

Quantifying gas bubble seepage, using multibeam echosounders

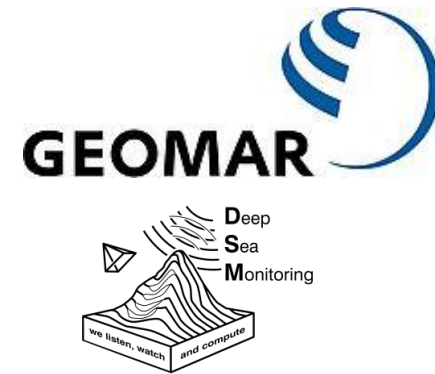
A scalable workflow for monitoring

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Gert-Jan Reichart^{3,6}, Jens Greinert⁵, and Thomas Hermans¹

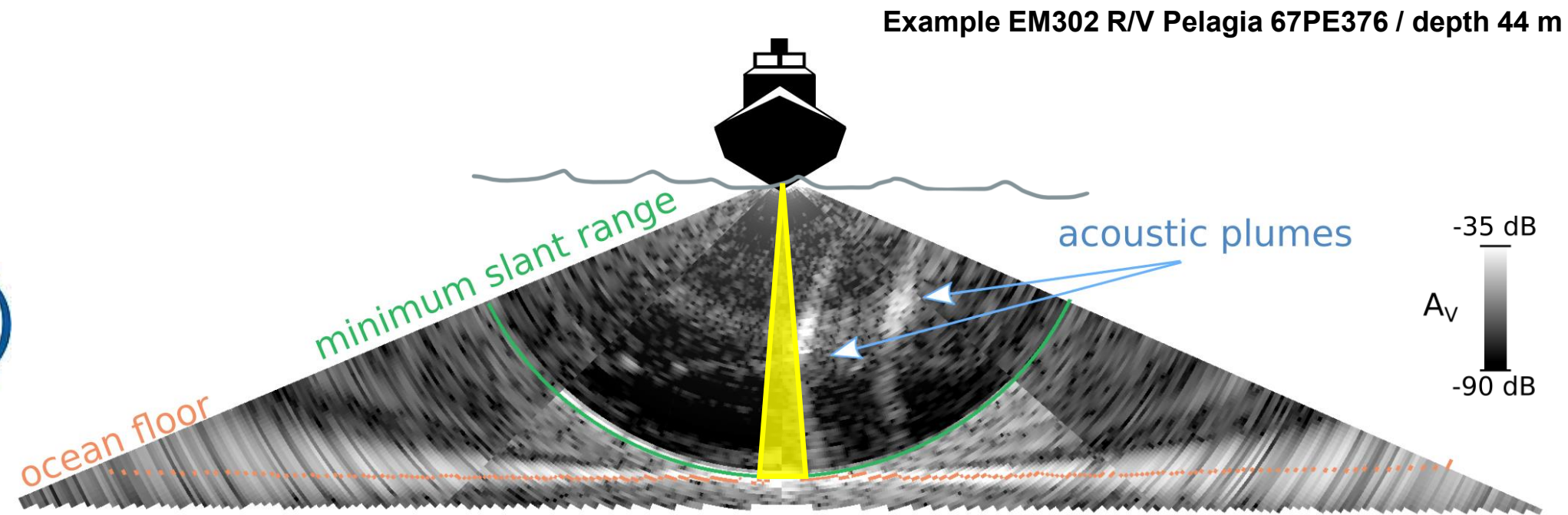
INTRODUCTION

MBES quantification workflow:

- 2013-2021 main work
- 2023-2025 last workflow publications
- Last Thursday: experimental validation



Utrecht University



04.09.2013 - Cruise: 67PE376, depth: 44m

sample#7 214ml/min

Why MBES?

- Scalable measurements
- Available devices

Detection sensitivity

Very sensitive to gas bubbles

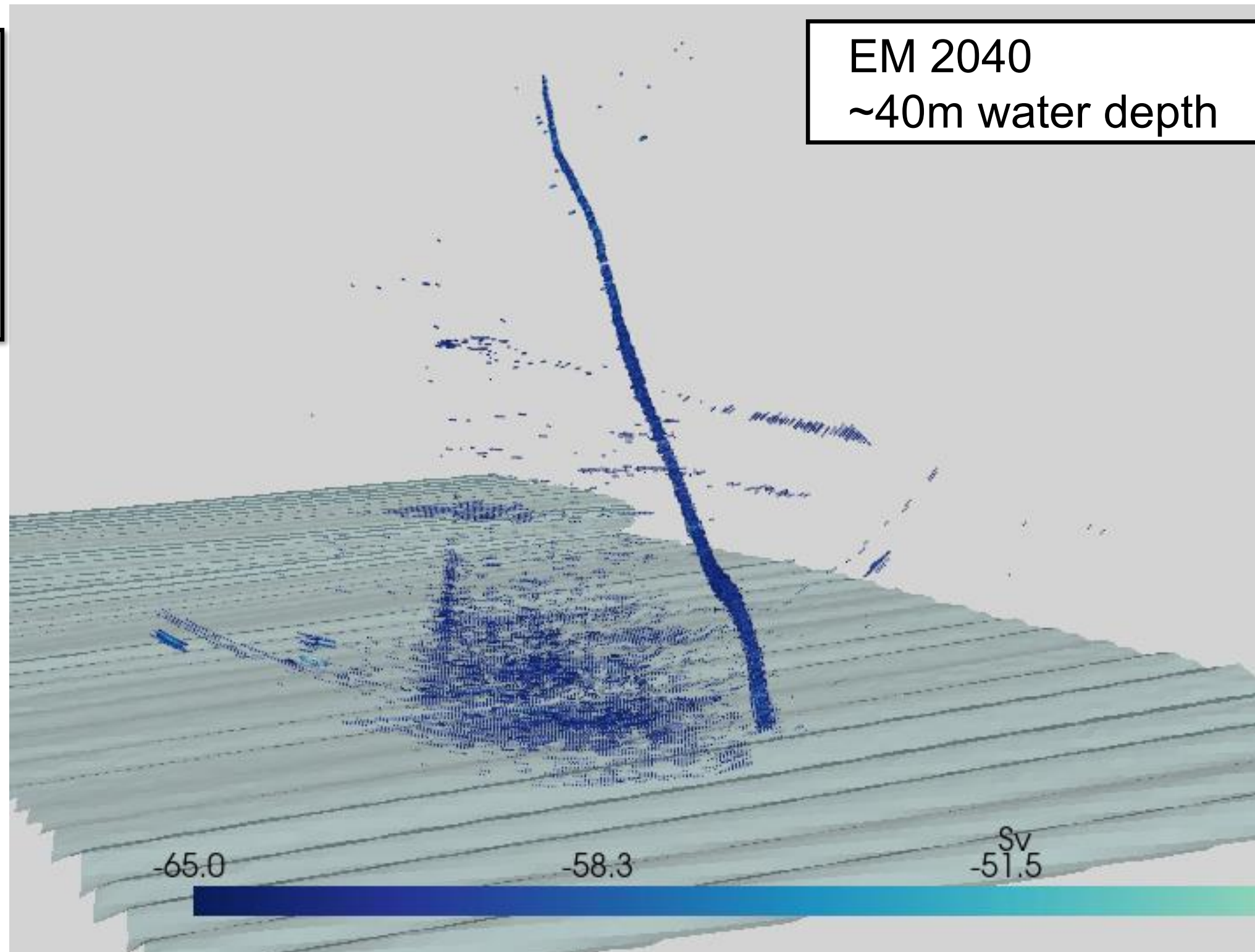
- Natural variability of bubble flow!
- Tidal phase!

Poster!

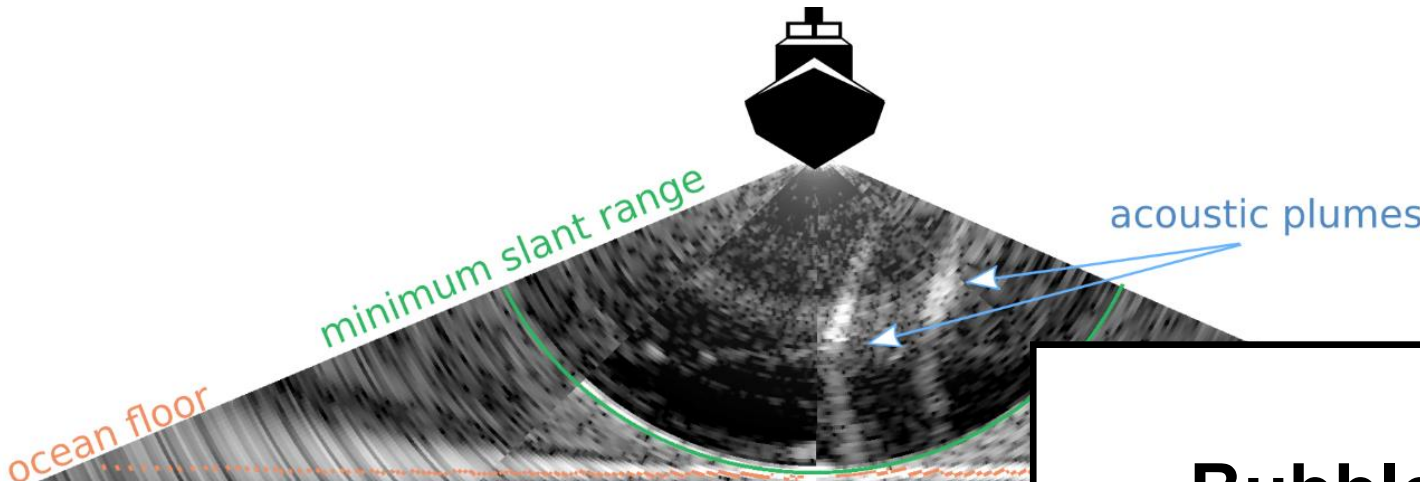
- Laurens van der ...
calibration using
- Last cruise R/V P ...
(9/10/2025)



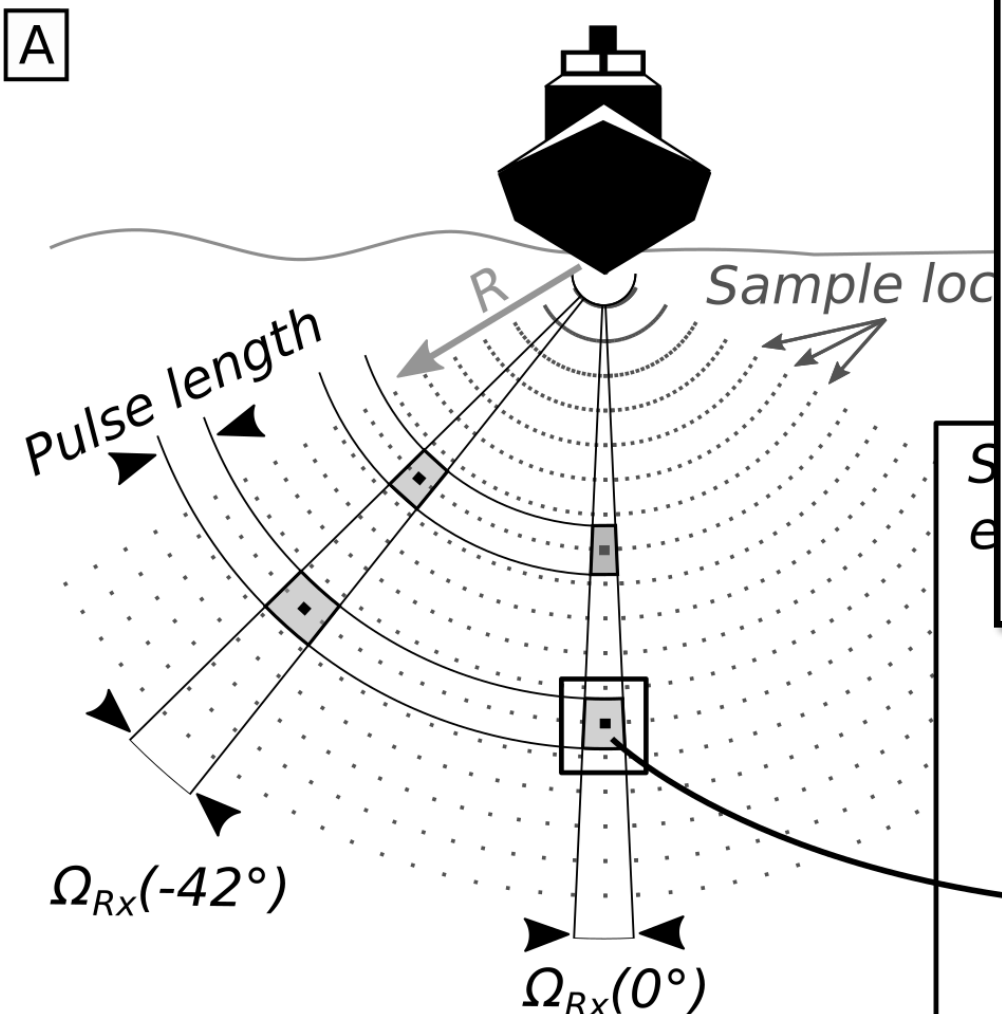
~2.5 mL/min



Echo integration and -inversion



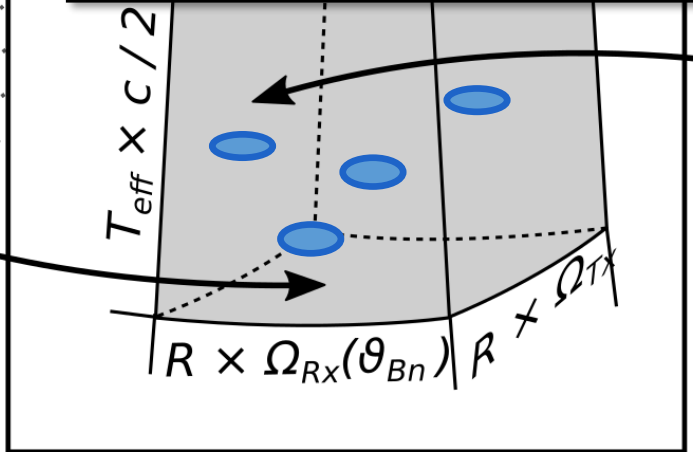
A



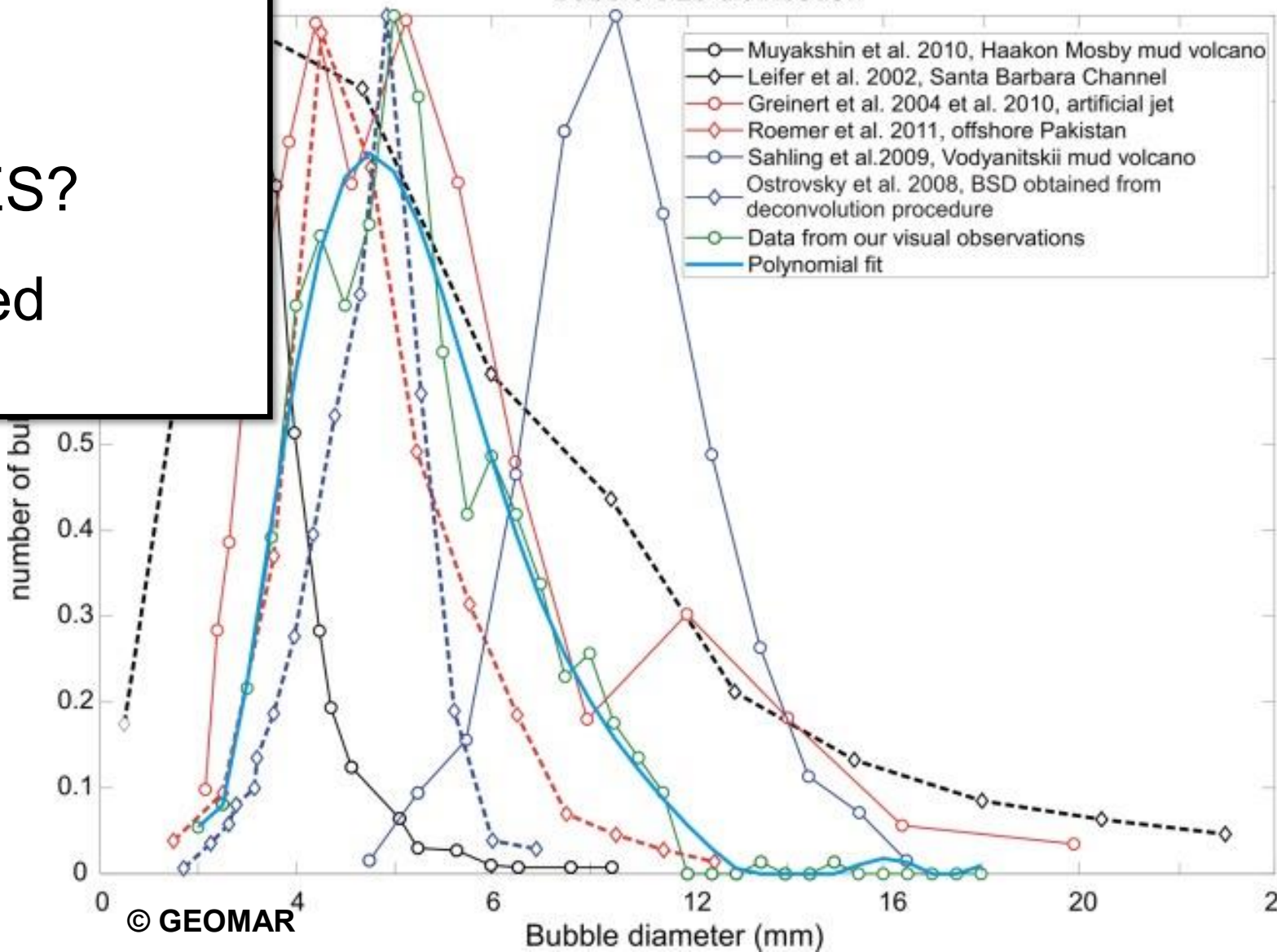
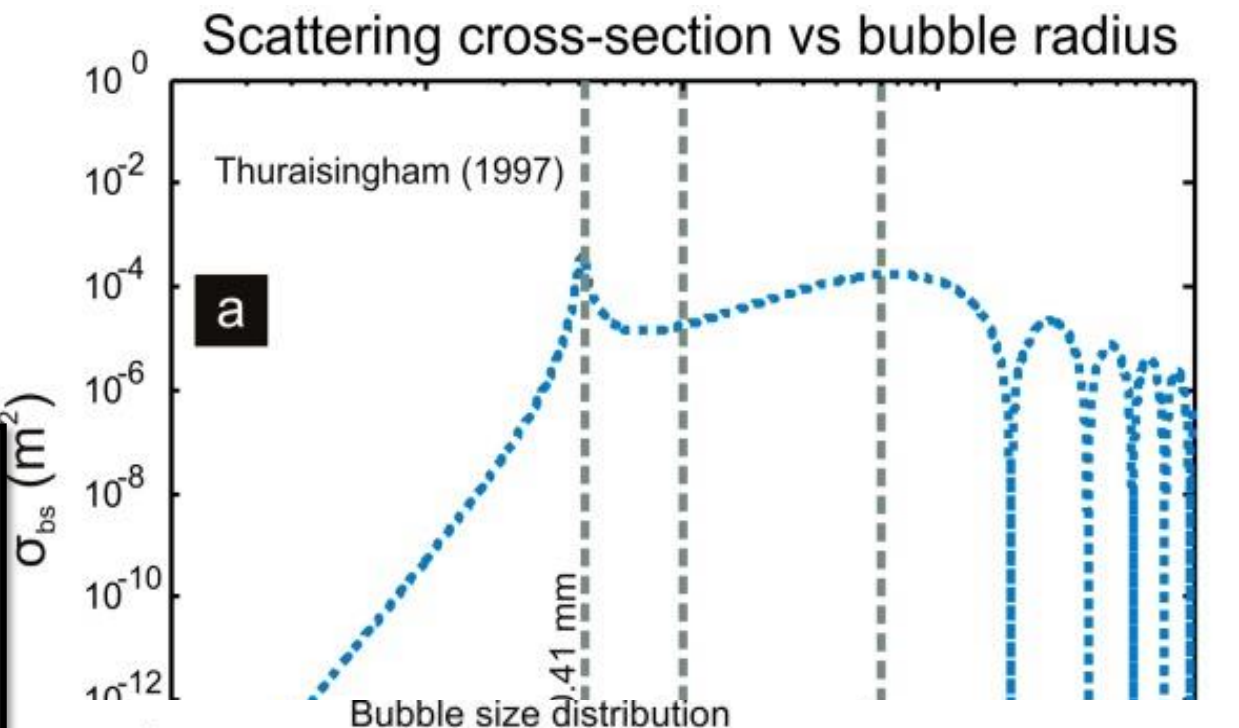
- Sample locations
- Selected sample location
- Covered volume of selected samples

Bubble size distribution!

- Cameras
- Passive acoustics
- Multifrequency MBES?
- Error can be modeled

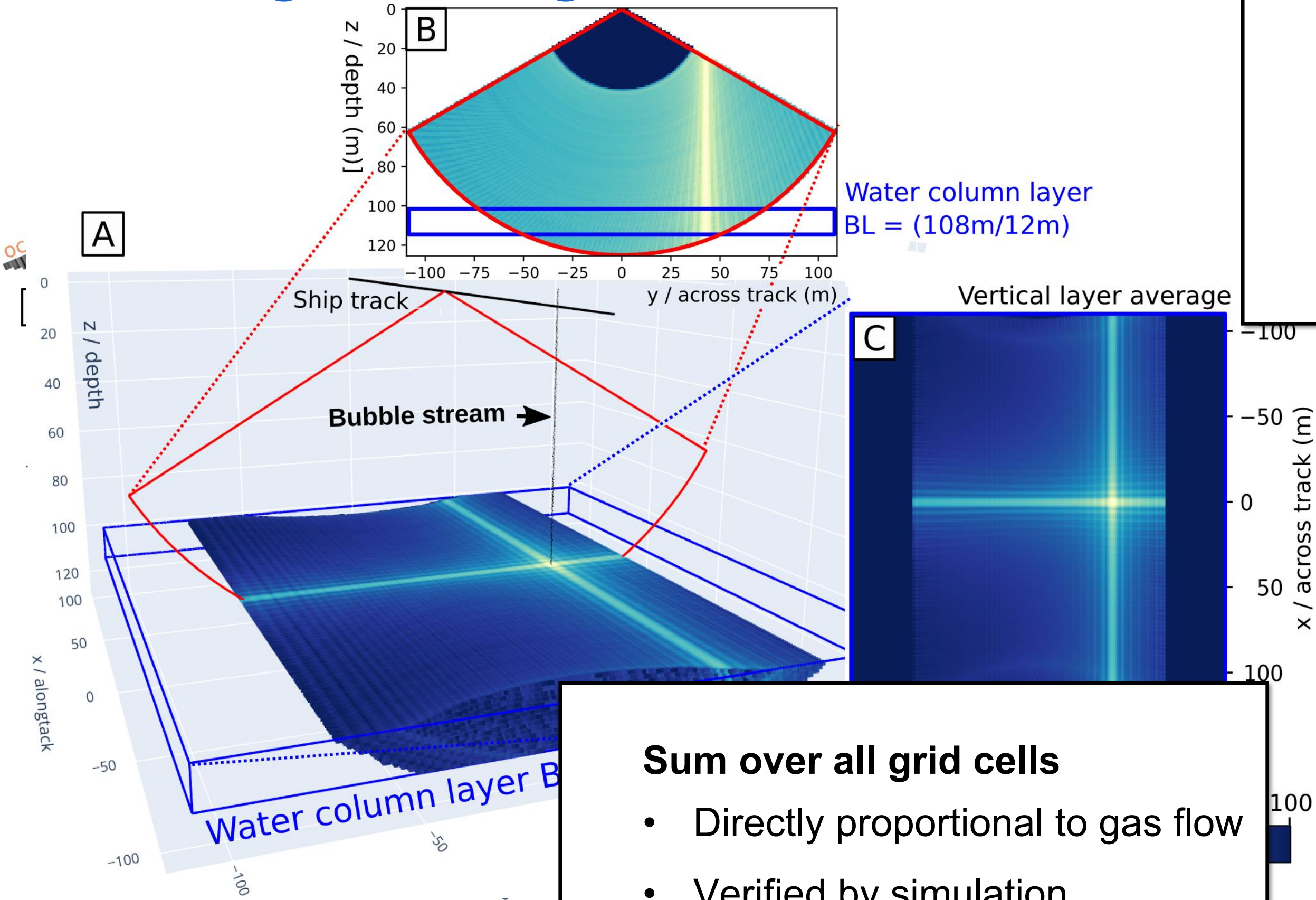


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© GEOMAR

Echo grid integration

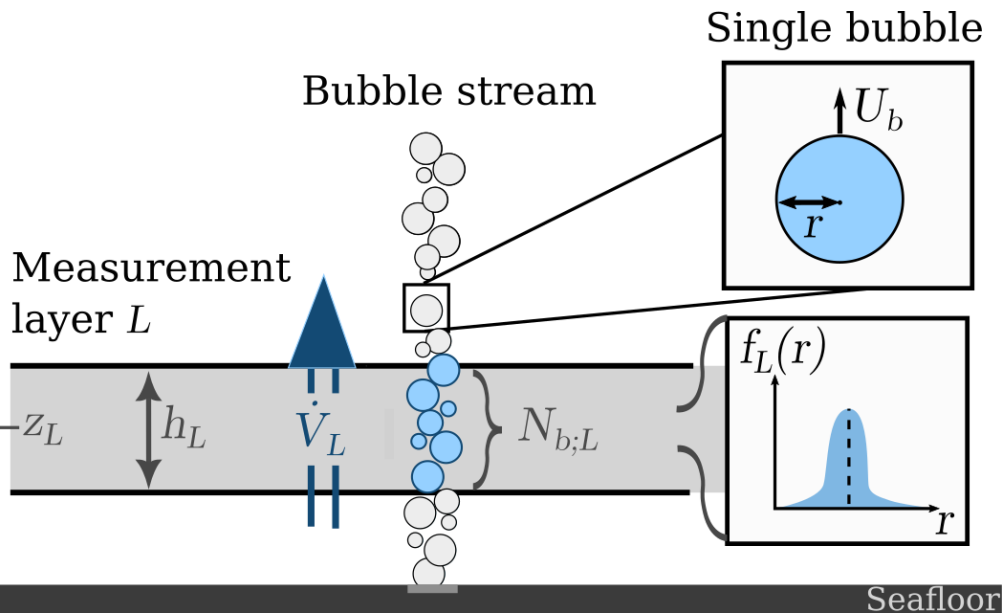


Echo grid integration

- High resolution grid
- Average Sv per grid cell
- Sum over all cells

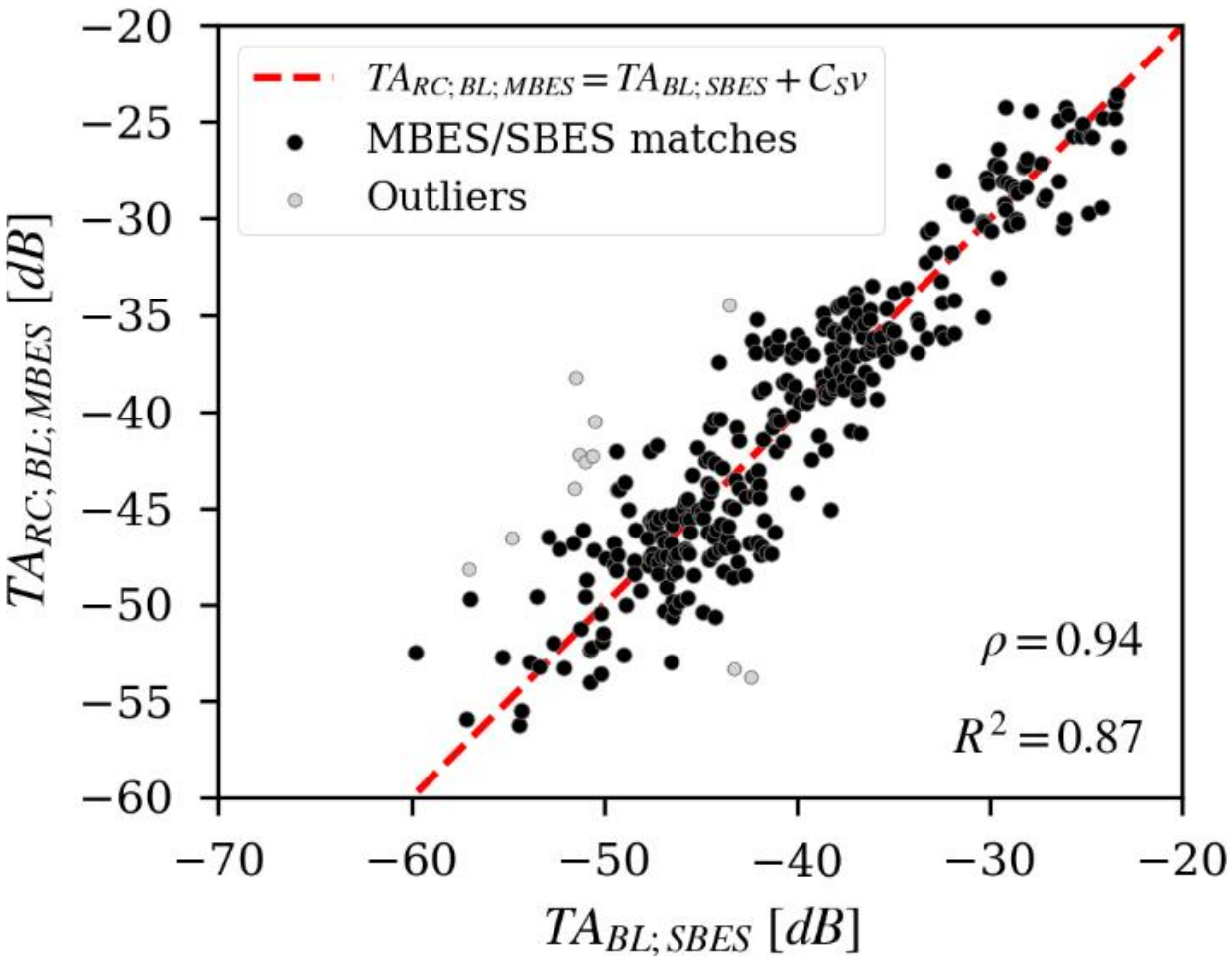
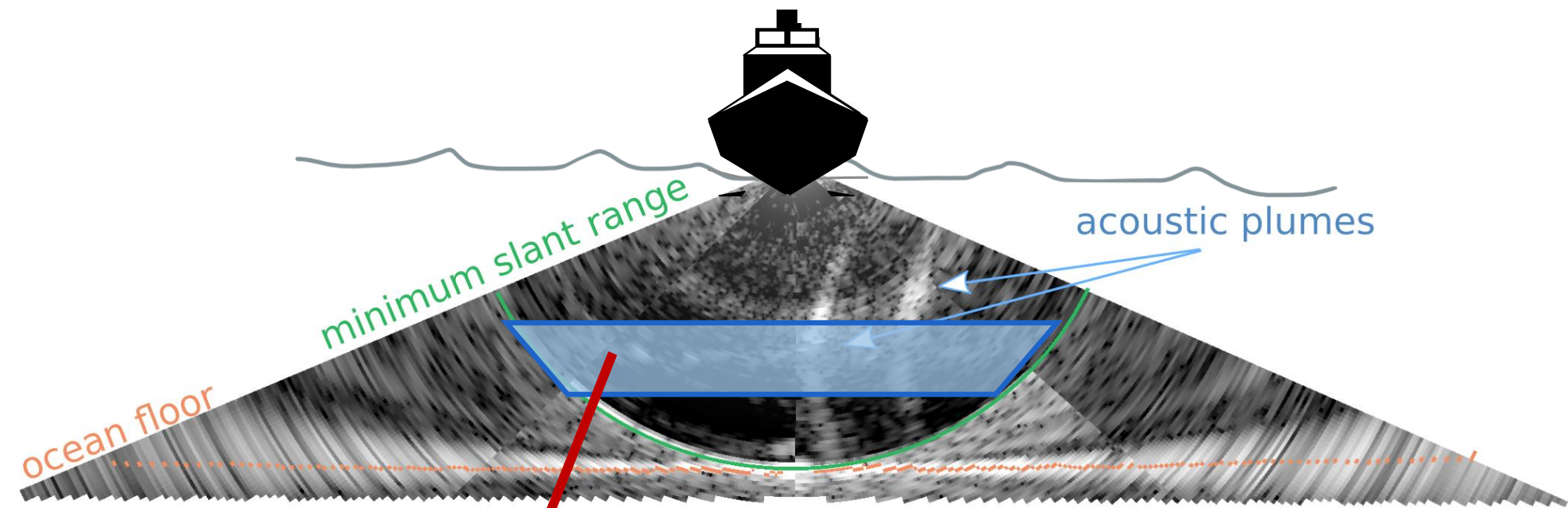
Sum over all grid cells

- Directly proportional to gas flow
- Verified by simulation

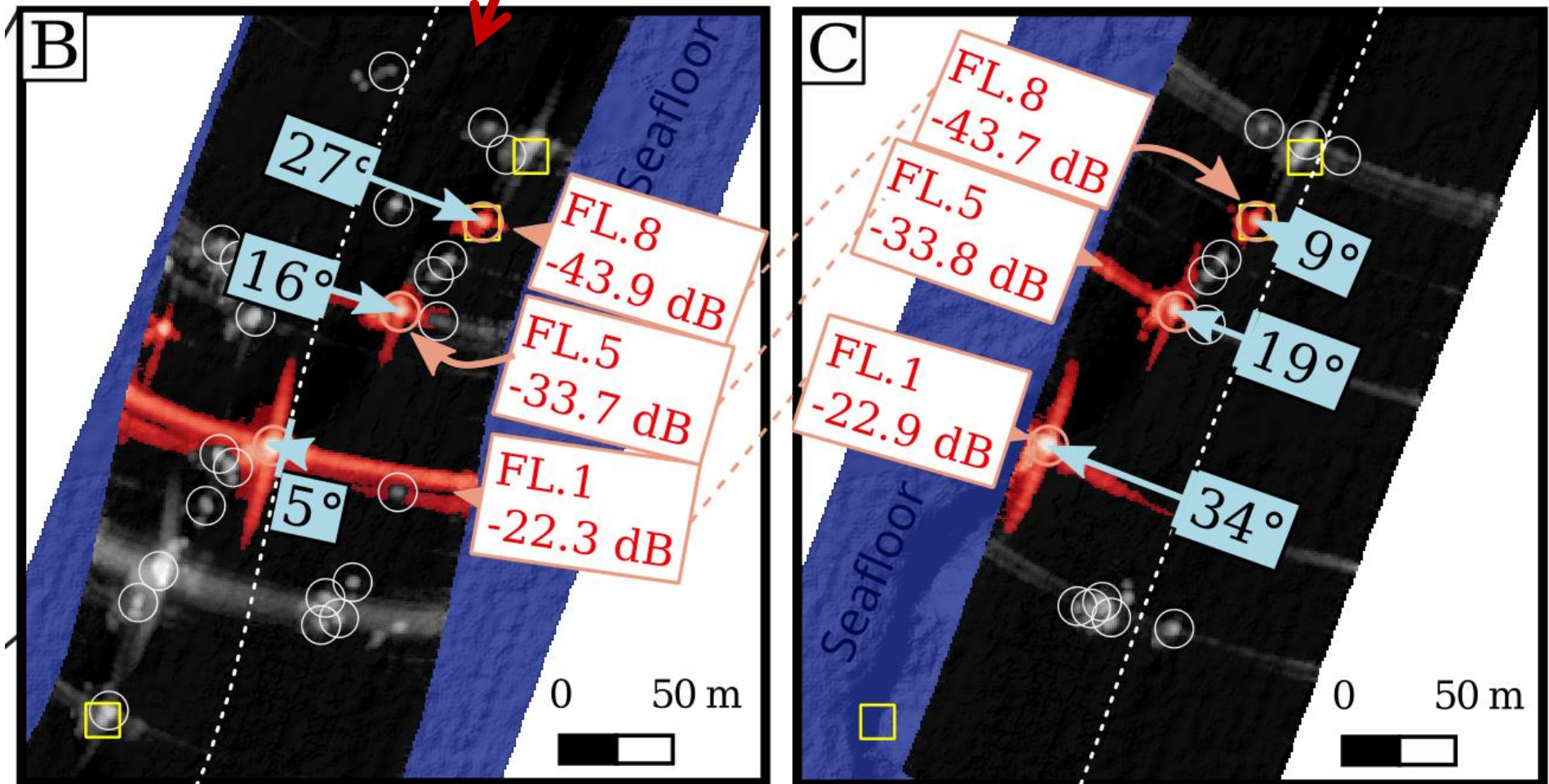


MBES CALIBRATION

Examples from the southern North Sea in ~40 m water depth (Urban et al. 2017)



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Calibration varies with:

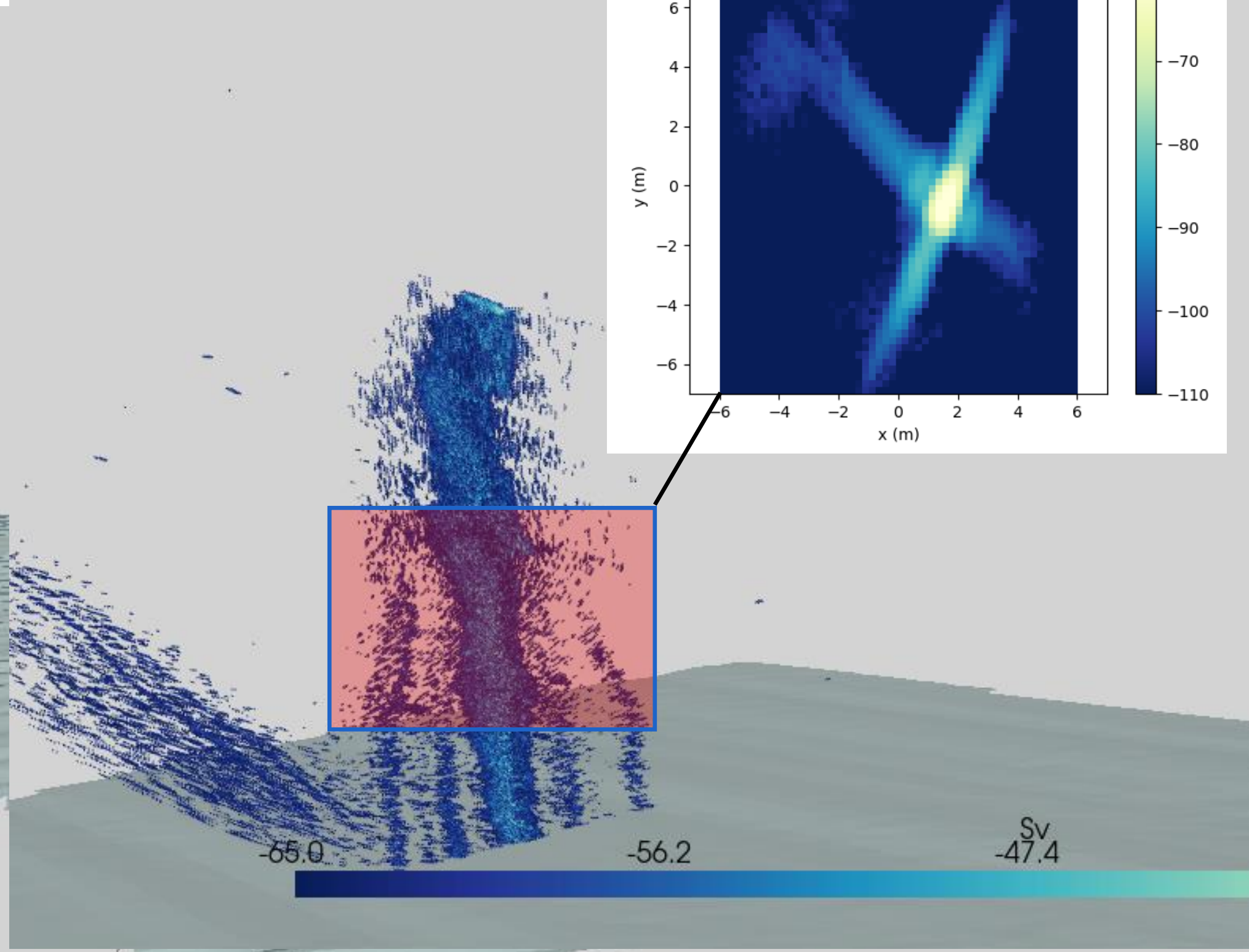
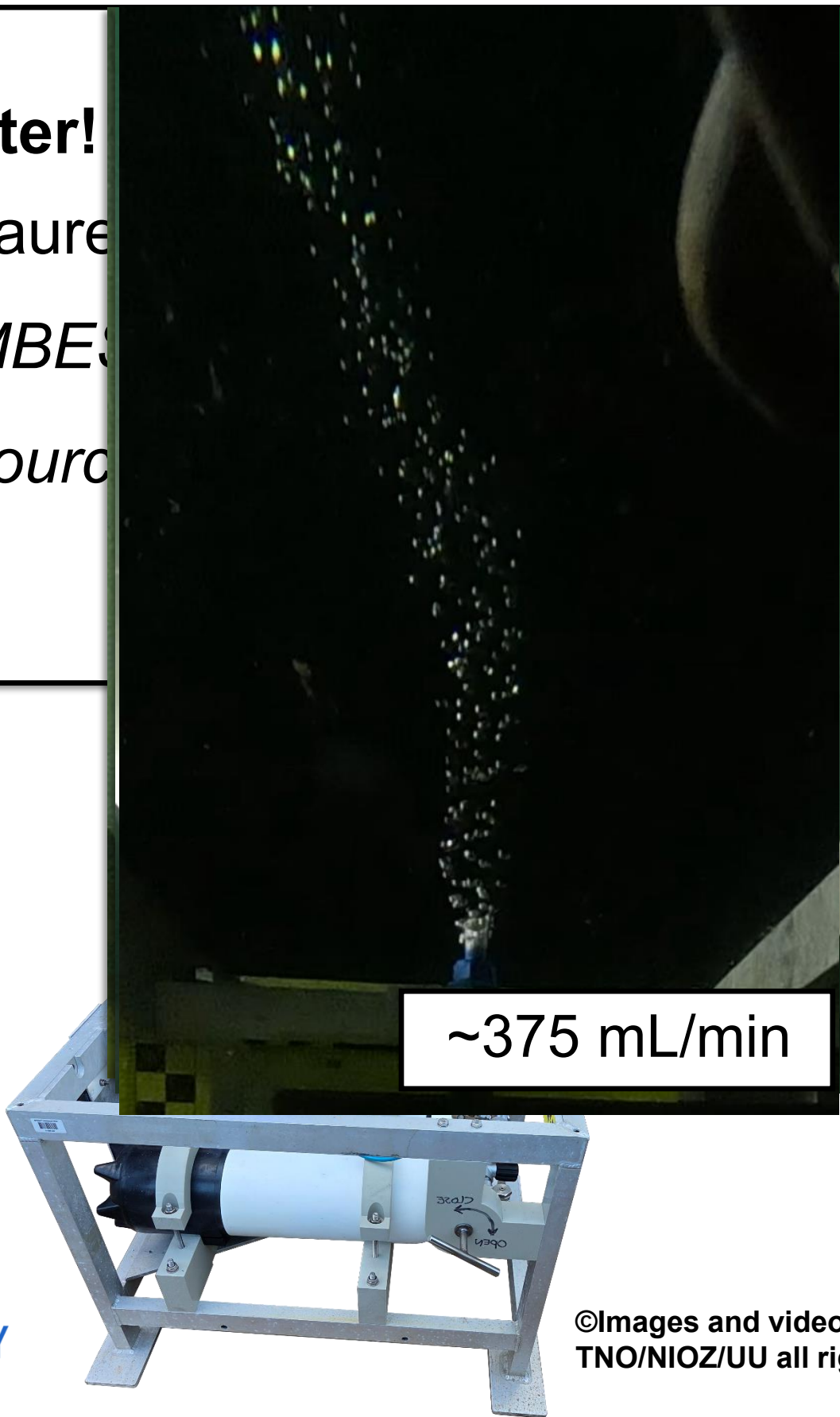
- System
- Water temperature
- System depth
- Time (Transducer aging)

Validation

R/V Pelagia Sept/Oct 2025

Poster!

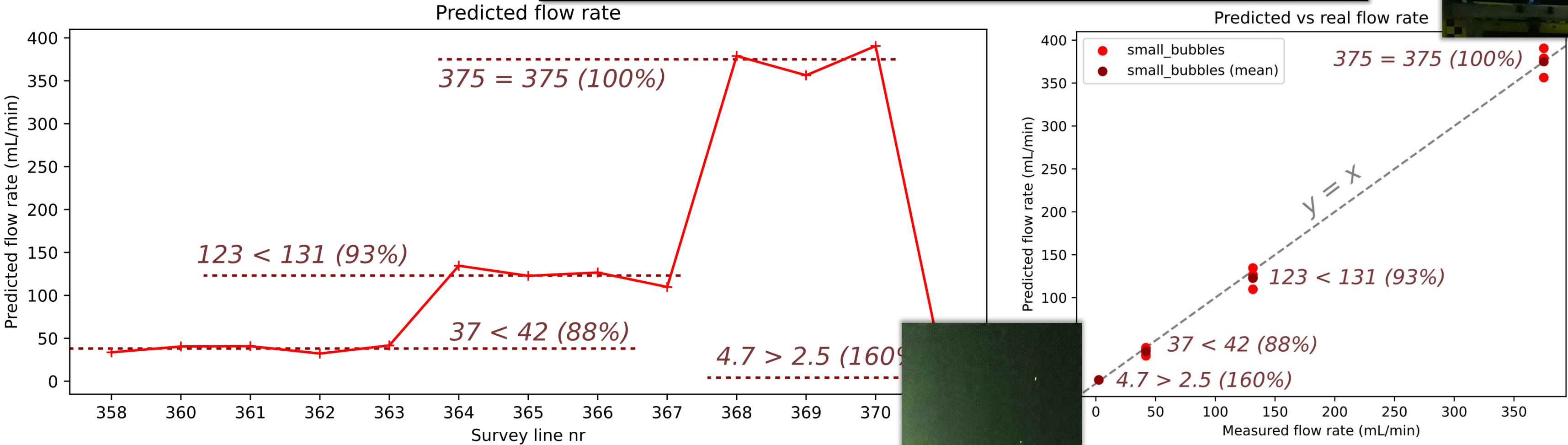
- Laure
- MBES
- source



Acoustics vs bubble gas flow rate: Directly proportional?

Confirmed!

- Directly proportional relationship (+- 10-20%)



Influence of bubble size distribution?

Sparger
(small bubbles)

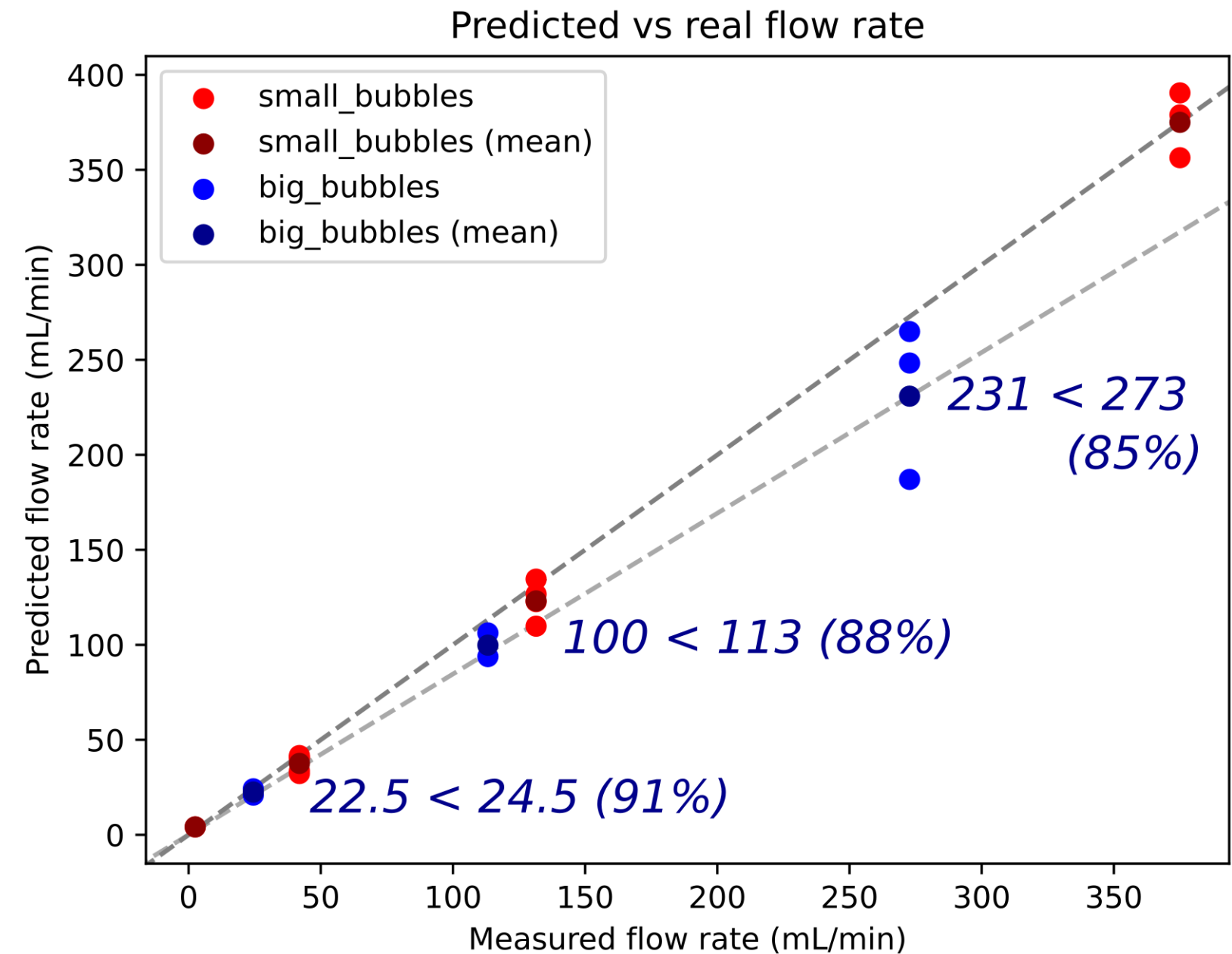


No sparger
(large bubbles)



Bubble sizes matter!

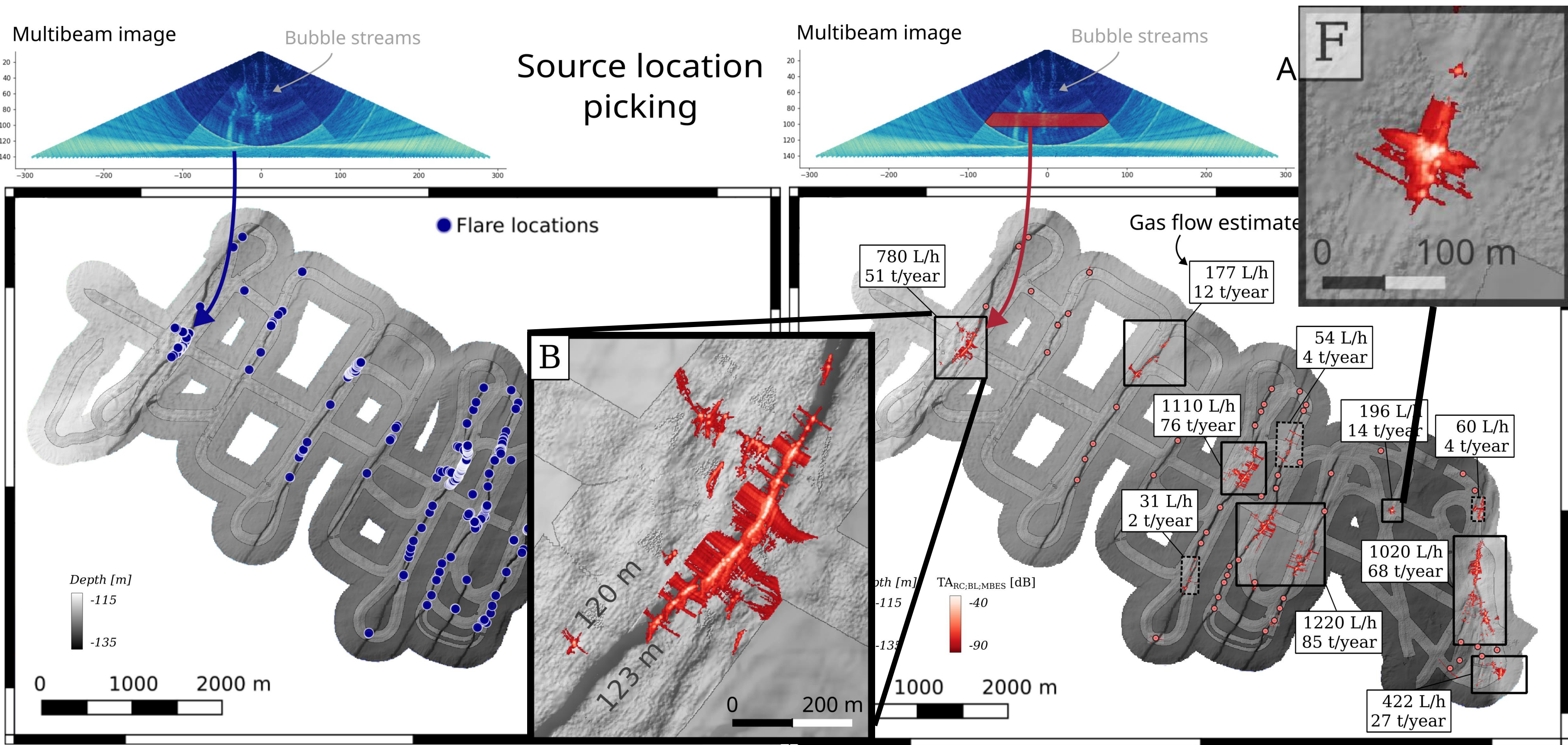
- ...but errors can be constrained



Conclusion



ACOUSTIC BUBBLE STREAM MEASUREMENTS



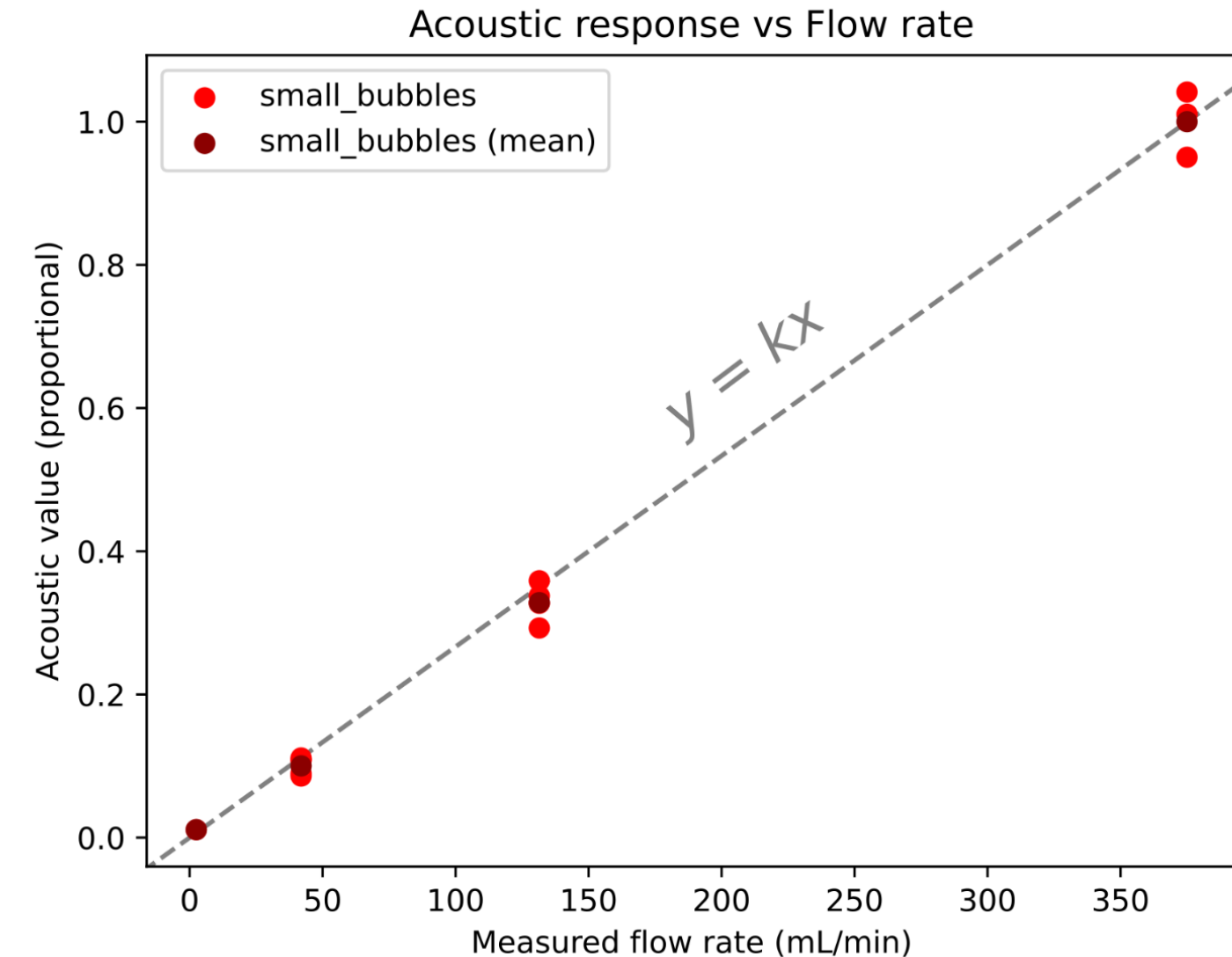
Complexity of the measurements

High complexity?

- Multiple aspects of calibration
- Multiple possibilities for flow rate scaling
- Planning of water column surveys
- Constraining errors
- Amount of method aspects
 - Bubble dissolution modeling

Low complexity:

- Operation at sea
- Mathematical operations / individual method steps
- Results and explained uncertainties



High methodological depth

- Complex considerations
- 'Simple' actions

THANK YOU!

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