SurfRef Project

TWCWG3

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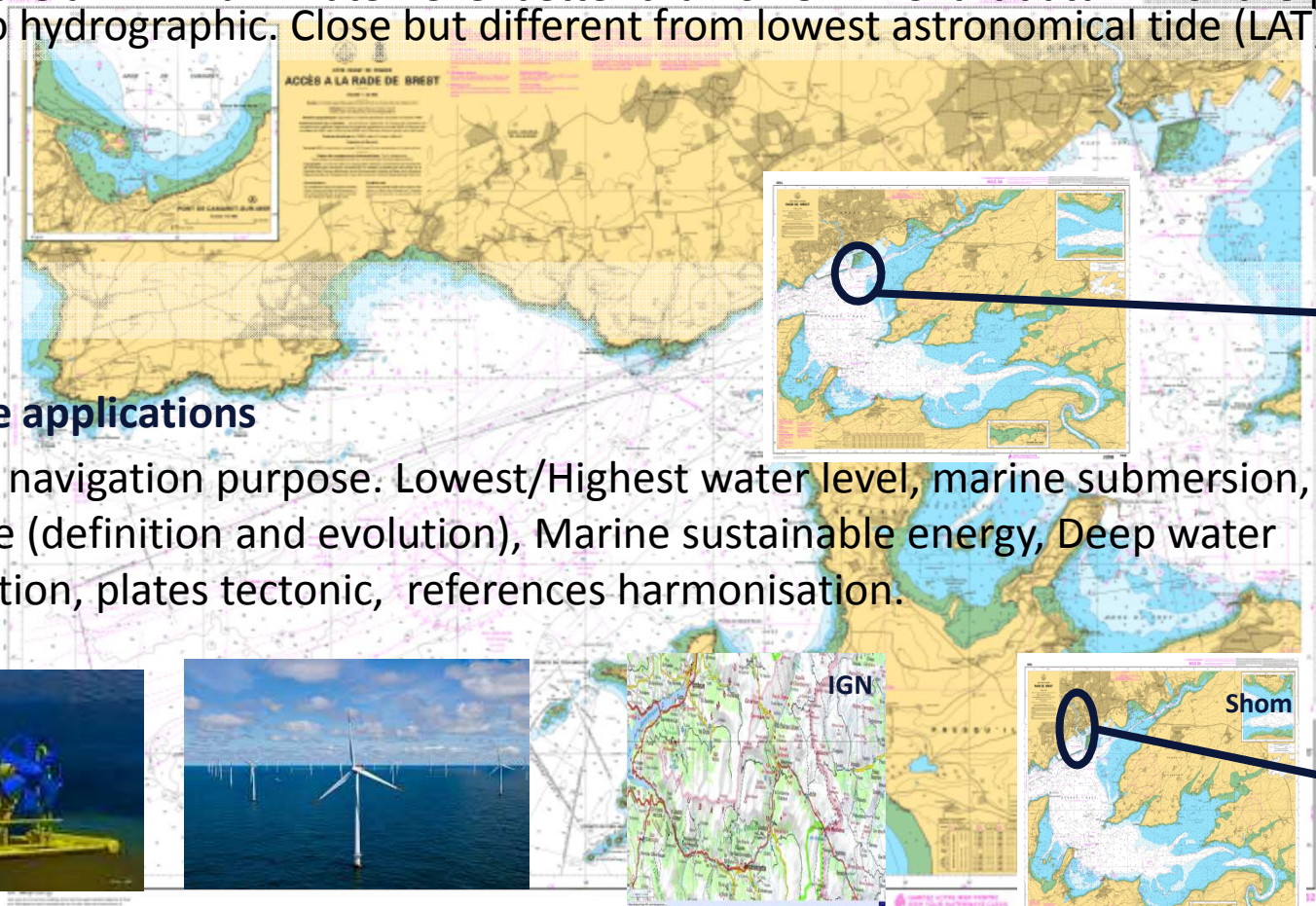
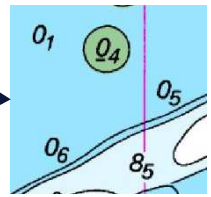
Marine reference surfaces: For who, for what?

2 needs

* Ensure a stable water level reference (this need is guided by scientific improvment and applications closely tied to IHO recommendations)

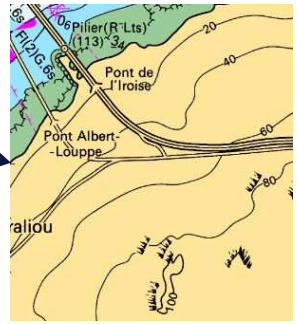
- Ensure a minimum water level better than 0.15 m : Chart datum. For the project ⇔ Zero hydrographic. Close but different from lowest astronomical tide (LAT).





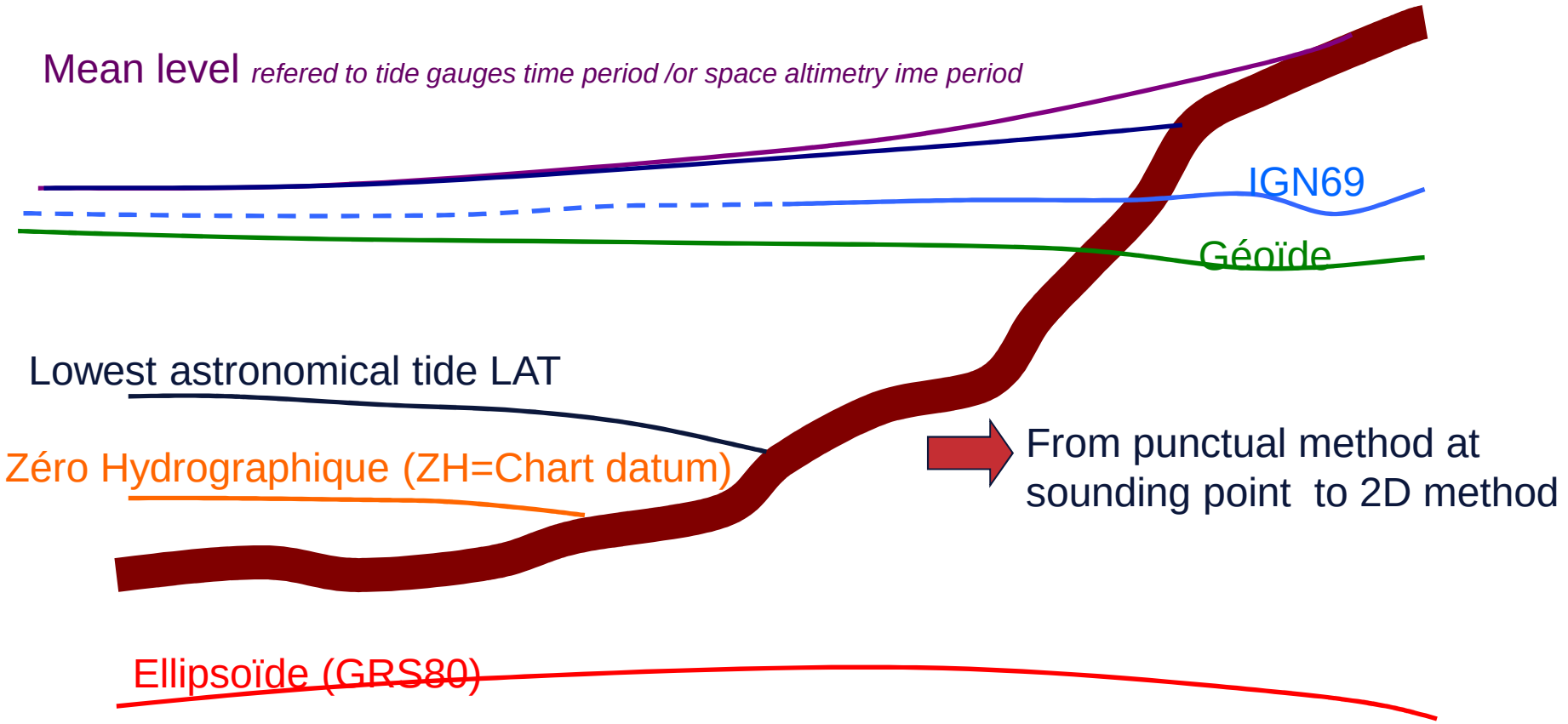
Multiple applications

* Safety navigation purpose. Lowest/Highest water level, marine submersion, coastline (definition and evolution), Marine sustainable energy, Deep water exploitation, plates tectonic, references harmonisation.



Source: M-F Lequentrec-Lalancette, journée ITRS, St-Mandé juin 2015

Starting point



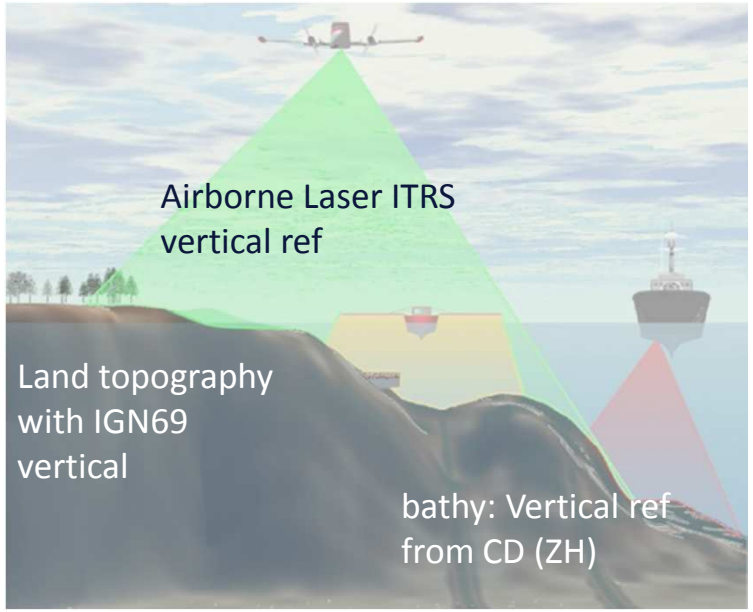
Basics from BATHYELLI = BATHYmétrie on ELLIpsoïde (2006, L. Pineau et al., G. Jan et al (2009), Y-M Tanguy et al. 2014)

Marine surfaces of reference

Need to use a common vertical reference frame (ellipsoid) => GRS80, legal reference system,

WGS84. (cf; IHO recommendations and the uses)

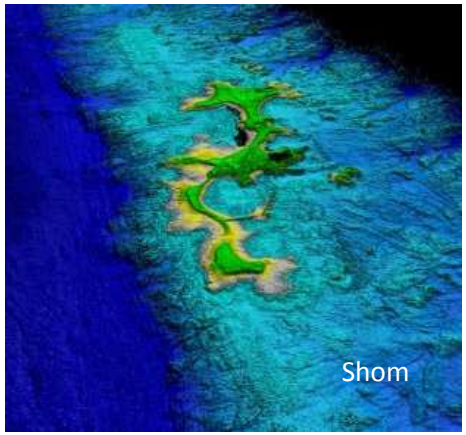
From NSHC32 : “TWG members agreed that in future for exchange of data, the GRS80 ellipsoid should be used as common reference frame.”
(https://www.iho.int/mtg_docs/com_wg/IHOTC/IHOTC8/IHOTC8-3-6-1.pdf, p 5)

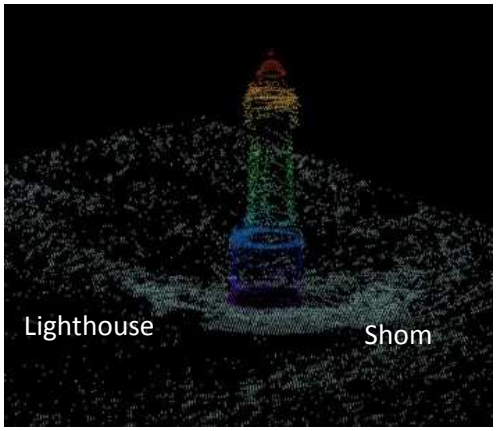


Source image : M-F Lequentrec-Lalancette, journée ITRS, St-Mandé 2015

Expected improovment : Litto3D (Shom, IGN)

The Litto3D program aims to produce a continuous land-sea altimetric digital model of the coastal fringe.

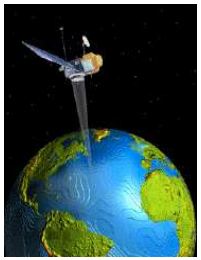




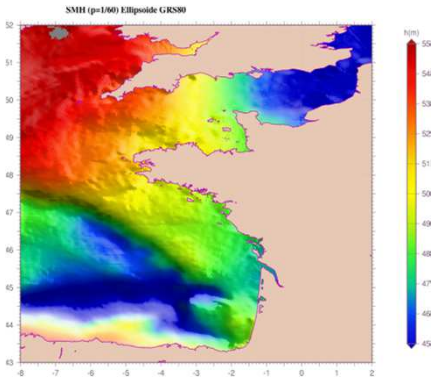
https://www.geoportail.gouv.fr/donnees/litto3d

http://www.shom.fr/les-activites/projets/modele-numerique-terre-mer/

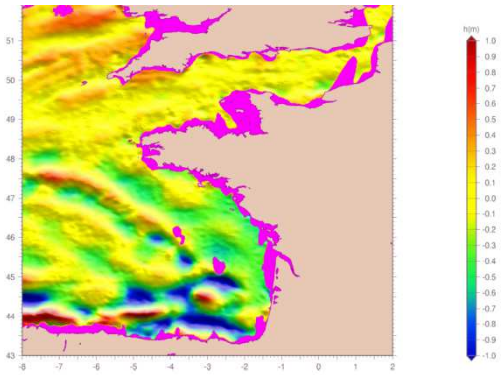
http://diffusion.shom.fr/produits/altimetrie-littorale



FR method ➔ 3 technics



Mean sea surface derived for space altimetry



Error on Smh/ GRS80 (Source CLS)

Tide gauges

Improovment : Increasing density of the GNSS pushes forward hydrogragphy and gives relief to the reference heights.

GPS : Land station

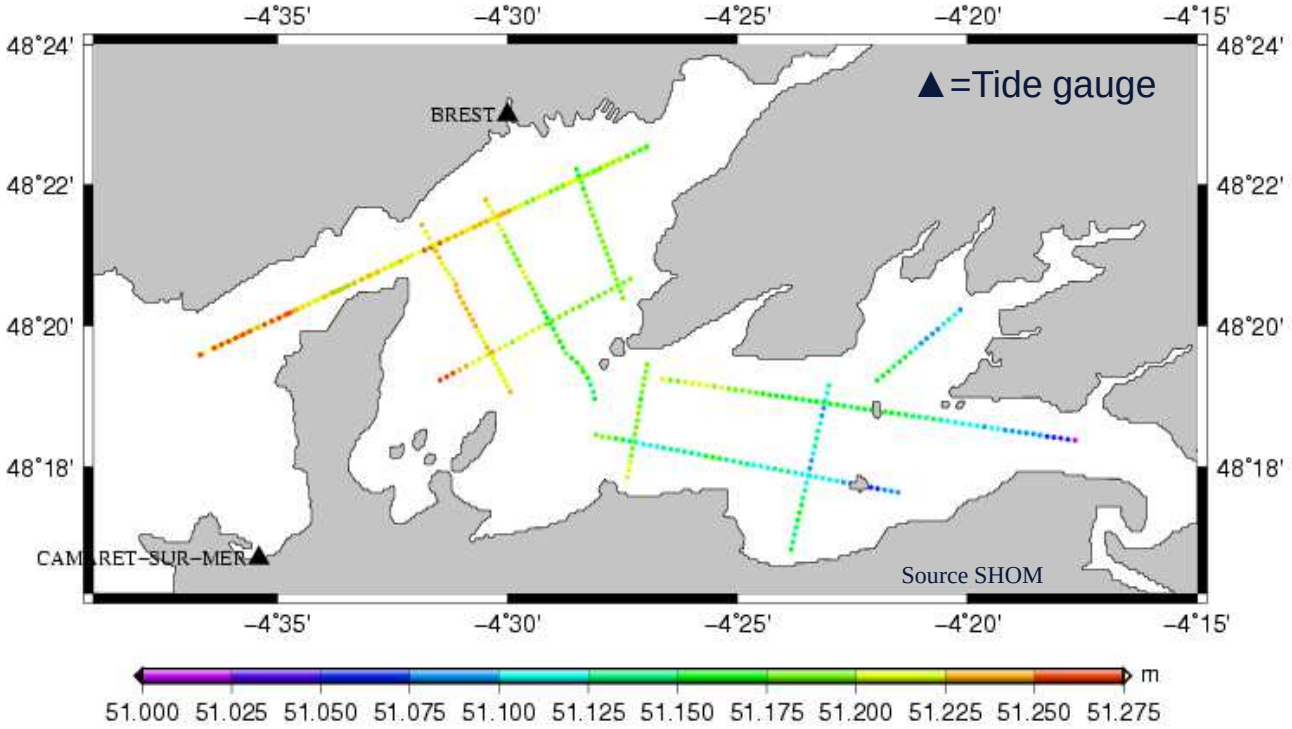
Ocean GPS : Kinetic mode

GPS buoy

G. Jan et al. 2017 GNNS day (Paris)

GPS Measurement

From profils towards a GPS MSS

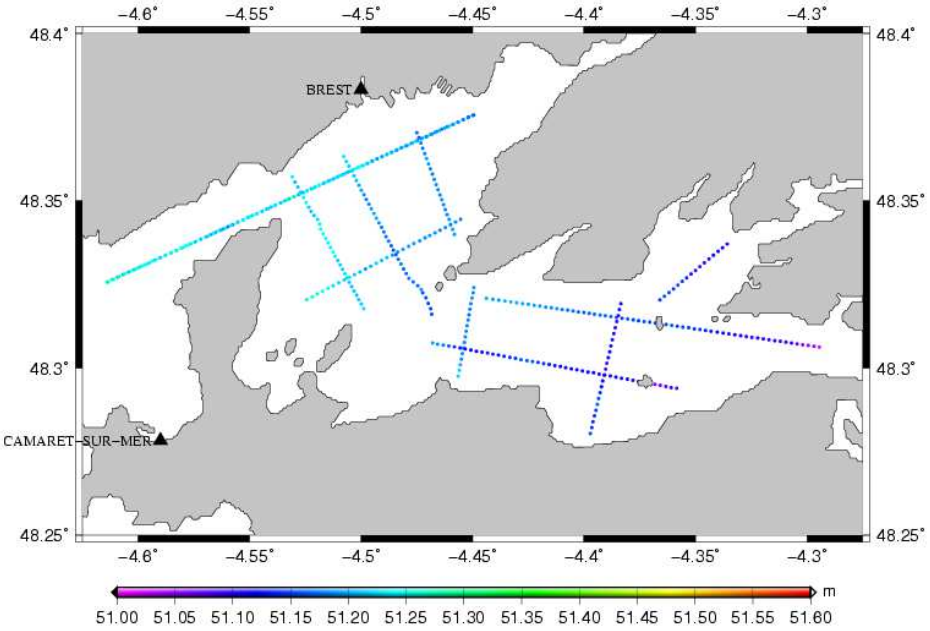


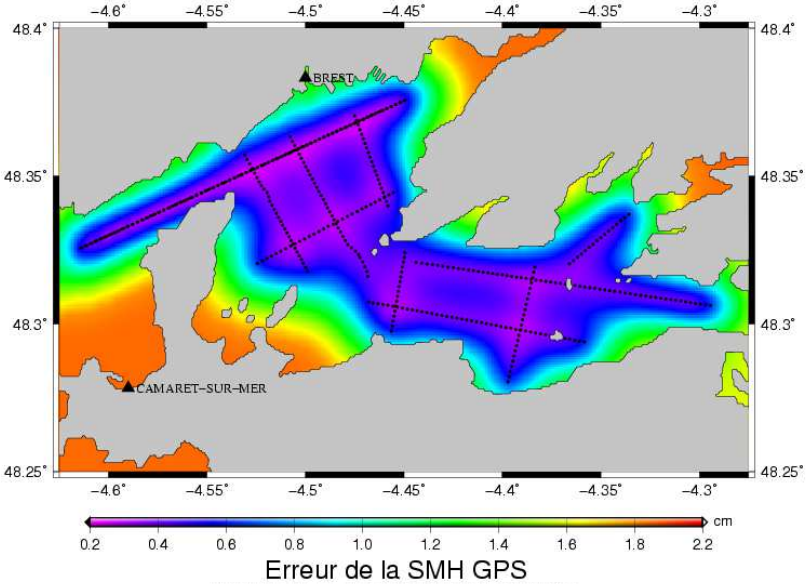
- Height minimisation at crossover point.
- Optimisation to built matrix more easy to inverse during the GPS MSS process.

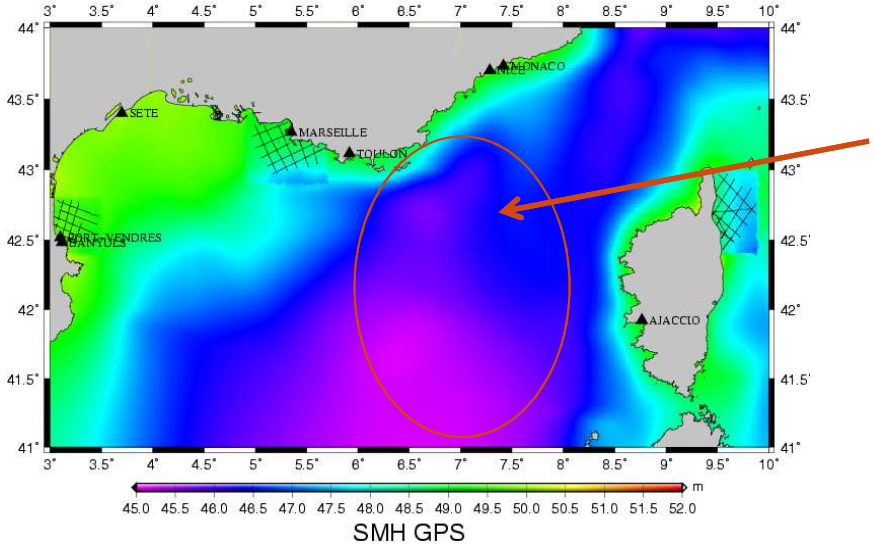
Nb de pts	*Min [m]*	*Max [m]*	*Mean [m]*	*STD [m]*	*Distance between 2 points [m]*
421	***51.0080***	***51.2810***	***51.1826***	***0.0488***	***187***

Interpolation

Covariances estimation using analytical models



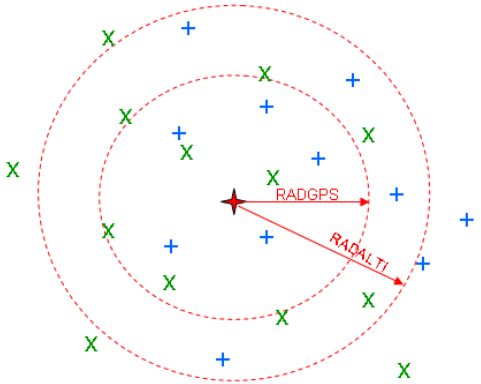


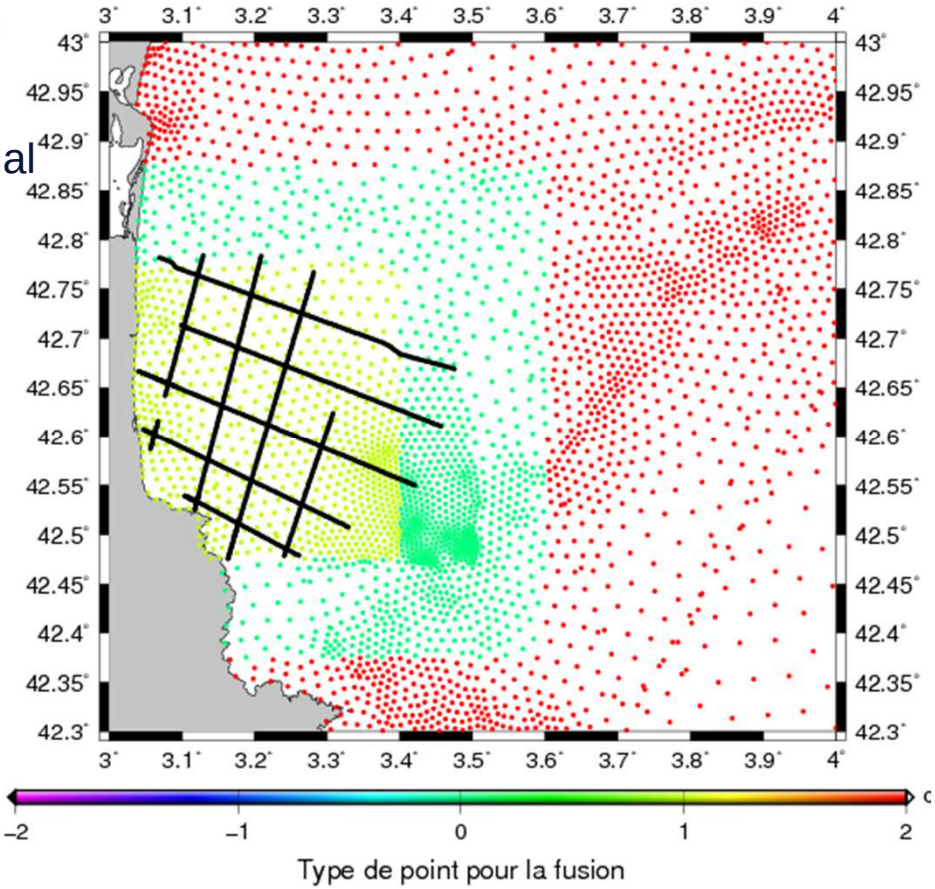


For area where there is no GPS, no tide gauge measurements, geoïd height is used (here, EGG97, computation done in 2009)

Optimal interpolation between GPS, ALTIMETRY, DATA SMH

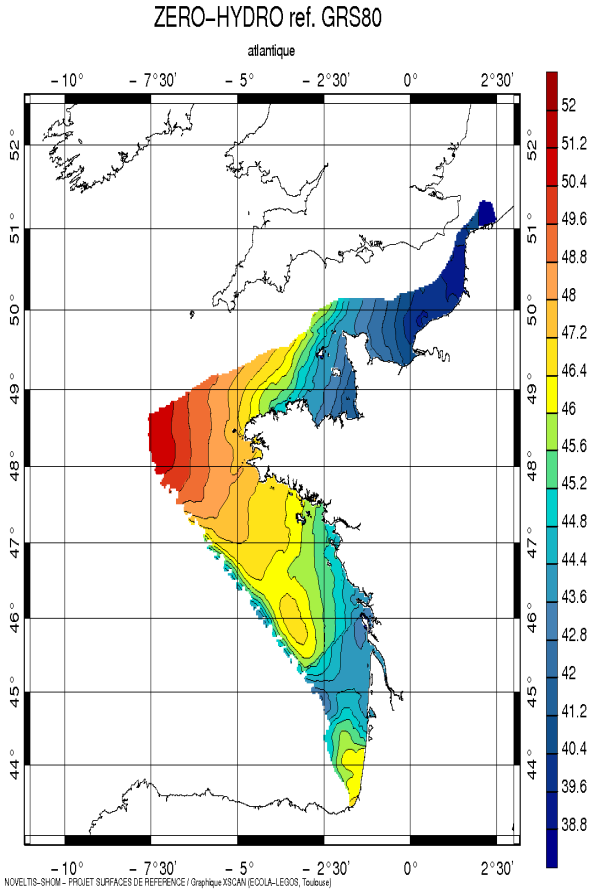
- Data selection (MSS GPS and MSS ALTI
  - At each grid point of the threshold area, data fusion is done : SMH GPS and ALTI in the optimal interpolation radius.
  - optimal radius are RADGPS et RADALTI,

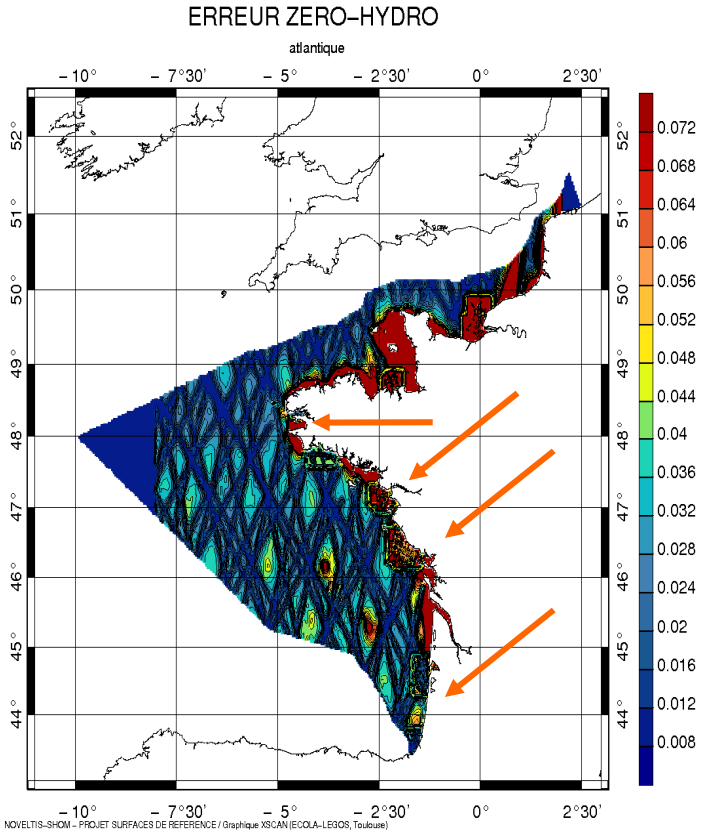




- **threshold area** (0)
- Valide GPS area (1)
- Valide alti area (2)

Merged reference surfaces result (Bathyelli)





http://data.shom.fr

Access to :

ZH (Fr chart datum)

Lowest astronomical tide (used for NSHC LAT comparison)

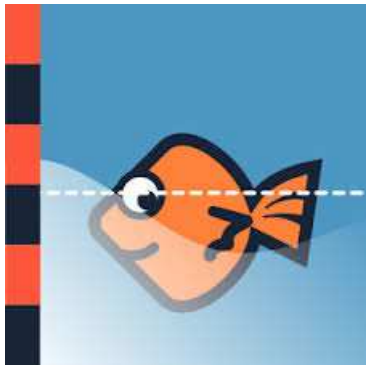
Mean water level (niveau moyen), GRS80 ITRS ellipsoid, IGN69.

SurfRef study : Surfaces of reference

- Importance of a global reference system as precise as possible

- Marine improovment ➔ Importance of the IHO framework and projects.

- Method and technology improovment suggested for this study : Geoid impact, Coupling marine vertical reference and Litto3d Shom/IGN land-sea mapping, GNSS precise positioning.

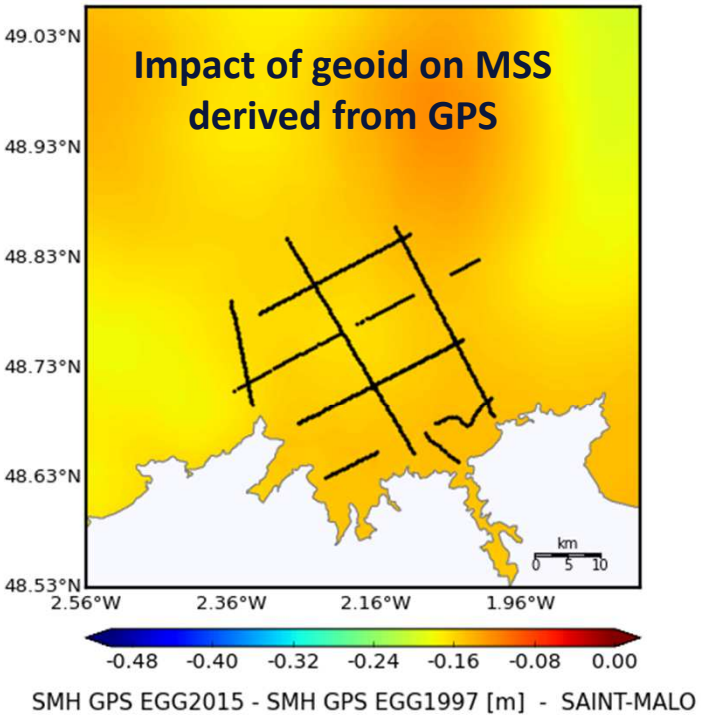


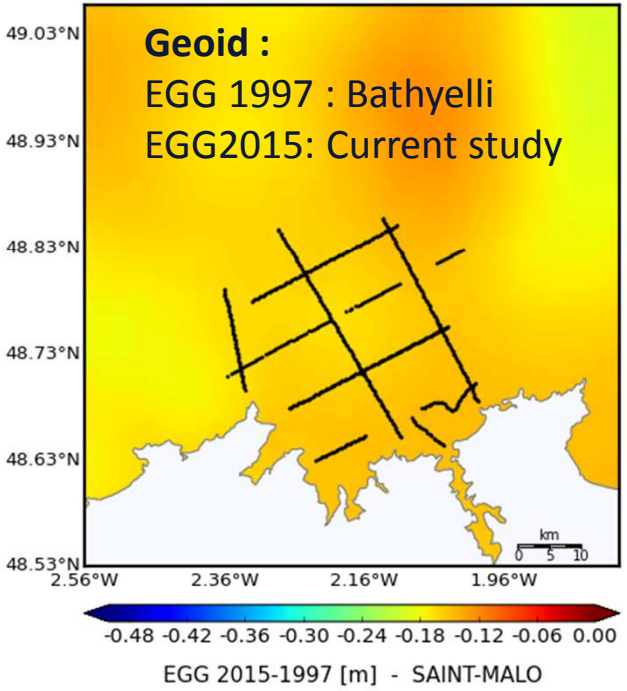
Src image: Android-logiciels.fr

Surf Ref study (CNES, Shom, GRGS, LIENSs: Univ. La Rochelle)

Test : Impact of the geoid on the SMH derived form altimetry and GPS

- EGG2015 vs. EGG97





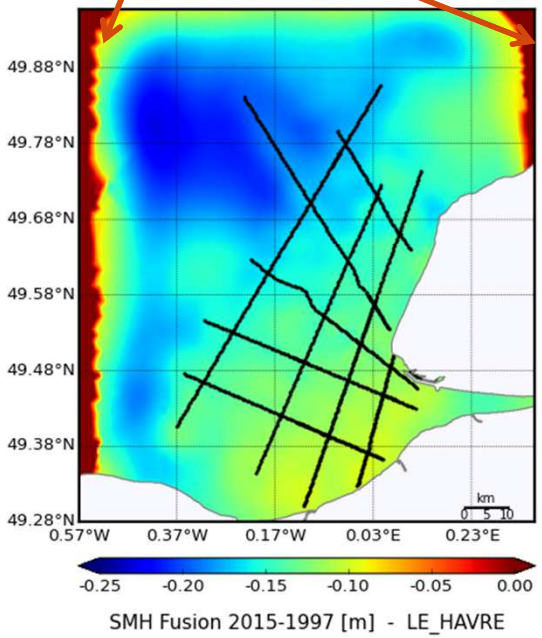
Preliminary results : test

Source : SurfRef project E. Renault (Shom)

Test : Impact of the geoid on the SMH derived form altimetry and GPS Le Havre

Latitude : 49.4938 °N
Longitude : 0.1077 °E

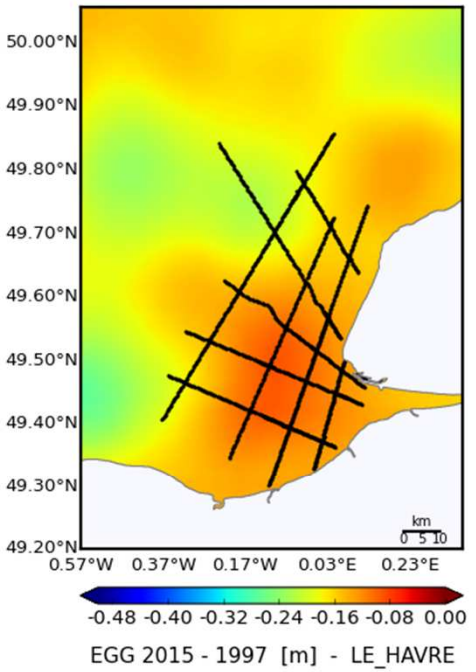
No merging area



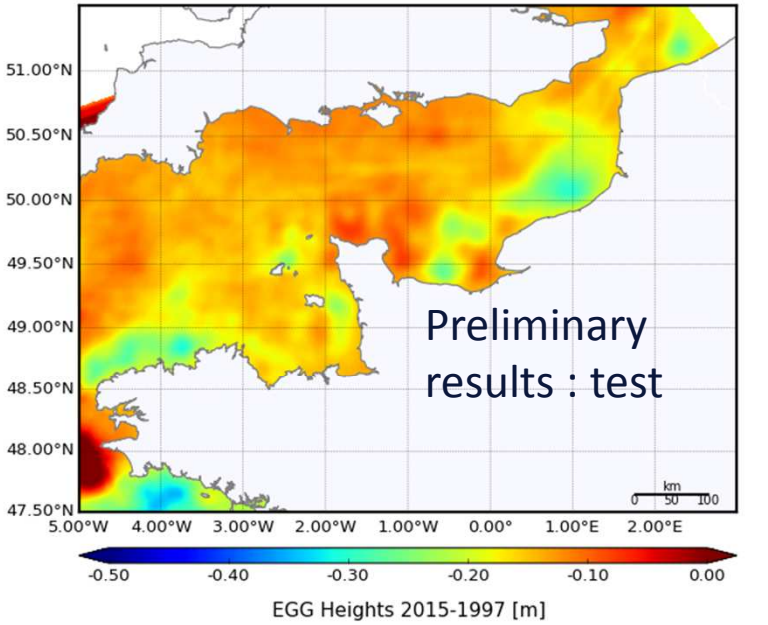
Source : SurfRef project
E. Renault (Shom)

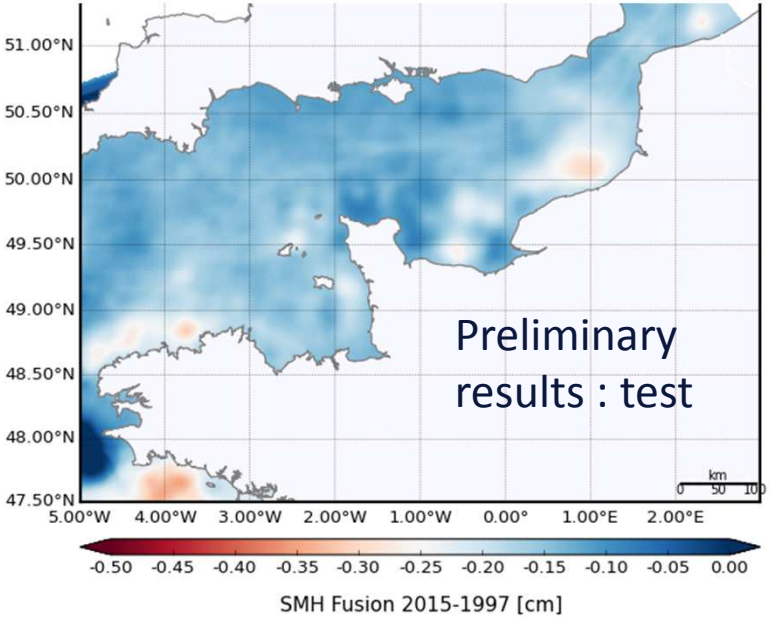
Preliminary results : test

Need to be improoved at Le Havre (GPS survey? Adding data?) and at the North border France.



Test : Impact of the geoid on the SMH derived form altimetry and GPS





Source : SurfRef project
E. Renault (Shom)

Impact du géoïde

European **G**ravimetric **G**eoid **EGG2015**

- Constant improvement of EGG97: releases 1997, 2008, 2015.
- Since the major re-computation of 2008:
  - Higher number of gravity field data sets
  - 5 releases of GOCE Global Model
  - Improvement of the modelling method

} EGG2015 Release

EGG1997	EGG2008	EGG2015
	Project gravity data base	
2,684,133 (744 sources)	5,355,206 (718 sources)	6,100,190 (766 sources)
	Other gravity data sources	
	195,840 (ArcGP)	389,196 (ArcGP)
335,124 (KMS1996)	13,222,260 (1' x 1' alt.)	13,222,260 (1' x 1' alt.)
–	120,747 (EGM2008 fillins)	120,807 (EGM2008 fillins)
3,019,257 (Total)	*18,894,053 (Total)*	*19,832,453 (Total)*
	Terrain data base	
7.5" ... 5' resol.	1" ... 30" resol.	1" ... 30" resol.
700 million elev.	8.3 billion elev.	8.3 billion elev.
15' x 20' RTM	15' x 20' RTM	15' x 20' RTM
	Global geopotential model	
EGM1996 (l_{max}=360)	EGM2008 (l_{max} =360/2190)	GOCO05S (l_{max}=280)
	Computation procedure	
	Remove-restore technique, spectral combination (1DFFT)	
	GRS80, zero-tide system, EVRS	
	Computation grid	
25° – 77°N, 35°W – 67.4°E	25° – 85°N, 50°W – 70°E	25° – 85°N, 50°W – 70°E
1.0' x 1.5'	1.0' x 1.0'	1.0' x 1.0'
3,120 x 4,096 pts.	3,600 x 7,200 pts.	3,600 x 7,200 pts.

Table 1: Characteristics of EGG from 1997 to 2015. (Denker, 2015)

Source: Denker, *« A new European Garvimetric (Quasi)Geoid EGG2015 »*, 26th IUGG General Assembly (Session 3), Prague, June 22 – July 2, 2015

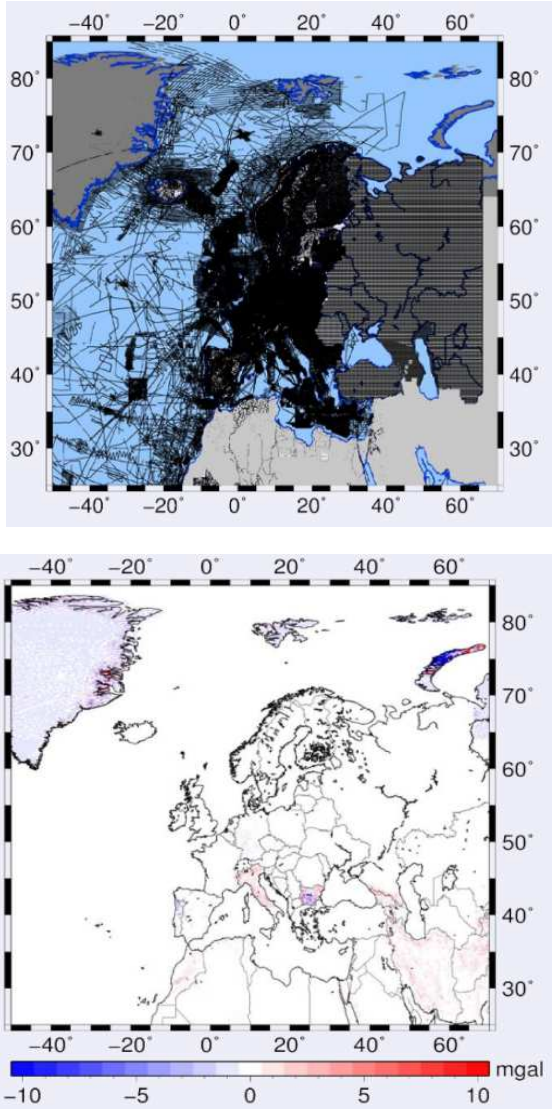


Figure 1 : Gravity dataset for EGG2015 (up) and differences between EGG2015 and the precedent version EGG08 (down). (Denker, 2015)

Differences between EGG2015 and EGM08: possible improvement for SurfRef

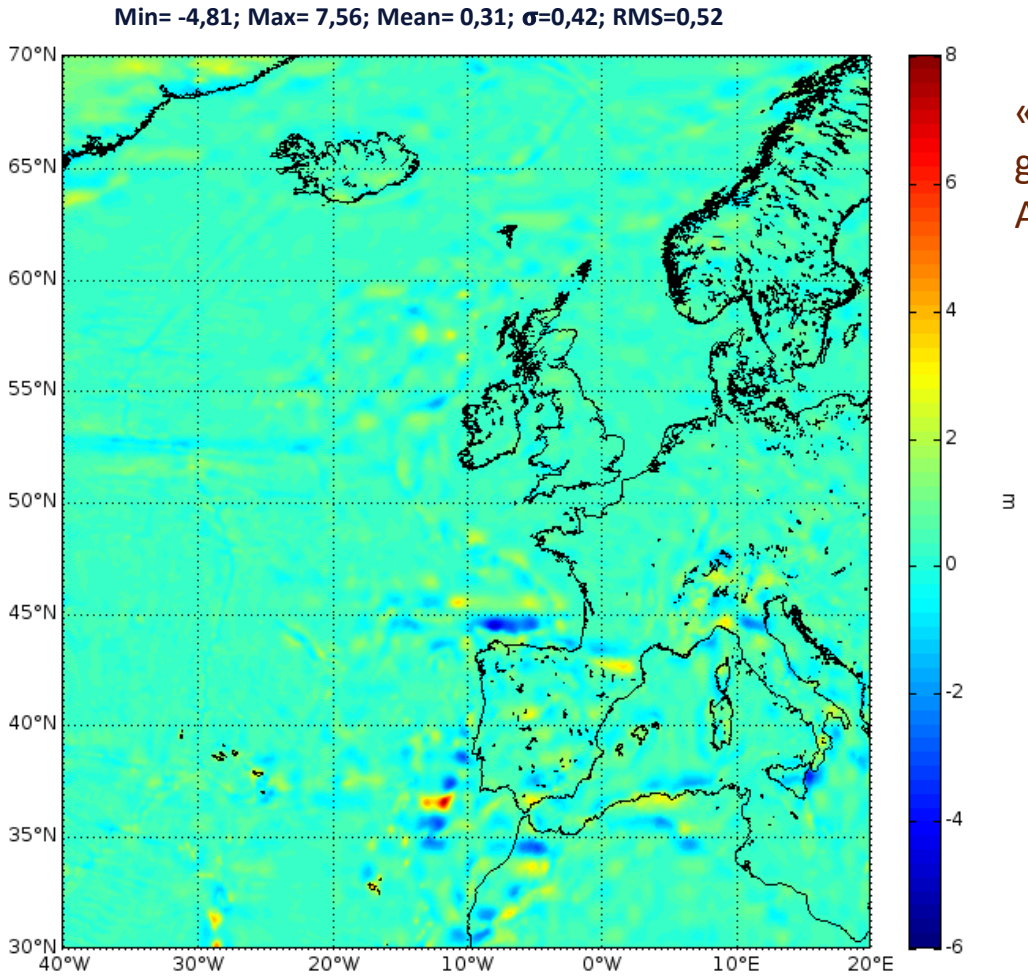


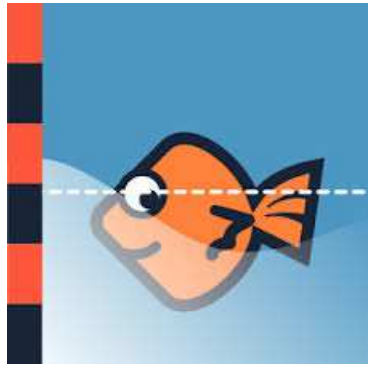
***Figure 3**: Differences between EGG2015 and EGM2008 1'x1' grids, in meters.*

« Today: precision of [3] cm for the best geoid models to 10 cm for most of them. About 80 cm 25 years ago. »

Higher differences on strong reliefs and high oceanic variability areas

- Denker, *« A new European Garvimetric (Quasi)Geoid EGG2015 »*, 26th IUGG General Assembly (Session 3), Prague, June 22 – July 2, 2015.
- Ismail, « *Determination de l'exactitude d'un géoïde gravimétrique* », Astrophysique. PSL Research University, 2016. Français.

Thank you



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http://diffusion.shom.fr/produits/altimetrie-littorale