In situ observations support the Methane Pledge
The Nord Stream leaks case study

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Introduction

The Global Methane Pledge was signed by nearly 100 countries to reduce anthropogenic methane (CH_4) by 30%.

CH_4 is emitted from landfills, agriculture, oil and gas systems.

Mitigation steps of greenhouse gases (GHG) are hard to assess.

The recent leaks from the Nord Stream pipes gave a rare opportunity to compare different methods and show particularly the value of in situ networks with standardized measurements.

Methodology

***In situ*, ground-based measurements.**
ICOS has 150 stations.
Precise and continuous GHG measurements in all weather conditions, day and night.

Satellites (GOSAT, Sentinel 5P TROPOMI, GHGSat) have spatial and temporal coverage; do not provide data over cloudy areas as most use reflected sunlight.

Models use both ground-based data and satellite data for optimizing their outputs.

The integration of in situ and satellite data into models allows the calculation of fluxes of GHG from the surface to the atmosphere.

Results

ICOS stations
CH_4 plume was detected first in Utö, then Norunda, followed by Hyltemossa and Birkenes, and finally Ridge Hill.

Satellites
had a limited view of the leak due to clouds.
CH_4 monitoring over high latitude seas is difficult.

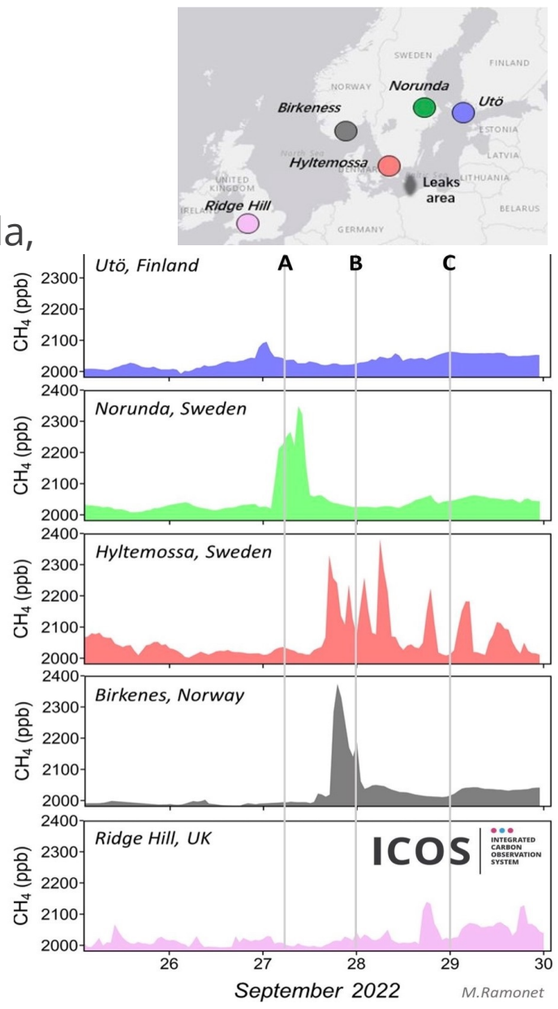

Fig 1. CH_4 concentrations from five ICOS stations[1]

Models
CAMS simulated the leaks, and were evaluated with ICOS data. Simulated and observed time series of atmospheric CH_4 at Hyltemossa (Sweden).

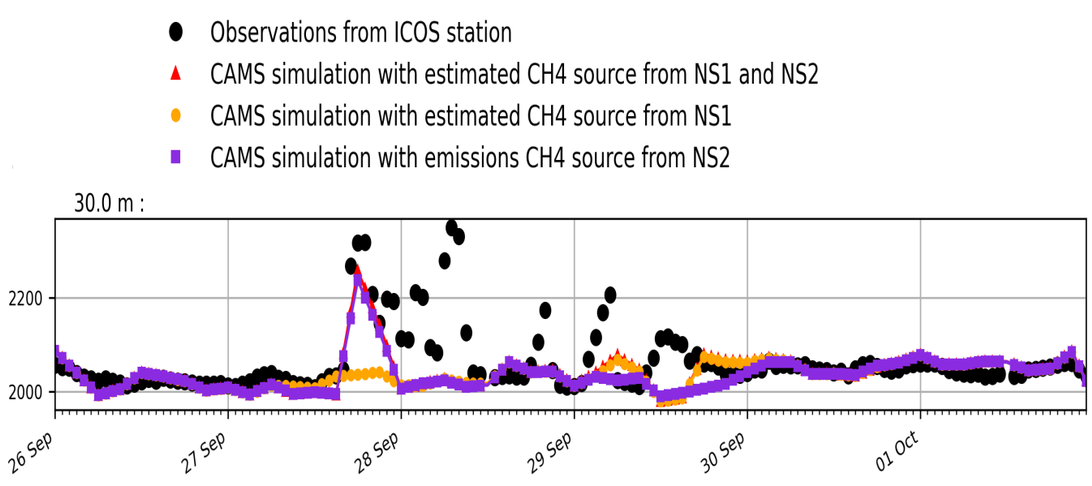

Fig 2. Methane concentrations at different heights at Hyltemossa from observation (black) and CAMS model simulation[3] with estimated CH_4 from Nord Stream pipes NS1 and NS2 (red), using NS1 only (yellow) and using NS2 (purple) only.

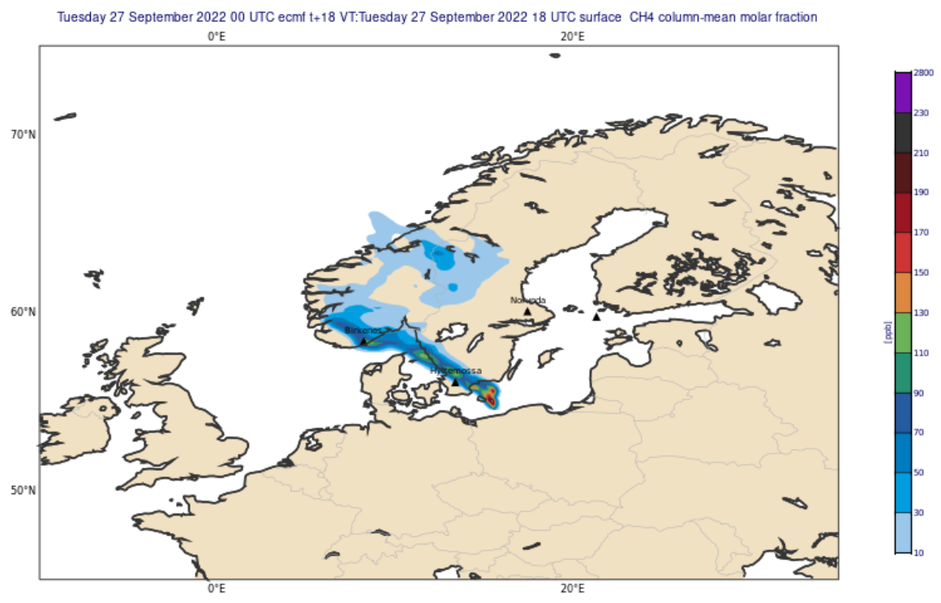

Fig 3. Simulated CH_4 plume for 27 September when it reached Hyltemossa.

Conclusions

ICOS stations detected CH_4 leaks in real-time. Multiple stations helped track the movement of the high CH_4 plume.

GHG satellites measure visible light, making CH_4 monitoring over seas difficult as water absorbs most of the light needed for measuring CH_4. Thus, satellites provide little information on how much CH_4 was released into the atmosphere during the leaks.

Different models simulated the leaks and movement of the CH_4 plume in order to estimate the amount of CH_4 lost. ICOS in situ data supported the models.

The Nord Stream leaks emphasize the need for an integrated observation system comprising ground-based stations, satellites and models, for the monitoring and mitigation of GHGs.

The practical use for the parties will be:

- Verification of emission reductions
- Detection of unreported methane fluxes (e.g. leakages in pipelines)
- Support of local efforts e.g. in cities or hot spot areas.

References and further info

CoCO2
Prototype system for a Copernicus CO_2 service

ICOS
Integrated Carbon Observation System

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