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SHOM
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# OVERVIEW OF SATELLITE-DERIVED BATHYMETRY PRODUCTION AT SHOM

**SMPHC22 - 02/2025**

**BATHYSAT@SHOM.FR**

# Introduction

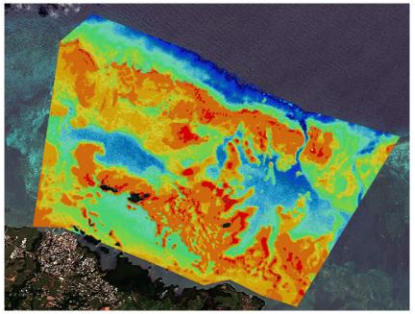
## Innovation partnership

Bathysat© is a semi-automatic tool for producing bathymetric data in coastal areas from multispectral images.


Multispectral image

Bathysat©

HyTECH Imaging

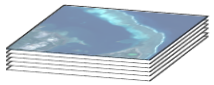


Satellite Derived Bathymetry

The Bathysat© solution developed by Hytech-imaging in partnership with the French Naval Hydrographic and Oceanographic Service (Shom) is based on the inversion of a radiative transfer model, which links the reflectance of the shallow water surface to the optical properties of water constituents, the seabed and water depth.

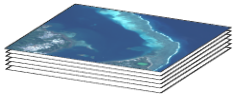
# Methods

Raw image
*Sentinel2 -L1C = 10m*
*Pléïade = 2m*



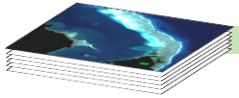
**IMPORT & CALIBRATION**

LTOA
*Luminance 'Top Of Atmosphere'*

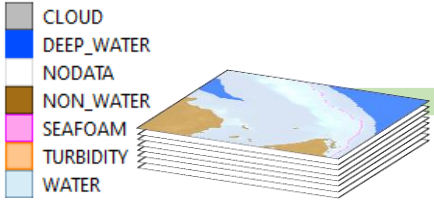


**ATMOSPHERIC CORRECTION**

RBOA
*Reflectance 'Bottom Of Atmosphere'*



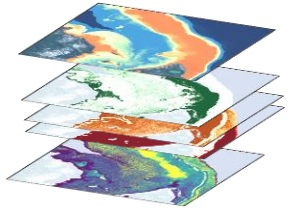
**MASKS**




**INVERSION OF THE WATER COLUMN RADIATIVE TRANSFER MODEL**

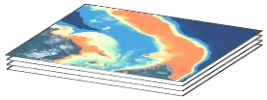
**PARAMETERS INITIALIZATION**

Water column components
*PHY, CDOM, NAP*
Adjustment of bottom spectra
*Light and dark bottom spectra*



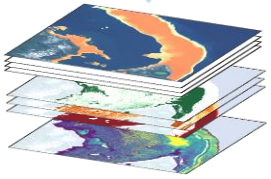
Estimated parameters
*Bathymetry*
*95% uncertainties*
*Water column*
*Bottom reflectance*

**TIDE CORRECTION**



Bathymetry referenced to chart datum

**FILTERING & MERGING**



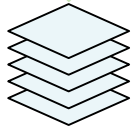
Final products

*IMPORT* | *PRE-PROCESSING* | *MODEL INVERSION* | *POST-PROCESSING*

# Methods

**INVERSION OF THE WATER COLUMN RADIATIVE TRANSFER MODEL**

SWIM



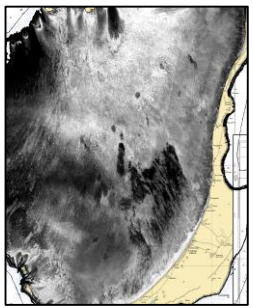
Estimated parameters

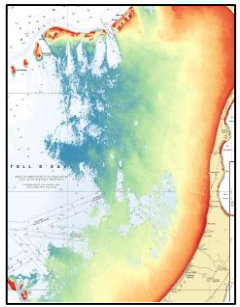
z
Bottom reflectance
Water column parameters

geotiff

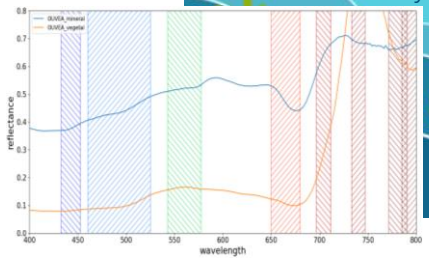
**SWIM : Shallow water mapping using optical remote sensor(s)**

⇒ Inversion by optimization using : multispectral frequencies, several images, operator designated areas representing shallow water, deep water, several types of seabed nature.





Reflectance 'bottom atm.'  Bottom absorption coeff.  Bathymetry



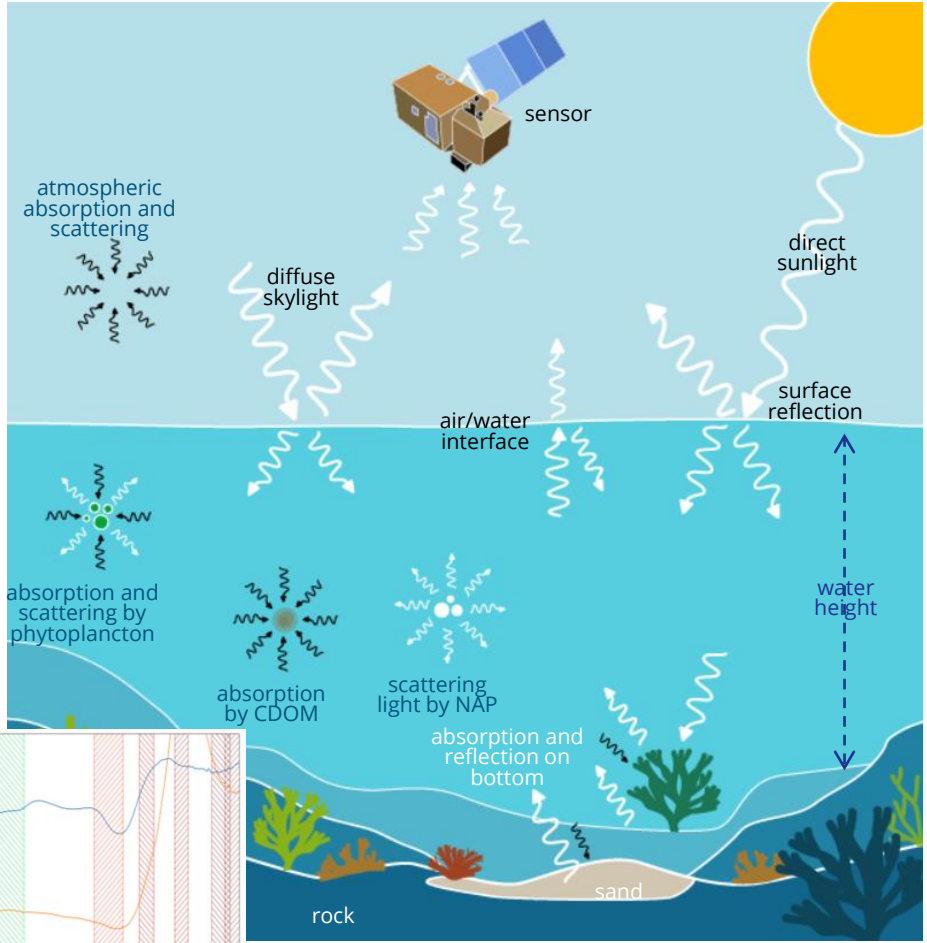
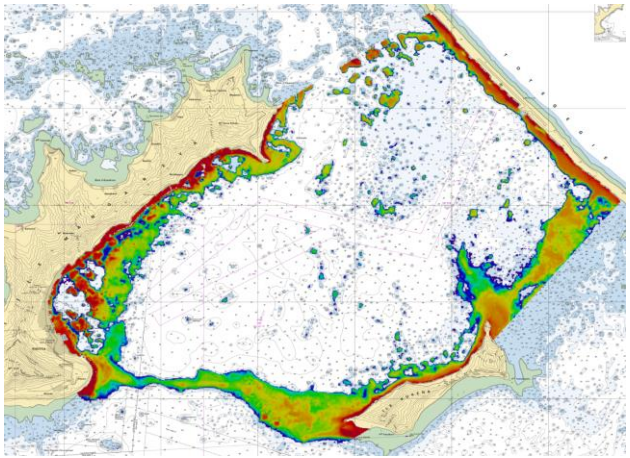




*Illustration ©Hytech imaging after Guyot (2021)*

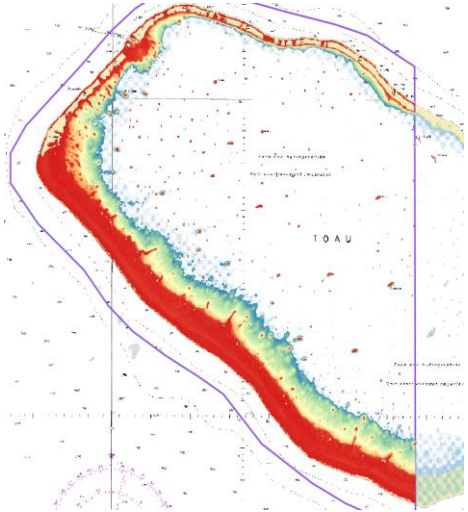
# Results : preliminary survey (BHPF)

## Mangareva



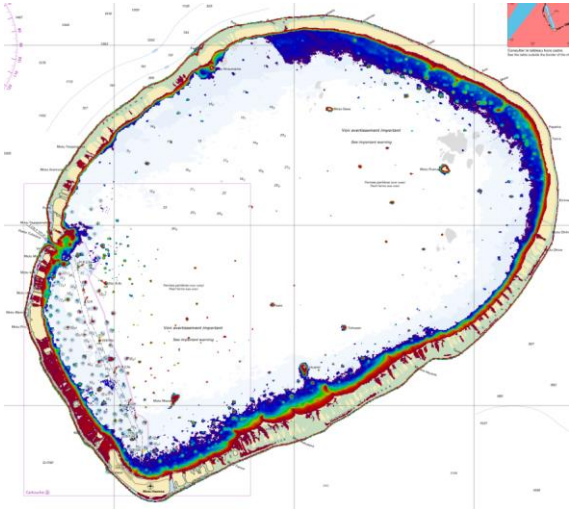
Depth range : 0 – 10 m

## Toau




Depth range : 0 – 12 m

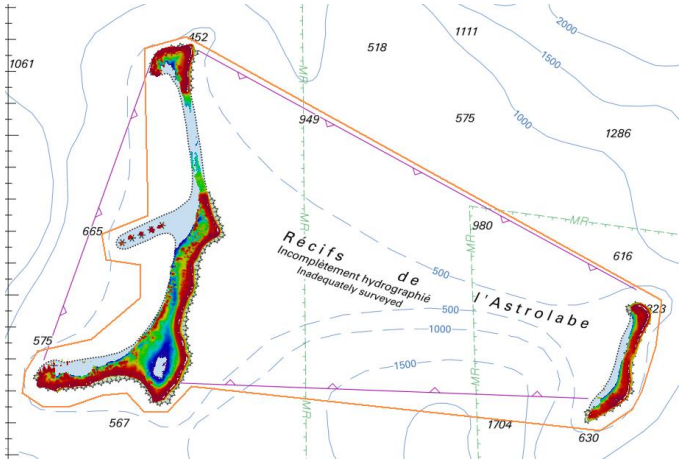
## Tikehau



Depth range : 0 – 13 m

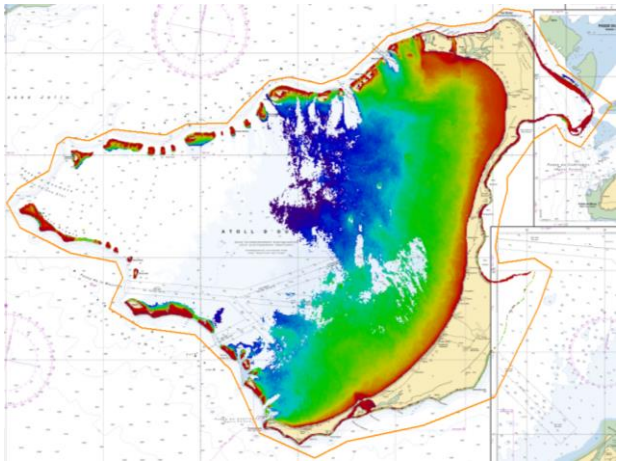
# Results : preliminary survey (BHNC)

## Astrolabe



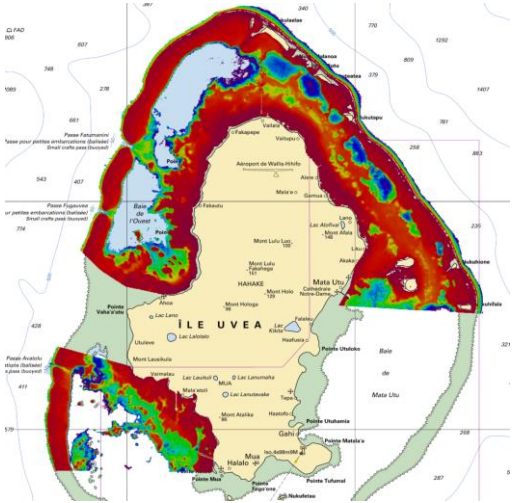

Depth range : 0 – 17 m

## Ouvea



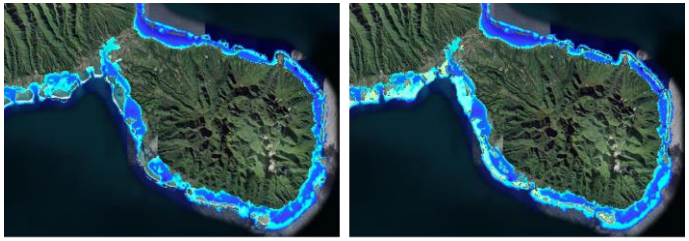
Depth range : 0 – 15 m

## Wallis



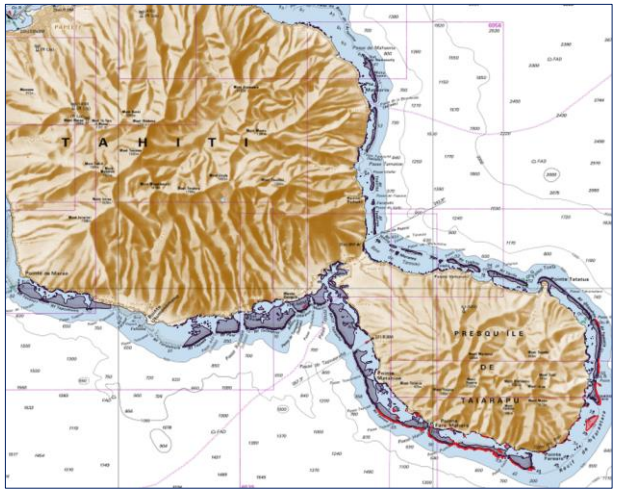

Depth range : 0 – 18 m

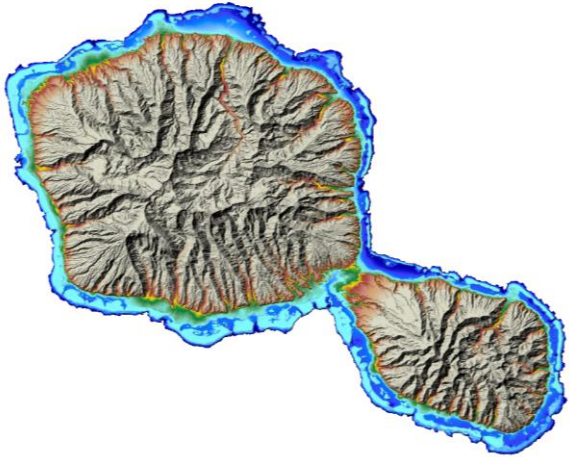
# Results : hydrodynamic modeling



DTM without SDB

DTM with SDB data input



**Identify DTM gaps**

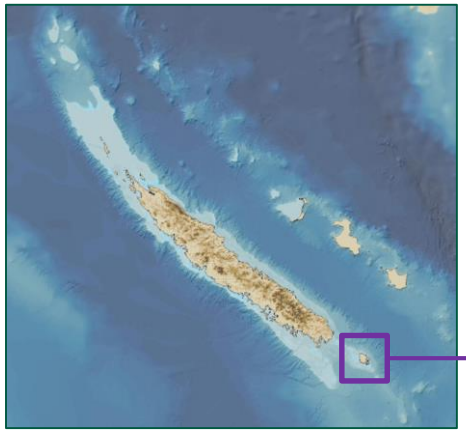
**SDB production**

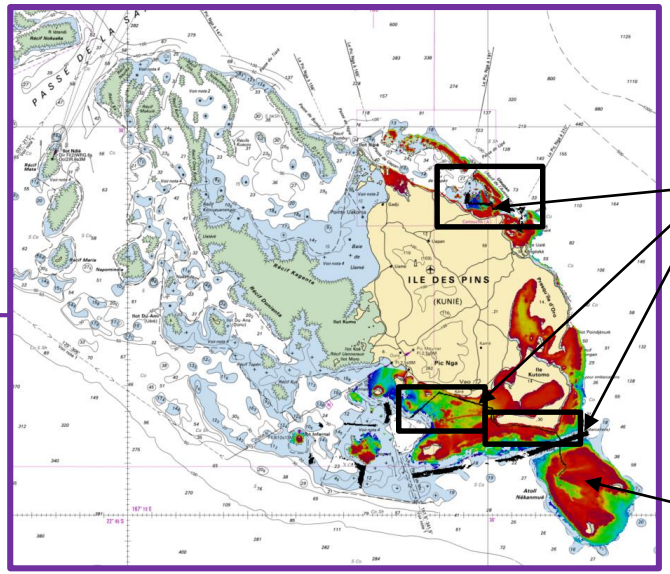
**Fusion to create a DTM**

# Qualification : SDB vs MBES

**Pine Island**
**(South of New Caledonia)**

Depth range : 0 – 20 m
Sand / coral reefs / rocks
Clear Waters : Secchi Depth ~10m






Black tracks = MBES order 1a survey
Sept. 2023
XY Resolution : 1m
Depth Uncertainty 95% ~ 30cm

Rainbow colour = SDB
Source : Sentinel-2 (2021-2022)
XY Resolution : 10m
Depth Uncertainty 95% ~ few meters
Filter : depth<20m + IC95_sup-inf<15m
No In Situ data assimilation

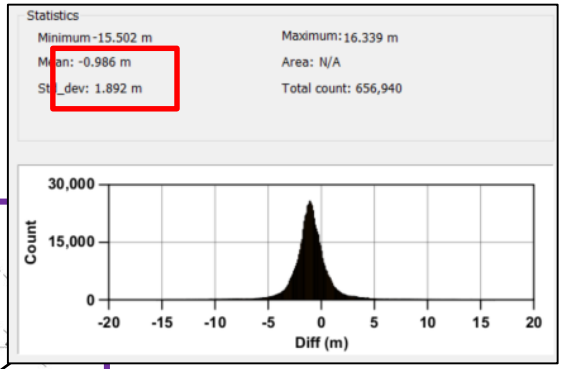
# Qualification : SDB vs MBES

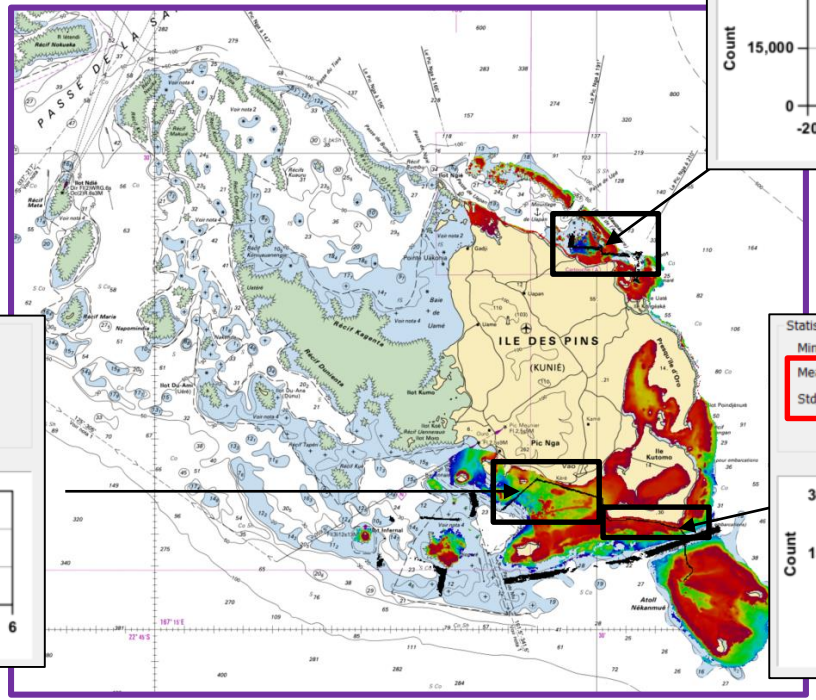
## (MBES – SDB) statistics

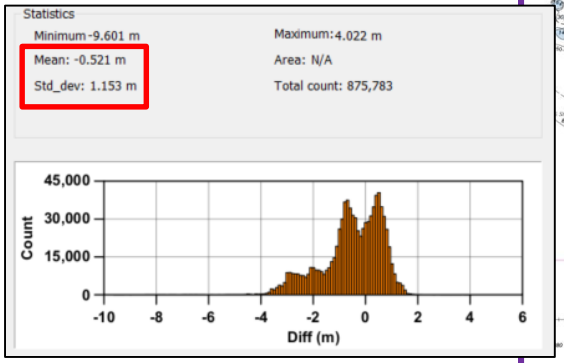
- Mean < 1m.

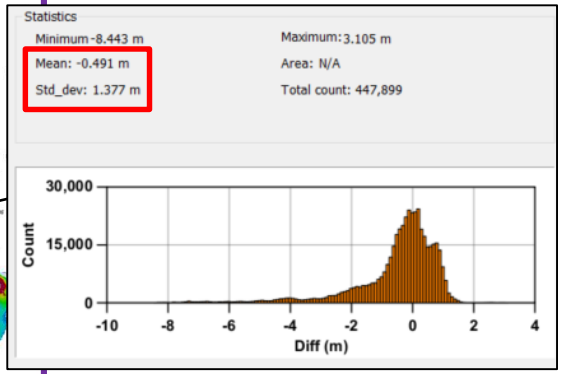
Mean < 0 => SDB deeper than MBES

- Std. Dev. ~ 1.5m



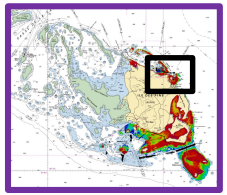



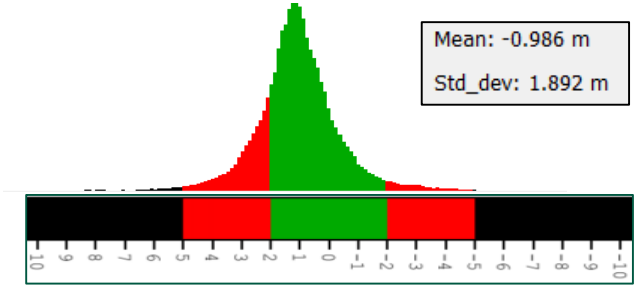



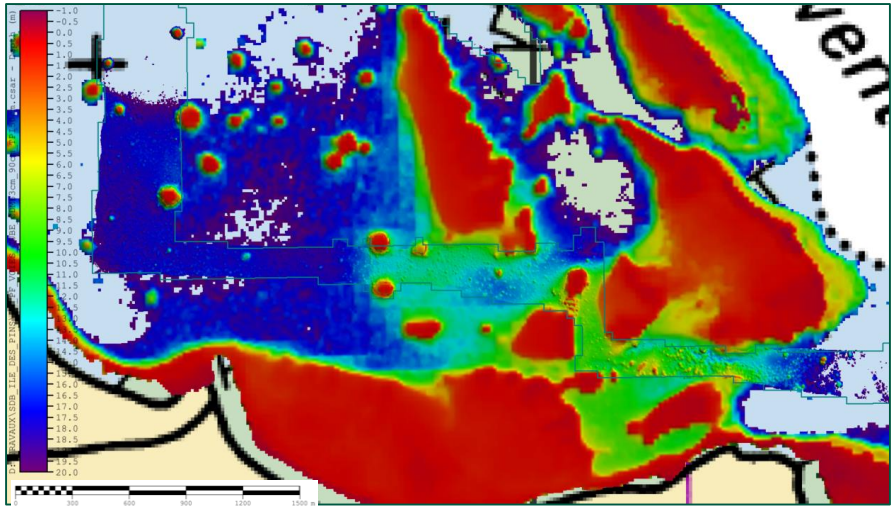
# Qualification : SDB vs MBES

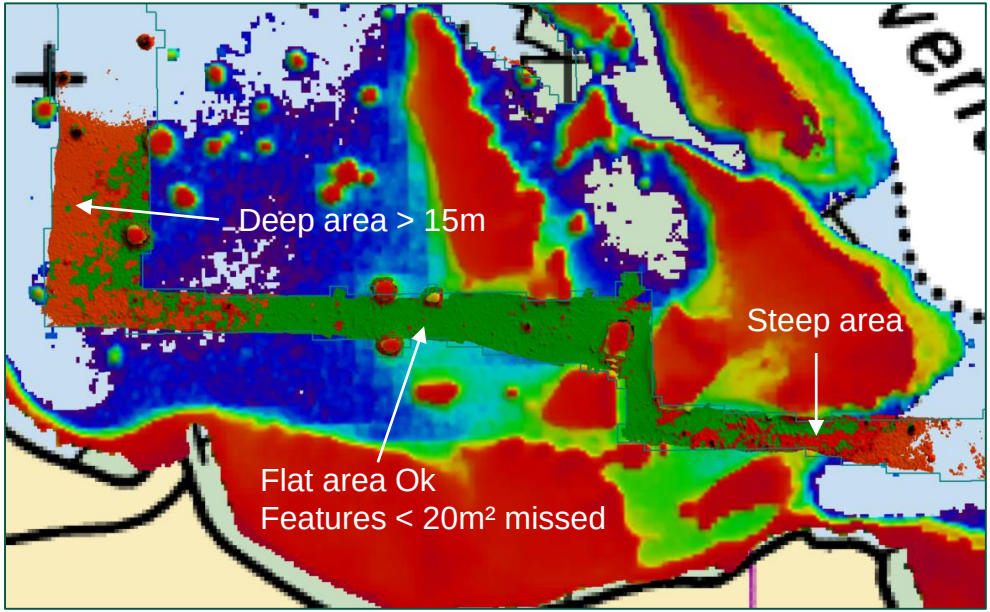
## Zone 1 : (MBES – SDB) statistics



- Error rises with depth ~20%*Depth
- Good on flat areas (Error <2m)
- No detection of features <20m ~ smoothing
- Difficult in steep areas (slopes, passes,…)



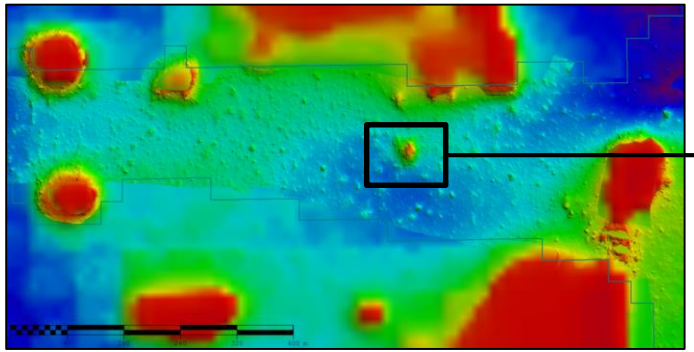



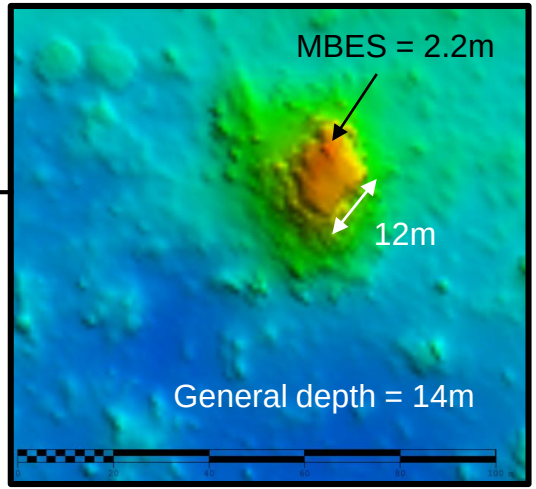


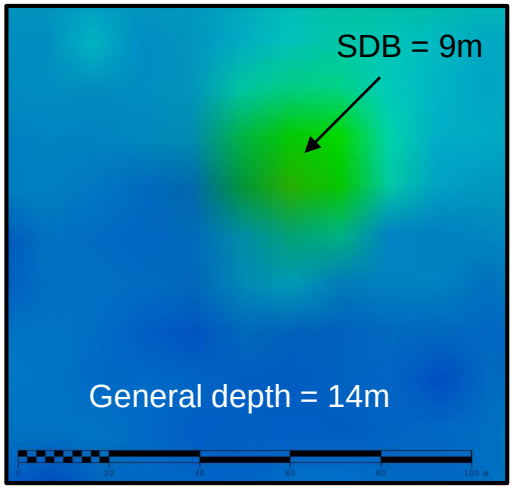
# Qualification : SDB vs MBES

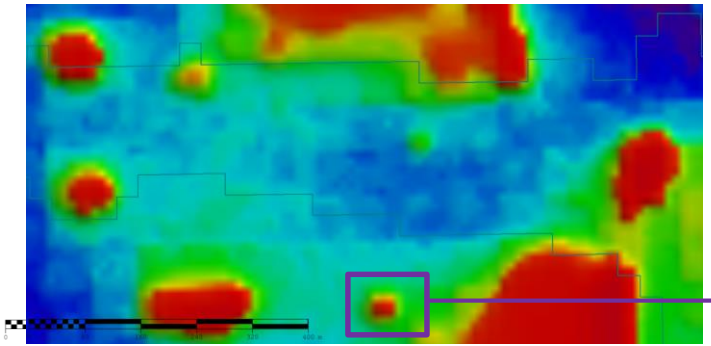
- Bad detection of features < 20m

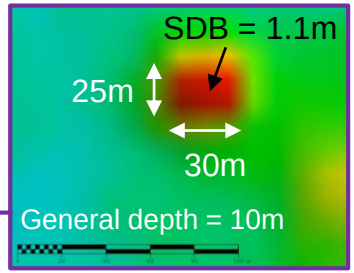
## Zone 1 : Feature detection





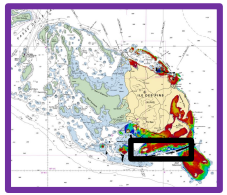





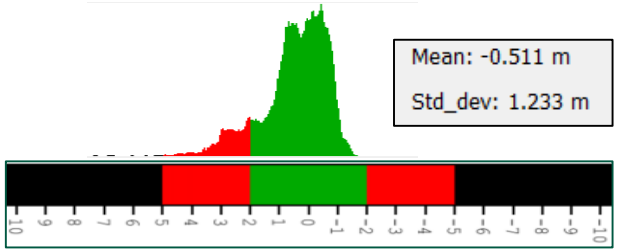

- Detection of features > 20m Ok
- /!\ Smoothing the top sounding value

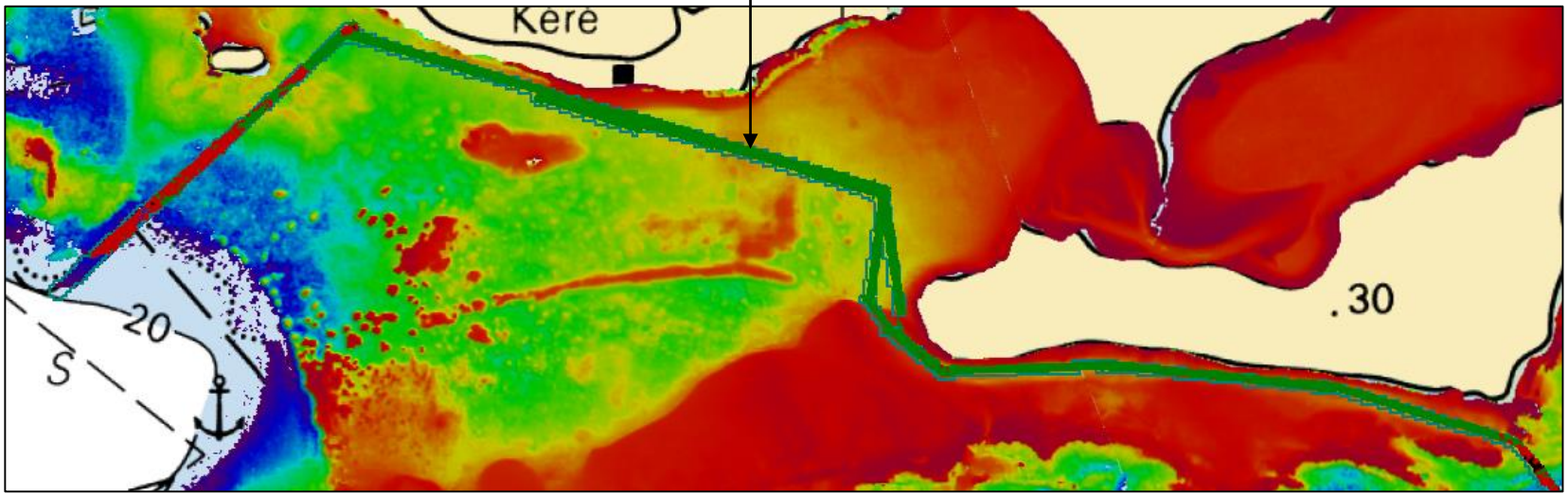
# Qualification : SDB vs MBES

## Zone 1 : (MBES – SDB) statistics

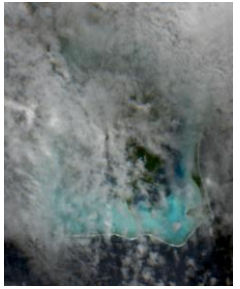


- Very good results : error ~ 1m in flat area with depth < 5m







# Discussion

## Applications

- Bathymetric recognition survey for decision support : assessment of general characteristics (average morphology of the area and slope gradient)
- Input parameter for coastal hydrodynamic modeling

## Advantages

- Acquisition of bathymetric information in non-permissive or difficult-to-access environments, despite very poor or non-existent initial knowledge
- Implementation of production within a short timeframe

## Limits

- Limited depth, approx. 15-20m
- Clouds, Water turbidity and dark bottoms restrictive
- High uncertainty => Explore Hyperspectral capacity
- Low spatial resolution => Explore PléïadeNeo images ~1.5m

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SHOM

L'océan en référence

IHO International Hydrographic Organization

South West Pacific Hydrographic Commission

# Thank you for your attention, Any questions?

*Guillaume Voineson*
*Head of Shom Pacific Survey Unit (GOP)*
*✆ : (+687) 23 21 09 / 79 52 56 - @ : gop-d@shom.fr*