

Water Column Data in Action

Quantifying Gas Bubble Release with Multibeam Systems

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History

2013 – 2021 Researcher @ GEOMAR, Germany



2022 – Now Researcher @ Ghent University, Belgium



2025 – Now hydroacoustic consultant



Focus:

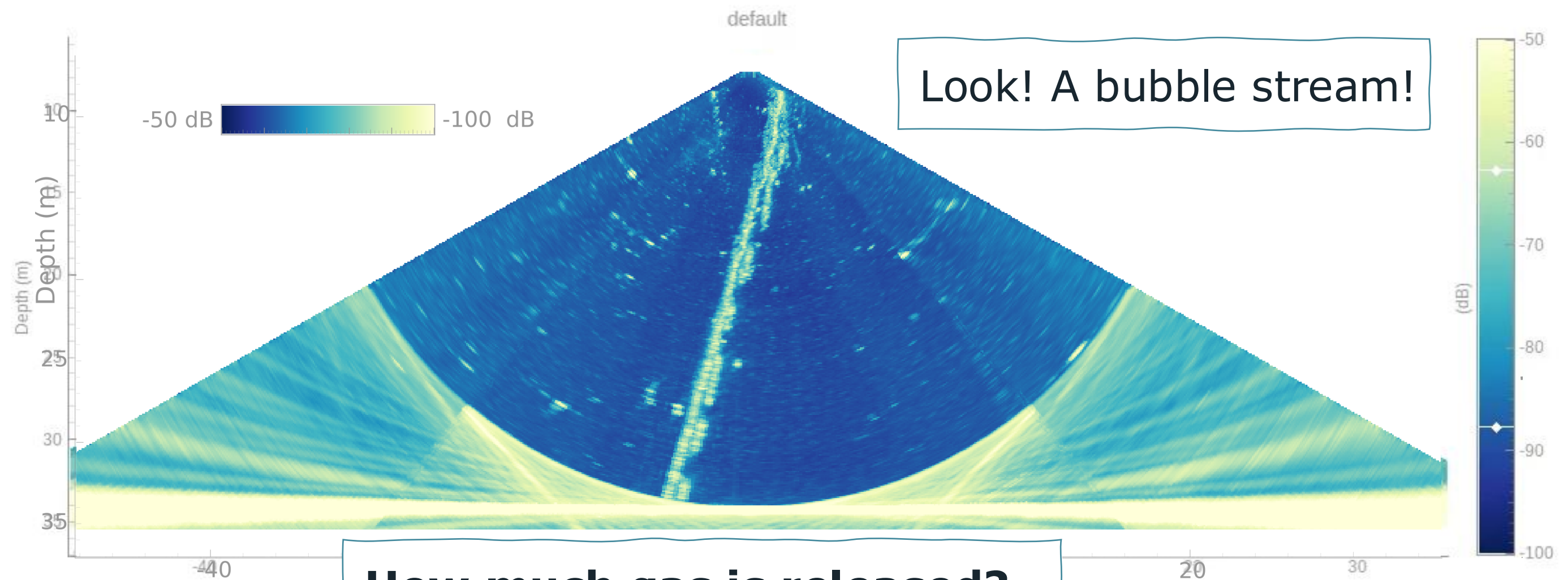
-)) Constraining uncertainties

Water column methods:

-)) Publications 2023, 2025,
-)) Ongoing with UGent and VLIZ (subm.)
-)) Ongoing with TNO, NIOZ (2027?)

Bubble stream investigation

MBES WATER COLUMN DATA



How much gas is released?

Bubble stream investigation

MARINE GAS RELEASE



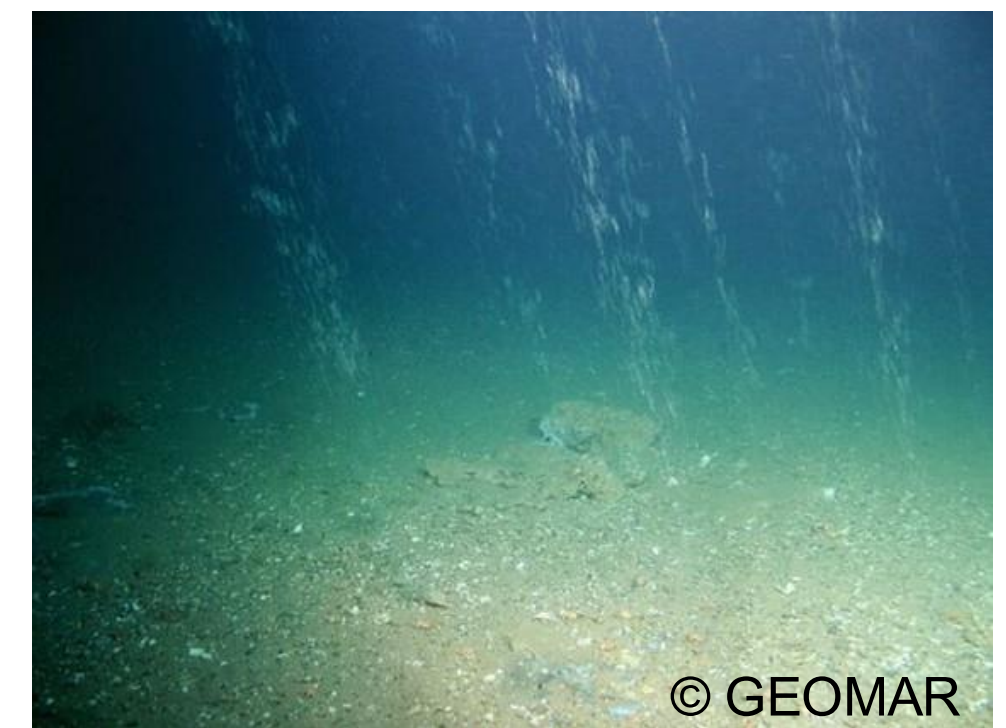
- Typically Methane or CO₂
- **Emission reporting**
 - Natural emissions
 - Abandoned wells
 - Pipelines
 - CCS sites



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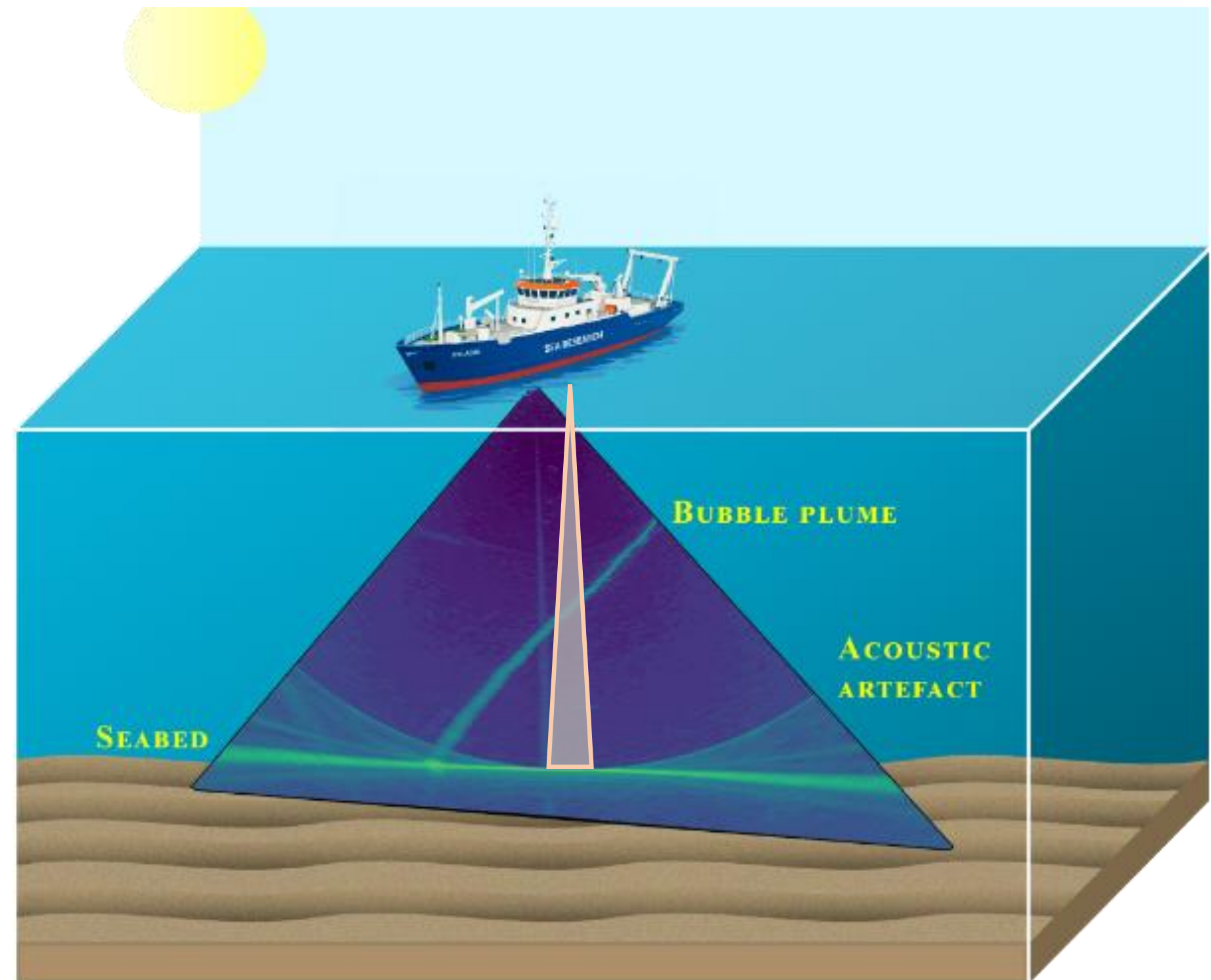
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Bubble stream investigation

WHY ACOUSTICS?



- Scaling / Operational effort
 - Smaller vessels
 - Combine detection with quantification



- Tradeoff
 - More theoretical complexity
 - Uncertainty in modeling

MEASUREMENT PRINCIPLE

Coverage!

Acoustics (MBES/SBES)

Acoustic layer



C_{Calib}

Summed σ_{BS}

Inversion

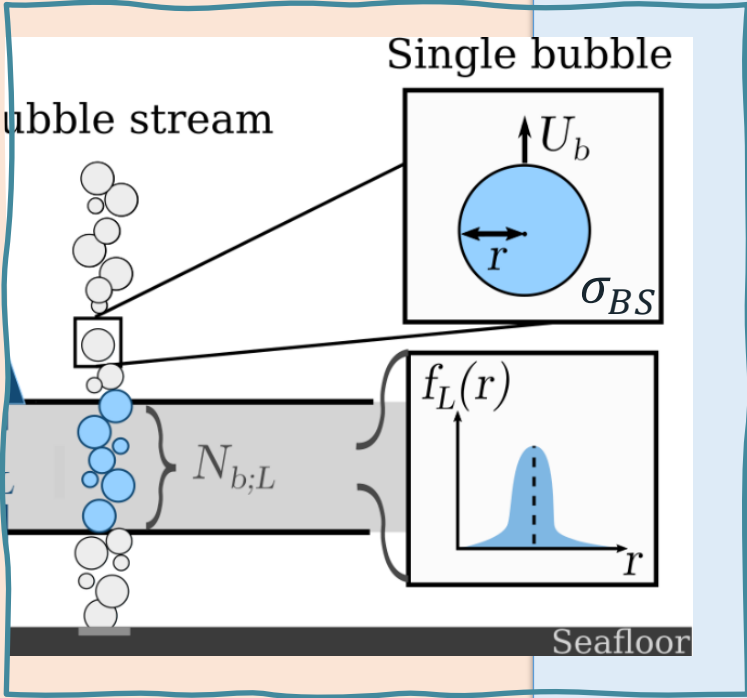
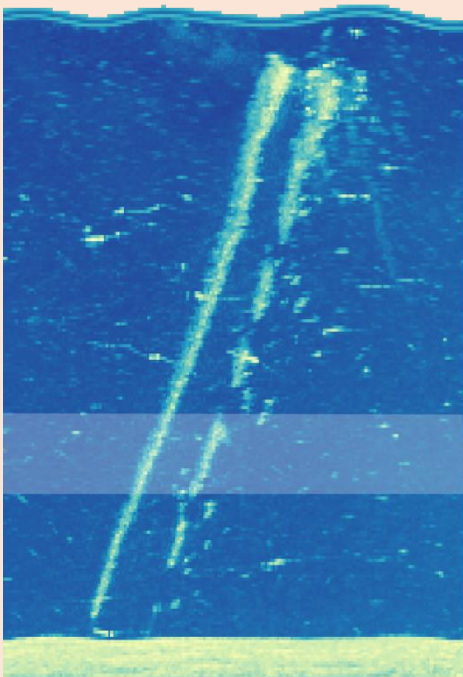


C_{Inv}

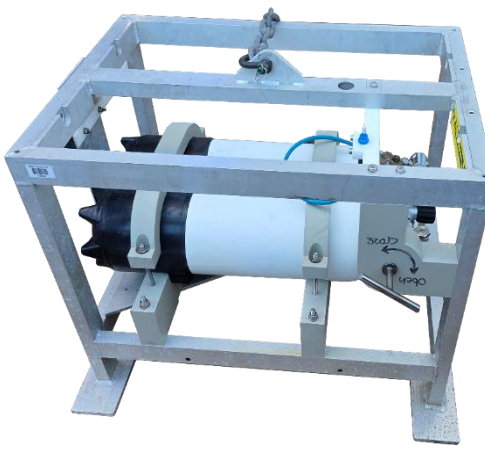
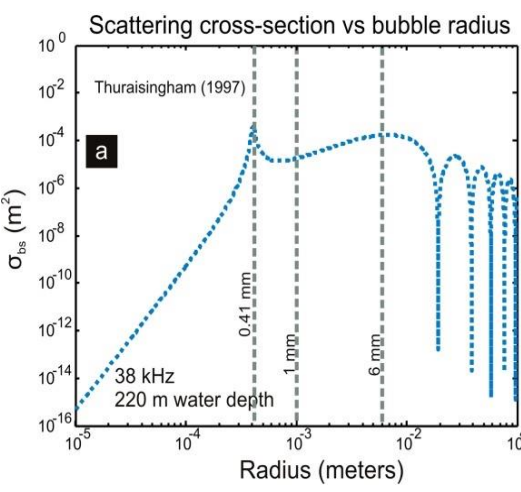
Gas flow

Inversion parameters:

- Frequency
- **Bubble sizes**
- Bubble shape
- Bubble dissolution
- ...



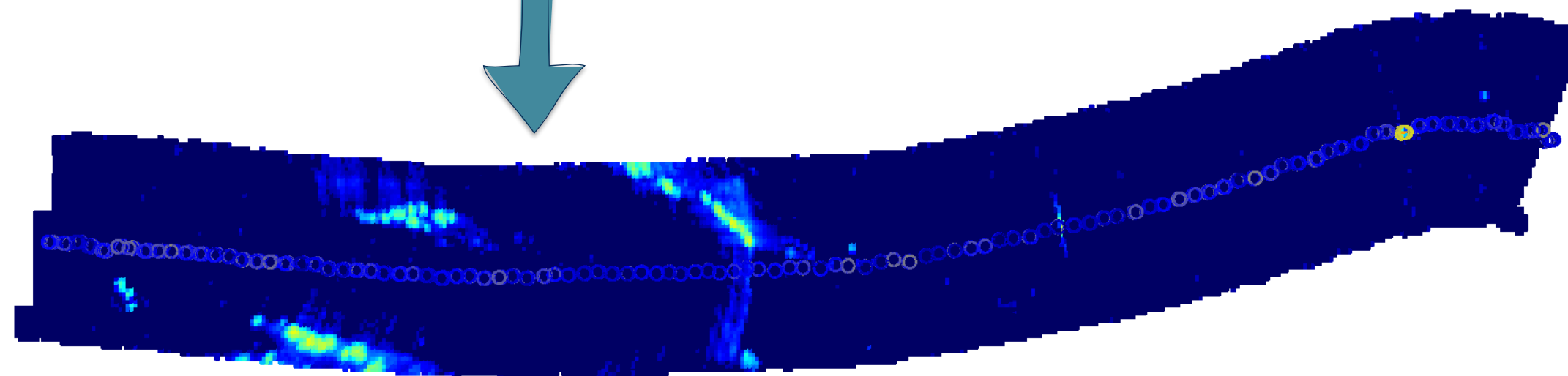
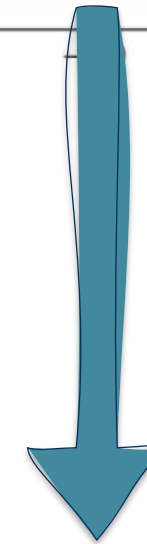
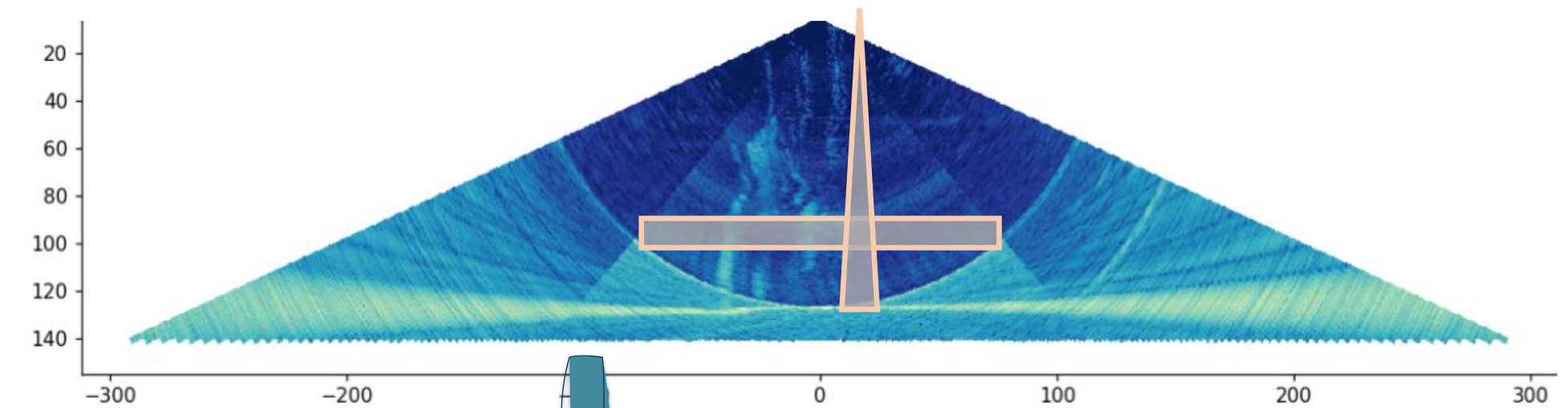
Modeling or Field calib.



WHY MBES



- SBES
 - Small ☺
 - Calibration ☺
 - Broadband ☺
 - Misses bubble streams ...
- MBES
 - Coverage! ☺
 - Availability ☺
 - Calibration?

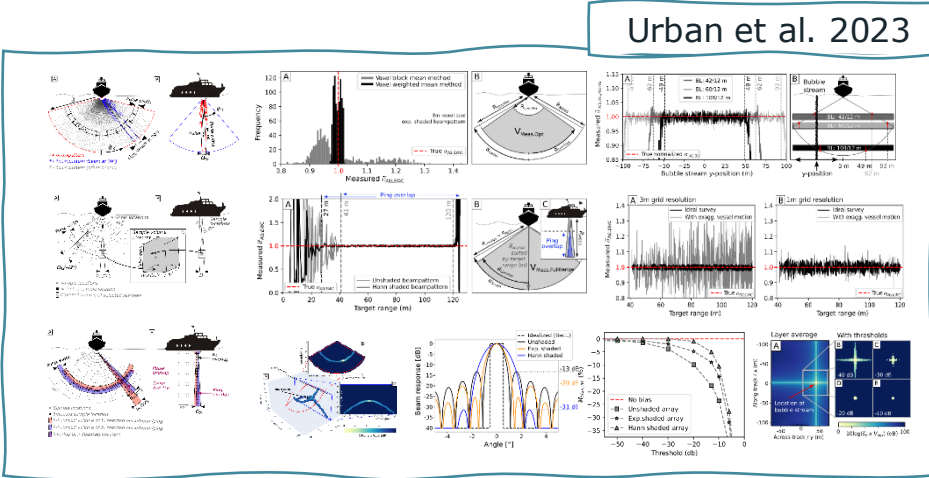
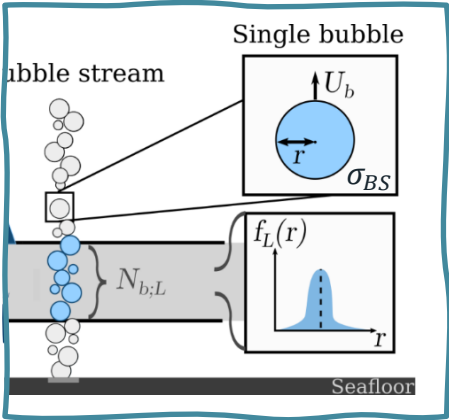
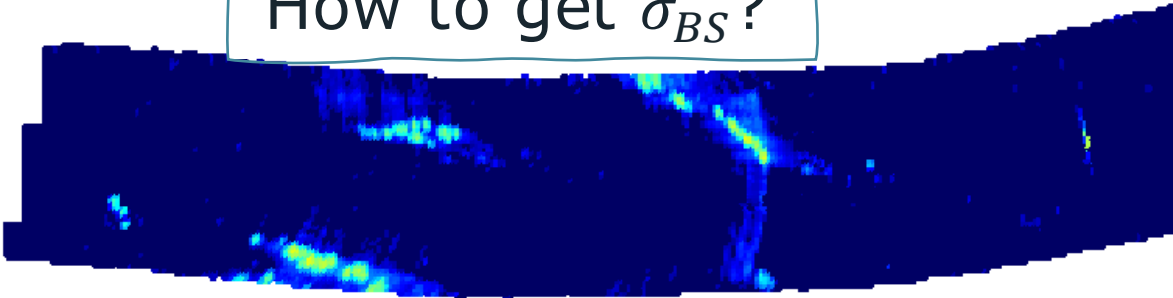


ECHO GRID INTEGRATION

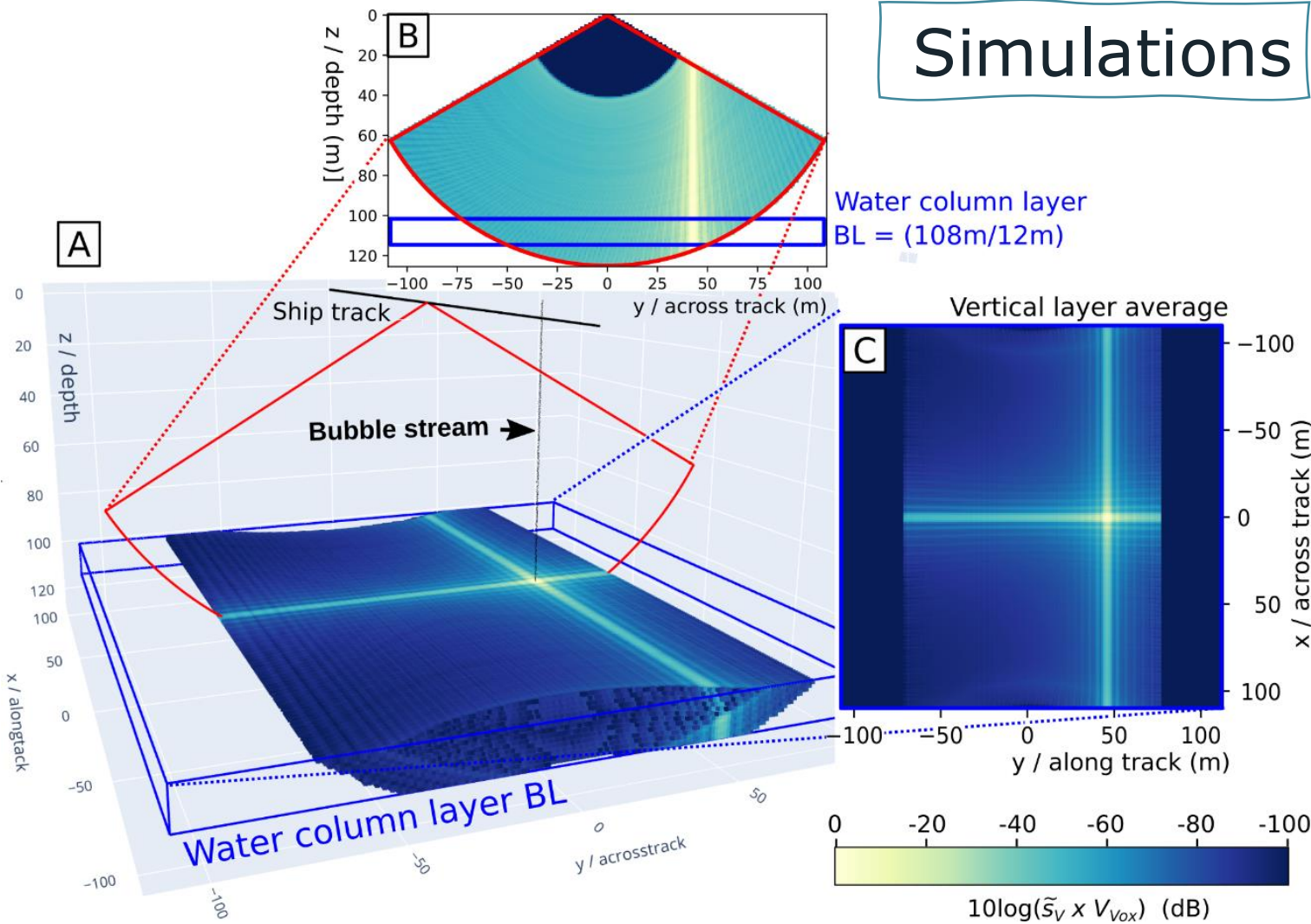


- MBES based quantification
 - Theoretical foundation published 2023
 - Sum over echo grid
 - **Validated using simulation**

How to get σ_{BS} ?



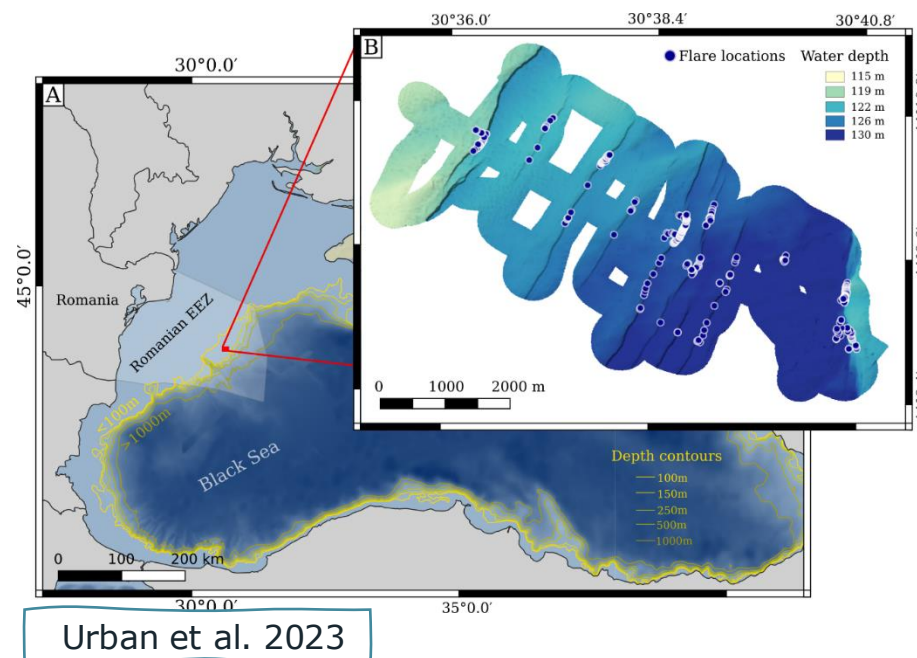
Simulations



Can a real MBES measure this?

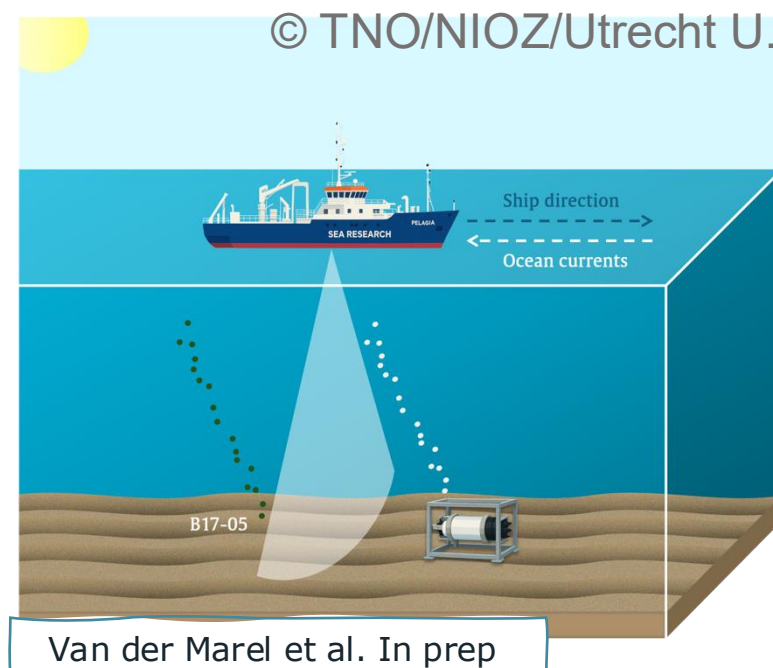
Verification experiments

TWO EXPERIMENTS



1: R/V Meteor, 2017 (Published 2025)

- Black sea shelf, 120m water depth
- Kongsberg EM710
- Calibrate against Simrad EK80 ES38



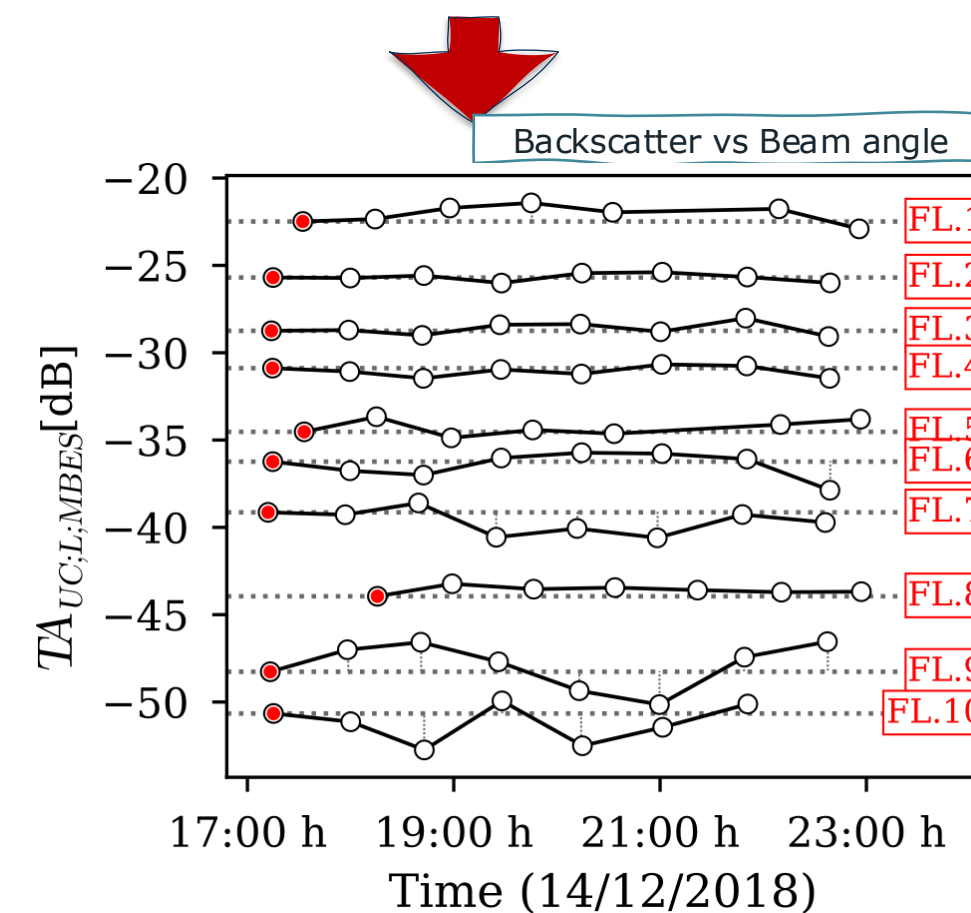
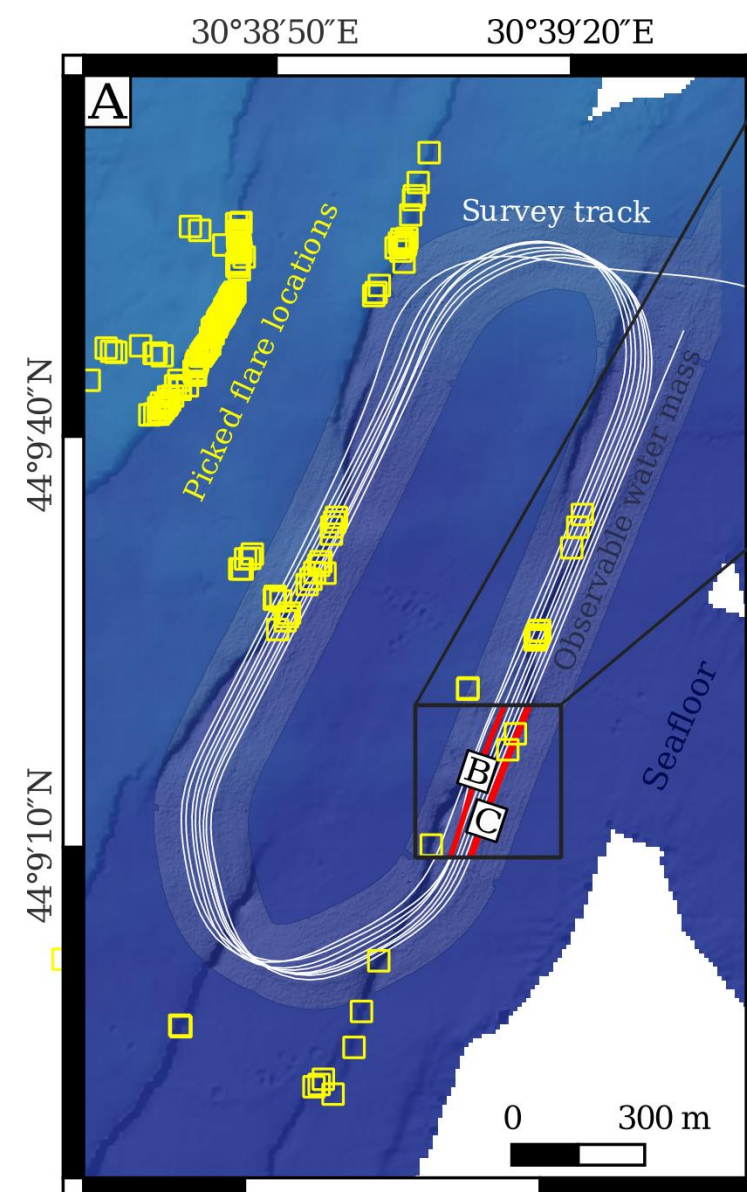
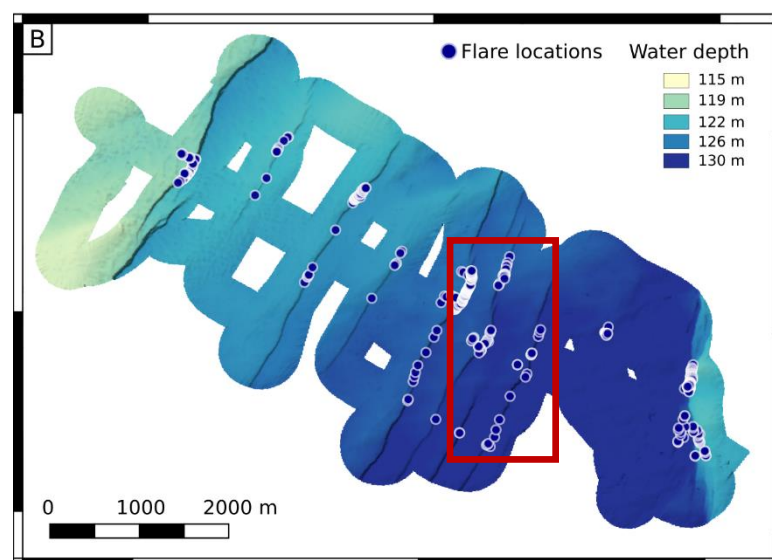
2: R/V Pelagia, 2025

- North sea, 25m water depth
- Kongsberg EM2040
- Calibrate against synthetic bubble source

MEASUREMENT CONSISTENCY



- Are measurements repeatable?
 - Over time ☺
 - Over beam angle ☺

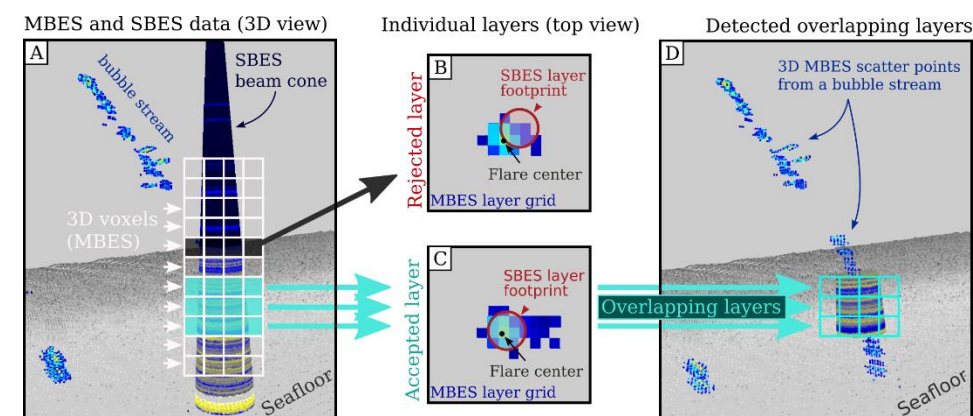
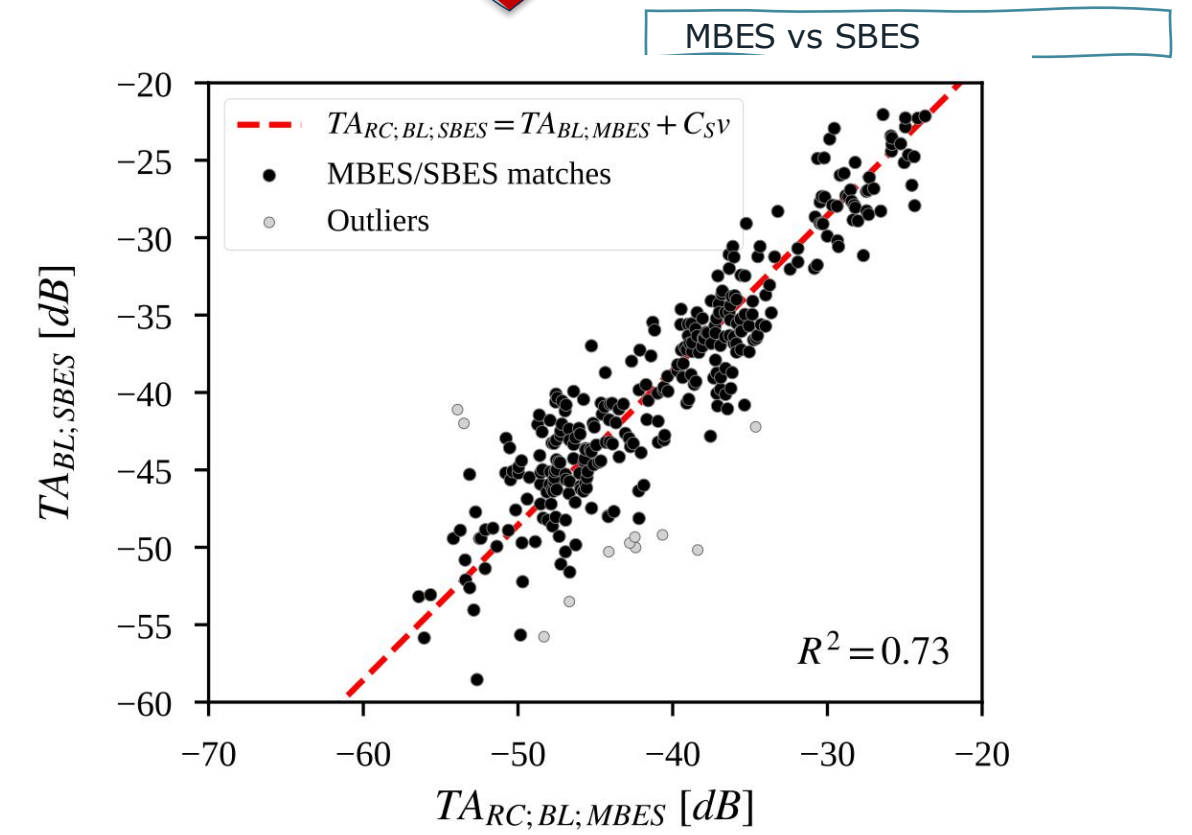
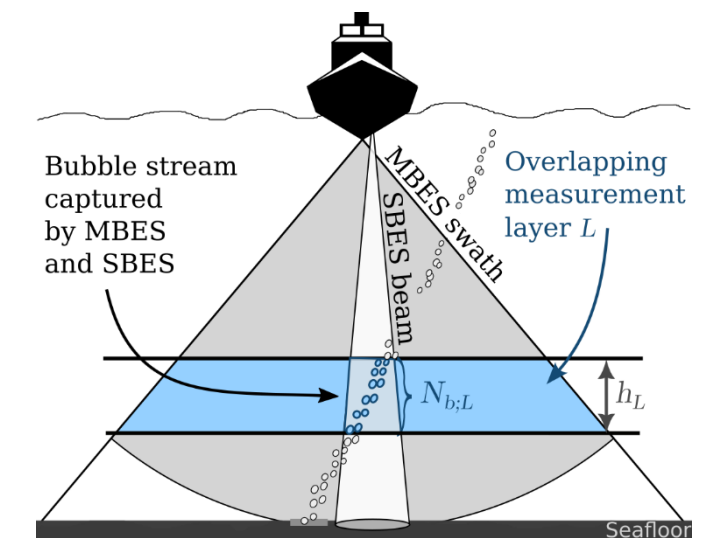
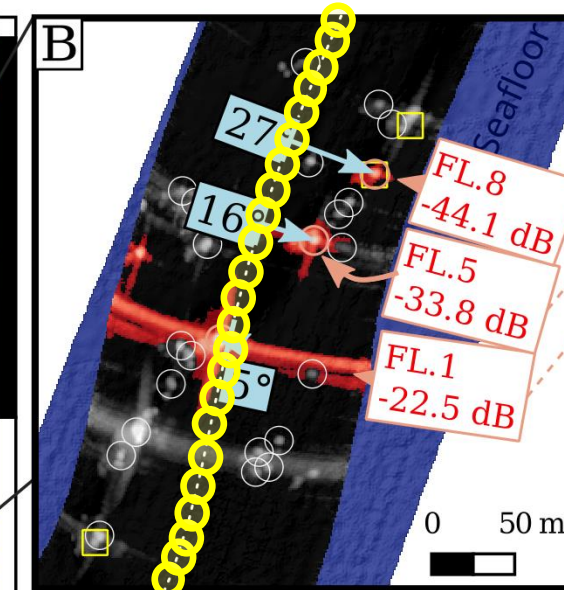
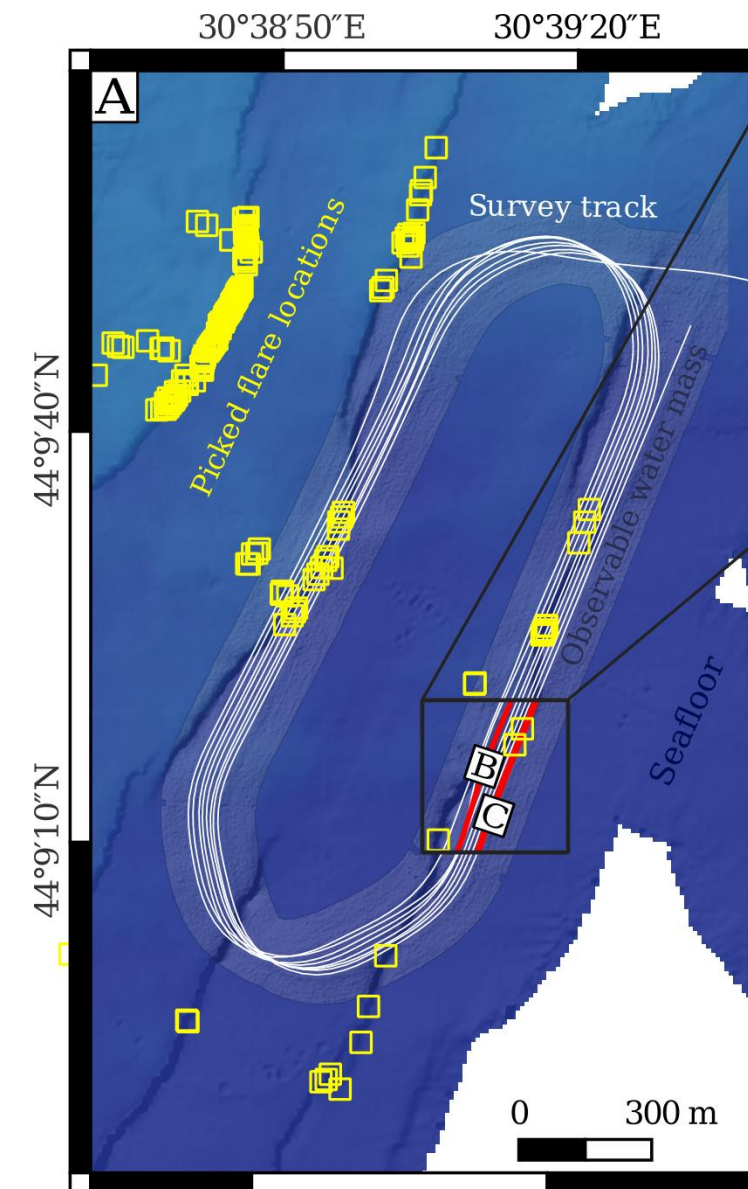


Verification experiments

VS SBES

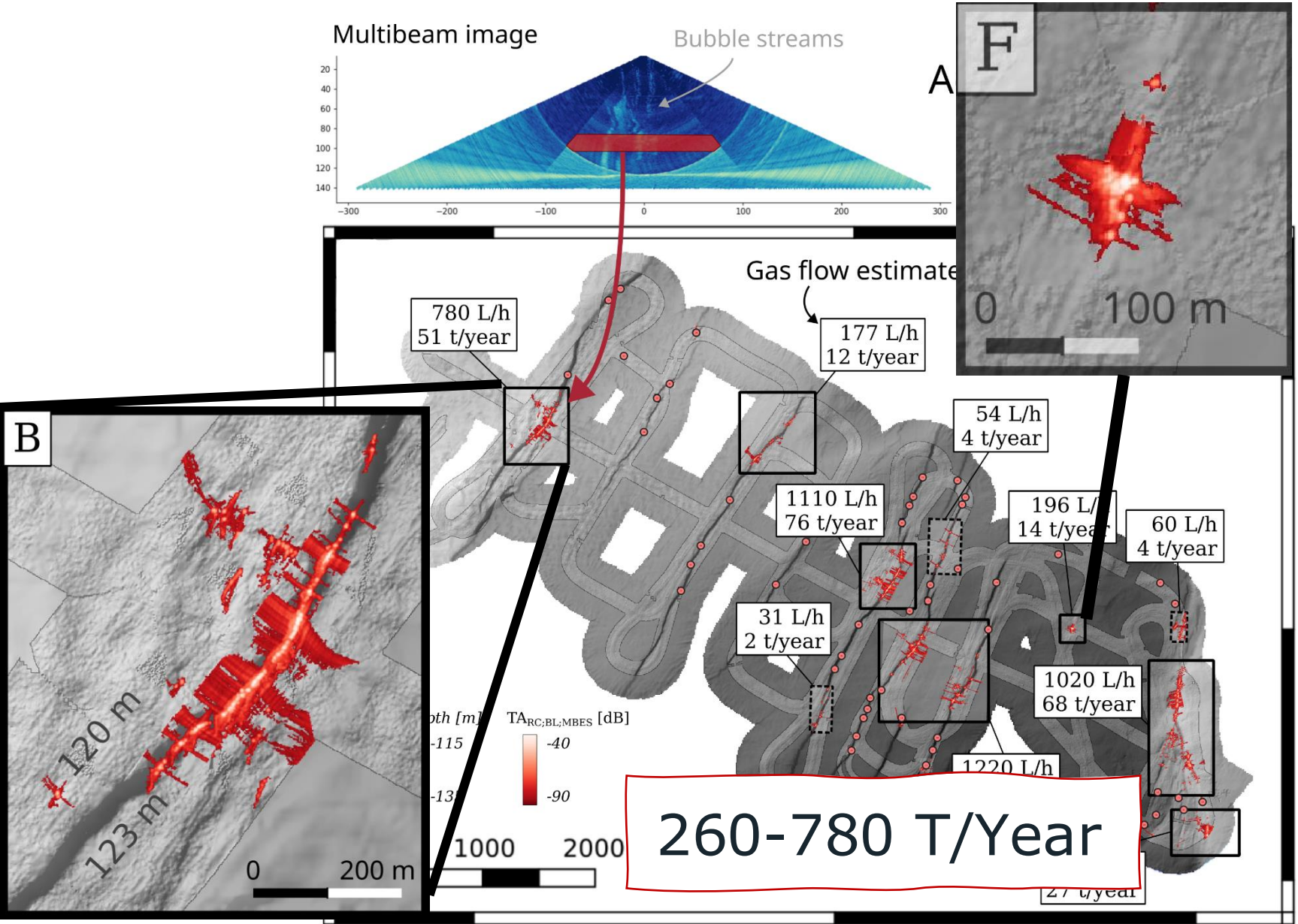
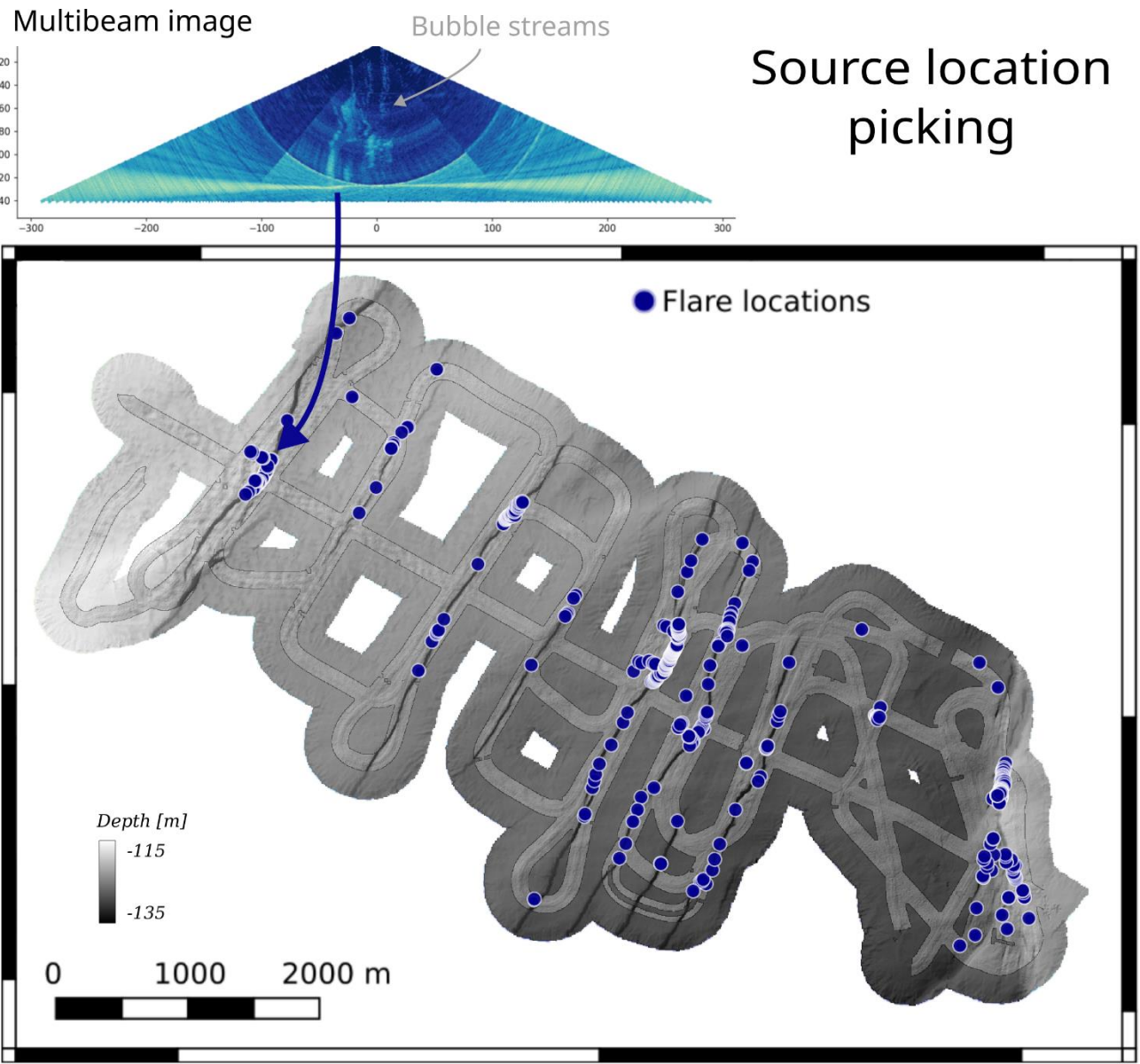
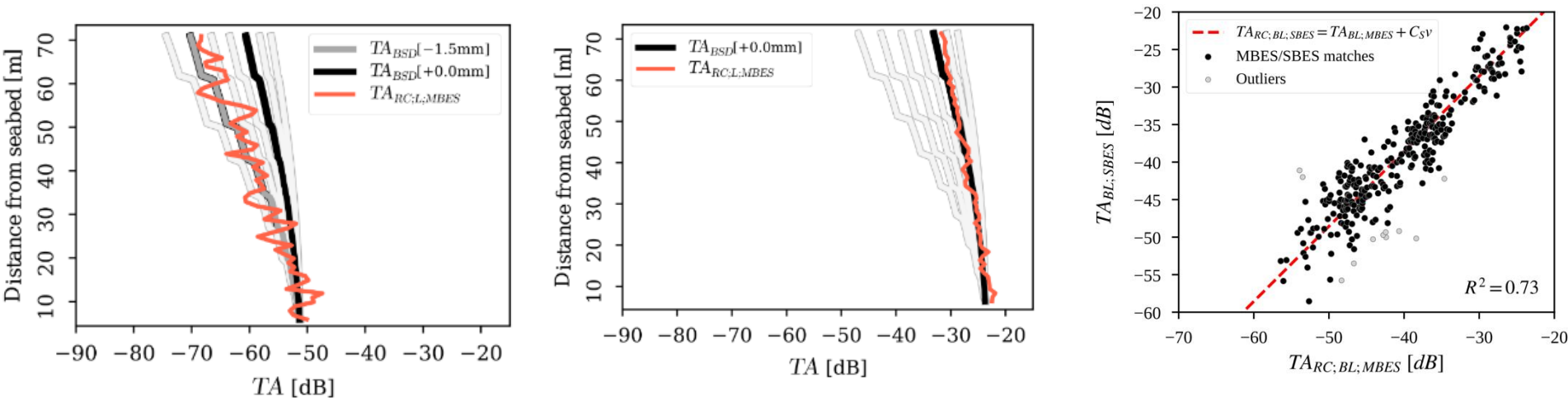


- MBES vs SBES?
- Same quality ☺
- Sees more ☺
- Can be cross-calibrated ☺



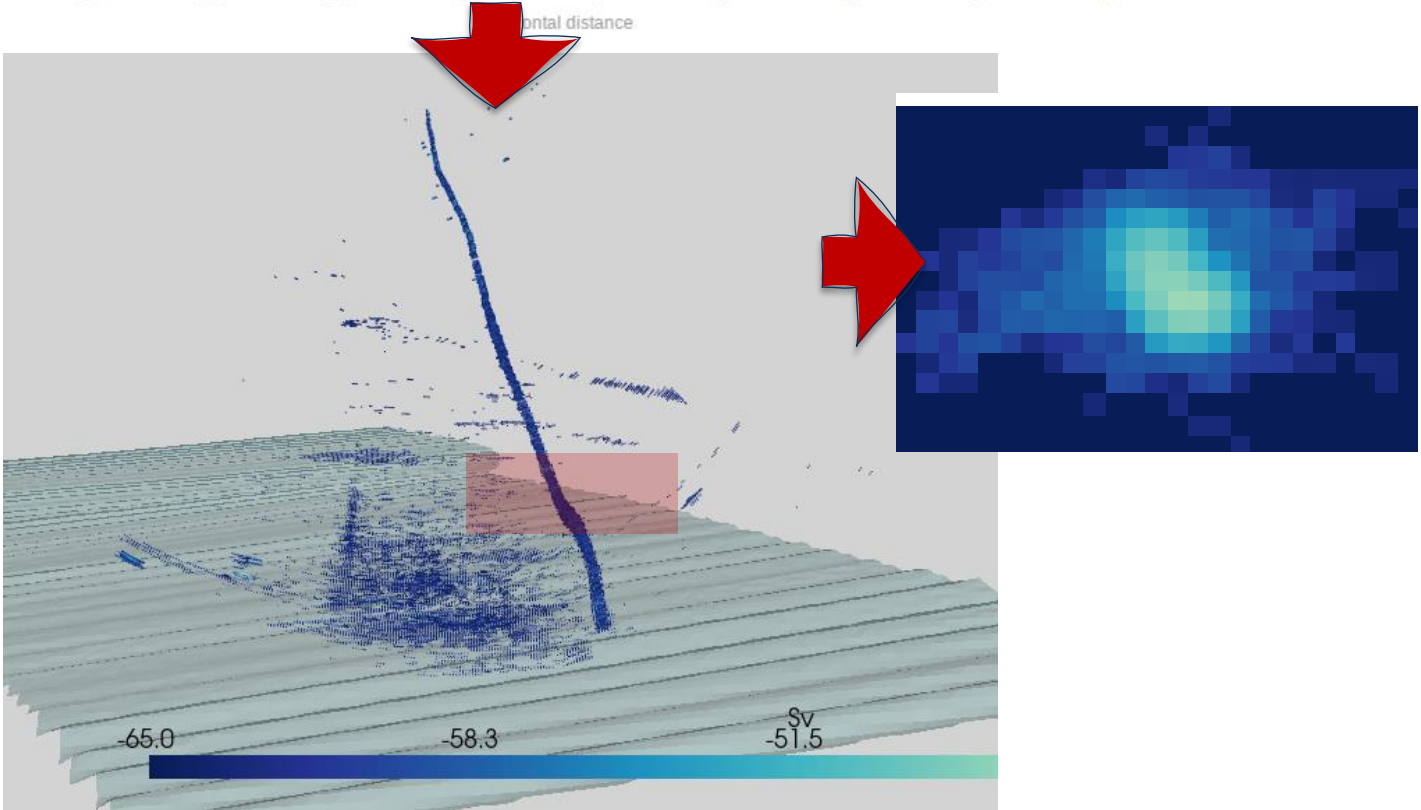
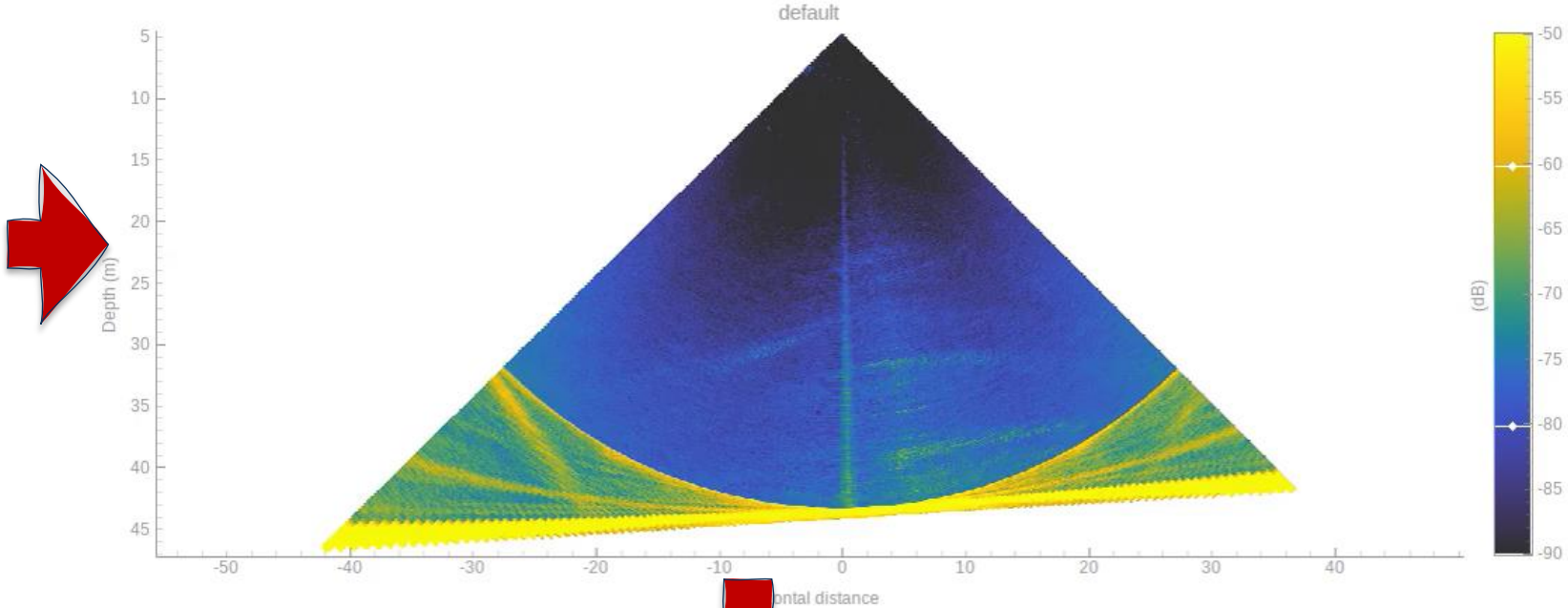
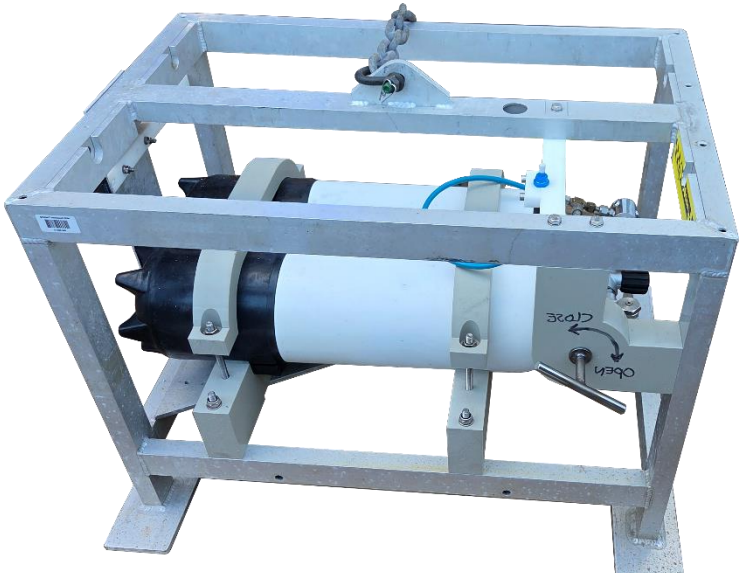
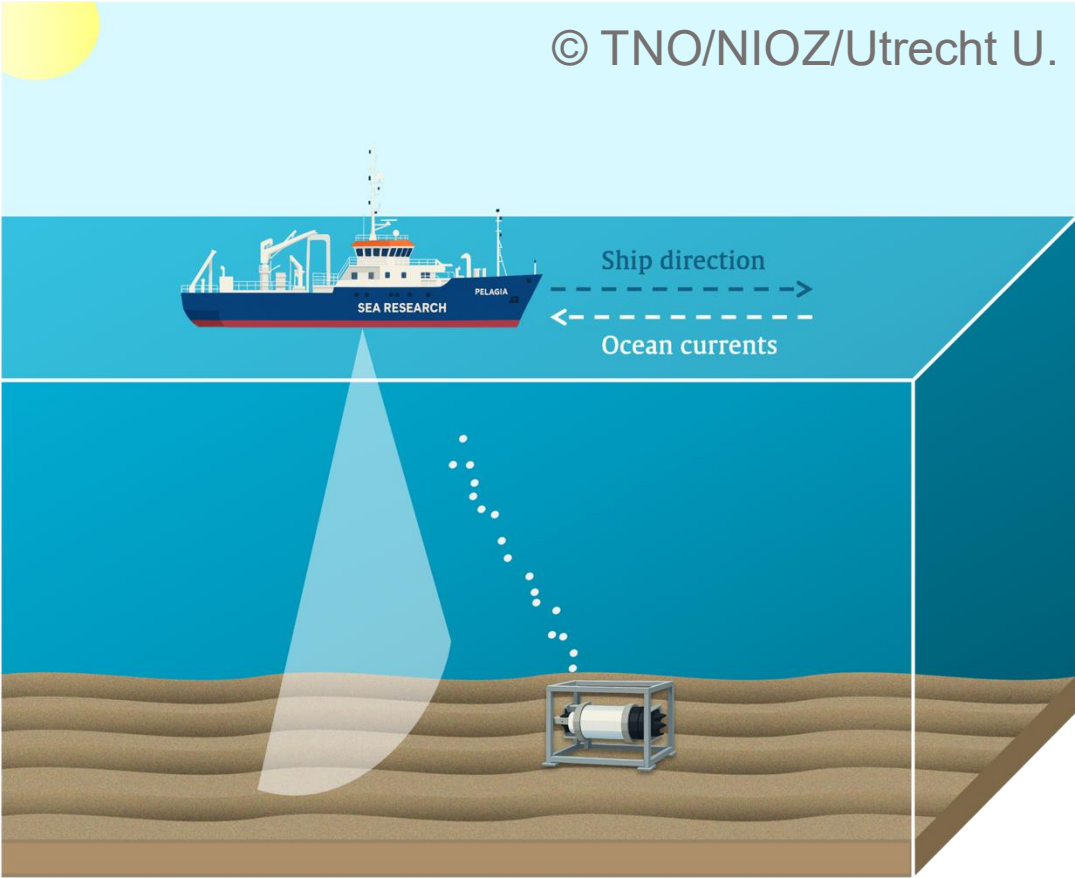
Verification experiments

QUANTIFICATION RESULTS



Verification experiments

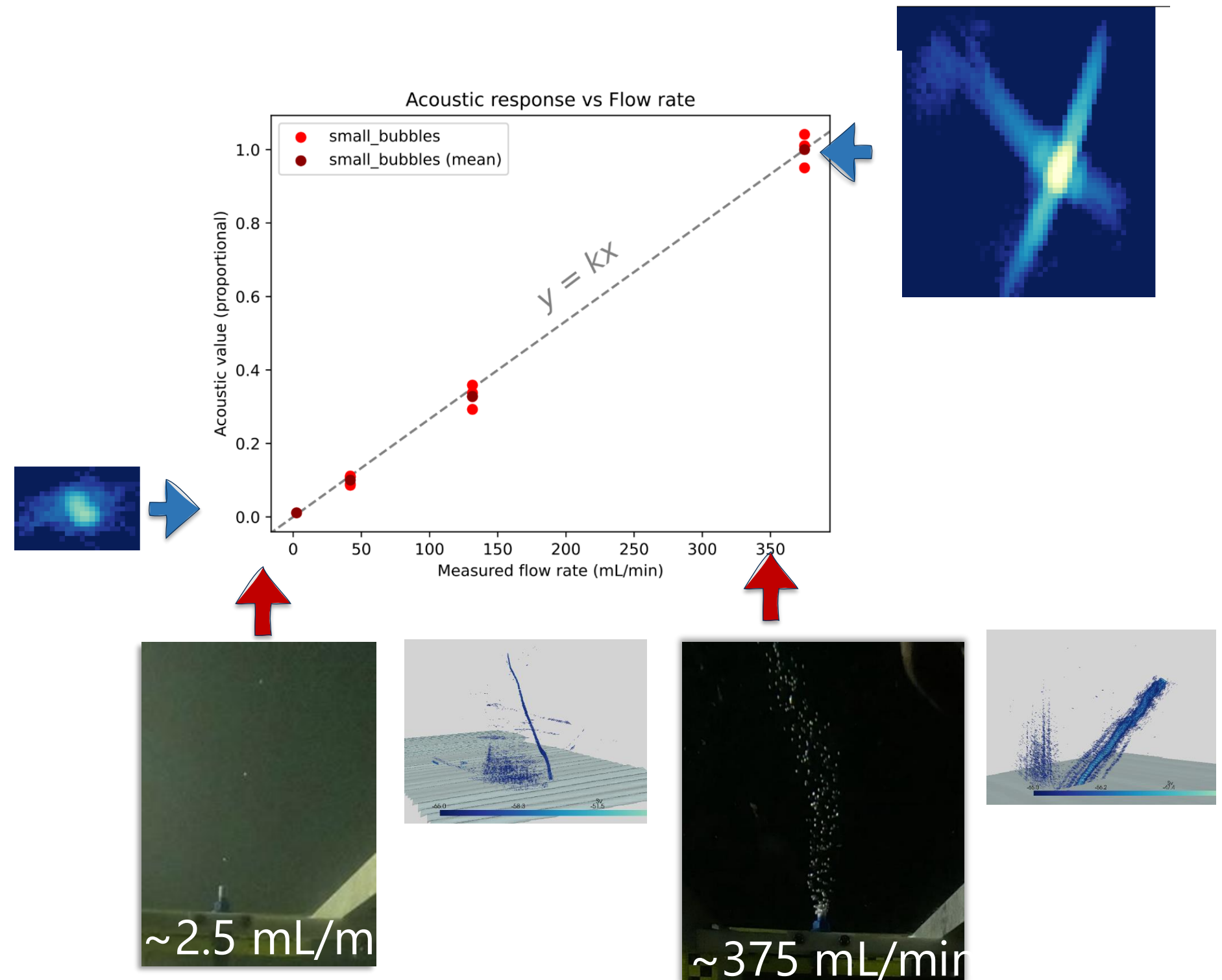
VS SYNTHETIC SOURCE



AGAINST SYNTHETIC SOURCE



- MBES results
 - Directly proportional 😊
 - Less variation than against SBES 😊
 - Bubble sizes 😊



Verification experiments

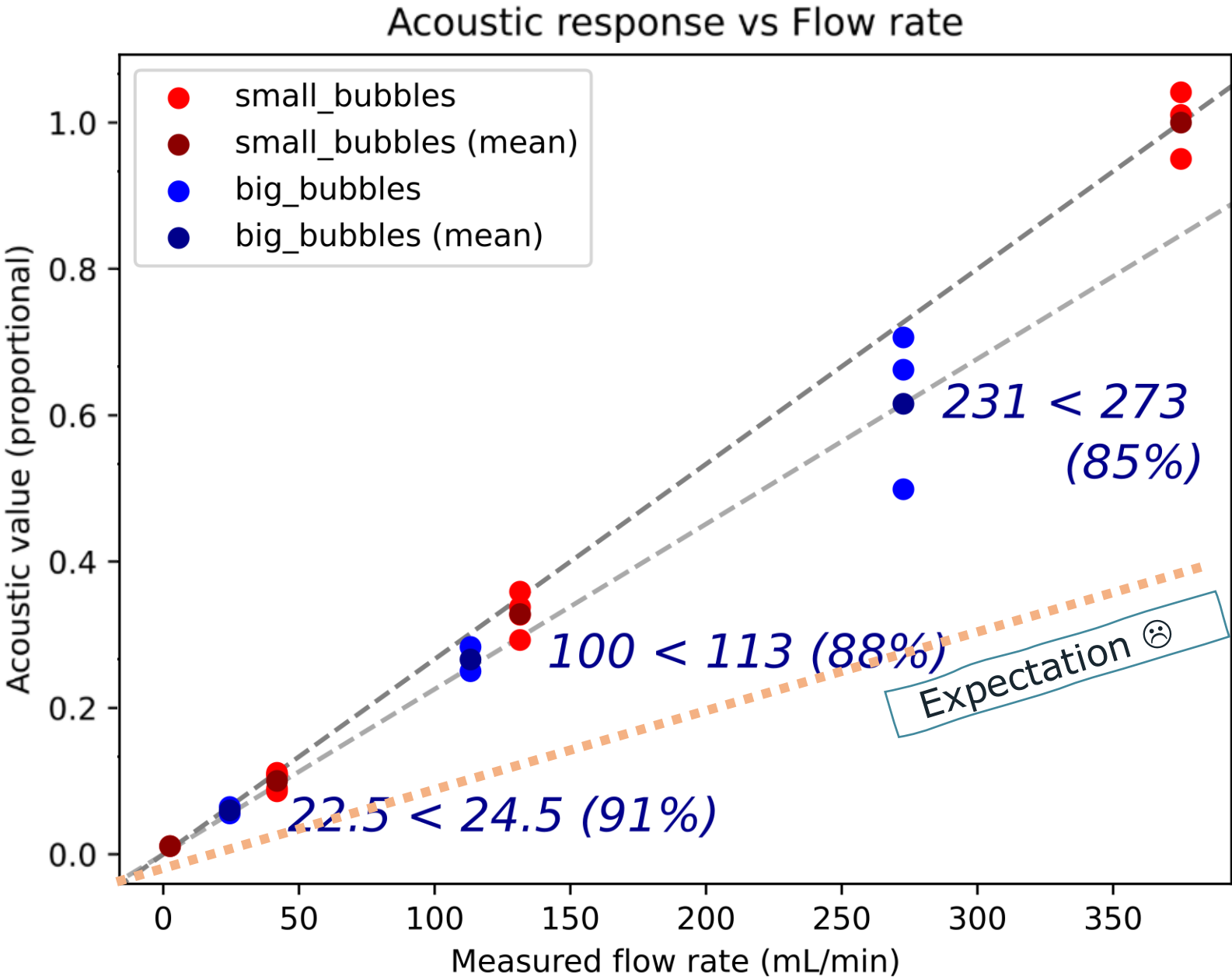
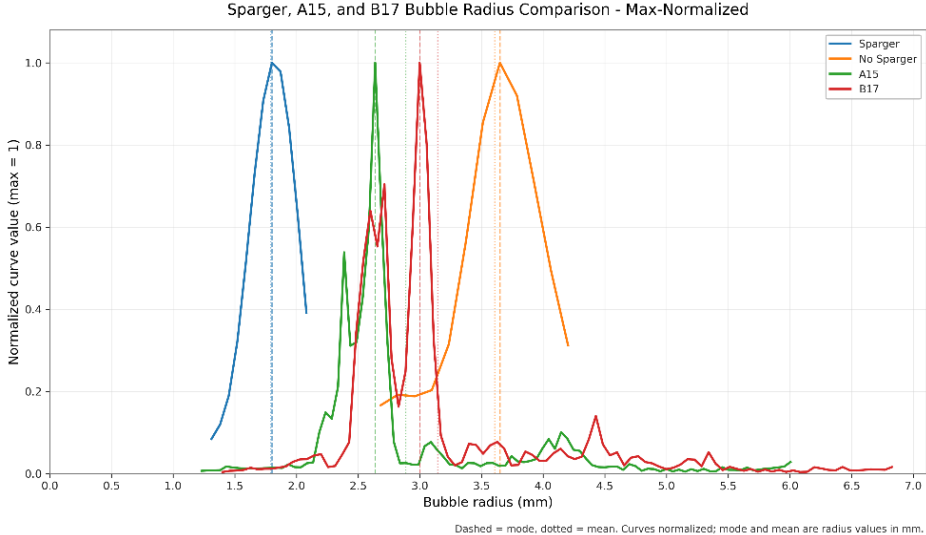
BUBBLE SIZES



Sparger
(small bubbles)



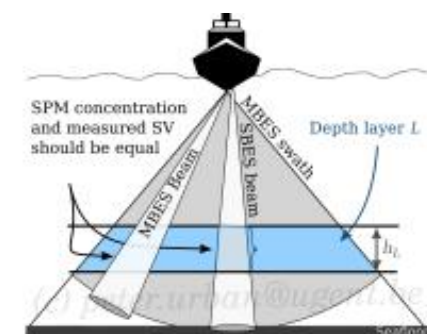
No sparger
(large bubbles)



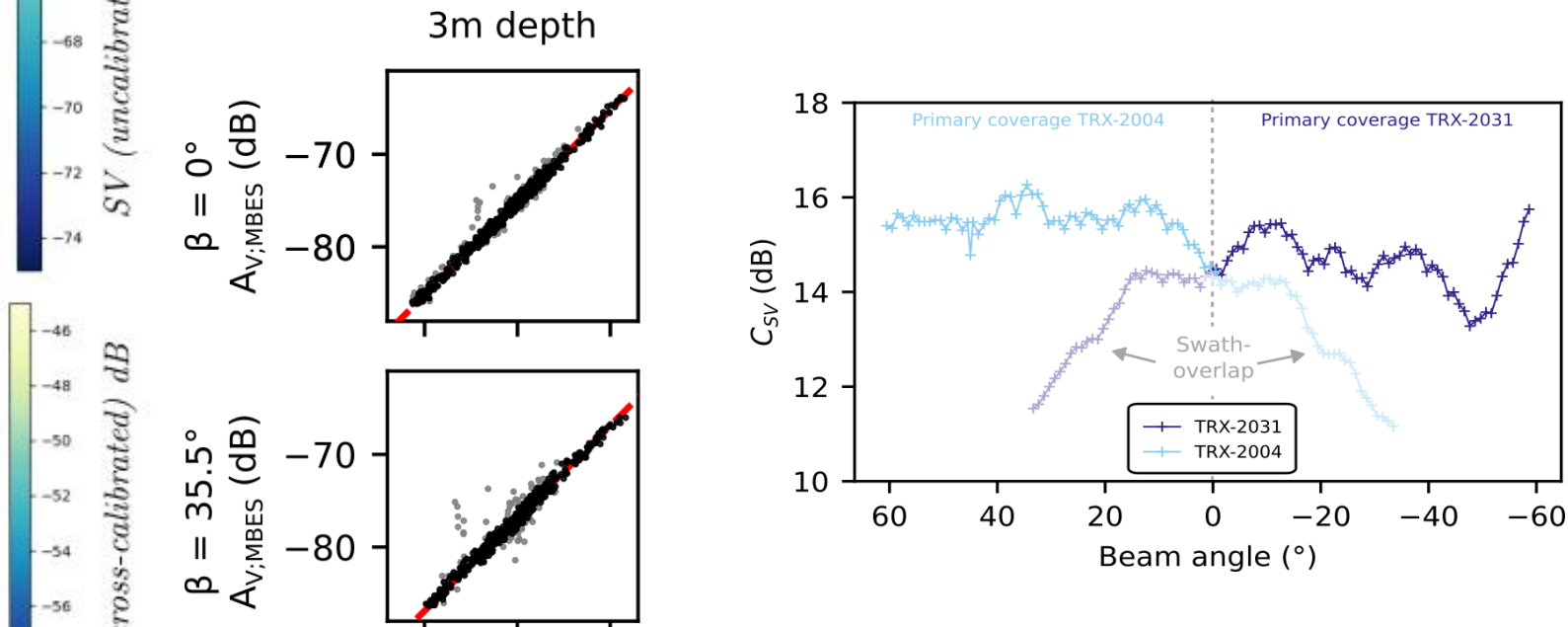
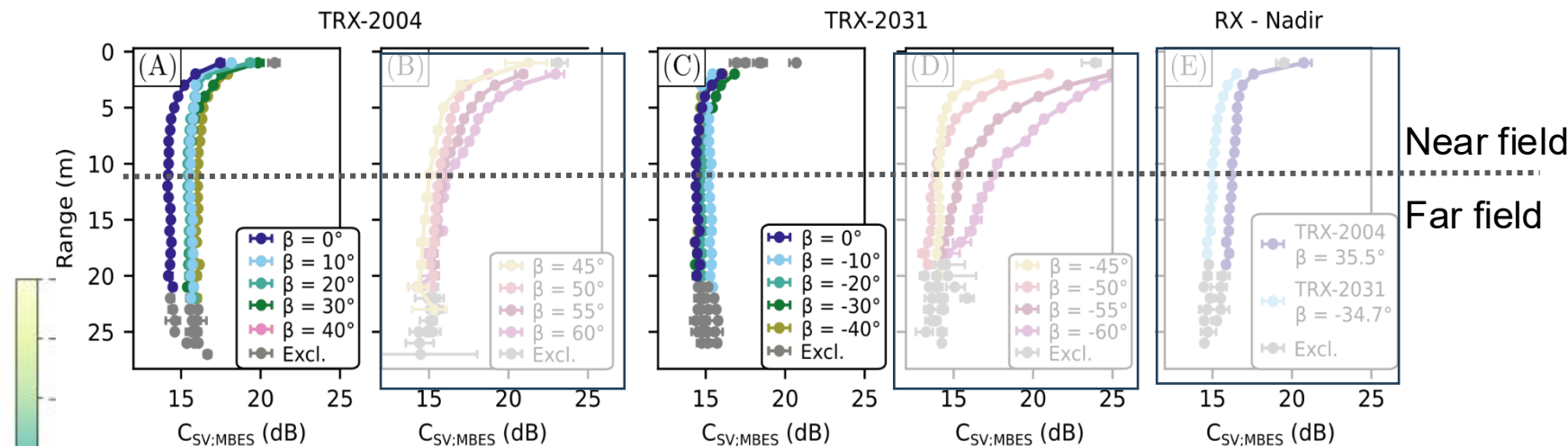
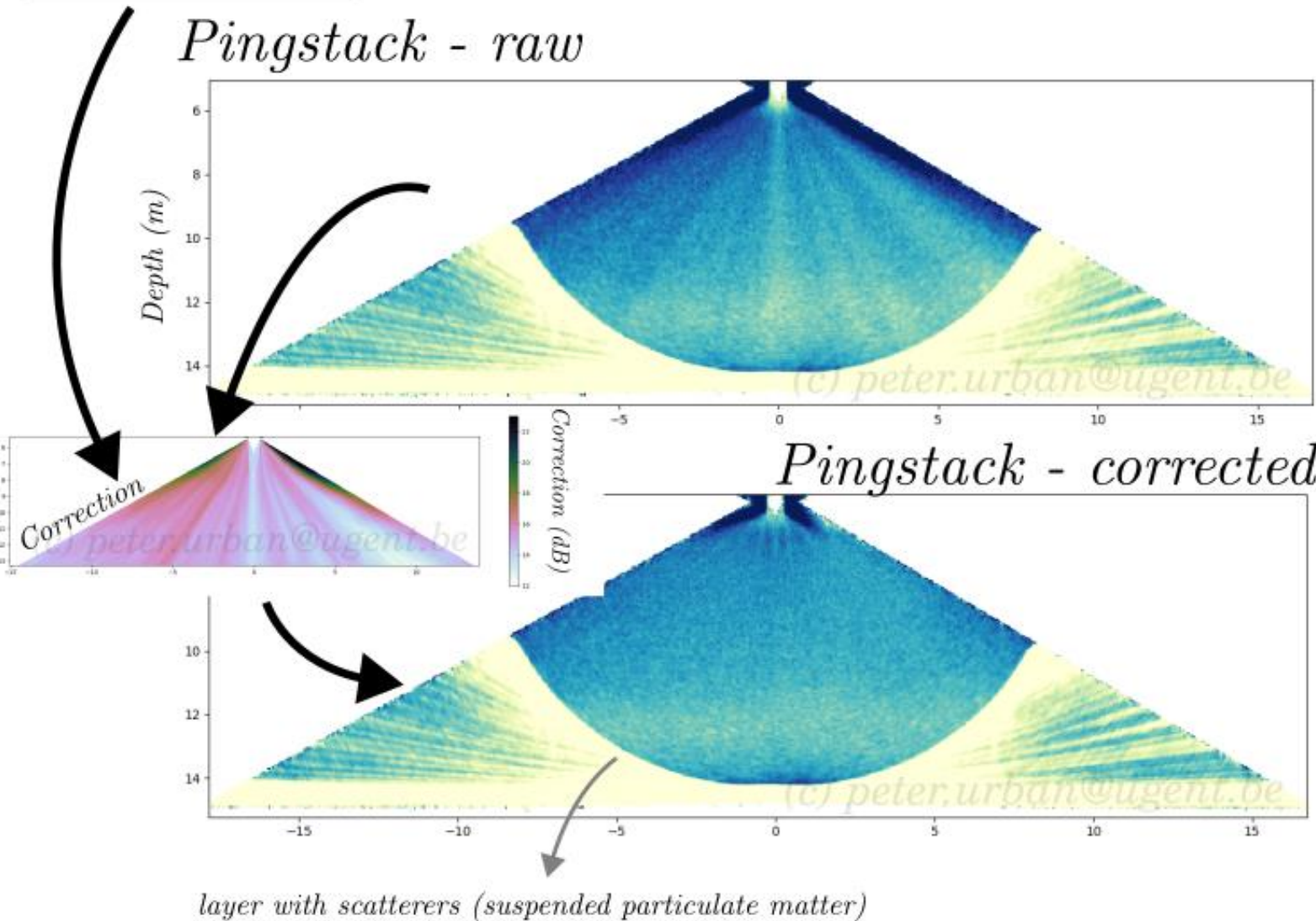
Lessons learned and outlook

Summary and lessons learned

MBESS ARE QUANTITATIVE DEVICES



Beam and nearfield correction

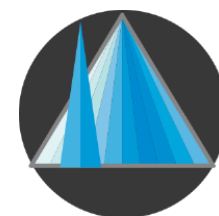
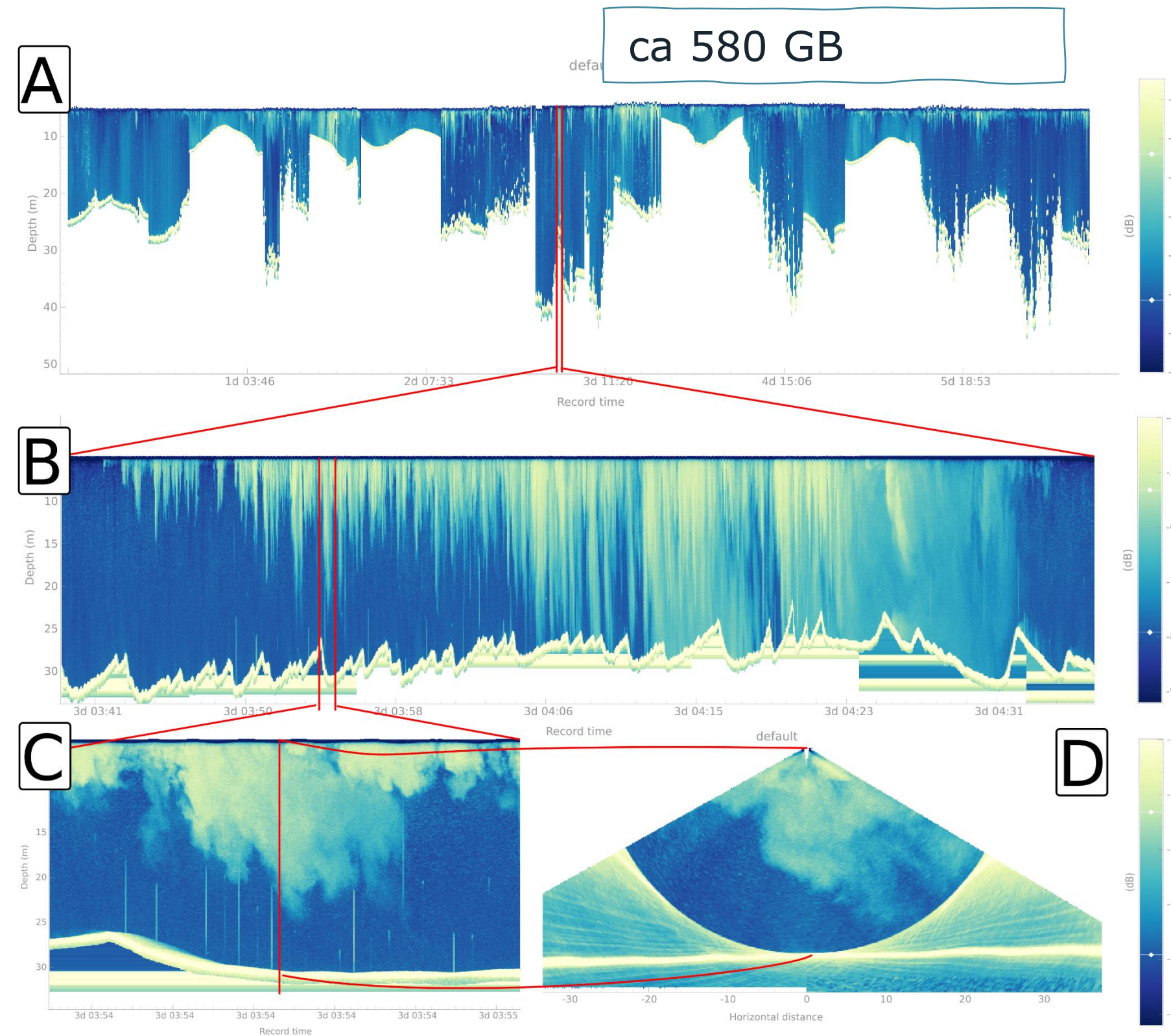


Summary and lessons learned

DATA SIZE?



- Adapt to your task:
 - Correct / appropriate ping rate
 - When to record what in which settings
 - Lossy compression
- Processing strategy
 - Workflow / tooling!
 - [Github.com/themachinethatgoesping](https://github.com/themachinethatgoesping)

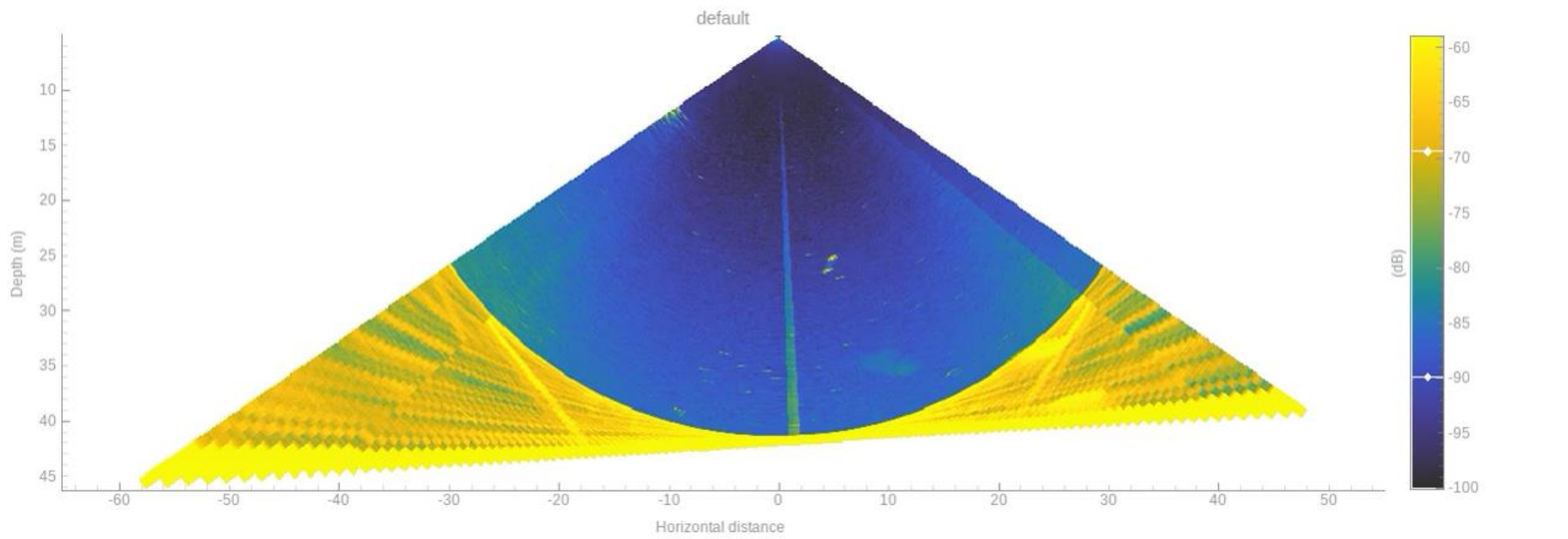
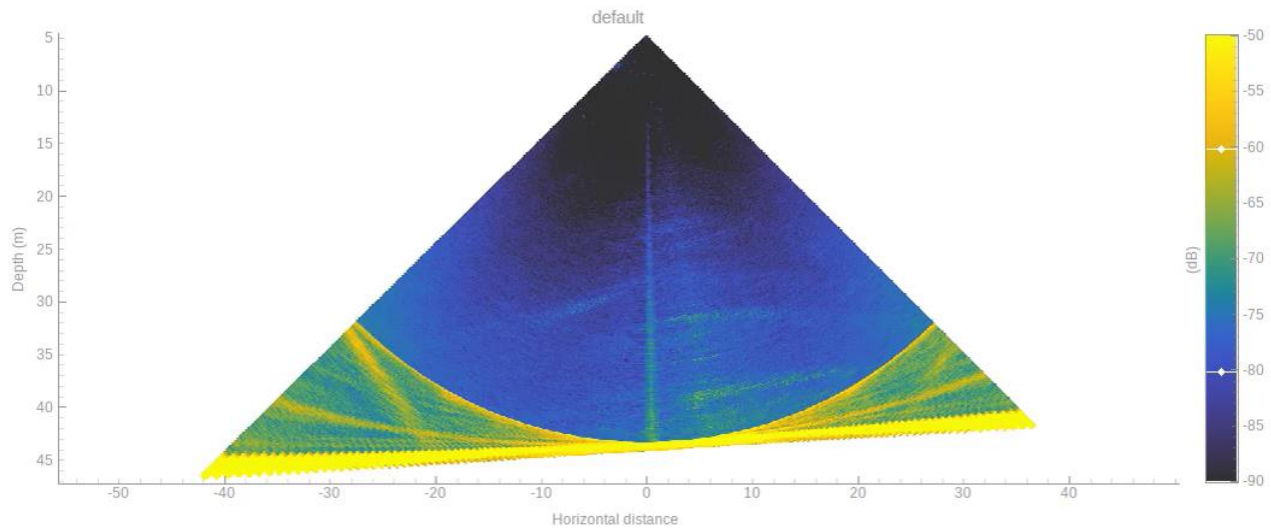
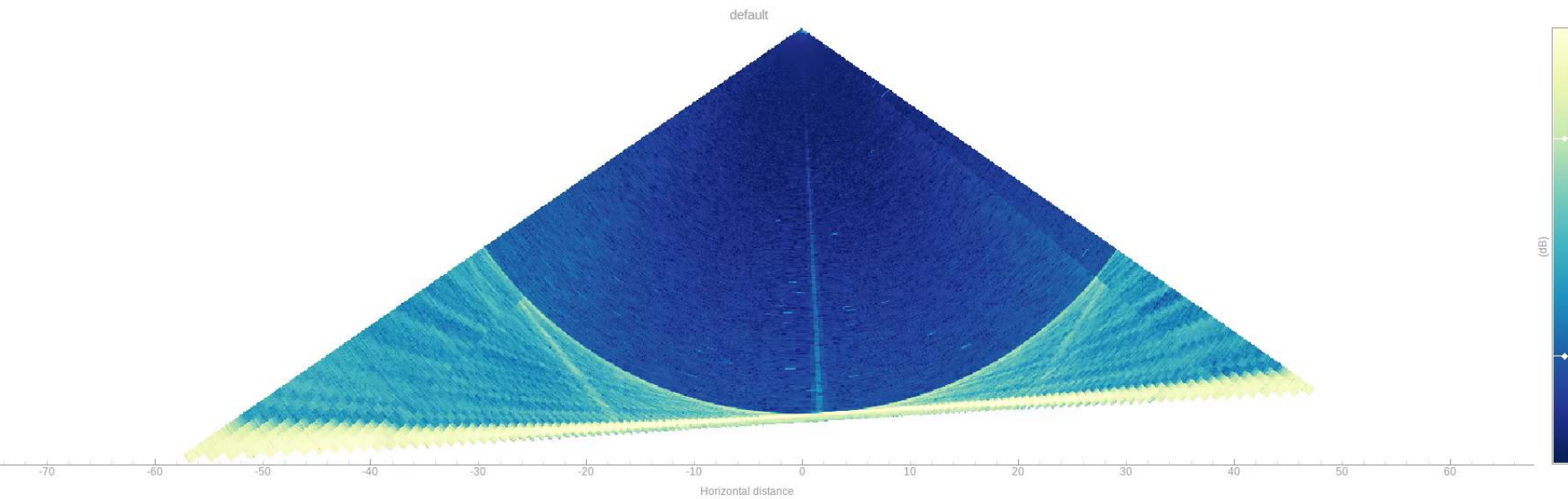
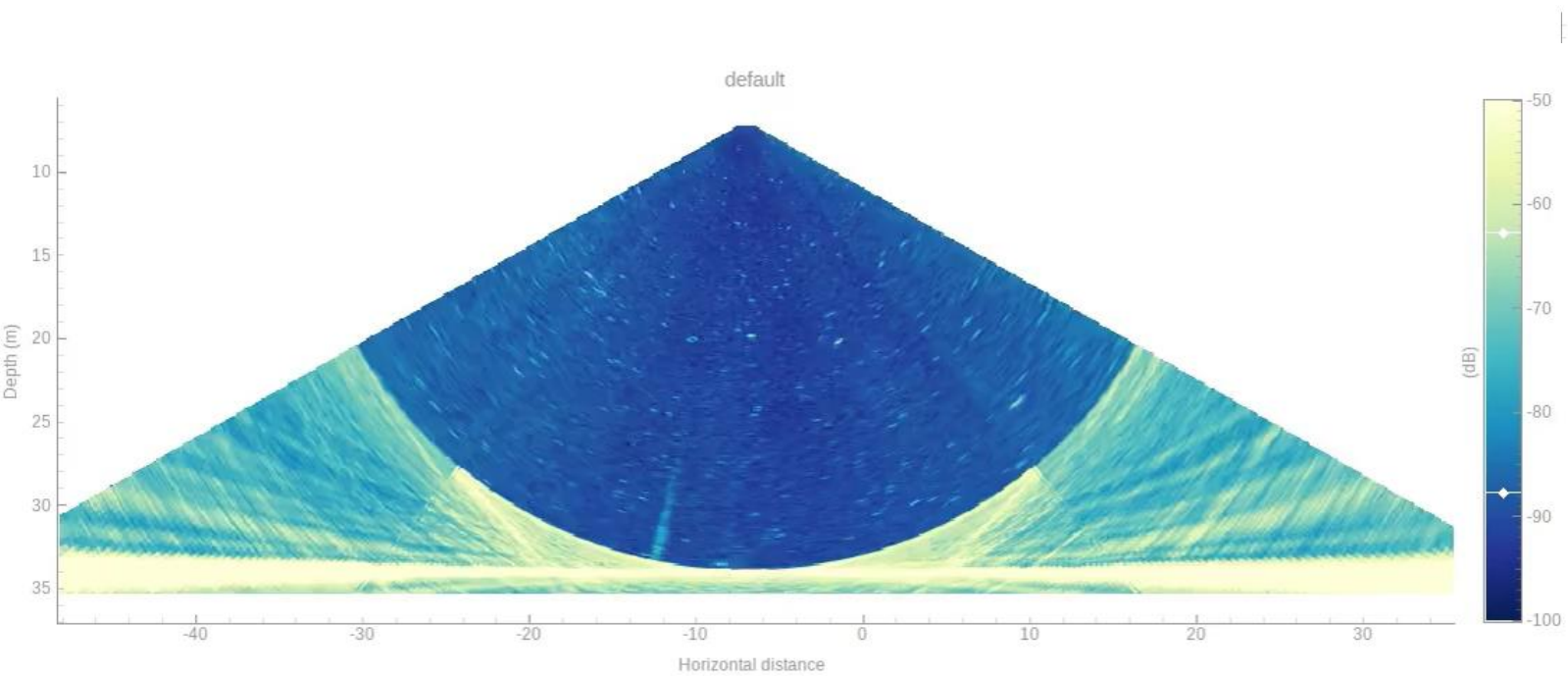
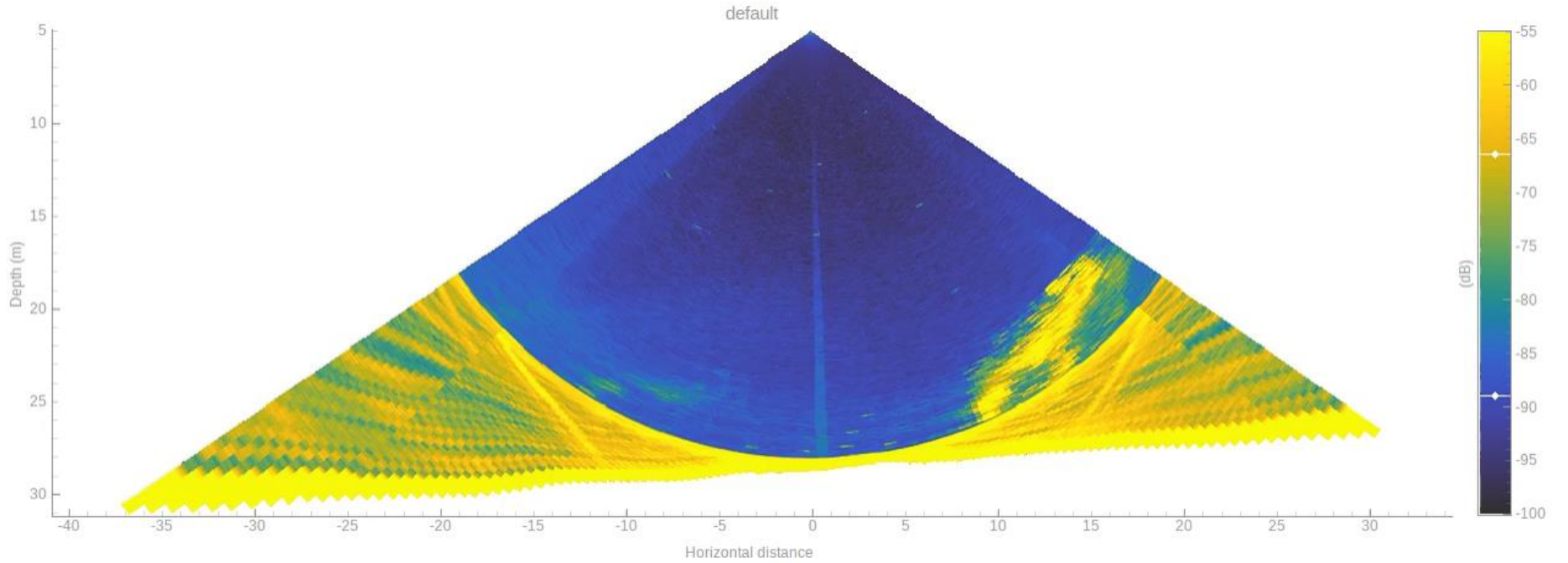


TURBEAMS



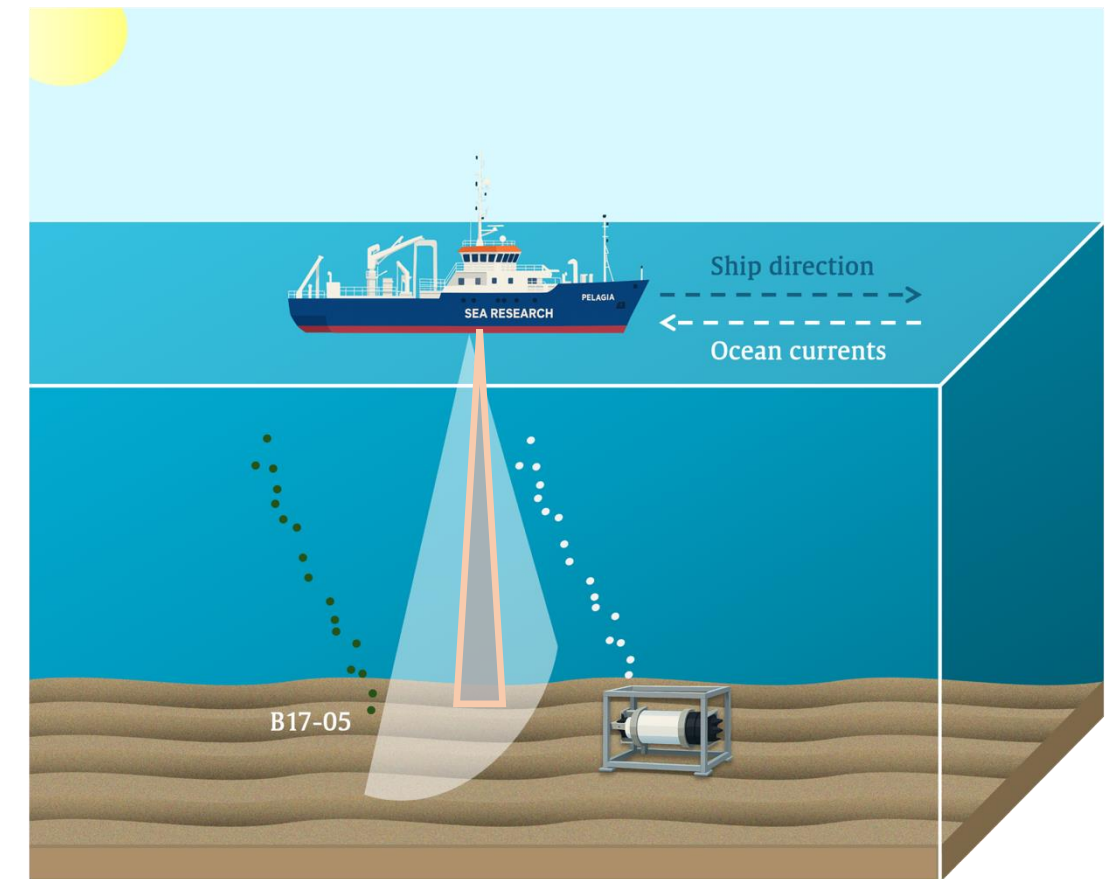
Summary and lessons learned

DETECTION LIMITS



Summary and lessons learned

MBES WORKFLOW



Calibrate against e.g.
synthetic bubble source

High effort ☹️

MBES survey planning
• Parallel lines, ping density,
overlap adapted to depth

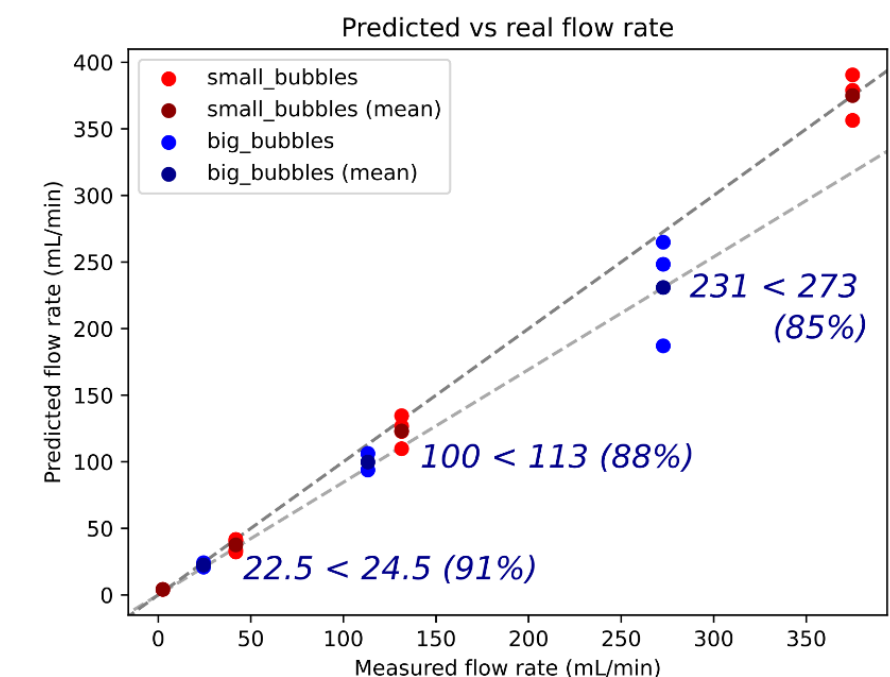
Robust 😊

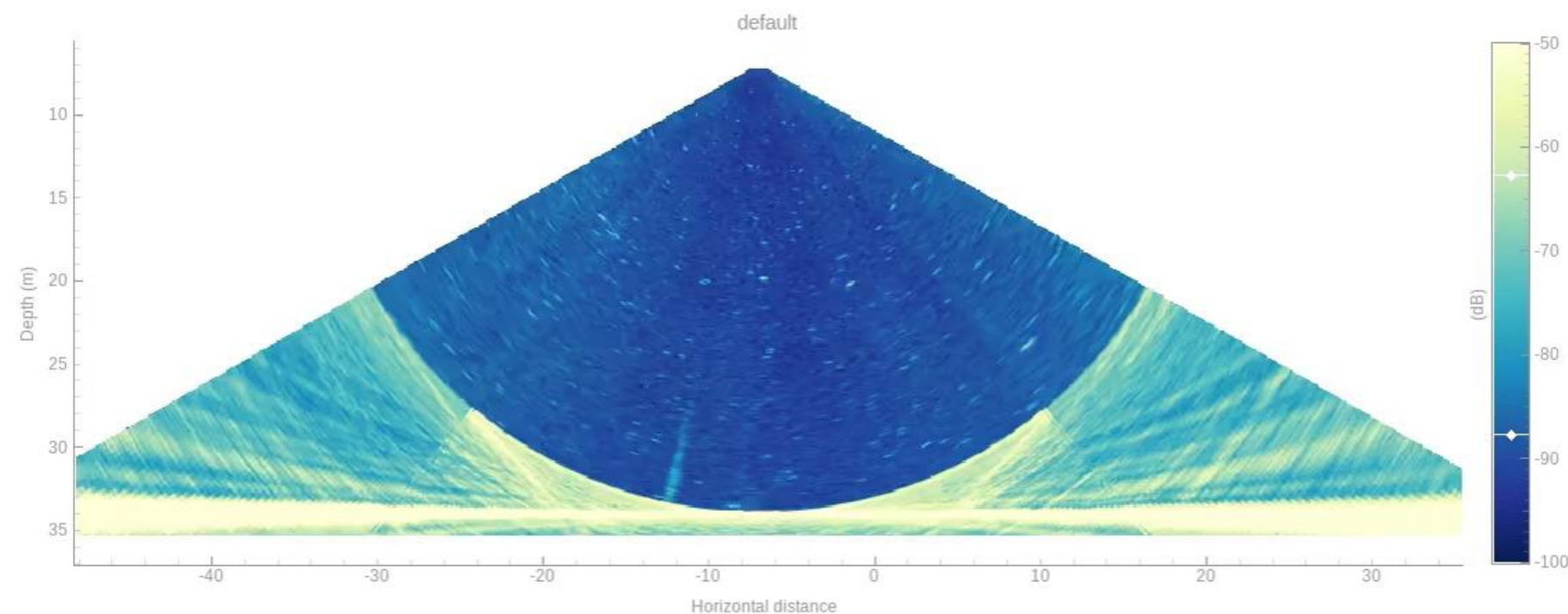
MBES detection
• Are a measurement

Low effort 😊

Repeated surveying
• Only to generate time series

Decrease uncertainties 😊





THANK YOU!

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