



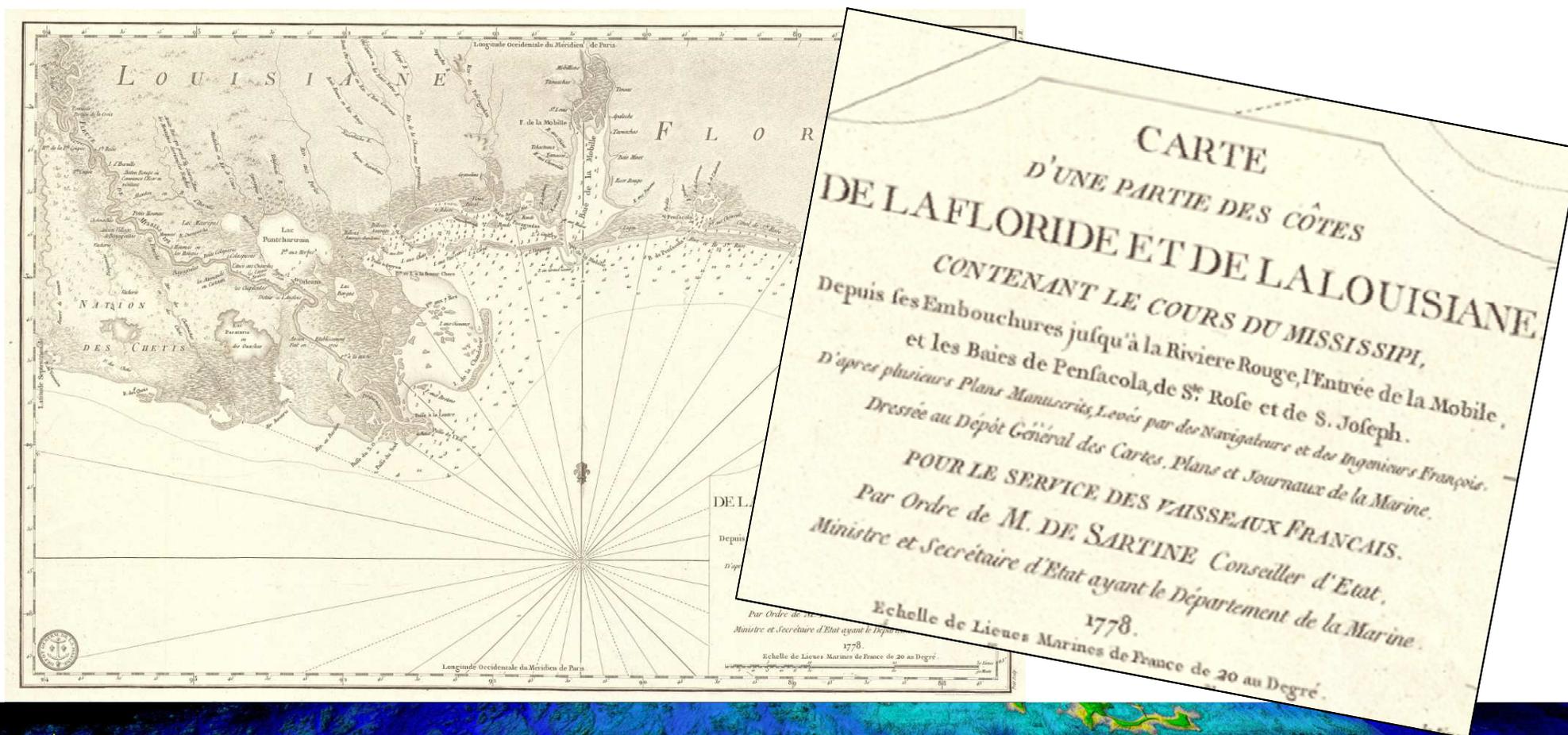
Litto3D® French Hydrographic office (SHOM) and Bathy lidar systems

Modèle numérique de terrain Sud ile de la Désirade



Few words about SHOM

Inheritor of the world's first official Hydrographic Office
1693 : publication of the nautical atlas, the “Neptune François”





Few words about SHOM

Navy department

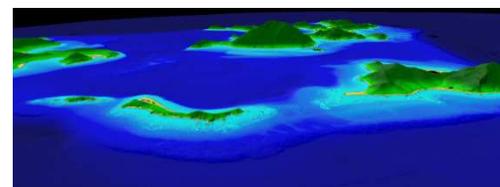
... 2007 : Public establishment (multisource funded – not only French DoD)

– One vocation

- To ensure the quality and the availability of the physical maritime, coastal and ocean environment information, in order to meet public requirements, both civilian and military, at the lowest possible cost.

– Three main missions ...

- National Hydrographic Service
- Defence Support
- Support to maritime public policies



Litto₃D[®] project

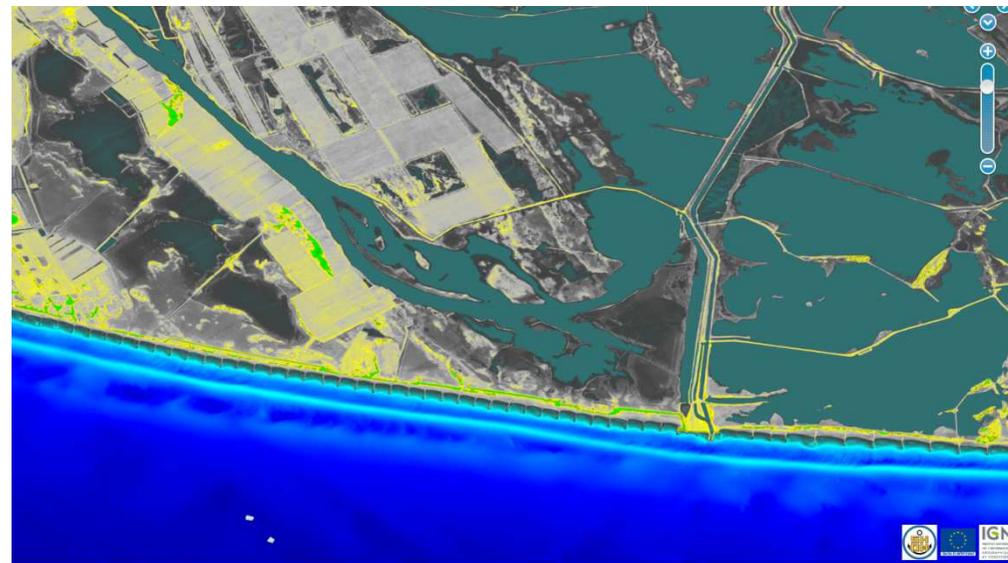
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Goal

High-resolution seamless elevation model along French shorelines (metropolitan France & overseas) for coastal zone management, risk prevention, habitat mapping...

Co-produced by
IGN and SHOM



Area of interest

Landwards : up to +10m height and at least 2km inland

Seawards : to the 10m isobaths (*or more depending on water clarity*)

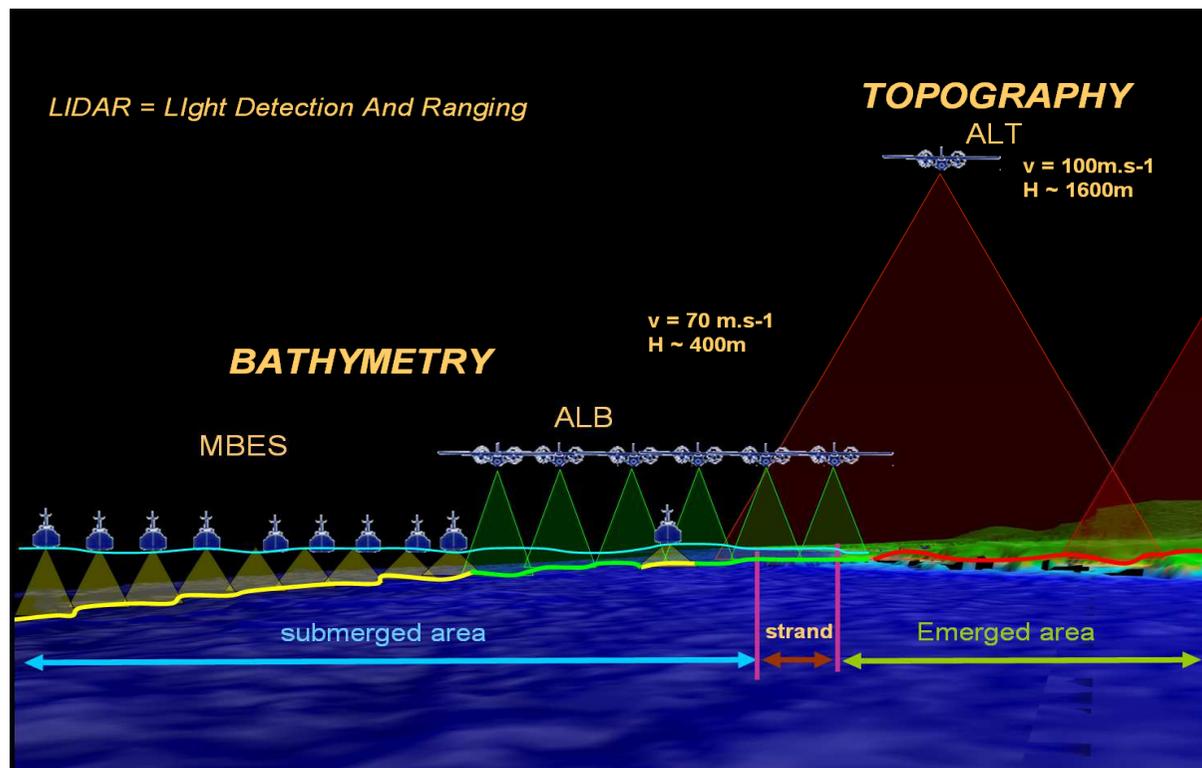
Litto₃D[®] project

Litto₃D[®]



Historical data irrelevant to build this model

→ Large scale surveys conducted along French coasts using state of the art technologies



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SHOM and IGN were appointed to elaborate this seamless altimetric model but only partly funded !

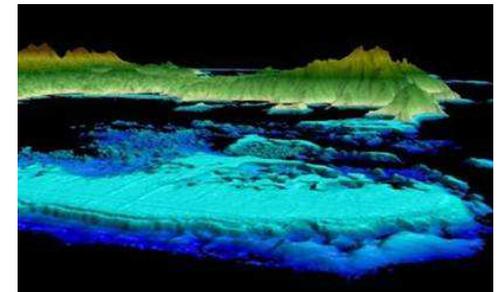
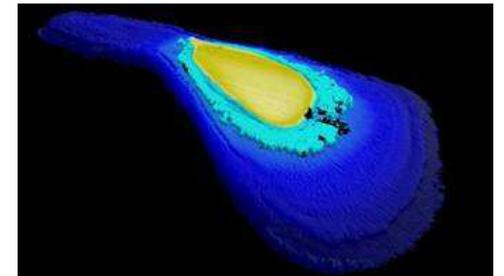
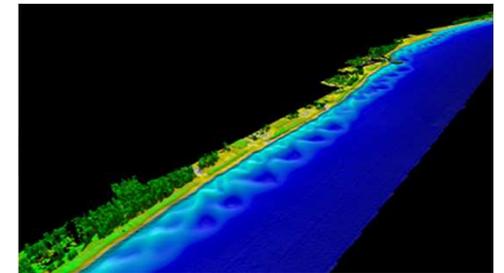
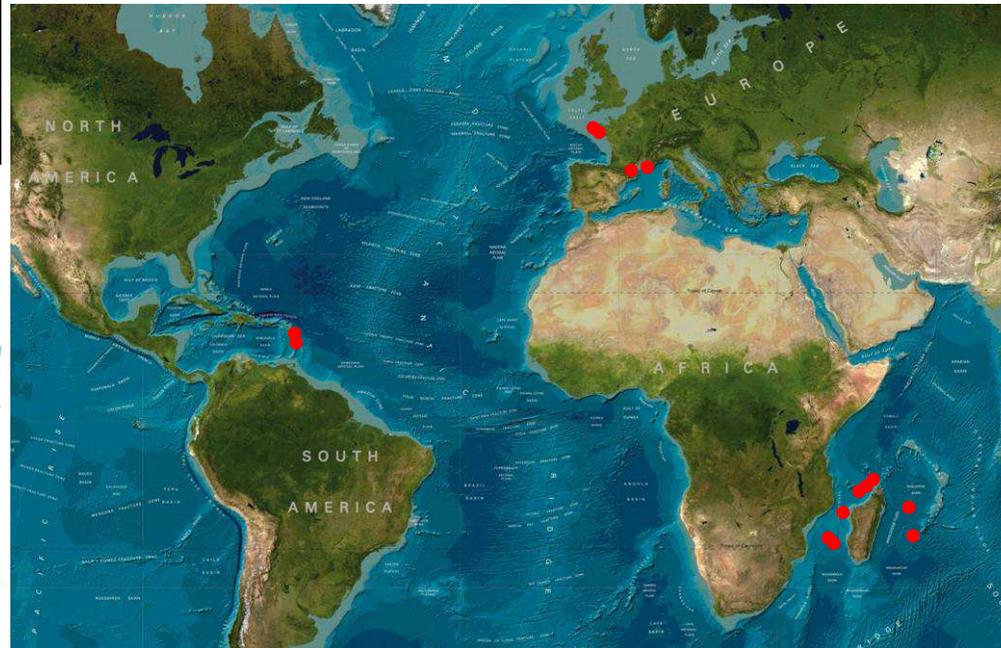
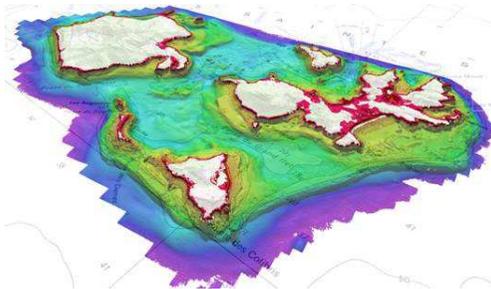
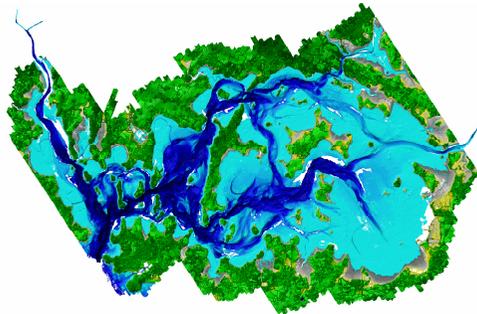
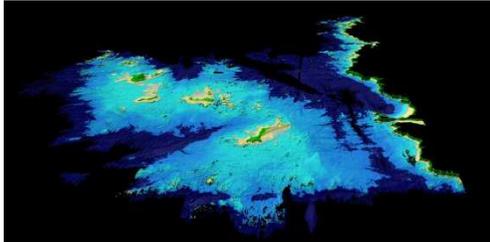
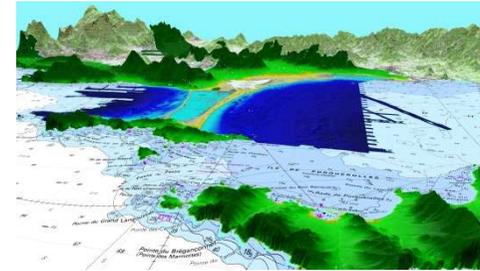
Need to establish upstream financing with the Government, local authorities and European funding for each territories

Step by step project, territories by territories

→ SHOM does not own his own LiDAR capability
Surveys subcontracted for each partnership

Surveys to meet IHO Order 1B

Litto3D® - Lessons learned

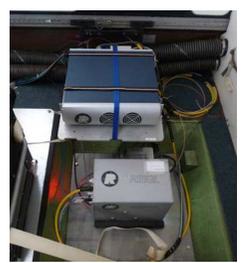


14 surveys since 2005...

Litto3D® - Lessons learned



Litto3D®



- Most of the systems used :**
- 7 for Litto3D surveys
 - 2 for tests



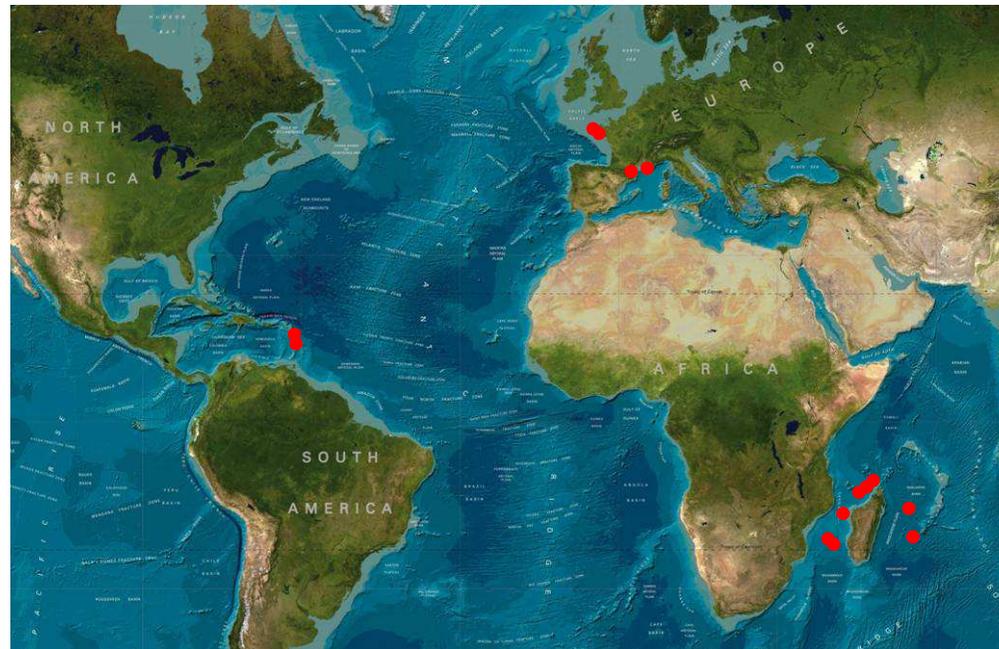
Litto3D® - Lessons learned



Fugro LADS Corporation

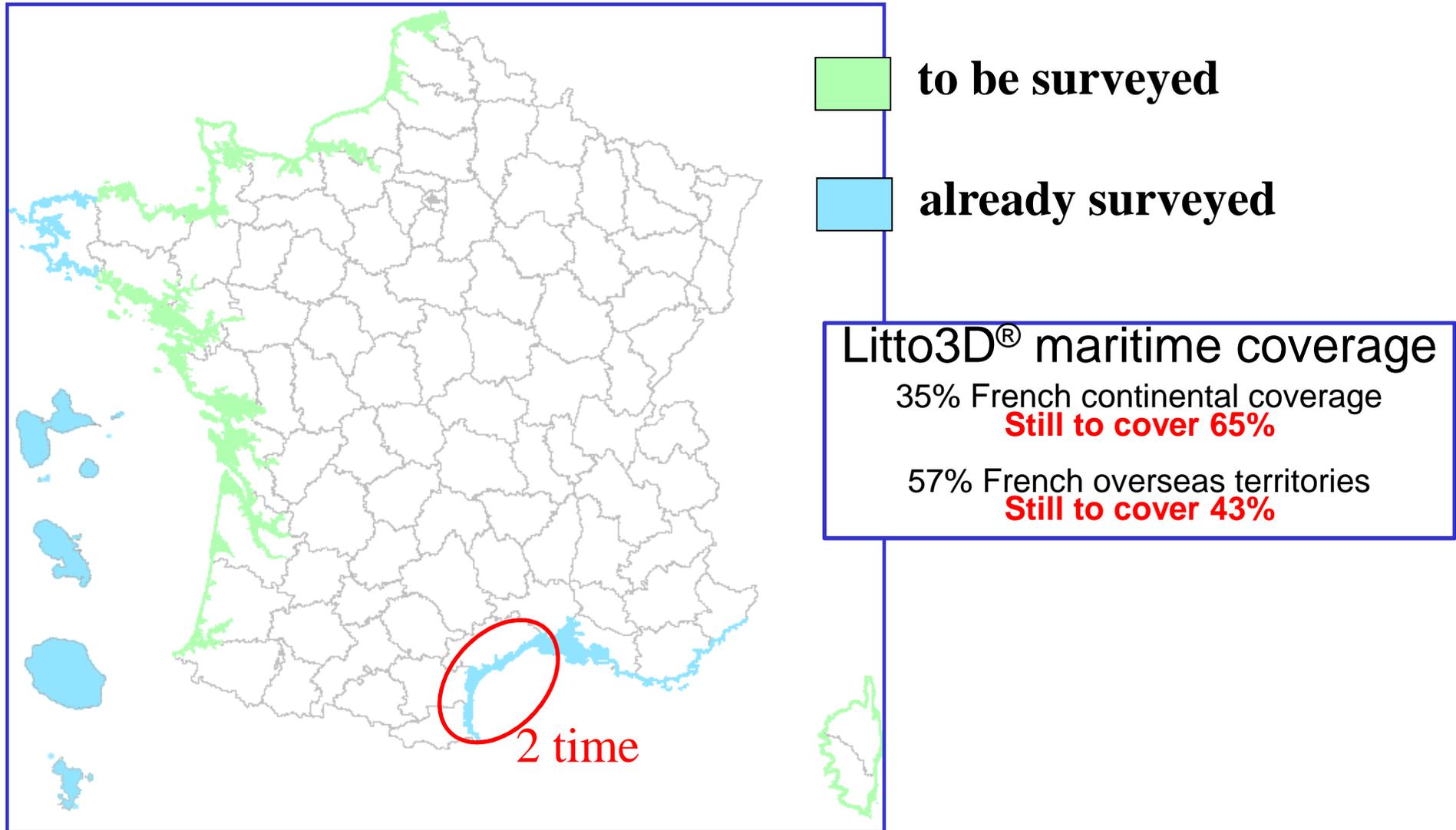


Fugro Pelagos



Surveys sub-contracted with many different companies...

Litto3D[®] - Progress



<http://data.shom.fr>

Litto3D®

Open data product

Navigation
Affichage
Données
Outils
Abonné

DATA.SHOM.FR
Information géographique maritime et littorale de référence

Catalogue

Actualités | Aide | FR | EN
Remonter une information

Provided open data:

- Point cloud (.xyz)
- DTM (1m, 5m, .asc)
- Metadata source, distance, specifications

WGS84 : 48° 43' 32.6" N, 3° 59' 13.2" W

Mentions légales et avertissements

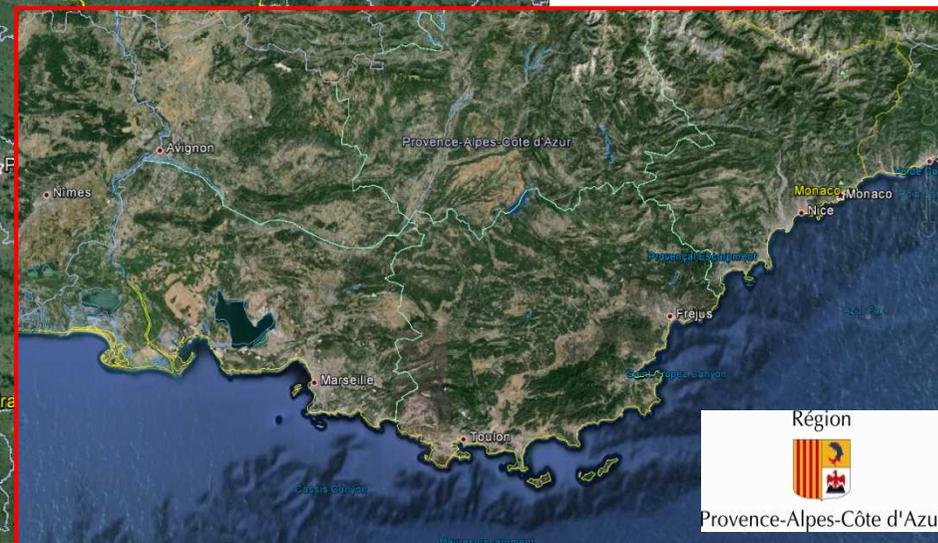
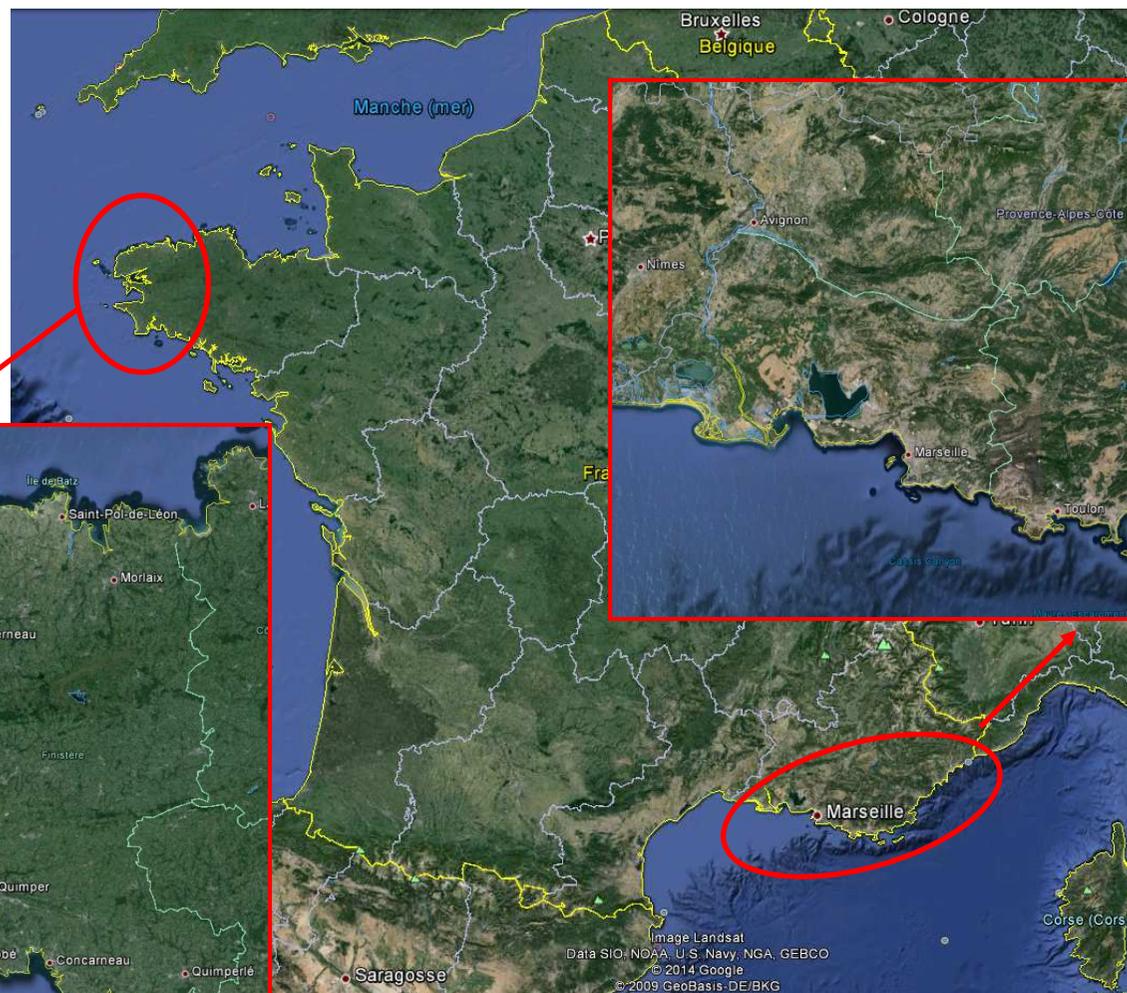
Echelle: 1 : 12 578

PACA and Finistère surveys

Litto3D®

Survey's area

FINISTERE
Survey
1520km²



PACA Survey
765km²

PACA and Finistère surveys

Litto3D®



LADS MkIII (Fugro LADS)



Mob 1 – BLOM CGR



Mob 2 & 3 – CAE Aviation

Survey done by

- Fugro GEOID (FR)
- Fugro LADS (AUS)

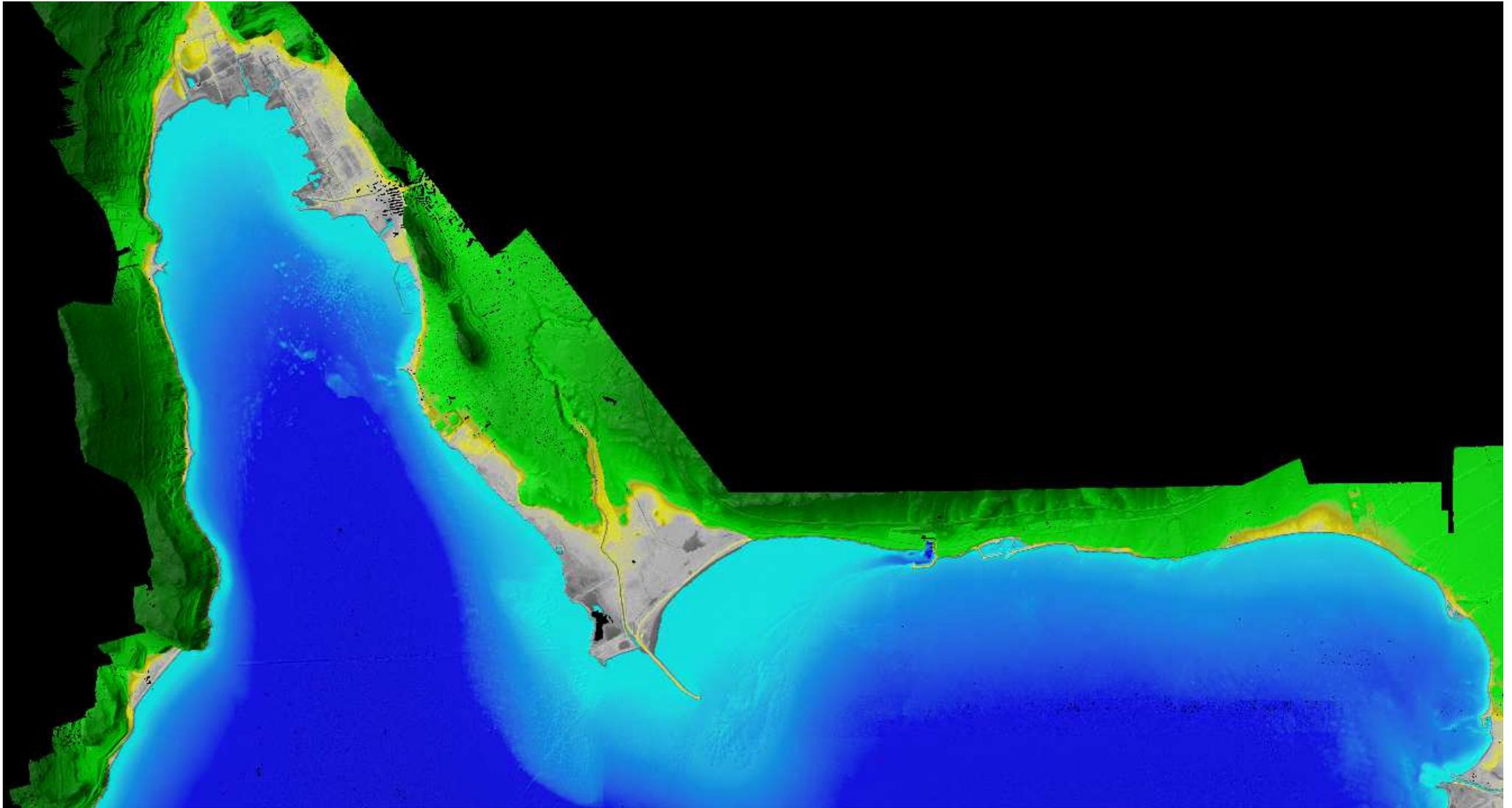


VQ-820-G (Riegl)

PACA and Finistère surveys

LADS and RIEGL: étang de Berre

Litto3D®



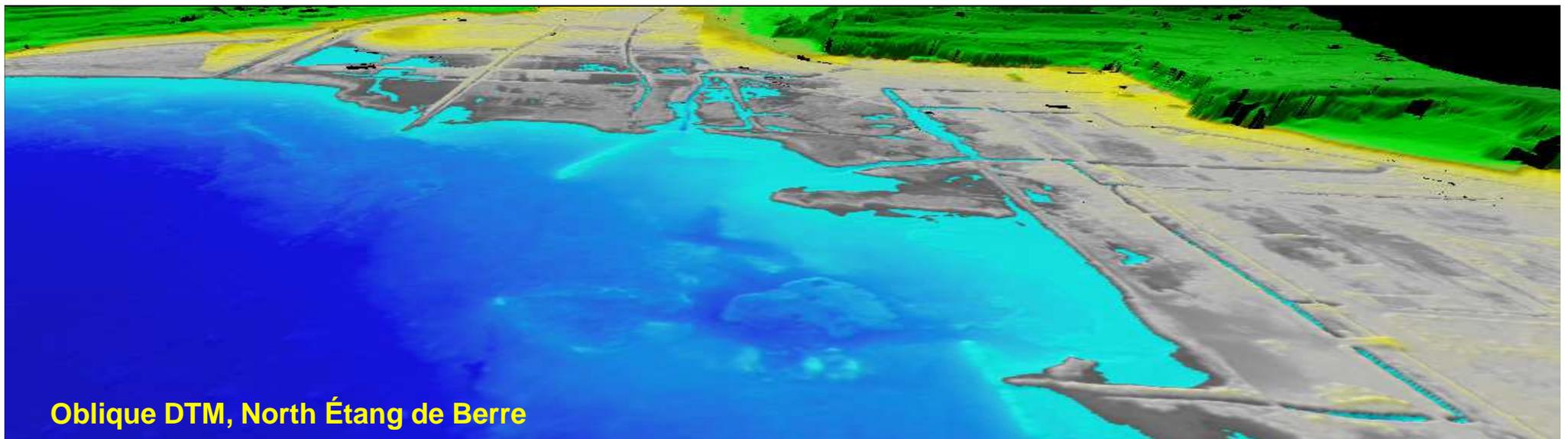
PACA and Finistère surveys

Litto3D®

LADS and RIEGL



Oblique photo, North Étang de Berre

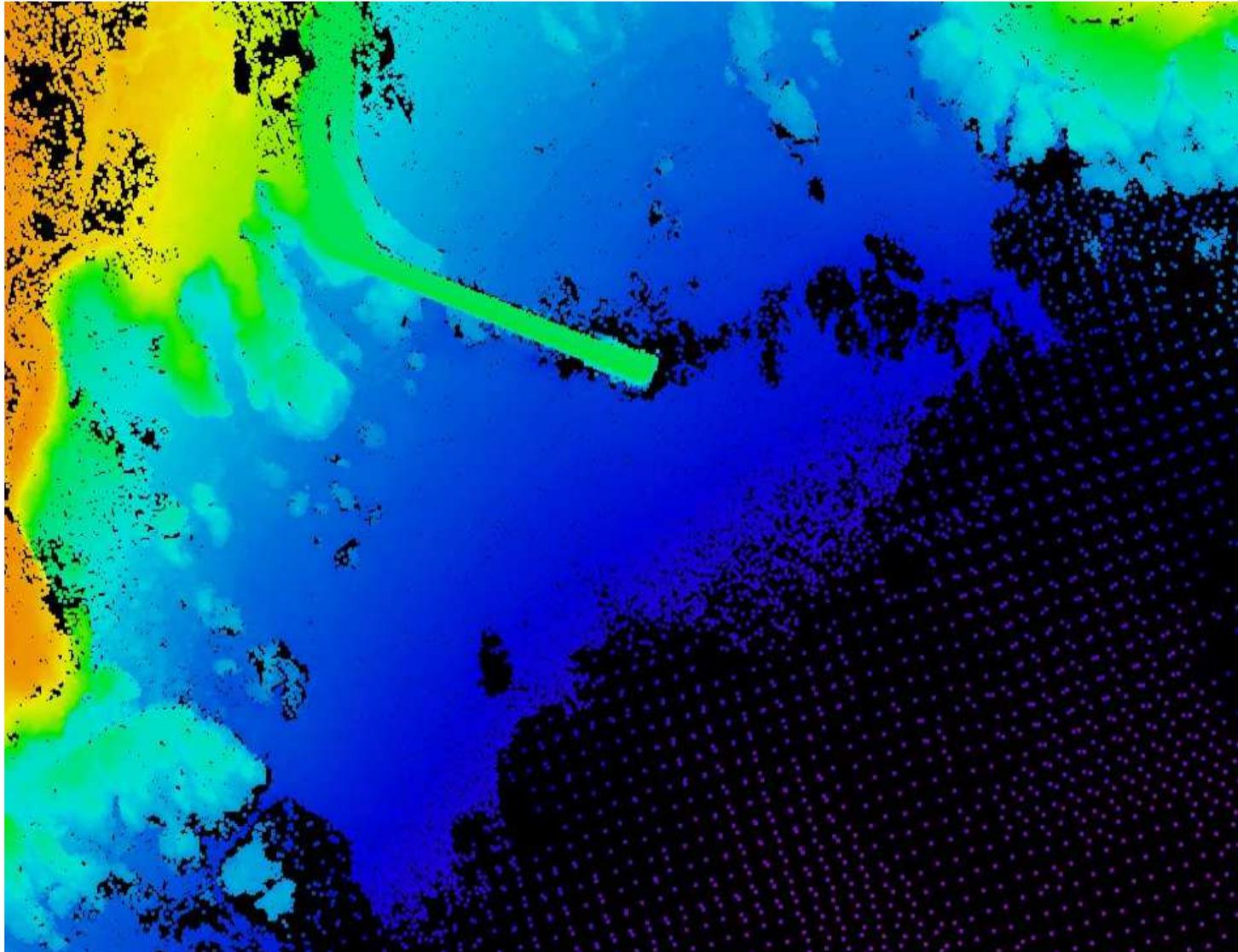


Oblique DTM, North Étang de Berre

PACA and Finistère surveys

Litto3D®

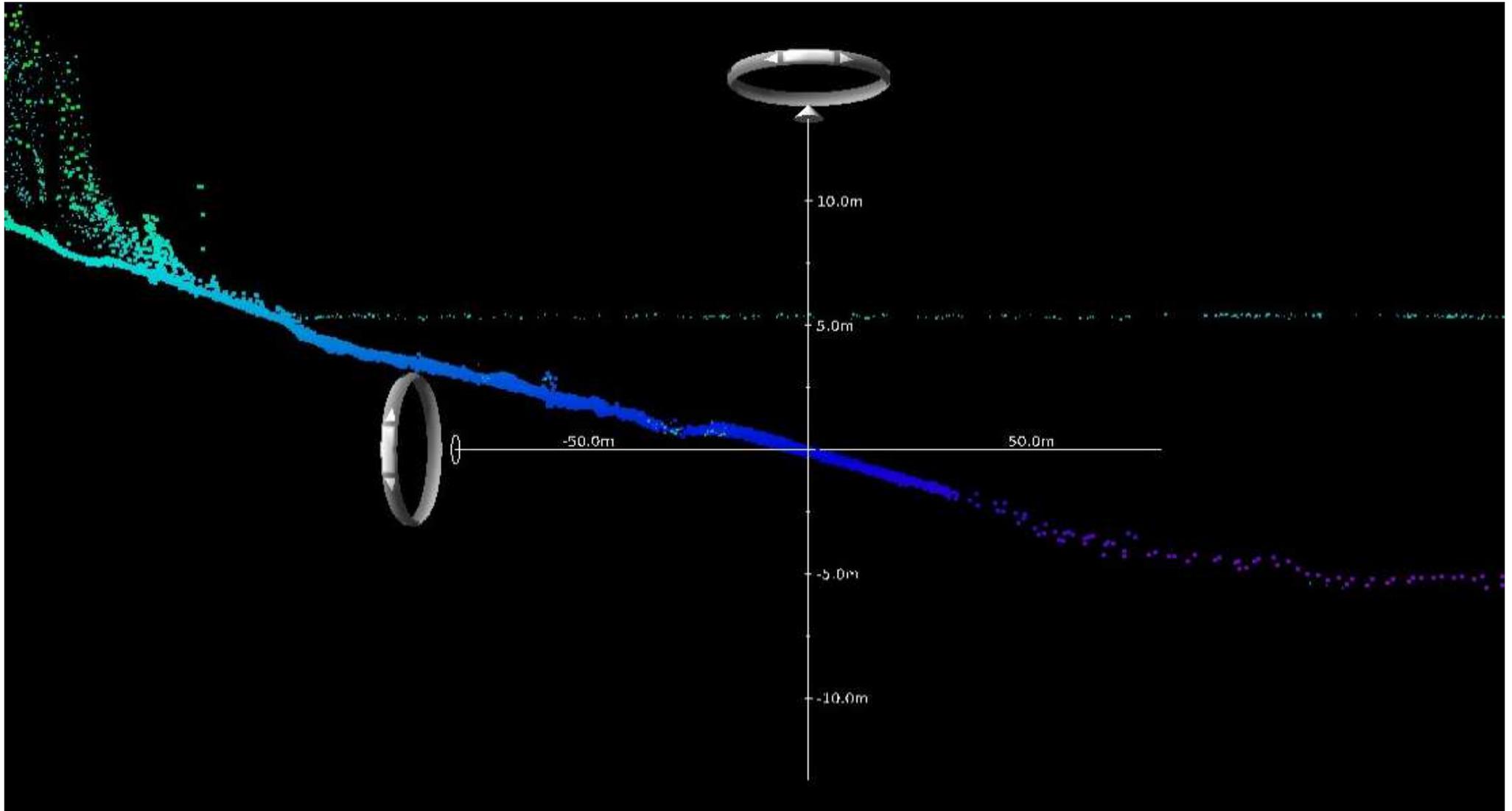
LADS and RIEGL



PACA and Finistère surveys

Litto3D®

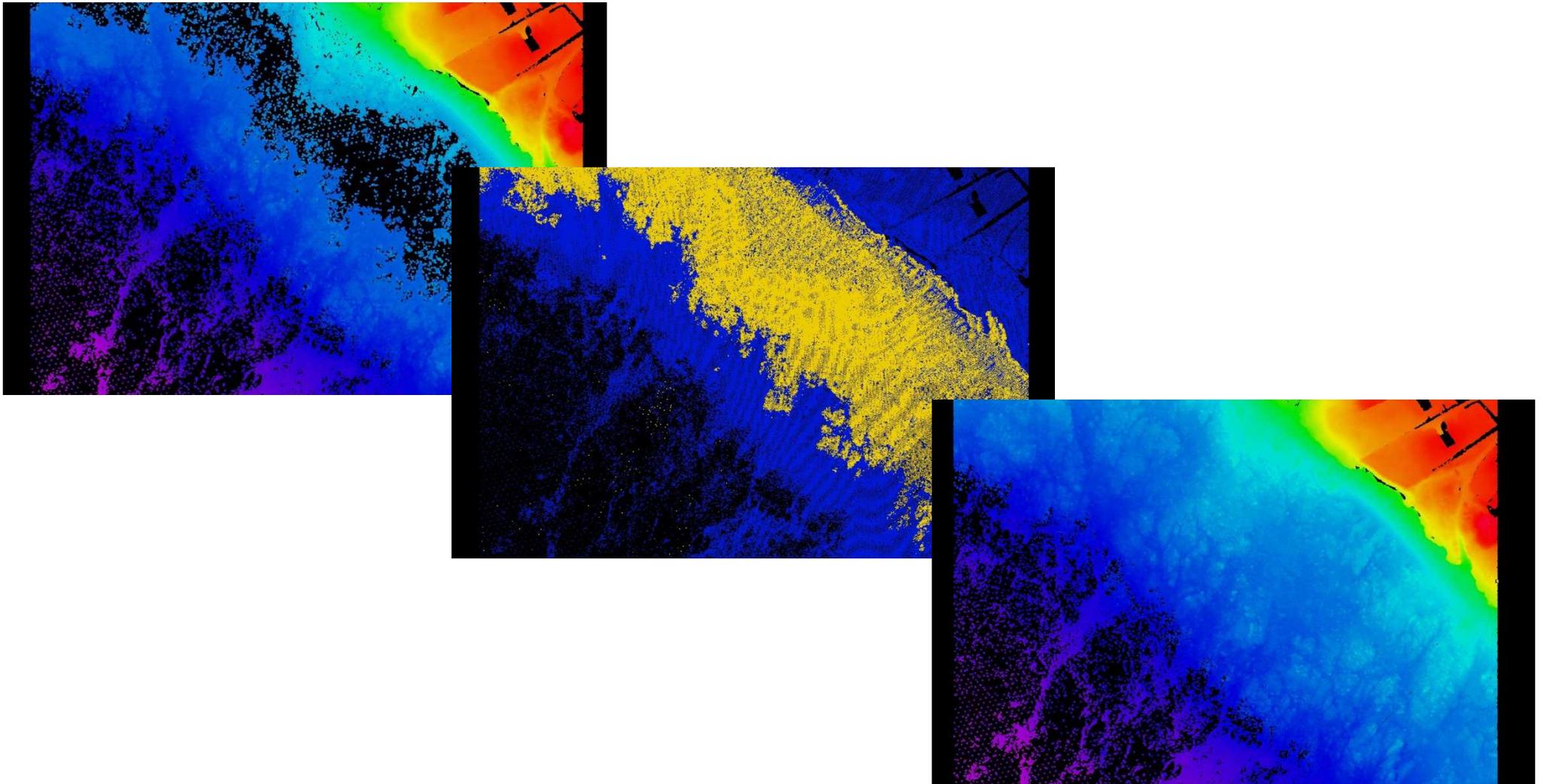
LADS and RIEGL



PACA and Finistère surveys

LADS and RIEGL

Litto3D®

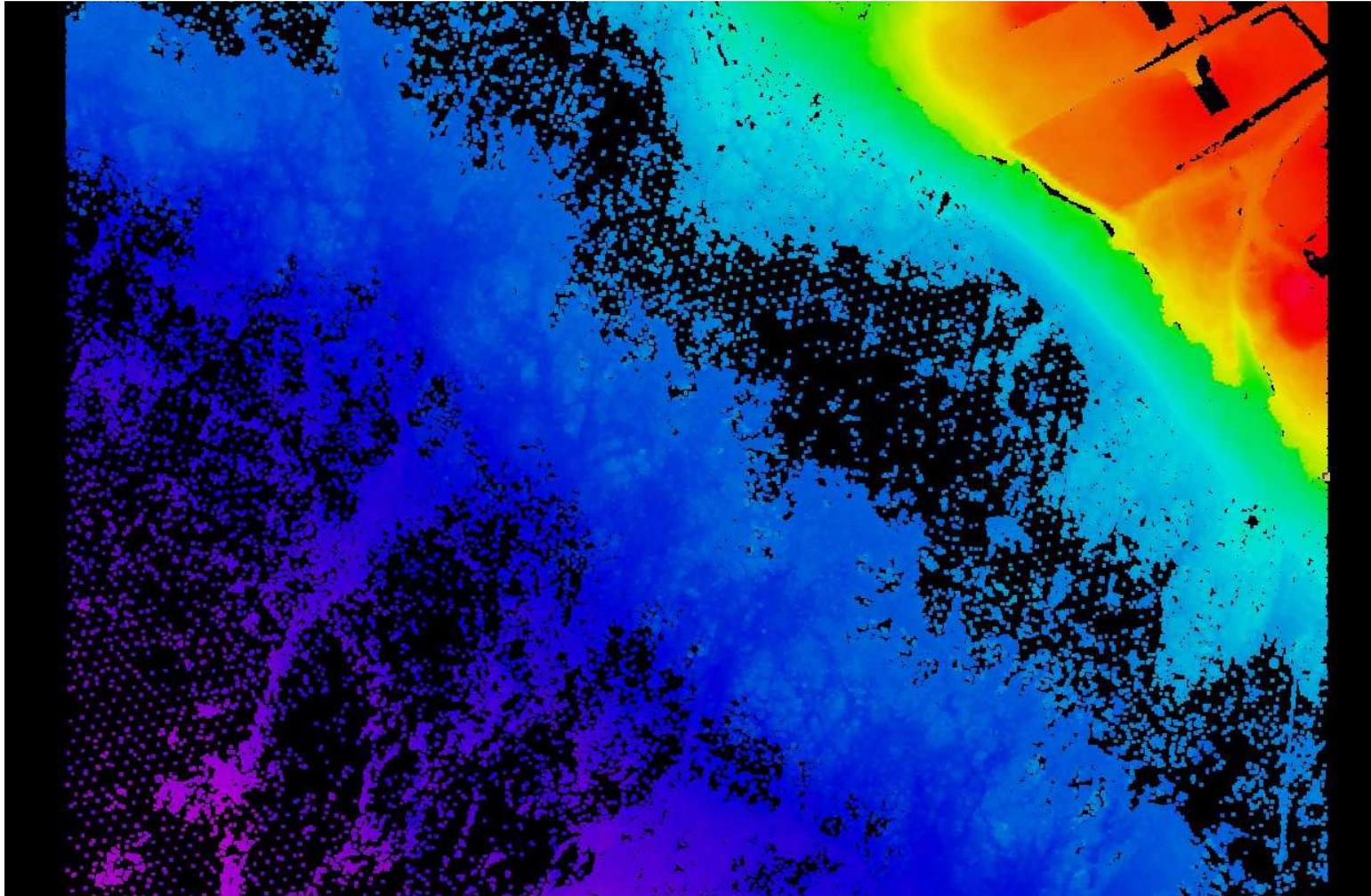


PACA and Finistère surveys

Litto3D®

LADS and RIEGL

First result

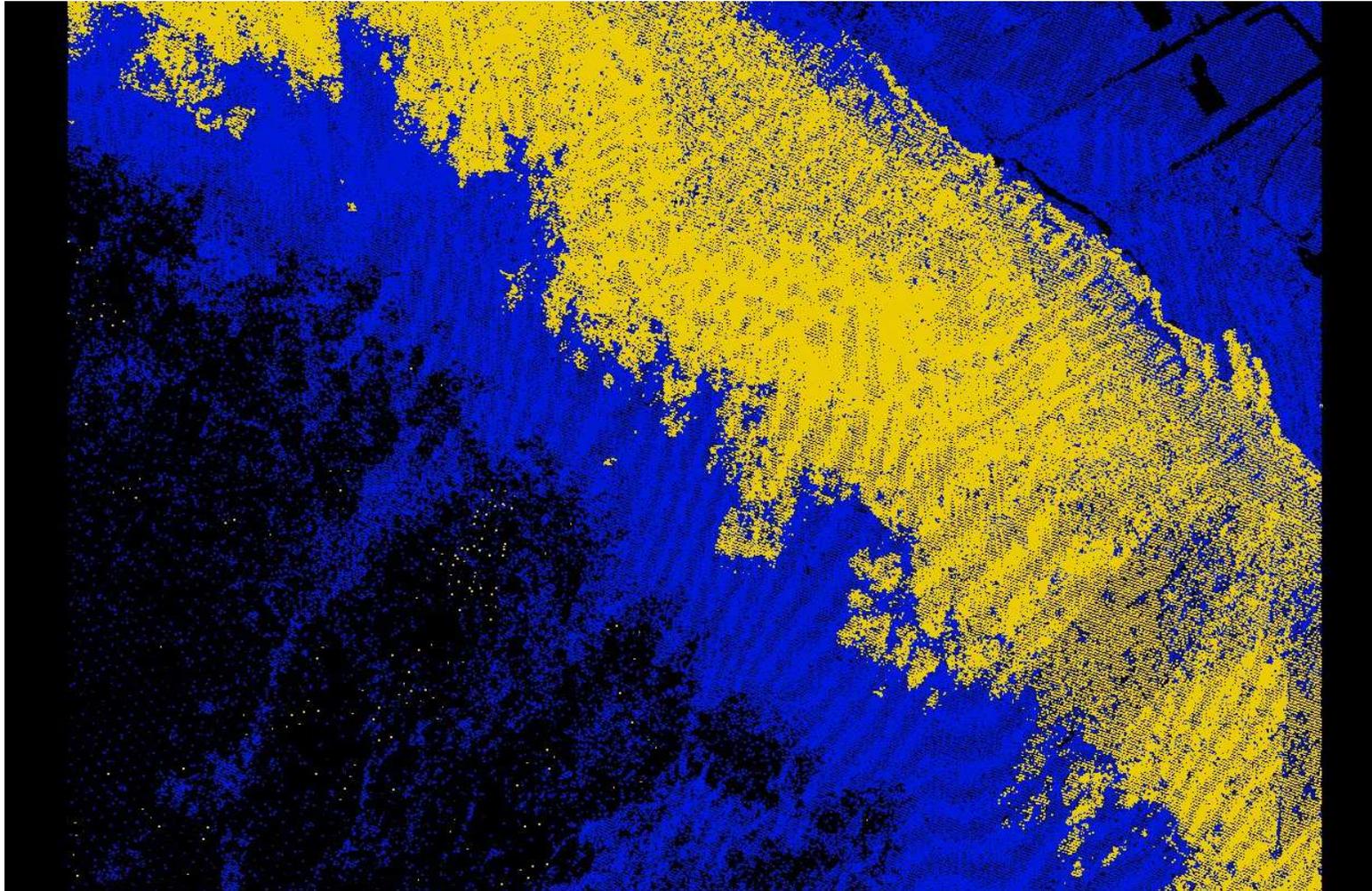


PACA and Finistère surveys

Litto3D®

LADS and RIEGL

Reprocessing by SHOM

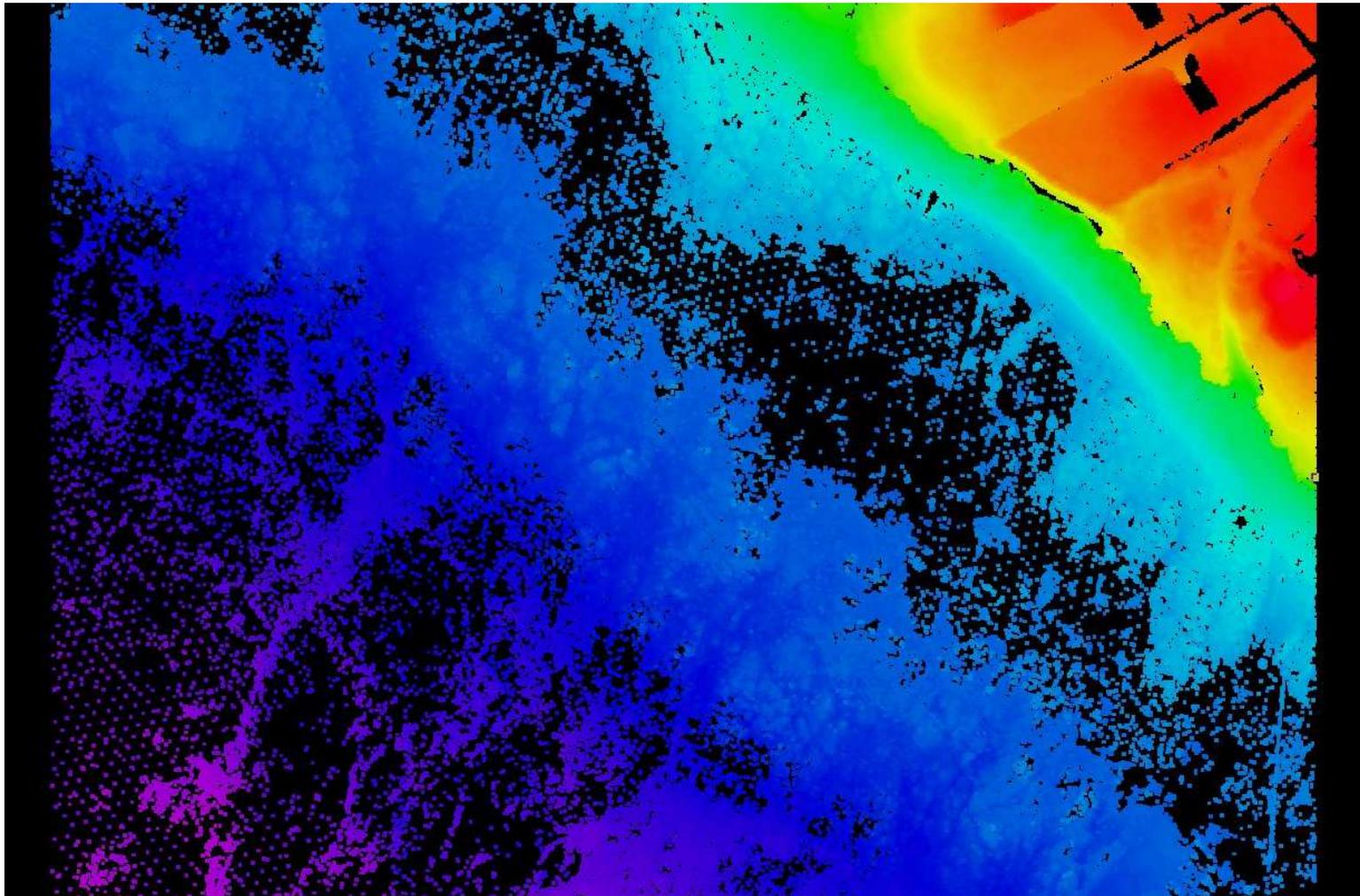


PACA and Finistère surveys

Litto3D®

LADS and RIEGL

First result

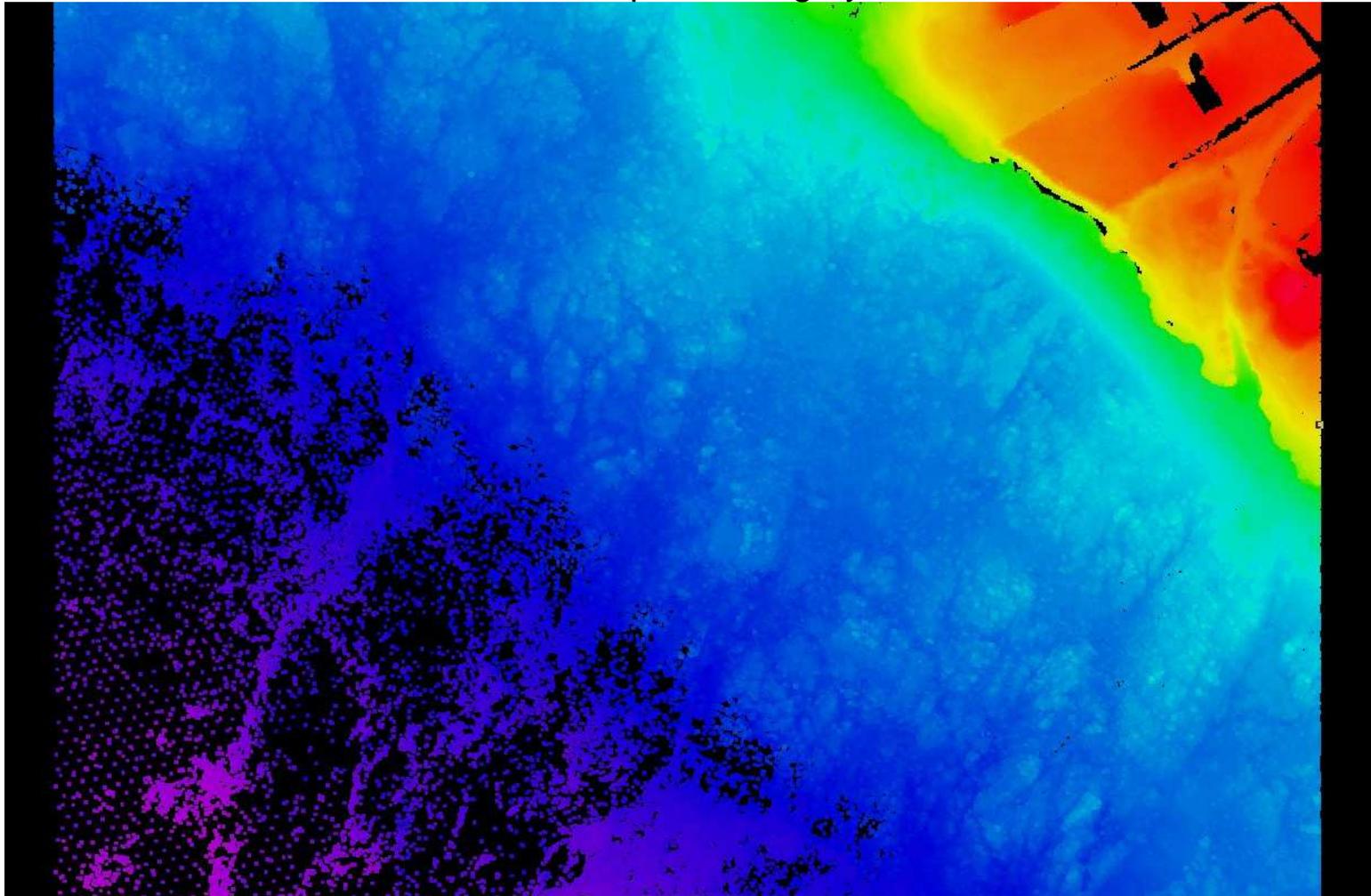


PACA and Finistère surveys

Litto3D®

LADS and RIEGL

After reprocessing by SHOM



First conclusion

Litto3D® 10th birthday

Our feedback:

- New topo-bathymetric lidar offers a breakthrough, but remember, post-processing is closer to hydrography than topography ;
- To meet project's requirements, a high-level re-post-processing has always been needed: it introduces a change in our procedure.

Survey companies will be in charge of acquisition and pre-validation (positioning & raw coverage).

SHOM will do the post-processing and QC.

- **Still a strong need for our own Bathymetric lidar capability**

Other perspectives

- Vertical reference surfaces ;
- Airborne Hyperspectral Derived Bathymetry (AHDB)



Vertical reference: international recommendation for bathymetric survey

- IHO standards for hydrographic surveys S-44 (and FIG n°37, September 2006)

Ideally the sounding datum should be a well defined vertical datum such as LAT, MSL, a geocentric reference frame based on ITRS (International Terrestrial Reference System) or a geodetic reference level.



In France, a Chart Datum (CD \neq LAT) is used.

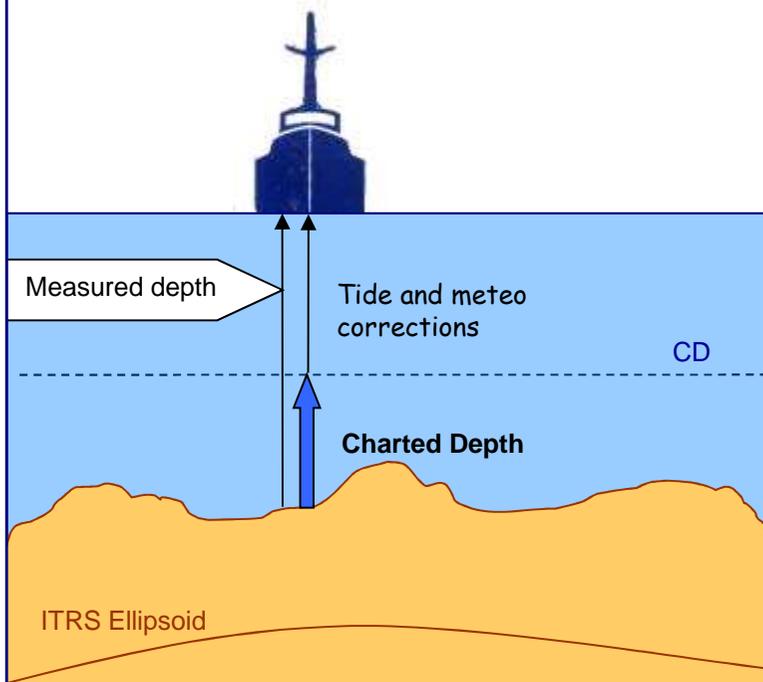
The ellipsoid **IAG-GRS80** (International Association of Geodesy) of the French legal geodetic system **RGF93** has been chosen by SHOM. As a vertical reference, it is:

- ***stable*** (mathematical definition),
- ***accessible*** (GNSS receiver),
- ***precise*** (linked to ITRS realisation).

Vertical reference: use of CD/GRS80 for ERS

Classical survey

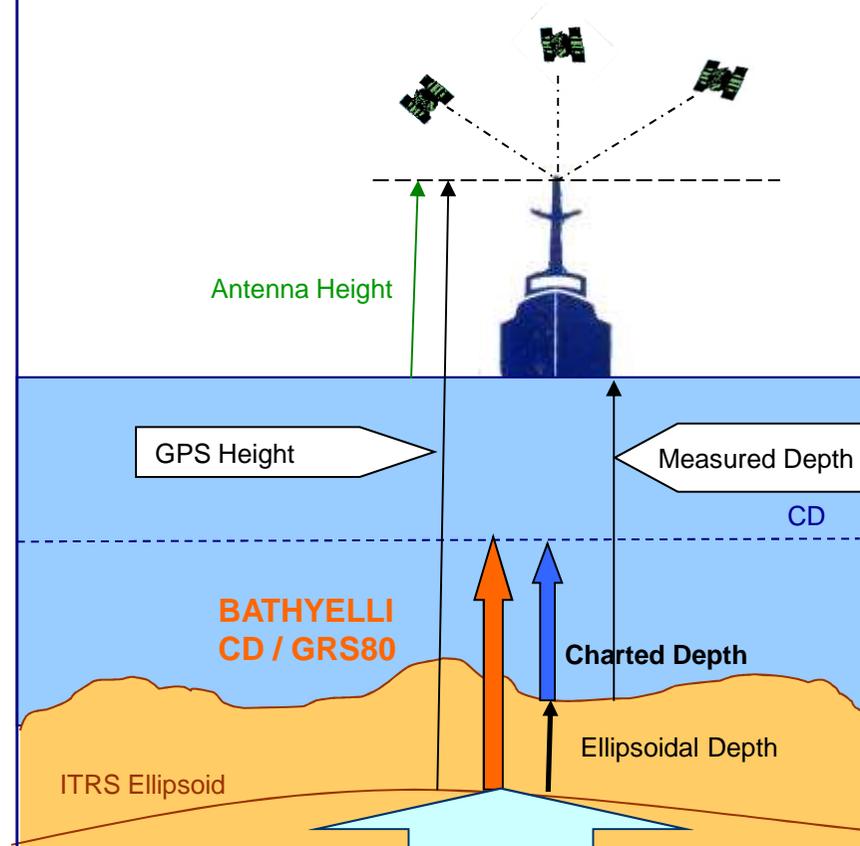
$$\text{Charted Depth} = \text{Measured Depth} - \text{Meteo} - \text{Tide}$$



Ellipsoid Referenced Survey (ERS)

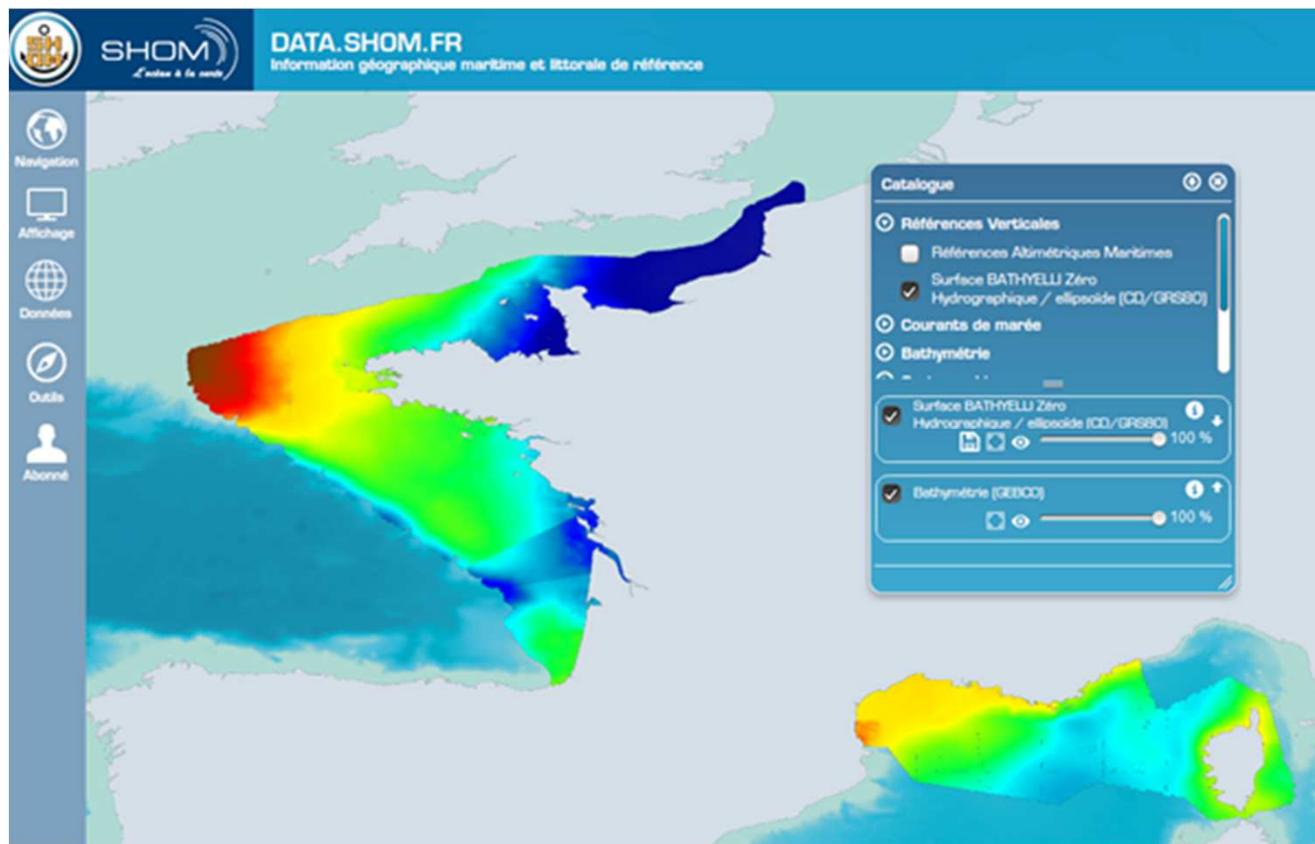
$$\text{Ellipsoidal Depth} = \text{GPS Height} - \text{Antenna Height} - \text{Measured Depth}$$

$$\text{Charted Depth} = \text{Ellipsoidal depth} - \text{CD/ellipsoid}$$



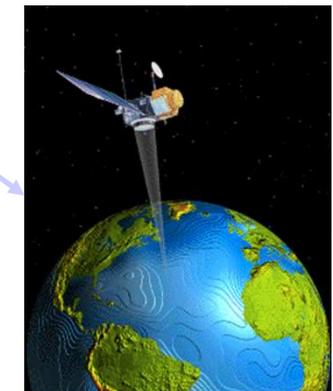
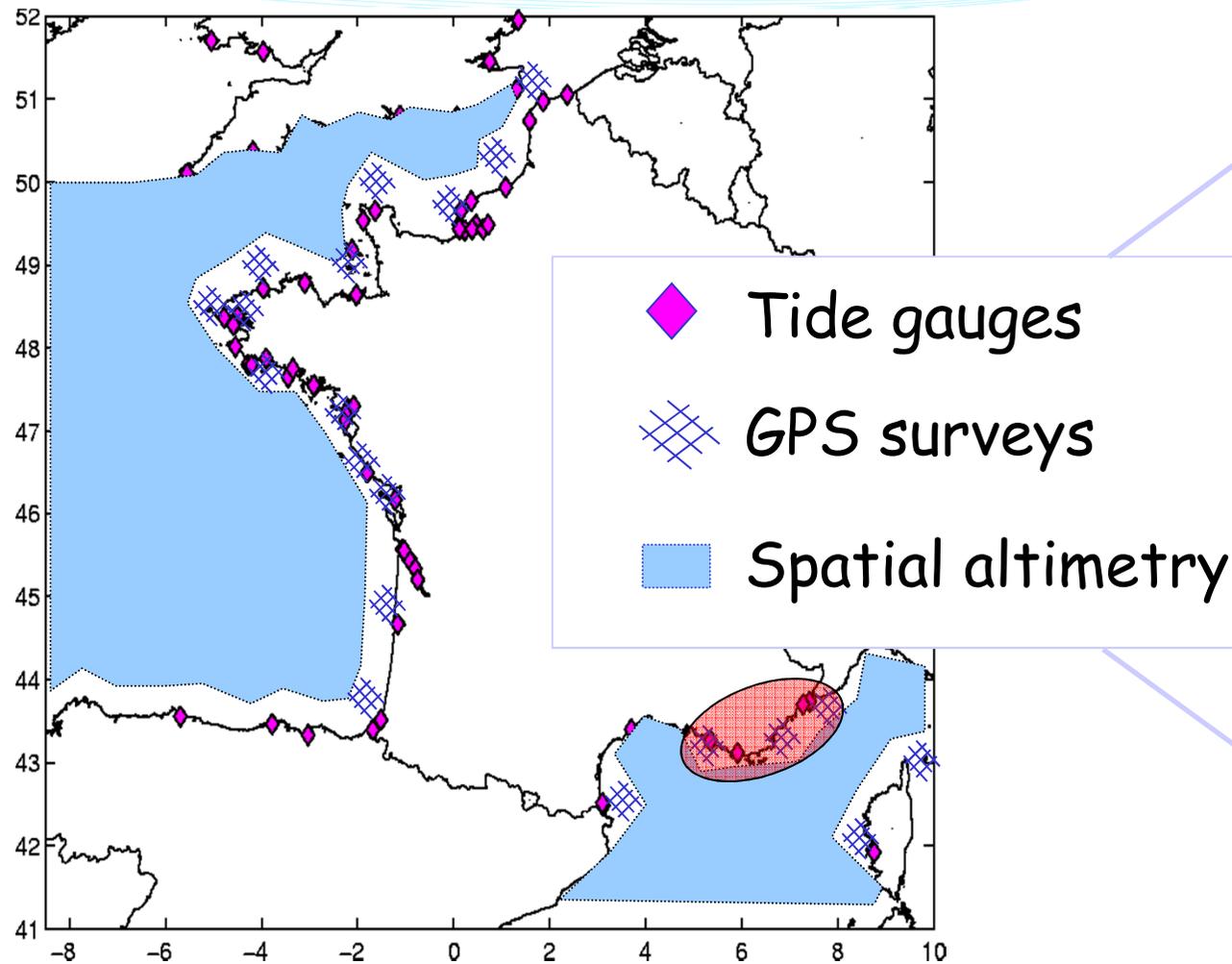
No tide and meteorological corrections

Vertical reference: BATHYELLI (FR), an equivalent of V-DATUM (US) or VORF (UK)



- **Chart Datum/GRS80** is an open data product: available on data.shom.fr since the 15th of November 2013 (v1.0)
- **A new version 1.1** will be released in July 2014

Vertical reference: source for MSL

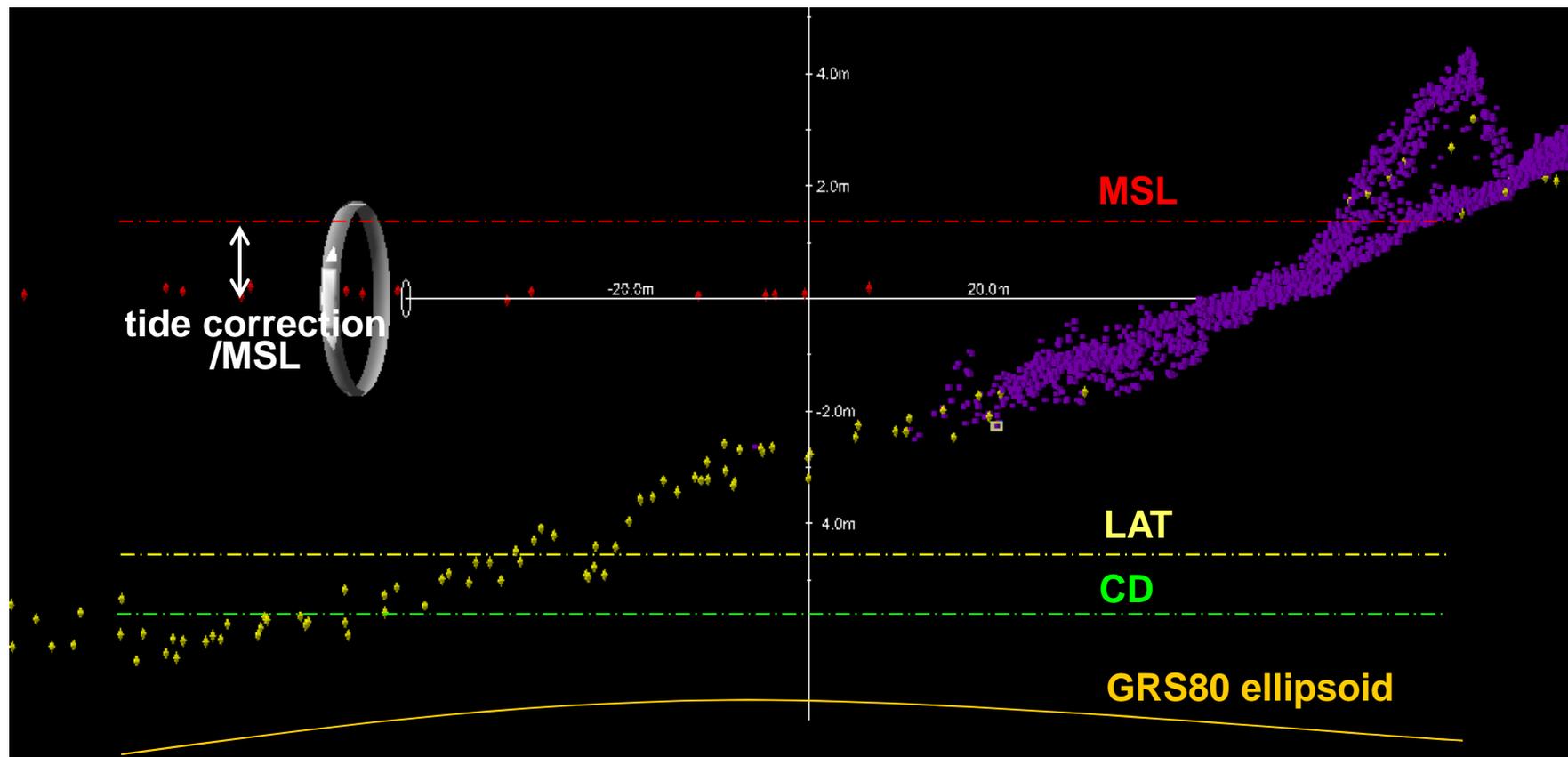


During the “Provence-Alpes-Côte d’Azur” (PACA) survey, the **RIEGL VQ820G laser** brought a side product: can the “sea surface returns” be used to get a Mean Sea Level surface ?

Vertical reference: topo/bathy lidar, new source for MSL?

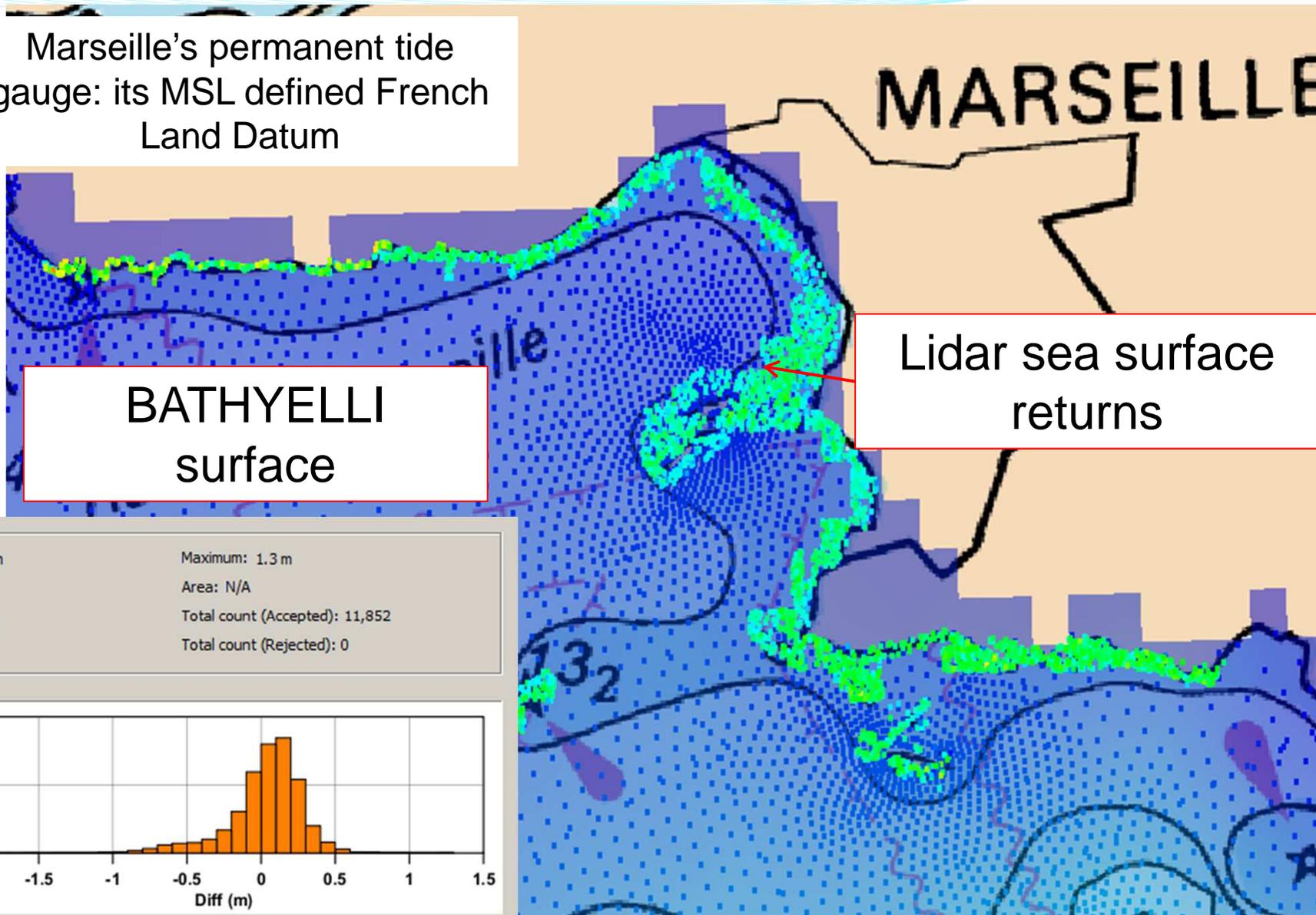
In order to estimate the ellipsoidal height of MSL, the procedure is to:

- from the points cloud, separate points corresponding to the sea surface (manually, not automated procedure)
- apply a tide correction (time & space, “MARMONDE” SHOM’s French tide model),
- compute simple statistics,
- compare with permanent tide gauges results or BATHYELLI surface.



Vertical reference: MSL in Marseille (RIEGL VQ820G)

Marseille's permanent tide gauge: its MSL defined French Land Datum



BATHYELLI
surface

Lidar sea surface
returns

Statistics

Minimum: -1.9 m

Maximum: 1.3 m

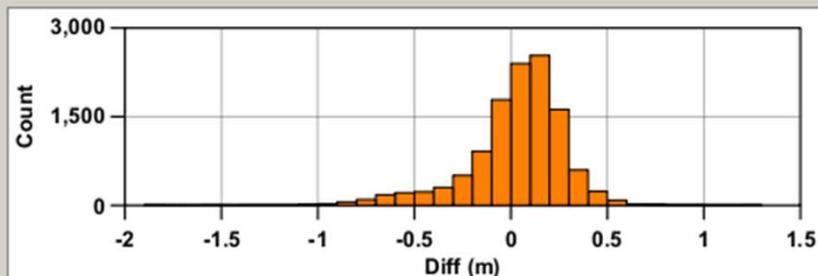
Mean: 0 m

Area: N/A

Std_dev: 0.2 m

Total count (Accepted): 11,852

Total count (Rejected): 0

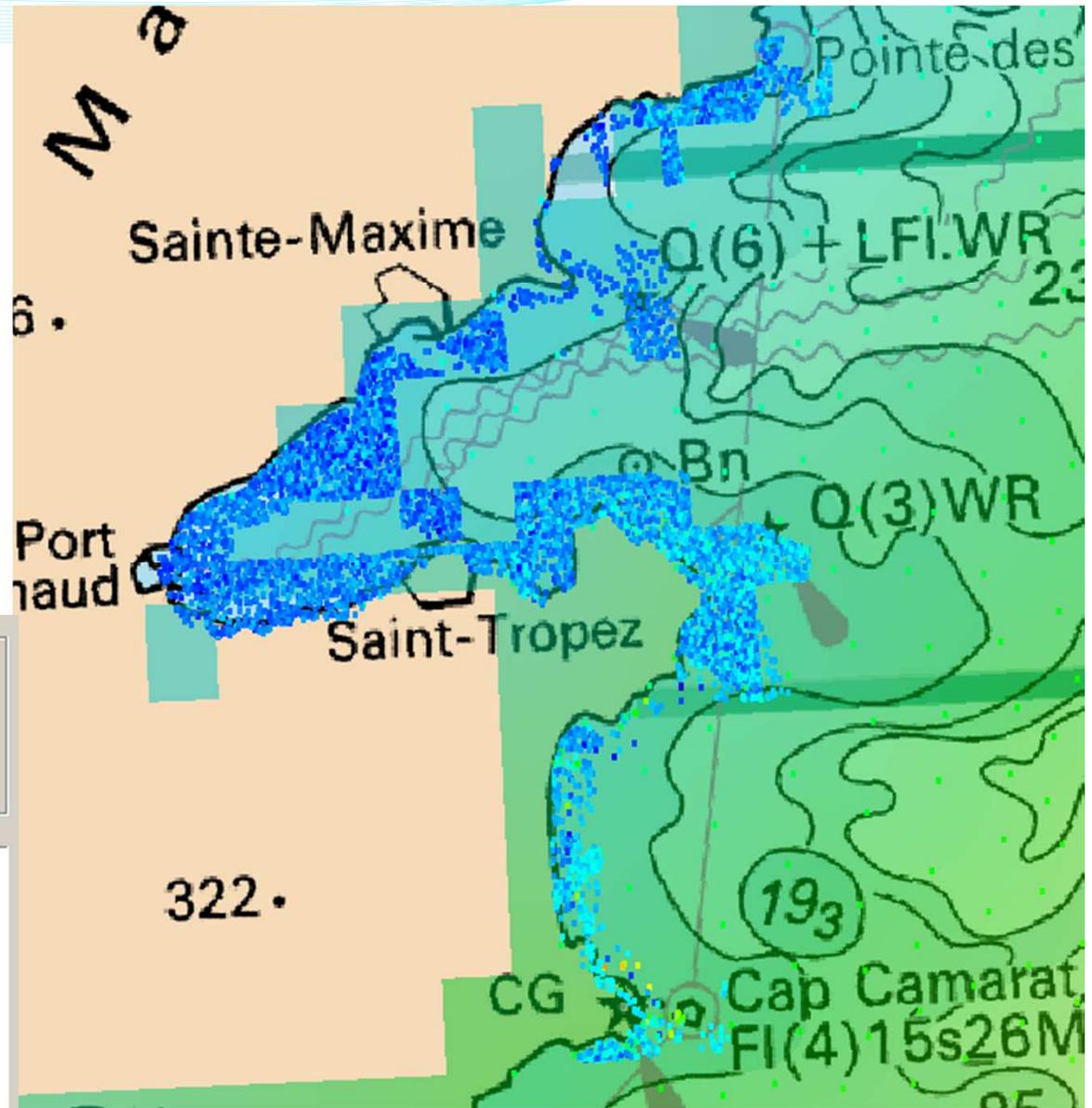


Vertical reference: MSL in Saint-Tropez (RIEGL VQ820G)

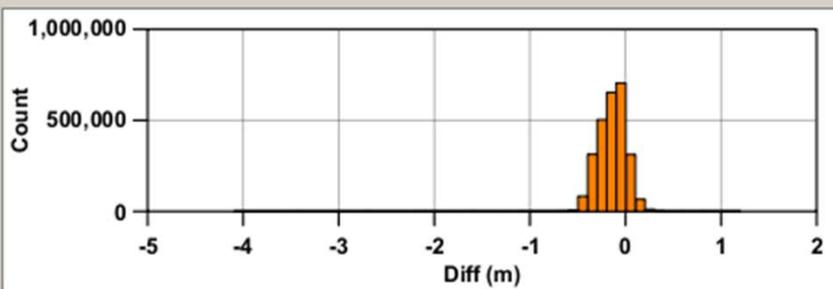
Saint-Tropez:

- Recent permanent tide gauge
 - Poor quality GPS survey
 - Important bathymetric gradient (deformation of SST)
- ⇒ complex area for BATHYELLI's MSL modelisation

Could lidar's sea surface returns be useful?

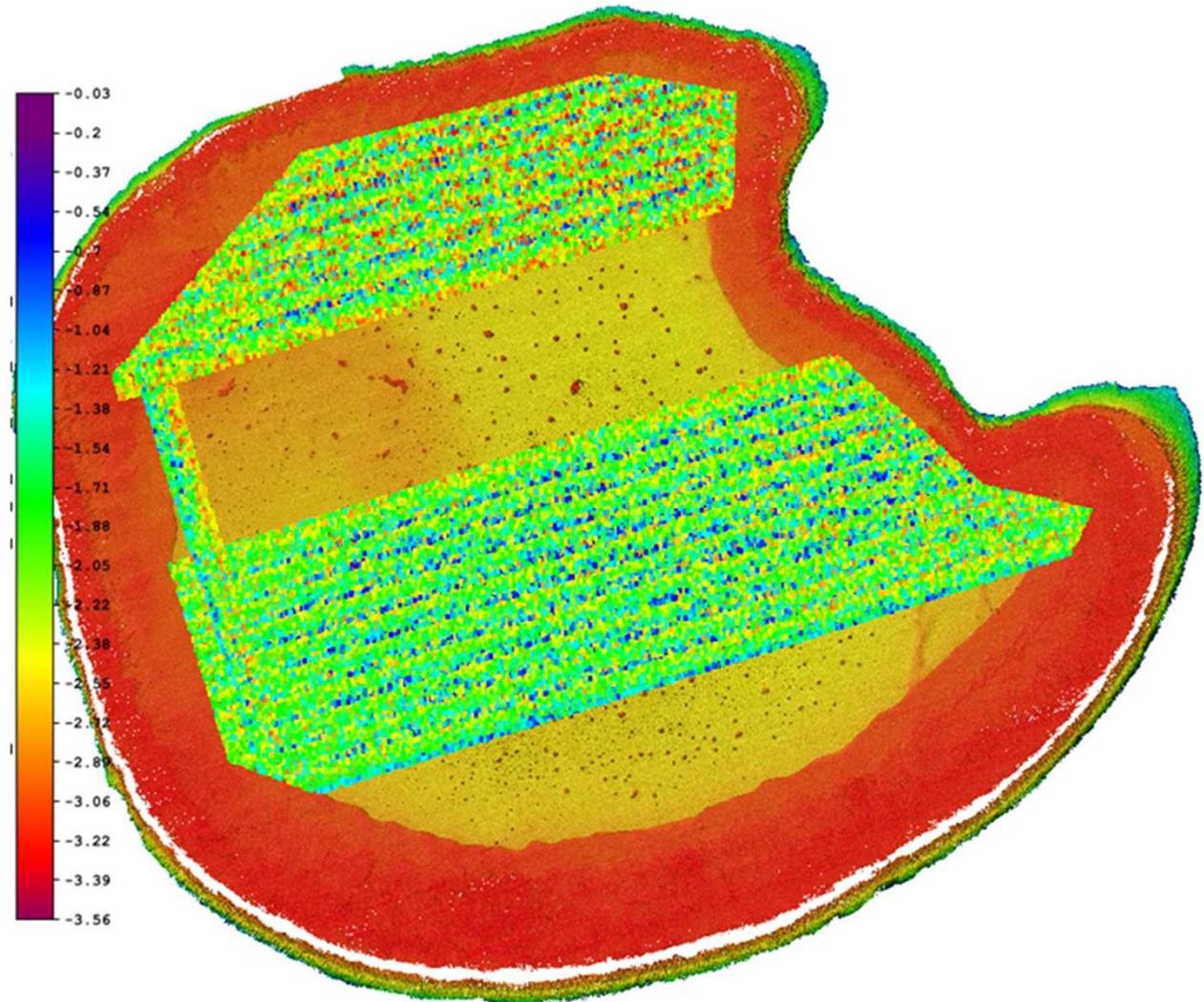


Statistics	
Minimum: -4.1 m	Maximum: 1.2 m
Mean: -0.1 m	Area: N/A
Std_dev: 0.1 m	Total count (Accepted): 2,655,732
	Total count (Rejected): 0



Vertical reference: LAT in Scattered Islands (HawkEye Ila)

- Completely isolated atoll in the Indian Ocean: no local tide data
- Use of:
 - bathy lidar data (HawkEye Ila)
 - global tide model (FES2004)
- to estimate:
 - MSL/GRS80,
 - LAT/GRS80.
- 10 cm consistency with altimetry (Topex-Jason MSL/GRS80)



Airborne Hyperspectral Derived Bathymetry?

- Hyperspectral data acquired and provided during airborne lidar survey: useful for environmental parameters (bottom nature, water column description)
- A lot of research around inversion of radiative transfer model: 3 parameters (bottom nature+water column description+depth) obtained by Actimar[®] SWIM software. Can hyperspectral “alone” be considered as a reliable source for bathymetry?
- Comparison in the French West Indies and Scattered Islands of the bathymetry resulting from 3 sources:

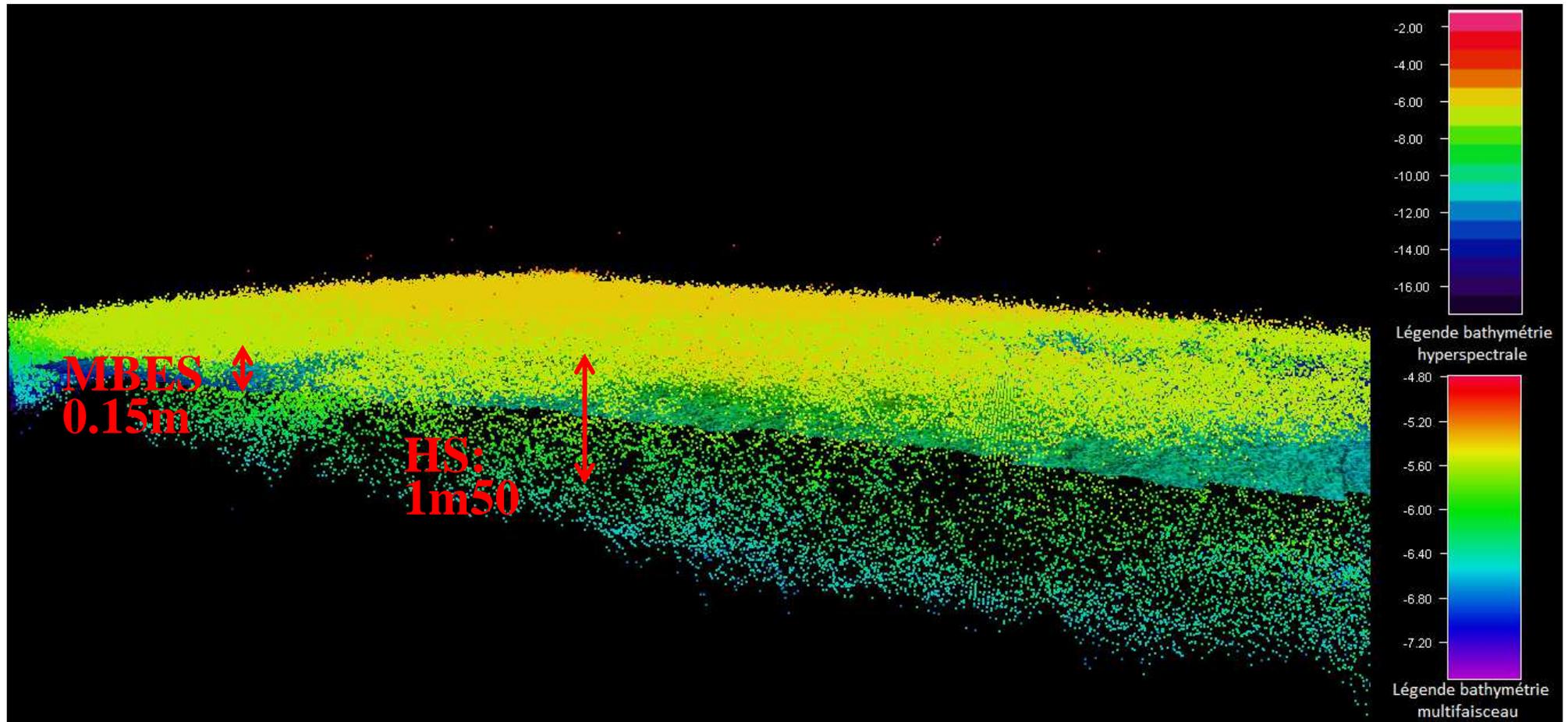


- MBES,
- bathy lidar data (HawkEye Ila and LADS mkII),
- Hyperspectral camera

Would AHDB respect IHO Order 2?

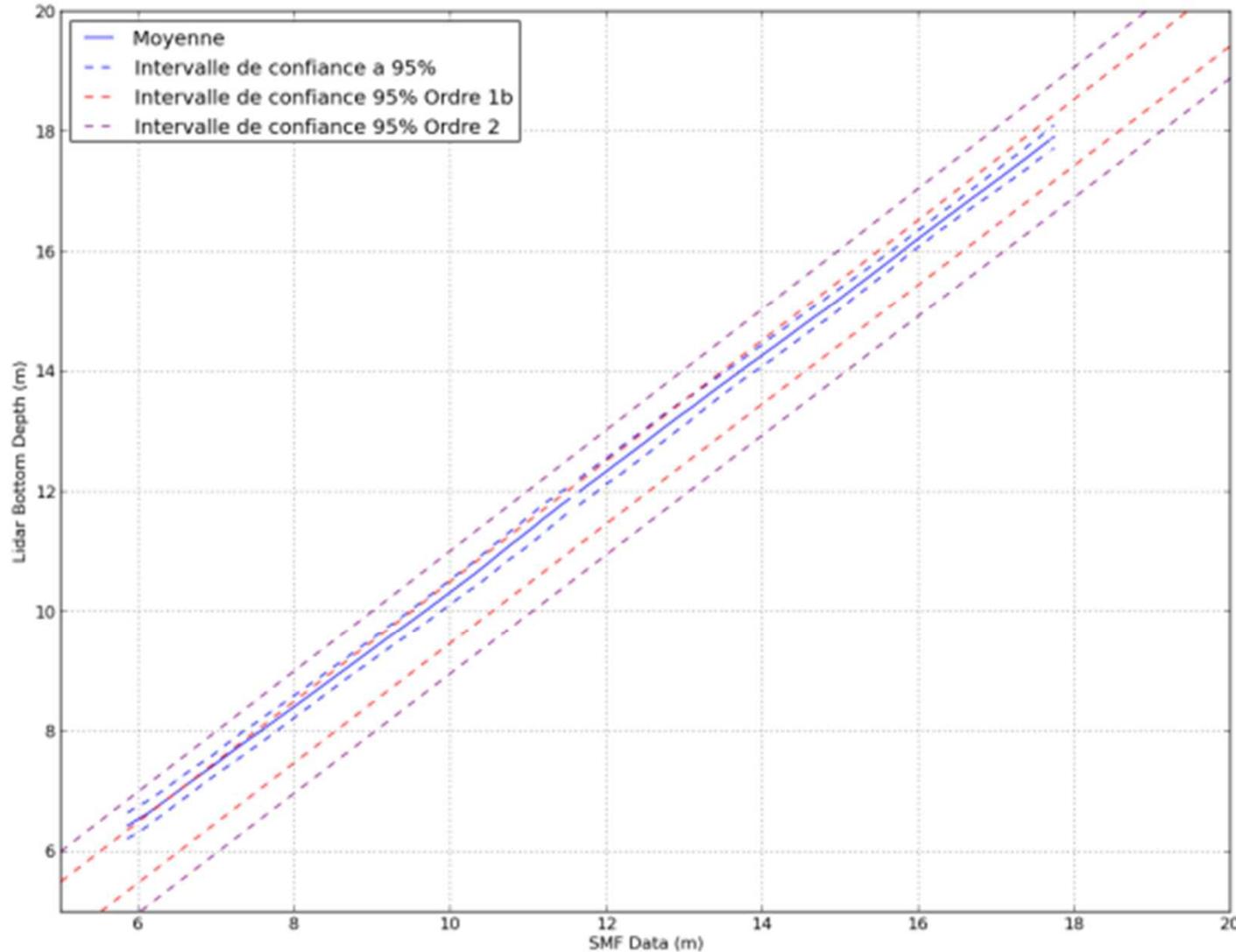
Airborne Hyperspectral Derived Bathymetry?

Thickness of the points cloud with "AHDB"



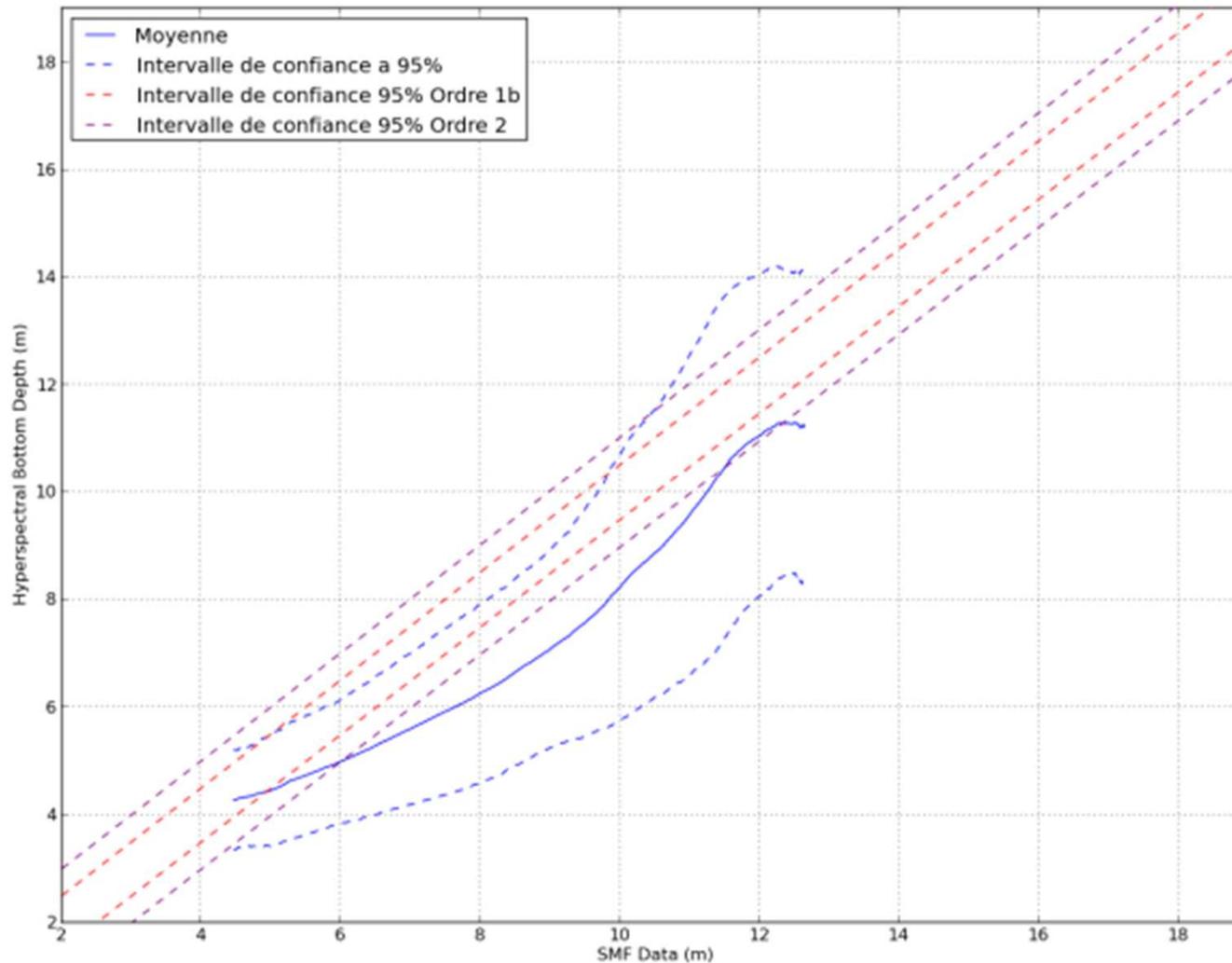
Airborne Hyperspectral Derived Bathymetry?

Comparison: MBES ~ ALB



Airborne Hyperspectral Derived Bathymetry?

Comparison: MBES \neq AHDB \Rightarrow disappointing results:



- outside IHO order 2 (whatever the considered depth)
- no ability for detection (coral pinnacles not found)
- points cloud too thick,
- uncertainty getting even worse if bathymetric gradient (slopes),
- strong influence of the bottom darkness

AHDB does not seem ready yet for hydrographic purposes.

Thank you

Merci

Archipel des Saintes (Îles de Guadeloupe)



Questions ?

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