Overview of ESA initiative to couple TROPOMI CAL/VAL experience with new Copernicus Contributing Missions (CCMs) measuring CH4 emissions with very high spatial resolution

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Quick Summary: An ATM-MPC team consisting of TROPOMI validation and calibration specialists has been assembled to lend guidance to atmospherically relevant Copernicus Contributing Missions (CCMs). The goal of CCM parties is to deploy series of small satellite instruments primarily aimed at hi-res emission hotspot monitoring and plume detection.

The collaborative ATM-MPC+ESA+CCM work aims to bring together:

1) **European Small Sat enterprises (CCMs)** for hi-res hotspot/emission detection
2) **ATM-MPC Tropomi VAL/CAL team core** with expertise in routine validation, QC
3) **CAMS assimilation & forecasting** aimed at developing new (urban) hi-res targets
4) **On-ground campaign support** at new European super sites created for CAL/VAL.

CCM parties focused on Atmospheric Composition

Currently two companies in contract with ESA to work toward becoming data providers of high-resolution atmospheric data. Both focus on Methane (CH_4) emission. Each company completed successful ESA reviews (Q2-2024), and are now working with a small team of ATM-MPC validation and calibration specialists for L1 and L2. Both aim to use TROPOMI data for tipping and cueing of sources.

SATLANTIS

Satlantis status summary: A Spanish company (https://satlantis.com/) Launched their first CH4-emission small satellite (GEISAT precursor) in June 2023, successfully completed a commissioning phase (Q1-2024) are now are actively planning on-ground measurements along with ways to build on and improve successor instruments. Plume detection has been successfully demonstrated in Northern Africa (see image right, recent press release, estimated 818 kg-CH4/h in Feb 2024).

ABSOLUT Sensing
Monitor · Understand · Predict

Absolut Sensing status summary: French company (https://absolut-sensing.com/) Preparing for their first launch CH4-emission small satellite in late-2024, they are actively planning on-ground calibration campaigns for this summer, particularly focusing on CH4 release experiments to characterize flow rates in plumes.

TROPOMI ATM-MPC approach for CCM-support:

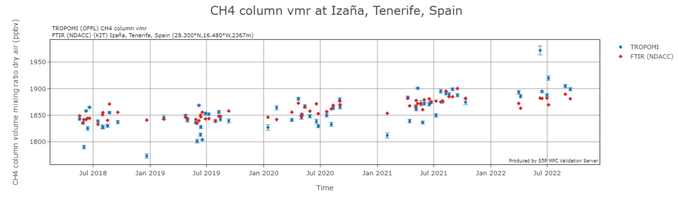
The baseline for TROPOMI methane validation relies upon two key global networks of ground-based monitoring TCCON and COCCON. Lower cost EM27/Sun spectrometers are essential for global CH4 measurement & S5P validation. Network data is fed in to the ATM-MPC Validation Server and can be plotted as soon as available to visualize biases and trends in the TROPOMI CH4 retrieval. This model for baseline operation will be evaluated and modified to develop the validation approach for CCM sample datasets.

Calibration of EM27/Sun spectrometers; image from Frey et al. AMT, 2019.

Multiple EM27/Sun instruments can be deployed to characterize release and/or plume detection experiments.

https://mpc-vdaf.tropomi.eu/

An example from the TROPOMI validation server using FTIR vs. TROPOMI CH4 column meausurements:



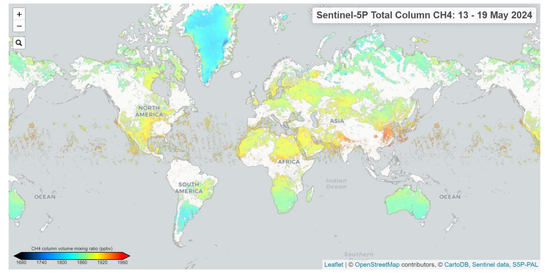
Evaluation is ongoing to assess how to bridge spatial scale difference between TROPOMI and small sats which typically have pixels as small as 30 m2.

https://www.radcalnet.org/ sites and data availability are being evaluated for applicability for the small sat Level 1 validation. Small swaths and long return periods of small sat present challenges to usability.

TROPOMI mapping sites like PAL help CCM parties set the context for first estimates of background CH4 amounts & visualize hotspots over time

Copernicus Sentinel-5P Product Algorithm Laboratory

https://maps.s5p-pal.com/ch4/



Current ATM-MPC activities:

- In general, look to give guidance about community standards and best practices
- Evaluate data naming conventions, file formatting, compatibility with S5P and Sentinel-type tools and software
- Mapping of small sat data processing and data product chains to S5P
- Consistency and clarity in error budgets
- Use case definitions & assessing maturity