EGU25-8267 Poster in session BG4.6 - Greenhouse gas dynamics and fluxes in aquatic ecosystems
Wednesday, 30 April 2025, 14:00-18:00, Hall X1, number X1.113

# Ship-based methodologies to investigate methane emissions from abandoned wells and natural sources: a case study from the Dutch North Sea

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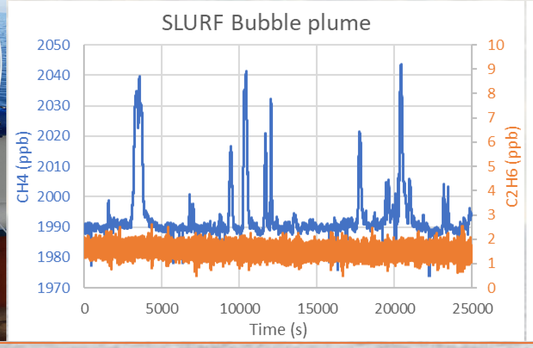
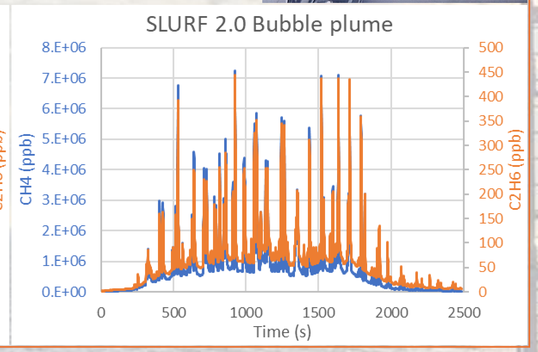
**Methane ($CH_4$) is commercially exploited at continental margins (worldwide/globally) from drilled wells. Typically, these are sealed with concrete once exploitation becomes commercially unprofitable. However, such wells may leak methane to the overlying water column and potentially to the atmosphere. Tailored towards the shallow water depth of the Dutch EEZ (Exclusive Economic Zone) of the North Sea, we developed four ship-based methods to detect methane in the water column or to measure methane emissions from the sea surface to the atmosphere.**


## 1. Online measurements of methane in the water column

Water from a few meters above the seabed was pumped up via 1) a weighted hose (“SLURF”) or 2) a funnel (“SLURF 2.0”) placed on top of a bubble plume with an ROV. The concentration of gases in the water ($CH_4$, $C_2H_6$, $N_2O$, $CO_2$ and CO) were measured with a laser spectrometer.

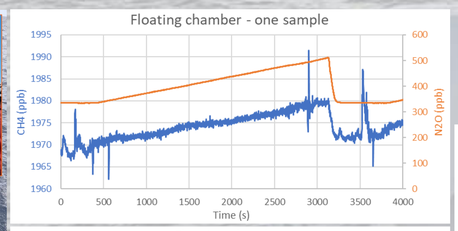
→ SLURF: Qualitative detection of $CH_4$ from bubble plumes
→ SLURF 2.0: $C_2H_6$ = indicator of thermogenic gas (qualitative)

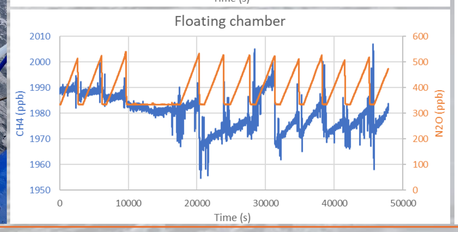


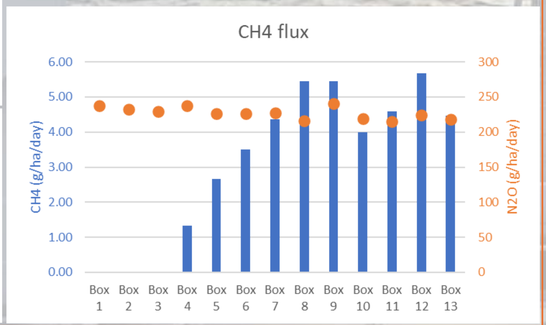

## 2. Floating chamber to quantify the flux of methane coming from the water phase into the atmosphere

Trace gases in the sampled air from a custom build floating chamber for offshore measurements were transported in a closed loop to the same laser spectrometer as the water phase measurements.
A known amount of a tracer gas was added to the return line with a controlled flow to estimate fluxes.




→ Quantification of $CH_4$ water-atmosphere flux
→ Hard to place on top of bubble plume
→ Sensitive for rough weather




## 3. Gradient measurements.

A 3D sonic anemometer and a frame equipped with inlets positioned at three heights above sea level were mounted at the ships portside. Gradient measurements for determining gas emissions were conducted by using a valve system that alternated between the inlets, allowing to measure $CH_4$, $CO_2$ and CO at each height with a gas analyzer for 5 min intervals.

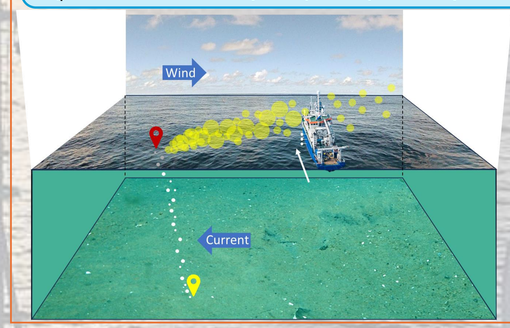
→ Quantification of $CH_4$ water-atmosphere flux possible without ship motion data
→ Sensitive for rough weather

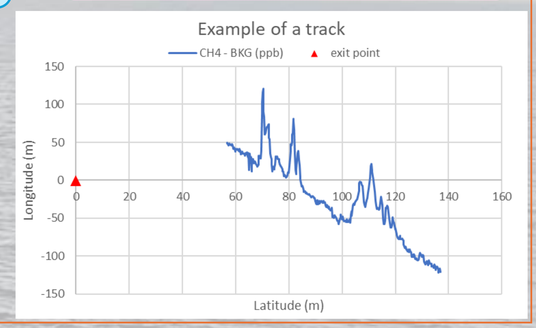
## 4. Plume measurements.

Multibeam (MBES) to detect bubble plumes and the exact location where the bubble plume exit the water (exit point ▼). Fluxes of bubble plumes from the water column to the atmosphere were assessed by sailing downwind of the bubble plumes with the inlet system facing towards the exit point upwind (1.7 m asl).

**Emission rate**
**=**
**$CH_4$ concentration + exit point (source) + wind speed + Gaussian plume model**

→ Quantification of $CH_4$ water-atmosphere flux
→ Sensitive for rough weather




## Conclusions

Four ship-based methods to detect $CH_4$ bubble plumes from leaking wells (or natural seepage) are presented.

1. SLURF can detect bubble plumes, and SLURF 2.0 can distinguish thermogenic and biogenic $CH_4$ via $C_2H_6$
2. Floating chamber can quantify $CH_4$ flux. Next to bubble plumes, flux is negligible.
3. Gradient measurements can quantify $CH_4$ flux, but laborious methodology
4. Plume transect measurements can quantify $CH_4$ flux (+ MBES, windspeed and Gaussian plume model)

| Method | Measurement | Emission quantification (EQ) |
|---|---|---|
| 1. SLURF | Bubble plumes in water | Presence |
| 2. Floating chamber | Flux water – Atmosphere | EQ |
| 3. Gradient | Flux water – Atmosphere | EQ |
| 4. Plume transect | Flux water – Atmosphere | EQ |

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De Bruin, G., de Stigter, H., Diaz, M., Delre, A., Velzeboer, I., Versteijlen, N., Niemann, H., Wilpshaar, M., Reichart, G.J., 2025. Methane leakages from abandoned wells in the Dutch North Sea. *Marine and Petroleum Geology* **171**: 107184 (https://doi.org/10.1016/j.marpetgeo.2024.107184)

Go to: **EGU25-12579** Oral In situ monitoring reveals episodic water column methane anomalies at abandoned wells in the Dutch North Sea
Thursday, 1 May 2025, 17:20, Session BG7.1 - Methane dynamics in aquatic systems, room 2.95

Go to: **EGU25-14858** Poster Advancing methane emission quantification: a robust methodology for site-level measurements
Thursday, 1 May 2025, 14:00-18:00, Hall X5 board number X5.116