Assessing Arctic atmospheric methane monitoring needs through synthetic data experiments

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Scenario’s
Yedoma, ESAS

Synthetic observations
GEOS

Signal detection
Towers, Satellite

Inversion
future step

East Siberian Arctic Shelf (ESAS) CH$_4$ release$^1$

Atmospheric tower network

Difference: baseline vs Scenario, Lidar
Yedoma thaw

- A 10% increased CH4 flux from yedoma can already be detected by 5 sites.
- A 130% increase means the entire network will detect it.
- Low fluxes as reported should be detectable by at least 3 towers.
- 10% of fluxes reported should be detectable by at least one tower.
Synthetic observations, Biases and Errors. Based on Bousquet 2018³
Difference between baseline and high flux

Percentage tests that differentiate, FDR corrected

- Large error, High flux
- Large error, Low flux
- Small error, High flux
- Small error, Low flux

Flux percentage

Mean difference (ppb)
- 5.1 - 11.6
- 11.6 - 18
- 18 - 24.5
- 24.5 - 30.9
- 30.9 - 37.4
- 37.4 - 43.9
- 43.9 - 50.3

ESAS
- Background
- Hotspot
**Conclusions**

- Both scenario’s should be detectible, with the current atmospheric tower network.
- Despite random errors at least an order of magnitude higher, Merlin(like) lidar functions just as well if not better than atmospheric towers, this can be attributed to its high rate of sampling and spatial coverage.
- Active sensors like Merlin can play a crucial role in understanding the high latitude carbon cycle.

**Future**

- Lidar based sampling for Yedoma case
- Tropomi like synthetic sampling
- Network optimization
- Inversion

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