Characterization of Bay of Biscay sound scattering layers using broadband acoustics, nets and video

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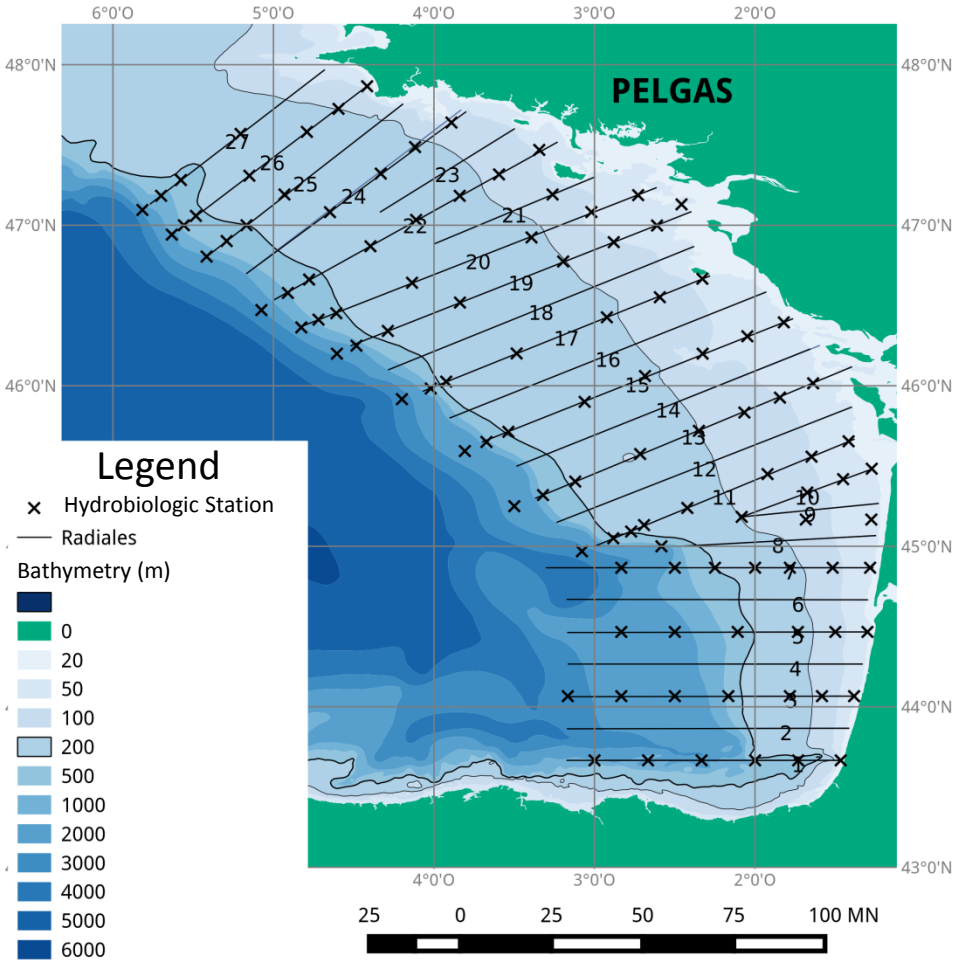
Context: Ecosystemic approach

- Raising consideration for an integrated evaluation of ecosystems
- Objective of the DCSMM (UE Marine Strategy Framework Directive)
- For the pelagic environment, a survey : PELGAS

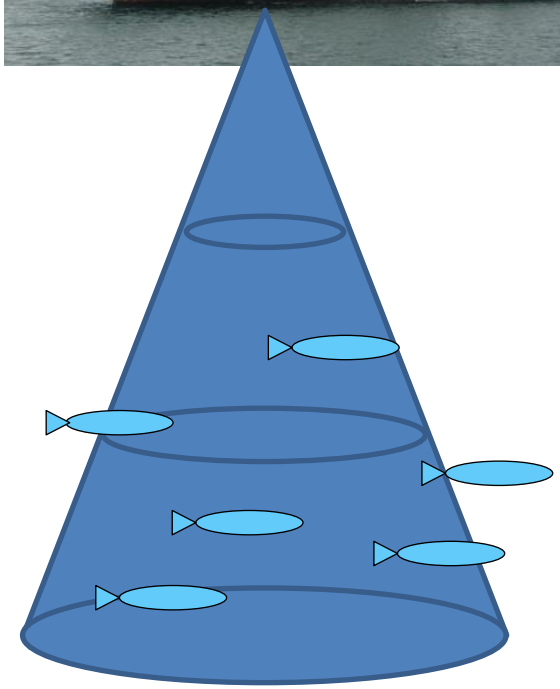
Context : The PELGAS survey

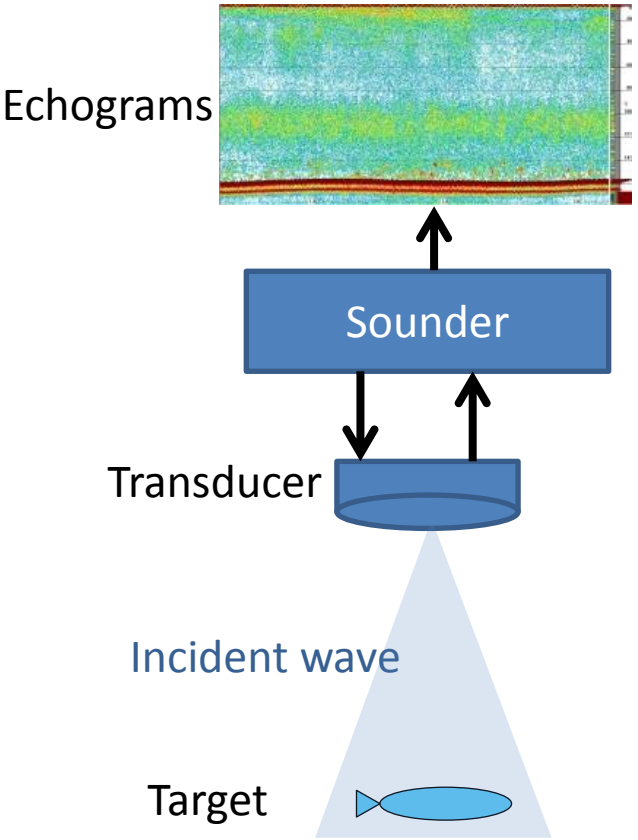
- PELagic GAScogne
- Evaluation of the chemical and physical environment
- Evaluation of all the ecosystem (from plankton to apex predator)
- Use of acoustic tools to determinate the abundance of small pelagic species:
  - Anchovy
  - Sardine
  - …



Some acoustic basis

- Sv = *Backscattering Strength Volume*, *i.e.* the acoustic density





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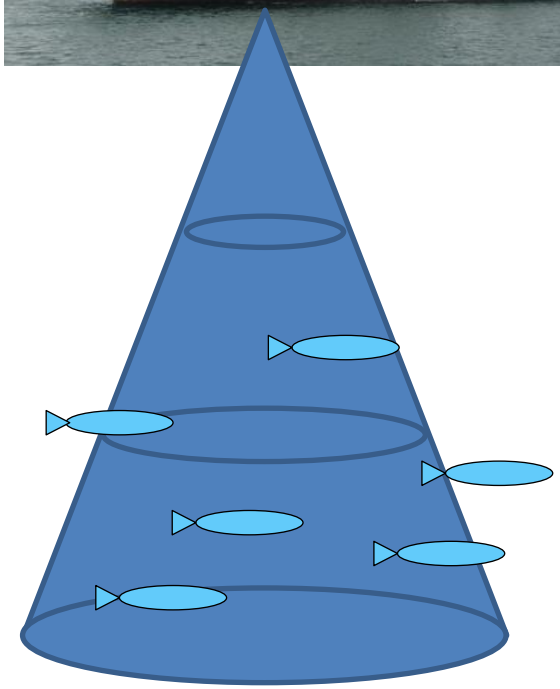

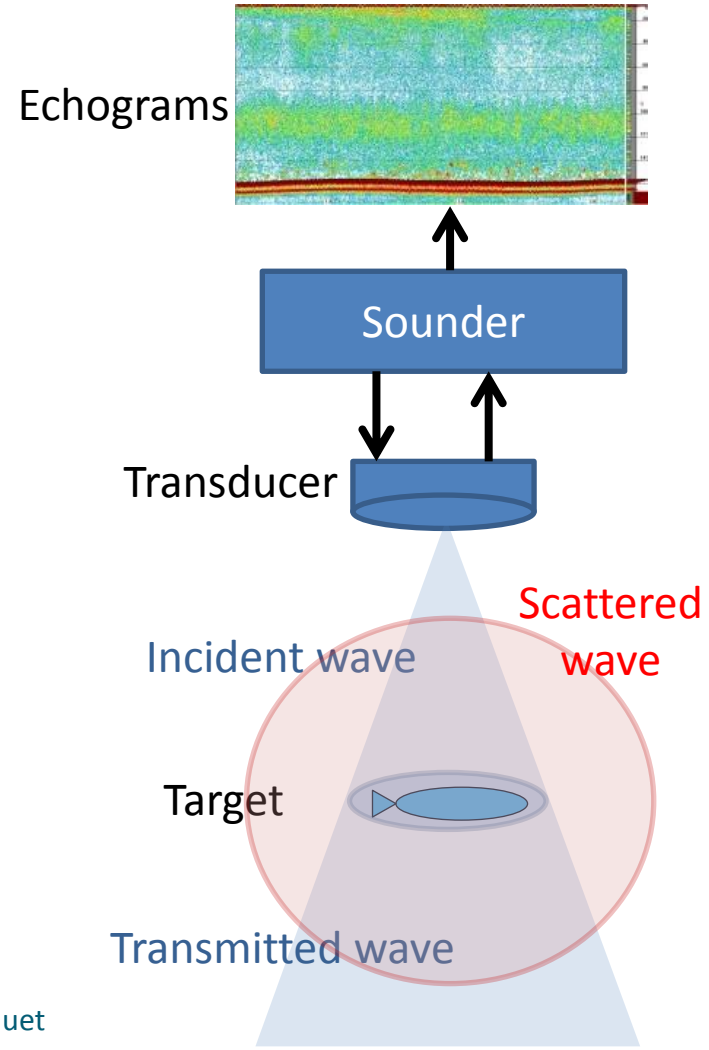

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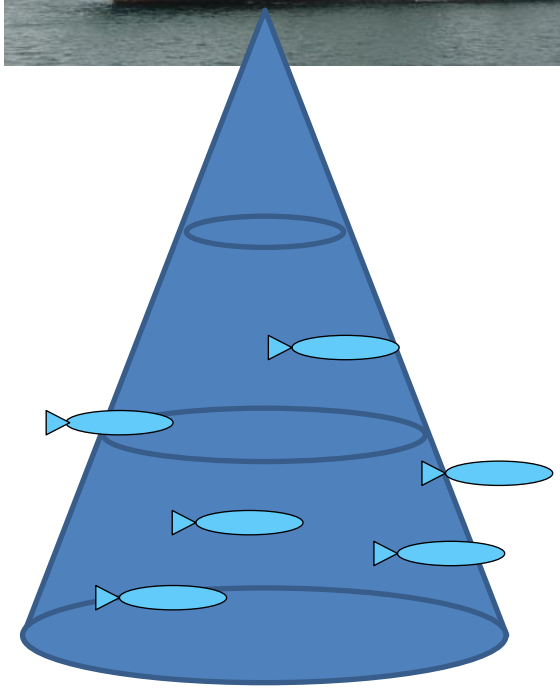
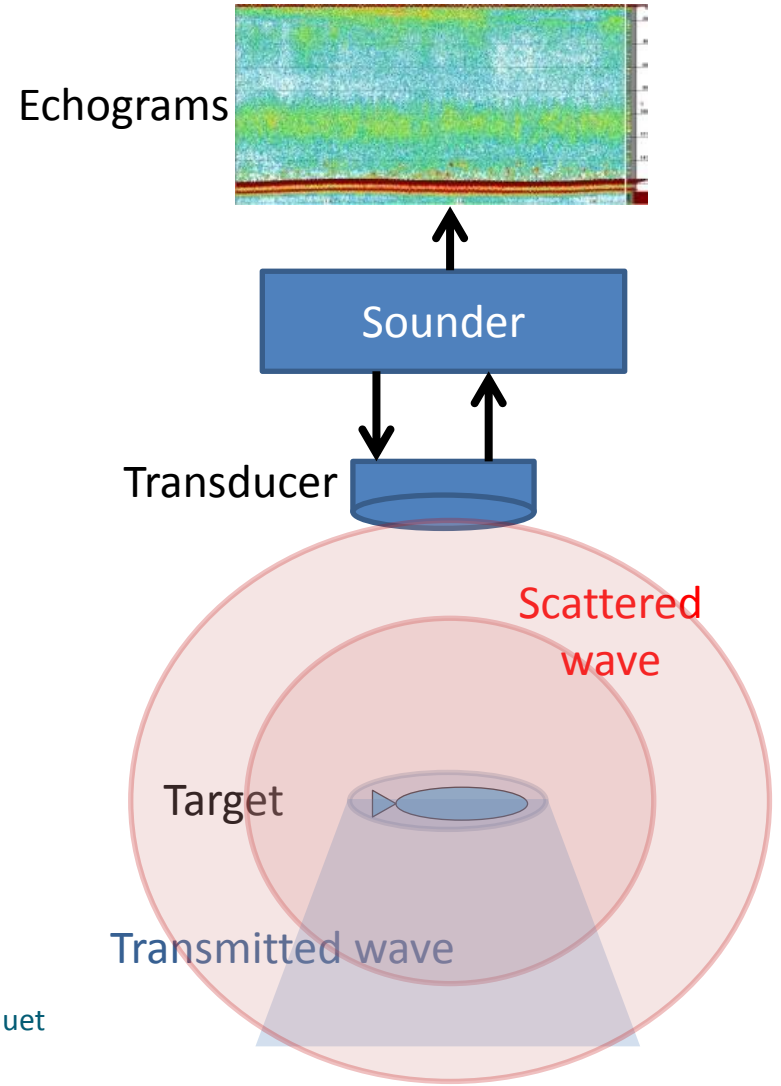
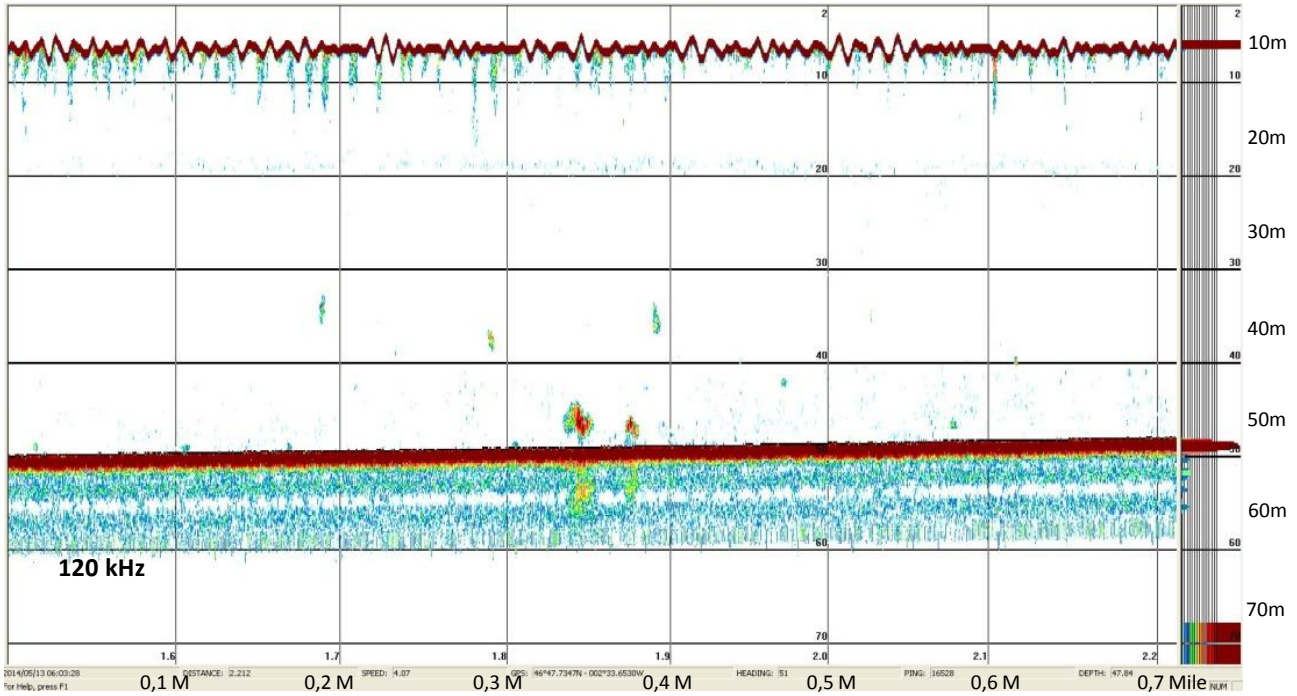




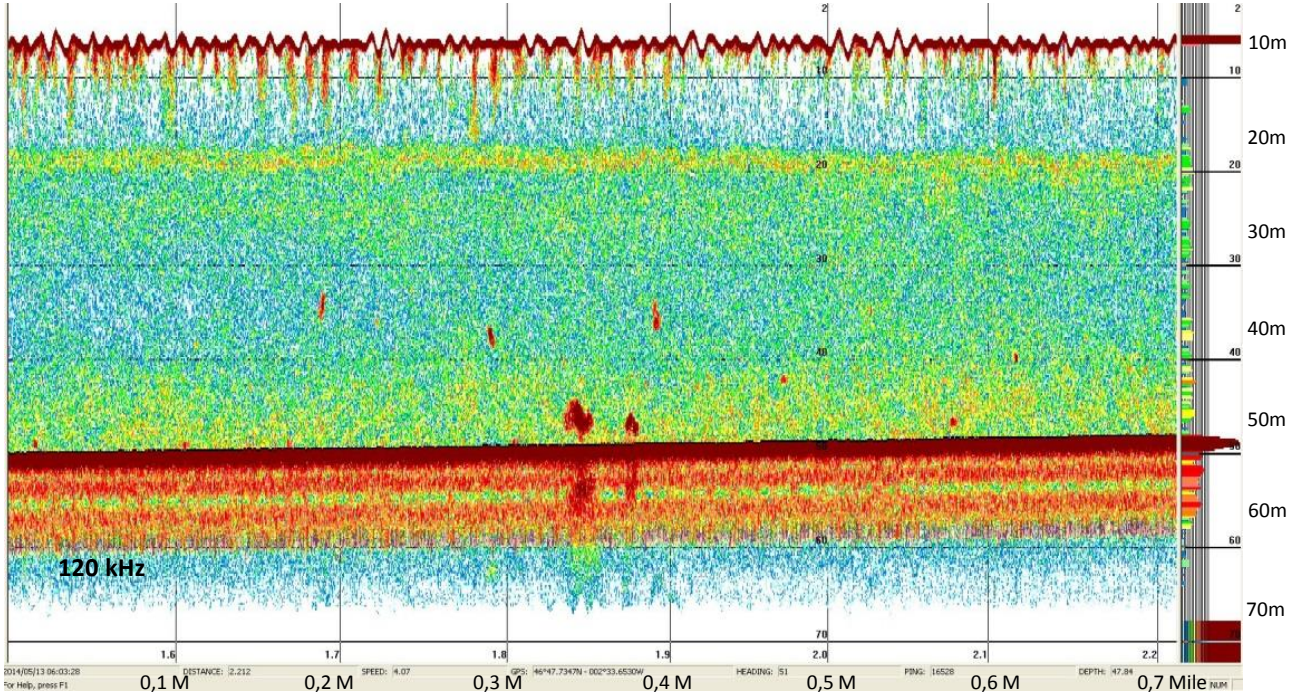
Some acoustic basis

- Acoustic developed for fish detection
- Any variation of density will scattered the incident wave



Some acoustic basis

- Acoustic developed for fish detection
- Any variation of density will scattered the incident wave
- Possibility of detection of a broad variety of organism with the appropriate thresholds and frequencies

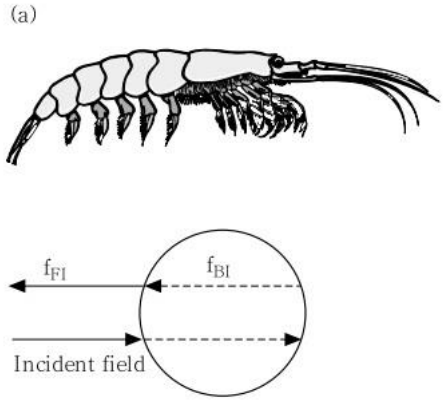


Scattering of marine organisms

3 broad categories of targets:

- **Fluid Like (FL) :** copepods, gelatinous organisms, euphausiids…

=> Characterized by a density close to the water



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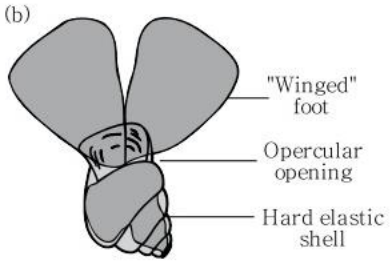

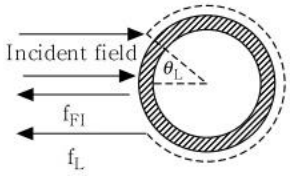

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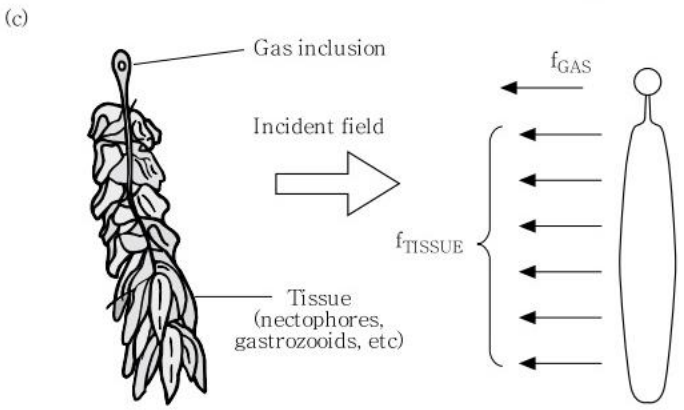
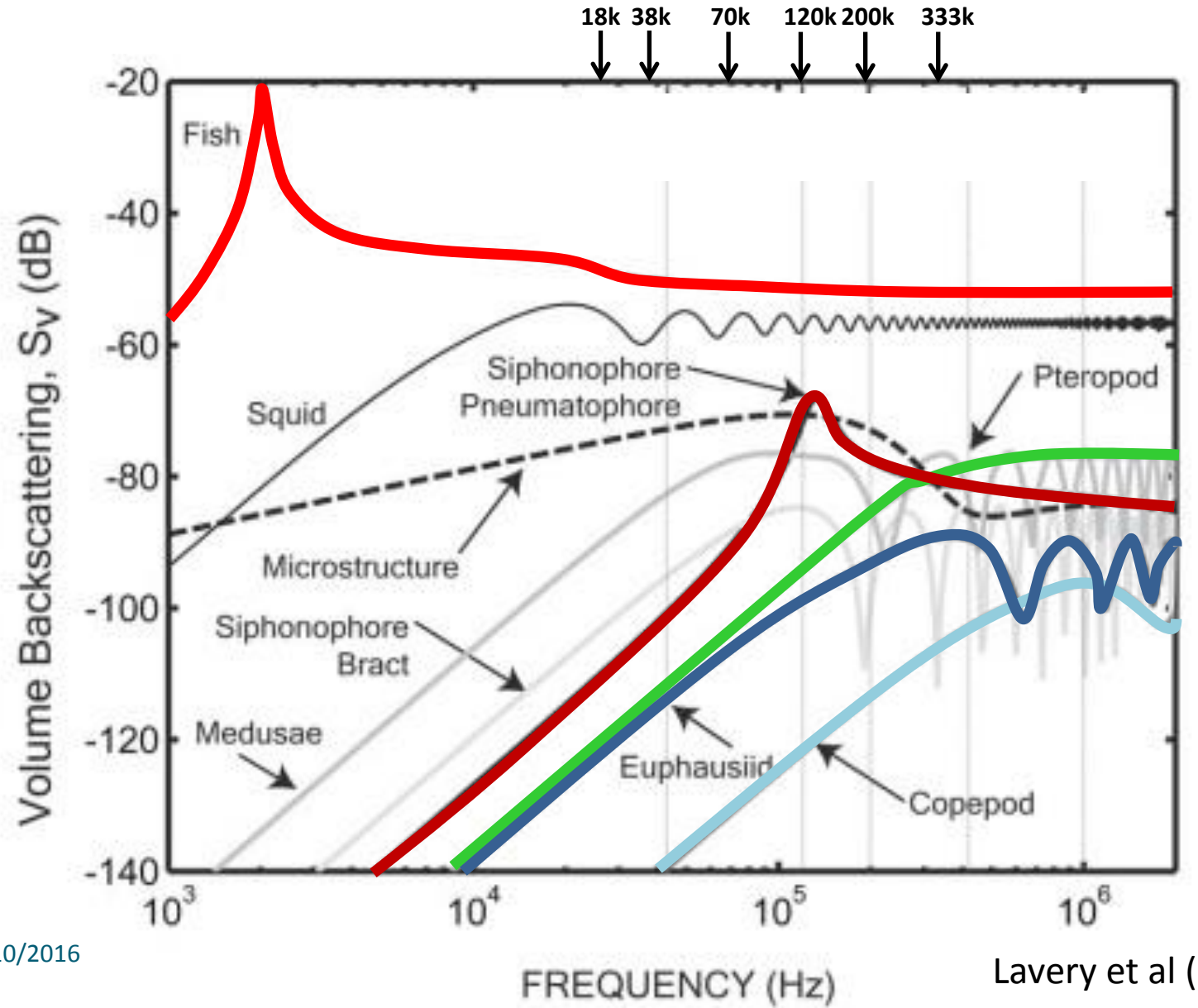
- **Gaz Bearing (GB) :** fish (adult, juveniles or larvae), siphonophores…

=> Characterized by a gas inclusion, with an important density contrast with water

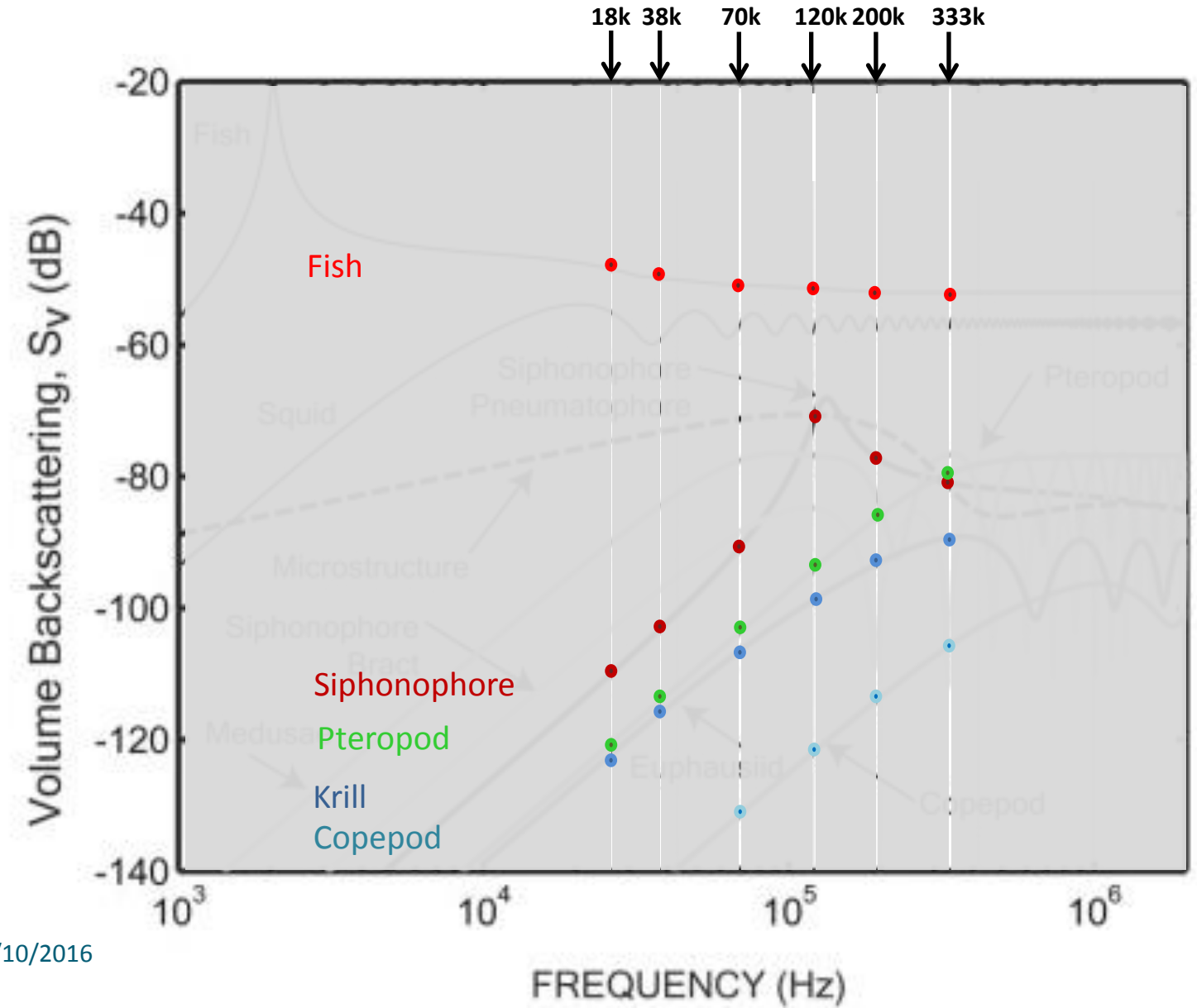


Models representations

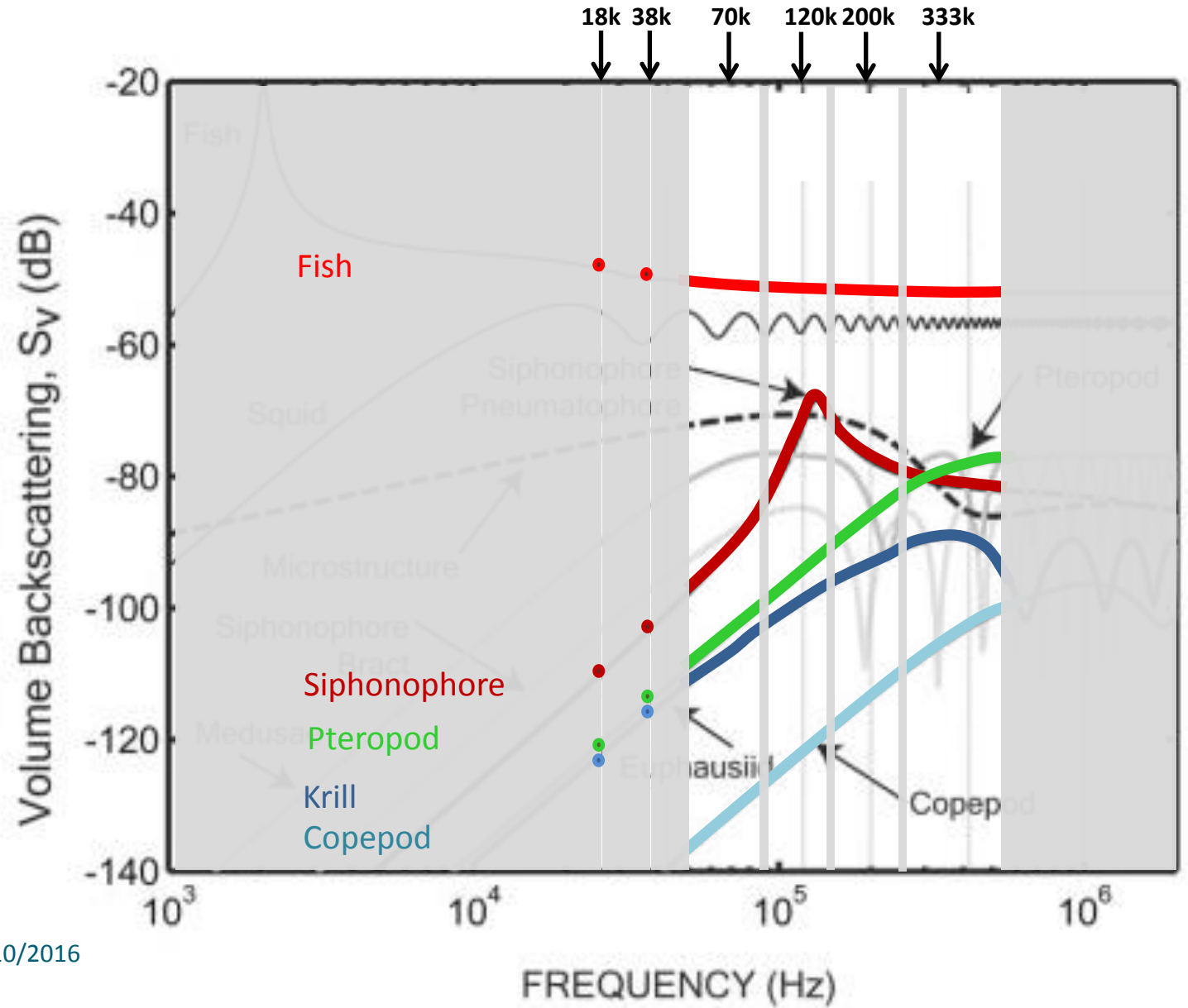


Lavery et al (2007)

Narrow Band (NB) acoustic

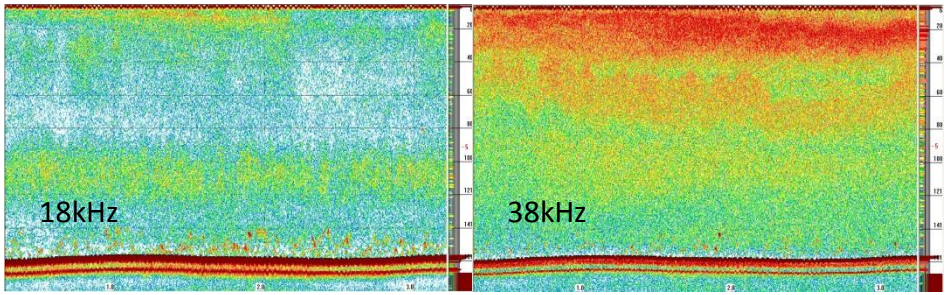


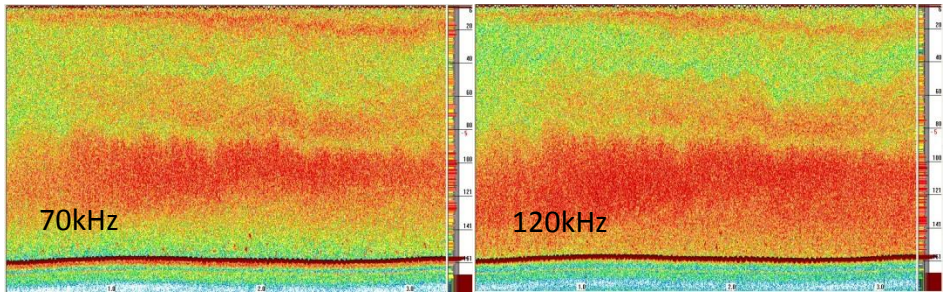
Wide Band (WB) acoustic

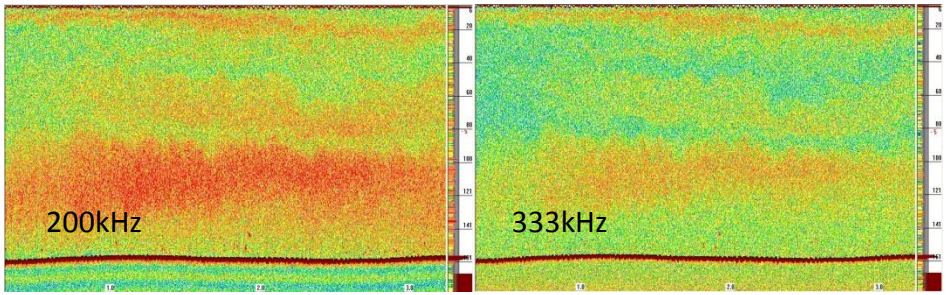


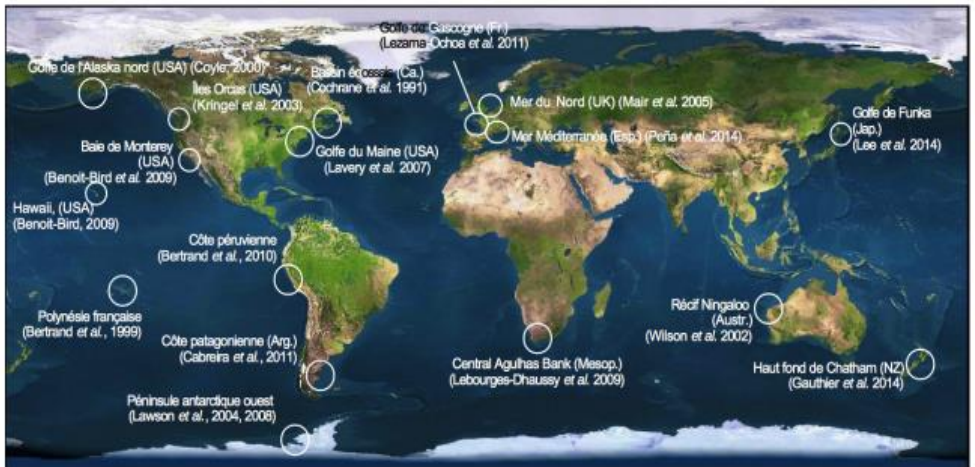
Sound Scattering Layers (SSLs)

- Layers of zooplanktonic and micronektonic organisms
- Observed in a great variety of ecosystems



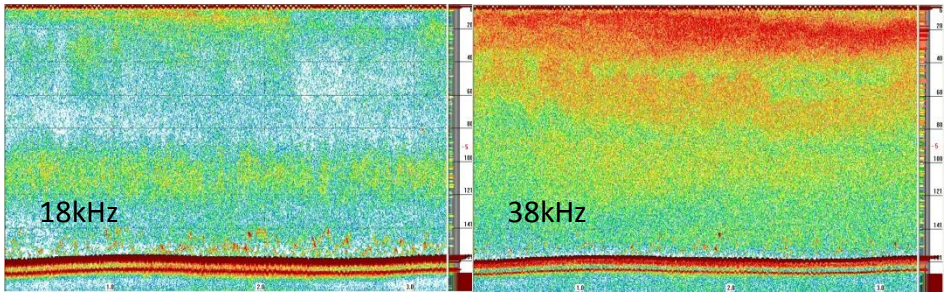


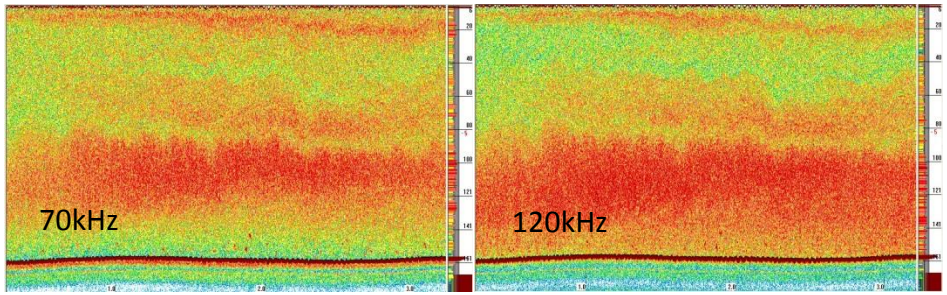


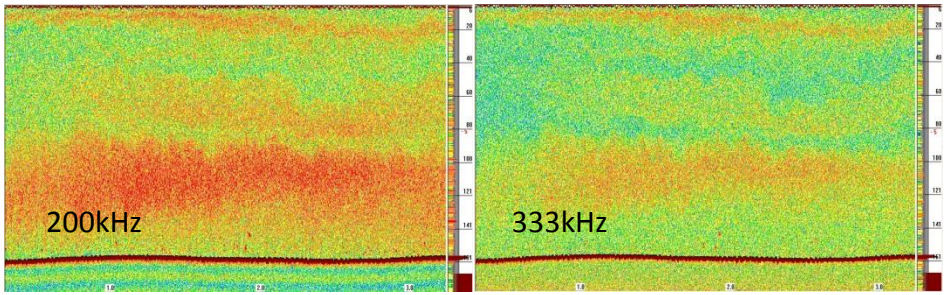


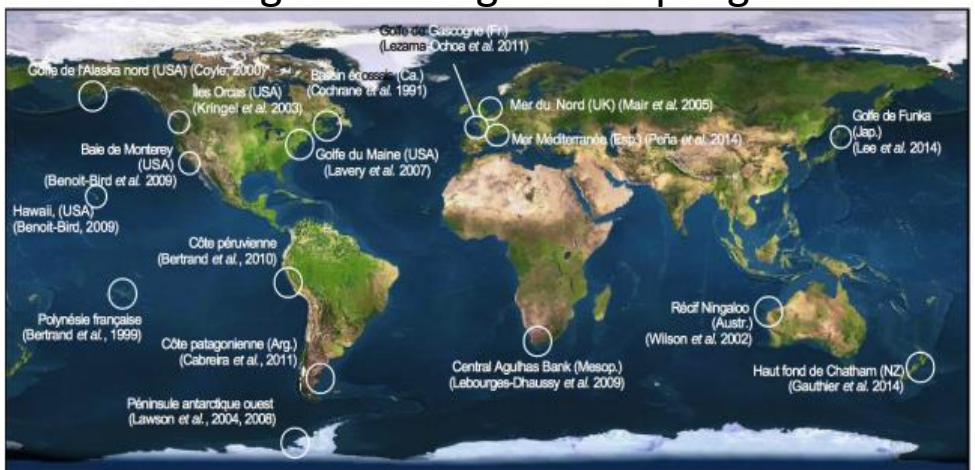
Micronekton SSLs

- Layers of zooplanktonic and micronektonic organisms
- Observed in a great variety of ecosystems
  - Common and very dense in the Bay of Biscay
- Acoustic response dominate by GB organisms
- The « blue noise » of *Ballon et al* (2011)
- Generally bad relationship between acoustic scattering and biological sampling









Fine scale study of SSLs

- Questions
  - Which organisms dominate the Bay of Biscay SSLs ?
  - Advantages of Wide Band (WB) acoustic for SSLs characterization?

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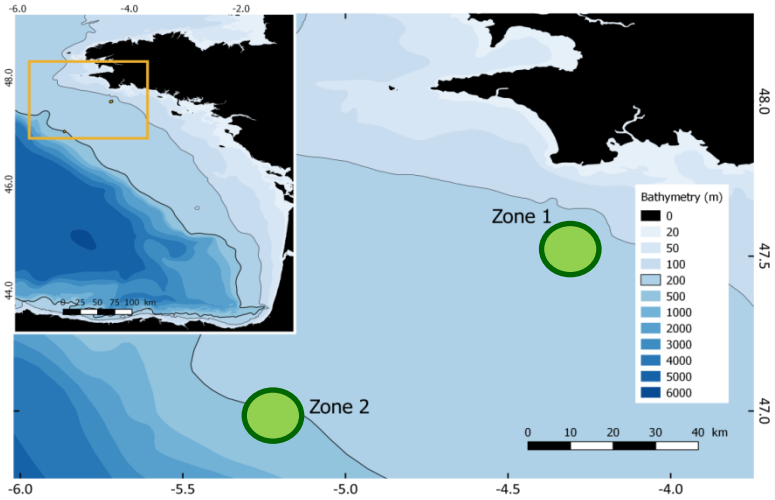
Sampling strategy

Acoustic and biological sampling on two contrasted zones in north Bay of Biscay



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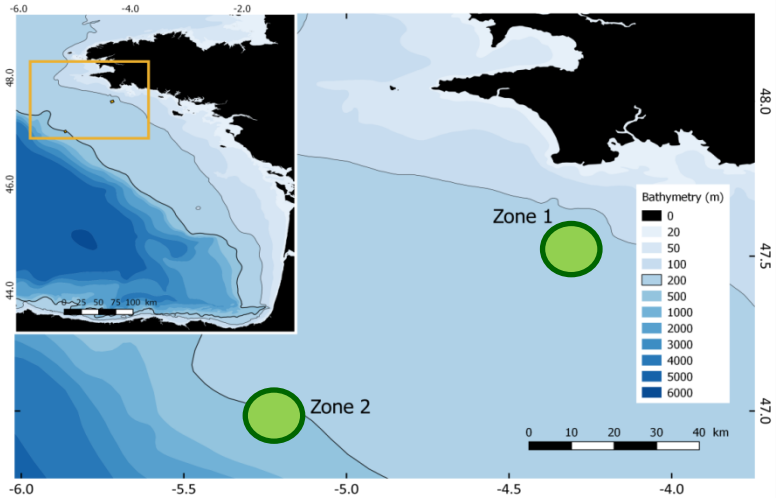

Methods

Forward approach: Comparison between modeled backscattering (Sv(f)) derived of sampled organisms and measured backscattering averaged over the same area

Modeled scattering from sampling

VS

Measured scattering

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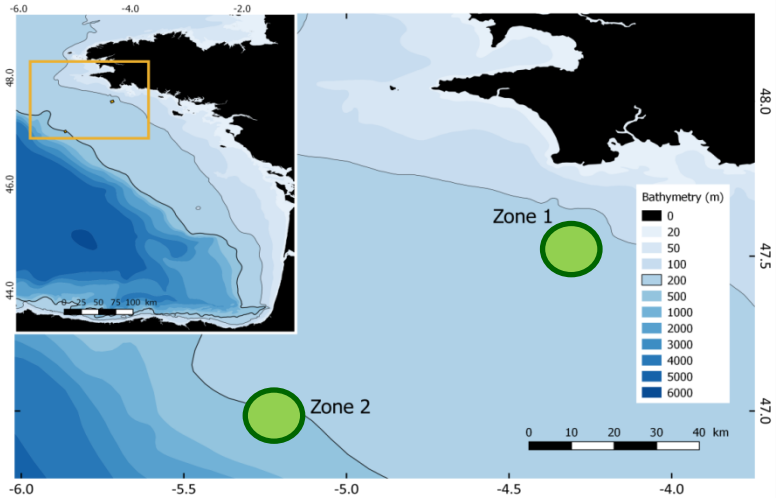

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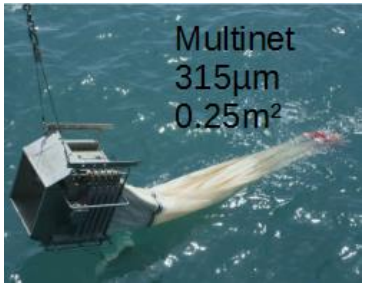
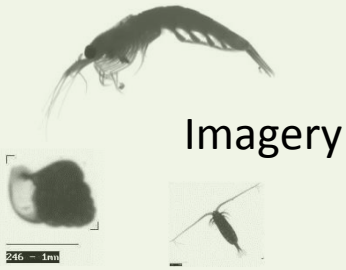
Samplers



Nets

GOPRO on MIK nets

Samples processing



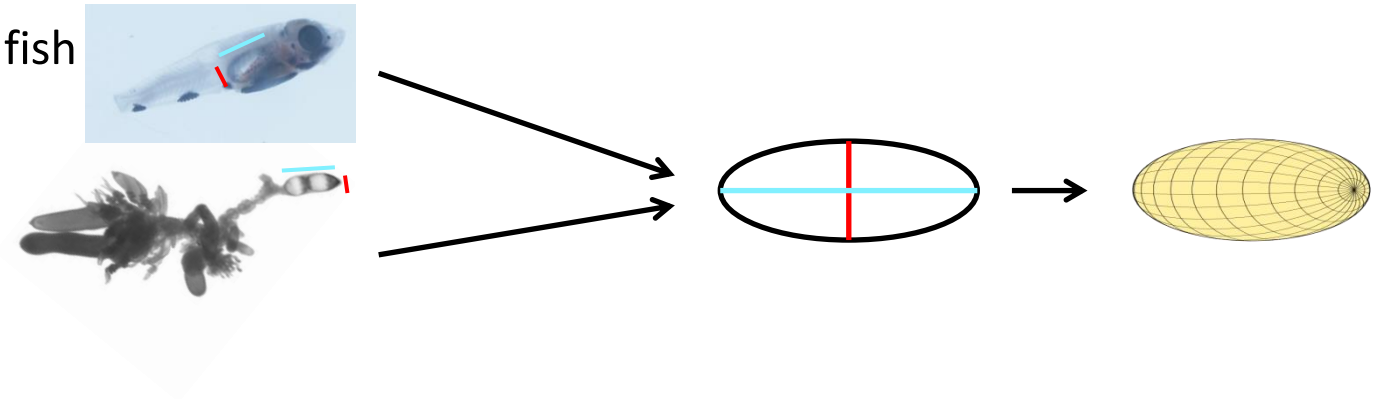
Imagery

Direct measurement

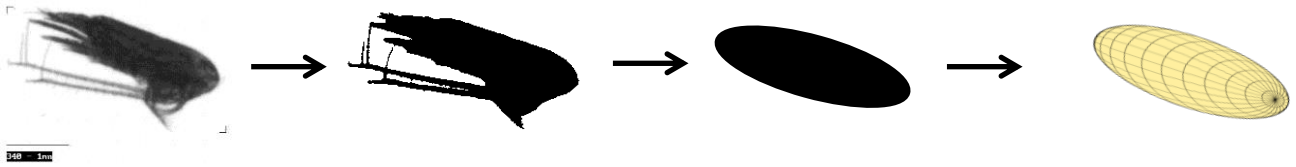
Video counting

Biological samples to acoustic model

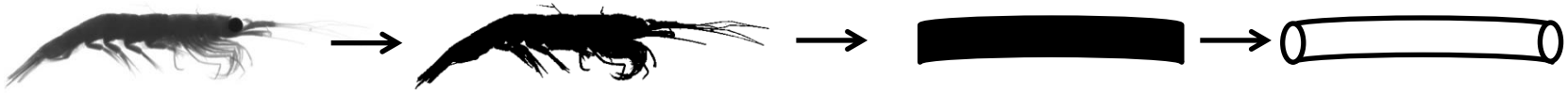
- GB organisms
  - Swimbladdered fish
  - Siphonophores



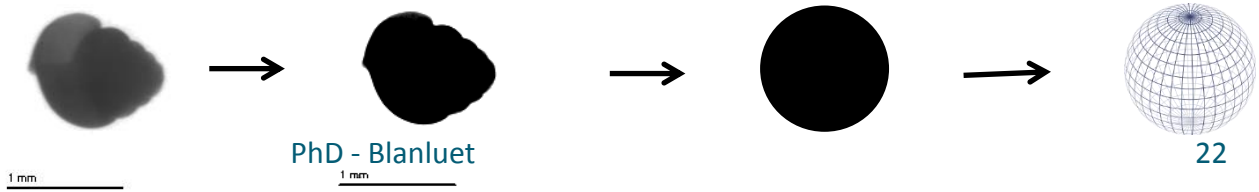
- FL organisms
  - Copepods
    - Ratio L/w = 2.55



  - Euphausiids
    - Ratio L/w = 5.5



- ES organisms
  - Limacina



Acoustical sampling

Samplers

Transducer	Signal	Bandwidth (kHz)
ES18-11	CW	18
ES38B	CW	38
ES70-7C	FM	47-90
ES120-7C	FM	95-160
ES200-7C	FM	180-240
ES333-7C	FM	280-420

Samples processing

Spectral analysis:

- Resolution in frequency: 0.5 kHz
- Range resolution: 1 m

Echo-integration

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VS

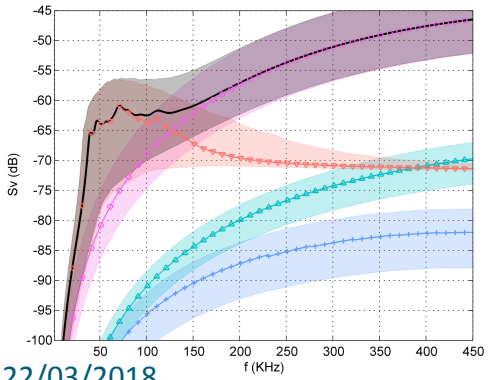
Measured scattering

Forward approach: modeled Sv(f)

Scatterers densities and size from catch

Sum of modeled backscattering

Layer Modeled Sv(f)



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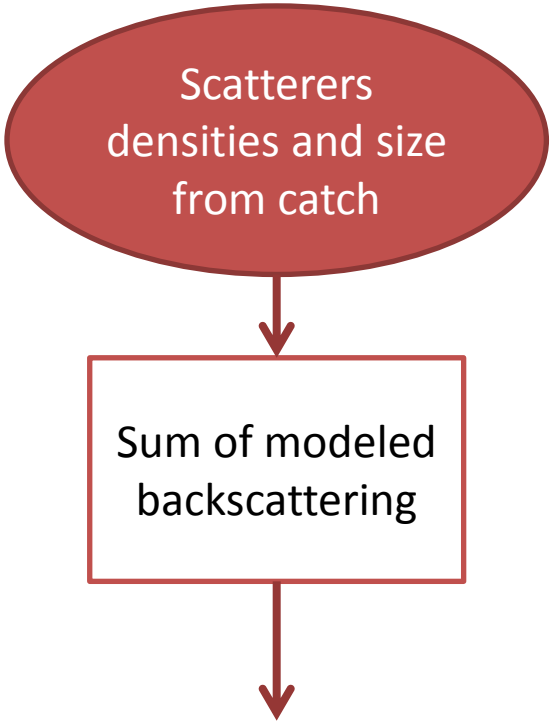
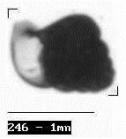
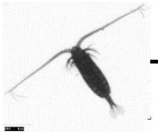


- Organisms backscattering modeling

– GB organisms: Modified Ye model (*Ye, 1997*)



– ES organisms: Stanton dense fluid sphere high pass model (*Stanton et al, 1998*)



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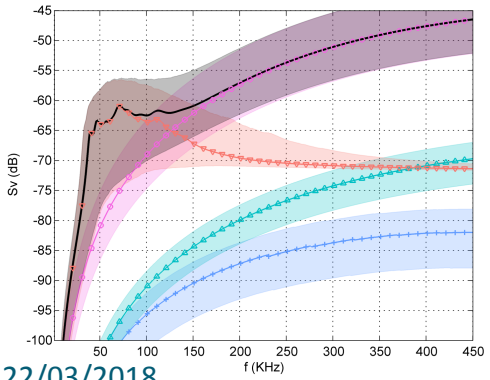

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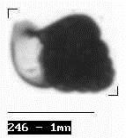

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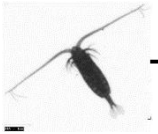
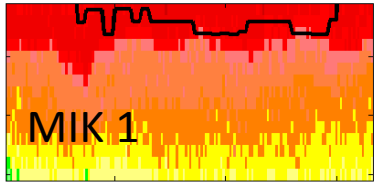
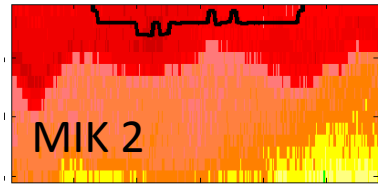


  - FL organisms: DWBA model (*Chu et al, 1993*)

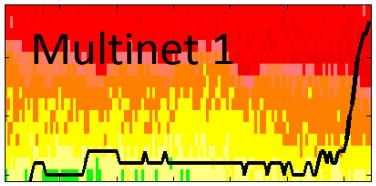
- Model uncertainty analysis
  - 1000 simulations with each parameter randomly drawn in distribution law based on literature value
  - Construction of confidence interval (90 %) based on these simulations

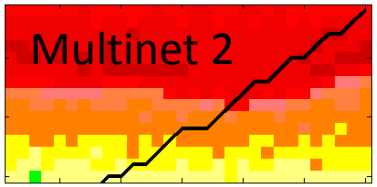
Forward approach: measured Sv(f)





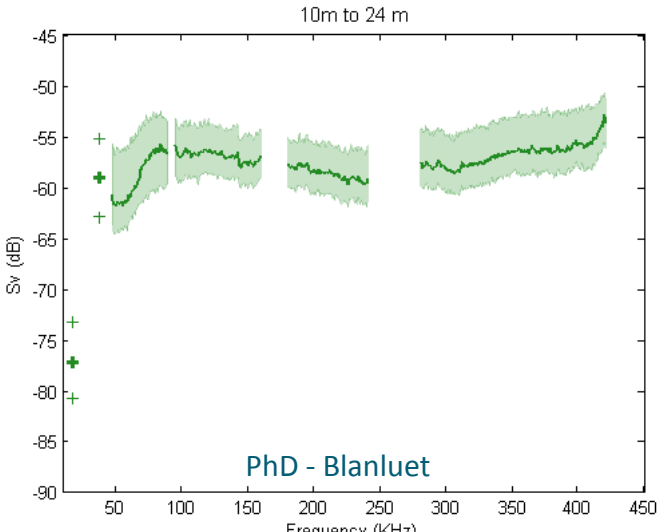
Tow tracks in the layer





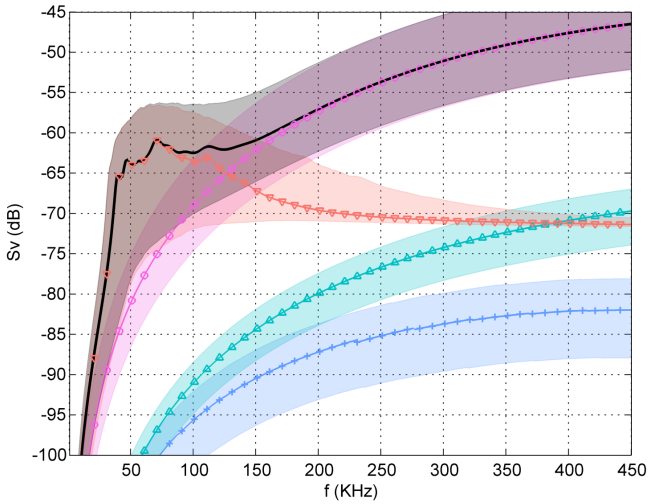
Mean of each tow tracks median Sv(f)

Layer measured Sv(f)



Forward approach: results

Layer Modeled Sv(f)



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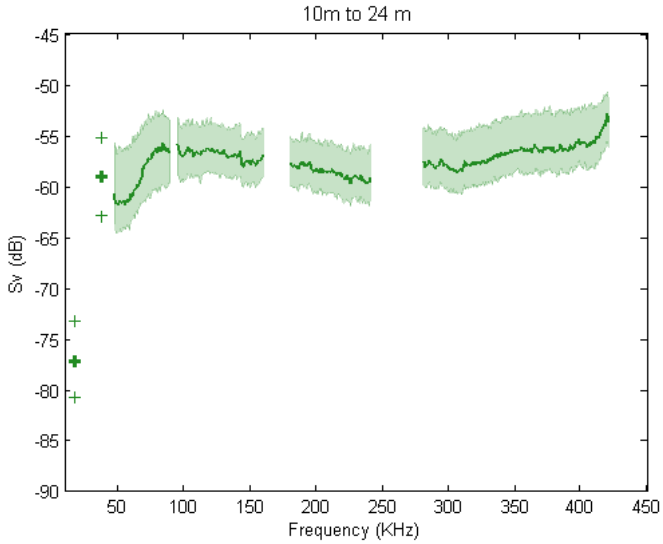
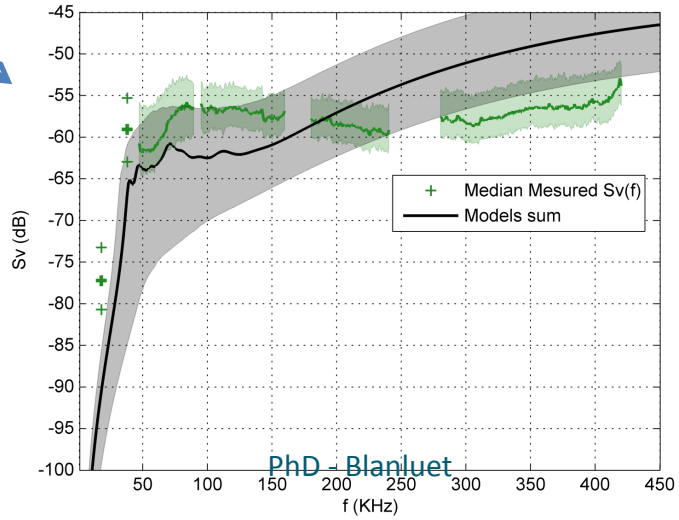
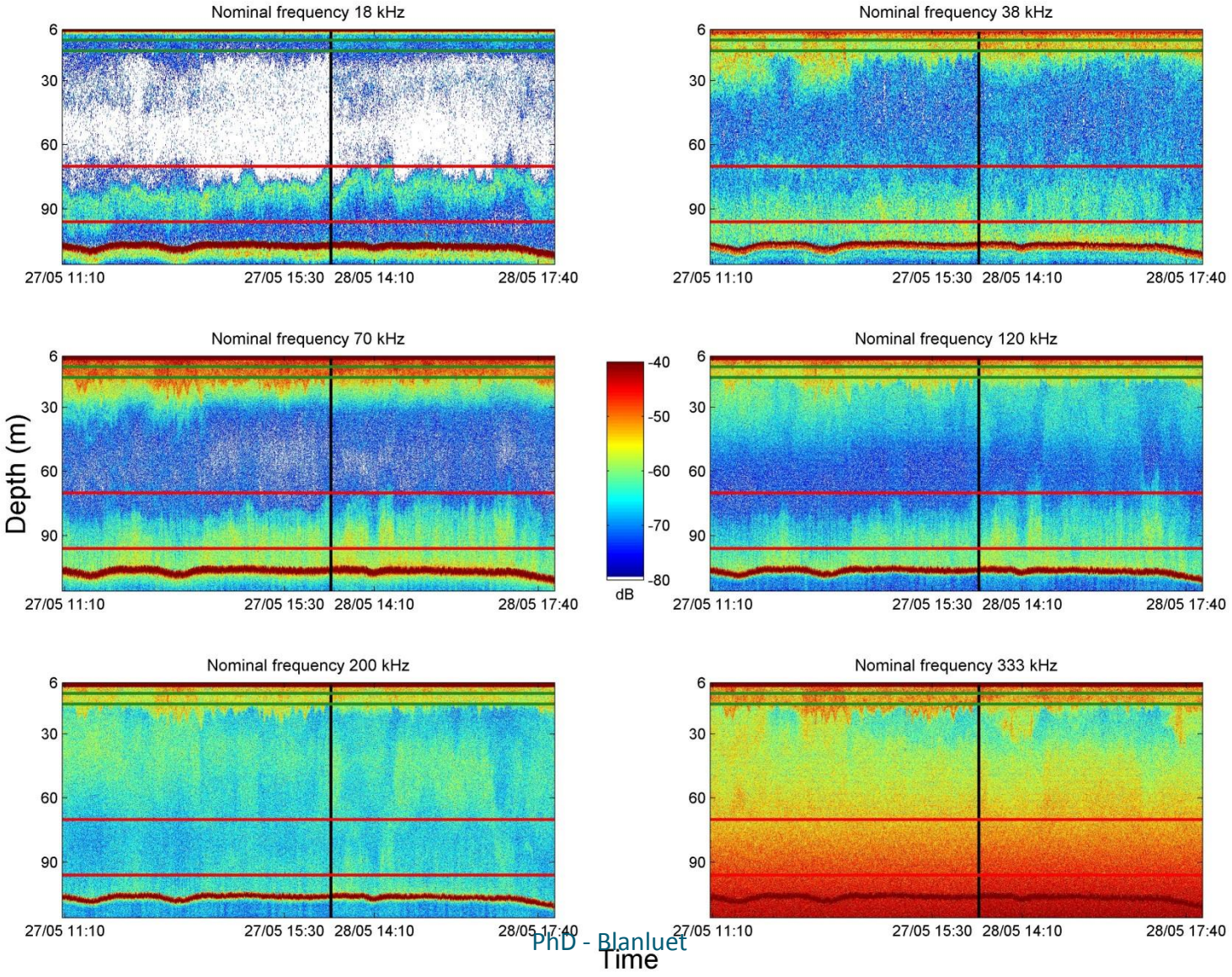


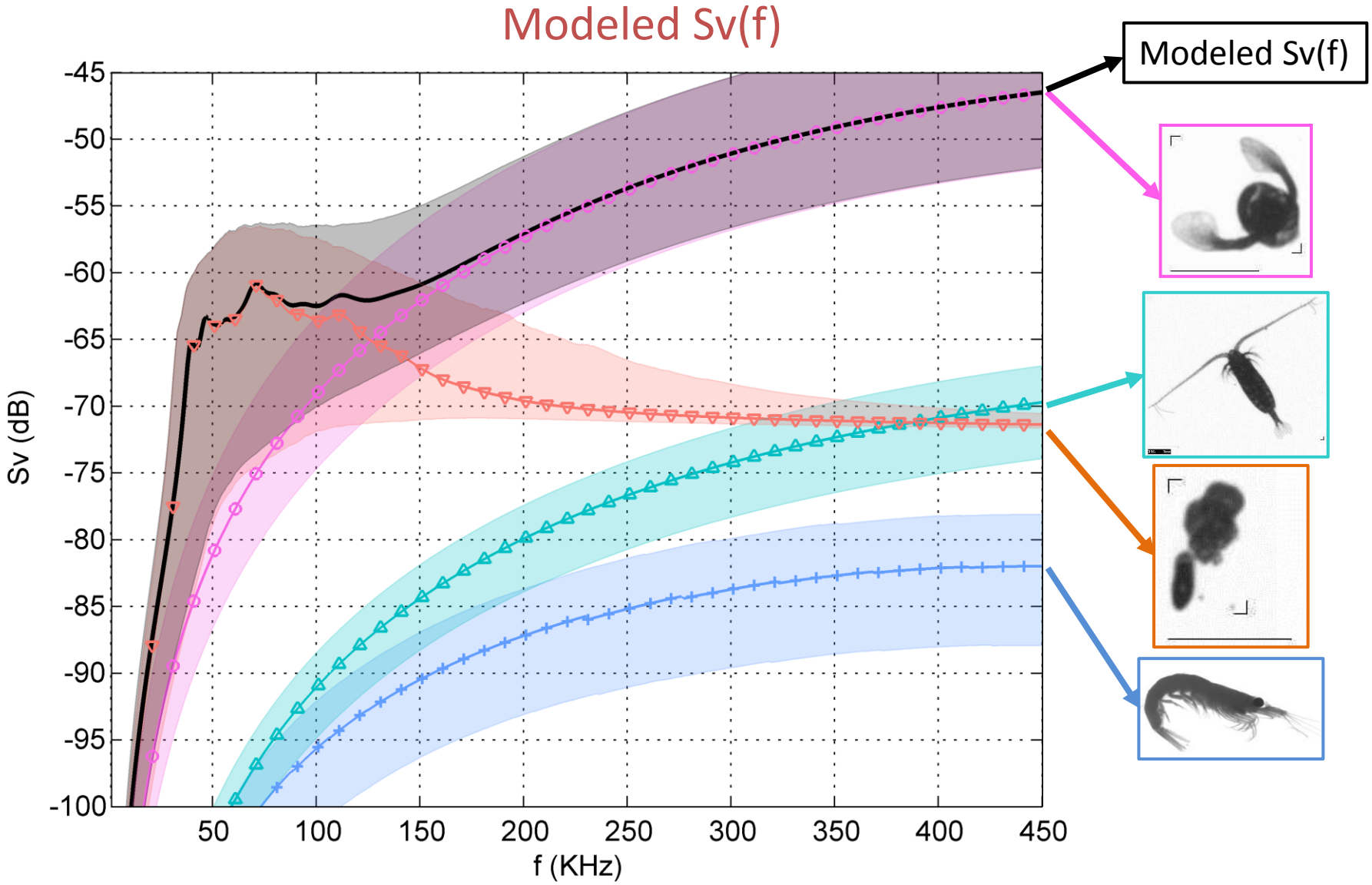


Forward approach: results

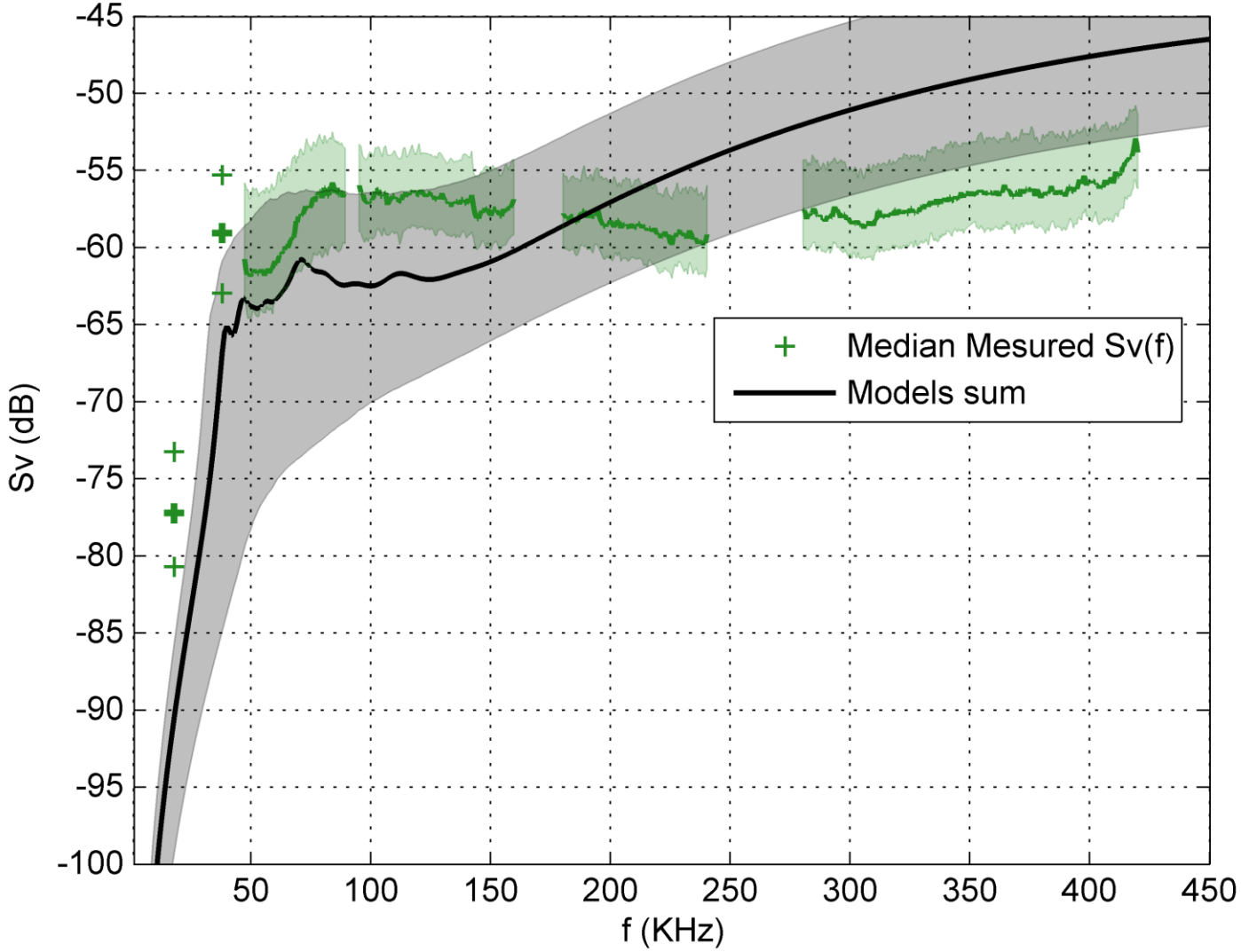
Continental shelf daytime surface layer

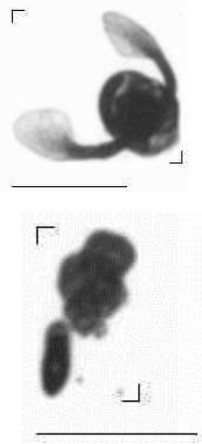


Forward approach: results



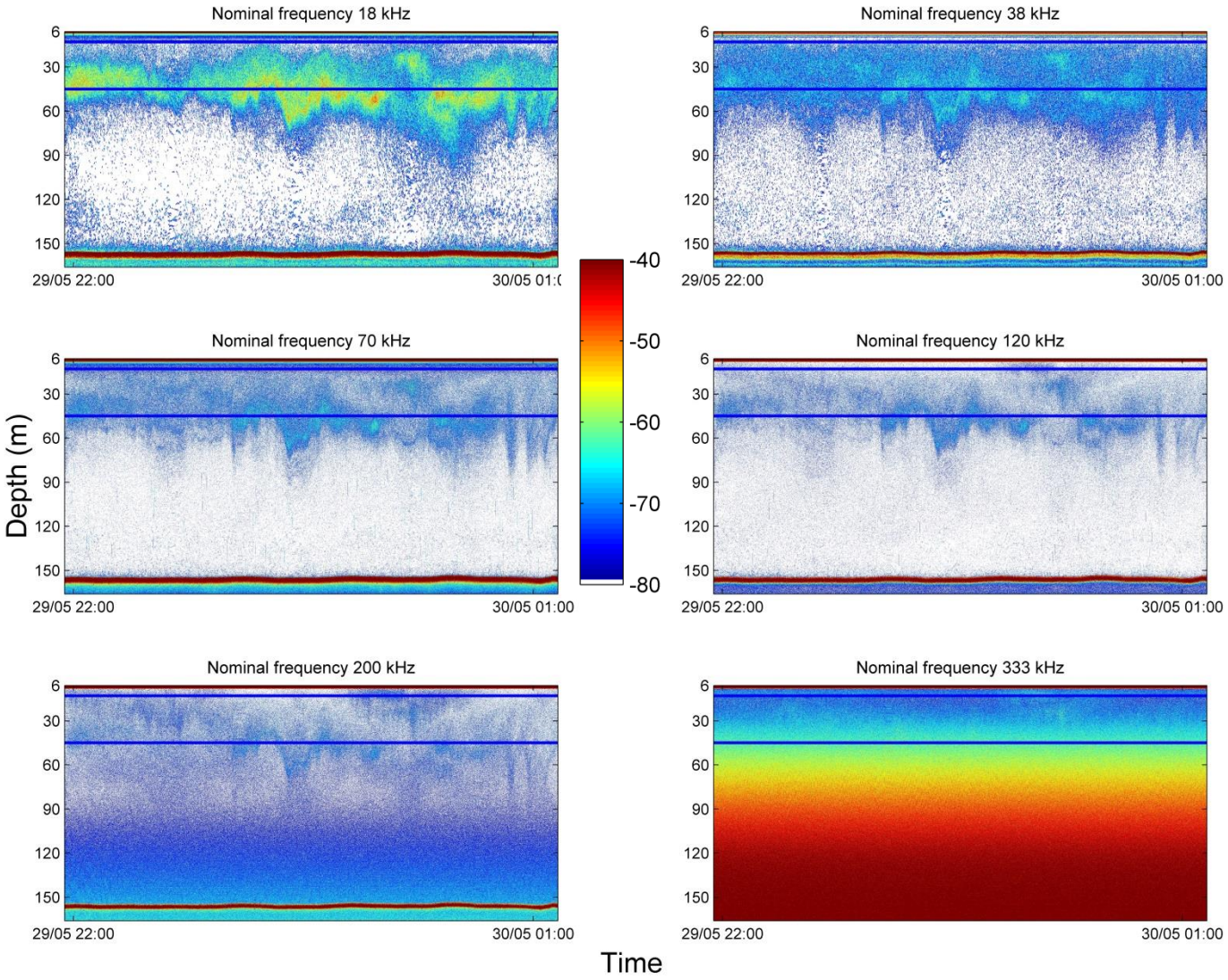
Forward approach: results





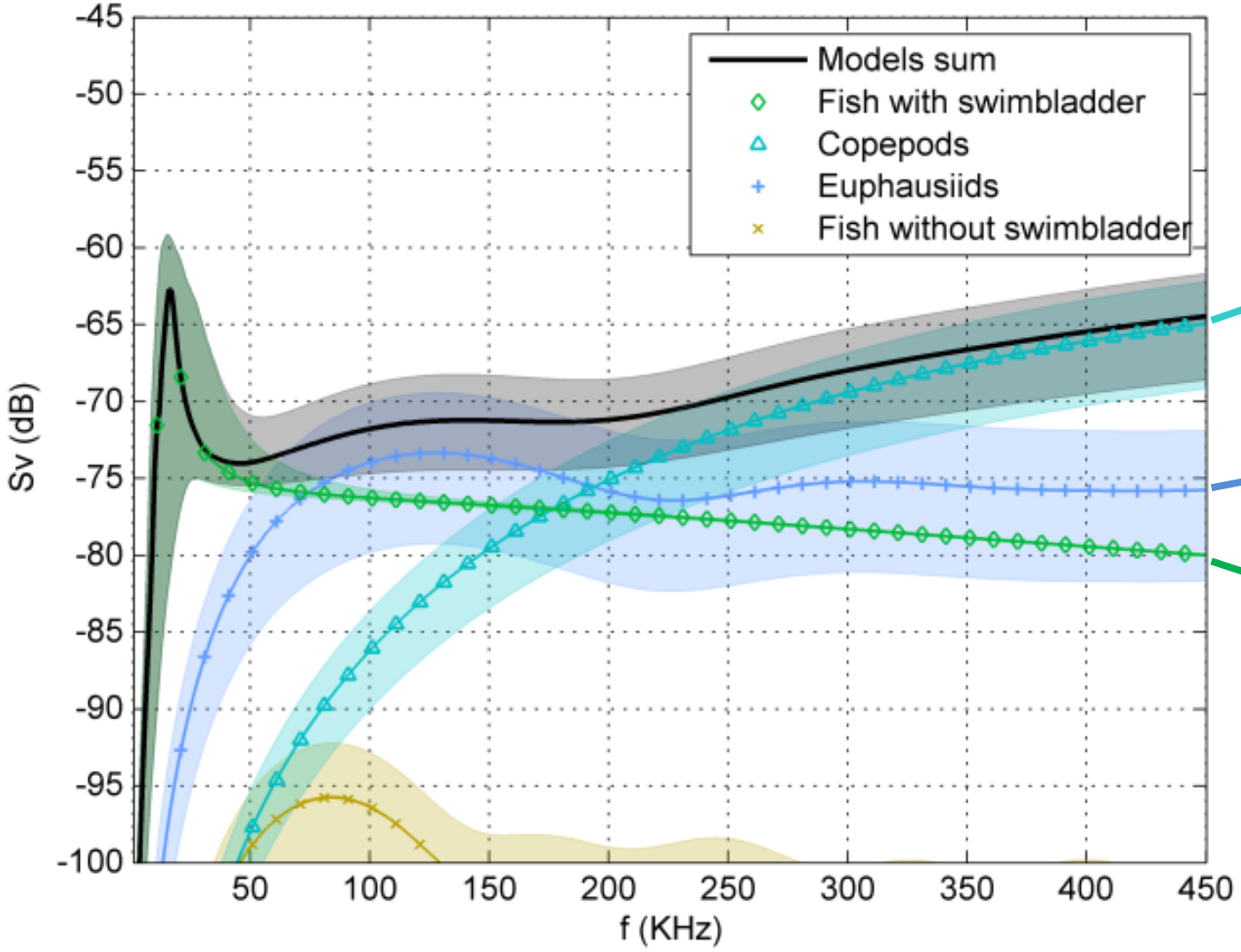
Forward approach: results

Slope nighttime surface layers



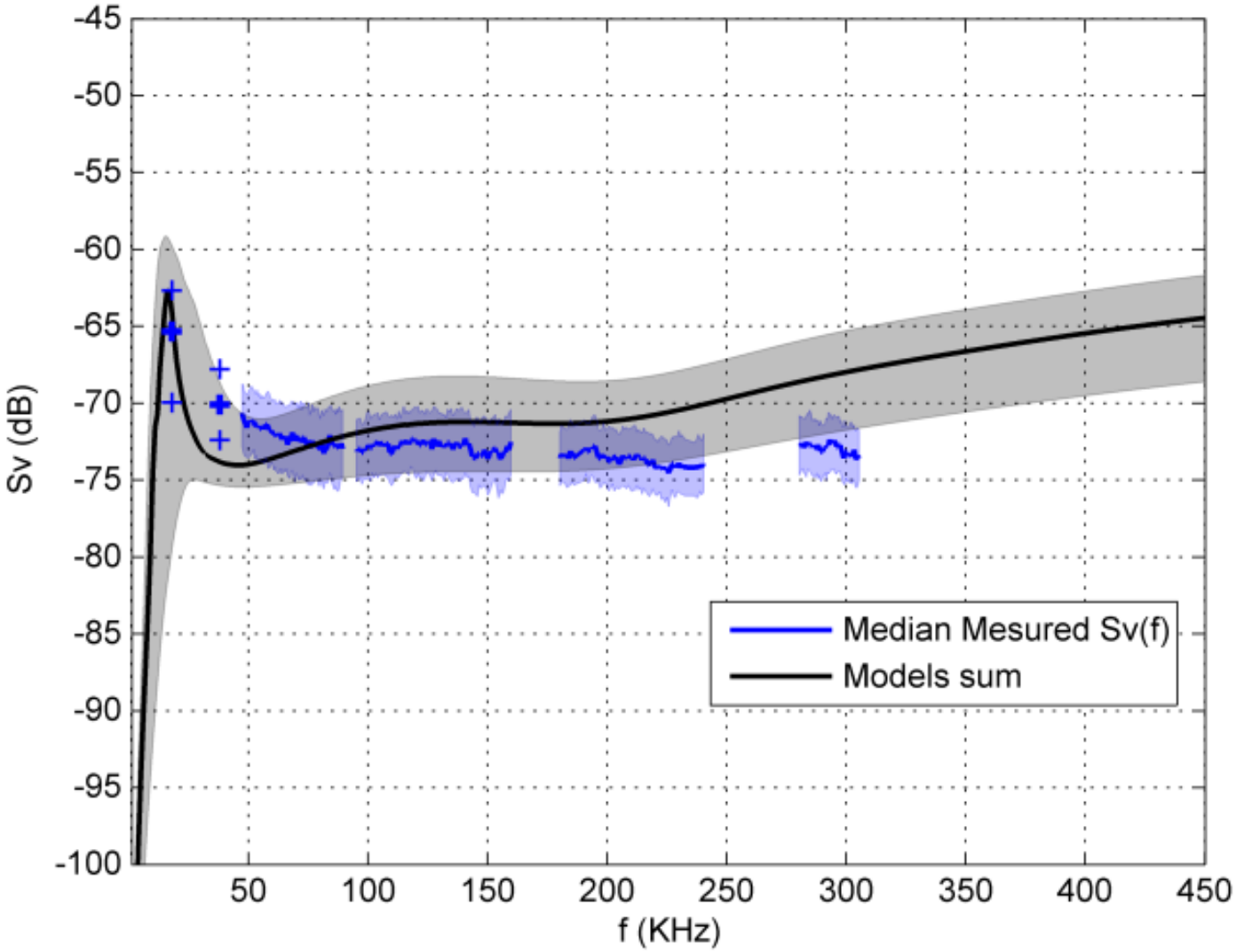
Forward approach: results

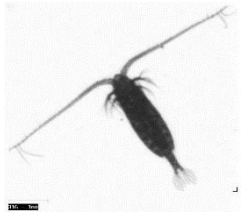
Modeled Sv(f)



Forward approach: results

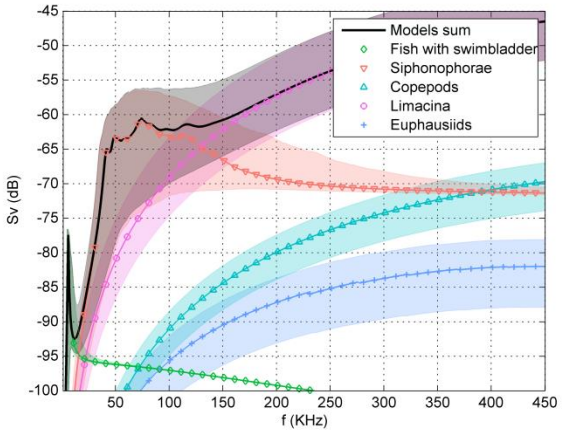
Modeled Sv(f) compare to measured Sv(f)

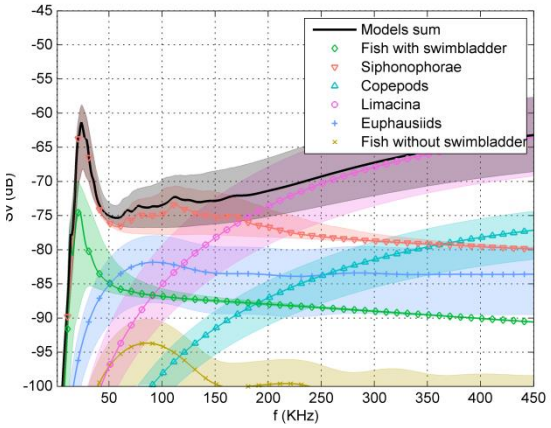


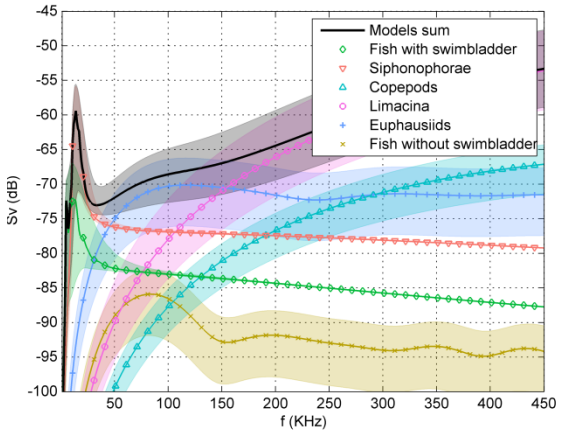


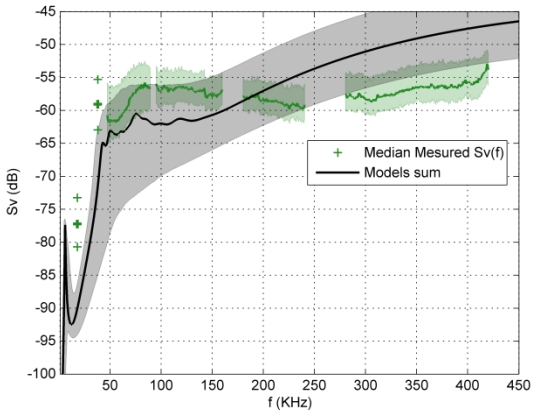
Forward approach : Result

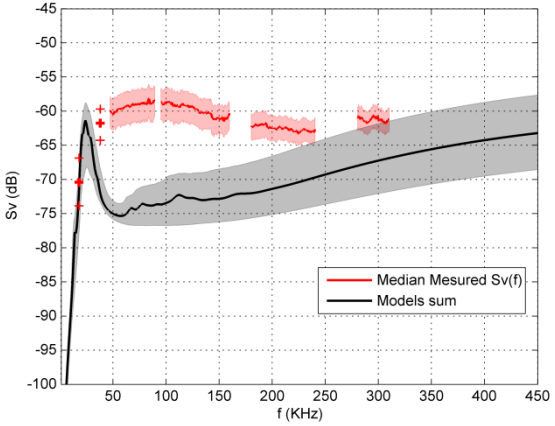
Zone 1

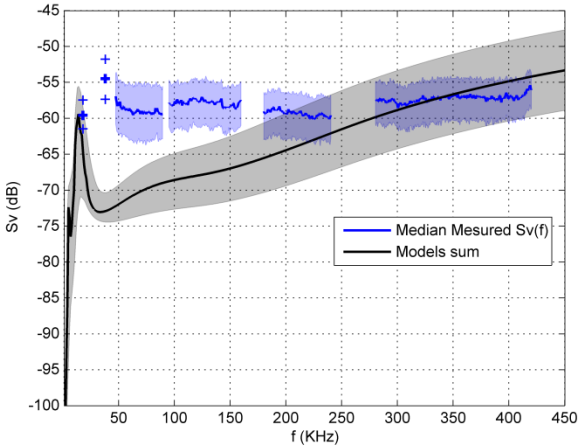












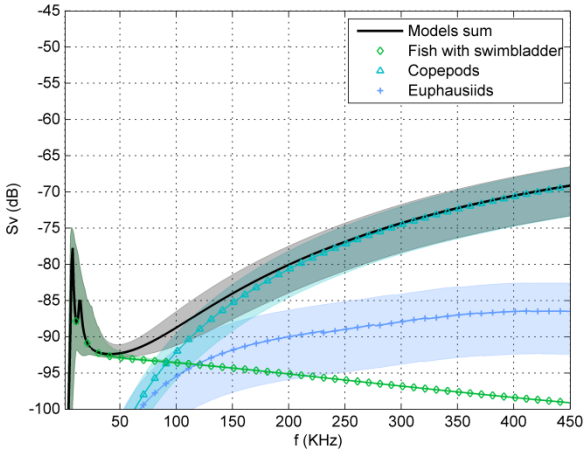
Surface layer

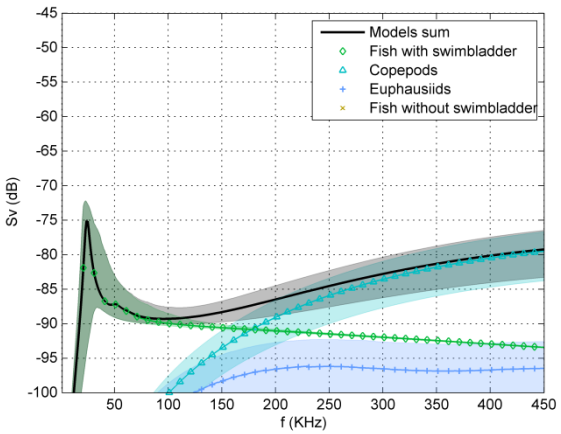
Deep layer

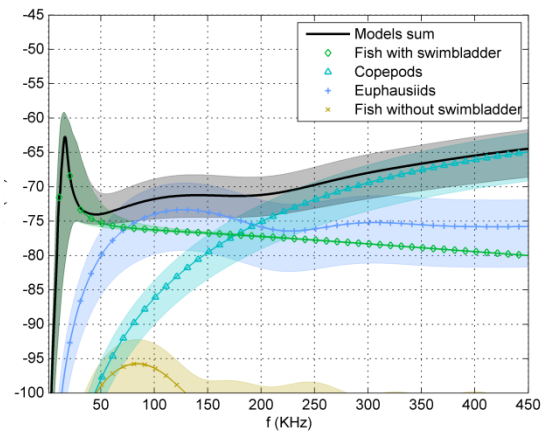
Night layer

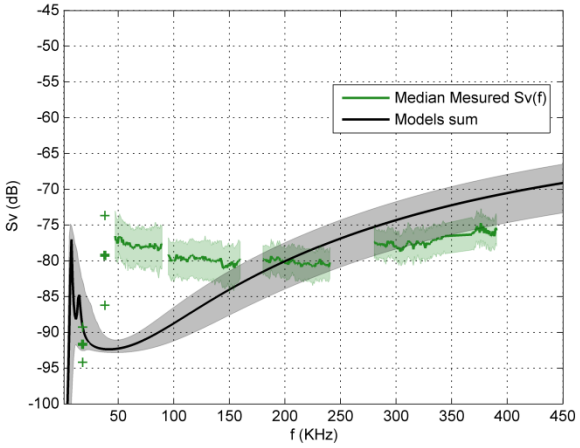
Forward approach : Result

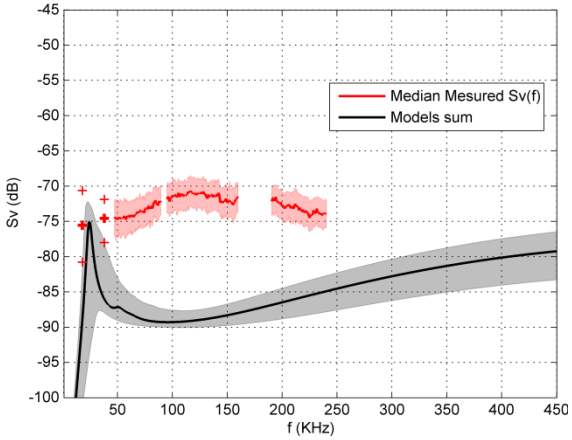
Zone 2

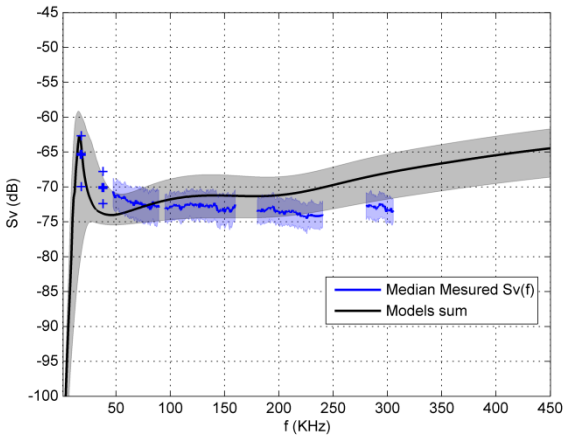












Surface layer

Deep layer

Night layer

SSLs dominant scatterers

- GB organisms
  - Dominate the SSLs at low frequencies
  - Hard to sample: mobile and fragile organisms

  - **Physonect siphonophores**: potential major backscatterers of Biscay shelf SSLs in springtime
    - First evidence of their contribution to Bay of Biscay SSLs
    - Importance of imagery and video for their sampling

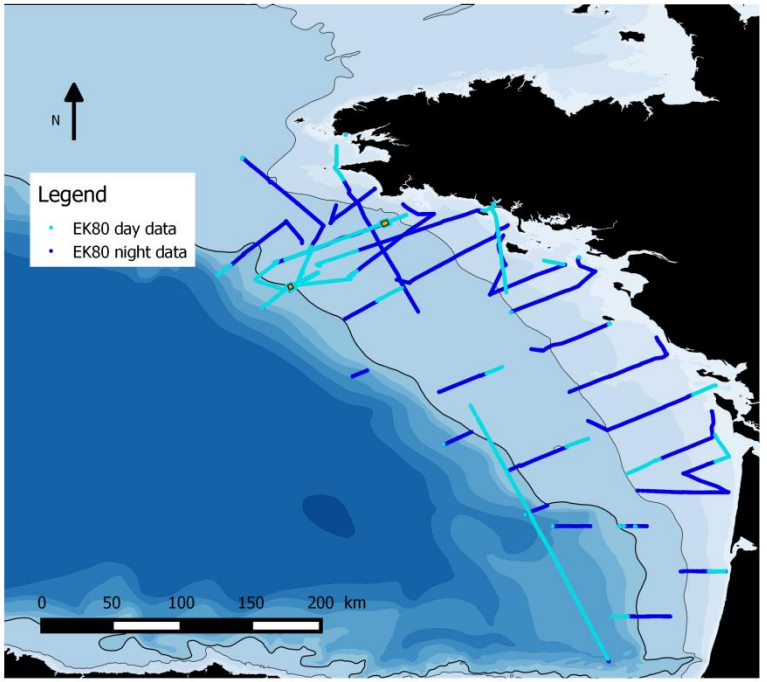
- Other organisms (Pteropods, euphausiids copepods)
  - Contribute to SSL backscattering at higher frequencies
  - Dramatic densities of pteropods

Further: large scale clustering

- Questions
  - Variability of SSLs backscattering spectrum in the Bay of Biscay
  - Dominance of Resonant layers?

Sampling strategy

- Echo-integration of good qualities opportunistic WB data acquired in side of PELGAS survey
- Principally night data



Methods

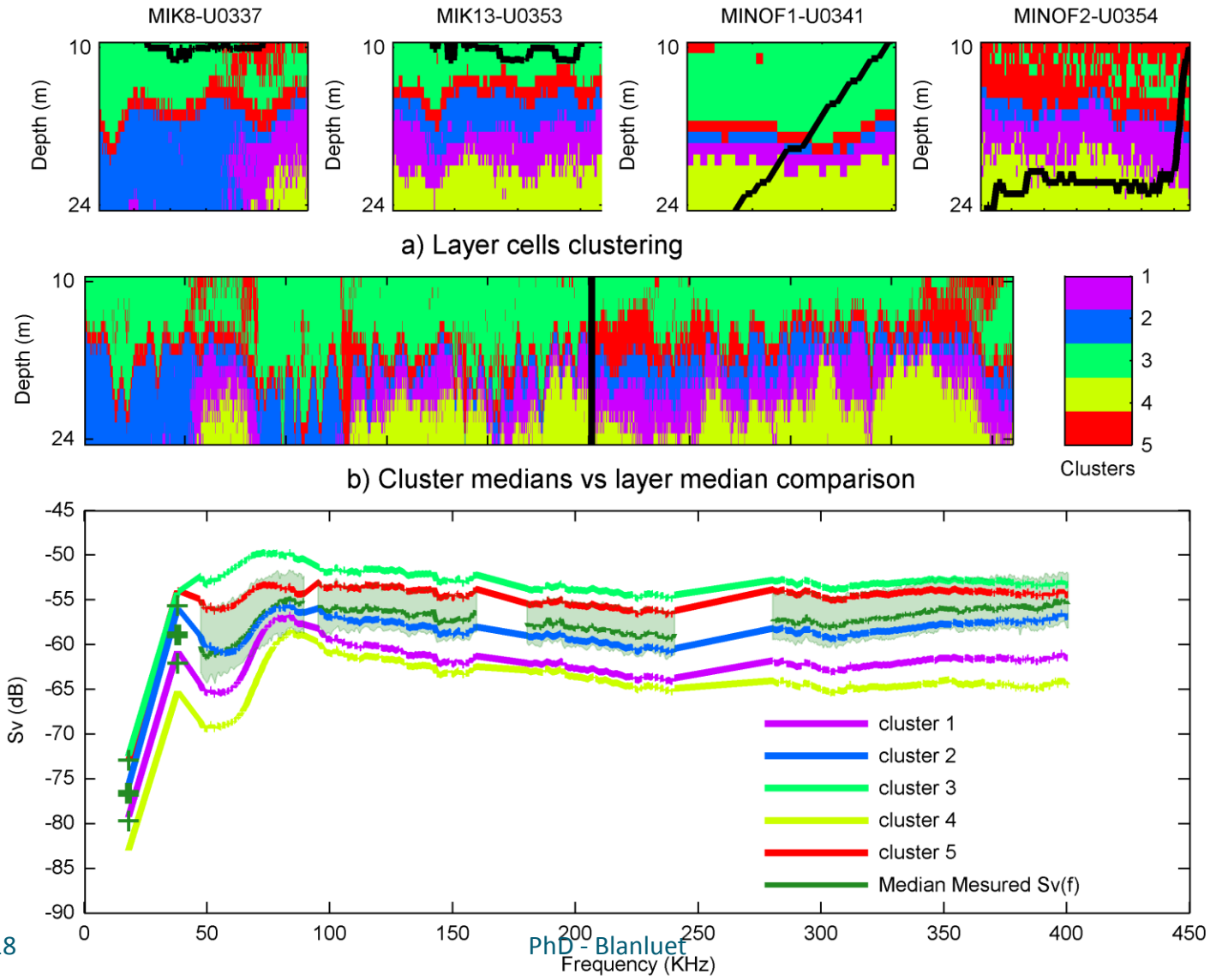
- Clustering (Kmean) on each area, extraction of clusters spectrum
- Comparison between clusters

Thank you for your attention!

arthur.blanluet@ifremer.fr

Finishing in January 2019

Classification approach

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