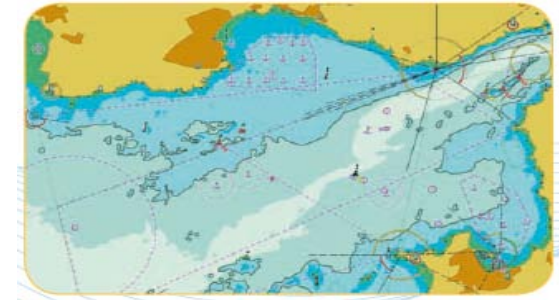
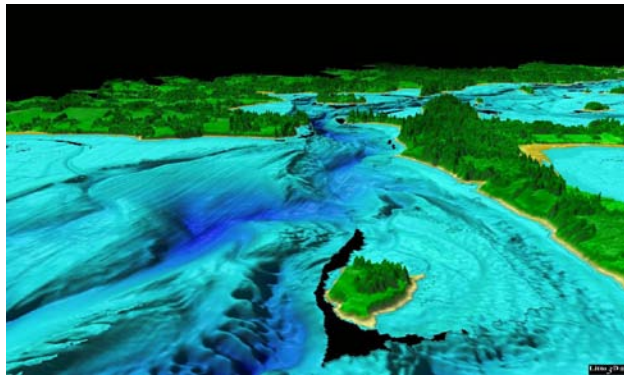


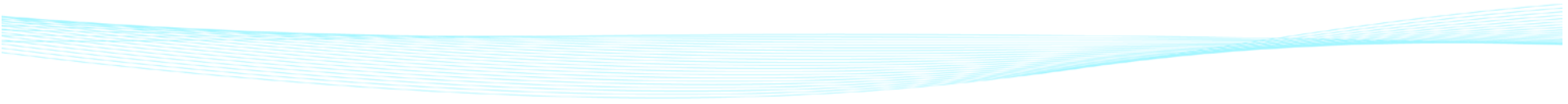
Quality control for Multibeam echosounders at the French Naval Hydrographic Service (SHOM)

*Christophe Vrignaud, Sophie Loyer, Patrick Michaux
Thierry Schmitt*

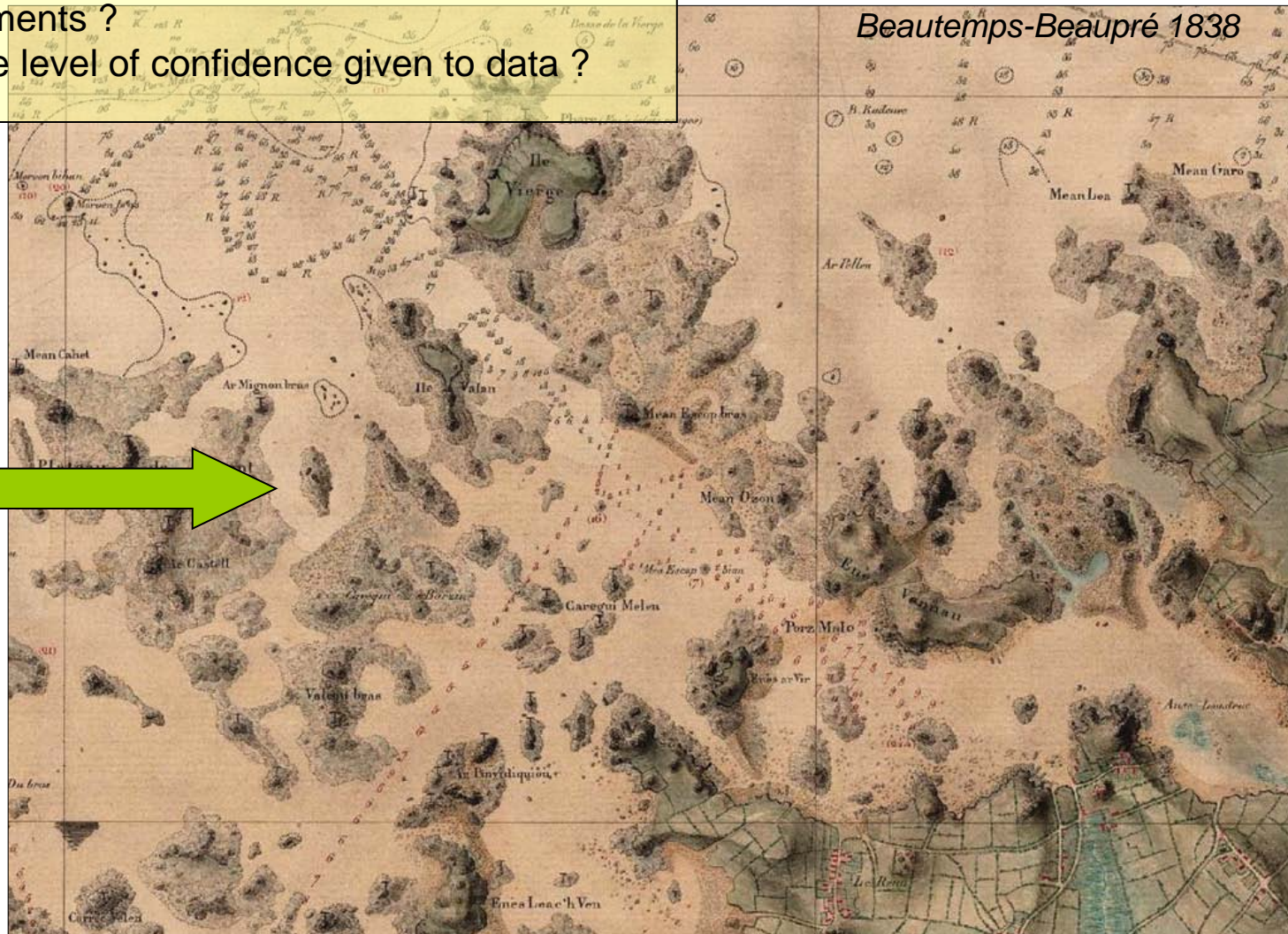
European bathymetric database and digital elevation model (EMODNET- HYDROGRAPHY initiative)

Thierry Schmitt as a servitor of the EMODNET
HYDROGRAPHY PROJECT

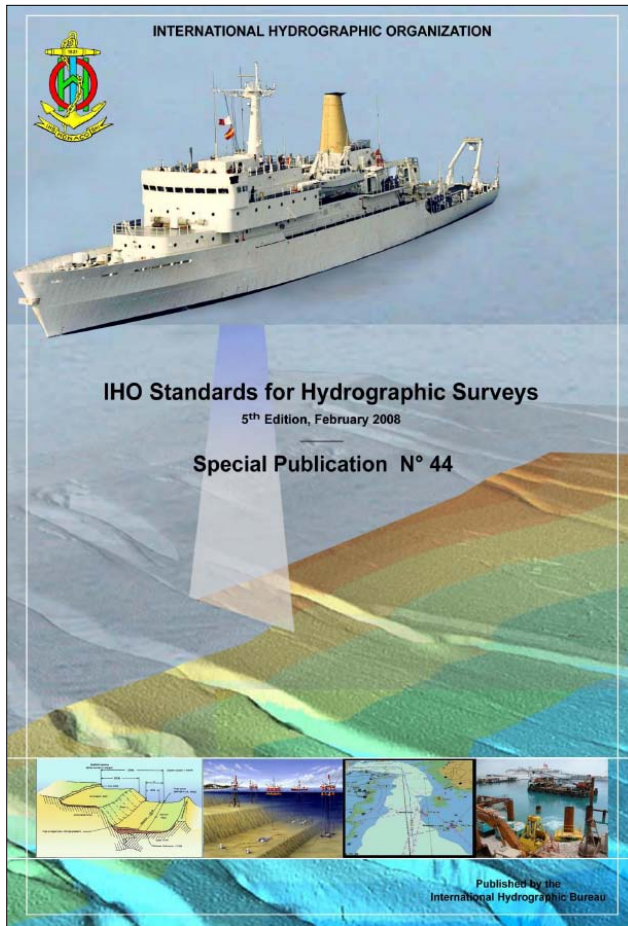


- 
- I The Hydrography requirements
 - II SHOM's quality control management
 - III Conclusion

- What is the real need ?
- What are the requirements ?
- In the end, what is the level of confidence given to data ?



IHO Special Publication N° 44, 5th Edition, February 2008



The international conventions give the global frame for the States.

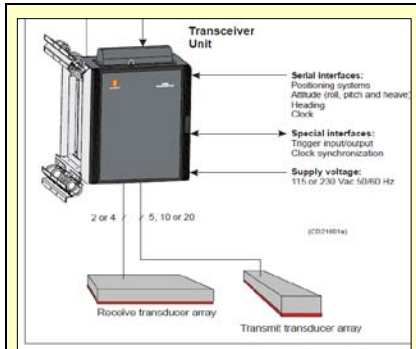
Concerning the requirements, the International Hydrographic Organization gives the **minimum** standards that must be achieved !

- SP44 provides requirements for horizontal and vertical accuracy, for detection features, for exploring methods ...
- SP44 provides also guidelines for quality control.

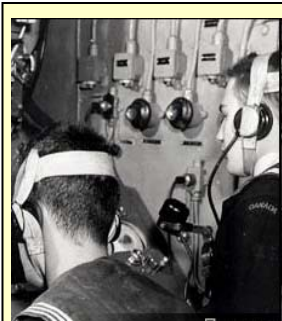
Reference	Order	Special	1a	1b	2
Chapter 1	Description of areas.	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but <i>features</i> of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Chapter 2	Maximum allowable THU 95% <i>Confidence level</i>	2 metres	5 metres + 5% of depth	5 metres + 5% of depth	20 metres + 10% of depth
Para 3.2 and note 1	Maximum allowable TVU 95% <i>Confidence level</i>	a = 0.25 metre b = 0.0075	a = 0.5 metre b = 0.013	a = 0.5 metre b = 0.013	a = 1.0 metre b = 0.023
Glossary and note 2	Full Sea floor Search	Required	Required	Not required	Not required
Para 2.1 Para 3.4 Para 3.5 and note 3	Feature Detection	Cubic <i>features</i> > 1 metre	Cubic <i>features</i> > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres	Not Applicable	Not Applicable
Para 3.6 and note 4	Recommended maximum Line Spacing	Not defined as full sea floor search is required	Not defined as full sea floor search is required	3 x average depth or 25 metres, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 metres	4 x average depth
Chapter 2 and note 5	Positioning of fixed aids to navigation and topography significant to navigation. (95% <i>Confidence level</i>)	2 metres	2 metres	2 metres	5 metres
Chapter 2 and note 5	Positioning of the Coastline and topography less significant to navigation (95% <i>Confidence level</i>)	10 metres	20 metres	20 metres	20 metres
Chapter 2 and note 5	Mean position of floating aids to navigation (95% <i>Confidence level</i>)	10 metres	10 metres	10 metres	20 metres

Multibeam: sensor for modern hydrography

From the pings to the post-processed data: not a simple task !



TX and RX array
(travel time and angle)



Sound velocity
surface and profil



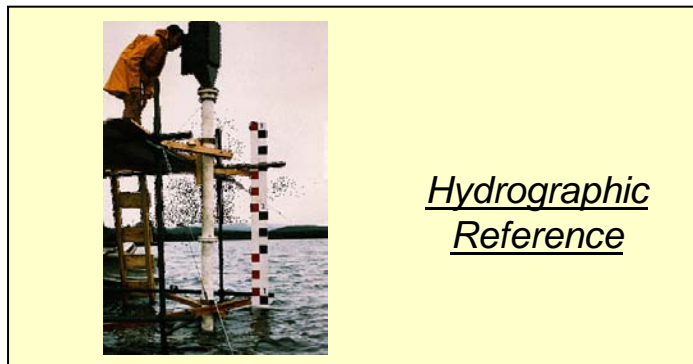
Motion Unit
Pitch, Roll, Heave + Heading



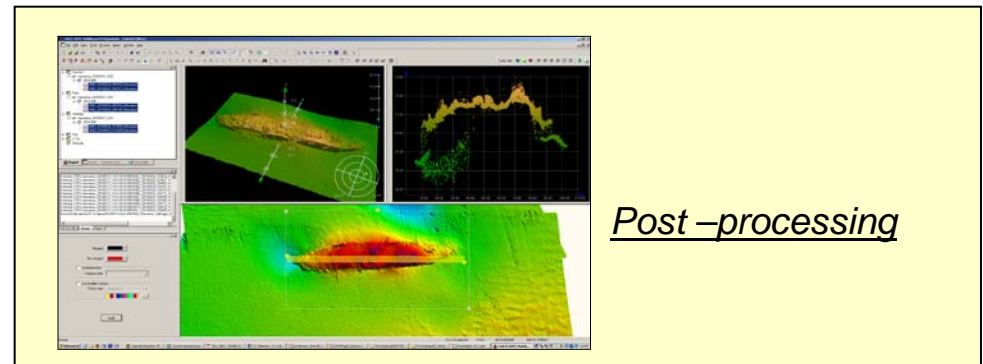
Positioning system
latitude and longitude + time stamps



Lever arms, angular offset + water line



Hydrographic Reference



Post-processing

- II The Hydrography requirements
- II SHOM's quality control management
- III Conclusion

- Training of surveyors
- Patch tests and calibration
- Reference areas
- Databases

- I The Hydrography requirements
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Training



S44 standard states (extract from the 5th edition – February 2008):

All components **and their combination** must be capable of providing data to the required standard. The hydrographic office / organisation needs to satisfy itself that this is so by, for example, conducting appropriate trials with the equipment to be used and by ensuring that adequate calibrations are performed prior to, as well as during and, if appropriate, after the survey being carried out. **The surveyor is an essential component of the survey process and must possess sufficient knowledge and experience to be able to operate the system to the required standard.** Measuring this can be difficult although surveying qualifications (e.g. having passed an IHO Cat A/B recognised hydrographic surveying course) may be of considerable benefit in making this assessment.

SHOM trains its staff in its own training centre: « SHOM's school »

- Hydrographic training programme for surveyors: FIG/IHO/ACI S-5 cat. B accredited (submitted for reconduction in 2011).
- Survey engineers are trained in ENSTA-Bretagne (S-5 cat. A programme)
- Vocational training throughout the career: hydrography, oceanography, nautical cartography, geophysics, quality management.
- Training effort (2010):
Global : 120 initial trainings and 214 vocational trainings in hydrography, oceanography, nautical cartography, geophysics, quality management.

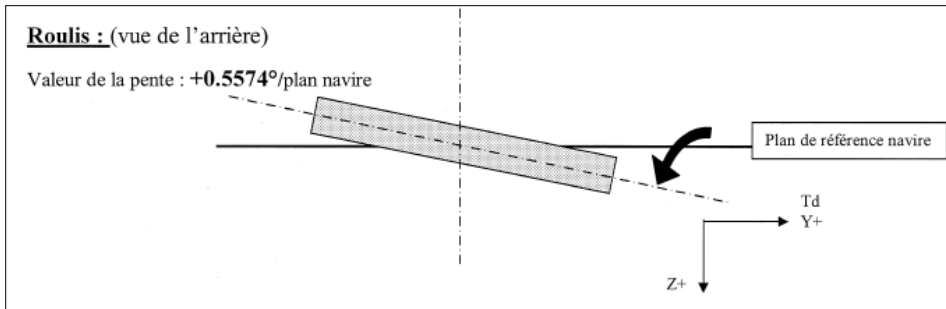
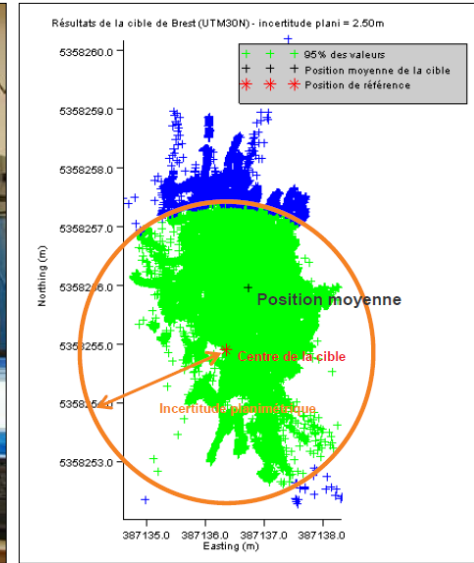
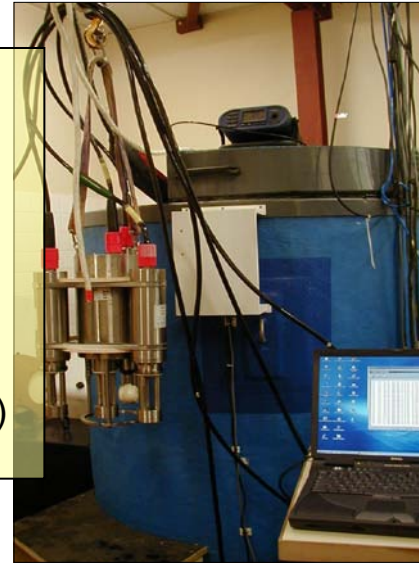


- I The Hydrography requirements
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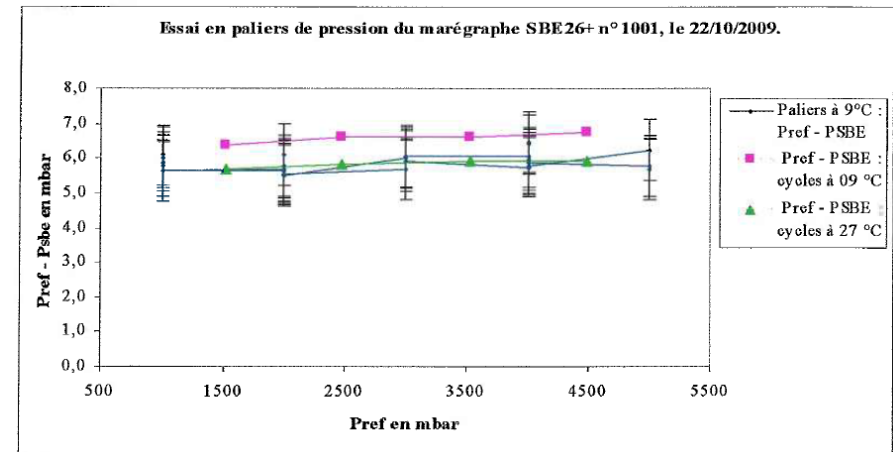
- Training of surveyors
- Patch tests and calibration
- Reference areas
- Databases

Sensors calibration (for MBES)

- Sound velocity sensor: every year
- Tide gauge: every year
- Positioning service (GPS target): as often as possible
- Lever arms and angular offsets: every 2-3 years in dry dock



Uncertainties of the sensors are provided via the TPU to processing algorithms (CUBE)



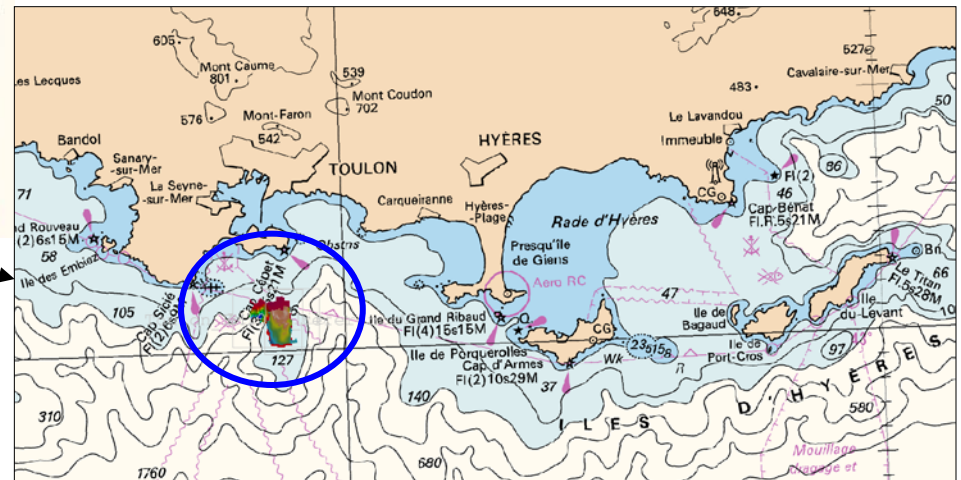
Areas for Patch Tests (canyons, wrecks, reference areas)

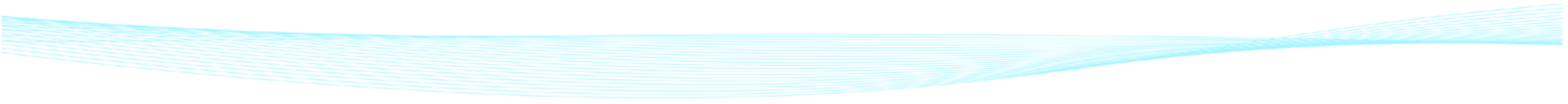
Deep Water (2200 & 4200m)

NE Atlantic Ocean

Medium Water (100m)

Mediterranean Sea



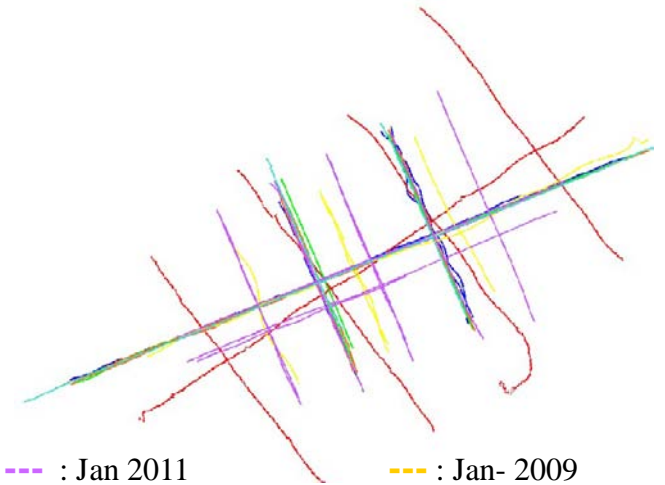
- 
- I The Hydrography requirements
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- Training of surveyors
- Patch tests
- Reference areas
- Databases

Comparison of multibeam lines to a reference surface: A vertical checking !

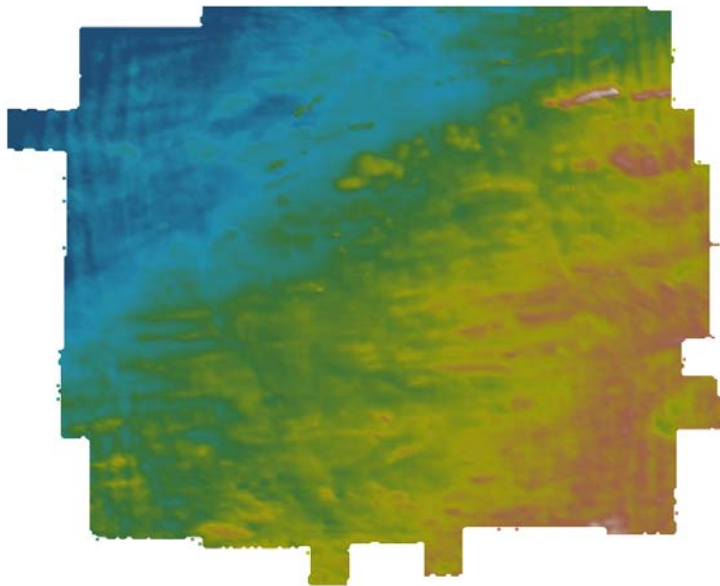
Main characteristics of a reference area:

- Small and flat area (which minimizes the effects of positioning errors)
- Exempted of known tide or hydrological complexity



--- : Jan 2011
--- : Jan- 2010
--- : Sept- 2010
--- : Oct- 2010

--- : Jan- 2009
--- : Sept- 2008
--- : Jul- 2007

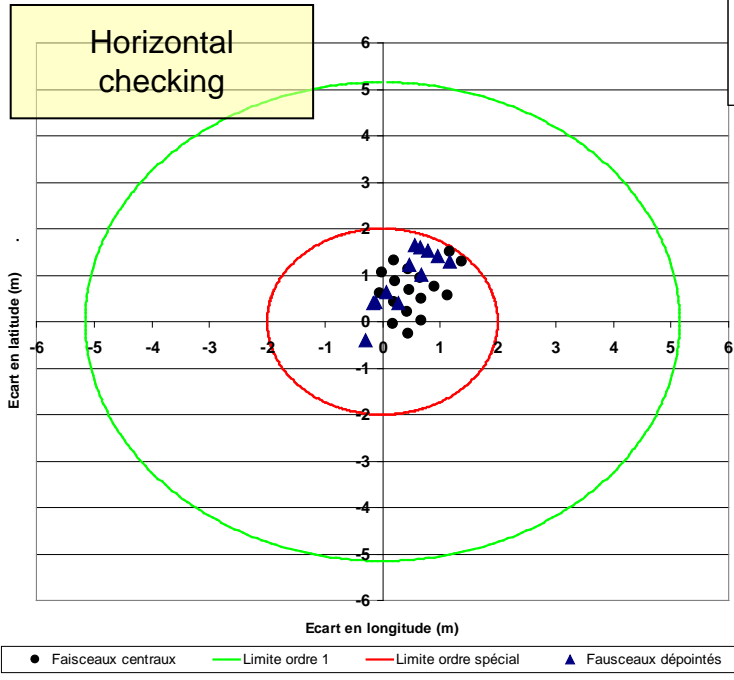


Individual analysis of each data set:

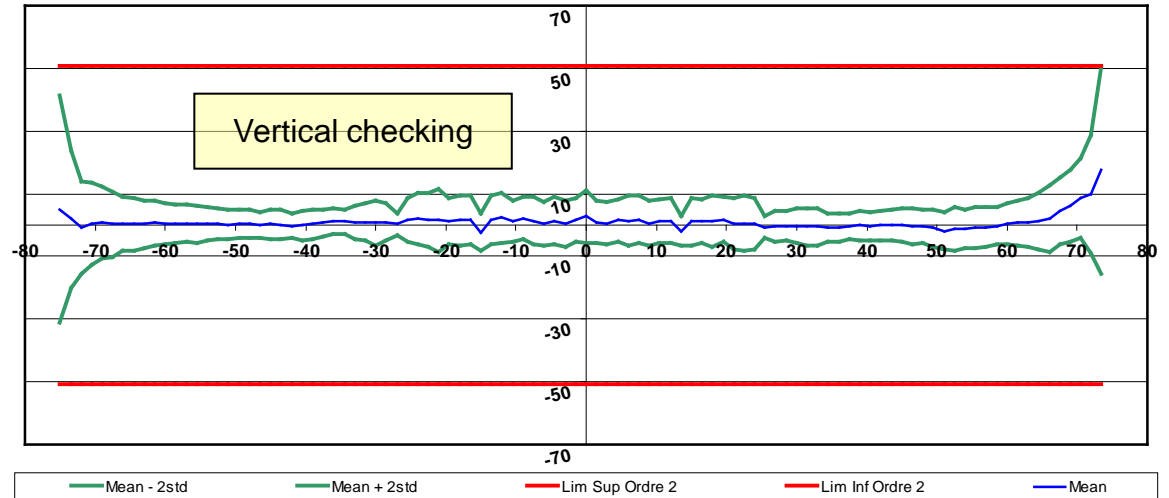
- Chasing for systematic errors which can invalidate the survey,
 - CUBE surfacing of the whole soundings data set, editing and examination of hypothesis to verify CUBE decisions,
- => Evaluating the performance of “the new survey” with respect to the other composing the reference surface.

MBES data quality control

Eloignement des sondes observées de la cible par rapport à la position théorique

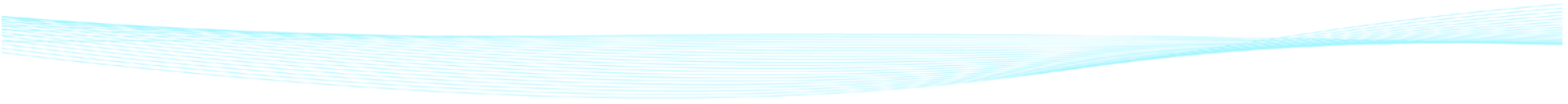


Contrôle qualité: ordre 2 - écart (m) par rapport à la référence en fonction de l'ouverture (°)



Every year: multibeam “check lines” are run and tested against the references

IDEA : what about developing an international network of reference areas and share them

- 
- I The Hydrography requirements
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- Reference areas
- Databases

Three Databases

1 - Equipment database

Repairs registration during all the life of the devices

Résultats de la recherche d'instruments

Critères : REPSHOM = "20140" N° Série = "" Désignation = "%"


	Rechercher	Exporter	
	Code santé	REPSHOM	N° de série
●	20140	1516	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1539	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1554	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1557	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1562	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1572	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1630	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1659	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1666	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1678	SONDEUR MULTIF. EM3002.ELECTRONIQUE
●	20140	1685	SONDEUR MULTIF. EM3002.ELECTRONIQUE

2 - Documentation database

Guides, manuals
(updated after each evolution of a system)

Non protégé

DO/MIP



Guide

Evaluation des performances bathymétriques des sondeurs multifaisceaux

<http://agora.shom.fr/docQual/2005/GU/GU2005-043>

Etat : Approuvé (à contrôler)

Version : 1.3.2
Dernière modification le 2009/03/05 09:12

Editeur : patrick.michaux@shom.fr
Chef de projet SME
le 2006/01/25 17:33

Vérificateur : marcel.jouven@shom.fr
Adjoint processus
le 2006/02/14 09:56

Approbateur : michel.even@shom.fr
Chef CH
le 2006/02/17 16:02

3 - Configuration database

Software, firmware and hardware configuration
Settings configuration
(sea test after upgrades)

2.2. Transducteur.

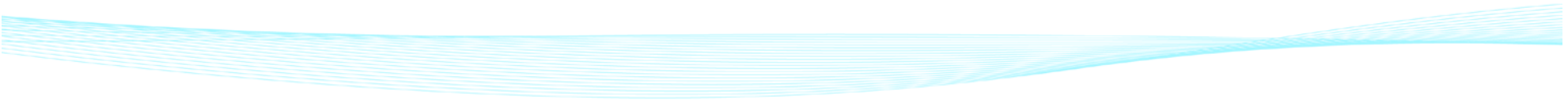
Numéro de série	213
Rattachement en X p/r au point de référence	22.78
Rattachement en Y p/r au point de référence	0.01
Rattachement en Z p/r au point de référence	6.67
Angle d'installation en roulis	0.13
Angle d'installation en tangage	1.95
Angle d'installation en cap	0.12
Biais en roulis avec M-PHINS	-0.13
Biais en tangage avec M-PHINS	-0.23
Biais en cap avec M-PHINS	0.20
Outerbeam angle offset	0.00
Biais en roulis avec SEAPATH	-0.24
Biais en tangage avec SEAPATH	-0.22
Biais en cap avec SEAPATH	0.00

2.3. Système temps réel.

Version SIS	Version 3.6.1
HWS12	N°632

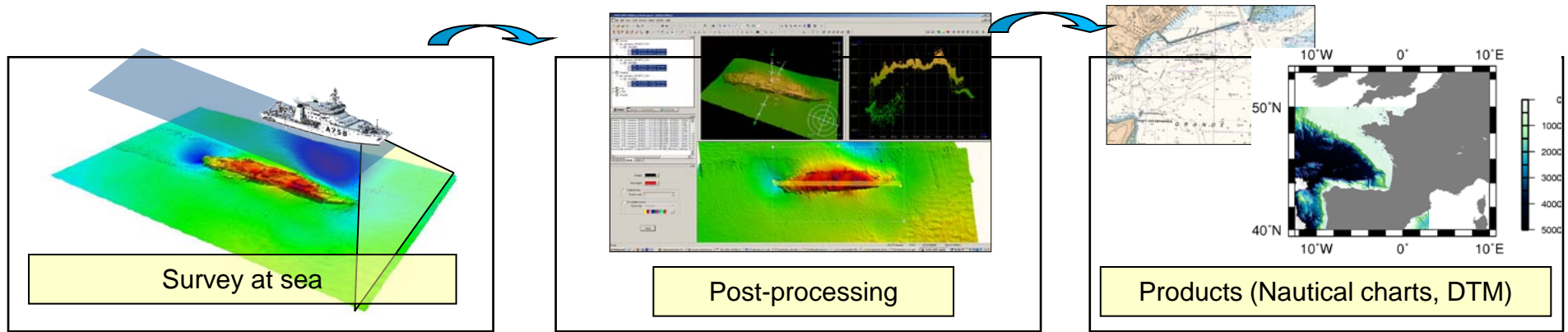
2.4. Firmware.

Version BSP Master	BSP version 1.5.5 du 050810
Version CPU	CPU (Old) version 1.3.3 du 060904
Version SPRX	SPRX version 1.0.6 du 991014
Version DDS	DDS version 3.27 du 050810

- 
- I The Hydrography requirements
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 - III Conclusion**

Take home message :

- frequent controls, associated with clear procedures and training of the surveyor guarantees a level of quality of bathymetric data and the lifelong performances of Multibeam echosounder systems
- Sharing reference areas would help comparing data quality amongst bathymetric data holders



Non publié

DDOMP

Guide

Evaluation des performances bathymétriques des sondeurs multifaisceaux

<http://igera.shom.fr/docQual/2005/GU/GU2005-043>

Etat : Approuvé (à consulter)

Versions : 13.2
Dernière modification le 2009-03-03 09:12

SHOM's Guides (database)

Systeme: ChangeMeur Dimensional

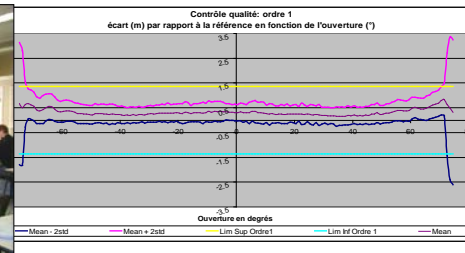
Configurations (database)

Résultats de la recherche d'instruments

Critères: REPISHOM = "N" N° Série = "" Désignation = "S-MBEW"

Code interne	REPISHOM	N° de série	Désignation	Egalité
28152	133		SONDELUR MULTIF. EN3800 LUC HW510	
28152	276		SONDELUR MULTIF. EN3800 LUC HW510	
28152	239		SONDELUR MULTIF. EN3800 LUC HW510	
28152	255		SONDELUR MULTIF. EN3800 LUC HW510	
28152	313		SONDELUR MULTIF. EN3800 LUC HW510	
28152	296		SONDELUR MULTIF. EN3800 LUC HW510	
28152	322		SONDELUR KONGERBERG LUC HW55	
28158	273		SONDELUR KONGERBERG LUC HW55	
28158	281		SONDELUR KONGERBERG LUC HW55	
28158	313		SONDELUR KONGERBERG LUC HW55	
28158	323		SONDELUR KONGERBERG LUC HW55	
28158	494		SONDELUR KONGERBERG LUC HW55	
28158	393		SONDELUR KONGERBERG LUC HW55	
28158	323		SONDELUR KONGERBERG LUC HW55	
28158	329		SONDELUR KONGERBERG LUC HW55	
28158	484		SONDELUR KONGERBERG LUC HW55	
28158	485		SONDELUR KONGERBERG LUC HW55	
28158	486		SONDELUR KONGERBERG LUC HW55	
28158	487		SONDELUR KONGERBERG LUC HW55	
28158	488		SONDELUR KONGERBERG LUC HW55	
28158	489		SONDELUR KONGERBERG LUC HW55	
28158	490		SONDELUR KONGERBERG LUC HW55	
28158	491		SONDELUR KONGERBERG LUC HW55	
28158	492		SONDELUR KONGERBERG LUC HW55	
28158	493		SONDELUR KONGERBERG LUC HW55	
28158	494		SONDELUR KONGERBERG LUC HW55	
28158	495		SONDELUR KONGERBERG LUC HW55	
28158	496		SONDELUR KONGERBERG LUC HW55	
28158	497		SONDELUR KONGERBERG LUC HW55	
28158	498		SONDELUR KONGERBERG LUC HW55	
28158	499		SONDELUR KONGERBERG LUC HW55	
28158	500		SONDELUR KONGERBERG LUC HW55	
28158	501		SONDELUR KONGERBERG LUC HW55	
28158	502		SONDELUR KONGERBERG LUC HW55	
28158	503		SONDELUR KONGERBERG LUC HW55	
28158	504		SONDELUR KONGERBERG LUC HW55	
28158	505		SONDELUR KONGERBERG LUC HW55	
28158	506		SONDELUR KONGERBERG LUC HW55	
28158	507		SONDELUR KONGERBERG LUC HW55	
28158	508		SONDELUR KONGERBERG LUC HW55	
28158	509		SONDELUR KONGERBERG LUC HW55	
28158	510		SONDELUR KONGERBERG LUC HW55	

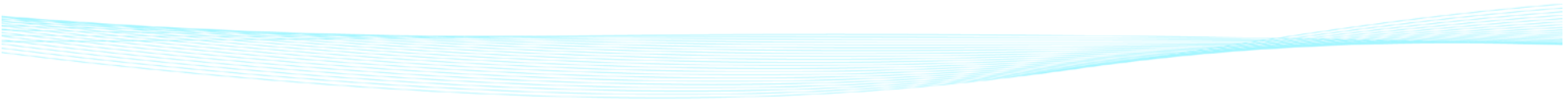
Equipement monitoring (database)



***European bathymetric database and digital elevation model
(EMODNET- HYDROGRAPHY initiative)***

***Thierry Schmitt as a servitor of the EMODNET
HYDROGRAPHY PROJECT***



- 
- I Context in terms of bathymetry in Europe
 - II Pilot EMODNET project
 - IV Access to the portal
 - V Future work

Status and constraints

Multiple data holders (HO, data centers)

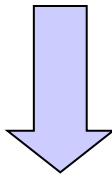
Multiple data format

Multiple acquisition/processing levels

Multiple acquisition/processing methodology

Multiple distribution policies

Multiple usage of the data



Poorly valorized datasets

**EMODNET
HYDROGRAPHY**

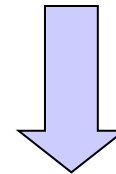
Objectives

Define one point shop (where distribution and usage policies can be discussed)

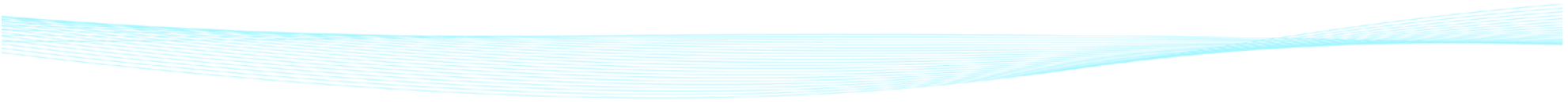
Unify data formats

Unify meta-data (inc. used sensor, date, ...)

Provide a freely accessible bathymetric grid



Promote the access of data
Evaluate bathymetric data
(coverage and quality)

- 
- I Context in terms of bathymetry in Europe
 - II **Pilot EMODNET project**
 - IV Access to the portal
 - V Future work

- Principle and philosophy
- Metadata and data
- grids

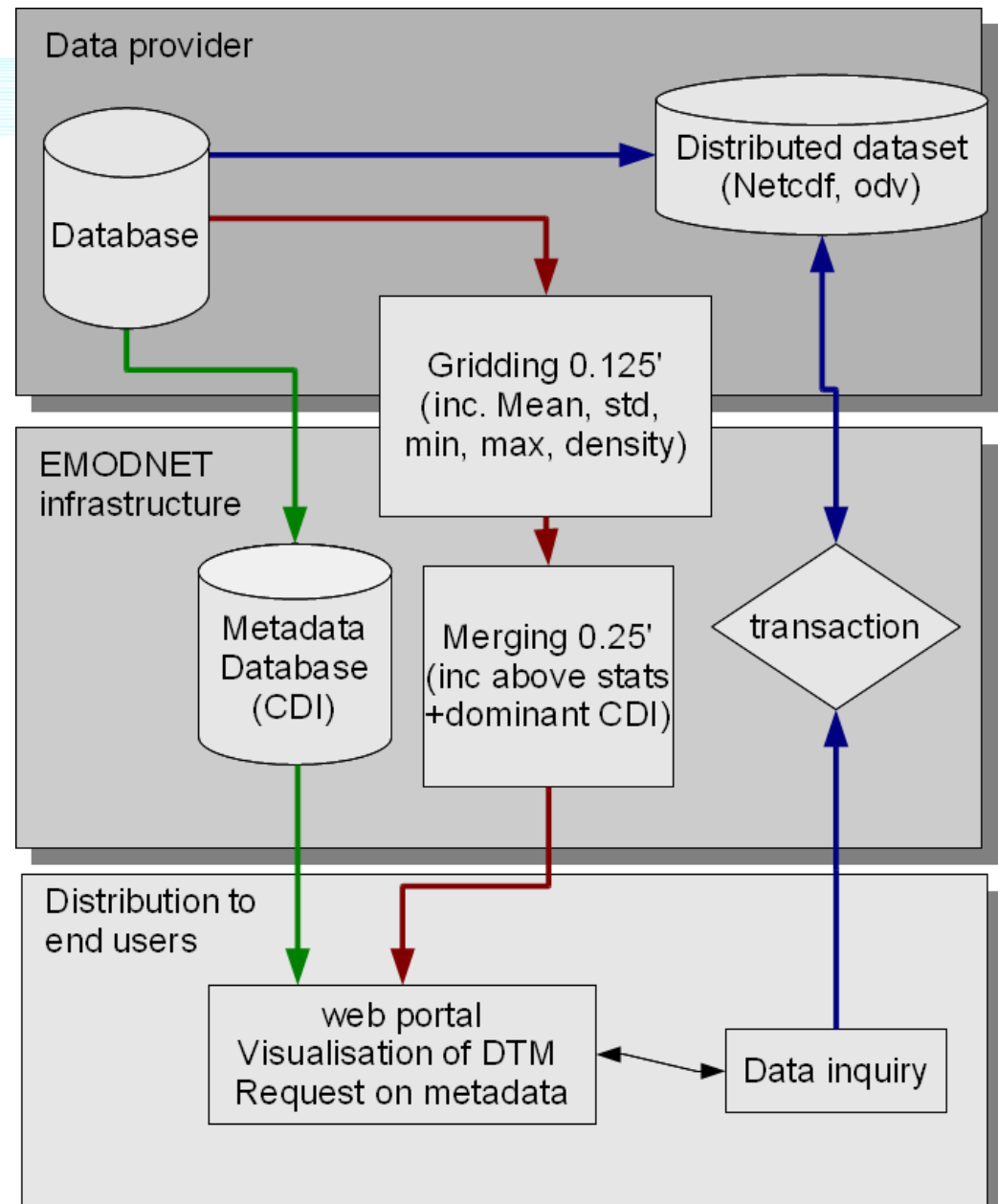
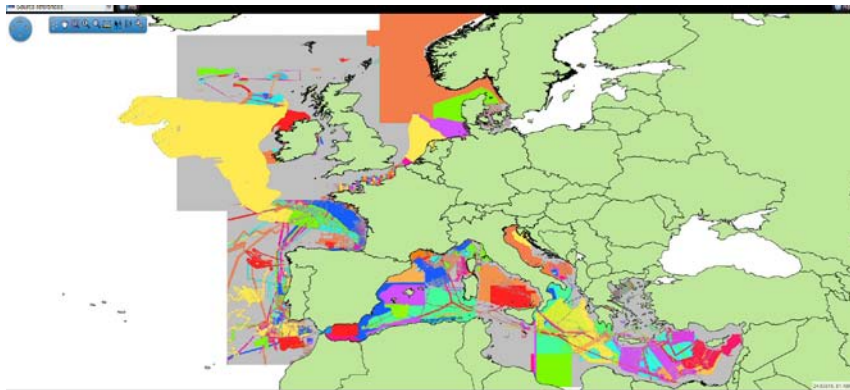
Pilot project

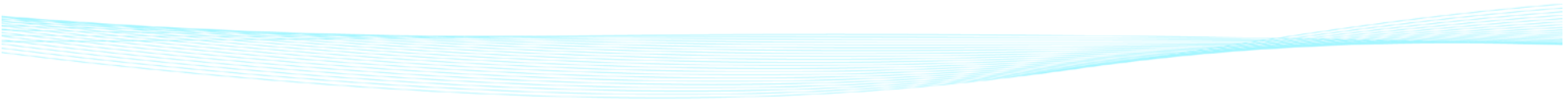
Distributed infrastructure

Encompass interests/constraints of HOs, data centres, industry

Facilitate the distribution of the data on the provider side

Maximise the use of the data



- 
- I Context in terms of bathymetry in Europe
 - II Pilot EMODNET project**
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Common Data Index (CDI)

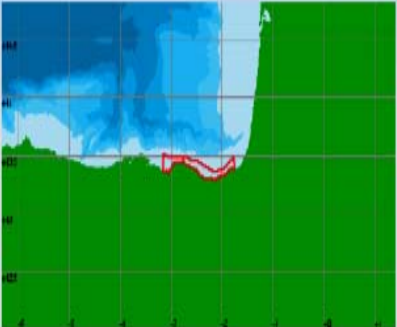
Data providers generate an xml file per data set

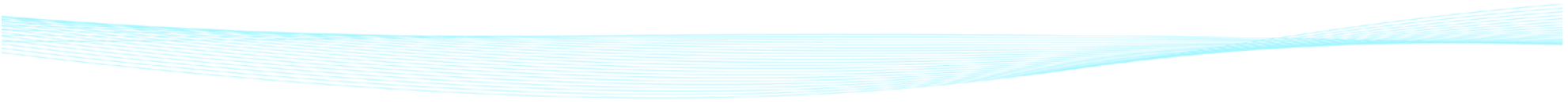
Formatted metadata are displayed on a web portal and are free to use

Data are staying by the data provider

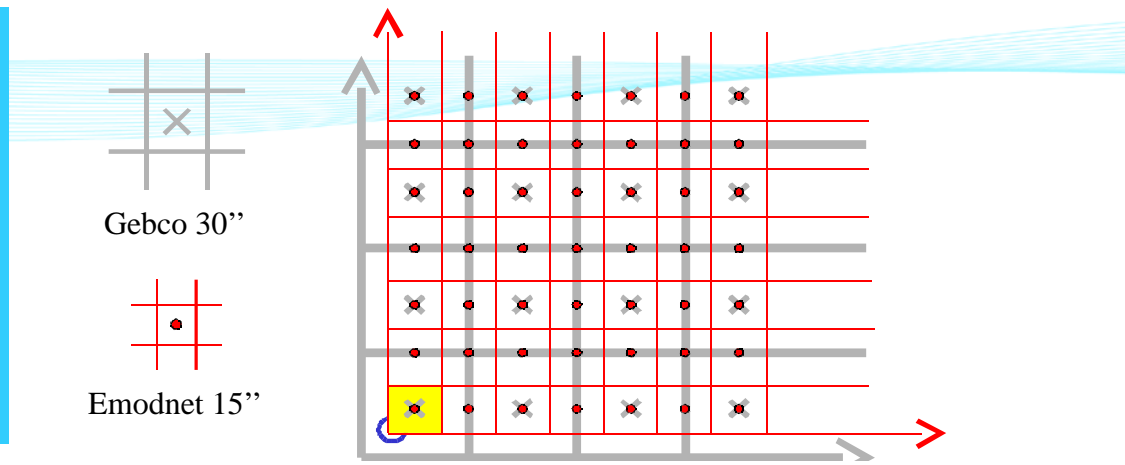
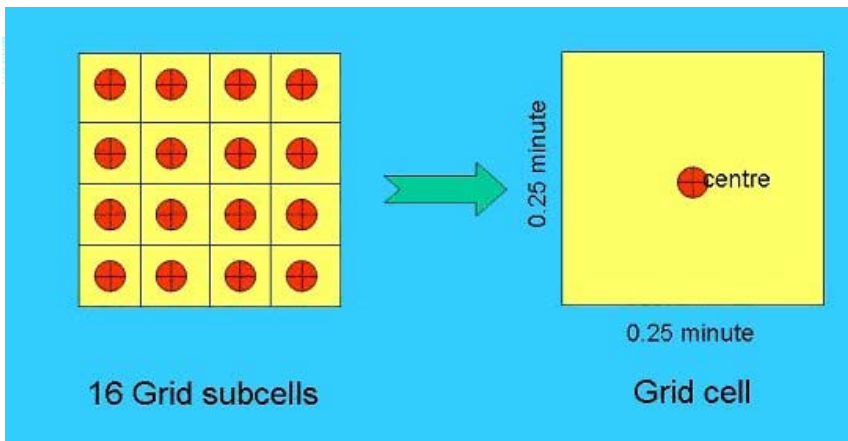
Ideally data are formatted in ODV or NetCDF-CF (undergoing work)

Data are distributed to the end-user after a phase of mutual agreement (condition of usage, principle of distribution)

WHAT?	
Data set name	PAIS_VASCO
Discipline	Marine geology Terrestrial
Category	Gravity, magnetica and bathymetry Terrestrial
Variables measured	Bathymetry and Elevation
Abstract	ELABORACIÓN DE MAPAS DE HÁBITATS Y CARACTERIZACIÓN DE LOS FONDOS MARINOS DE LA PLATAFORMA CONTINENTAL VASCA
Data format	Climate and Forecast NetCDF - Version 3.5
Data set creation date	20110520
WHERE?	
Map	
GM id	ms01
GM objects	Name Description 33_29110401 Polygon
Datum	World Geodetic System 84
Measuring area type	surface
Water depth (m)	-9999
Depth reference	sea level
Minimum instrument depth (m)	4.27
Maximum instrument depth (m)	114.058
WHEN?	
Start date	2009101
Start time	00:00:00
End date	2009101
End time	00:00:00
Sampling interval	indeterminate
HOW?	
Instrument / gear type	Differential Global Positioning System receivers multi-beam echosounders sound velocity sensors
Track resolution	2 Metres
Platform type	research vessel
Cruise name	ARGI Y AZTITAR BAT
Alternative cruise name	AAB
Cruise start date	2009101
WHO?	
Originator	ATI - Tecnalia, Heidevarres, Bermeo(Guirona)
Data Holding centre	ATI - Tecnalia, Heidevarres, Bermeo(Guirona)
Project name	HABITATS: Elaboración de mapas de hábitats y caracterización de fondos marinos de la plataforma continental vasca
HOW TO GET THE DATA?	
Data Distributor	ATI - Tecnalia, Heidevarres, Bermeo(Guirona)
Access/ordering of data	web data access with registration
Access restriction	restricted
CDI-METADATA	
CDI-record id	1175401
CDI-record creation date	20110905
CDI-partner	Swedish Oceanographic Institute

- 
- I Context in terms of bathymetry in Europe
 - II Pilot EMODNET project**
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 - V Future work

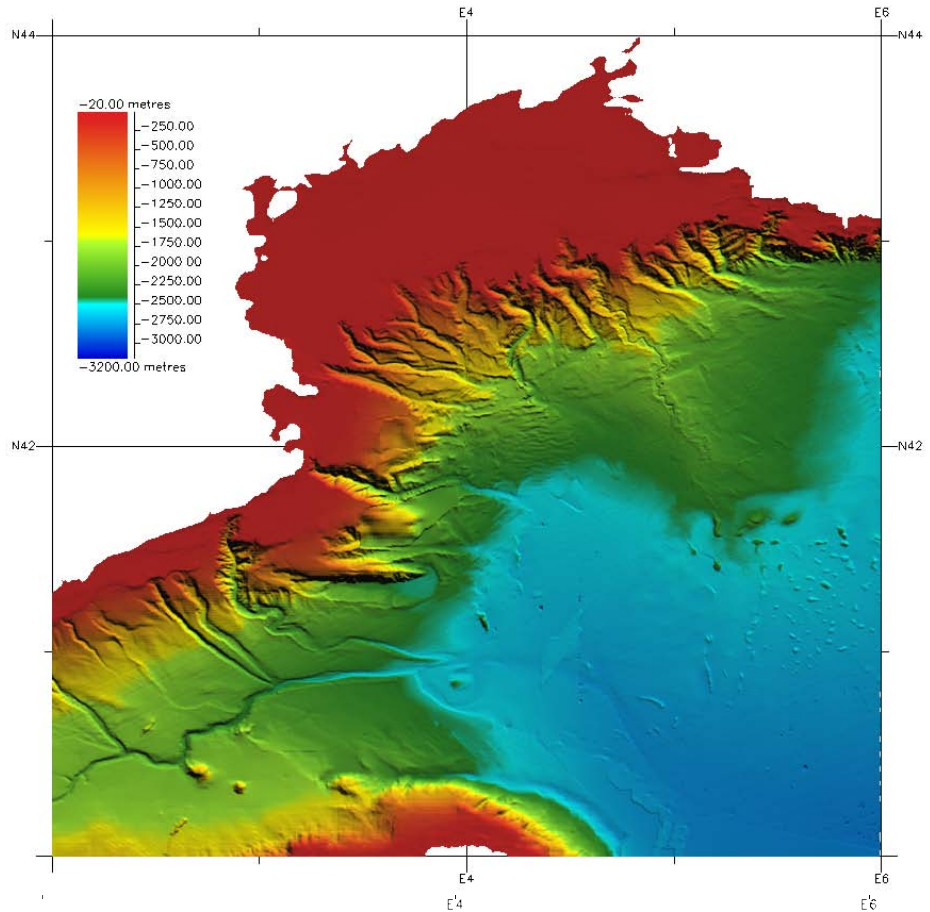
- Principle and philosophy
- metadata
- grids

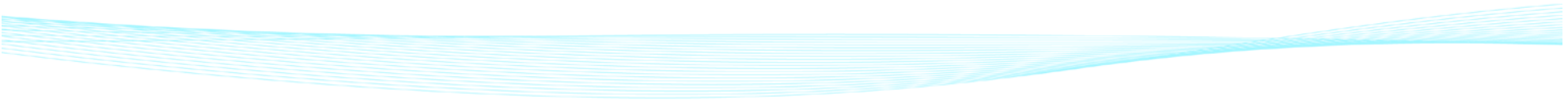


Minimum cell depth
 Maximum cell depth
 Average cell depth
 Standard deviation
 Number of depths used for
 computation of cell depth
 Number of sub-cells used for the
 computation of the average cell depth

 Major contributor of the cell

 Spline surface (with holes filled with
 GEBCO 30")



- 
- I Context in terms of bathymetry in Europe
 - II Pilot EMODNET project
 - IV Access to the portal**
 - V Future work

EMODnet European Marine Observation and Data Network

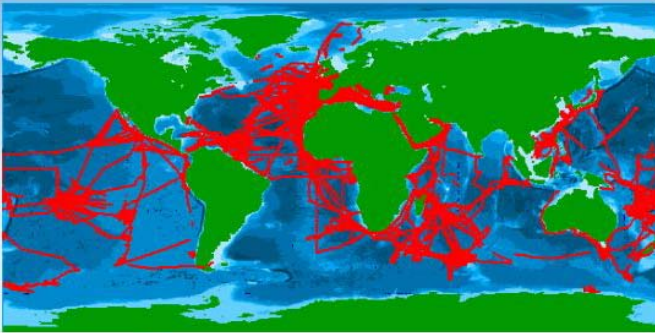
Pilot portal for Hydrography
Data Discovery and Access Service

Cart: 0 Dataset(s) Proceed to check out Reset basket Export Store query Summary Hide map ?

Reset all steps

Tools

- Enlarge
- Position
- Index



Layer control Expand Add layer

- CDI entry Points ?
- CDI entry Tracks ?
- CDI entry Areas ?
- Grid Lines ?
- Regional sea ?
- Regional sea labels ?
- Main sea ?
- Main sea labels ?
- Bathymetry ?
- Blue Marble ?
- Display all selected records
- Only selected records in results list

Zoom to selected

Search by:

Geographical Box

Time period

Measuring area type
surface (6306)

Add to basket 20 50 100 Records | Found 7012 | Show (1-20) | Previous | Next 20

<input type="checkbox"/>	#	Data set name	Variables measured	Instrument / gear type	Show
<input type="checkbox"/>	540-S201001900-2		Marine geology > Gravity, magnetics and bathymetry Terrestrial > Terrestrial	multi-beam echosounders	
<input type="checkbox"/>	540-S201001900-1		Marine geology > Gravity, magnetics and bathymetry Terrestrial	multi-beam echosounders	

<http://www.emodnet-hydrography.eu/>

EMODnet European Marine Observation and Data Network

Pilot portal for Hydrography

Emodnet site Products Surveys

Map View

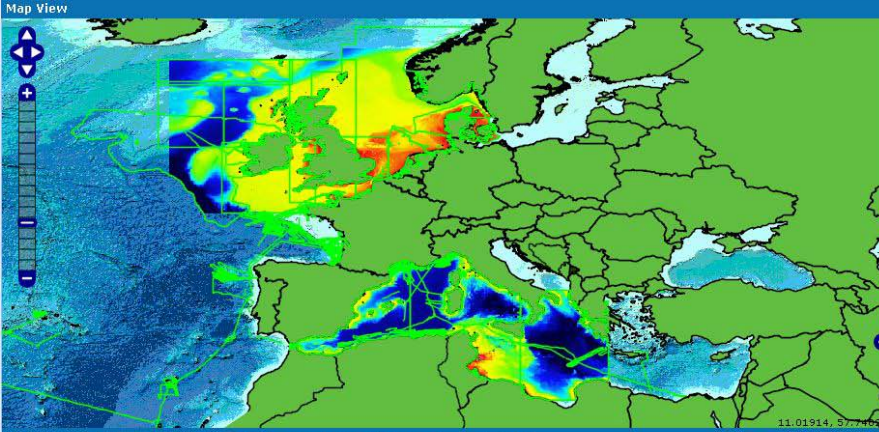
Hydrographic Data

Status search Quick search Advanced quer

IM status: All

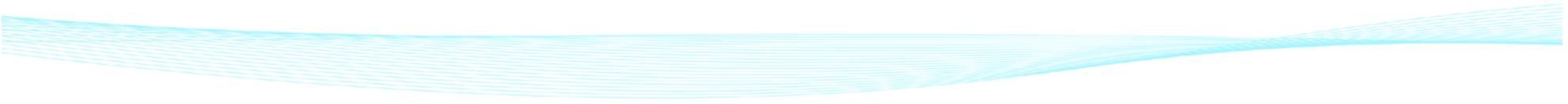
Find

- Name
- Germany
- Denmark
- Norway
- Belgium
- Ireland
- Celtic_Seas_TopLeft
- Celtic_Seas_BottomRight
- Ifremer 1
- Ifremer 2



Page 1 of 32 | Displaying 1 - Settings Pan ZoomBox Draw polygon Clear polygon Select

Ready Help

- 
- I Context in terms of bathymetry in Europe
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 - V **Future work**

GENERAL

Evaluate the European bathymetric coverage and set the effort to undertake to get an up-to-date coverage

Extend to other area (Black Sea, Baltic Sea, North-East Atlantic)

Attract new data providers (inc. Industrial sector and crowd-sourcing)

GRID

Evaluate the quality of the grid

Improve the quality of the grid (i.e. filtering out dataset, smoothing/interpolation algorithm)

Include source data used for the creation of the GEBCO grid (i.e. only originating from NGDC database)

Converge with new standards (IHO S10x) and europeans obligations (INSPIRE) for data and metadata distribution