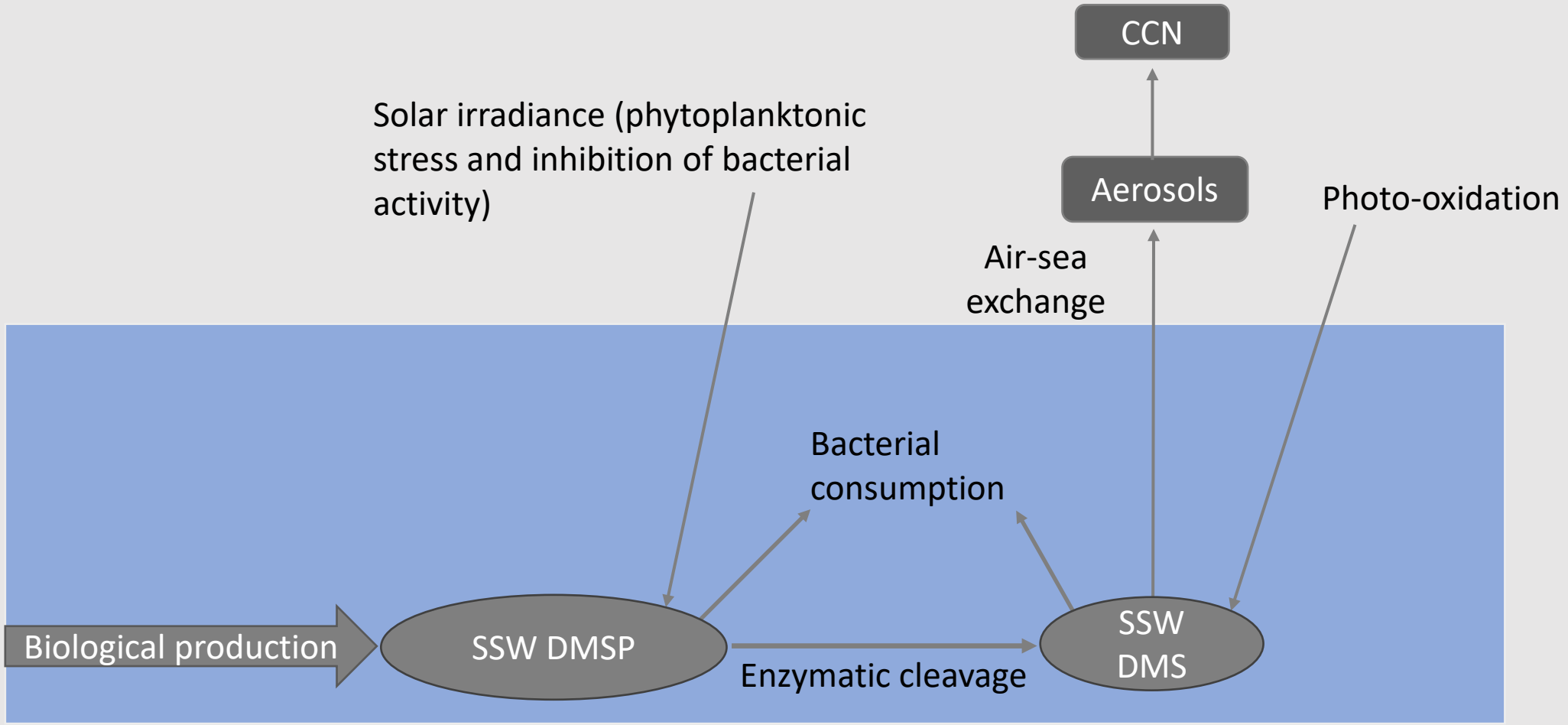
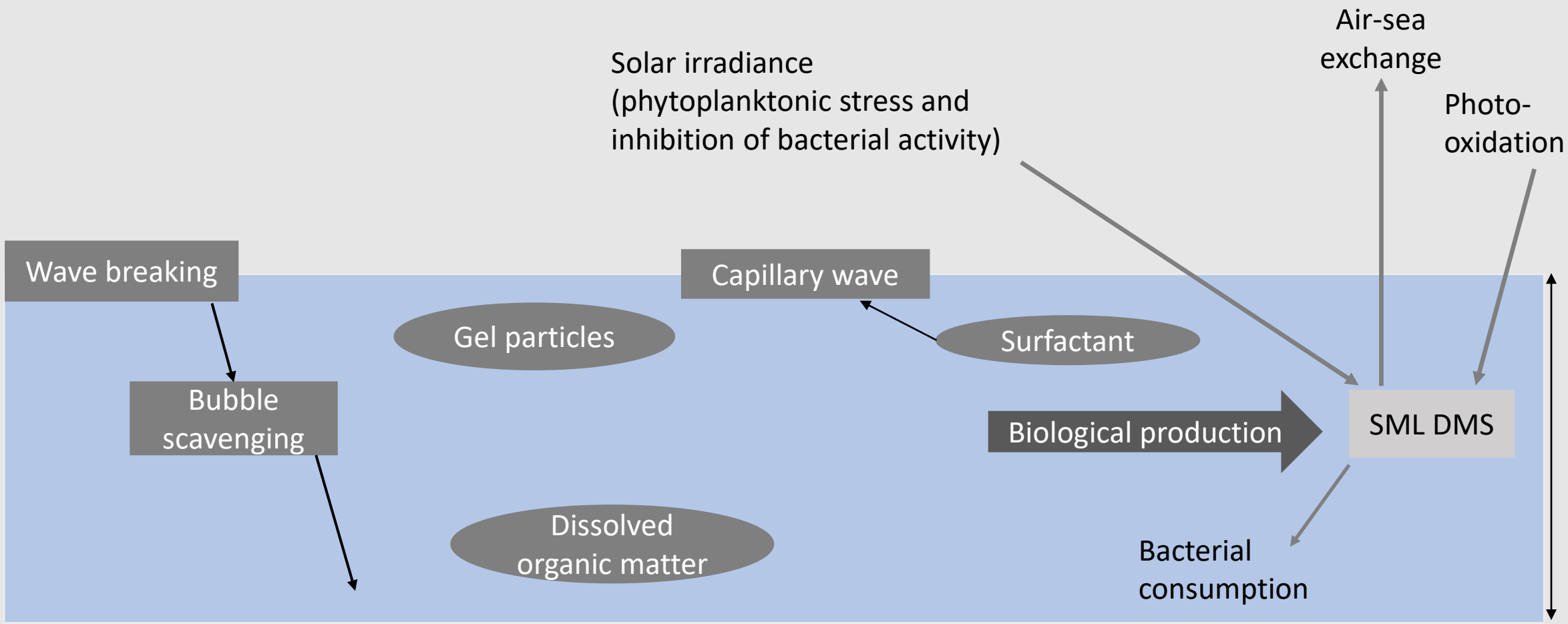
Testing and application of a diffusion-based method for sampling DMS in the Sea Surface Microlayer

Alexia Saint-Macary, Theresa Barthelmeß, Cliff Law

DMS cycling in surface ocean



Influence of Sea Surface Microlayer (SML)



SML sampling methods

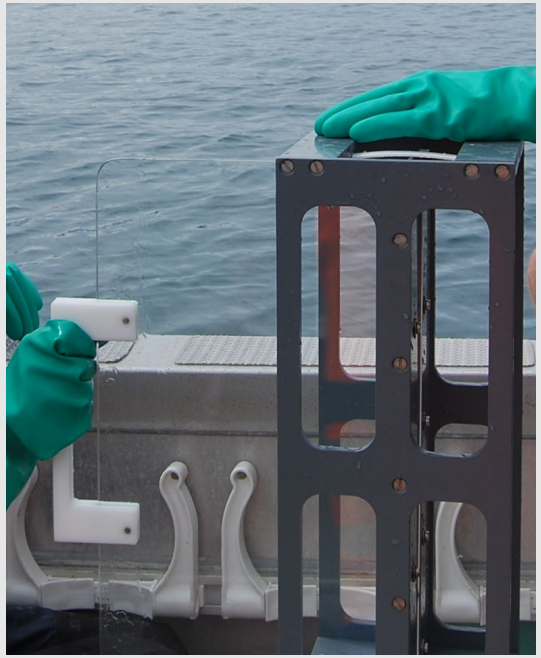


Plate and squeegee frame from GEOMAR

Mesh screen from GEOMAR

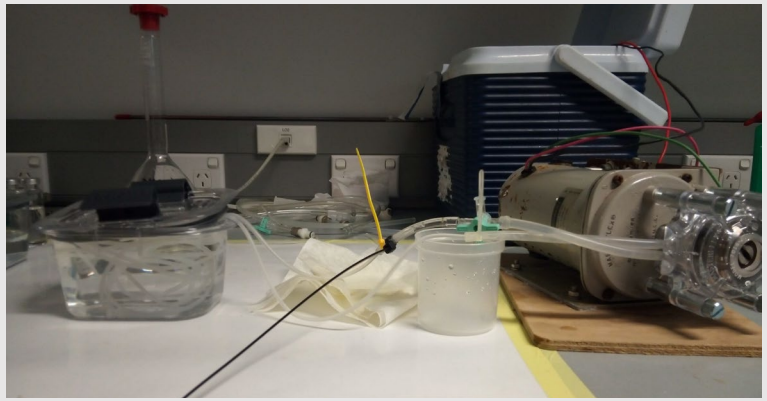
S^3 and Rotating drum Ribas-Ribas, 2017

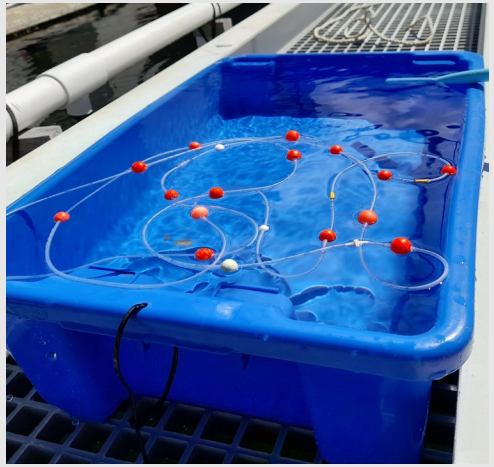
Gas-permeable tube

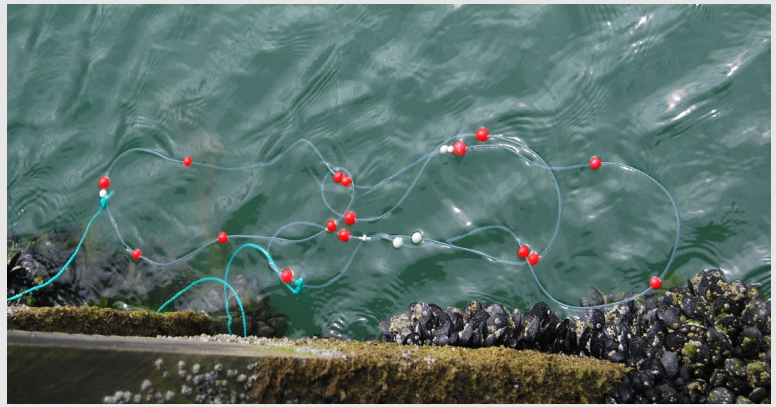
Develop a sampling method for DMS that minimizes exposure of the sample to the atmosphere

Diffusion based method due to DMS concentration gradient

Gas-permeable tube approach







Part A

- Laboratory
- DMS stock solution
- Only an immersed tubing

Part B

- Semi-controlled conditions
- Seawater with ambient DMS
- Floating tube

Part C

- Field
- Methods comparison
- Floating tube

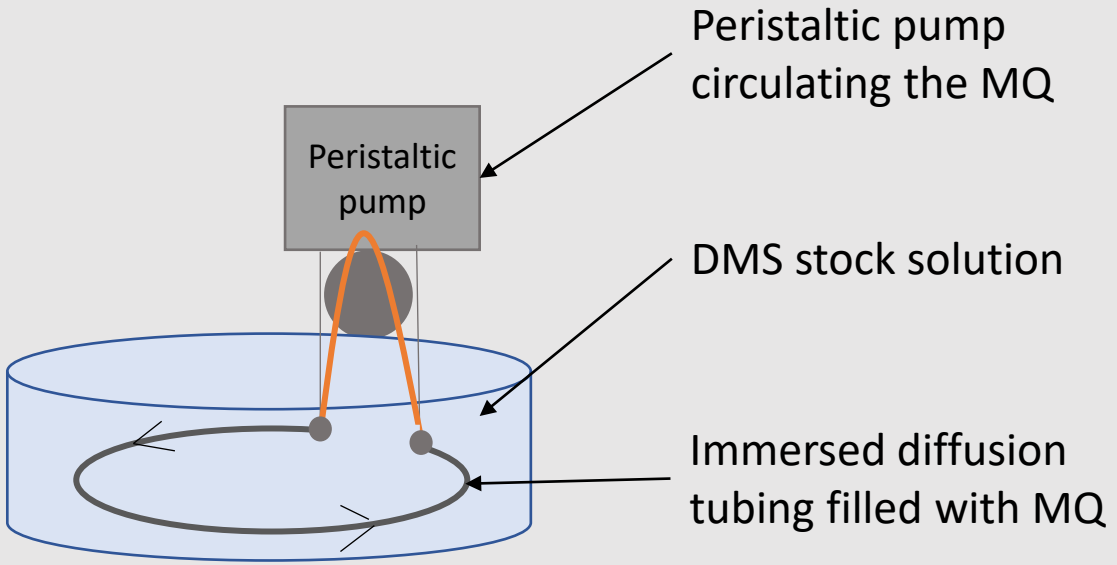
Laboratory development

Tested diffusion efficiency with:

- different tube types
- exposure times (20 to 120 min)
- flowing vs static MQ
- exposure to atmosphere

Diffusion Efficiency (D)

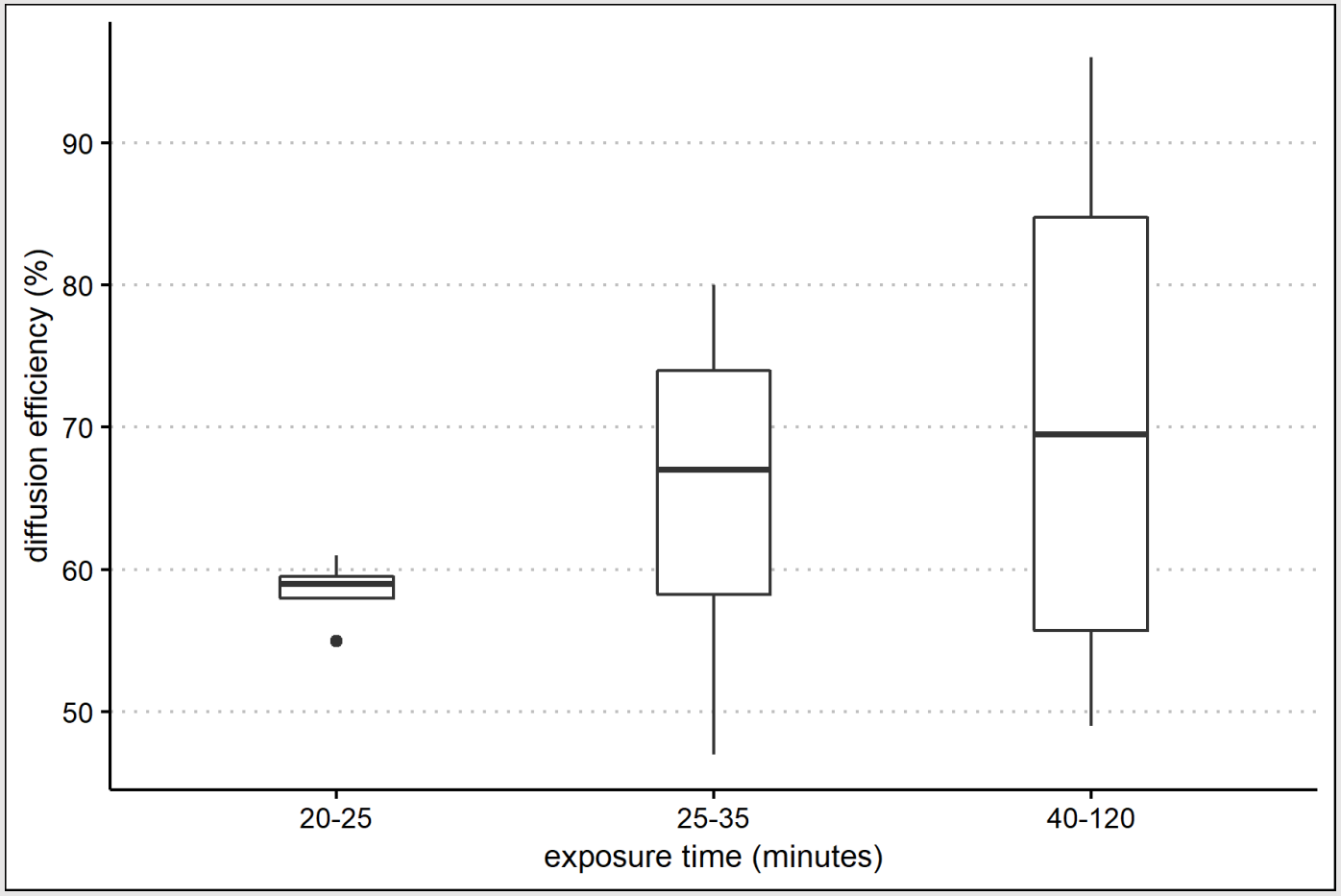
$$D = \frac{[\mathrm{DMS}]_{\mathrm{MQ}}}{[\mathrm{DMS}]_{\mathrm{stock}}} \times 100$$



Laboratory development

Results:

- tube dimensions
- external diameter 2.41 mm
- wall thickness 0.49 mm
- length 280 cm
- exposure time < 20 min
- no peristaltic pump
- minimize exposure to the atmosphere

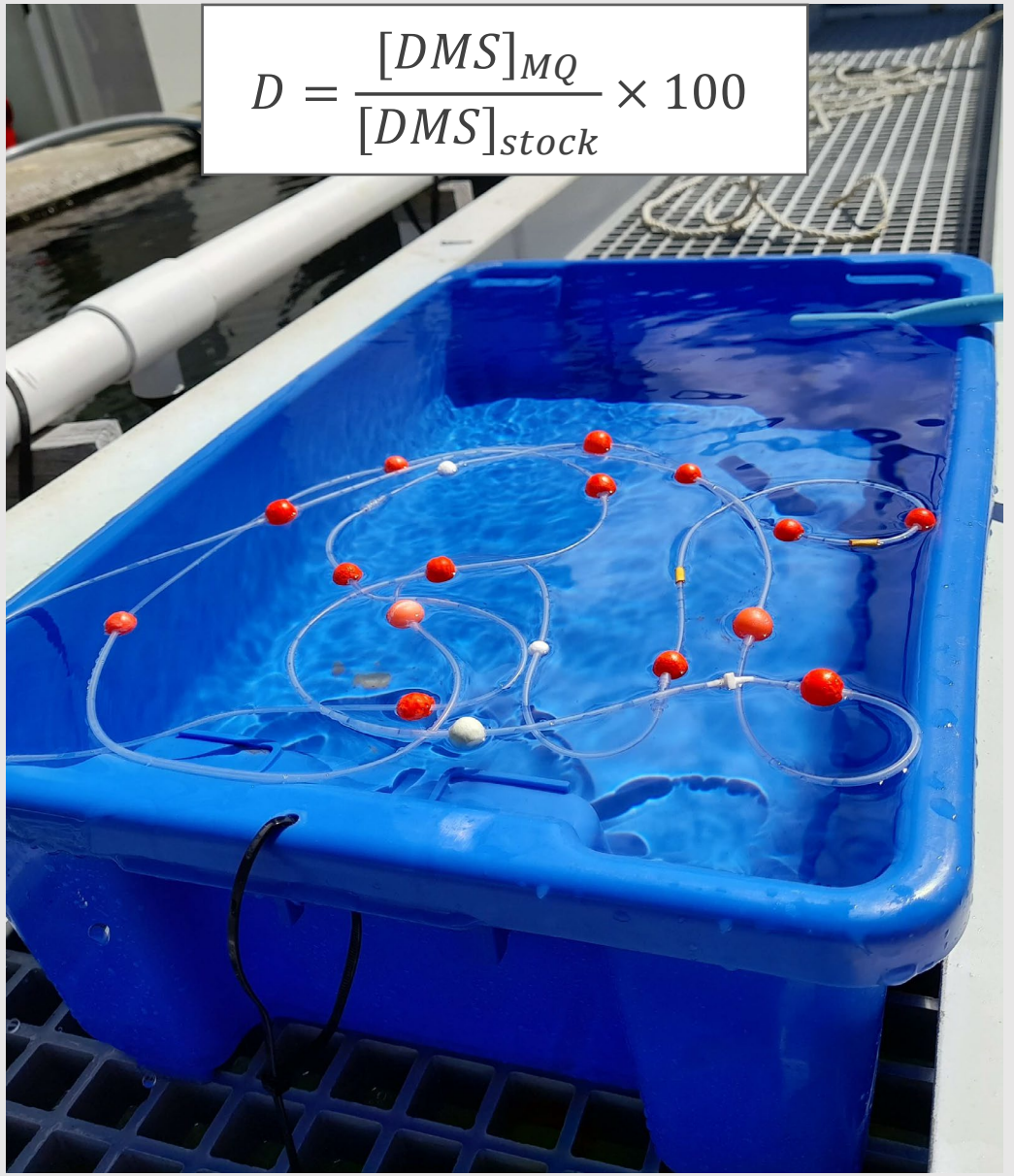


Semi-controlled conditions

- Determining D with floating tube in the SML
- Exposure time: 10 min
- Reproducibility and accuracy determination

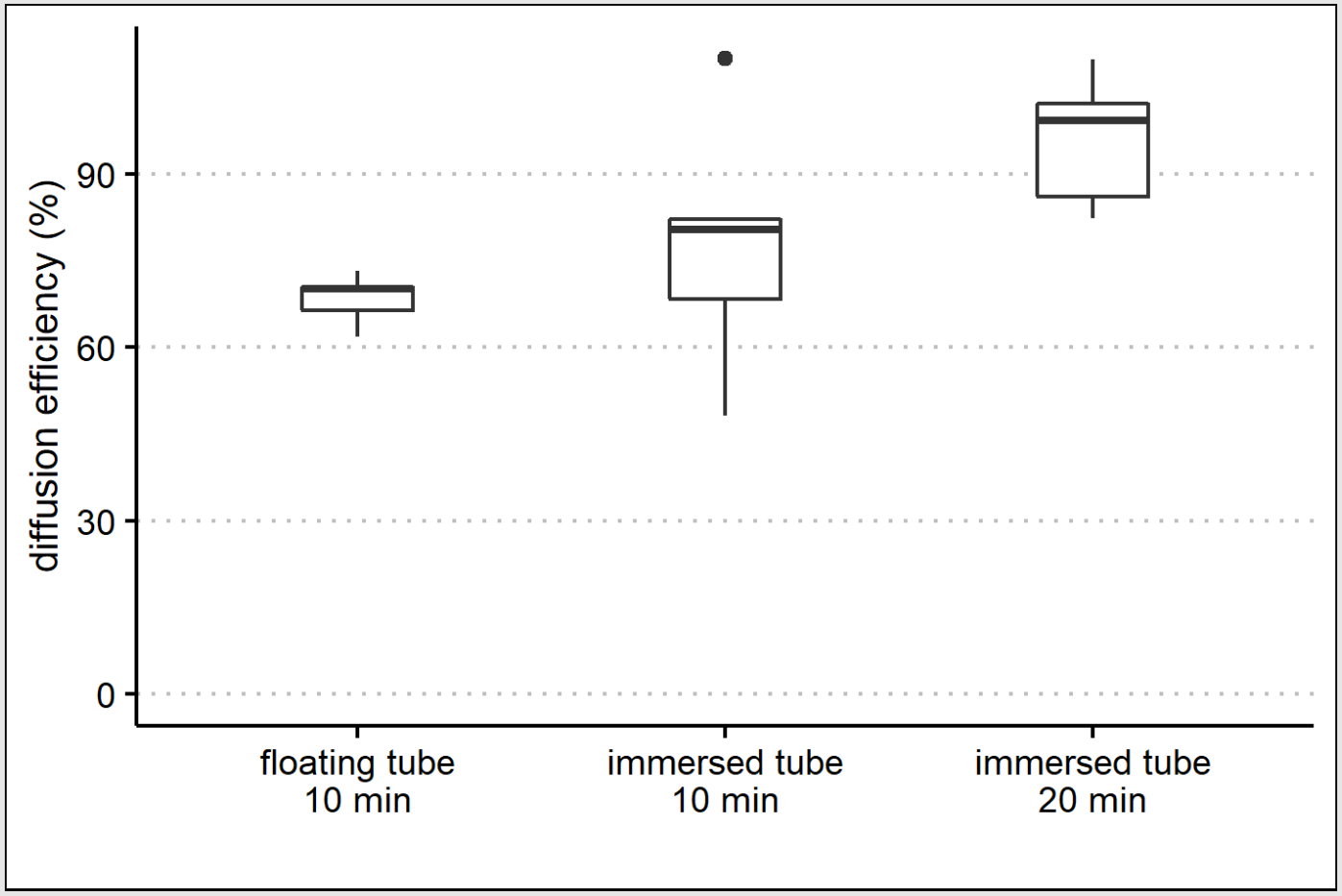
$$C_{SML} = [DMS]_{MQ} \times \frac{100}{D}$$

$$D = \frac{[DMS]_{MQ}}{[DMS]_{stock}} \times 100$$



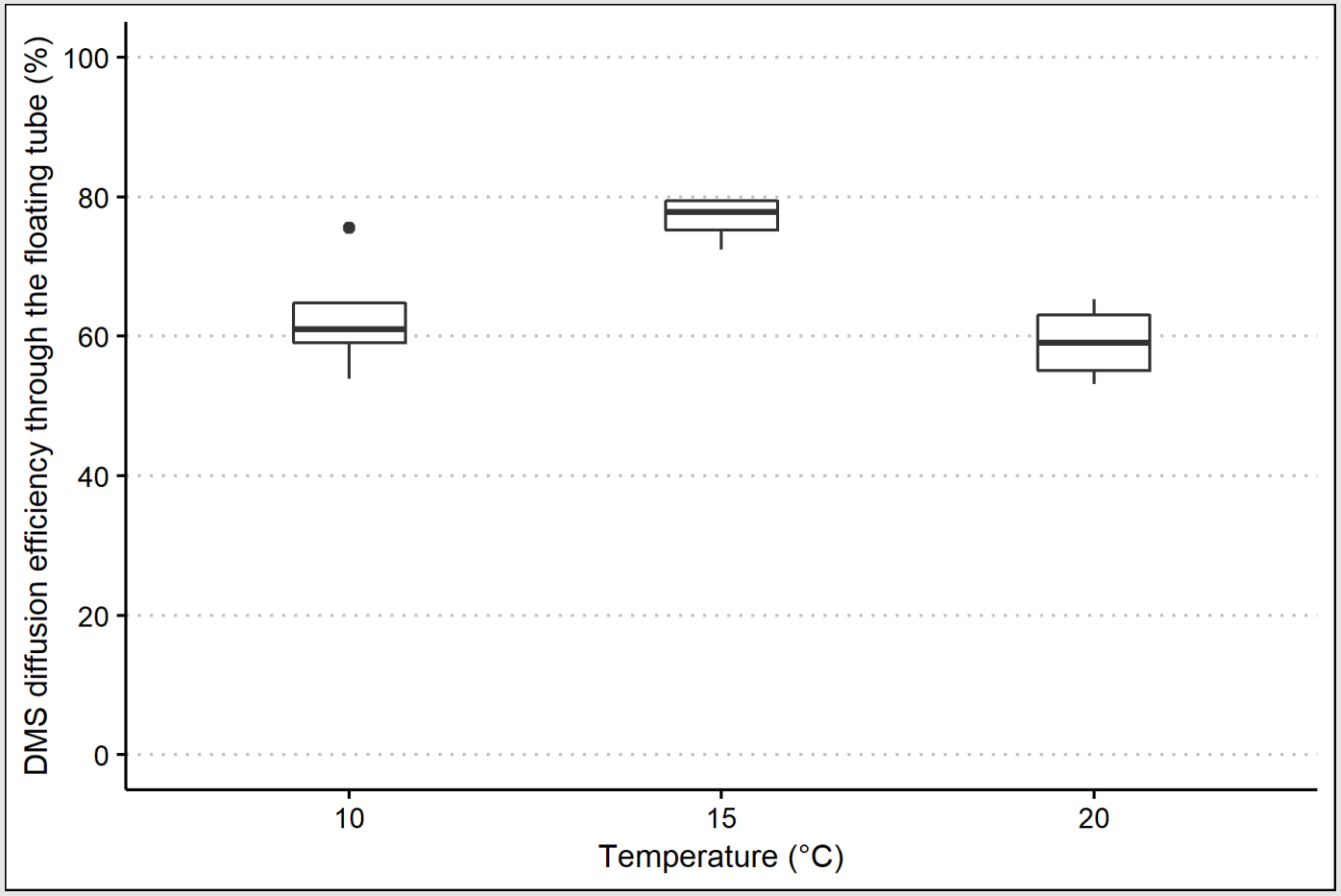
Semi-controlled conditions

- Immersed tube 20 min:
  D = 99% (11% sd, n=5)
- Immersed tube 10 min:
  D = 80% (22% sd, n=5)
- Floating tube 10 min:
  D = 70% (4% sd, n=5)



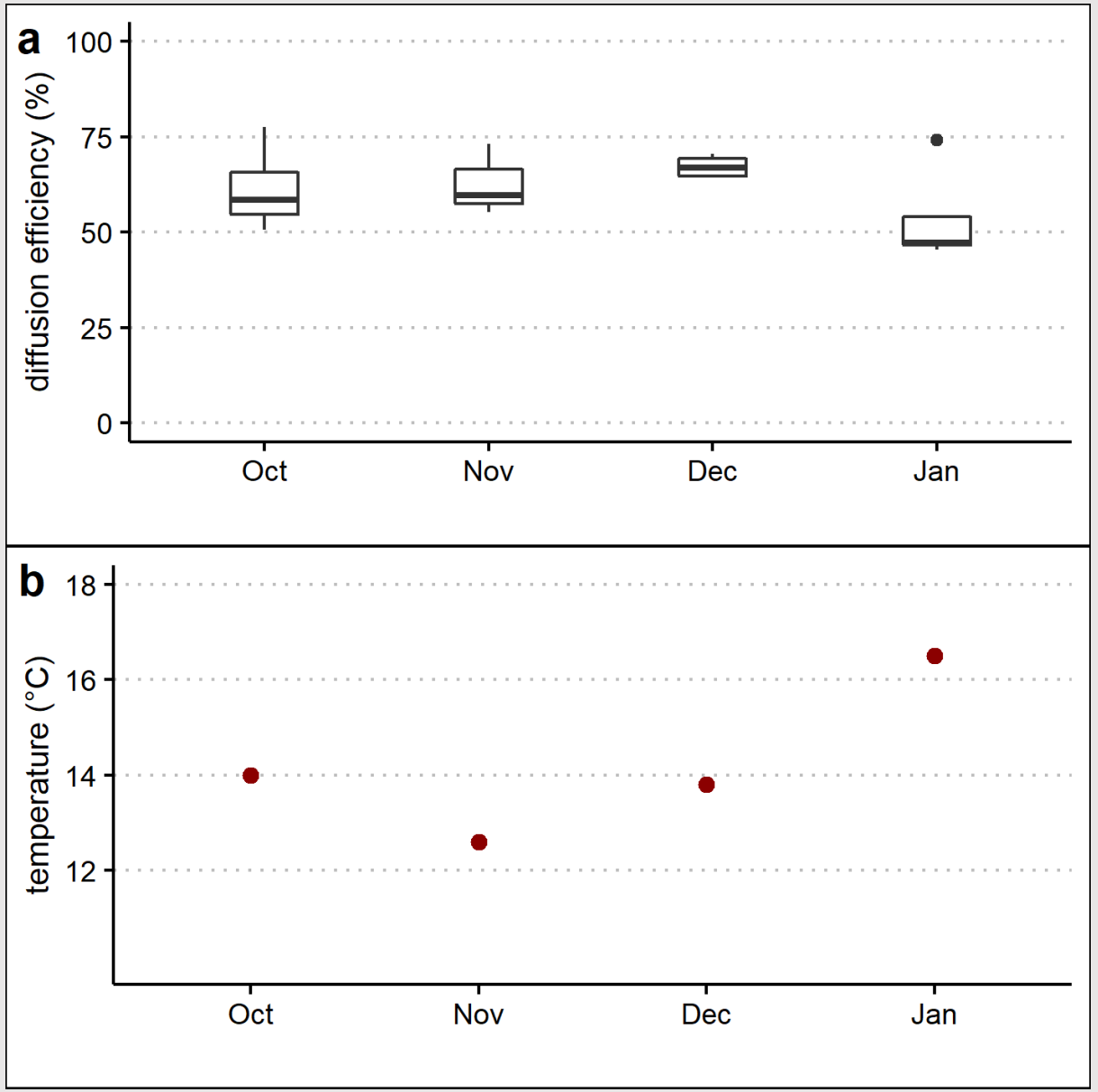
Semi-controlled conditions

- Test temperature dependence on diffusion efficiency
- Reproducibility improved by rinsing procedure in between repetitions



Semi-controlled conditions

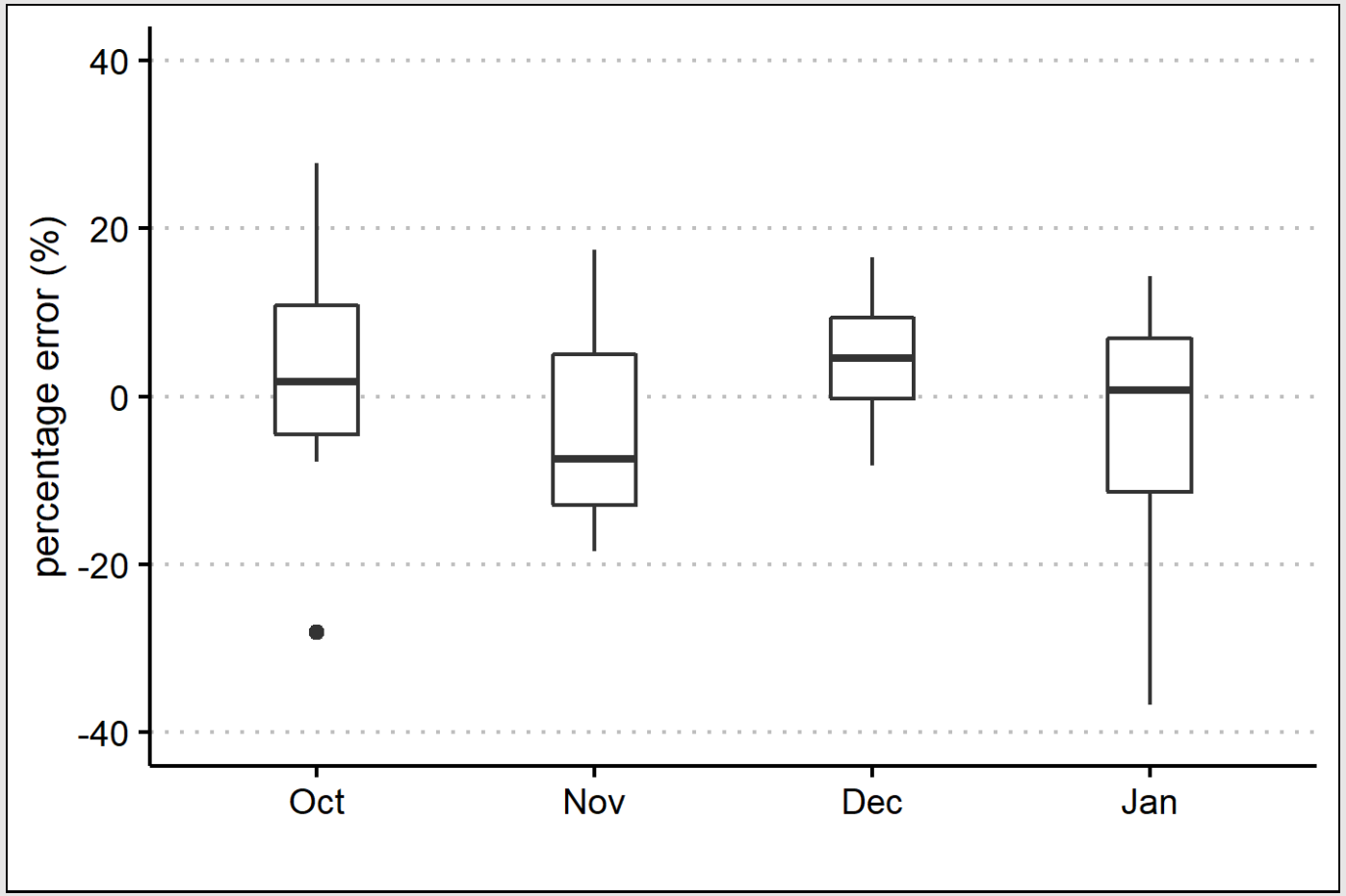
- Test temporal variability
- Diffusion efficiency 47% to 67%
- Ambient DMS concentration range: 1 to 15 nmol L^{-1}
- Diffusion efficiency influenced by environmental conditions



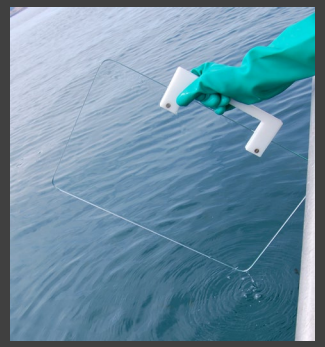
Semi-controlled conditions

$$\%\text{error} = \frac{[\text{DMS}]_{\text{F.tube}} - [\text{DMS}]_{\text{tank}}}{[\text{DMS}]_{\text{tank}}} \times 100$$

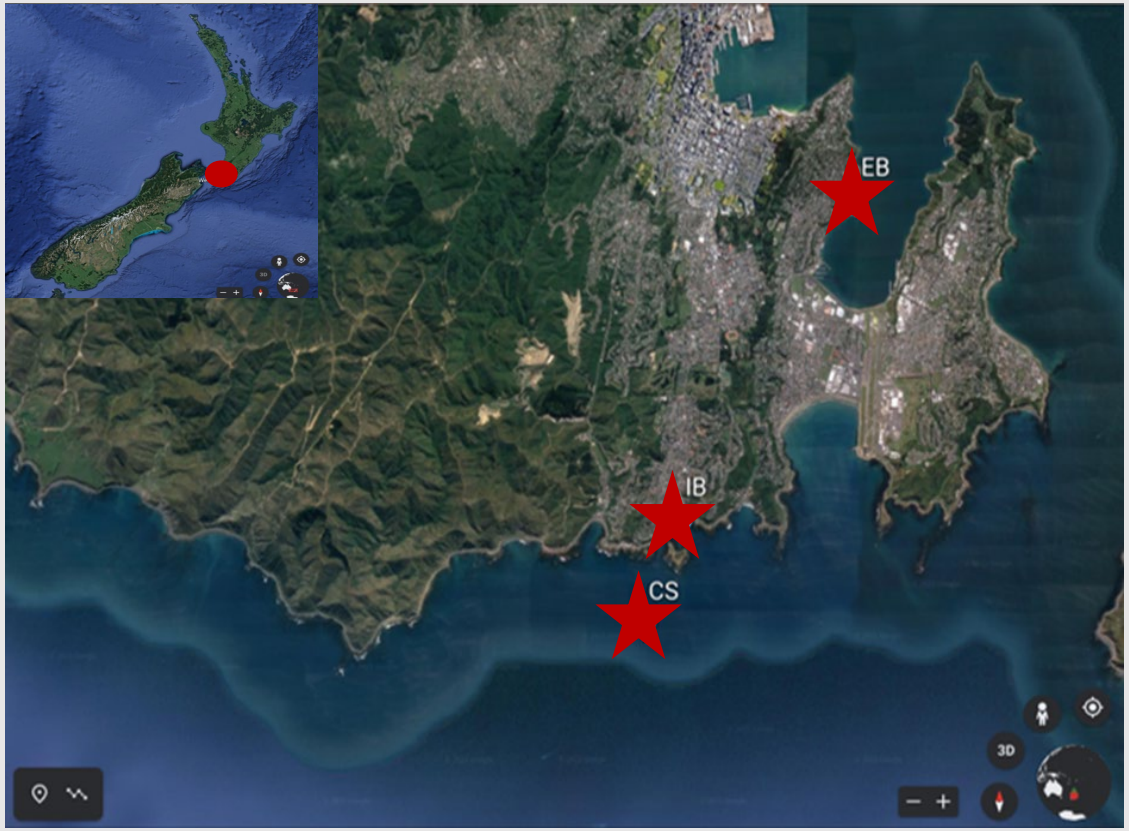
- Mean range:
  -5% to 4%
- Interquartile range:
  -13% to 18%



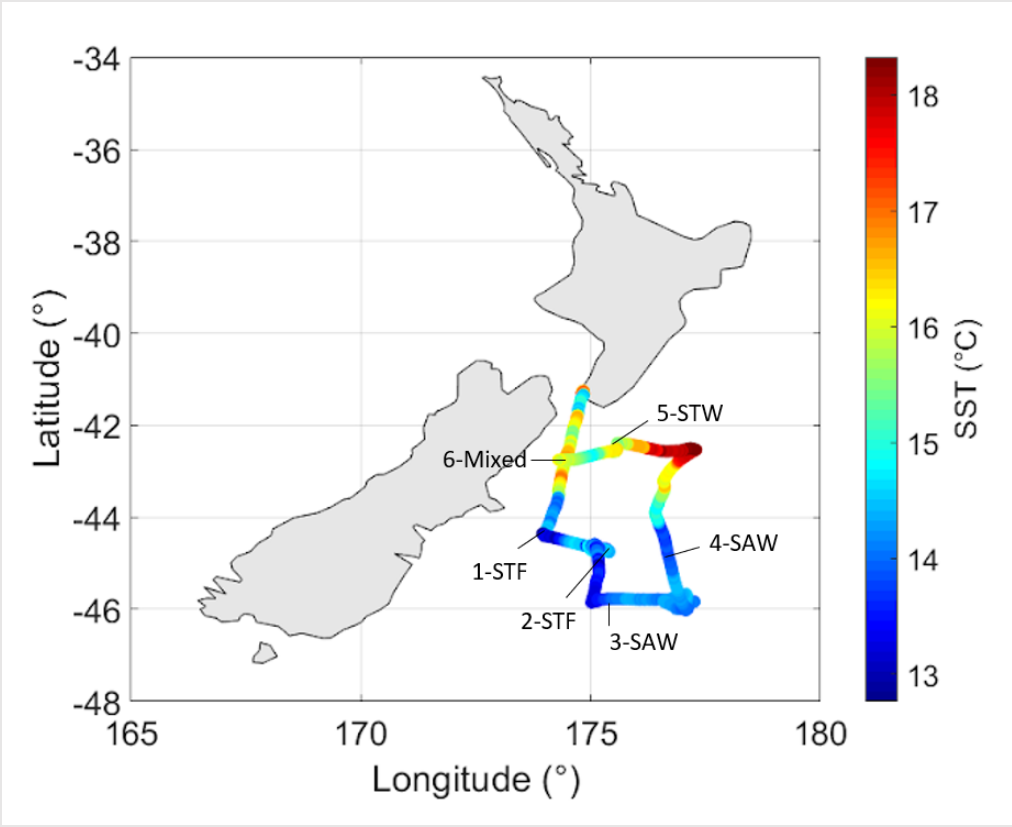
Methods comparison



Coastal study

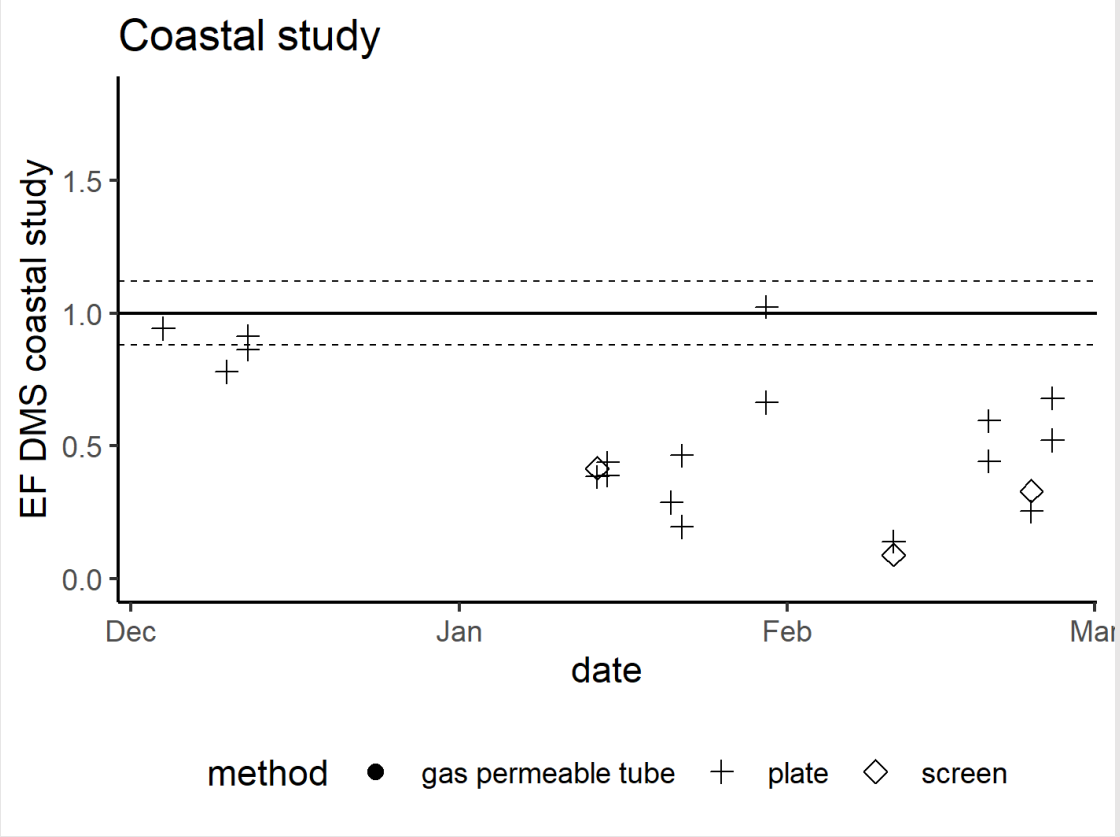


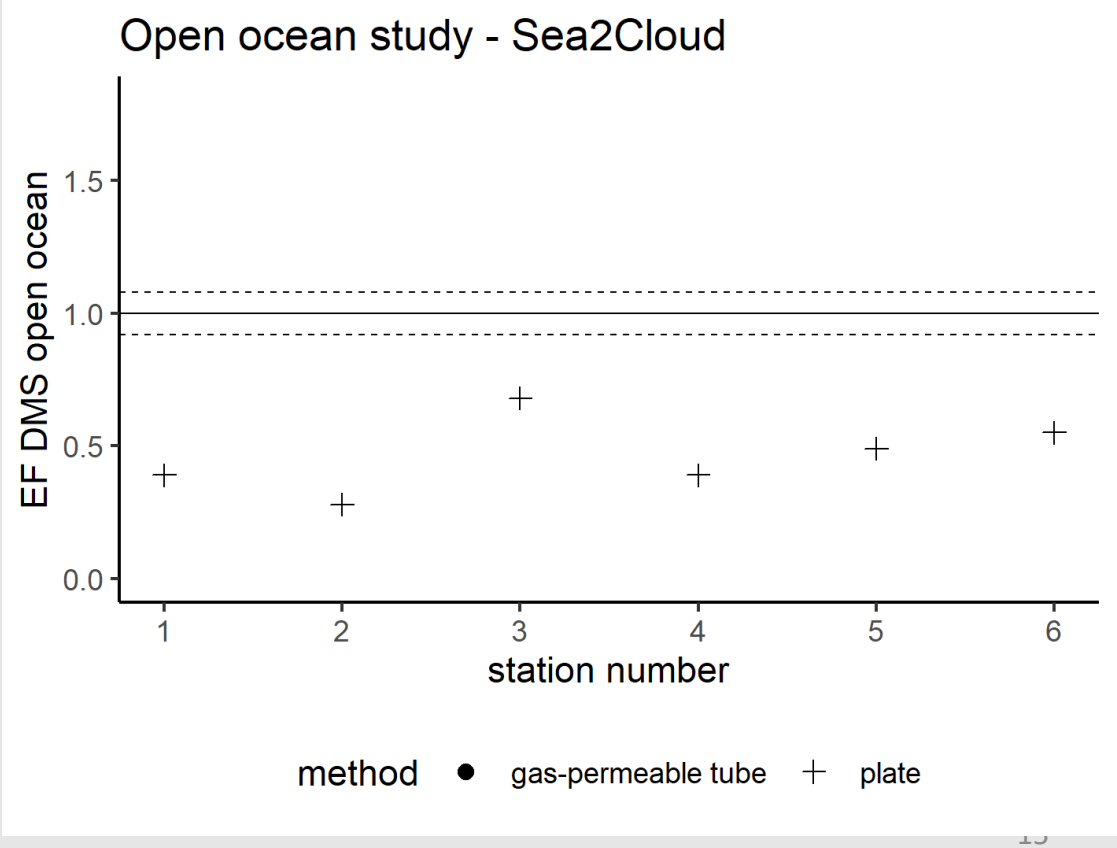
Open ocean study – *Sea2Cloud*



Results from field studies

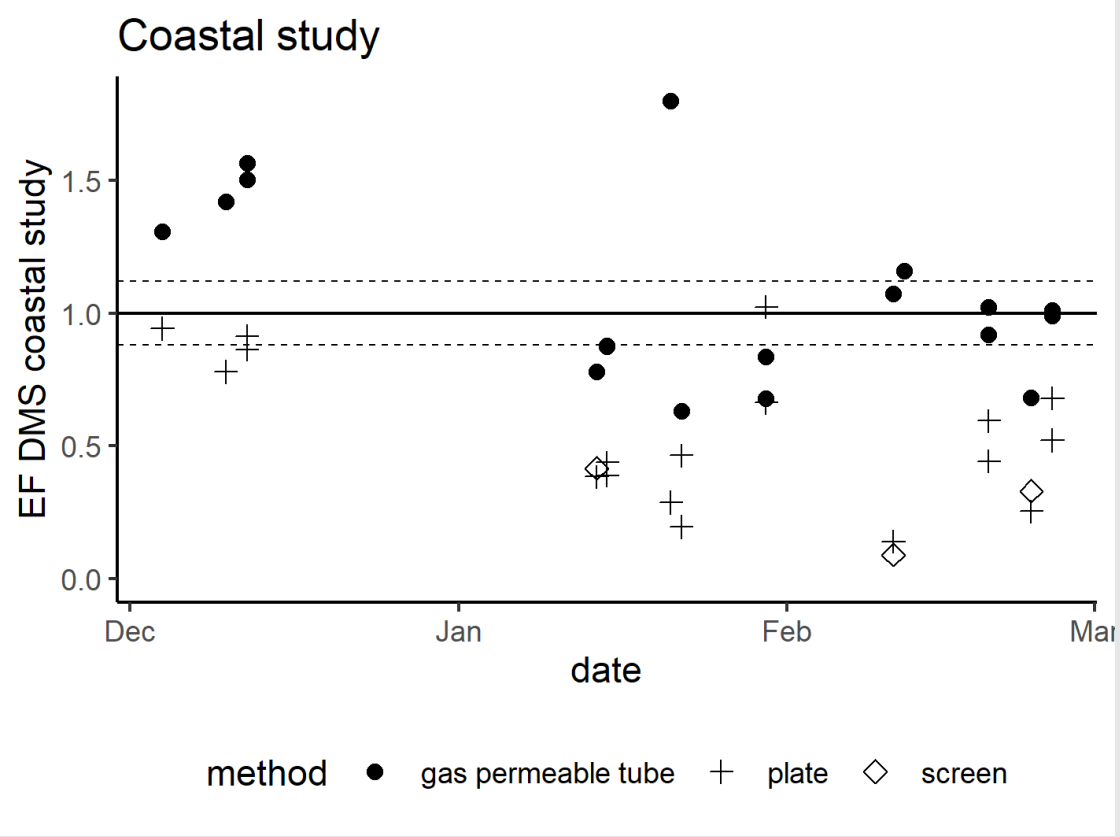
$$EF = [DMS]_{SML} / [DMS]_{SSW}$$

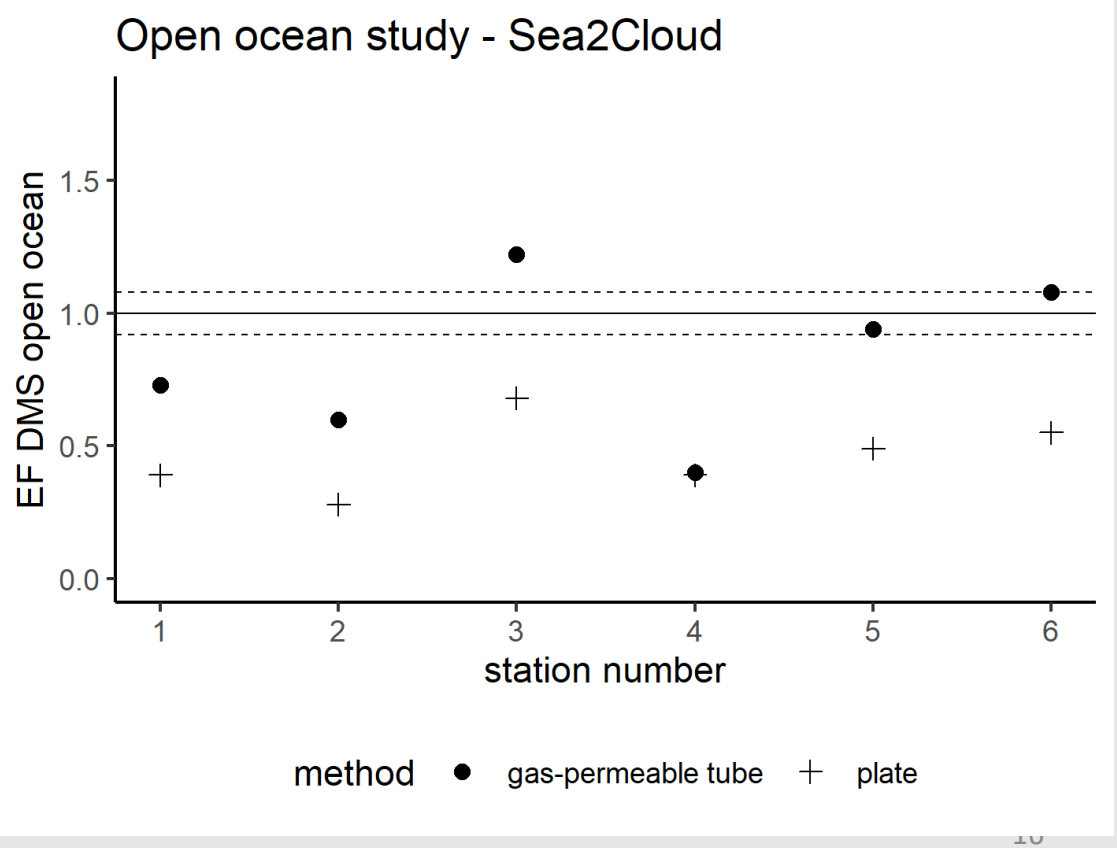




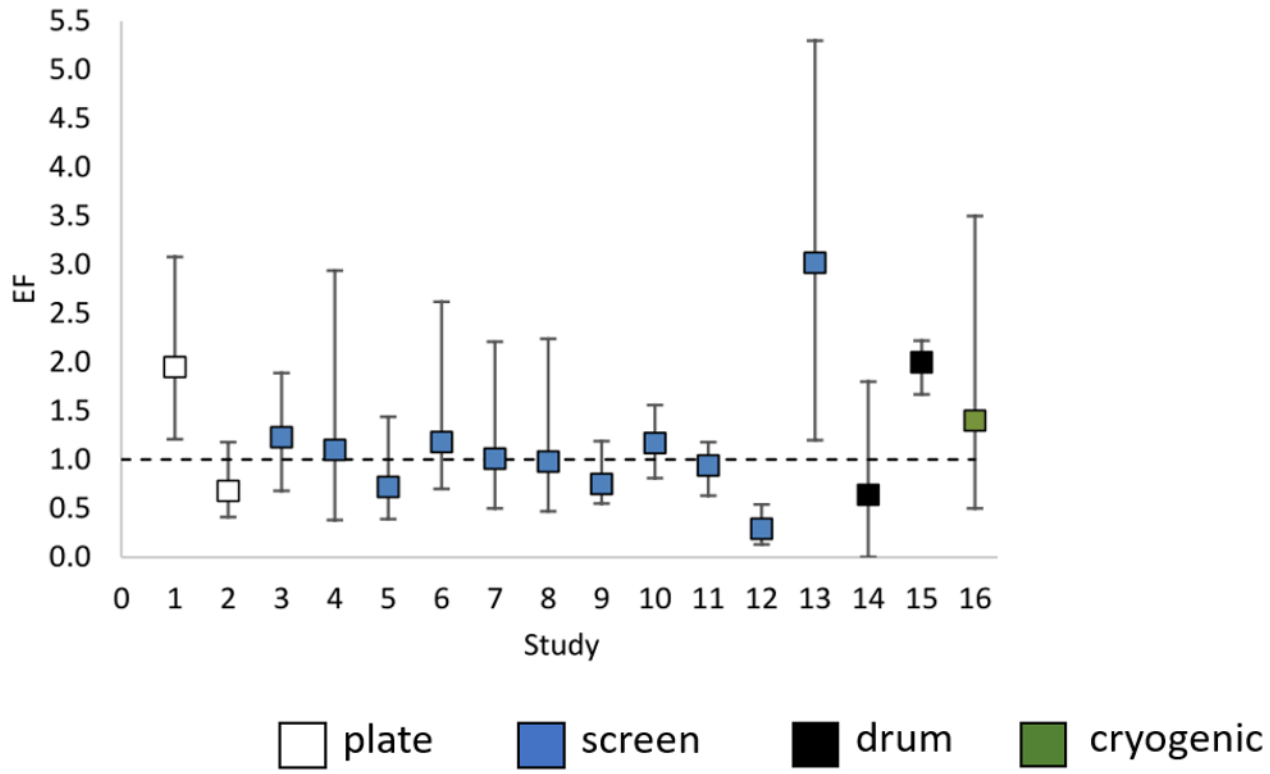
Results from field studies

$$EF = [DMS]_{SML} / [DMS]_{SSW}$$



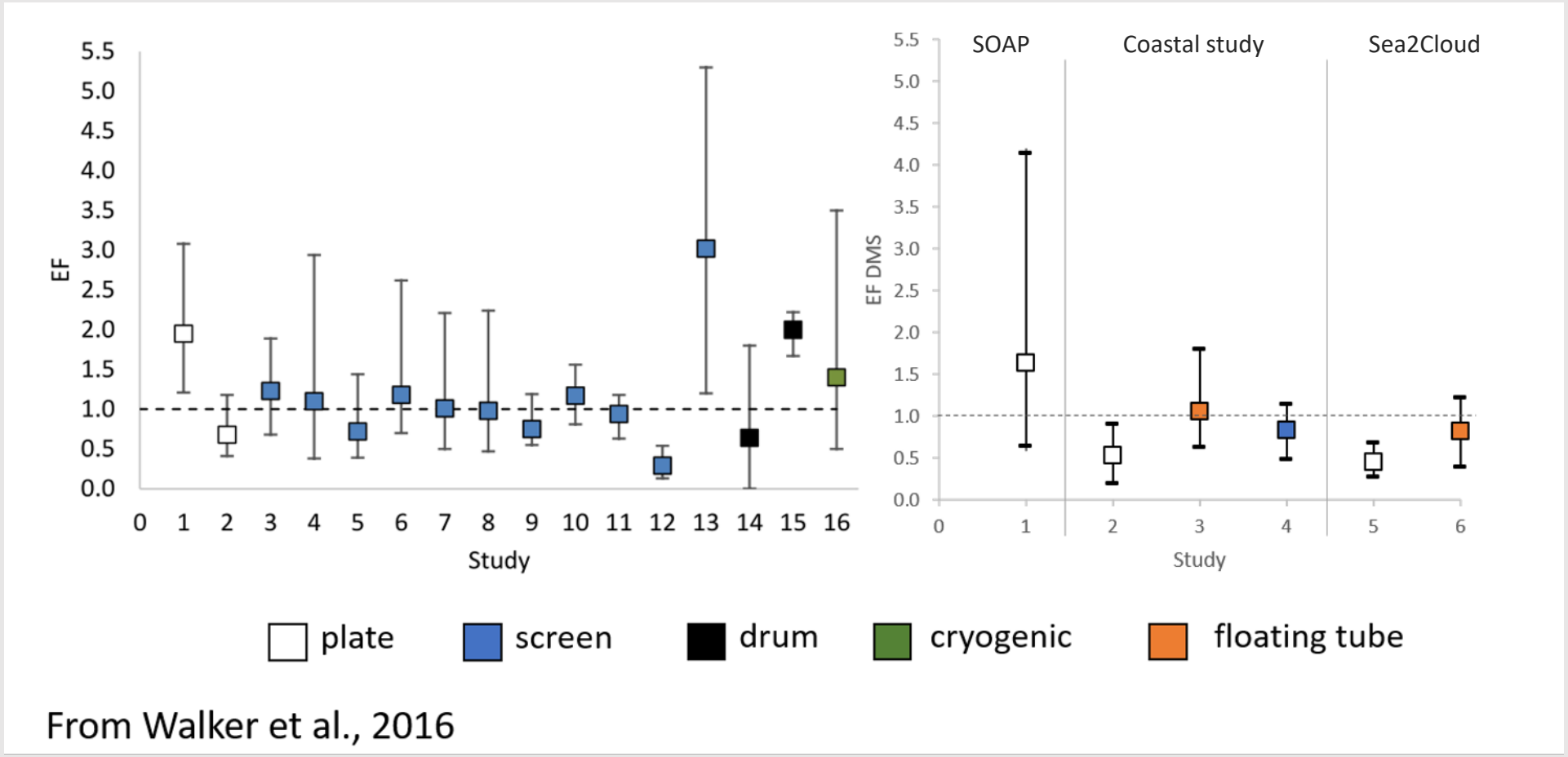


EF DMS in different studies



From Walker et al., 2016

EF DMS in different studies

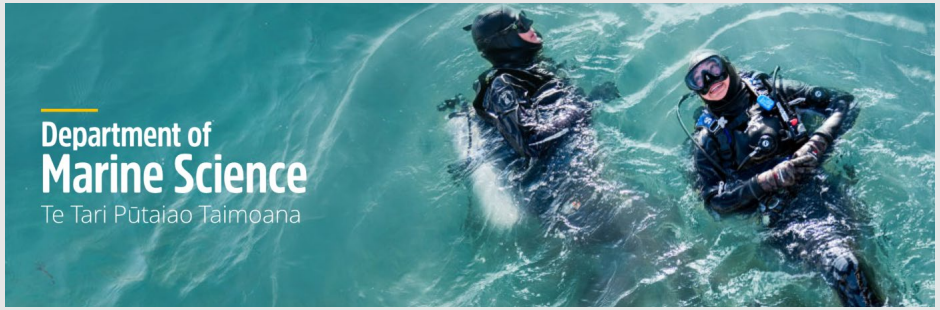


From Walker et al., 2016

Conclusion

- The gas-permeable tube method was shown to be accurate and reproducible
- Higher SML DMS concentration and EF relative to the plate and screen
- The gas-permeable tube method shows potential for SML DMS measurements and possibly for other trace gases in the SML.

Thank you for your attention



alexia.stmac@gmail.com

@Alexia_StMac