First atmospheric ICOS station in Belgium in support of the VERBE project

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First atmospheric ICOS station in Belgium

Figure: Left: Location of Meerdaal and the surrounding ICOS stations. Middle: The communications tower in Meerdaal with the two platforms at 58 and 81 m. Right: Diagram of the tower measurement setup.

A new atmospheric ICOS site will be established in Belgium with the support from Michel Ramonet and Morgan Lopez at LSCE. The location will be an Astrid telecommunications mast on the DOVO-SEDEE military site in the Meerdaal forest in Oud-Heverlee (7 km South of the city of Leuven). The tower has platforms at 58 and 81 m above ground level. Air sampling inlets will be installed on these two platforms. The sampled air is pumped to a Picarro G2401 CO_2, CH_4 and CO gas analyzer in a lab container at the foot of the tower.

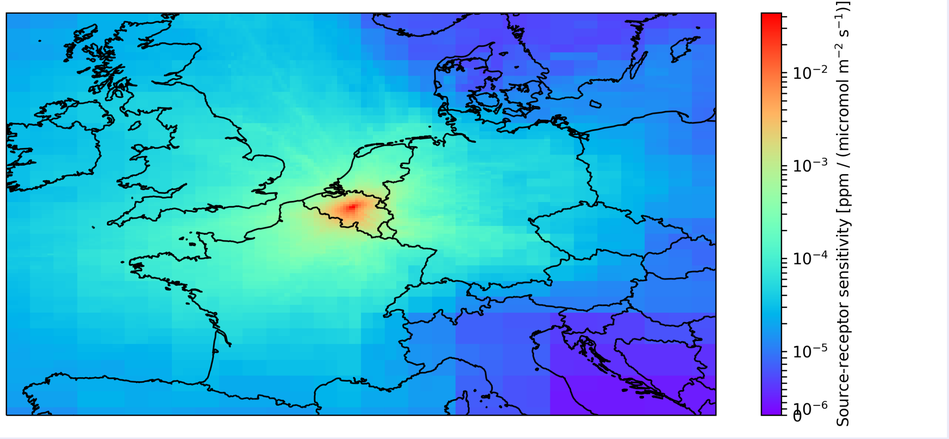


Figure: Average STILT surface sensitivity for the year 2022 at the 81 m tower level in Meerdaal [1].

The site is located near the center of Belgium and offers good coverage of the entire Belgian territory and neighboring countries.

VERBE project and objectives

VERBE (`https://verbe.aeronomie.be/`) is a BRAIN-be 2.0 project, funded by the Belgian Science Policy Office, that aims to establish a sustainable Belgian observation- and model-based Monitoring and Verification System (MVS) for emissions of greenhouse gases (GHGs) anchored in a structural collaboration between BIRA-IASB and UAntwerp, The target GHGs are CO_2, CH_4 and N_2O.

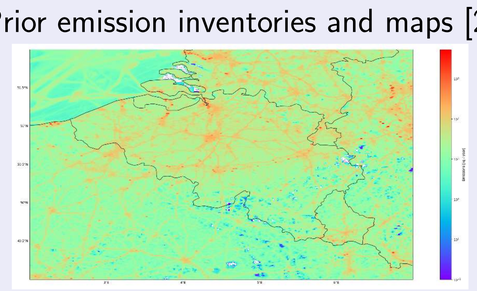
The **long-term objectives of VERBE** are:

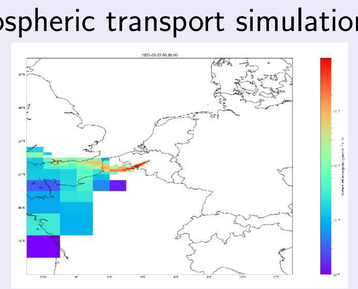
- Quantifying the GHG concentrations above Belgium at a subregional scale ($\sim$ 25 km^2),
- Identifying and quantifying major sources and sinks,
- Distinguishing between anthropogenic and biogenic sources and sinks
- Monitoring the evolution of the atmospheric burden of GHGs above Belgium and evaluating the impact of mitigation strategies, e.g., the impacts of the energy transition and future negative emission technologies, traffic control measures, changes in agricultural practices, etc...
- Providing indications for sectors or point-sources with a high potential for GHG emission reduction.

VERBE Concept

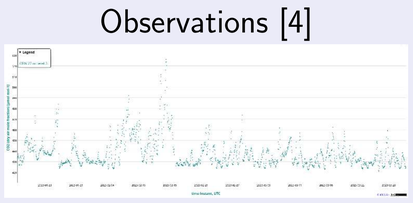
VERBE will develop a system that combines ground- and space-based observations of atmospheric GHG concentrations with atmospheric transport models in a Bayesian inversion framework (in collaboration with DLR). The observations are used to constrain prior emission inventories and to yield top-down emission estimates for the target GHGs.

Prior emission inventories and maps [2] Atmospheric transport simulations [3]





Observations [4]



Bayesian inversion [5]

CTDAS
CarbonTracker Data Assimilation Shell

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A posteriori emission estimates and maps constrained by the observations

FTIR campaign around Antwerp

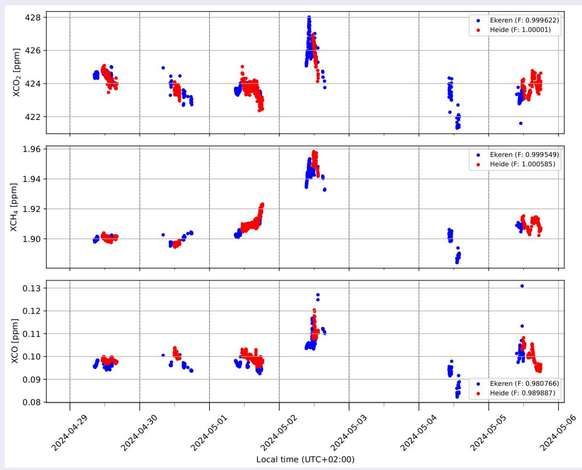
Campaign setup

Figure: Left: KIT Bruker EM27/SUN in Ekeren, VU Amsterdam EM27/SUN enclosure in Heide, KIT EM27/SUN in Wilrijk, Bruker Invenio in a prototype BIRA-IASB instrument enclosure with solar tracker in Kruibeke. Right: FTIR instrument locations around Antwerp during the FTIR campaign.

The first VERBE FTIR measurement campaign was carried out between April 25 - May 5 2024 around the city and port of Antwerp. Four mobile FTIR remote sensing instruments were placed up- and downwind of the Antwerp area to monitor the city and port emissions.

Results

The weather during the campaign was not favorable with only a few sunny days. Furthermore the EM27/SUN instrument in Wilrijk and the BIRA-IASB prototype enclosure had pointing problems with their solar trackers. Only the two instruments on the north side of Antwerp, in Heide and Ekeren, delivered usable data.



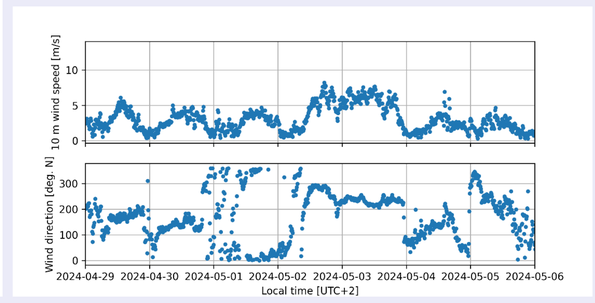


Figure: Left: column-averaged dry-air mole fractions of CO2, CH4 and CO measured in Ekeren and Heide. Data was analyzed using PROFFAST and individual instrument calibration factors obtained as part of the COCCON have been applied [6]. Right: Wind speed and direction from the KMI-IRM weather station in Stabroek (51.325°N, 4.364°E) [7].

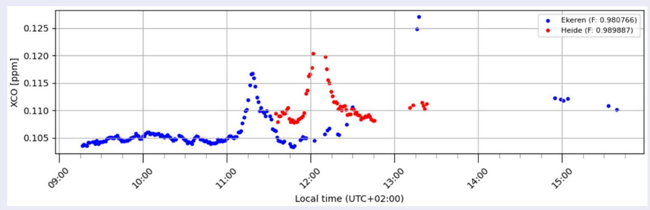


Figure: Peaks in XCO detected at Ekeren and Heide on May 2, 2024. The timing and intensity of these pronounced peaks suggest a strong, local source.

Related projects and partners

Related projects

- BELSPO FEDtWIN project BE-MVS: A Belgian greenhouse gas emissions Monitoring and Verification System (BIRA-IASB and UAntwerp)
- ICOS Belgium is supported by ICOS Infrastructure Projects (FWO-IRI), ICOS-BE (BELSPO), ICOS-WB (SPW)
- ESA World Emission project (`https://www.world-emission.com`)

National and international partners

International partners from Germany, France and the Netherlands are involved in the VERBE project or are member of the project's follow-up committee. DWD and DLR are part of the ITMS project, that aims to establish an integrated greenhouse gas monitoring system for Germany (`https://www.itms-germany.de`).

References

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7. `https://opendata.meteo.be/geonetwork/srv/eng/catalog.search#/metadata/RMI_DATASET_AWS_10MIN`