SeaDataNet

History of the building and upgrade of an European oceanographic data infrastructure

Download the presentation:
https://cloud.ifremer.fr/index.php/s/6BgEpDOBJGebGG5

Michèle Fichaut, IFREMER, SISMER (NODC)

Open Research Data Week, Malta, 25 January 2022

sdn-userdesk@seadatanet.org – www.seadatanet.org

Overview

1. The context: Marine Data Management
2. The SeaDataNet infrastructure building
3. Results of SeaDataNet, SeaDataNet2 and SeaDataCloud projects
4. FAIR principles and data FAIRness

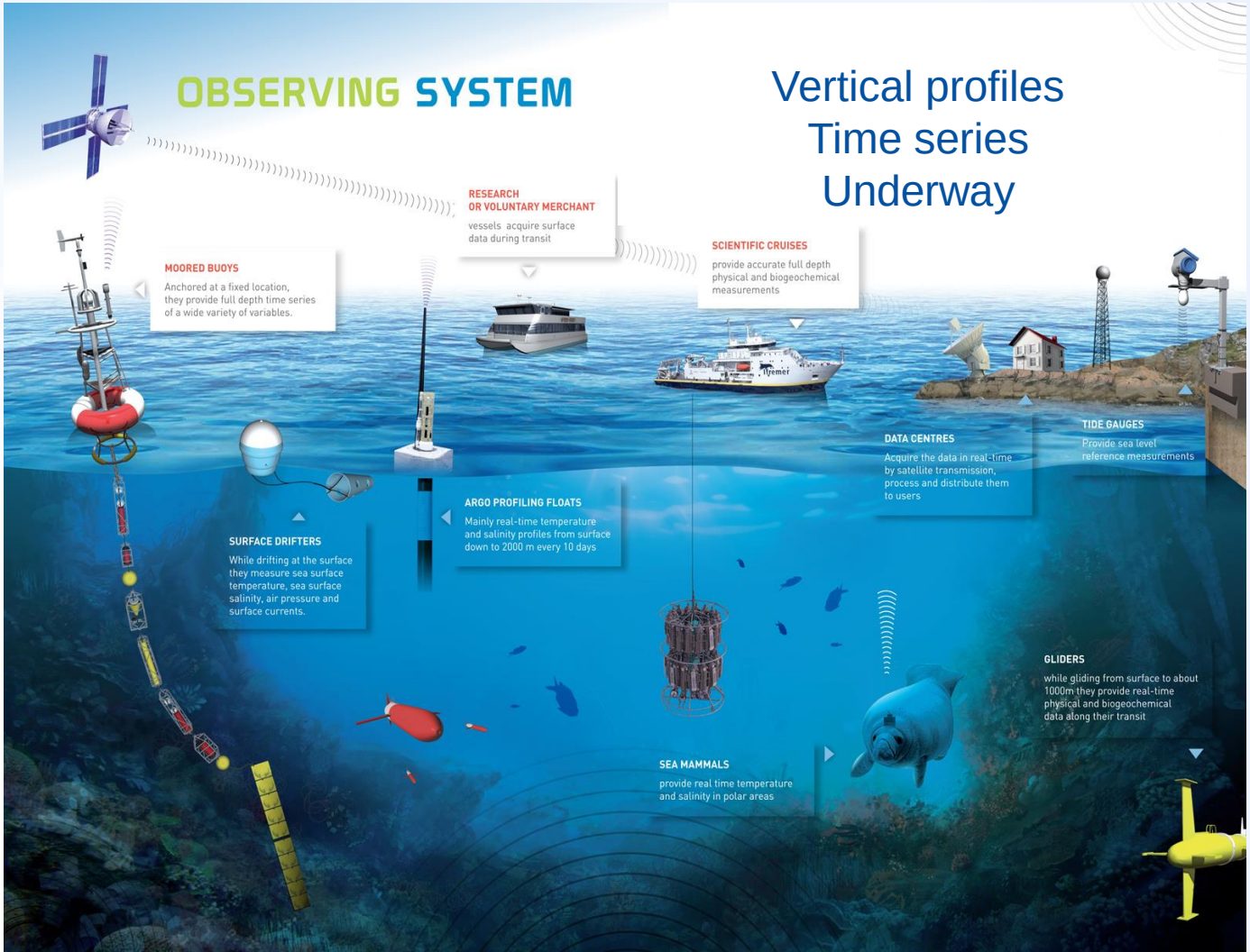
Part 1

- The context: marine data management
  - Data collection at sea
  - Data workflow: from collection to diffusion
  - Contribution of the data centres
  - Quality checks of the data
  - IODE and the NODC network
  - European Landscape

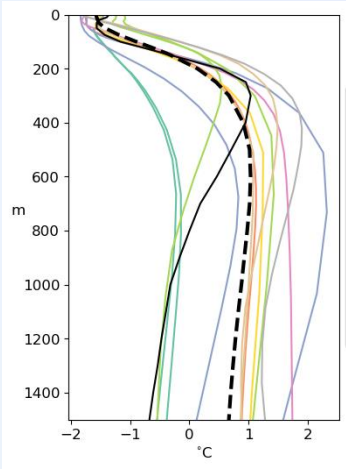
Marine Data management

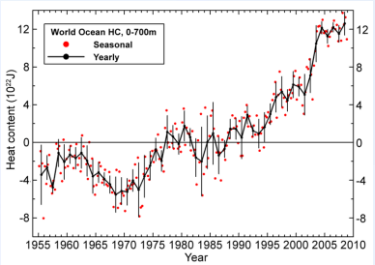
- Data measured in Seas and Oceans
  - Physical
    - Temperature, salinity, current, waves…
  - Chemical
    - Nutrients(nitrate, phosphate, silicate), dissolved oxyfen, PH, …
  - Biological
    - Zooplankton and phytoplankton, benthos, Chlorophylle…
  - Geosciences
    - Bathymetry, magnetism, gravimetry...
  - Meteorology at the interface Ocean/Atmosphere

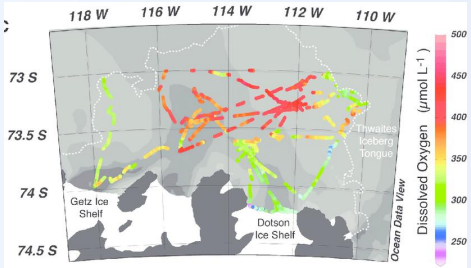
Different observing systems measuring data



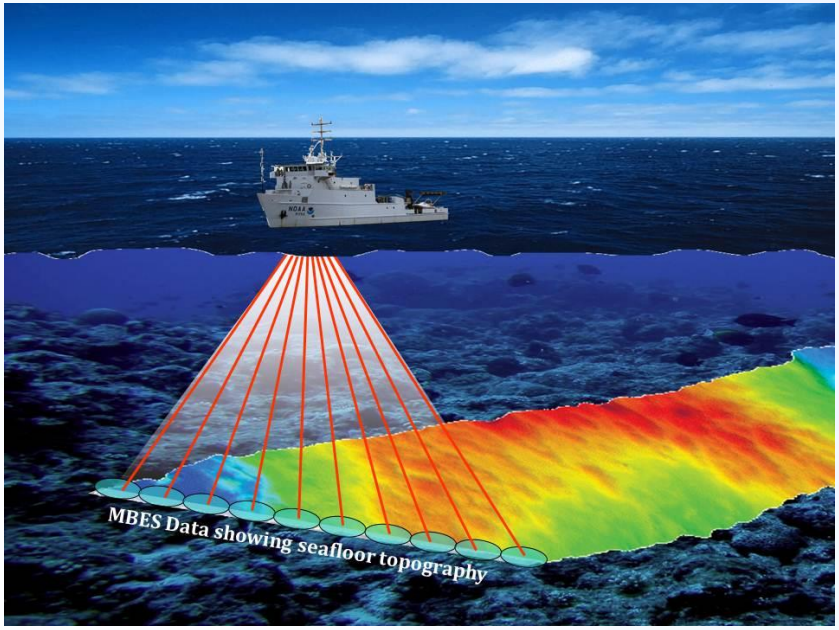
Vertical profiles
Time series
Underway



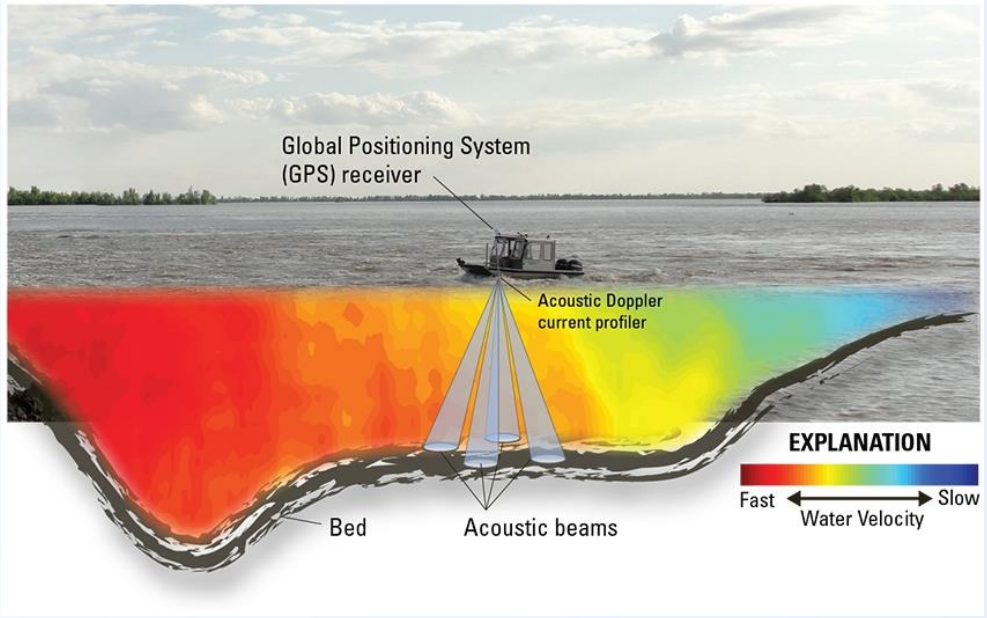




Underway measurements



Bathymetry



Currents measurements with ADCPs
(Acoustic Doppler Current Profilers)

In-situ data workflows

1. Transmitted to a data centre

- **In Near Real Time(**between 2 hours and one week after the data collection)
  - Automatic sensors like tide Gauge, Argo floats, sensors on sea mammals…
- **In Delayed mode**
  - Systematic measurements on ships: transmitted at the end of the research cruise
  - by the ship owner or the chief scientist (generally 2 months max after the end of a cruise)
    - Thermosalinometer, meteorological data, bathymetry, sismic, gravimetry, magnetism, ADCP
  - Targeted measurements by the scientific team on board, analysed and calibrated in the laboratories (several months to several years after the end of the end of the cruise)
    - Chemistry measurements that require equipment not available on board
    - Measurements requiring post-calibration

In-situ data workflows

2. Archived by the projects that funded their collection
3. Kept in the scientific laboratories

   sometimes on non sustainable supports

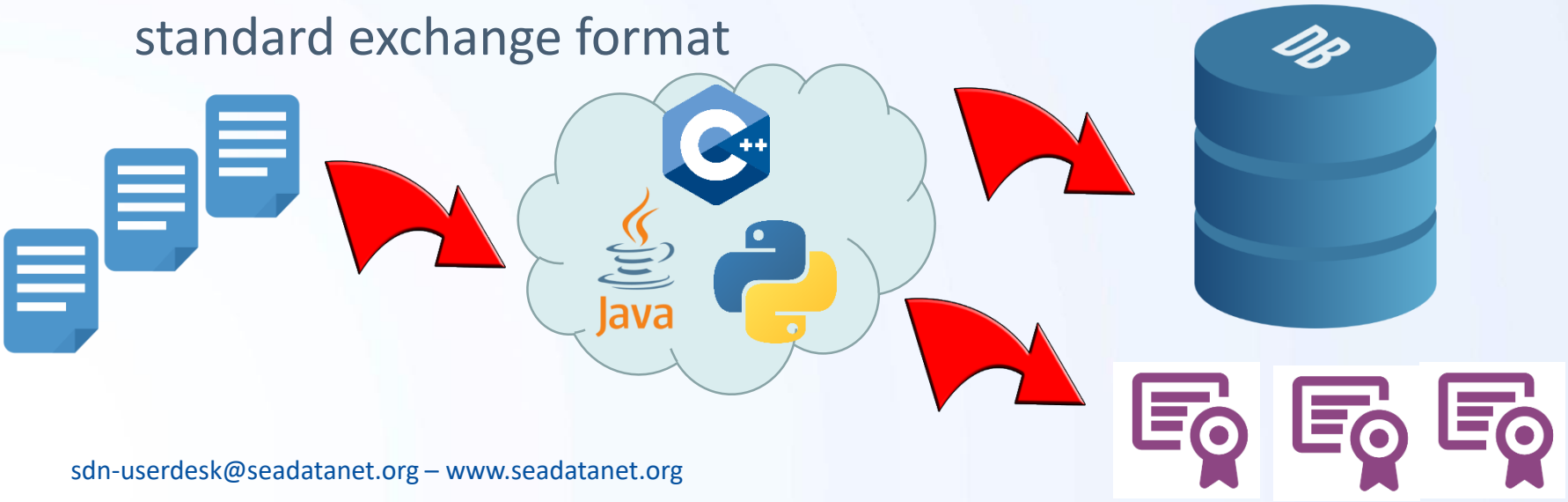
Less and less true because of

Format of the data sent to NODCs

- For Near Real Time data
  - Manufacturer's format of the sensors
- For Delayed mode data
  - Manufacturer's format of the sensors
  - Format of the on-board data acquisition centre
  - Any format when the data have been transmitted through the scientific laboratories
    - ASCII (text, CSV,…), Binary (netCDF), Excel sheets…

Processing of the data file received in NODCs

- When formats are defined, known and stable
  - One reading script per format
- When formats are arbitrary
  - one generic program able to read several formats
- To ingest the data in a database or to convert them in a standard exchange format

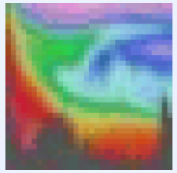


Archiving data in NODCs

- Conversion to standards
- Quality check of the data
- Long-term archiving
- Data distribution by mean of different supports and protocols
  - Web site (Discovery through metadata, Access to the data), FTP, OpenDap, …
- Following a data policy: public data, confidential data, data with a moratorium

Standard formats for oceanographic data

- OceanData View (ODV) ➔ ASCII CSV format



Ocean Data View

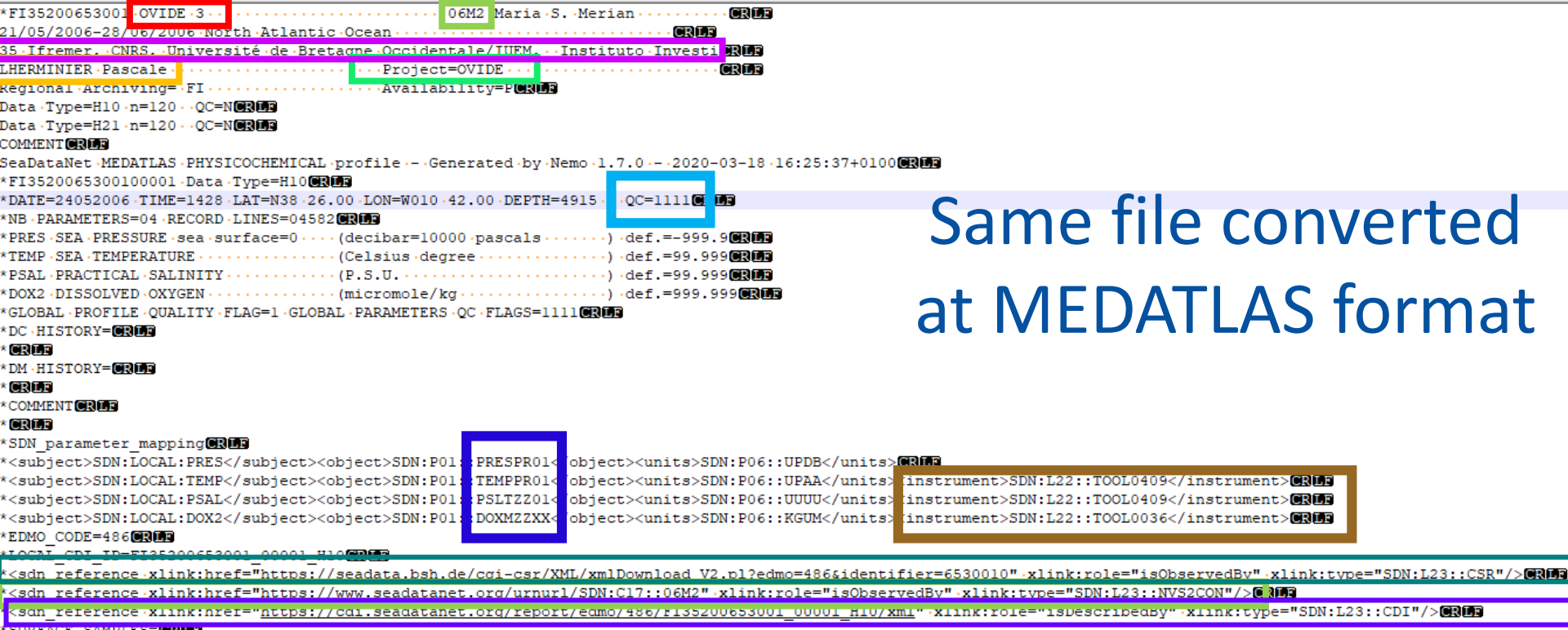
- netCDF ➔ binary format

- MedAtlas ➔ ASCII

```
001 OVIDE 06 ..... Maria S. MERIAN  NB ....
*No station,nom campagne,nom navire,type sonde
*(i3,2(1x,a16),1x,a6)
24052006 1428 N  38 26.00 W  10 42.00  4 4582 4915 ....1 4582
*Date,heure,lat.,lon.,nb parametres,nb mesures,fond,pmin,pmax
*(a8,1x,i2,i2,1x,a11,1x,a11,1x,i2,4(1x,i4))
PRESSION ..............dbar ........
TEMPERATURE ...........deg.cels. ...
SALINITE ..............p.s.u. ......
OXYGENE DISS. .........um/kg .......
....1.0 16.512 36.198 233.5
....2.0 16.512 36.198 233.5
....3.0 16.512 36.198 233.5
....4.0 16.512 36.198 233.5
....5.0 16.512 36.198 233.5
....6.0 16.512 36.198 233.5
....7.0 16.512 36.198 233.5
....8.0 16.512 36.198 233.5
....9.0 16.512 36.198 233.5
...10.0 16.512 36.198 233.5
...11.0 16.512 36.198 233.5
...12.0 16.512 36.198 233.5
...13.0 16.512 36.198 233.5
...14.0 16.512 36.198 233.5
...15.0 16.512 36.198 233.5
...16.0 16.512 36.198 233.5
...17.0 16.512 36.198 233.5
...18.0 16.512 36.198 233.5
...19.0 16.512 36.198 233.5
...20.0 16.496 36.197 236.3
...21.0 16.492 36.197 236.5
...22.0 16.464 36.197 236.3
...23.0 16.417 36.207 236.9
...24.0 16.380 36.219 235.8
...25.0 16.351 36.225 235.0
...26.0 16.333 36.228 236.8
...27.0 16.353 36.223 237.6
...28.0 16.346 36.225 237.8
...29.0 16.336 36.226 238.5
...30.0 16.328 36.226 238.8
...31.0 16.300 36.226 238.6
...32.0 16.259 36.224 237.6
...33.0 16.234 36.222 238.8
...34.0 16.191 36.217 239.9
...35.0 16.166 36.211 240.7
```

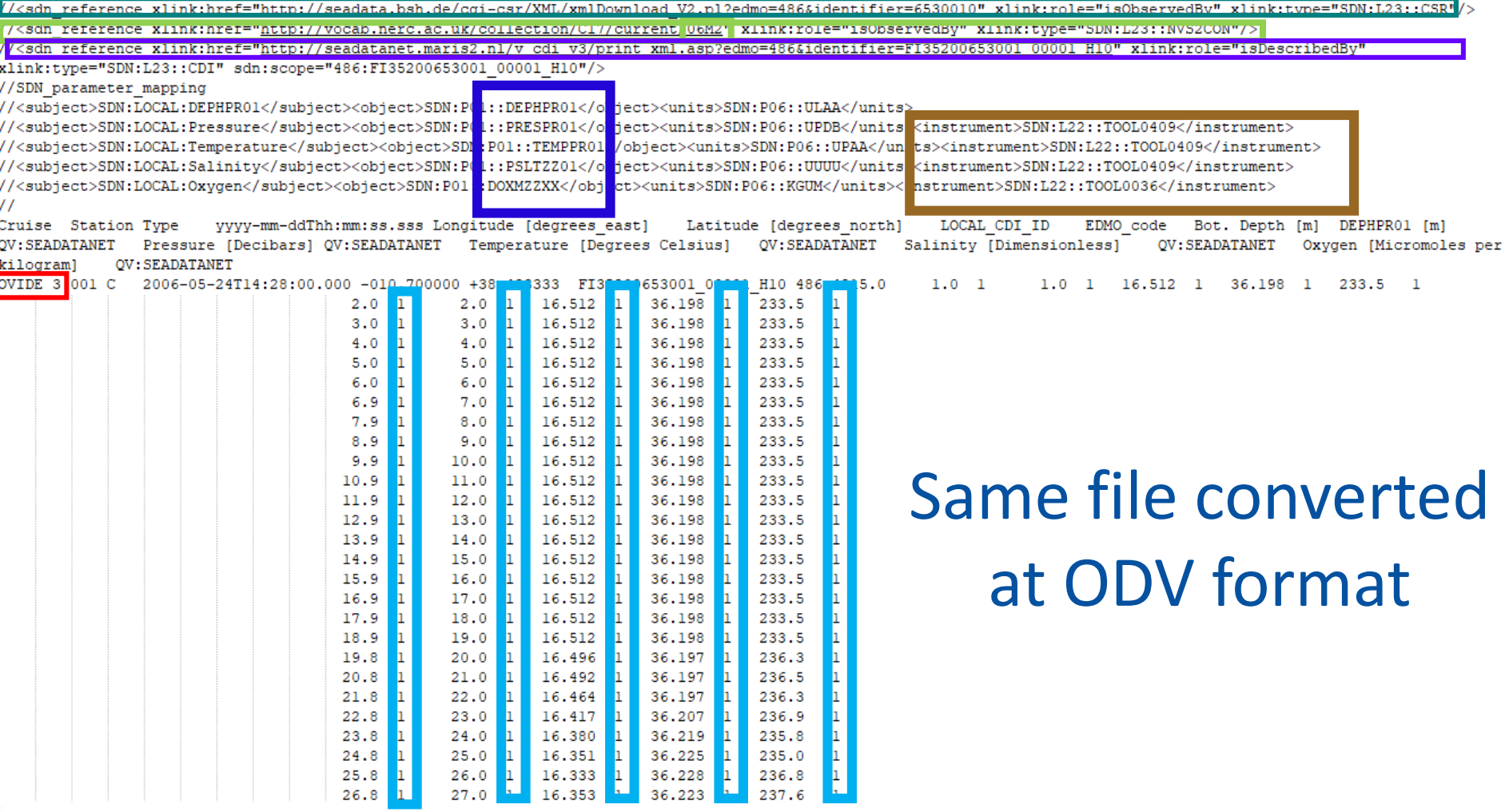

Exemple of received file

- Text file with minimum metadata
- And 4 measured parameters



Same file converted at MEDATLAS format

- Additional metadata
  - Cruise name, ship, chief scientist, laboratories involved, project, instrument used…
  - Links to the Cruise report, to the full metadata file
- Standard name for the parameters
- Quality flags on all measurements and metadata



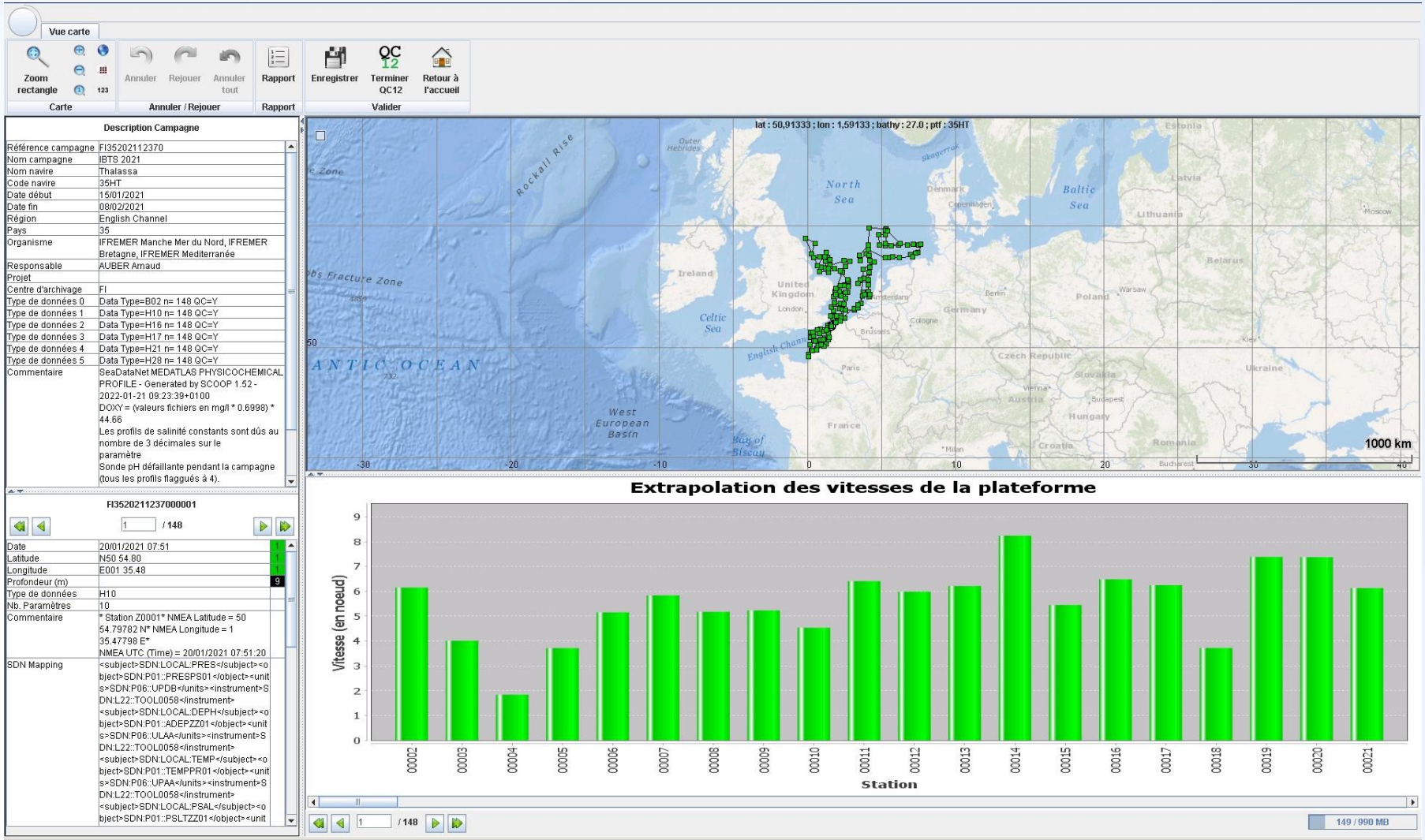
Same file converted at ODV format

- Additional metadata
  - Cruise name, link to the Cruise report, link to the full metadata file, ship, instrument used
- Standard name for the parameters
- Quality flags on all measurements

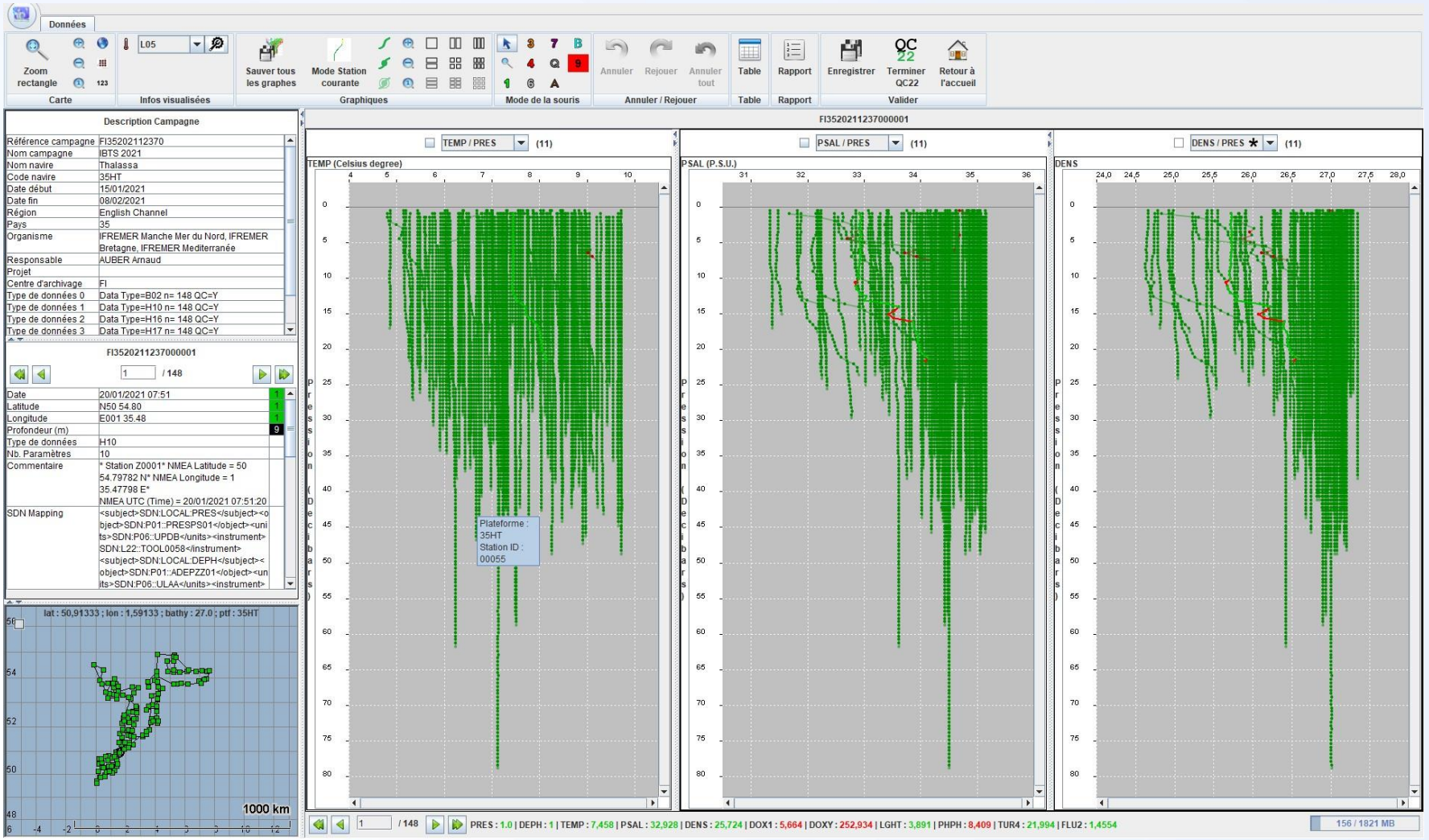
Quality checks (QC)

- QC of all data received at the Data centre
- 3 steps
  - Automatic checks of the format
  - Automatic and visual checks of the metadata
  - Automatic and visual checks of the measured data
  - Results
    - A quality flag on all numerical values

Quality Checks – Checks of the metadata



Quality Checks – Checks of the data



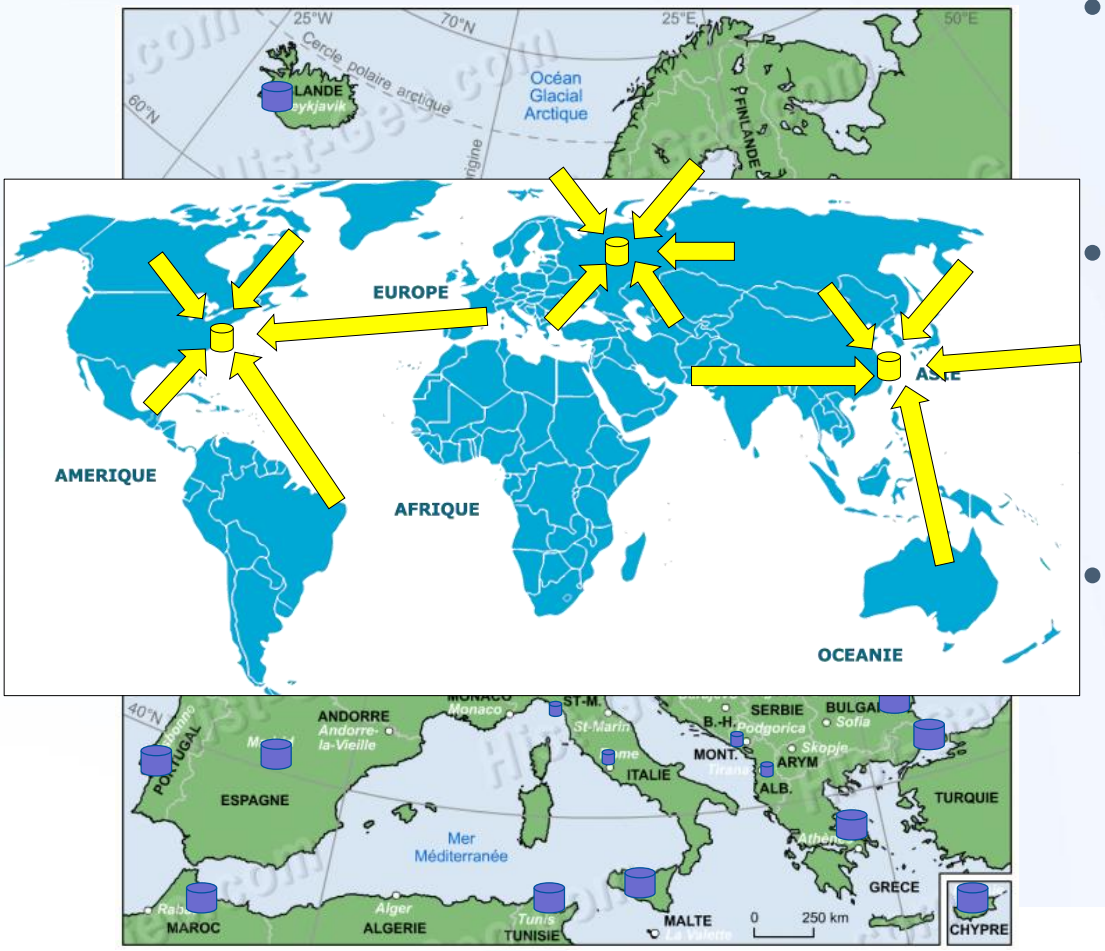
IOC/IODE NODC network

- The programme "International Oceanographic Data and Information Exchange" (**IODE**) of the "Intergovernmental Oceanographic Commission" (IOC) of UNESCO was established in 1961. Its purpose is to enhance marine research, exploitation and development, by **facilitating the exchange of oceanographic data and information between participating Member States**, and by meeting the needs of users for data and information products.

IOC/IODE objectives

- **To facilitate and promote the discovery, exchange of, and access to, marine data** and information
- To **encourage the long term archival**, preservation, documentation, management and services of all marine data, data products, and information
- To develop or use existing **best practices** for the discovery, management, exchange of, and access to marine data and information
- To assist Member States **to acquire the necessary capacity** to manage marine research and observation data and information and become partners in the IODE network (Capacity building)
- To **support** international scientific and operational marine programmes

NODC network in Europe



- Oceanographic data are managed by the NODCs (part of the IODE network)
- ICES in Copenhagen is a European data centre collecting data from EU NODCs
- 3 World Data centres collecting data from NODCs worldwide

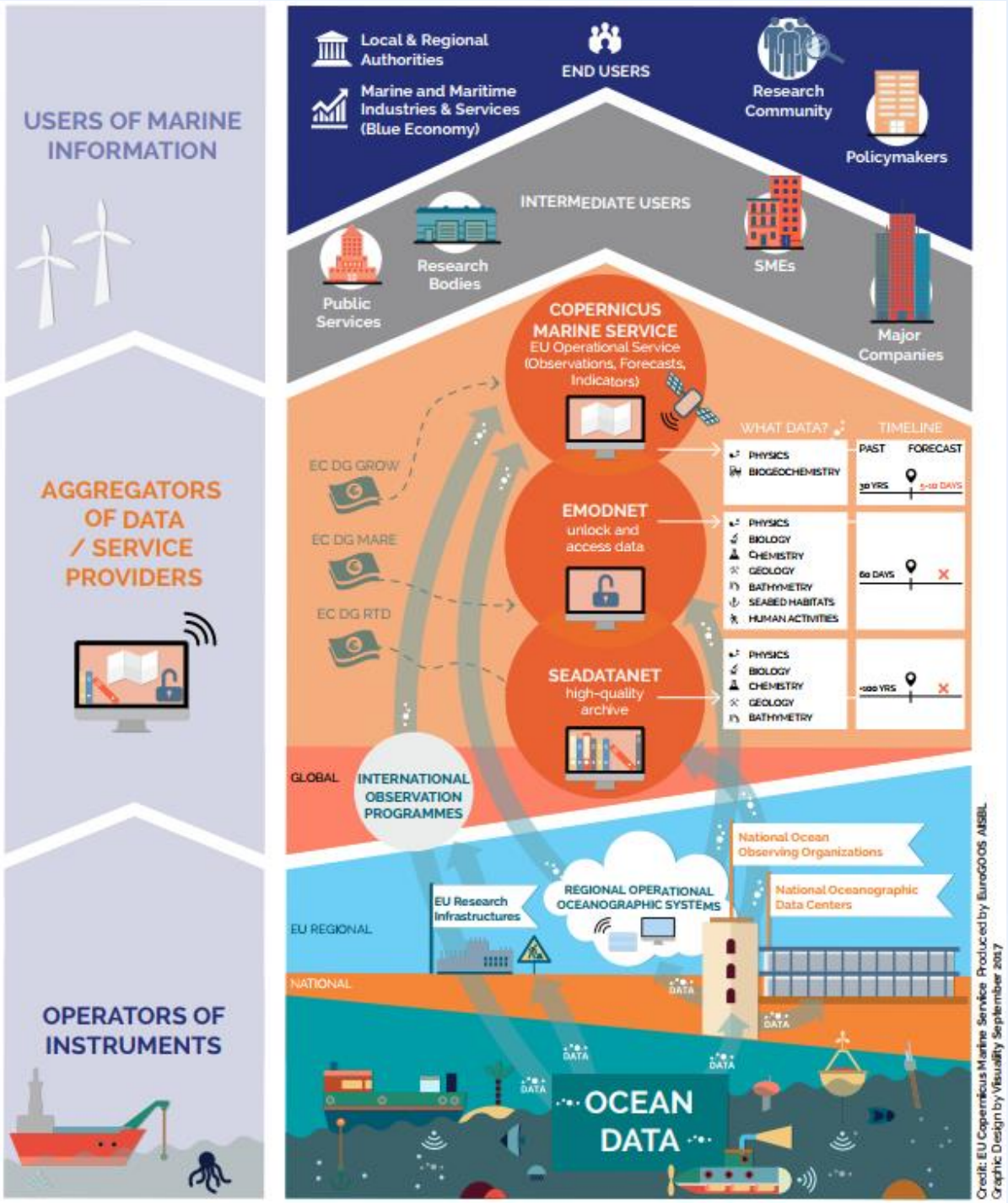
NODCs network

- Through IOC/IODE programme, NODCs meet every 2 years during one week
- During these meetings the IODE projects are discussed, recommendations are given on best practices for data management, quality assurance, standards …
- But no standards are imposed
  - No common vocabularies
  - No common formats

This is done in the frame of European projects

SeaDataNet

European landscape in terms of Marine Data management: 3 main components



sdn-userdesk@seadatanet.org – www.s

End of part 1

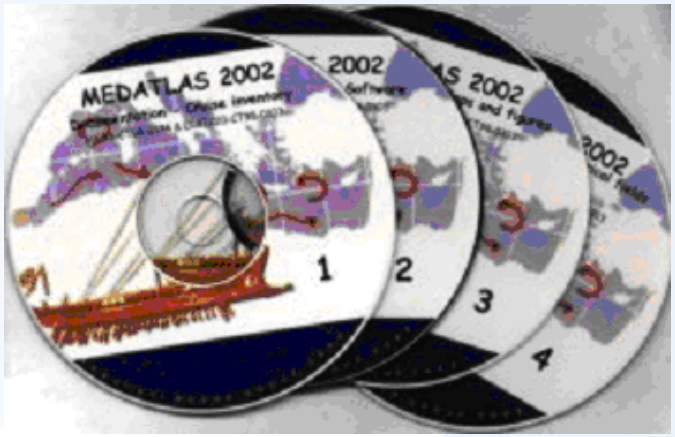
Part 2

The SeaDataNet infrastructure

- History
- Objective and principle
- Roadmap
- Method applied to reach interoperability of data and metadata

Need for standardisation

- Over the last 30 years, development of European projects
  - Bringing together NODCs from different countries in joint oceanographic data projects
  - Need for standardisation, to disseminate homogeneous and coherent data sets: CD-ROMs at the end of the 1990s, beginning of the 2000s



The SeaDataNet infrastructure

- Stop projects requiring the centralisation of homogeneous data
- Data remain in NODCs but are accessible from a single location: the SeaDataNet portal = virtual data centre, based on the European research infrastructure (RI) SeaDataNet

SeaDataNet

EU – MAST

EU –MASTII

EU-FP5

EU-FP6

EU-FP7

H2020

90s

EDMED

Euronodim

MEDATLAS

2002-2005

Sea-Search

2006-2011

SeaDataNet

2011-2015

SeaDataNet II

2016-2021

SeaDataCloud

Partners : 35 countries, bordering European seas

Coordonnated by IFREMER

SeaDataNet - Objectives

- Federation of the the oceanographic data centres of 35 countries bordering the European seas
- Creation of a single virtual data centre, allowing a user searching for physics/chemistry data to connect to all 35 countries from a single user interface
- Distribute complete datasets in specific sea basins to privileged users (modellers)
- Creation and dissemination of products (climatologies and aggregated datasets) made from the data put into the infrastructure

SeaDataNet Infrastructure - Principle

- semi-distributed system that aggregates **NODCs** and enhances the existing NODC network.
- The technical developments implemented allow the NODCs connected to the SeaDataNet system to be seen as a **single virtual data centre** able to deliver **quality controlled data**, metadata and products through a **single web portal**

SeaDataNet – Road map

- SeaDataNet (2006-2011) : 10 M€
  - System implementation in 2 steps
    - Connection of the 10 most technologically advanced data centres to implement and test the system
    - Connecting the other 29 data centres in a progressive way with assistance from the 10 already connected
- SeaDataNet 2 (2011-2015) : 6 M€
  - Make the system more reliable (monitoring), more automated (machine-to-machine data exchange) and sustainable (infrastructure funded outside the European project)
  - Connect more data centres
  - Add more data, and more types of data (biology)

➔ Bigger, Better, Faster

SeaDataNet – Road map

- SeaDataCloud (2016-2021) : 10 M€
  - Improving access to data
  - Take into account the evolution of technologies => Cloud, HPC
    - More data processing capacity
    - Improved response times
  - Give a central role to the users
    - Provide the user with tools in a virtual environment (VRE, Virtual Research Environment) in which he/she will be able to work on his/her own data + data from SeaDataNet
    - To store his/her working environment: MySeaDataCloud

SeaDataNet : Method

- Development of standards
  - Common vocabulary for metadata
  - Common protocol for data and metadata control (Have comparable data)
  - Common file formats
- Definition of common catalogues
- Definition of rules for making data available
- Use of common software developed in the framework of SeaDataNet and made available to all partners (and more)

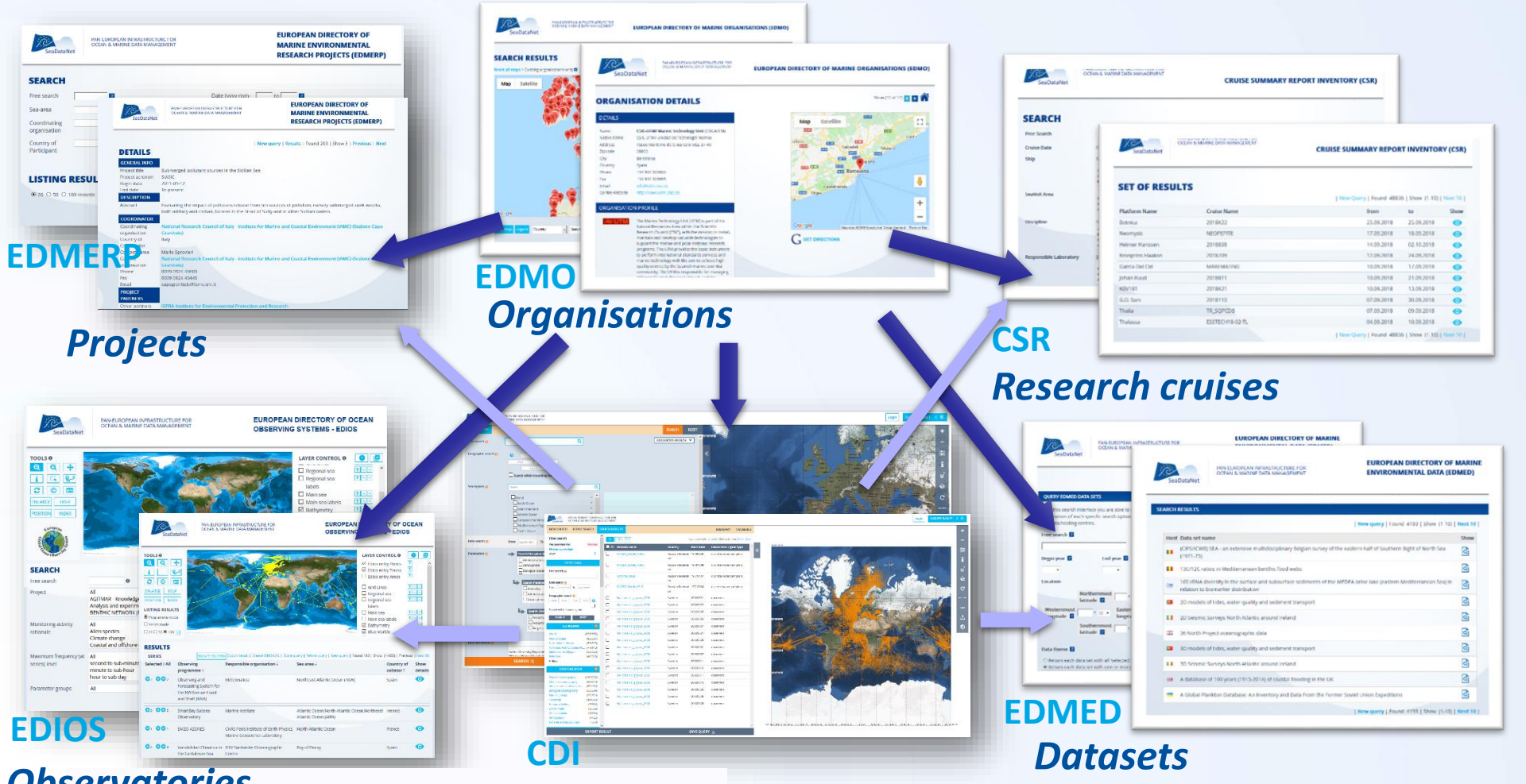
Speak the same language: Common vocabularies ➔ Interoperability

- Vocabulary lists maintained by the British Oceanographic Data Centre (NercVocabularyServer/BODC)
- 90,000 terms in over 110 vocabulary lists
  - Geographical area, ships, ports, scientific disciplines, data types, parameters, measurement units, instruments, positioning systems.....
- On-line through
  - Web site : https://www.seadatanet.org ➔ Look-up vocabularies
  - Web services: http://www.bodc.ac.uk/products/web_services/vocab/

To speak the same language : Common metadata descriptions ➔ interoperability

- Following International/European standards
  - Metadata descriptions based upon ISO-19115 and ISO-19139 for the compliancy to INSPIRE
  - available on-line on SeaDataNet website (https://www.seadatanet.org/Standards/Metadata-formats) and on the Ocean best practices repository (https://www.oceanbestpractices.org/)

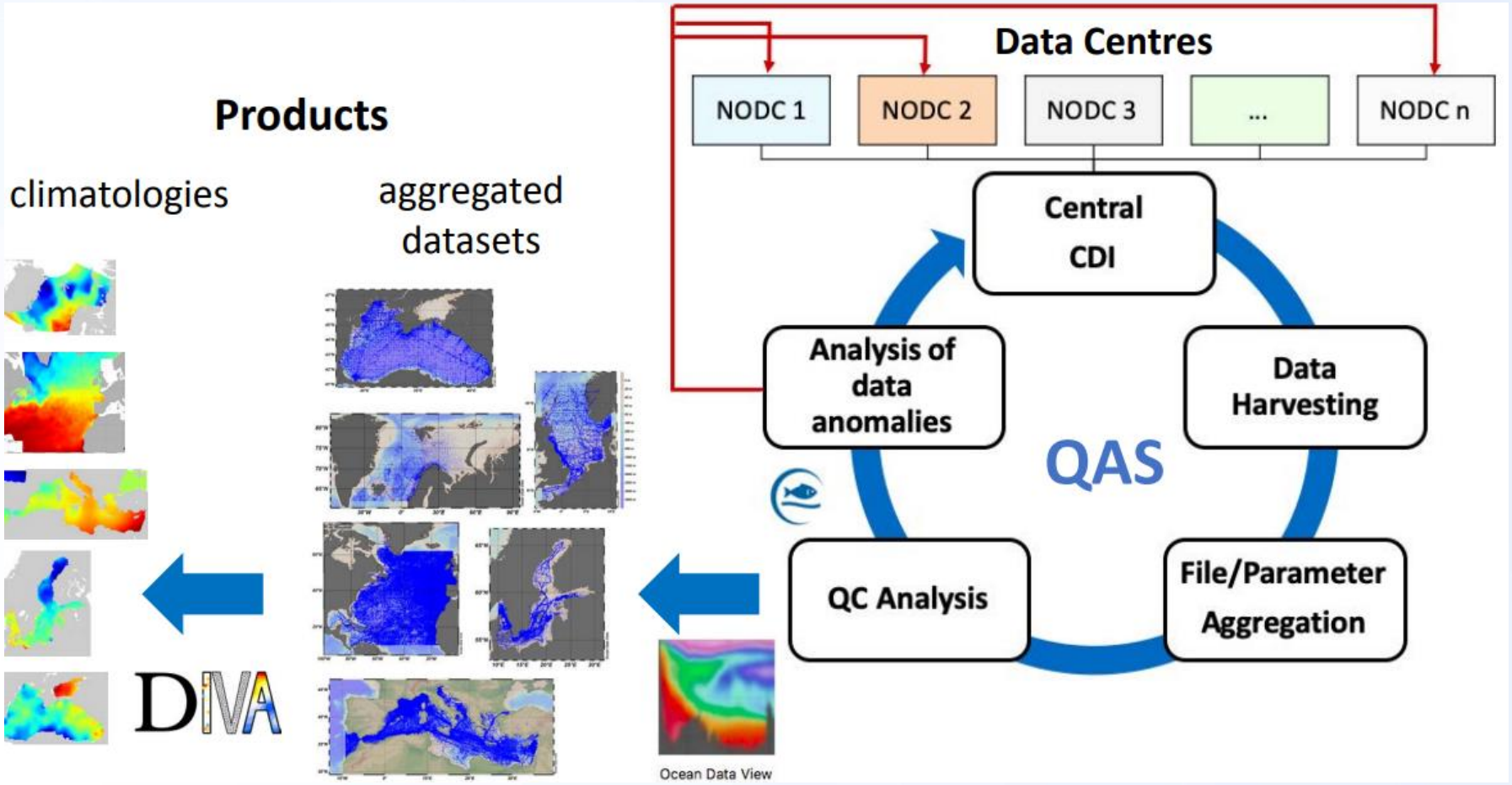
6 common catalogues of metadata



Have comparable data ➔ interoperability

- Same file formats relying on the common vocabularies
    - ODV - Ocean Data view (ASCII)
    - MEDATLAS (ASCII)
    - NETCDF – CF (Binaire)
- Quality check protocol based on international (IOC/IODE) recommendations applied by all data centres
  - With automatic and manual checks
- Same quality flags on all measurements (part of the common vocabularies)
- Quality Assurance strategy, implementing a QC -Loop

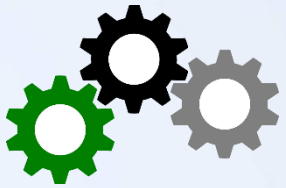
QC-Loop with feedback to data centres



Have common tools for data and metadata preparation

- **Tools are distributed to all SeaDataNet partners**
  - **MIKADO** : To generate the metadata descriptions of the SDN catalogues
  - **NEMO** To convert files to SeaDataNet formats
  - **OCTOPUS** : To convert from One SDN format to another
  - **Ocean Data View (ODV)** : To visualise and QC the data
  - **DIVA** : For adata analysis and product generations (climatology)
  - **Download Manager (DM) and Replication Manager (RM)** : to send datafiles from one data centre to the users or to the cloud

Have common tools for data and metadata access



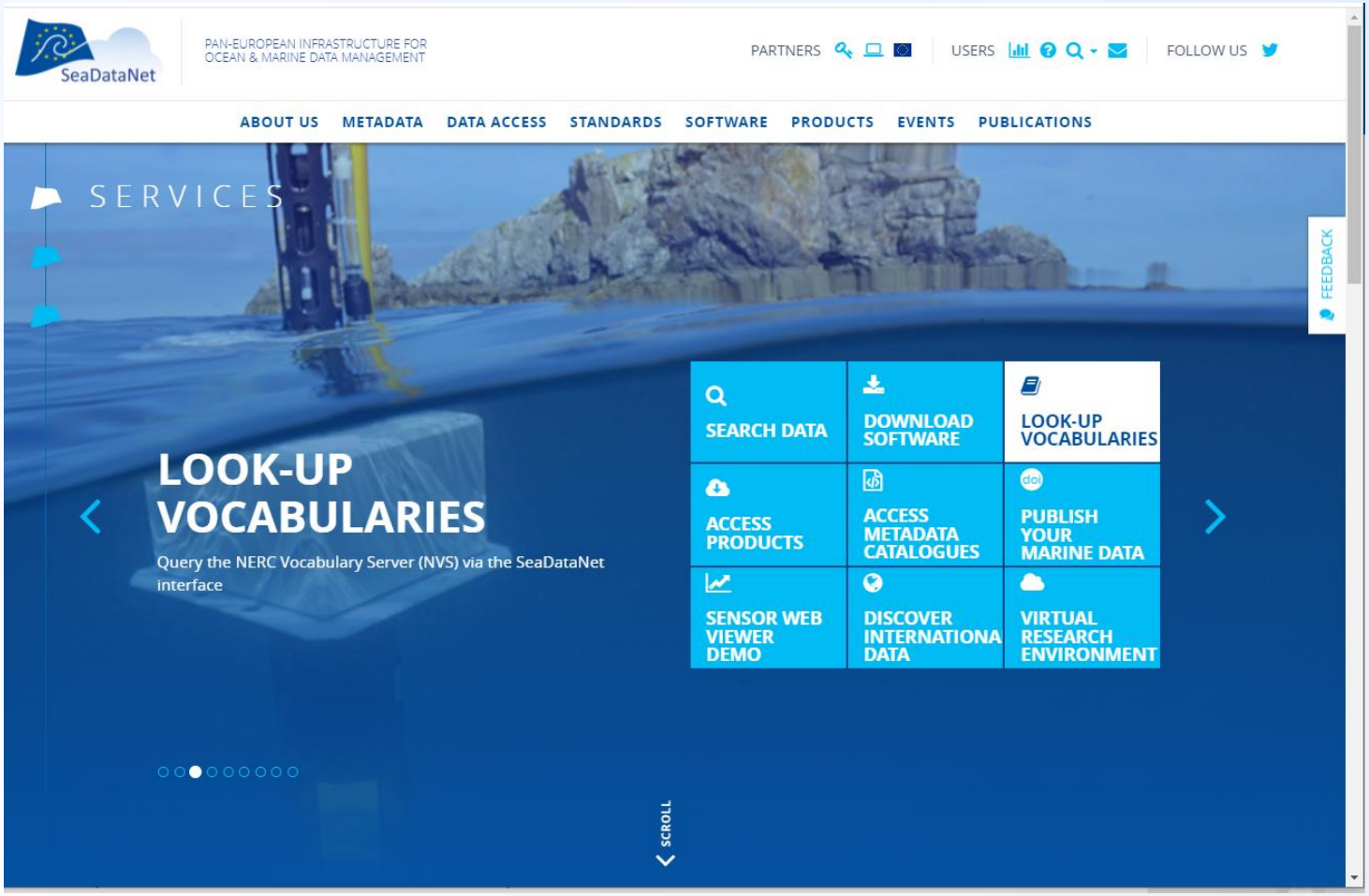
- **Installed on central servers: :**
  - **Central catalogues and the corresponding CMS =** Content Management System for updating (for projects and cruises and datasets)
  - **Web interfaces** for querying the various catalogues and searching for data
  - **Request Status Manager (RSM):** so that a user can track the progress of his or her data request
  - MARINE iD for identification in case of data downloading

Define the data policy

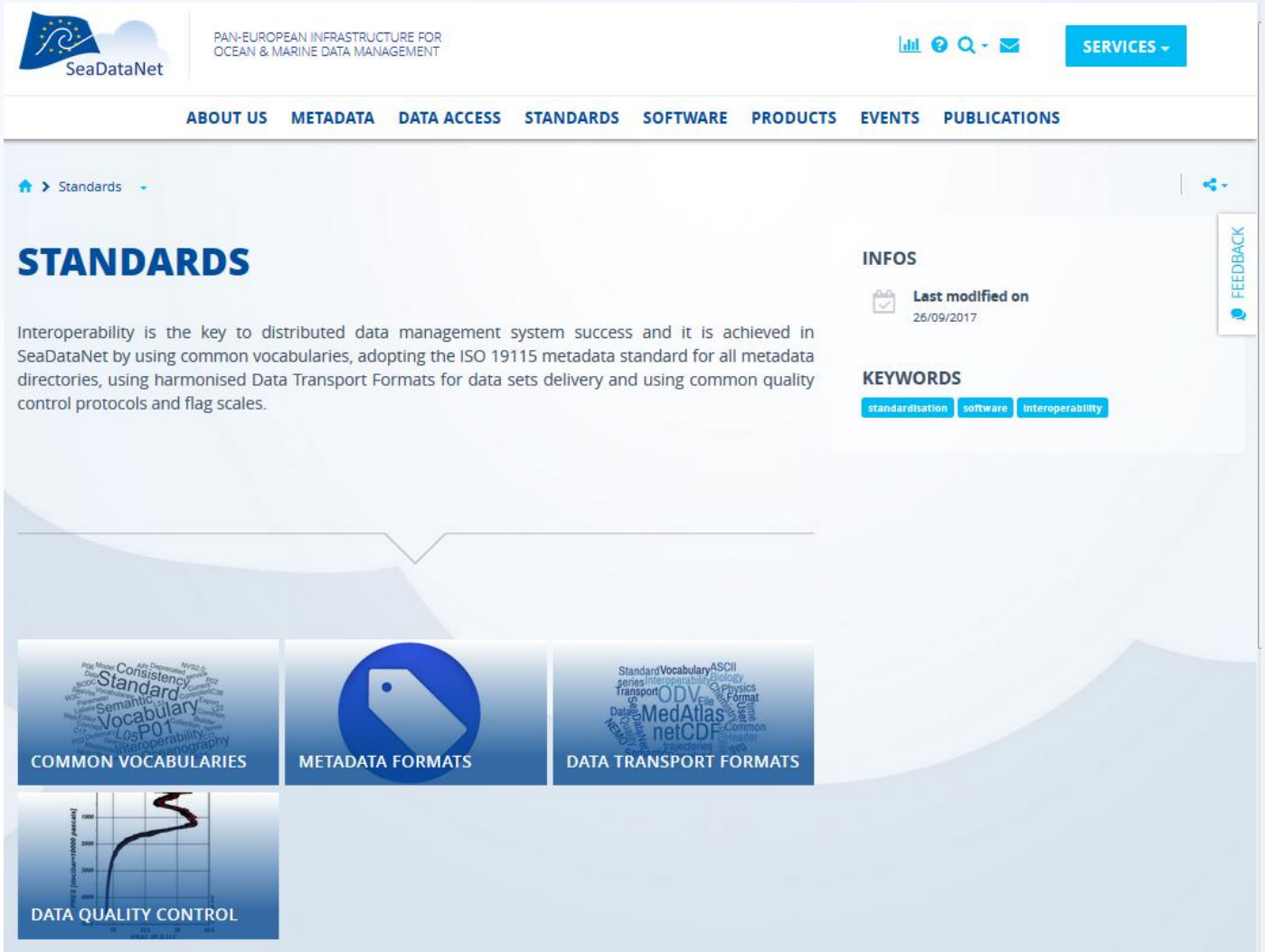
- Most of the SeaDataNet data are publicly available (CC-by licence) for download (91%)
- 9% of restricted data are managed too : restriction like moratorium or other access restrictions
  - The metadata of restricted data are available but
  - Their distribution is under the responsibility of each data centre that have included them in the SeaDataNet infrastructure : case per case negotiation with the data user

SeaDataNet portal- https://www.seadatanet.org/

- Metadata
- Data
- Standards
- Tools
- Products



Standards


SeaDataNet
PAN-EUROPEAN INFRASTRUCTURE FOR
OCEAN & MARINE DATA MANAGEMENT
SERVICES
ABOUT US
METADATA
DATA ACCESS
STANDARDS
SOFTWARE
PRODUCTS
EVENTS
PUBLICATIONS
Standards
STANDARDS
Interoperability is the key to distributed data management system success and it is achieved in SeaDataNet by using common vocabularies, adopting the ISO 19115 metadata standard for all metadata directories, using harmonised Data Transport Formats for data sets delivery and using common quality control protocols and flag scales.
INFOS
Last modified on
26/09/2017
KEYWORDS
standardisation
software
interoperability
FEEDBACK
COMMON VOCABULARIES
METADATA FORMATS
DATA TRANSPORT FORMATS
DATA QUALITY CONTROL

Tools

DOWNLOAD SOFTWARE

SOFTWARE

INFOS

Last modified on

A major objective and challenge in SeaDataNet is to provide an integrated and harmonised overview and access to data resources, managed by distributed data centres. Moreover it is an objective to provide users common means for analysing and presenting data and data products. Therefore the Technical Task Team of SeaDataNet has designed an overall system architecture, and is developing common software tools for data centres and users.

Common software tools are being developed and freely made available to **Data Centres and/or End Users** for:

- Editing and generating XML metadata entries: **MIKADO javatool**
- Tool for the generation of spatial objects from vessel navigation during observations: **EndsAndBends**
- SeaDataNet file format convertor : **OCTOPUS**
- Conversion of any ASCII format to the SeaDataNet ODV4 ASCII format: **NEMO javatool**
- Connecting systems of Data Centres to the SeaDataNet portal for data access: **Replication Manager javatool**
- Analysing and visualising of data sets: **Ocean Data View (ODV) software package**
- Interpolation and variational analysis of data sets: **DIVA software package**

sdn-userdesk@seadatanet.org – www.seadatane

Capacity building

- Around every 2 years: Training for all data centres connected to SDN infrastructure

End of part 2

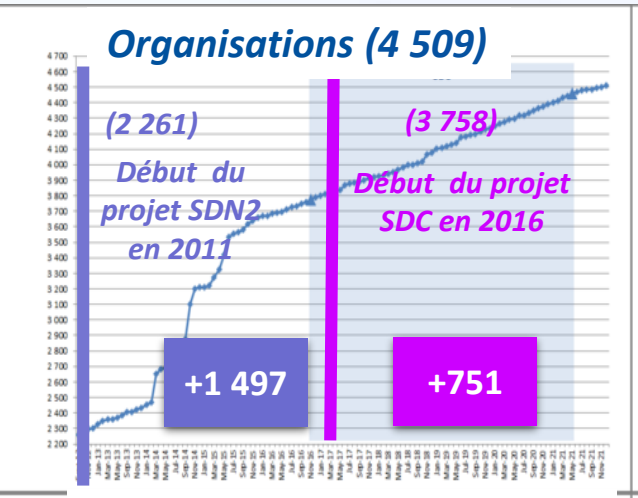
Part 3

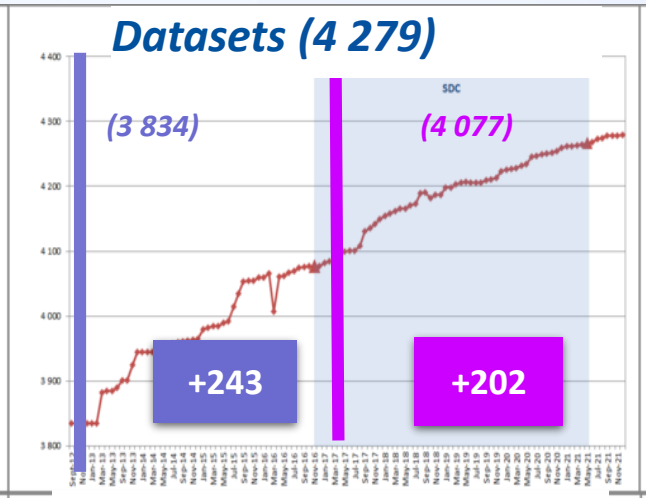
The SeaDataNet infrastructure

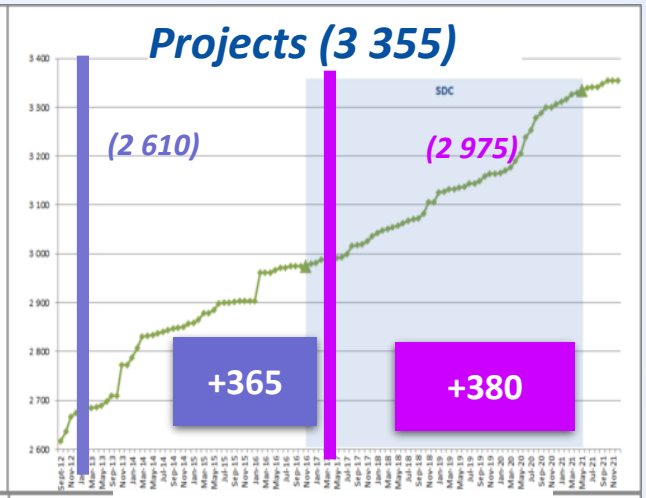
- Current content
- Example of proposed services

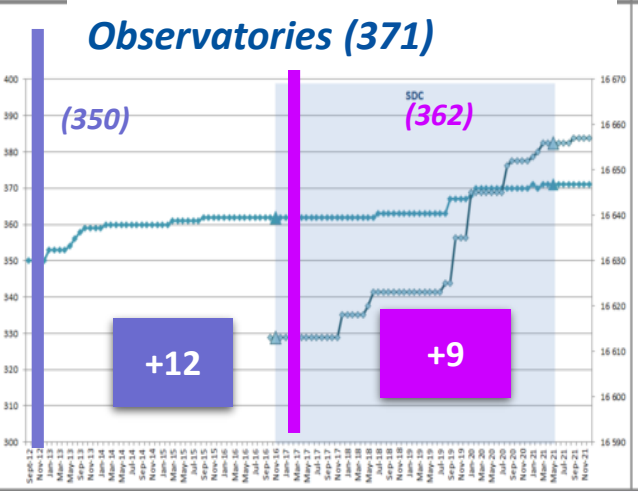
Current content of the SDN infrastructure

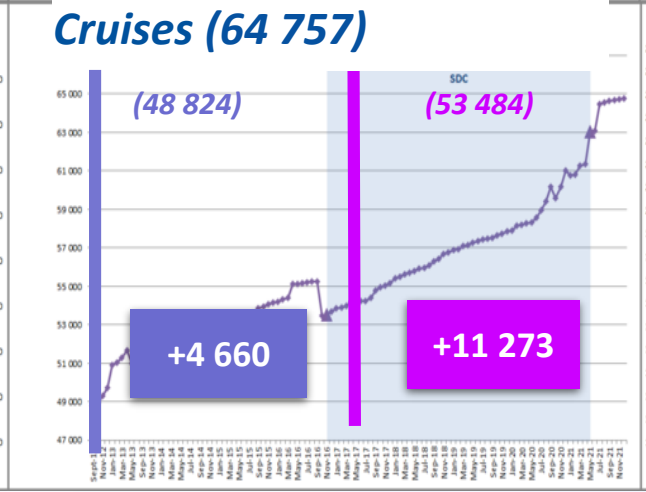
- Content of the catalogues

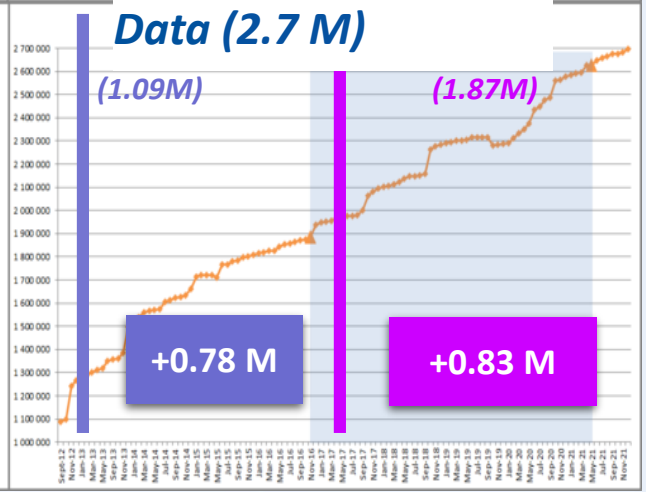






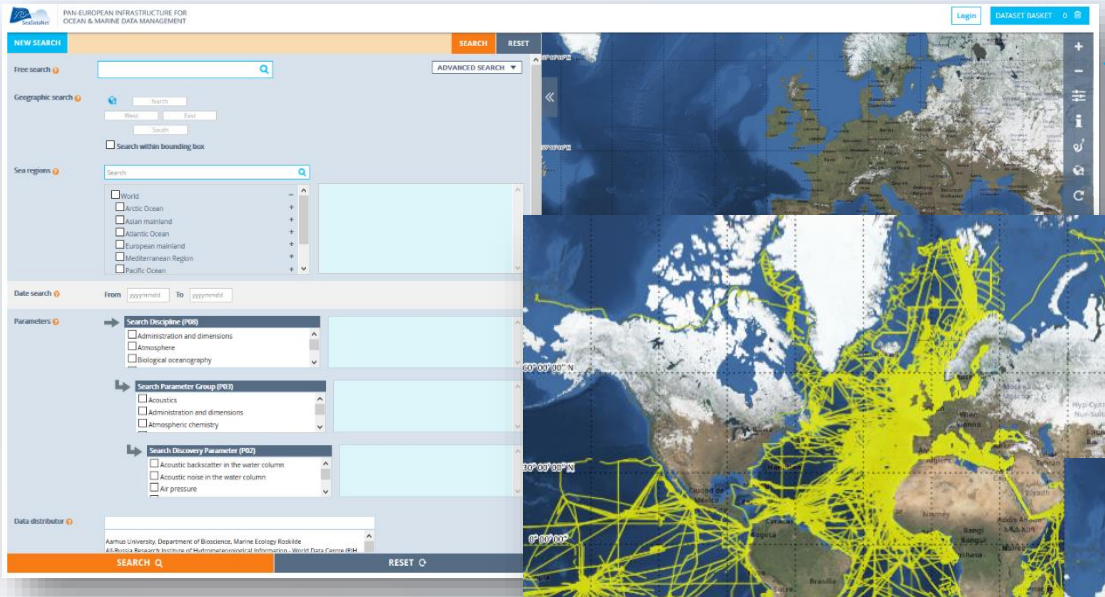






SeaDataNet

Open Research Data Week, Malta, 25 January 2022



Search interface

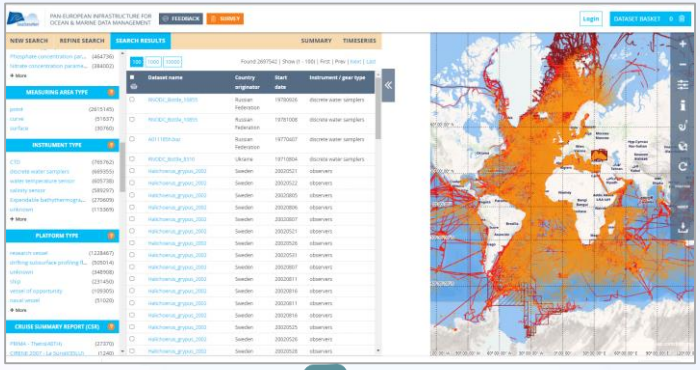
cdi.seadatanet.org/search

Trajectories

Vertical profiles or time series

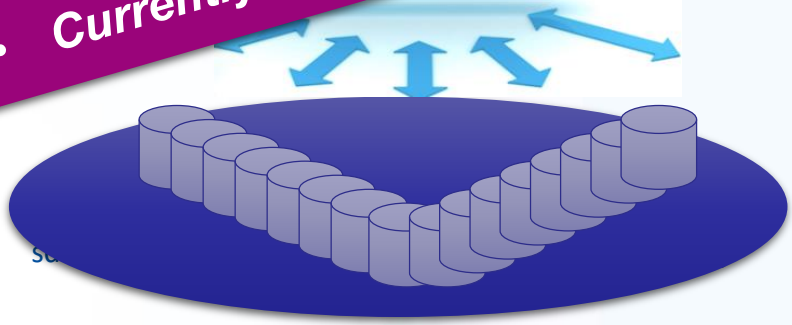
- since 1800 ➔ 2022
- 2.69 Millions of CDI for physics, chemistry, biology, geology and geophysics
- 91 % free access after Marine-ID connection

Service to users: Discovery and Access to data



Data discovery

- At the end of the 1st project (2011): 40 data centres, data distributed in NODCs
- 2nd project (2016): 80 data centres , data distributed in NODCs
- Currently (2022): 113 data centres, public data duplicated in the Cloud



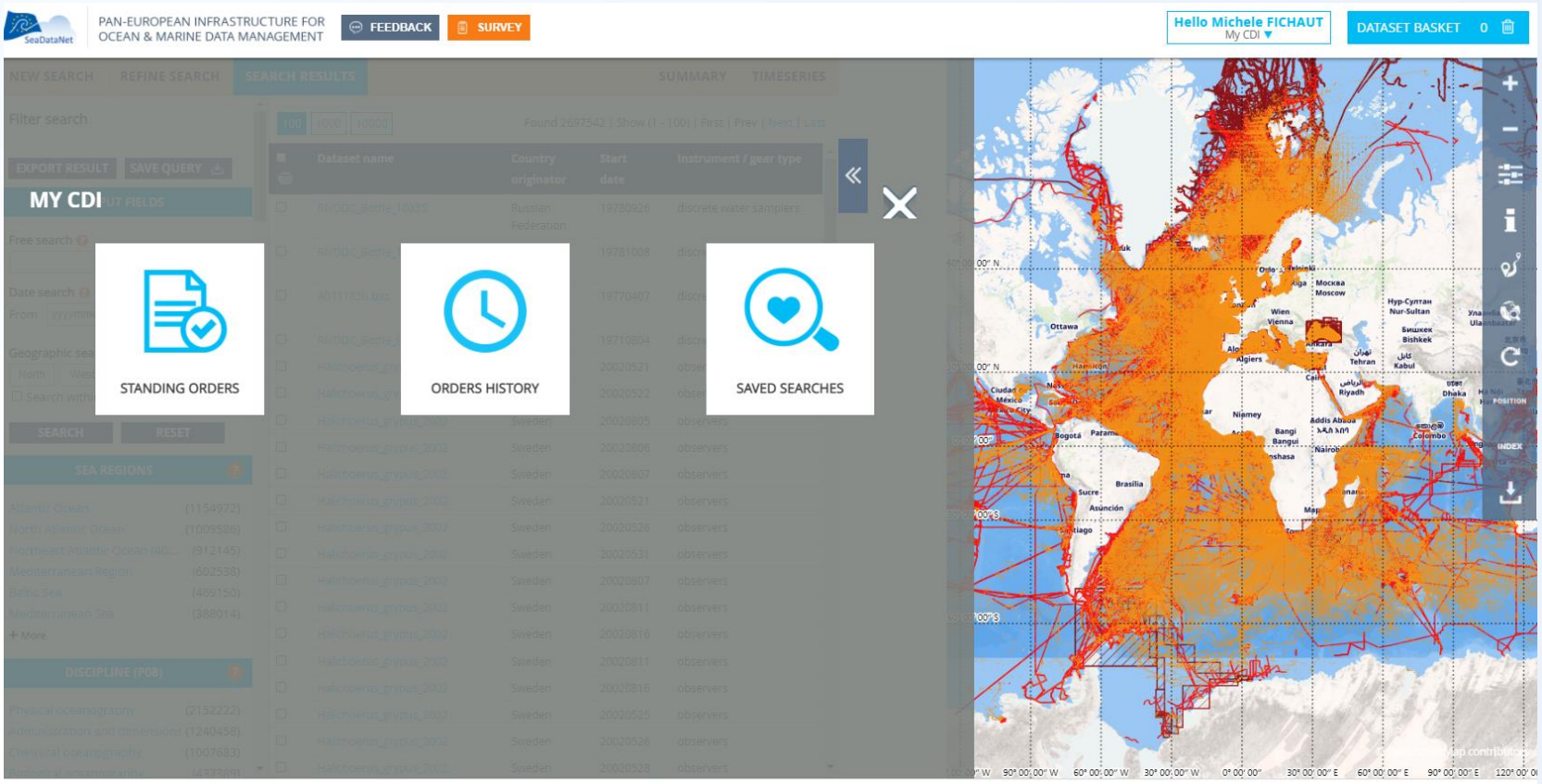
Data sources =

Data centres fed by

more than 800 collecting laboratories

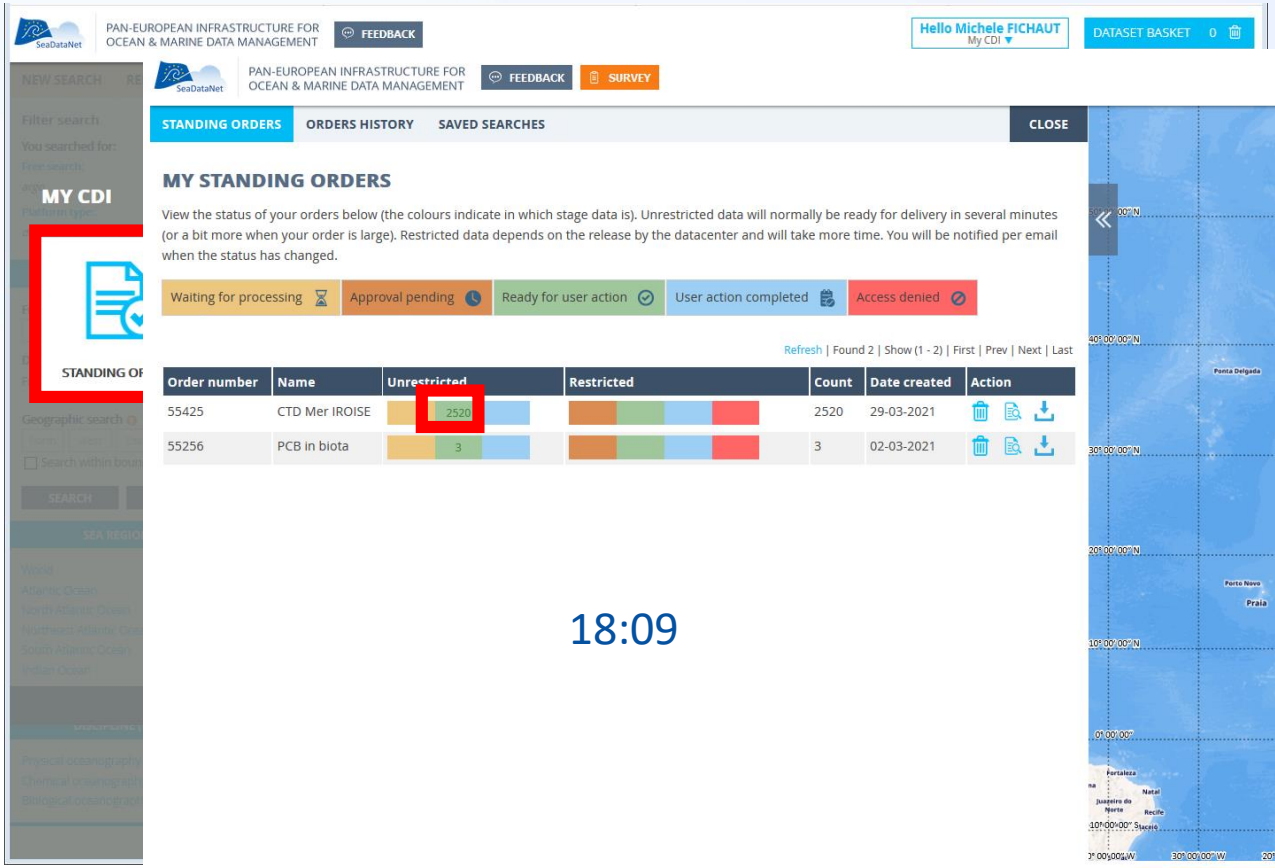
User personal environment: MySeaDataCloud

- To be able to save and share searches, to follow the status of data requests, to have an history of data downloads



User personal environment: MySeaDataCloud

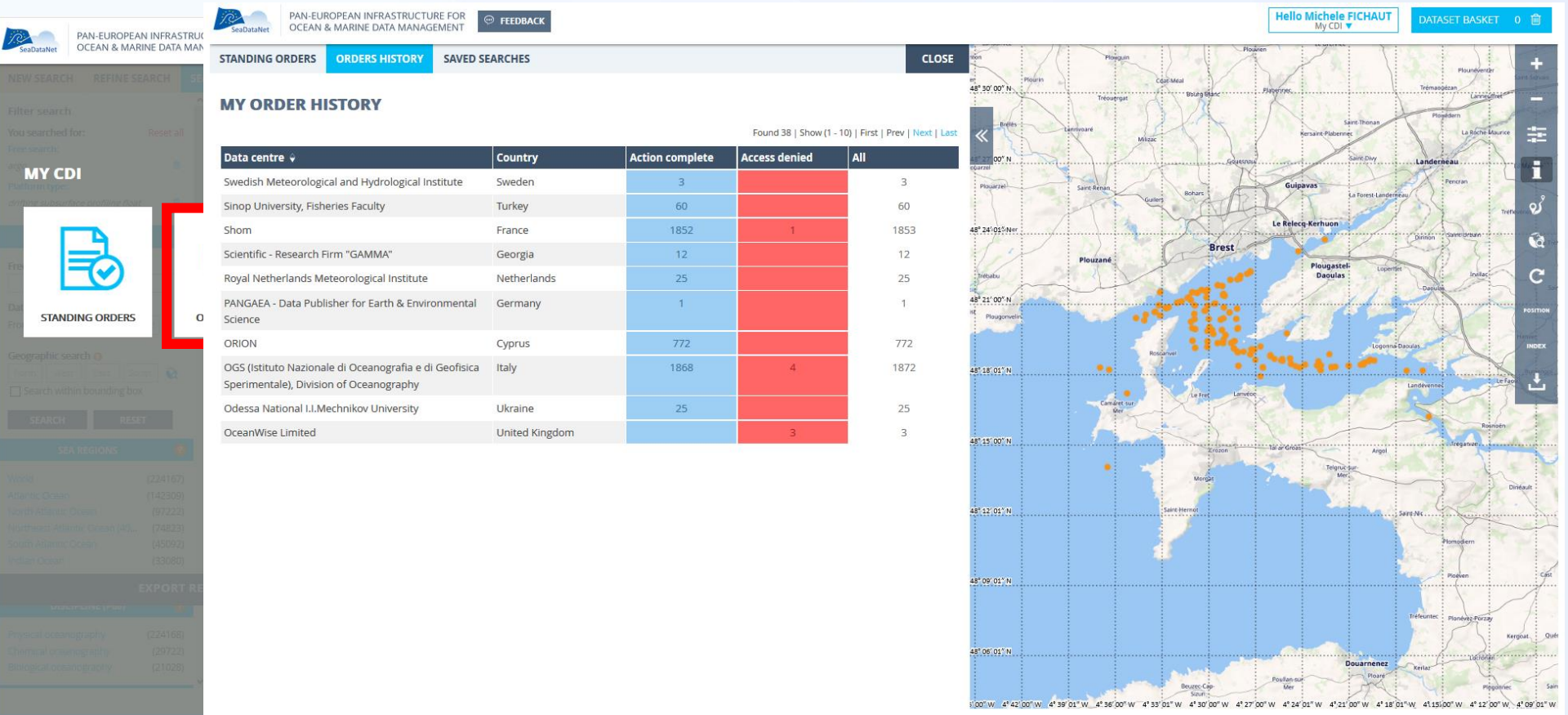
- Standing orders



18:09

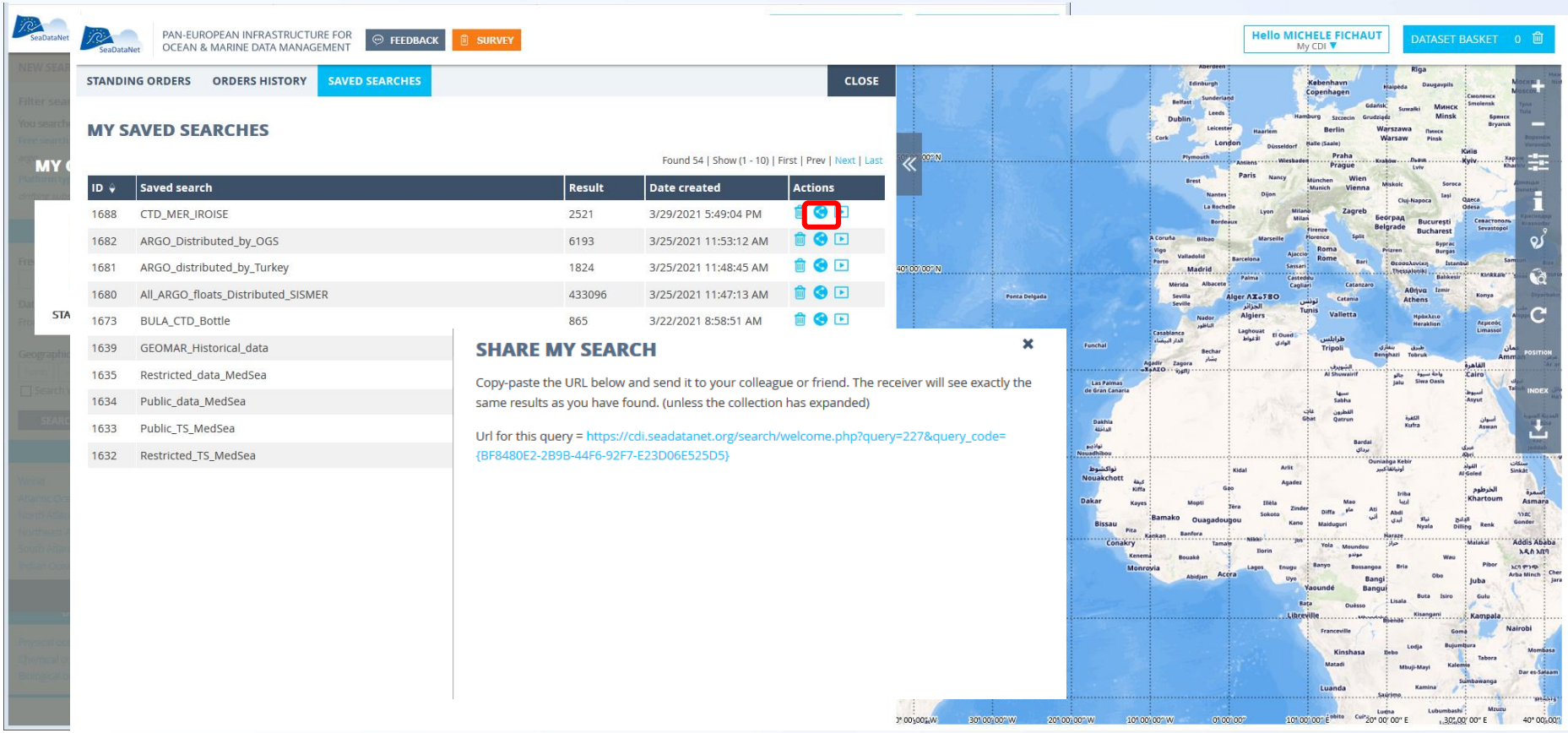
User personal environment: MySeaDataCloud

- Orders history



User personal environment: MySeaDataCloud

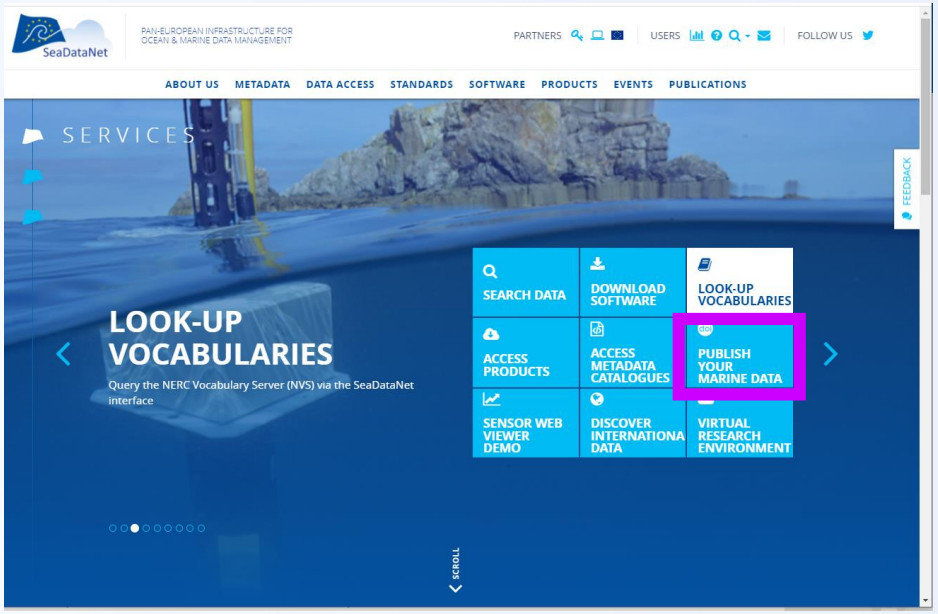
- Saved searches



Publishing service

SEANOE Sea scientific open data publication

- To offer scientists a place to publish their datasets and get DOI (Digital Object Identifier)
  - Useful for publications based on datasets, publisher often require a DOI on the studied dataset



Publishing service : landing page

Cruises PRIMO 1994 (CNR IT): Hydrographic measurements in the Sicily Channel and in the southern Tyrrhenian Sea (spring and fall 1994)

Click to download the data — DATA

Date	2021-12-13
Temporal extent	1994-05-20 -1994-10-18
Author(s)	Sparnocchia Stefania[1], Borghini Mireno[2]
Affiliation(s)	1 : CNR-ISMAR, Trieste, Italy 2 : CNR-ISMAR, La Spezia, Italy
DOI	10.17882/85185
Publisher	SEANOE
Keyword(s)	CTD, Sicily Channel, Tyrrhenian Sea, Western Mediterranean
Abstract	This data set contains the CTD data collected from the RV URANIA of the CNR (Italy) during the PRIMO-94 and PRIMO-94B cruises (20-29 May 1994 and 5-18 October 1994). These cruises were part of an intensive field program in the Sicily Channel and in the southern Tyrrhenian basin conducted by the Stazione Oceanografica of CNR in different periods from 1993 to 1995. Data have been used in several studies (see References). CTD profiles were collected using a Neil-Brown MKIII CTD. The probe was calibrated in temperature and conductivity at the SACLANT Center of La Spezia, before and after each cruise, and at sea in salinity and oxygen, against water samples. Declared instrumental precisions were 0.002 °C for temperature and 0.005 for salinity (PSS-78). The data set is provided per cruise as ODV Spreadsheet files in TXT format, containing: • Cruise name • Station number • Type of acquisition (here C) • Date in mon/day/yr and Time in hh:mm:ss • Coordinates in Longitude [degrees_east] and Latitude [degrees_north] • Bottom depth [m] • Depth, salt water [m] • Temperature, IPTS-68 [degC] • Conductivity [S/m] • Temperature, ITS-90 [degC] • Salinity, PSS-78 (Practical Salinity) • Dissolved oxygen [ml/l]
Licence	CC BY-NC
Utilisation	These data are published without any warranty, express or implied. The user assumes all risk arising from their use. These data are intended to be quality controlled, but it is possible that they contain errors. It is the unique responsibility of the user to assess if the data are appropriate for their use, and to interpret the data, data quality, and data accuracy accordingly. Authors welcome users to ask questions and report problems.
Acknowledgements	This data set was collected by the group known as the Stazione Oceanografica (Oceanographic Station) of the CNR, Pozzuolo di Lerici, La Spezia, led by Mario Astraldi and Gian Pietro Gasparini. We are grateful to Mr. Carlo Galli, Mr. Egisto Lazzoni and Mr. Domenico Bacciola for their remarkable contribution in the field and in the laboratory work. The research was funded by the EU through the MAST program (Contracts MAS2-CT93-0061 GEODYME and MAS2-CT93-0066 EUROMODEL II-MTP). The experiment in the Sicily Channel was a contribution to the IOC Programmes POEM and PRIMO.
Sensor metadata	Neil-Brown MK III CTD

Data

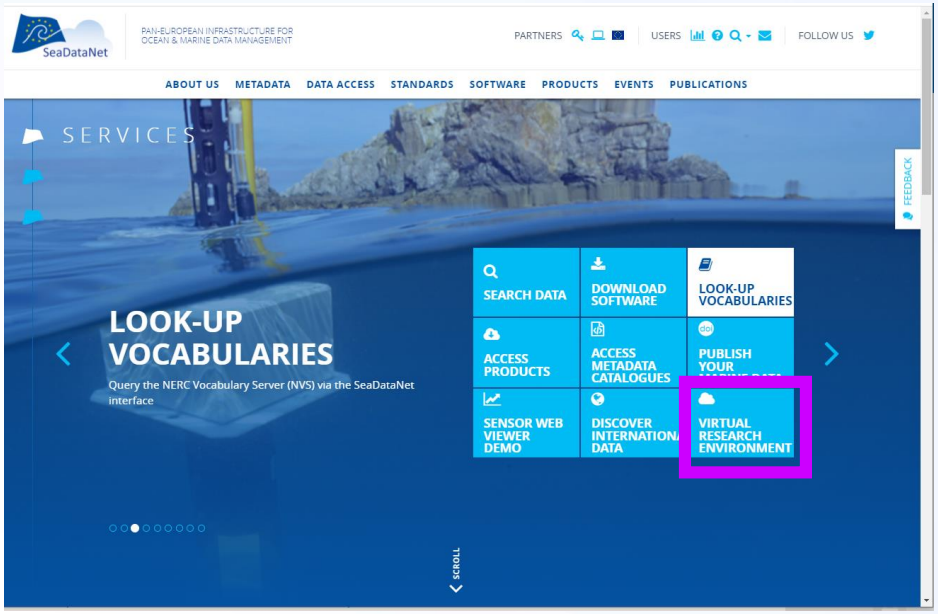
File	Size	Format	Processing	Access
CTD Data from PRIMO-94	9 MB	ODV		Open access
CTD Data from PRIMO-94B	9 MB	ODV		Open access

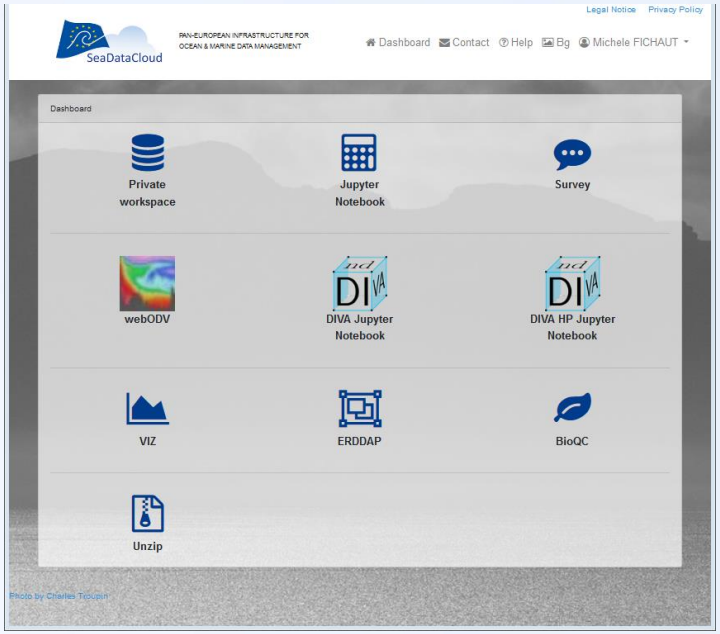
How to cite

Sparnocchia Stefania, Borghini Mireno (2021). **Cruises PRIMO 1994 (CNR IT): Hydrographic measurements in the Sicily Channel and in the southern Tyrrhenian Sea (spring and fall 1994).** SEANOE. https://doi.org/10.17882/85185

Virtual Research Environment for users

- A virtual environment in the Cloud,
  - With data and tools
  - Possibility to add his/her own data





End of part 3

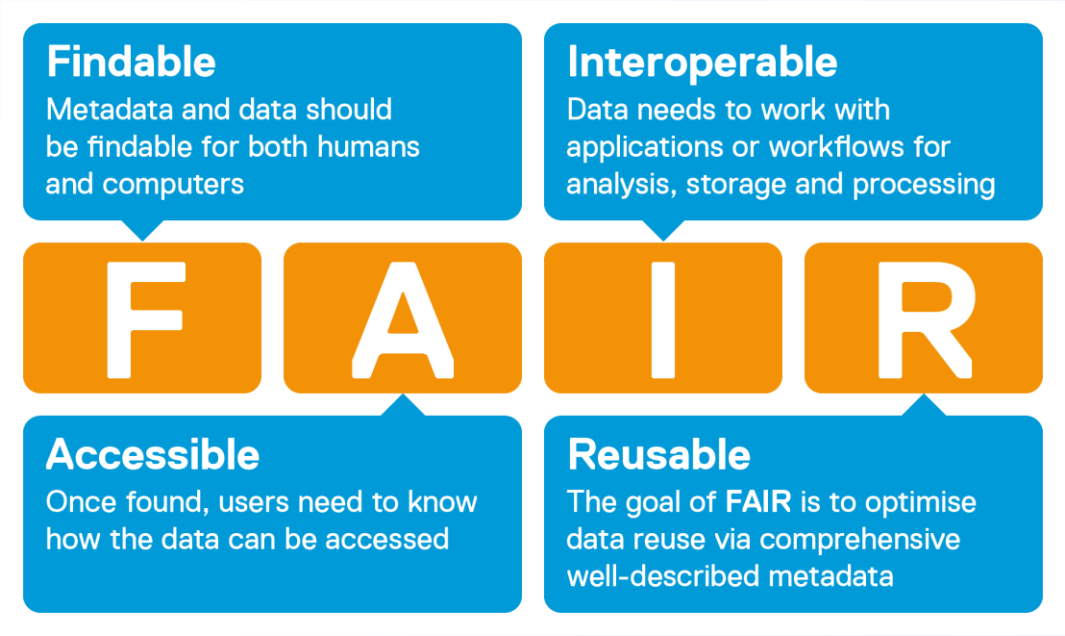
Part 4

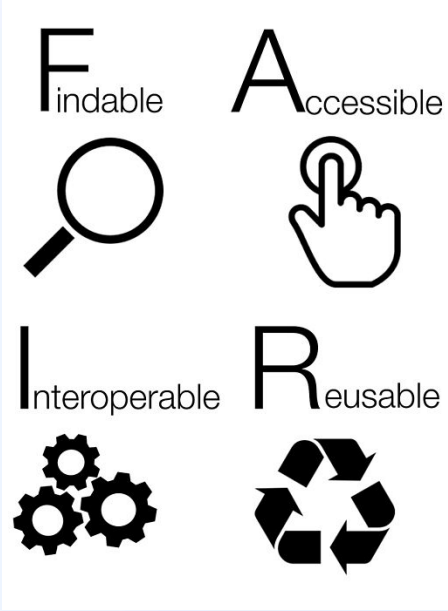
FAIR Principles and data FAIRness

- Presentation of the FAIR principles
- Evaluation of the data FAIRness
- Example of SDN French physical/chemical cruises data distributed in SeaDataNet

FAIR data and metadata

- 2016, Paper « The FAIR Guiding Principles for scientific data management and stewardship" par Wilkinson, Dumontier, & Aalbersberg https://doi.org/10.1038/sdata.2016.18
- The FAIR Principles = a set of guidelines for managing research data
- aiming to make them **F**indable, **A**ccessible, **I**nteroperable and **R**e-usable by both humans and machines





FAIR principles

F : Findable

- ✓ F1. (Meta)data are assigned a globally unique and persistent identifier
- ✓ F2. Data are described with rich metadata (defined by R1 below)
- ✓ F3. Metadata clearly and explicitly include the identifier of the data they describe
- ✓ F4. (Meta)data are registered or indexed in a searchable resource

A : Accessible

- ✓ A1. (Meta)data are retrievable by their identifier using a standardised communications protocol.
  - ✓ A1.1. The protocol is open, free, and universally implementable.
  - ✓ A1.2. The protocol allows for an authentication and authorisation procedure, where necessary
- ✓ A2. Metadata are accessible, even when the data are no longer available

I : Interoperable

- ✓ I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
- ✓ I2. (Meta)data use vocabularies that follow FAIR principles
- ✓ I3. (Meta)data include qualified references to other (meta)data

R : Reusable

- ✓ R1. (Meta)data are richly described with a plurality of accurate and relevant attributes
  - ✓ R1.1. (Meta)data are released with a clear and accessible data usage license
  - ✓ R1.2. (Meta)data are associated with detailed provenance
  - ✓ R1.3. (Meta)data meet domain-relevant community standards

RDA - FAIR Data Maturity Model (FDMM) WG

- Specification and guidelines: https://doi.org/10.15497/RDA00050
- Indicators that aim to formulate measurable aspects of each principle that can be used by assessment approaches
- Generic self-assessment model to measure the level of maturity of a dataset

FAIR Data Maturity Model indicators

- 41 indicators have been defined by the WG RDA-FDMM
  - **F1** : 7 indicators
  - **A** : 12 indicators
  - **I** : 12 indicators
  - **R** : 10 indicators

Indicators are classified as
- Essential: utmost importance
- Important: substantially increase FAIRness
- Useful: nice to have

	Principle				
Priority	Findable	Accessible	Interoperable	Reusable	Grand Total
Essential	7	8	0	5	20
Important	0	3	7	4	14
Useful	0	1	5	1	7
Grand Total	7	**12**	**12**	**10**	**41**

FAIR Data Maturity Model indicators

- 7 indicators for FINDABLE (all essentials) - identifiers
  1. **F1-01M**: Metadata identified by a persistent identifier
  2. **F1-O1D**: Data identified by a persistent identifier
  3. **F1-O2M**: Metadata is identified by a globally unique identifier
  4. **F1-O2D**: Data is identified by a globally unique identifier
  5. **F2-O1M**: Rich metadata is provided to allow discovery
  6. **F3-O1M**: Metadata includes the identifier of the data
  7. **F4-O1M**: Metadata is offered in such a way that it can be harvested and indexed

FAIR Data Maturity Model indicators

- 12 indicators for ACCESSIBLE (8 essential, 3 important, 1 useful)
    8. **A1-01M**: Metadata contains information to enable the user to get access to the data
    9. **A1-02M**: Metadata can be accessed manually (i.e. with human intervention)
    10. **A1-02D** : Metadata identifier resolves to a metadata record
    11. **A1-03M**: Metadata identifier resolves to a metadata record
    12. **A1-03D**: Data identifier resolves to a digital object
    13. **A1-04M**: Metadata is accessed through standardised protocol (e.g. HTTP, FTP, …)
    14. **A1-04D**: Data is accessed through standardised protocol (e.g. HTTP, FTP, …)
    15. **A1-05D**: Data can be accessed automatically (i.e. by a computer program)
    16. **A1.1-01M**: Metadata is accessed through a free access protocol
    17. **A1.1-01D**: Data is accessed through a free access protocol
    18. **A1.2-01D**: Data is accessed through an access protocol that's support Authentication and Authorisation
    19. **A2-01M**: Metadata is guaranteed to remain available after data is no longer available

FAIR Data Maturity Model indicators

- 12 indicators for INTEROPERABLE (7 important, 5 useful)
    20. **I1-01M**: Metadata uses knowledge representation expressed in standardised format
    21. **I1-01D**: Data uses knowledge representation expressed in standardised format
    22. **I1-02M**: Metadata uses machine-understandable knowledge representation
    23. **I1-02D**: Data uses machine-understandable knowledge representation
    24. **I2-01M**: Metadata uses FAIR-compliant vocabularies
    25. **I2-01D**: Data uses FAIR-compliant vocabularies
    26. **I3-01M**: Metadata includes references to other metadata
    27. **I3-01D**: Data includes references to other data
    28. **I3-02M**: Metadata includes references to other data
    29. **I3-02D**: Data includes qualified references to other data
    30. **I3-03M**: Metadata includes qualified references to other metadata
    31. **I3-04M**: Metadata includes qualified references to other data

FAIR Data Maturity Model indicators

- 10 indicators for REUSABLE (5 essential, 4 important, 1 useful)
    32. **R1-01M**: Plurality of accurate and relevant attributes ae provided to allow reuse
    33. **R1.1-01M**: Metadata includes information about the licence under which the data can be used
    34. **R1.1-02M**: Metadata refers to a standard reuse licence
    35. **R1.1-03M**: Metadata refers to a machine-understandable reuse licence
    36. **R1.2-01M**: Metadata includes provenance information according to community-specific standards
    37. **R1.2-02M**: Metadata includes provenance information according to a cross-community language
    38. **R1.3-01M**: Metadata complies with a community standard
    39. **R1.3-01D**: Data complies with a community standard
    40. **R1.3-02M**: Metadata is expressed in compliance with to a machine-understandable community standard
    41. **R1.3-02D**: Data is expressed in compliance with to a machine-understandable community standard

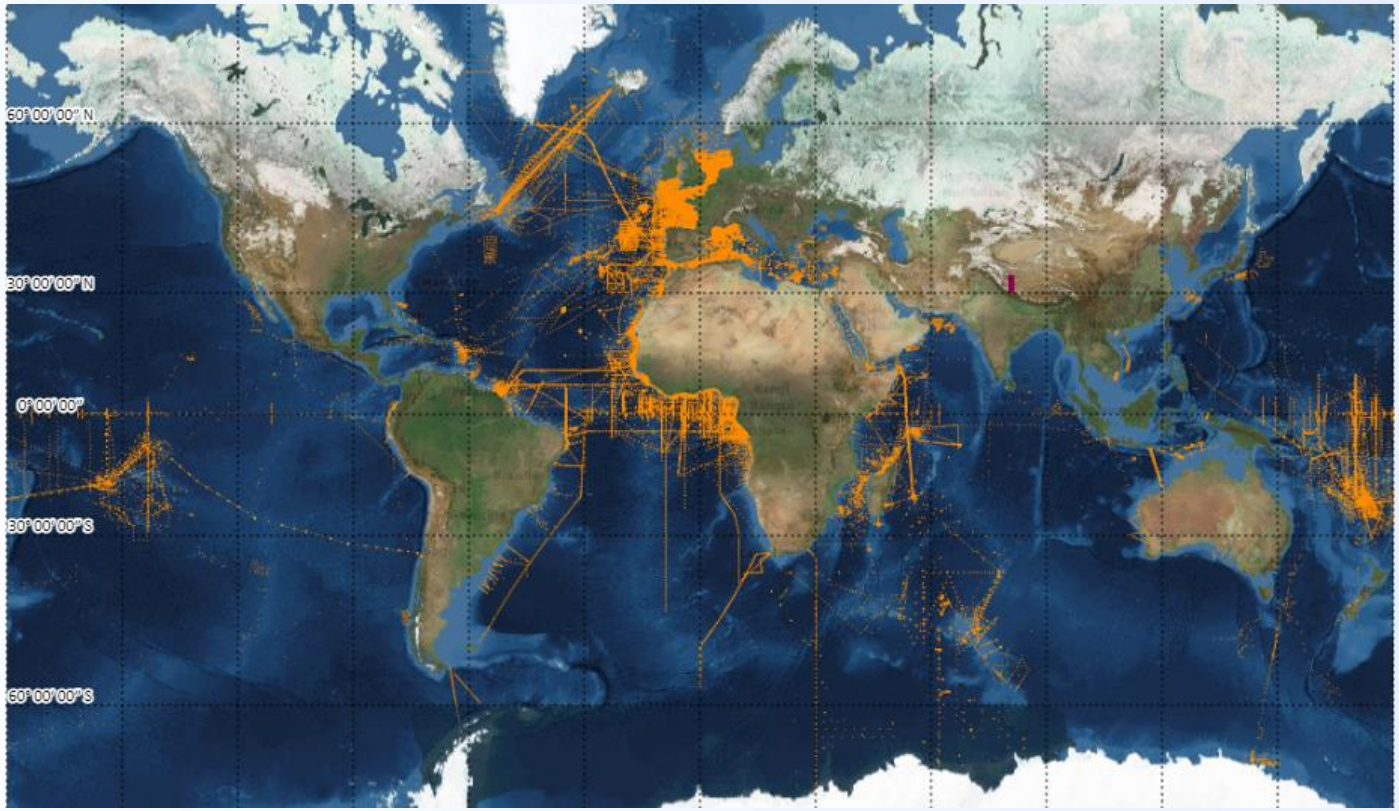
FDMM evaluation methods

- 2 methods
  - Measuring progress
    - Delivering a measure of the extent to which a resource under evaluation meets the requirements of an expressed indicator following the scale
      - 0 : not applicable
      - 1 : not being considered yet
      - 2 : under consideration or in planning phase
      - 3 : in implementation phase
      - 4 : fully implemented
  - Measuring pass-or-fail
    - Determining whether a resource under evaluation meets the requirements of an expressed indicator on a binary pass-or-fail scale

FAIRness of the Physics-Chemistry data from the French cruises

- In SeaDataNet : 118 508 CDIs

14 717 XBTs
49 500 CTDs
51 997 Bottles
2 294 Currentmeters

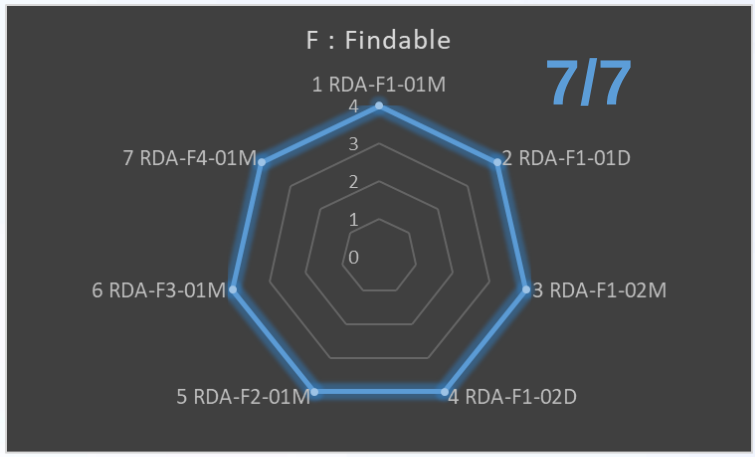


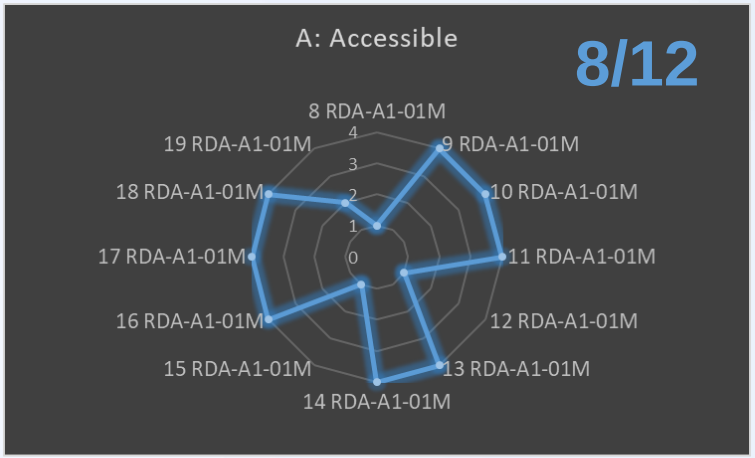
FAIRness of the Physics-Chemistry data from the French cruises

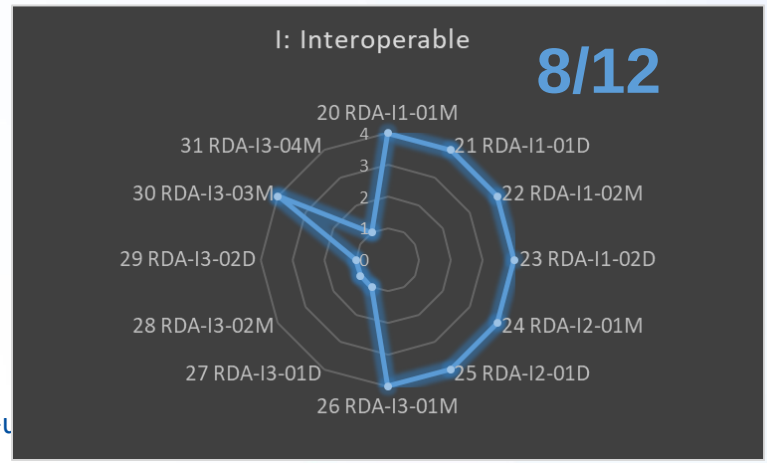
- Review of the 41 criteria previously presented and assignment of a level (0, 1, 2, 3 or 4) per criterion for this in situ dataset

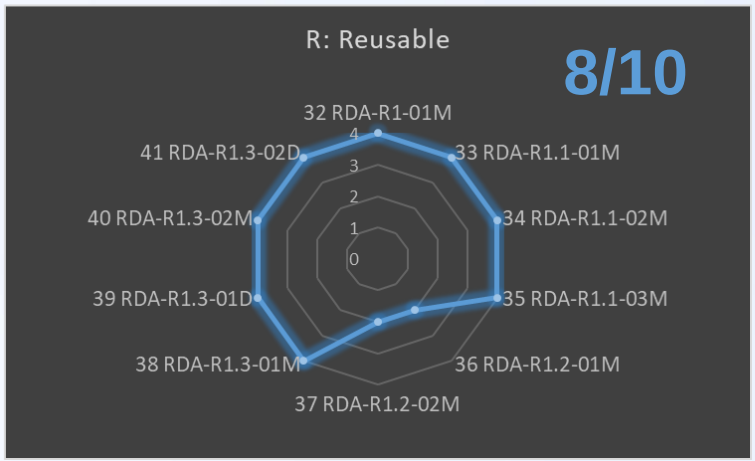
Results of the evaluation per FAIR principle

- Total 31/41





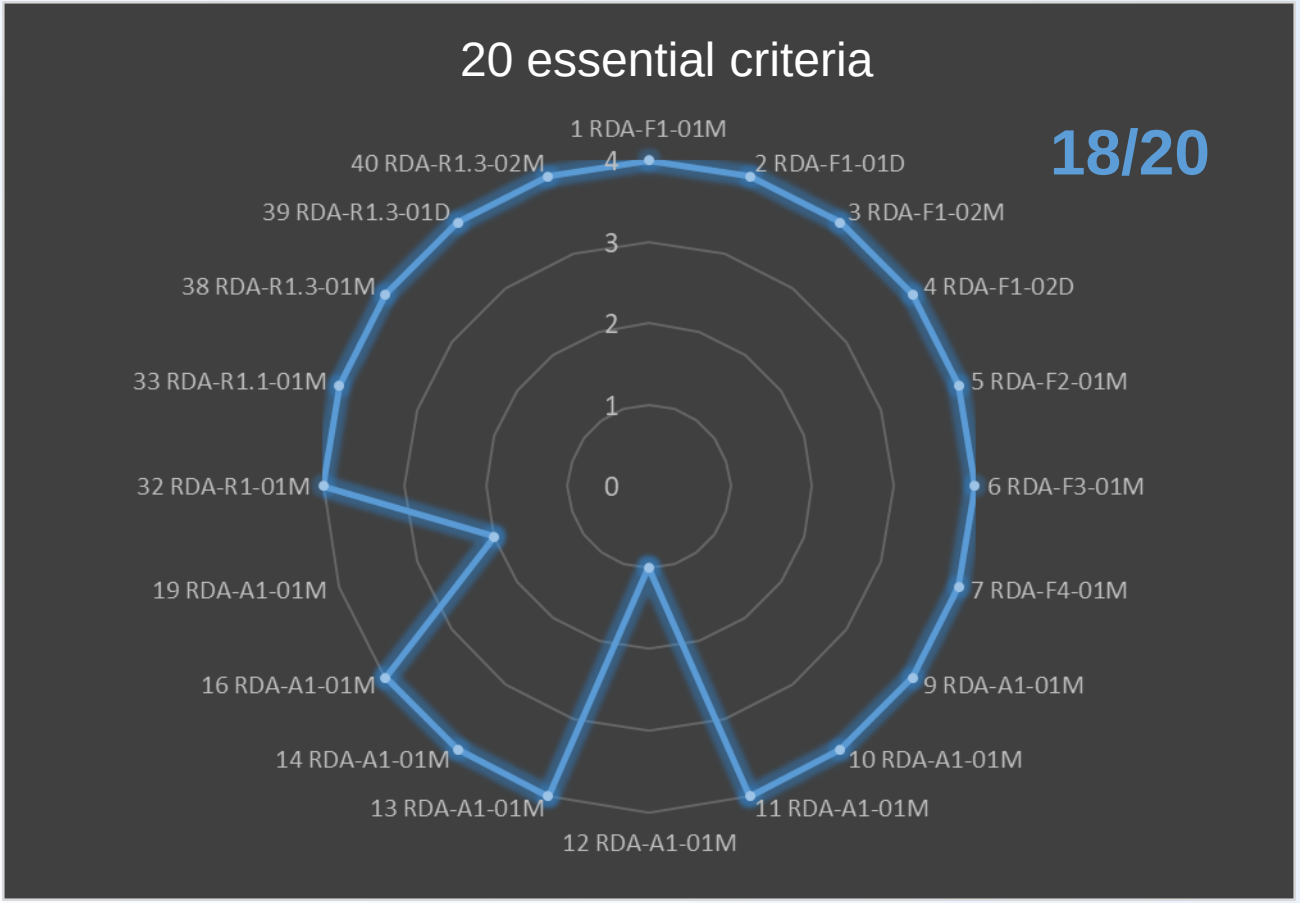




Per priority : Essential

MISSING

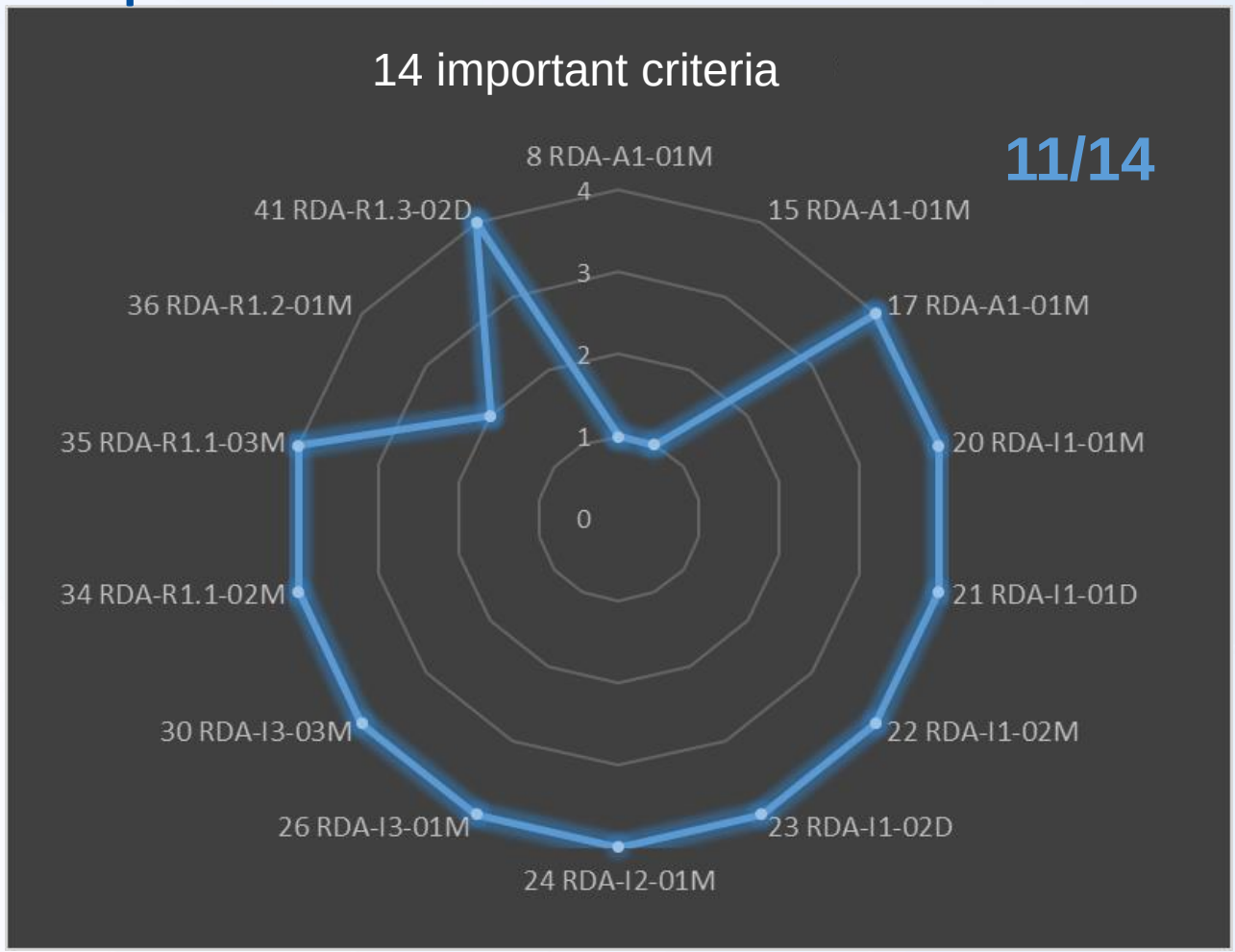
- 12 (A): direct access to data via an API for example
- 19 (A): Obsolete metadata are kept but the info is not accessible online at the moment



Per priority : Important

MISSING

- 8 (A): Direct access to data via metadata
- 15 (A): No API on data
- 36 (R): Provenance according to community standard



Per priority : Useful

MISSING

- 27 (I): Data with references to other data
- 28 (I): Metadata with references to other data
- 29 (I): Data with qualified references to other data
- 31 (I): Metadata with qualified references to other data

Conclusion

- Interesting exercise to see what improvements can be made to the datasets in particular with regard to the essential criteria which are “mandatory” to have FAIR data

End of part 4