



FLOTTE
OCÉANOGRAPHIQUE
FRANÇAISE par Ifremer

Multi-frequency Backscatter analysis using three calibrated multibeam echo-sounders

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FEMME, 26th-29th September 2023



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La Flotte océanographique française,
une très grande infrastructure de recherche opérée par Ifremer



Objective

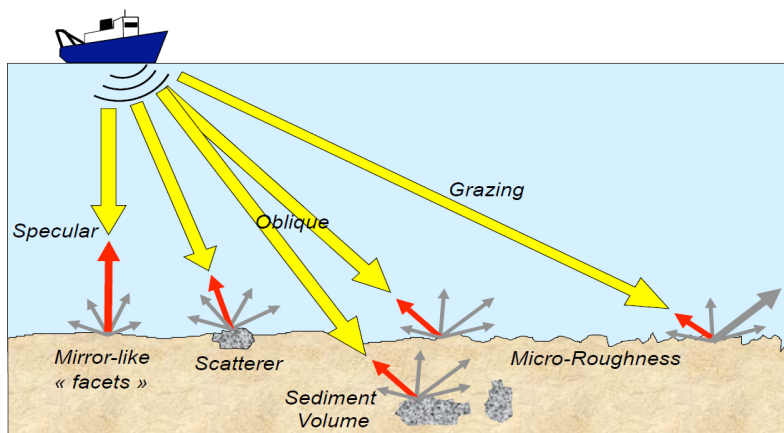
➤ Main Goal:

Multi-frequency study of the Backscatter Angular Response Curve (ARC) using **calibrated** Multibeam for seafloor characterization.

➤ Essential for:

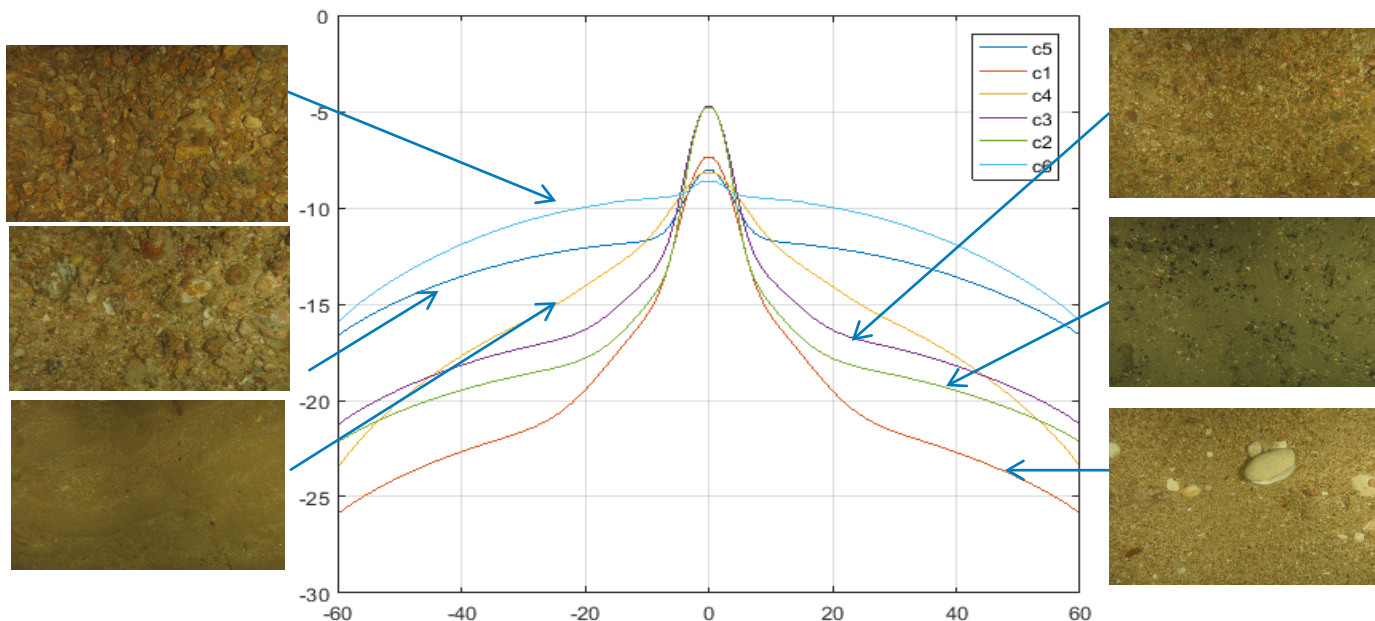
- Inter-comparison of data between different acoustic systems
- Seafloor type monitoring (time series)
- Multispectral analysis for seafloor classification
- Physical modelling

Seafloor characterization using Angular Response Curves (ARC)



Backscatter Strength (BS) is dependent on:

- Seabed properties
- Incident angles
- Frequency

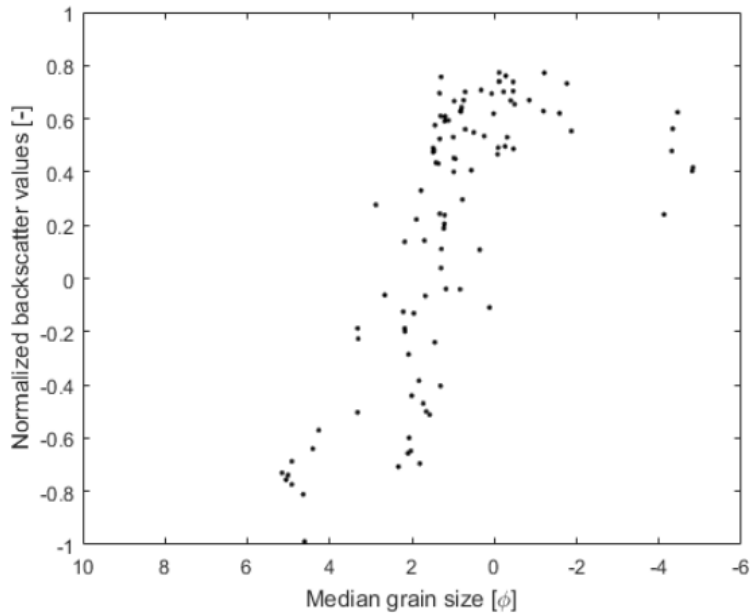


ME70 (90 kHz)- English channel

Seafloor characterization using Angular Response Curves (ARC)

Multi-frequency BS to increase the seafloor discrimination according to:

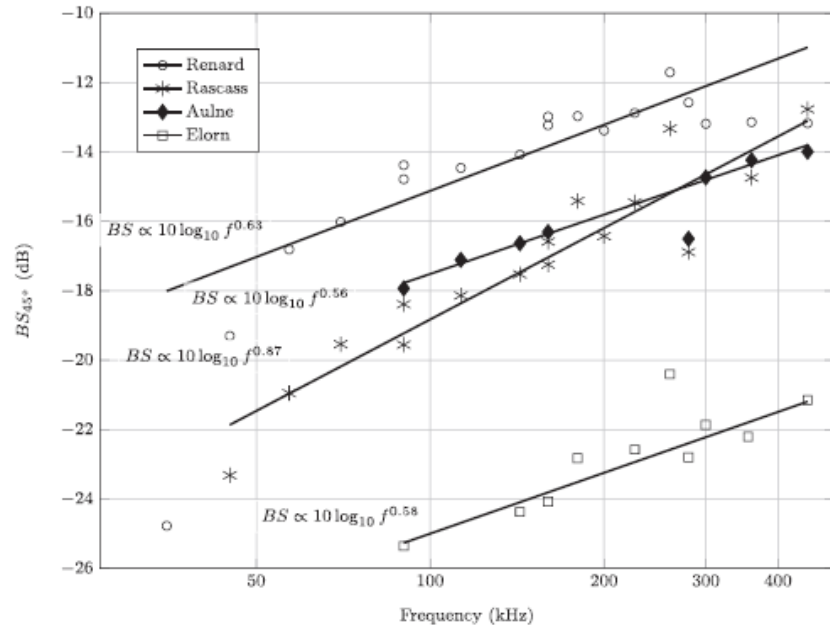
- Seabed roughness
- Volume scattering (penetration depth)
- Scattering regime



Snellen & all.

<https://doi.org/10.1109/JOE.2018.2791878>

EM3002 (300 kHz)

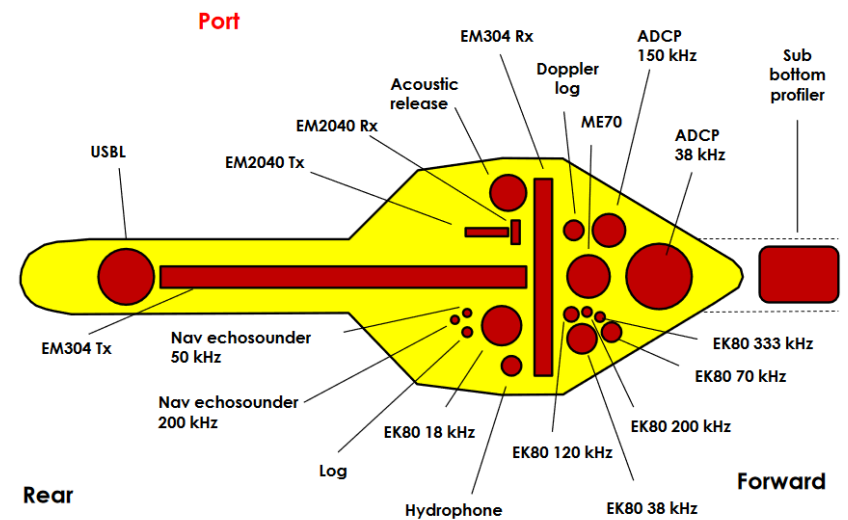


Fezzani & all.

<https://doi.org/10.1121/10.0005428>

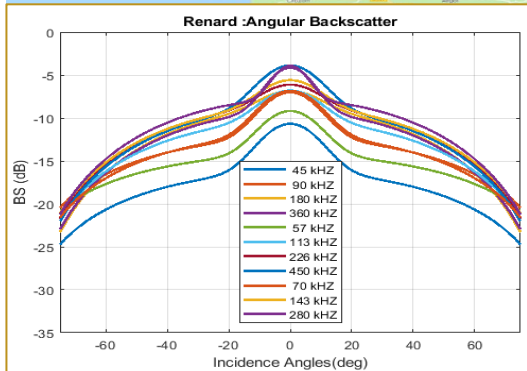
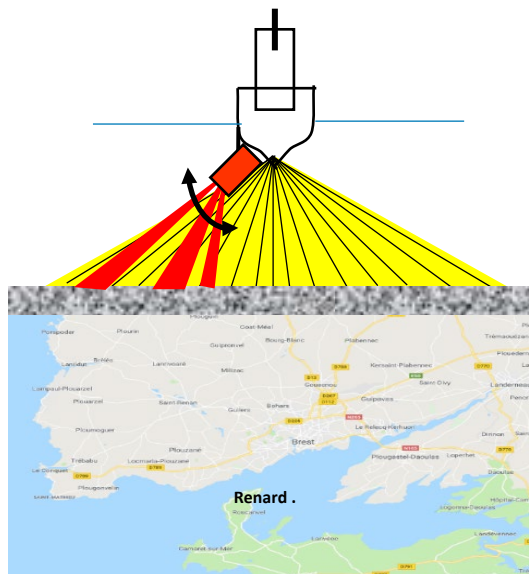
RV Thalassa MBES

- **Fishery:** ME70 with bathymetric option since 2008
 - 90 kHz; 3°/3°; 120°; up to 200 Soundings.
- **Bathymetry:** since 2018
 - **EM2040:** 200, 300,400 kHz; ; 0,5°/1°; 140°; up to 400 Soundings.
 - **EM304:** 30 kHz; 0,5°/1°; 140°; up to 800 Soundings.

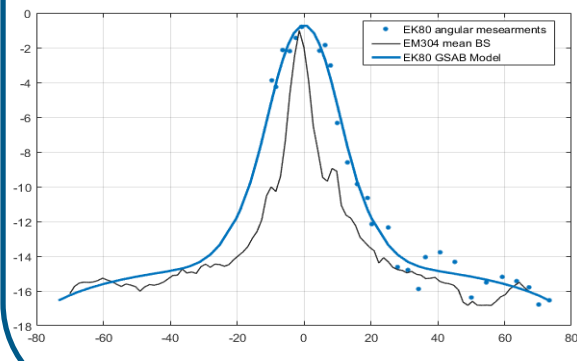
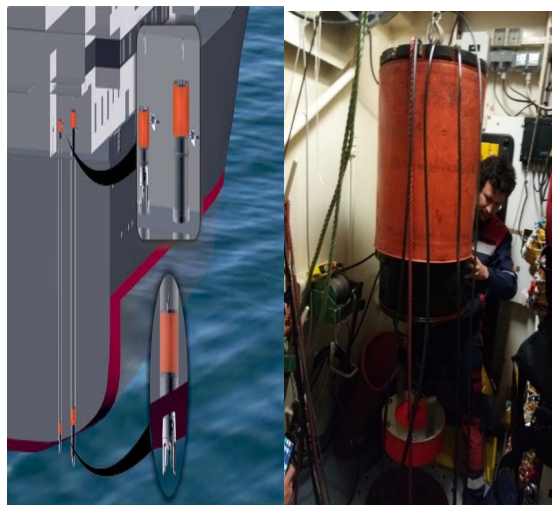


Thalassa MBES Calibration Methods

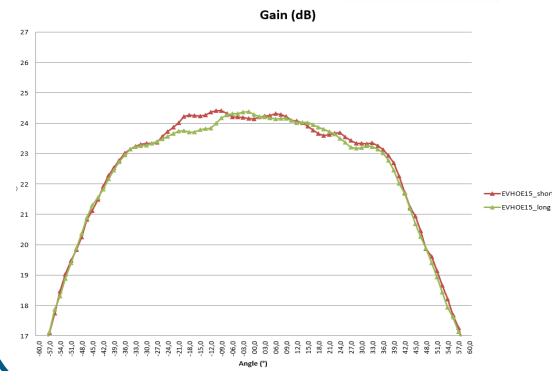
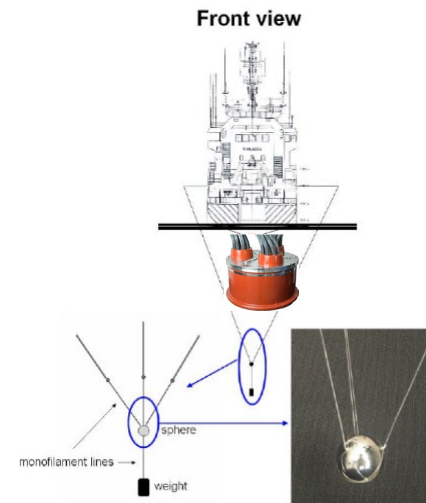
Reference area for HF MBES (EM2040)



Cross-calibration using a calibrated SBES (EM304)

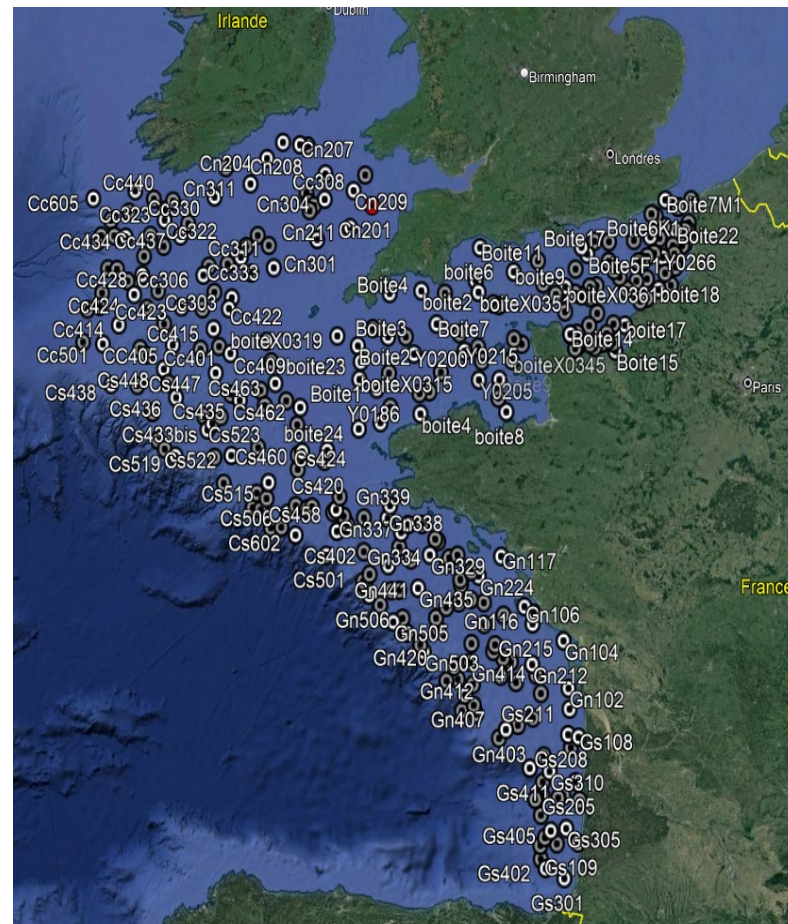


Reference target spheres for ME70 MBES

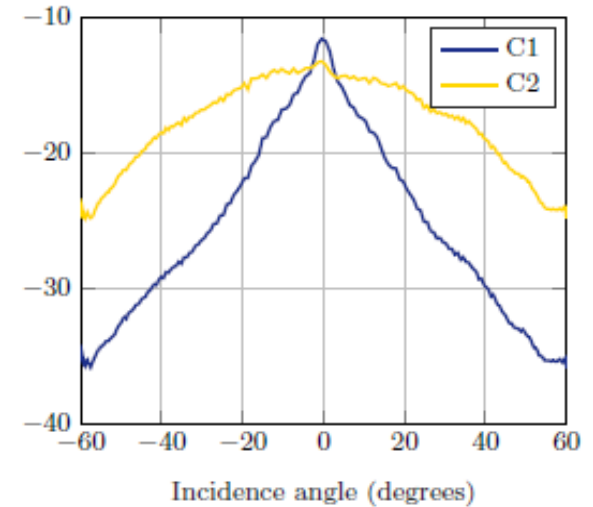
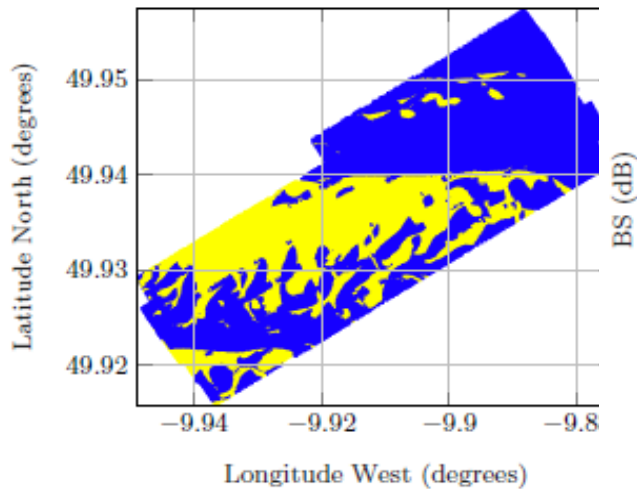
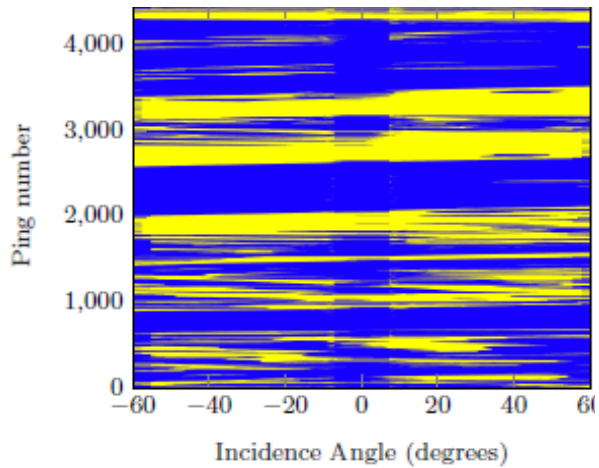
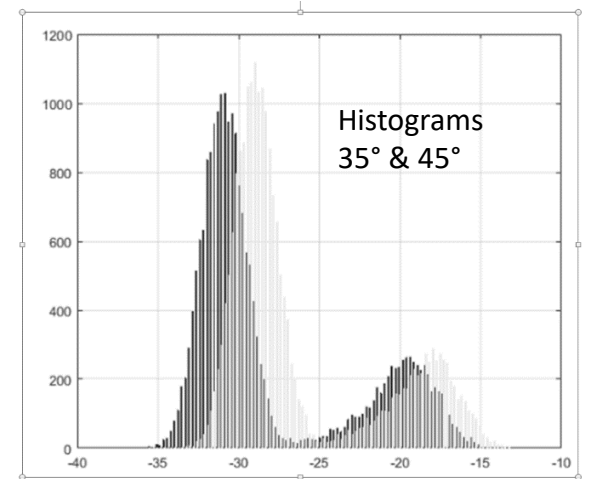
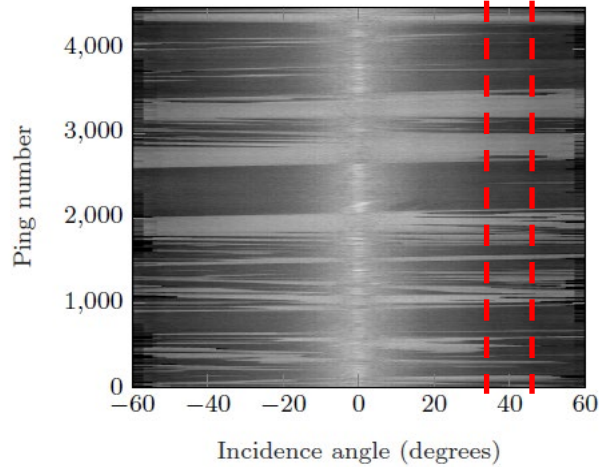
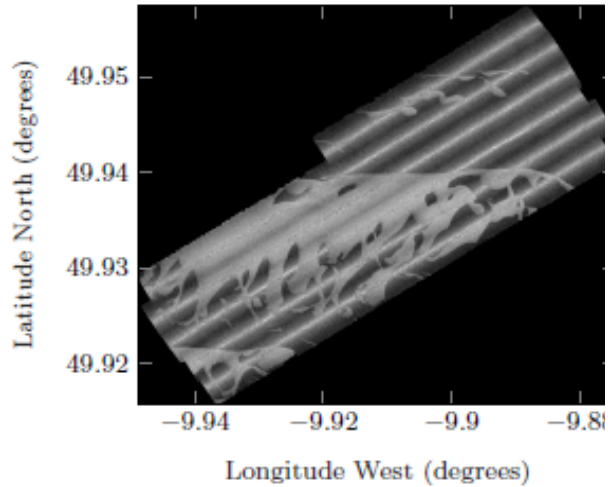


The EVHOE & CGFS campaign program

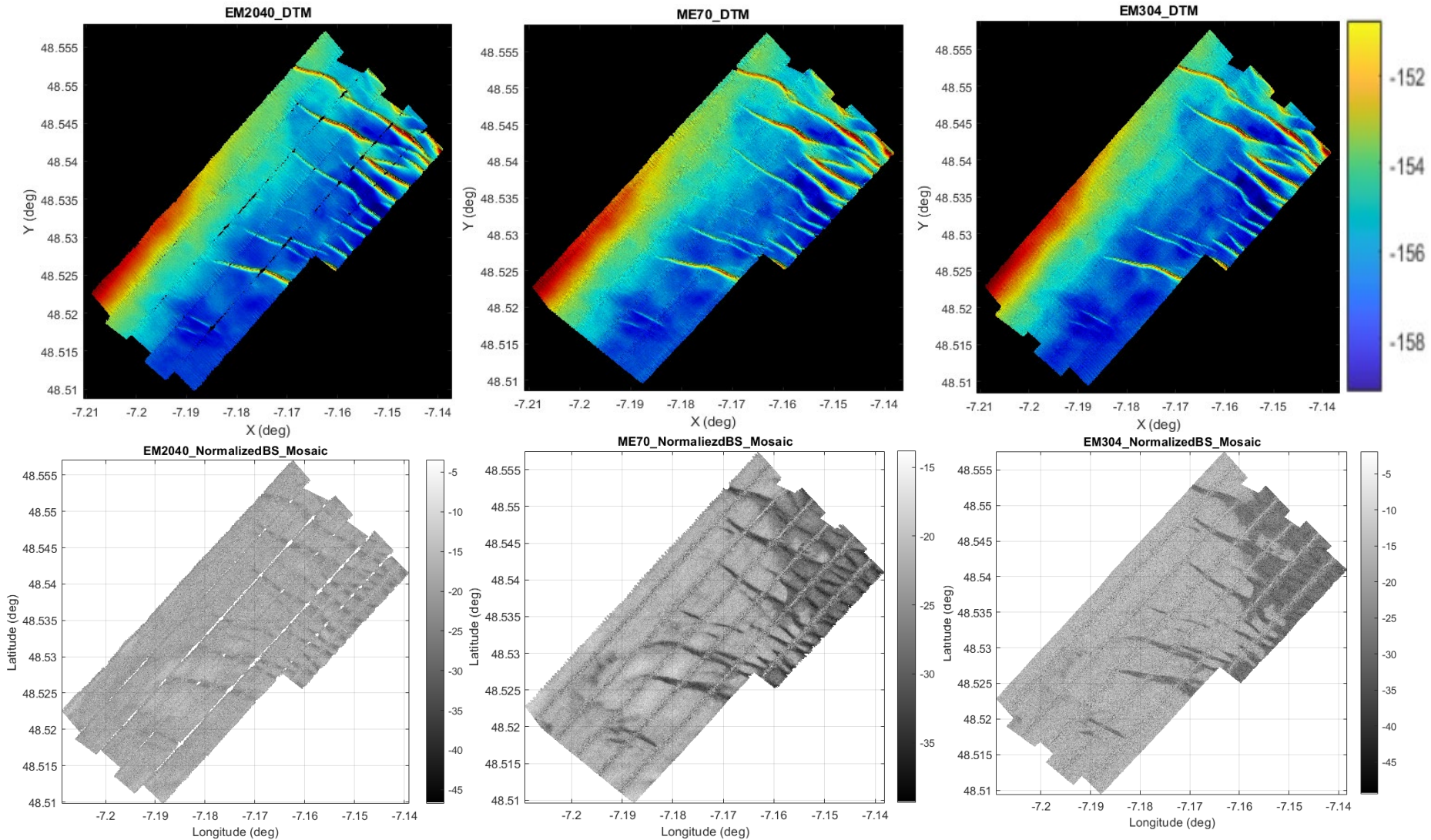
- Conducted yearly:
 - EVHOE since 2008 (6 weeks/y)
 - CGFS since 2017 (4 weeks/y)
- Scientific purpose: data collection at **regional scale** for:
 - Fish stock assessment
 - **Habitat mapping**
- A unique corpus of seafloor backscatter data
 - Strict constant protocol
 - **Calibrated** MBES
- More than **300** surveys with ME70
- New **multi-frequency** data acquisition protocol since 2021:
 - Depth < 100 m
 - EM2040: 300 kHz, long pulse
 - ME70: short pulse
 - Depth > 100 m
 - EM2040: 200 kHz, long pulse
 - ME70: short pulse
 - EM304: shallow mode
- Shortcoming: very little seafloor groundtruthing!



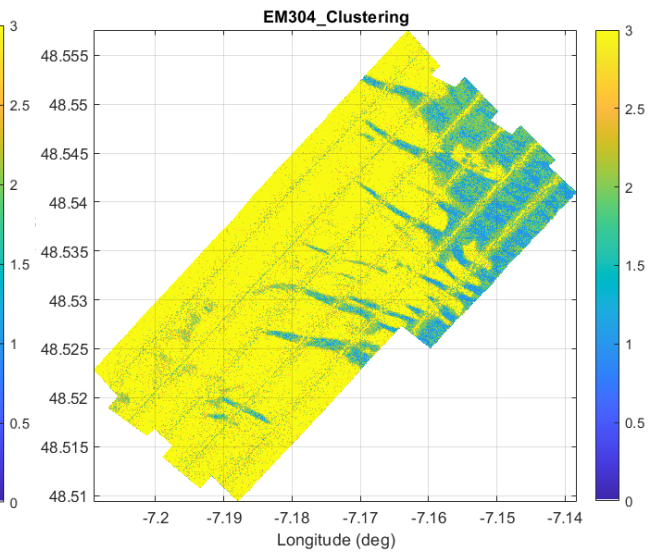
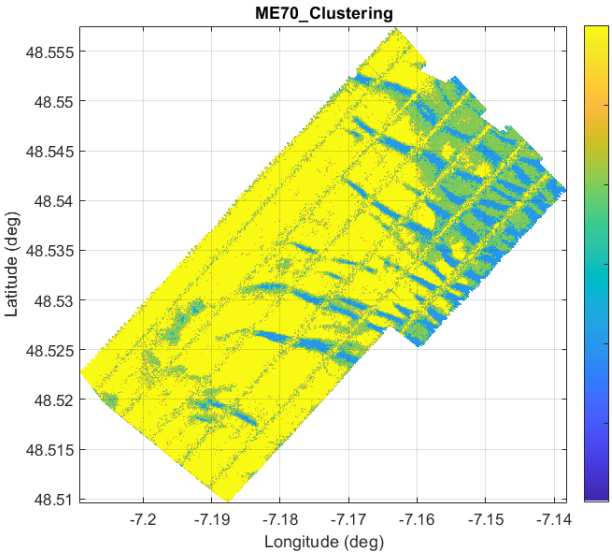
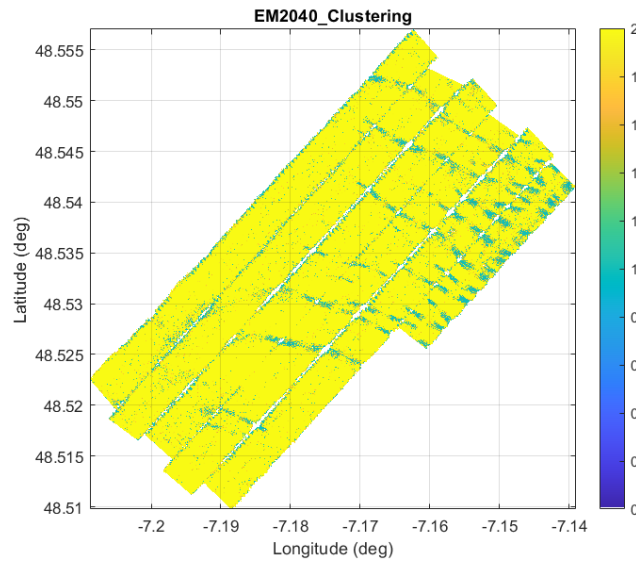
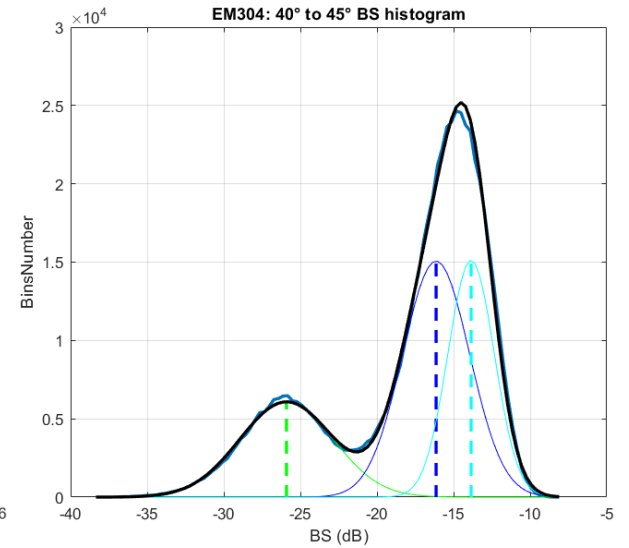
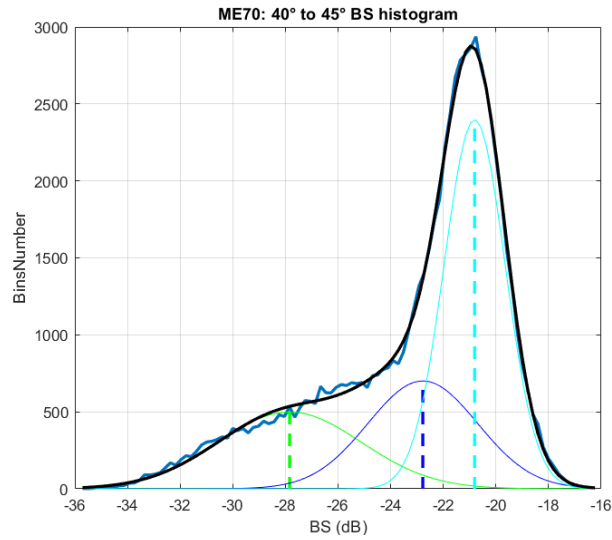
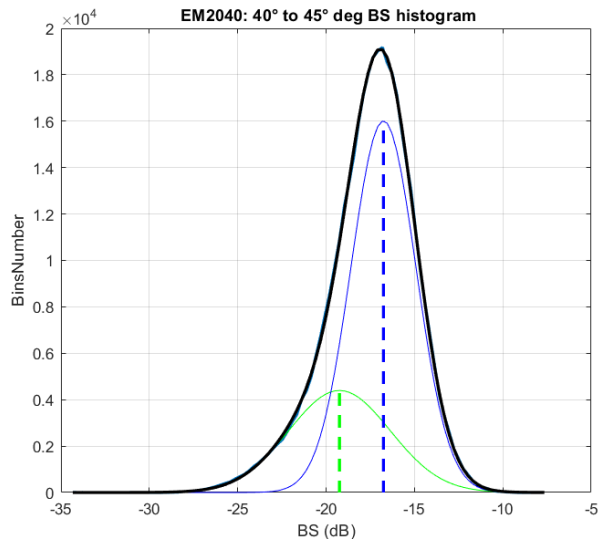
ARC processing



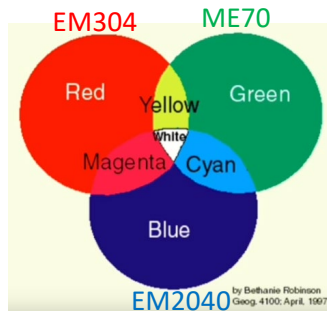
Case study(1)



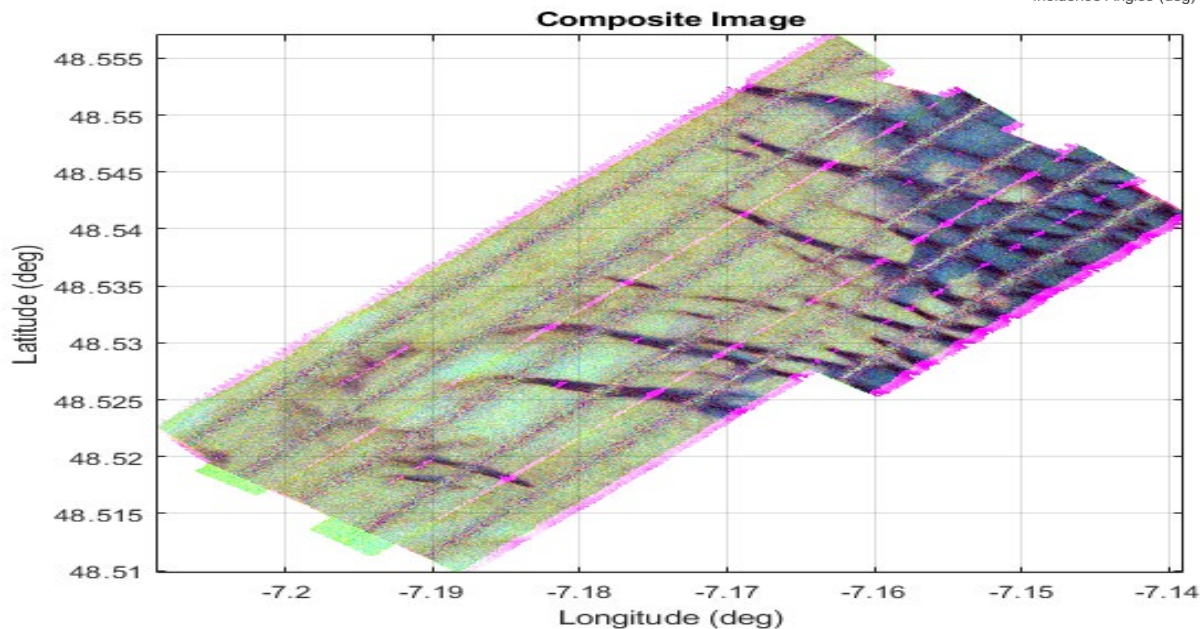
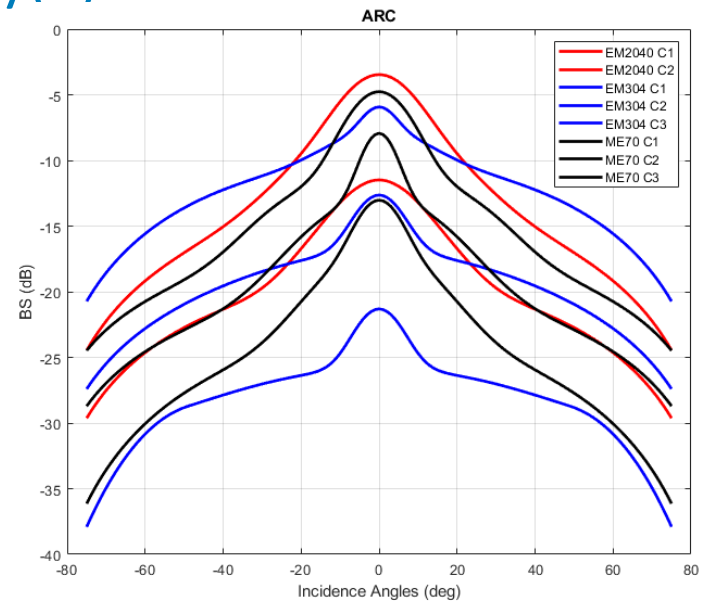
Case study(1)



Case study(1)

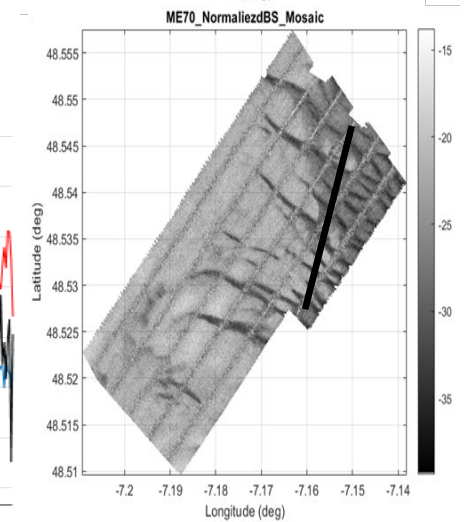
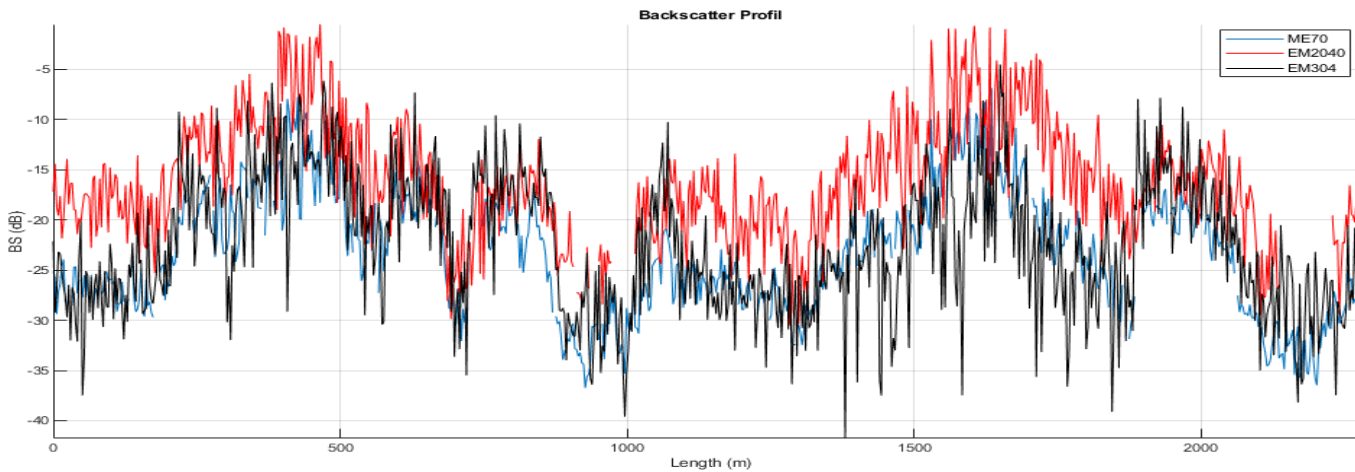
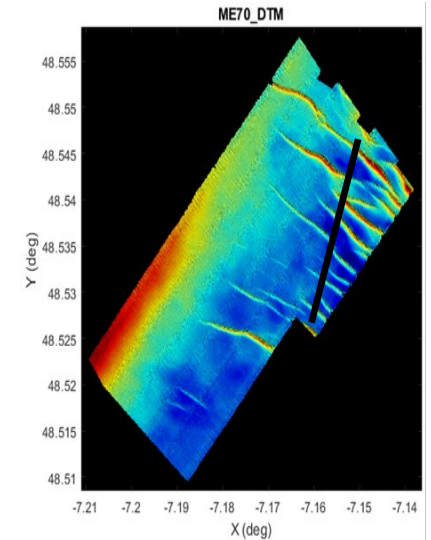
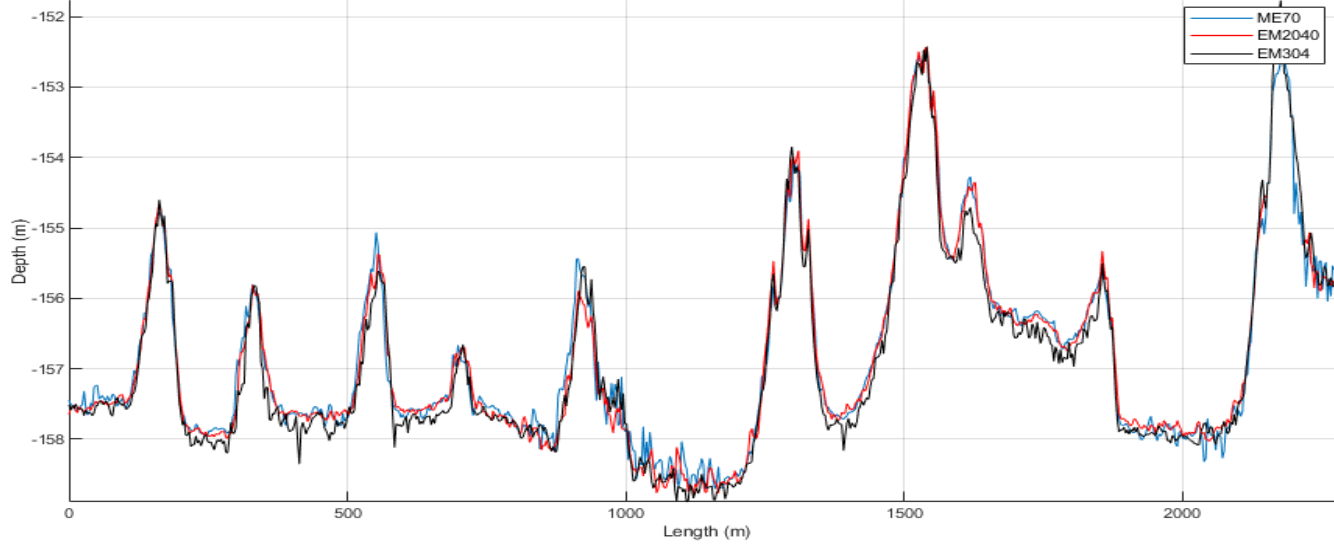


- If three primary colors are superimposed in unequal amounts, then number of colors are produced
- If three primary colors are superimposed in equal amounts, then greys ranging from black to white are produced

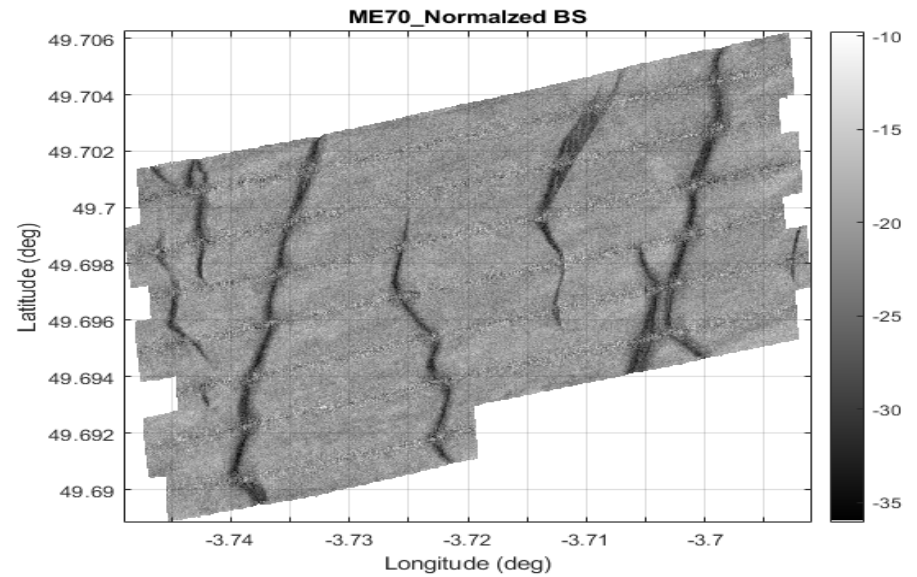
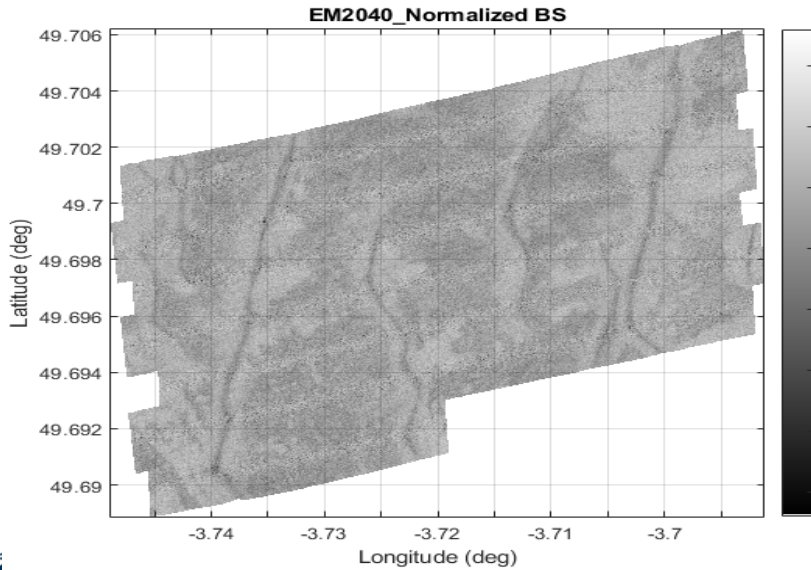
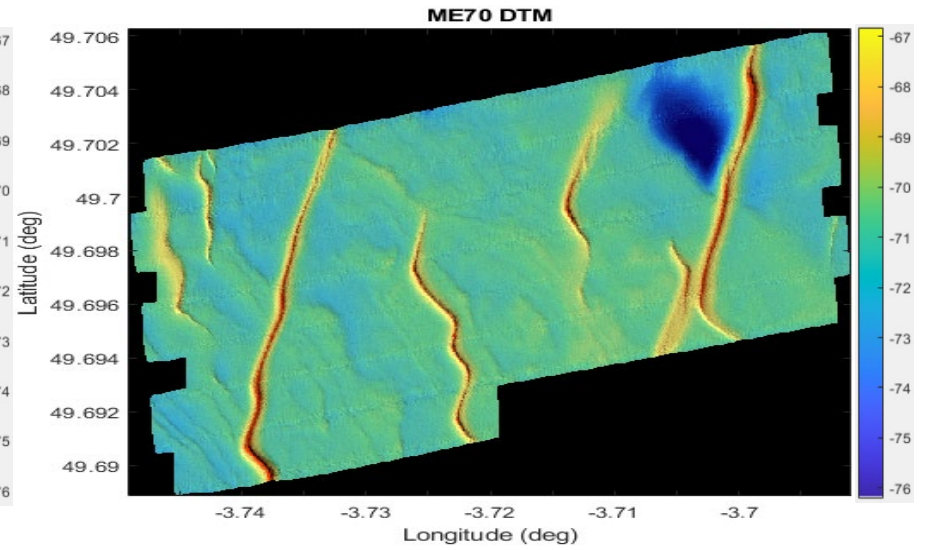
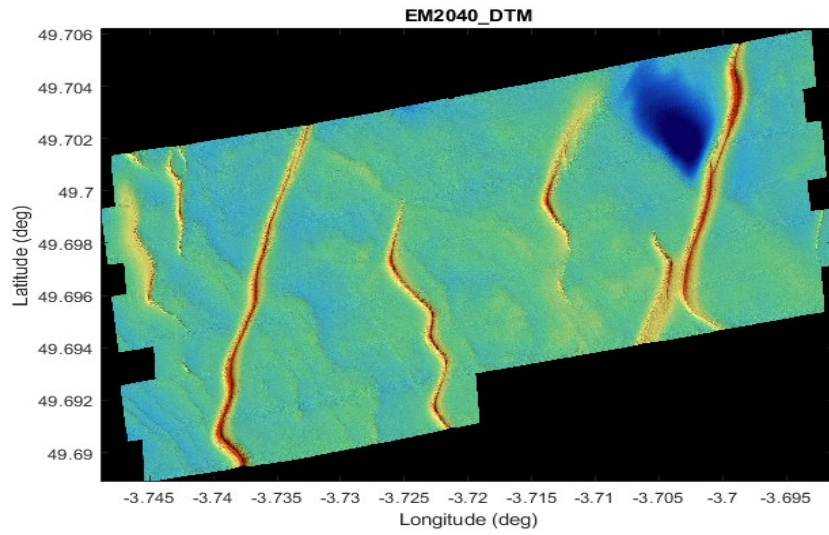


Case study(1)

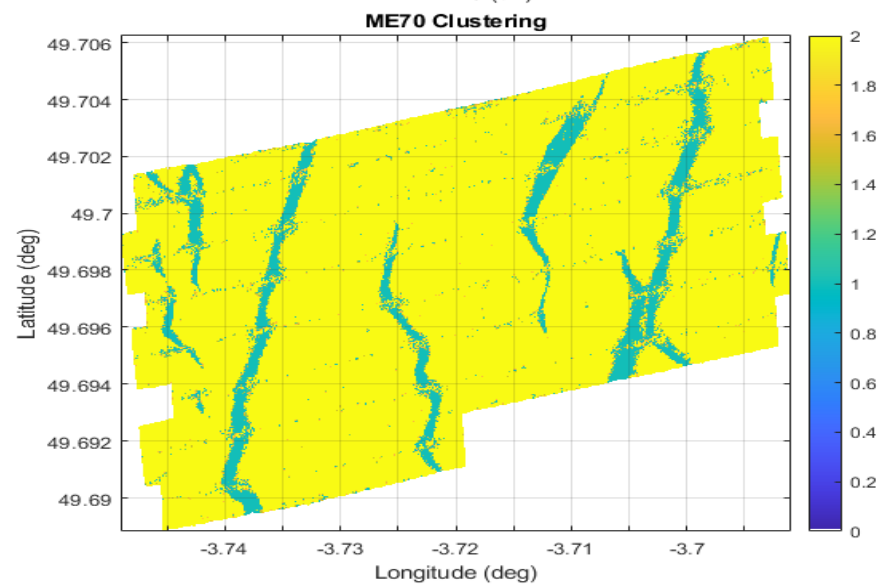
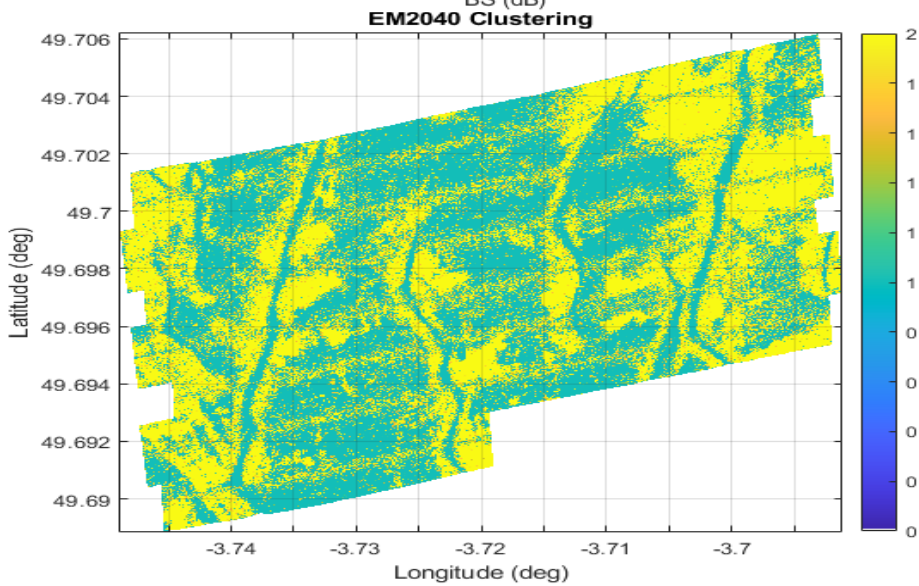
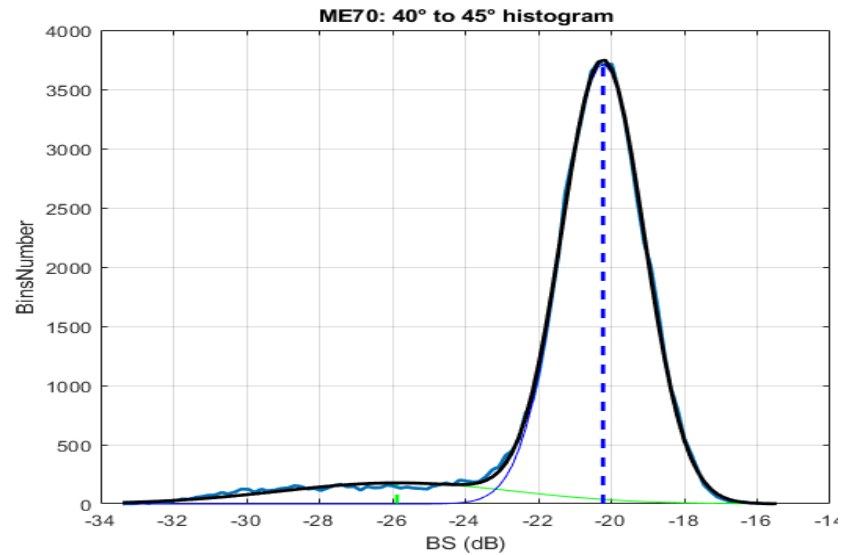
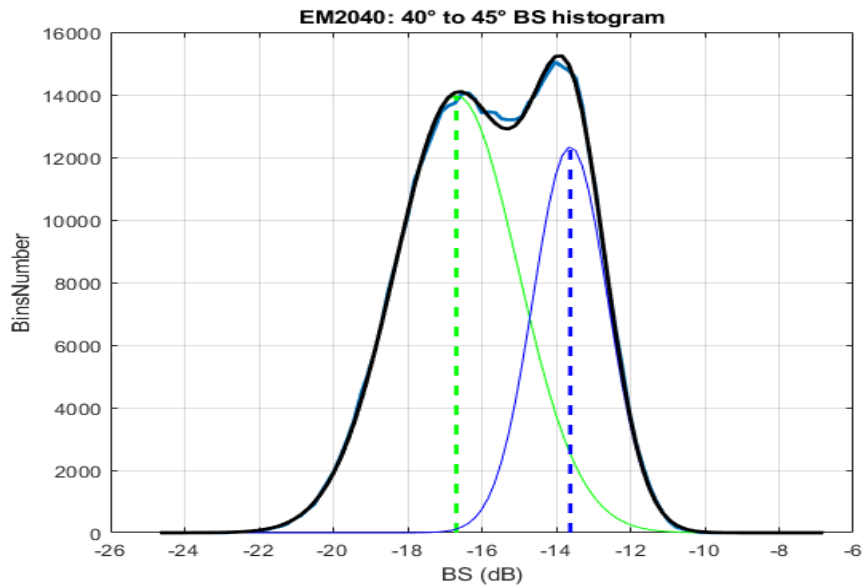
Bathymetry Profil
Length (deg) : 0.022223 Length (m) : 2288.4437 Azimuth : 21.2749 X : [-7.16 -7.1487] Y : [48.5265 48.5457]



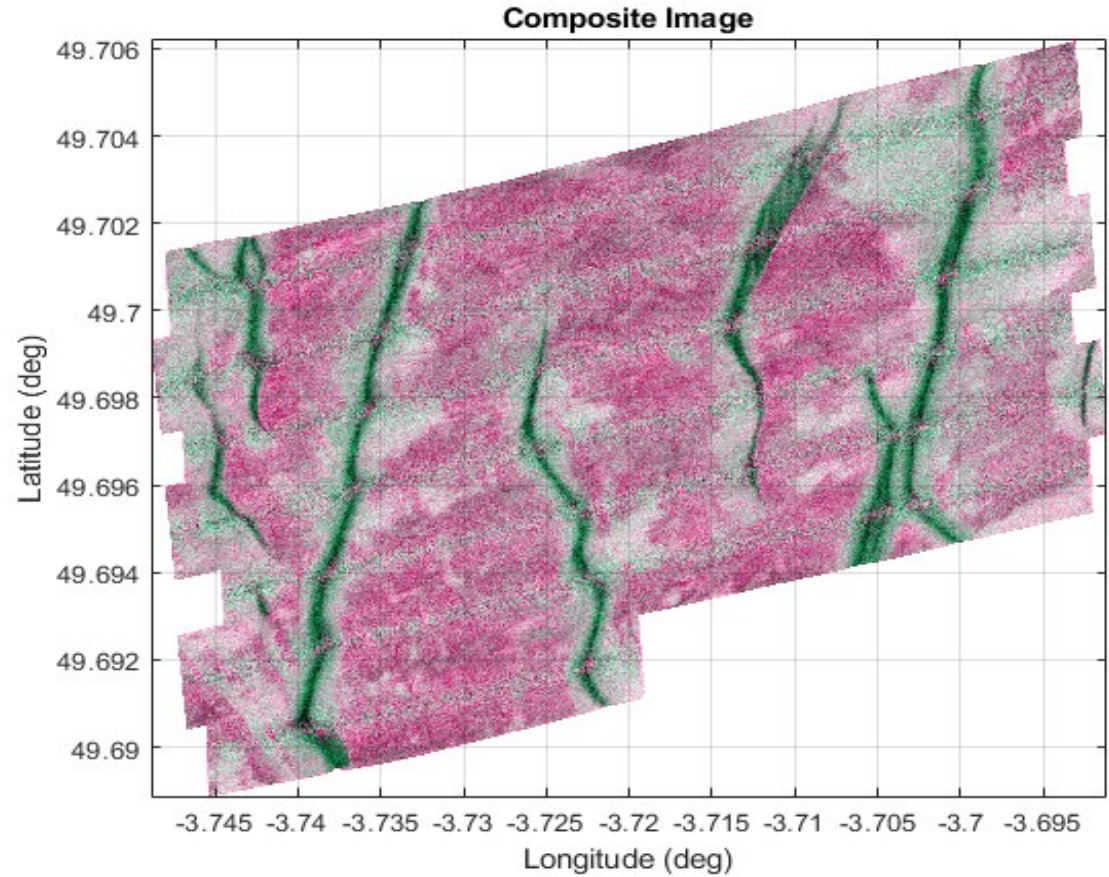
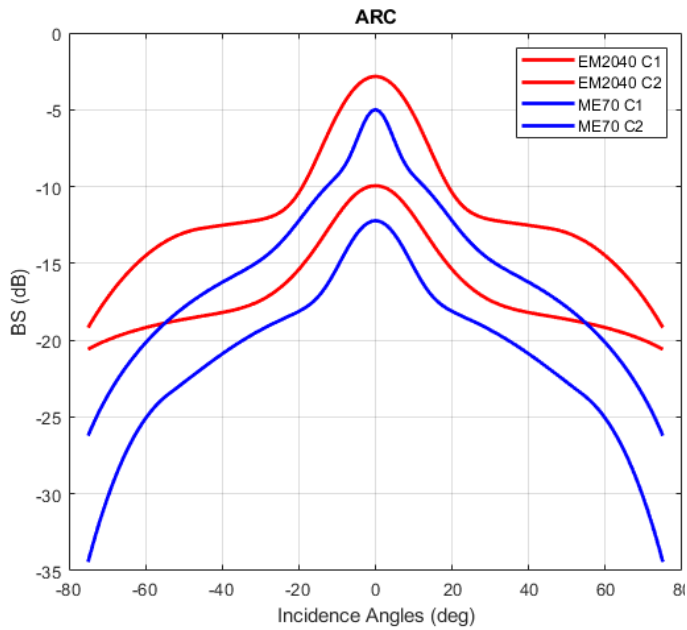
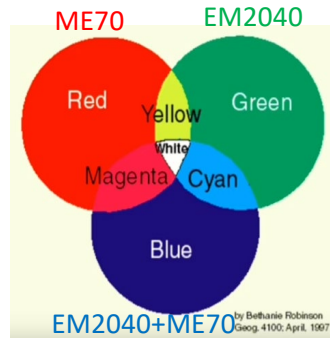
Case study(2)



Case study(2)



Case study(2)



Conclusion and prospective

- **Classification method to combine information from different frequencies in a single map**
- **Enrichment of the database of calibrated seafloor backscatter and ground truthing samples**
- **seafloor characterization using machine learning algorithms**
- **Geoacoustical parameter analysis:**
 - ✓ **Backscatter measurements in a controlled environment: BSinFlume project**
 - ✓ **physical modelling (collaboration with Dr. Xavier & Dr. Luciano)**
 - **Frequency dependence**
 - **Few parameters**
 - **data fitting**

