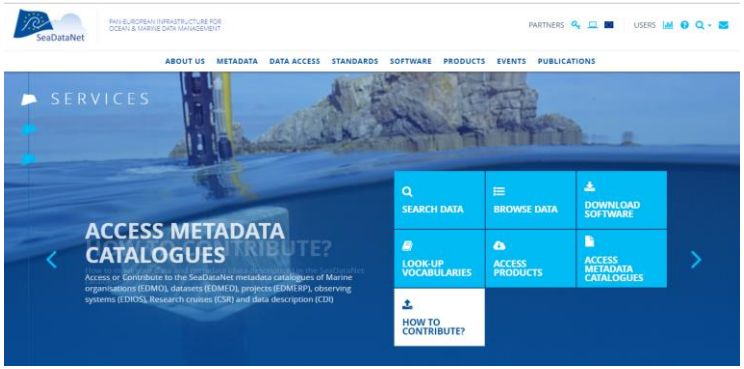
Water body by

flow cytometry

The cluster name is managed in a separate vocabulary list

- FCM Standardized Common Vocabulary

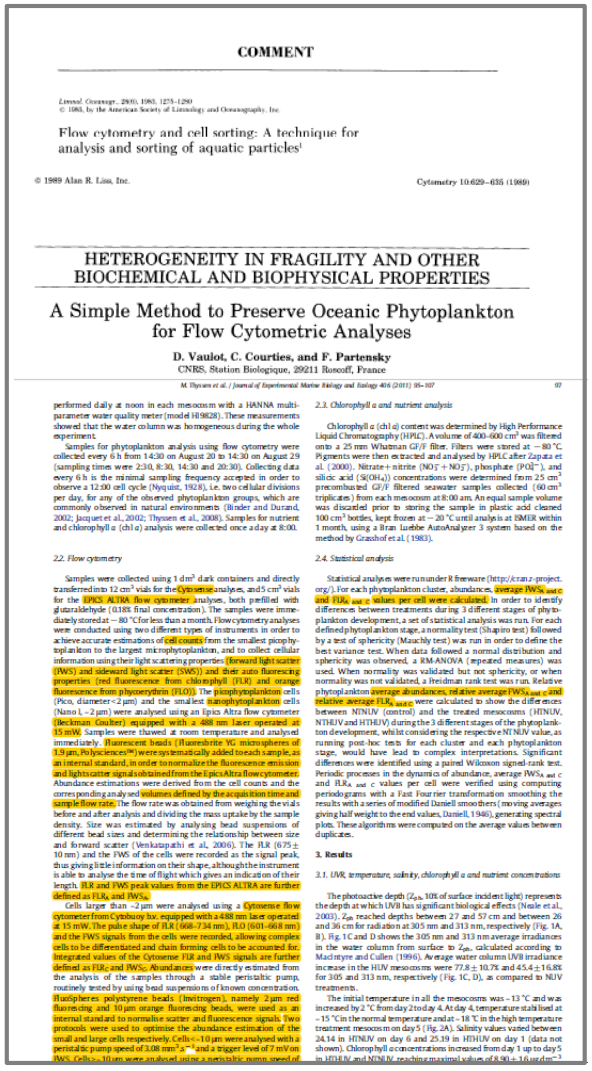
➔ https://www.seadatanet.org/



BODC WEBSERVICES V2 (LIBRARIES) CL12

Library	Thesaurus	Title	Alt Title	Version	Members	Modified
C16		SeaDataNet sea areas	SDN sea areas	9	127	11/7/2012 2:00:06 AM
C17		ICES Platform Codes	ICES Platforms	712	5607	3/20/2018 2:00:05 AM
C19		SeaVoX salt and fresh water body gazetteer	SeaVoX water bodies	17	263	2/21/2018 2:00:03 AM
C32		International Standards Organisation countries	ISO countries	7	251	1/14/2016 2:00:02 AM
C34		Activity purpose categories	Purpose categories	4	22	8/27/2011 3:00:05 AM
C35		European Nature Information System	EUNIS3 Habitats	1	56	2/19/2010 2:01:37 AM
F02		SeaDataCloud Flow Cytometry Standardised Cluster Names	SDC flow cytometry cluster names	2	11	2/3/2018 2:00:02 AM
P01		BODC Parameter Usage Vocabulary	BODC PUV	800	37732	3/14/2018 2:00:03 AM
P02		SeaDataNet Parameter Discovery Vocabulary	SeaDataNet PDV	107	435	2/13/2018 2:00:03 AM
L22		SeaVoX Device Catalogue	SeaVoX Device Catalogue	324	1280	3/6/2018 2:00:04 AM
P06		BODC data storage units	BODC units	99	346	2/16/2018 2:00:02 AM

- Literrature review from 1983 till 2017



COMMENT

Limnol. Oceanogr., 28(6), 1983, 1275–1280
© 1983, by the American Society of Limnology and Oceanography, Inc.

Flow cytometry and cell sorting: A technique for analysis and sorting of aquatic particles[1]

© 1989 Alan R. Liss, Inc. Cytometry 10:629–635 (1989)

HETEROGENEITY IN FRAGILITY AND OTHER BIOCHEMICAL AND BIOPHYSICAL PROPERTIES

A Simple Method to Preserve Oceanic Phytoplankton for Flow Cytometric Analyses

D. Vaulot, C. Courties, and F. Partensky
CNRS, Station Biologique, 29211 Roscoff, France

M. Thyssen et al. / Journal of Experimental Marine Biology and Ecology 406 (2011) 95–107 97

performed daily at noon in each mesocosm with a HANNA multi-parameter water quality meter (model H19828). These measurements showed that the water column was homogeneous during the whole experiment.

Samples for phytoplankton analysis using flow cytometry were collected every 6 h from 14:30 on August 20 to 14:30 on August 29 (sampling times were 2:30, 8:30, 14:30 and 20:30). Collecting data every 6 h is the minimal sampling frequency accepted in order to observe a 12:00 cell cycle (Nyquist, 1928), i.e. two cellular divisions per day, for any of the observed phytoplankton groups, which are commonly observed in natural environments (Binder and Durand, 2002; Jacquet et al., 2002; Thyssen et al., 2008). Samples for nutrient and chlorophyll *a* (chl *a*) analysis were collected once a day at 8:00.

2.2. Flow cytometry

Samples were collected using 1 dm³ dark containers and directly transferred into 12 cm³ vials for the Cytosense analyses, and 5 cm³ vials for the EPICS ALTRA flow cytometer analyses, both prefilled with glutaraldehyde (0.18% final concentration). The samples were immediately stored at −80 °C for less than a month. Flow cytometry analyses were conducted using two different types of instruments in order to achieve accurate estimations of cell counts from the smallest picophytoplankton to the largest microphytoplankton, and to collect cellular information using their light scattering properties (forward light scatter (FWS) and sideward light scatter (SWS)) and their auto fluorescing properties (red fluorescence from chlorophyll (FLR) and orange fluorescence from phycoerythrin (FLO)). The picophytoplankton cells (Pico, diameter <2 μm) and the smallest nanophytoplankton cells (Nano L, ~2 μm) were analysed using an Ipics Altra flow cytometer (Beckman Coulter) equipped with a 488 nm laser operated at 15 mW. Samples were thawed at room temperature and analysed immediately. Fluorescent beads (Fluoresbrite YG microspheres of 1.9 μm, Polysciences™) were systematically added to each sample, as an internal standard, in order to normalize the fluorescence emission and light scatter signal obtained from the Epics Altra flow cytometer. Abundance estimations were derived from the cell counts and the corresponding analysed volumes defined by the acquisition time and sample flow rate. The flow rate was obtained from weighing the vials before and after analysis and dividing the mass uptake by the sample density. Size was estimated by analysing bead suspensions of different bead sizes and determining the relationship between size and forward scatter (Venkatapathi et al., 2006). The FLR (675 ± 10 nm) and the FWS of the cells were recorded as the signal peak, thus giving little information on their shape, although the instrument is able to analyse the time of flight which gives an indication of their length. FLR and FWS peak values from the EPICS ALTRA are further defined as FLR_A and FWS_A.

Cells larger than ~2 μm were analysed using a Cytosense flow cytometer from Cytobuoy bv, equipped with a 488 nm laser operated at 15 mW. The pulse shape of FLR (668–734 nm), FLO (601–668 nm) and the FWS signals from the cells were recorded, allowing complex cells to be differentiated and chain forming cells to be accounted for. Integrated values of the Cytosense FLR and FWS signals are further defined as FLR_C and FWS_C. Abundances were directly estimated from the analysis of the samples through a stable peristaltic pump, routinely tested by using bead suspensions of known concentration. FluoSpheres polystyrene beads (Invitrogen), namely 2 μm red fluorescing and 10 μm orange fluorescing beads, were used as an internal standard to normalise scatter and fluorescence signals. Two protocols were used to optimise the abundance estimation of the small and large cells respectively. Cells<~10 μm were analysed with a peristaltic pump speed of 3.08 $mm^3 s^{-1}$ and a trigger level of 7 mV on FWS. Cells>~10 μm were analysed using a peristaltic pump speed of

2.3. Chlorophyll a and nutrient analysis

Chlorophyll *a* (chl *a*) content was determined by High Performance Liquid Chromatography (HPLC). A volume of 400–600 cm^3 was filtered onto a 25 mm Whatman GF/F filter. Filters were stored at −80 °C. Pigments were then extracted and analysed by HPLC after Zapata et al. (2000). Nitrate+nitrite ($NO_3^- + NO_2^-$), phosphate (PO_4^{3-}), and silicic acid ($Si(OH)_4$) concentrations were determined from 25 cm^3 precombusted GF/F filtered seawater samples collected (60 cm^3 triplicates) from each mesocosm at 8:00 am. An equal sample volume was discarded prior to storing the sample in plastic acid cleaned 100 cm^3 bottles, kept frozen at −20 °C until analysis at ISMER within 1 month, using a Bran Luebbe AutoAnalyzer 3 system based on the method by Grasshof et al. (1983).

2.4. Statistical analysis

Statistical analyses were run under R freeware (http://cran.r-project.org/). For each phytoplankton cluster, abundances, average $FWS_{A\ and\ C}$ and $FLR_{A\ and\ C}$ values per cell were calculated. In order to identify differences between treatments during 3 different stages of phytoplankton development, a set of statistical analysis was run. For each defined phytoplankton stage, a normality test (Shapiro test) followed by a test of sphericity (Mauchly test) was run in order to define the best variance test. When data followed a normal distribution and sphericity was observed, a RM-ANOVA (repeated measures) was used. When normality was validated but not sphericity, or when normality was not validated, a Freidman rank test was run. Relative phytoplankton average abundances, relative average $FWS_{A\ and\ C}$ and relative average $FLR_{A\ and\ C}$ were calculated to show the differences between NTNUV (control) and the treated mesocosms (HTNUV, NTHUV and HTHUV) during the 3 different stages of the phytoplankton development, whilst considering the respective NTNUV value, as running post-hoc tests for each cluster and each phytoplankton stage, would have lead to complex interpretations. Significant differences were identified using a paired Wilcoxon signed-rank test. Periodic processes in the dynamics of abundance, average $FWS_{A\ and\ C}$ and $FLR_{A\ and\ C}$ values per cell were verified using computing periodograms with a Fast Fourier transformation smoothing the results with a series of modified Daniell smoothers (moving averages giving half weight to the end values, Daniell, 1946), generating spectral plots. These algorithms were computed on the average values between duplicates.

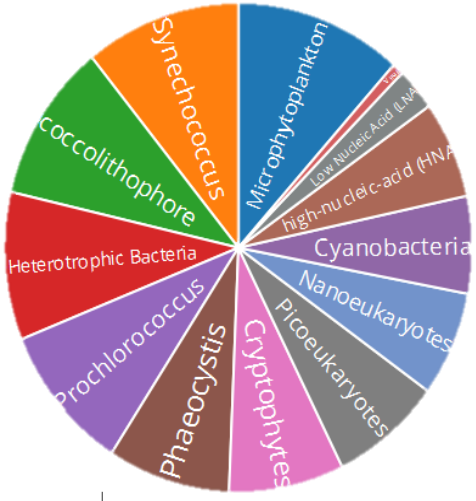
3. Results

3.1. UVR, temperature, salinity, chlorophyll a and nutrient concentrations

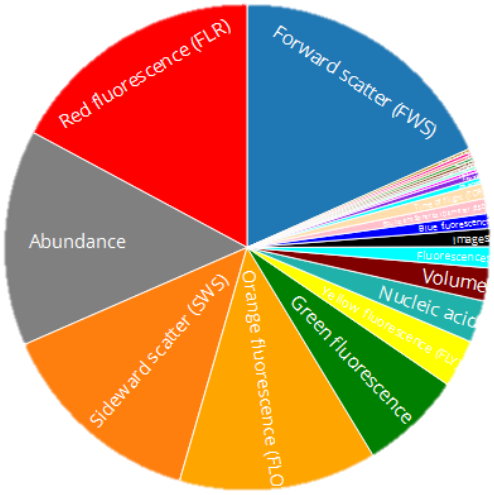
The photoactive depth (Z_{eu}, 10% of surface incident light) represents the depth at which UVB has significant biological effects (Neale et al., 2003). Z_{eu} reached depths between 27 and 57 cm and between 26 and 36 cm for radiation at 305 nm and 313 nm, respectively (Fig. 1A, B). Fig. 1C and D shows the 305 nm and 313 nm average irradiances in the water column from surface to Z_{eu}, calculated according to MacIntyre and Cullen (1996). Average water column UVB irradiance increase in the HUV mesocosms were 77.8 ± 10.7% and 45.4 ± 16.8% for 305 and 313 nm, respectively (Fig. 1C, D), as compared to NUV treatments.

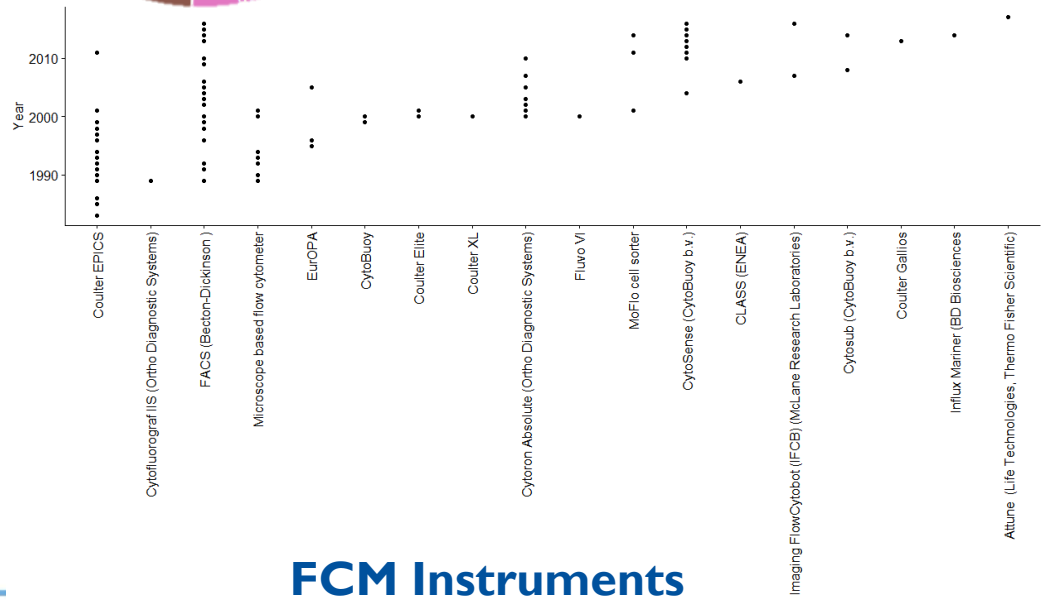
The initial temperature in all the mesocosms was ~13 °C and was increased by 2 °C from day 2 to day 4. At day 4, temperature stabilised at ~15 °C in the normal temperature and at ~18 °C in the high temperature treatment mesocosms on day 5 (Fig. 2A). Salinity values varied between 24.14 in HTNUV on day 6 and 25.19 in HTHUV on day 1 (data not shown). Chlorophyll *a* concentrations increased from day 1 up to day 5 in HTHUV and NTNUV, reaching maximal values of 8.30 ± 1.0 μg L^{-1}

Clusters



Parameters





FCM Instruments

Flow Cytometry vocabulary standardization Questionnaire

This flow cytometry vocabulary standardization questionnaire is dedicated to identify your metadata and data vocabulary that you use during your measurements. it will take approximately 10 to 15 minutes to complete.

This questionnaire is carried out within the framework of JERICO NEXT and SeaDataCloud (H2020 projects) so as to build a common vocabulary in order to standardize, validate and guarantee a long-term storage and access of flow cytometry datasets.

It is divided into four main parts:

- Part I : Group name and definition
- Part II : Flow Cytometer Metadata
- Part III : Sample Metadata
- Part IV : Flow Cytometer Data

There are 56 questions in this survey.

Load unfinished survey | Next ▸ | Exit and clear survey

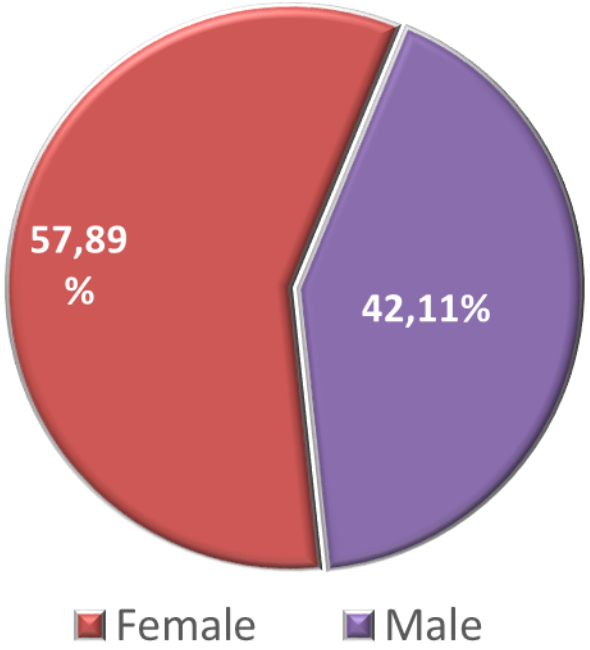
Questionnaire sent to 180 FCM users all around the world

➔ 38 Answers to questionnaire (2 months)

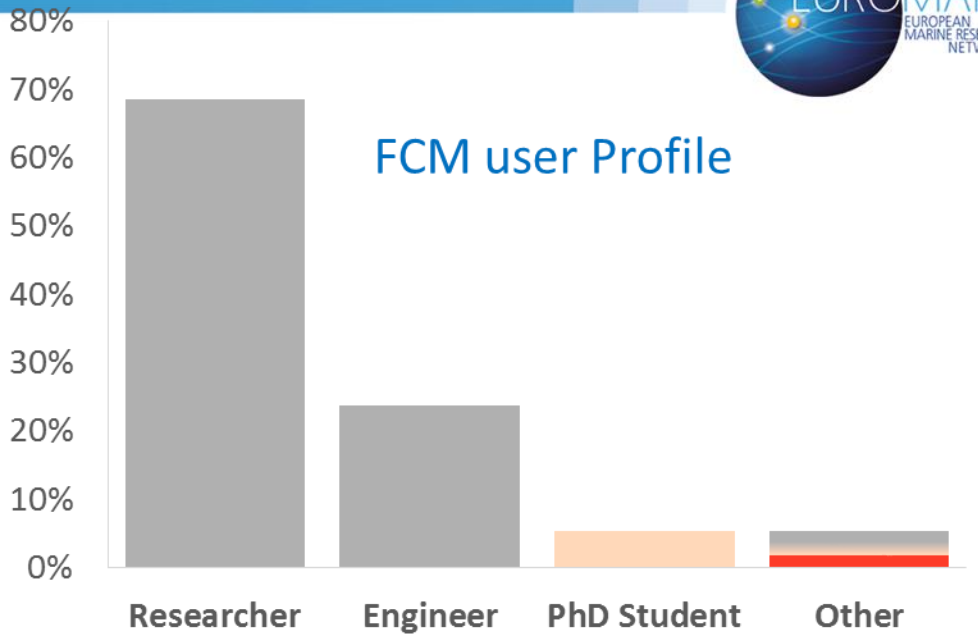
Completed answers (79%)

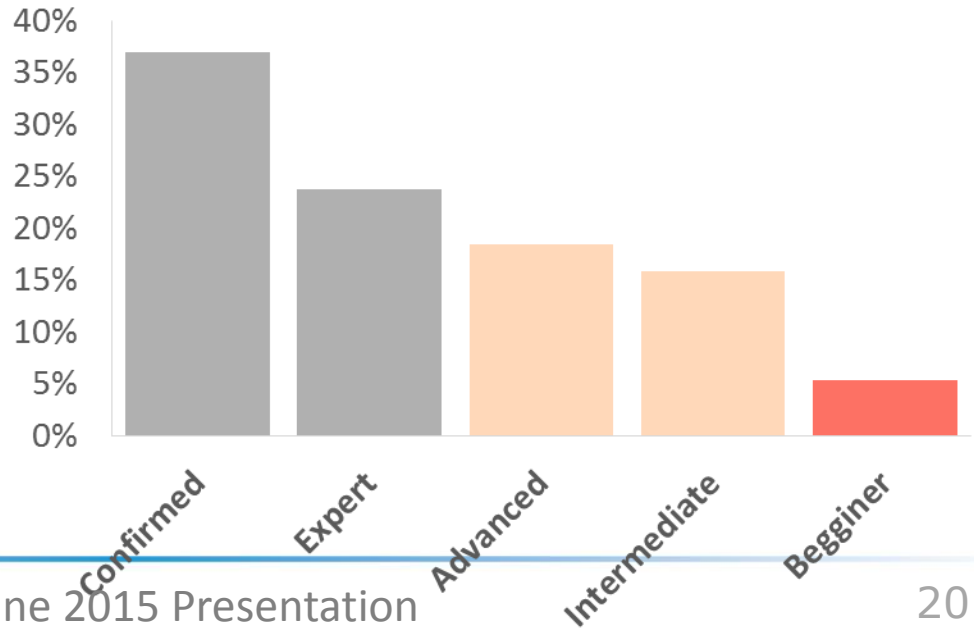
Uncompleted answers (21%)

Gender participation



FCM user Profile





II. FCM Data Management

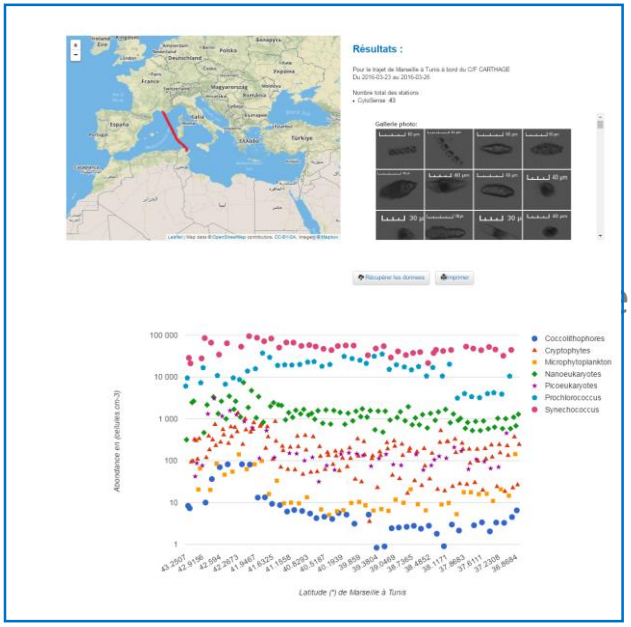
mio Institut Méditerranéen d'Océanologie

CytoClus

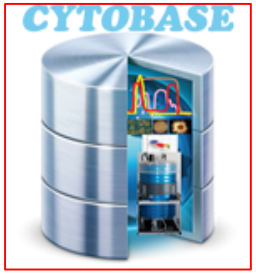
R

Table Données
Table photo
Collection photos

Acquisition | **Analysis** | **Consolidation** | **Expert QC**

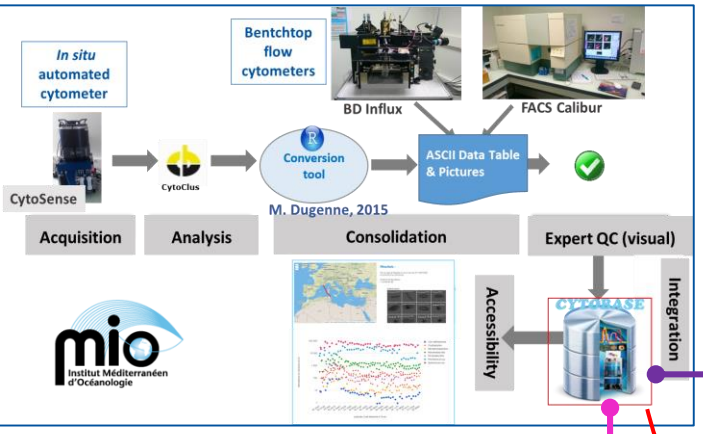


Accessibility



Integration

II. FCM Data management



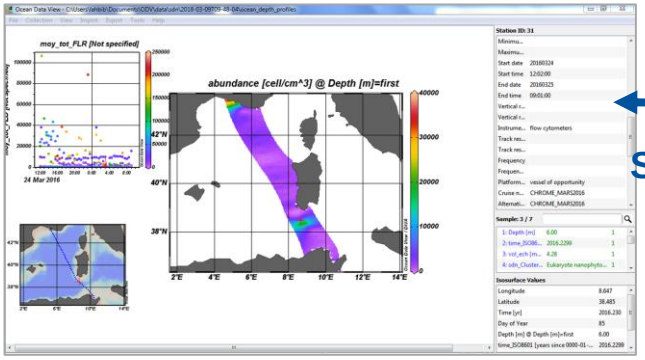
Metdata generation

MIKADO

Coupling table

Download Manager

Ocean Data View
https://odv.awi.de
© 2017 Reiner Schlitzer



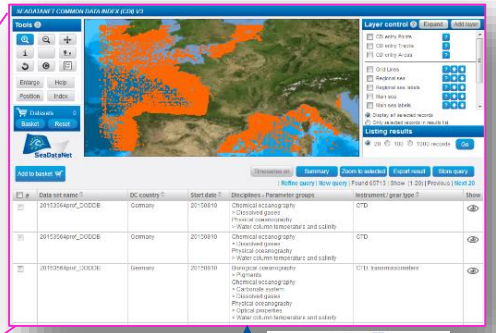
IMPORT

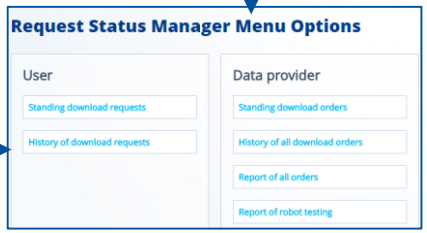
SDN Format

SeaDataNet

SEADATANET PORTAL

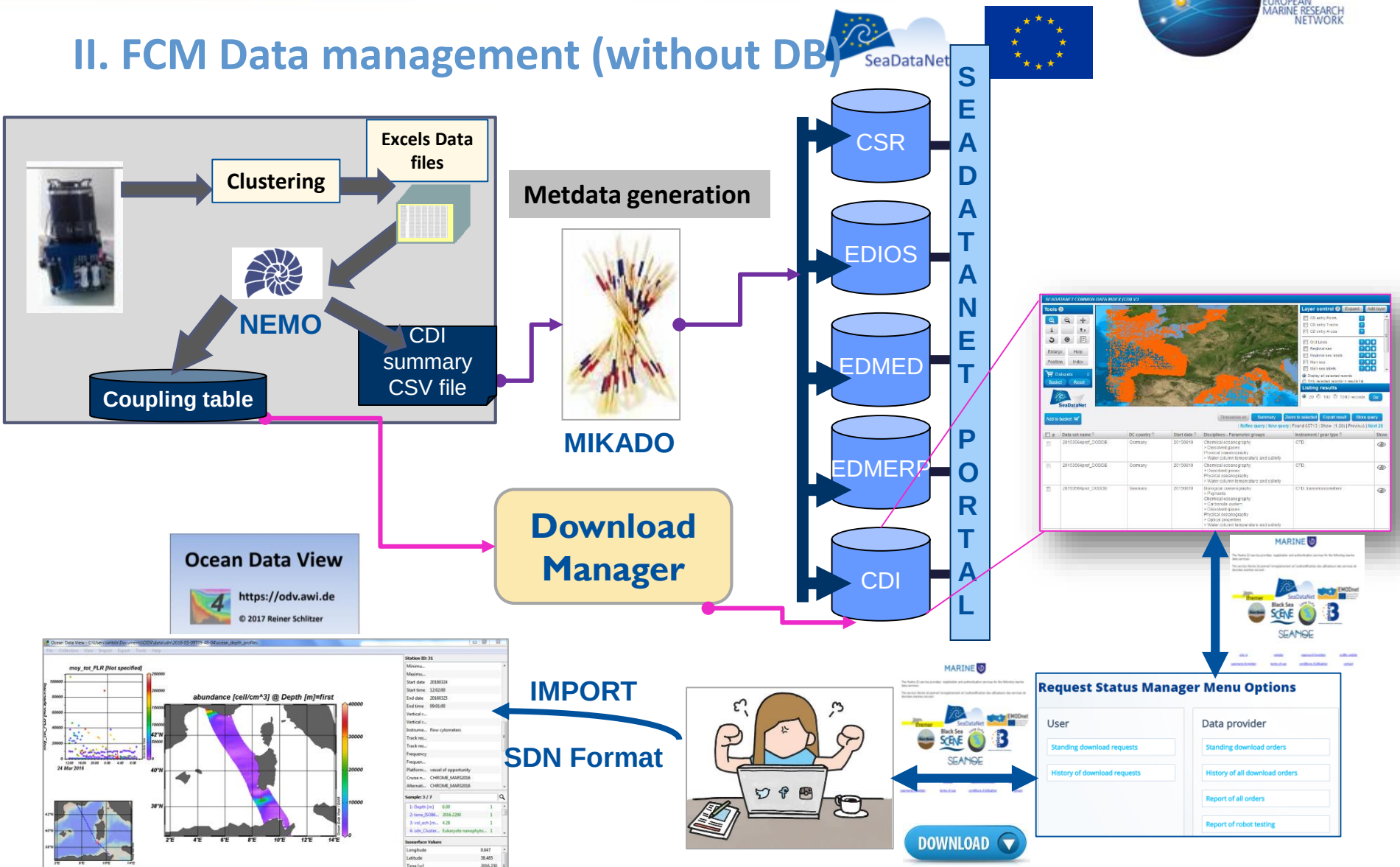
CSR
EDIOS
EDMED
EDMERP
CDI



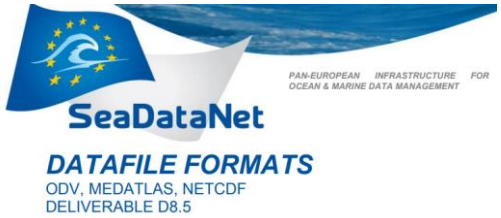


OCEAN DATA VIEW ASCII FORMAT

II. FCM Data management (without DB)



- **Create New ODV data format**



Content

THE ODV FORMAT DATA MODELS	
NAME	**TYPE**
Biological data	Time series
Chemical	Time series
Contaminant in Biota	Time series
Tide gauge	Time series
Tide gauge with instrument	Time series
Trajectory TSG	Time series
Contaminant in sediment	Profiles
CTD	Profiles
CTD with instruments	Profiles
XBT	Profiles

ScientificName:INDEXED_TEXT	QV:SEADATA	ScientificNameID:INDEXED_TEXT	QV:SEADATA	Sex:INDEXED	QV:SEADATA	LifeStage:INI
Prorocentrum	2	urn:lsid:marinespecies.org:taxname:109566	2	Not Specifie	9	Not Specifie
Dinophysis acuminata	2	urn:lsid:marinespecies.org:taxname:109603	2	Not Specifie	9	Not Specifie
Chaetoceros	2	urn:lsid:marinespecies.org:taxname:148985	2	Not Specifie	9	Not Specifie
Fragilaria	2	urn:lsid:marinespecies.org:taxname:149028	2	Not Specifie	9	Not Specifie
Melosira	2	urn:lsid:marinespecies.org:taxname:149042	2	Not Specifie	9	Not Specifie
Paralia sulcata	2	urn:lsid:marinespecies.org:taxname:149055	2	Not Specifie	9	Not Specifie
Thalassionema nitzschioides	2	urn:lsid:marinespecies.org:taxname:149093	2	Not Specifie	9	Not Specifie
Guinardia delicatula	2	urn:lsid:marinespecies.org:taxname:149112	2	Not Specifie	9	Not Specifie

P01 (BODC PARAMETER USAGE VOCABULARY)

Overview | Export subset of list | Export full list | New query | Found 2 | Current | Previous | Next

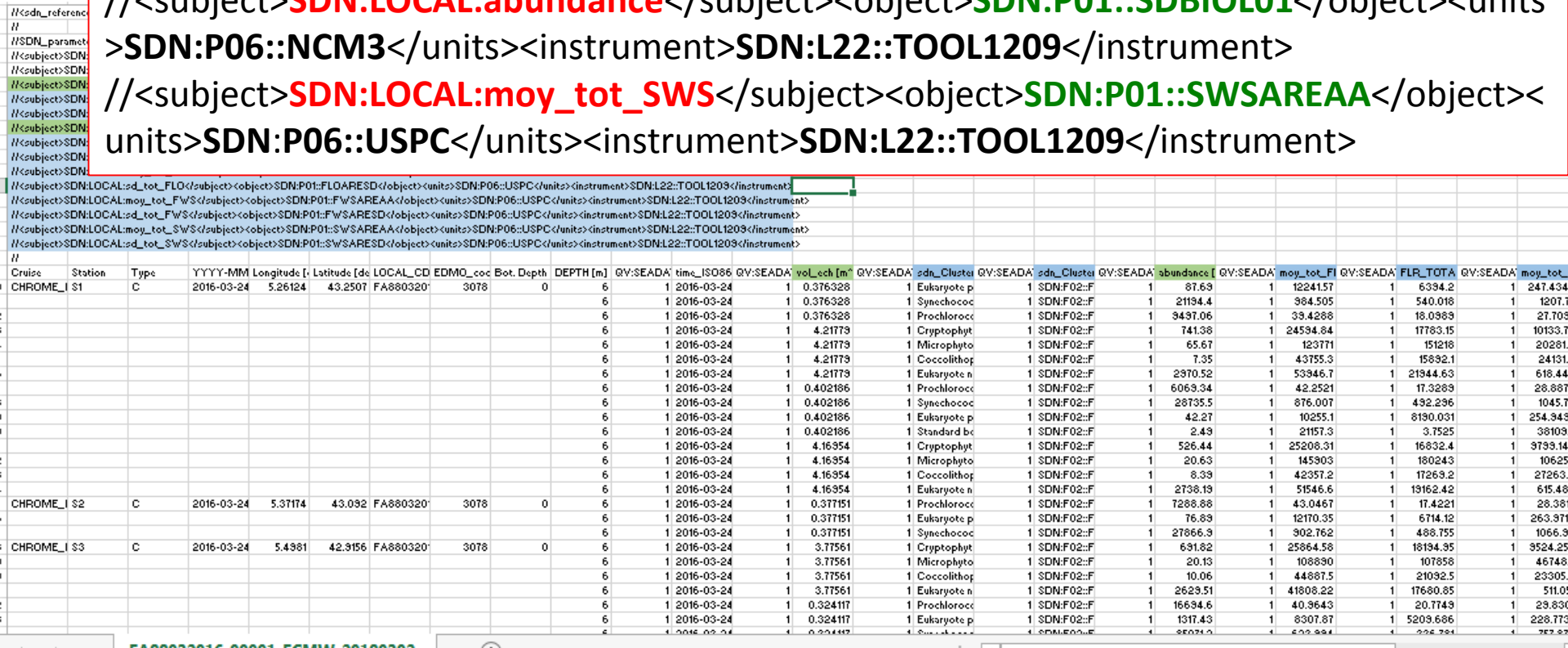
ConceptID	Preferred label	Alt label	Definition	Modified
SCNAME01	Taxon of biological entity specified elsewhere	Name_BE007117	The scientific name of the biological object.	1/21/2016 13:55:16
SNANID01	Identifier (LSID) of biological entity specified elsewhere	LSID_BE007117	A global unique identifier for the nomenclatural details of the scientific name of a biological object (urn:lsid:marinespecies.org:taxname:ID)	1/21/2016 13:55:16

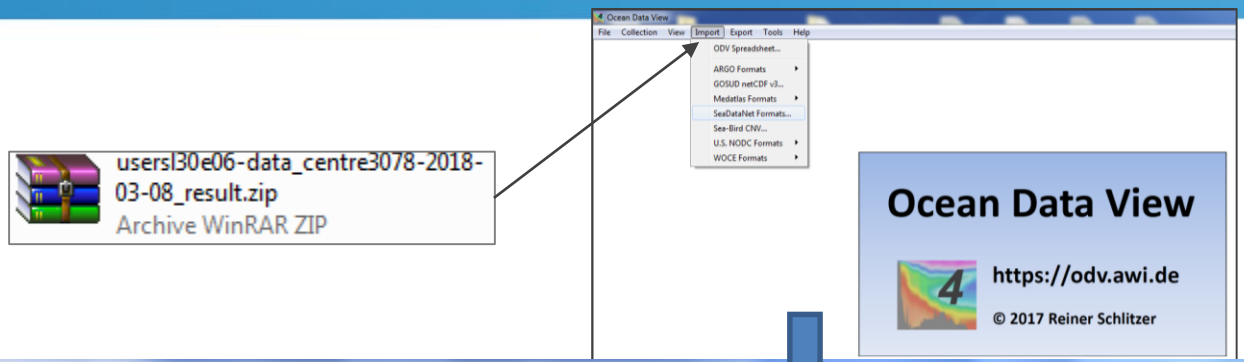
Example: SCNAME01= Akashiwo sanguinea and SNANID01= urn:lsid:marinespecies.org:taxname:232546

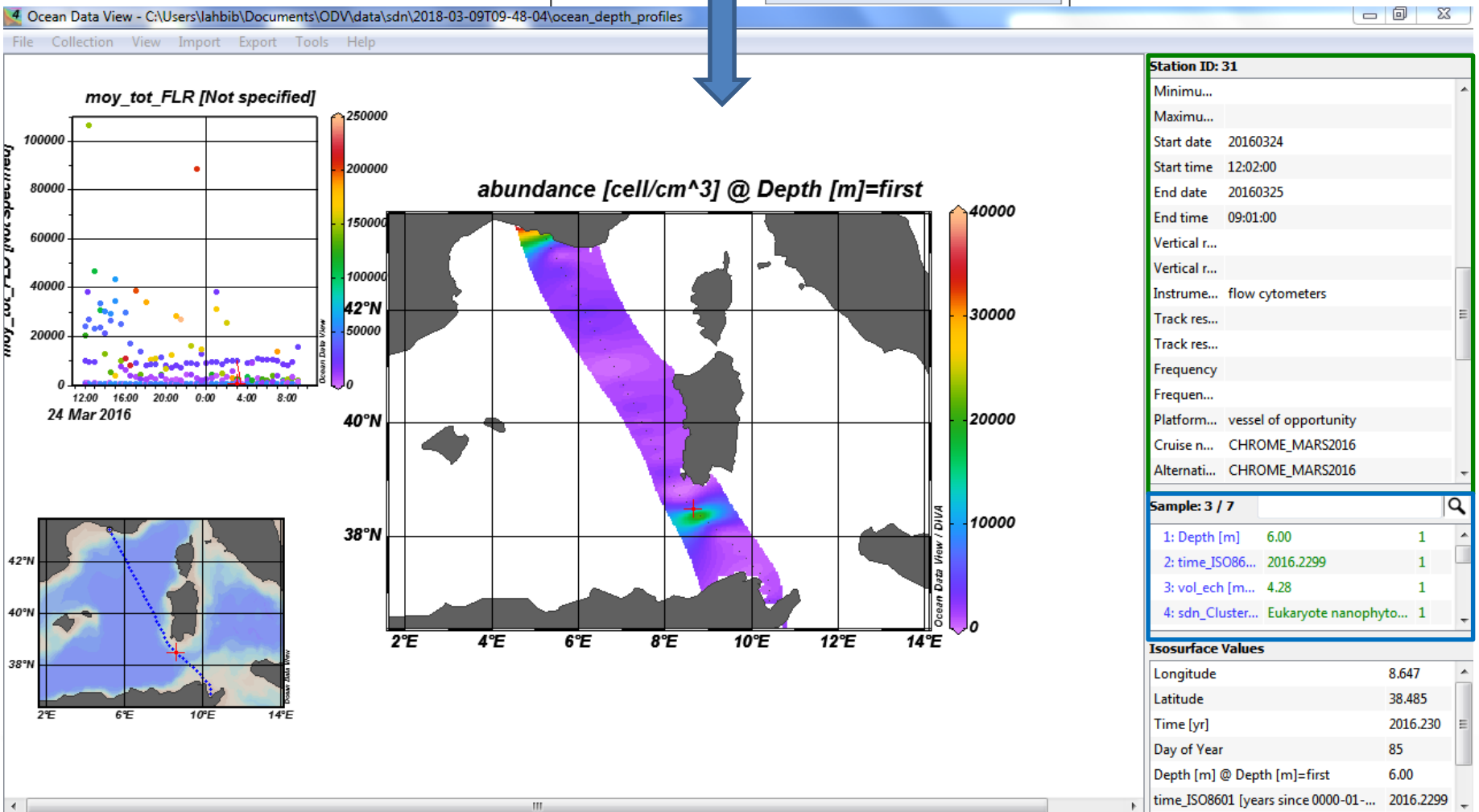
ConceptID	Preferred label	Alt label	Definition	Modified
NMCLFL02	Registered name of flow cytometry cluster by classification to a term from the NVS SeaDataCloud Flow Cytometry Standardised Cluster Names Vocabulary (SDN:F02::)	ClusterName	Text term identifying the type of particles belonging to a specific flow cytometry cluster, taken from the NVS SeaDataCloud Flow Cytometry Standardised Cluster Names controlled vocabulary F02.	2/1/2018 21:53:44
IDCLFL02	Registered name identifier of flow cytometry cluster by classification to a term from the NVS SeaDataCloud Flow Cytometry Standardised Cluster Names Vocabulary (SDN:F02::)	ClusterNameID	Opaque key term identifying the type of particles belonging to a specific flow cytometry cluster, taken from the NVS SeaDataCloud Flow Cytometry Standardised Cluster Names controlled vocabulary F02	2/1/2018 21:53:44

Example: NMCLFL02 = Microphytoplankton and IDCLFL02 = SDN:F02::F0200008

//<subject>SDN:LOCAL:**vol_ech**</subject><object>**SDN:P01::VOLWBSMP**</object><units>**SDN:P06::MCUB**</units><instrument>**SDN:L22::TOOL1209**</instrument>
//<subject>SDN:LOCAL:**sdn_ClusterName**</subject><object>**SDN:P01::NMCLFL02**</object><units>**SDN:P06::UUUU**</units><instrument>**SDN:L22::TOOL1209**</instrument>
//<subject>**SDN:LOCAL:abundance**</subject><object>**SDN:P01::SDBIOL01**</object><units>**SDN:P06::NCM3**</units><instrument>**SDN:L22::TOOL1209**</instrument>
//<subject>**SDN:LOCAL:moy_tot_SWS**</subject><object>**SDN:P01::SWSAREAA**</object><units>**SDN:P06::USPC**</units><instrument>**SDN:L22::TOOL1209**</instrument>



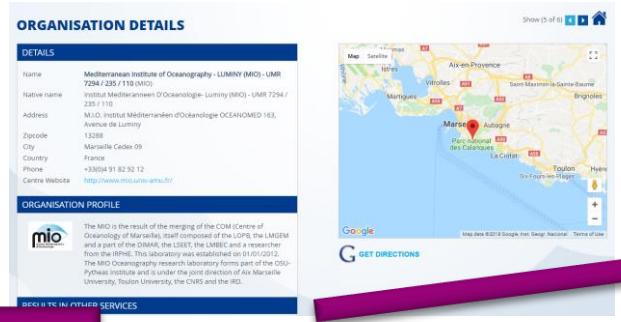

users\30e06-data_centre3078-2018-03-08_result.zip
Archive WinRAR ZIP
Ocean Data View
https://odv.awi.de
© 2017 Reiner Schlitzer

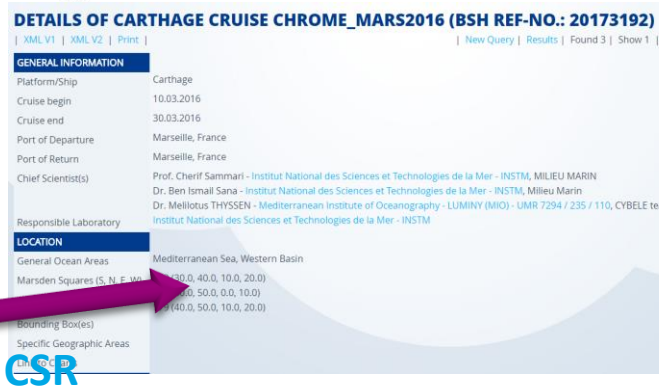

Ocean Data View - C:\Users\lahbib\Documents\ODV\data\sdn\2018-03-09T09-48-04\ocean_depth_profiles
File Collection View Import Export Tools Help
moy_tot_FLR [Not specified]
24 Mar 2016
abundance [cell/cm^3] @ Depth [m]=first
Station ID: 31
Minimu...
Maximu...
Start date 20160324
Start time 12:02:00
End date 20160325
End time 09:01:00
Vertical r...
Vertical r...
Instrume... flow cytometers
Track res...
Track res...
Frequency
Frequen...
Platform... vessel of opportunity
Cruise n... CHROME_MARS2016
Alternati... CHROME_MARS2016
Sample: 3 / 7
1: Depth [m] 6.00 1
2: time_ISO86... 2016.2299 1
3: vol_ech [m... 4.28 1
4: sdn_Cluster... Eukaryote nanophyto... 1
Isosurface Values
Longitude 8.647
Latitude 38.485
Time [yr] 2016.230
Day of Year 85
Depth [m] @ Depth [m]=first 6.00
time_ISO8601 [years since 0000-01-... 2016.2299

CNRS MIO SDN metadata directories

EDMERP

Projects



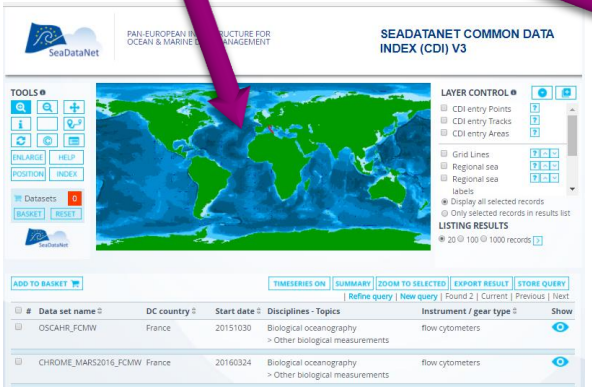


CSR

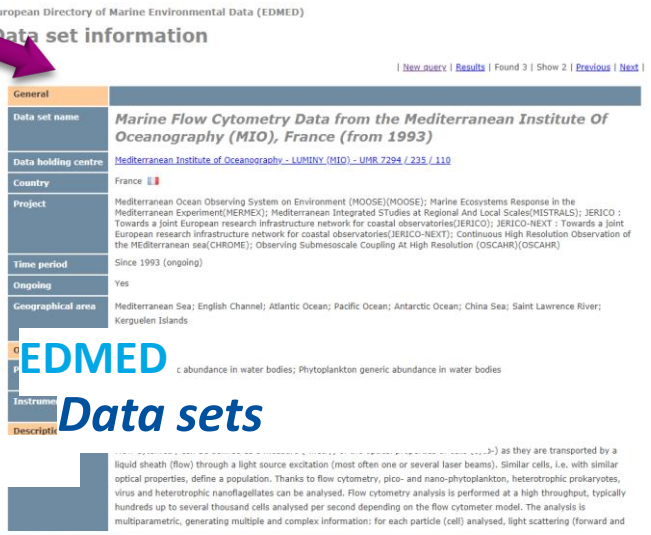
Research cruises

EDIOS

Observing programmes



CDI *Data index*



EDMED

Data sets

Conclusion

- Whatever the instrument used ➔Common Vocabulary (CV)
- We created 44 FCM CV ➔ European portals
- Decide on a group of experts interested in contributing to the vocabulary work and decide on a co-ordinator
- Update is possible/The BODC Vocabulary Editor webpage: https://www.bodc.ac.uk/resources/vocabularies/vocabulary_editor/
- BODC is setting up some repositories on GitHub for each individual collection and F02 will have its own too. So this could be used to share and discuss issues more widely.
- MIO will share CYTOBASE and Mathilde tool
- Quality control protocol for FCM data (70% no data flag)

Thank you for your attention