Data
Models
Inventories

PARIS

Process Attribution of Regional Emissions

GA 101081430, RIA

New F-gas measurements uploaded to ICOS portal

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Horizon Europe Cluster 5: Climate, energy and mobility
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1. Changes with respect to the DoA (Description of the Action)

It was originally intended to upload a complete year of extended and quality-controlled data in month 14 of PARIS. However, it became clear at an early stage that this would not be possible due to the timeline of the data review process, which would in large parts be incorporated into the AGAGE data review process. This review process takes place twice a year and as every data point should be viewed at least during two data reviews, this data release is always at least a year behind schedule. For quality reasons we decided to only submit data for PARIS which have undergone at least one data review. Therefore, the deliverable is slightly delayed. While the data will be released publicly, there is a disclaimer that the data are embargoed up to the release of the bottom-up emissions for the respective year. The data up to the end of the year 2023 have been uploaded to the ICOS carbon portal and available on request (https://horizoneurope-paris.eu/data/).

2. Dissemination and uptake

The PARIS data are publicly available through the ICOS carbon portal. They are, however, restricted in use by a data disclaimer (Annex), as they have not undergone the whole AGAGE data review process. PARIS data which are fully controlled are released in parallel through the AGAGE network and are currently (as of July 2024) available up to June 2023 (https://agage2.eas.gatech.edu/data_archive/agage/gc-ms-medusa/event/taunus/netcdf/).

3. Short Summary of results

As part of PARIS, a new MEDUSA (Arnold et al., 2012; Miller et al., 2008) measurement system was installed at Taunus Observatory (Schuck et al., 2018) in early February 2023, with continuous measurements commencing on February 5, 2023. To ensure that PARIS data is intercomparable with data from other programs such as ACTRIS, PARIS data is fully incorporated into the AGAGE network (Prinn et al., 2018). This includes full quality control and provision of consistent absolute scales, and ensures that the quality of the new measurements (instrument precision) is comparable to other AGAGE stations. Data which are being used in the inversions of the PARIS project are from the new station at Taunus and the existing AGAGE stations at Mace Head, Tacolneston, Zeppelin, Monte Cimone and Jungfraujoch, the latter station not being part of the PARIS project.

4. Evidence of accomplishment

4.1 Introduction | Background of the deliverable

Concerning the F-gases, the PARIS project has identified three major limitations in our understanding of F-gas fluxes across Europe, as outlined in our proposal:

1) the limited measurement network,
2) poor understanding of the spatial and temporal distribution of emissions and,
3) the wide variation in emission factors used by different countries in UNFCCC reporting.

A prerequisite for improving the second and third aspect is the establishment of a robust observational network.

PARIS has chosen to focus on the most important F-gas climate forcers in Europe, including HFC-134a, -143a, -125, -32, -227ea, -365mfc, -152a, HFC-23, HFC-245fa, HFC-43-10mee, PFC-14, -116, -218, -318, NF_3, SF_6. Any reference to F-gases in this context refers to this list unless otherwise specified.

Despite their smaller emissions compared to major greenhouse gases like CO_2, CH_4, and N_2O, these F-gases contribute significantly to climate change due to their high global warming potentials. In fact, relative to 1750 conditions, halogenated greenhouse gases have had a larger impact on climate change than N_2O. Nonetheless, the observational network for these gases remains sparse.

Because of their very low abundance compared to the major GHGs, measuring F-gases is challenging and requires sophisticated and expensive gas chromatograph mass-spectrometer (GC-MS) systems. The current measurement infrastructure in Europe, supported by the AGAGE network and related activities, includes GC-MS "Medusa" systems or similar instruments at key sites, enabling the measurement of major fluorinated gases approximately every two hours. Our current capacity to estimate top-down European F-gas emissions is based on high-frequency measurements from Mace Head (Ireland), Tacolneston (UK), Jungfraujoch (Switzerland) and Monte Cimone (Italy), as well as low-frequency flask samples from Taunus (Germany) (Fig. 1). However, significant caps remain in our sensitivity to European emissions (Fig. 2 and 3). While high-frequency measurements for a subset of F-gases are currently available from Taunus, their lower quality compared to other AGAGE stations limits their value for top-down emissions inference.

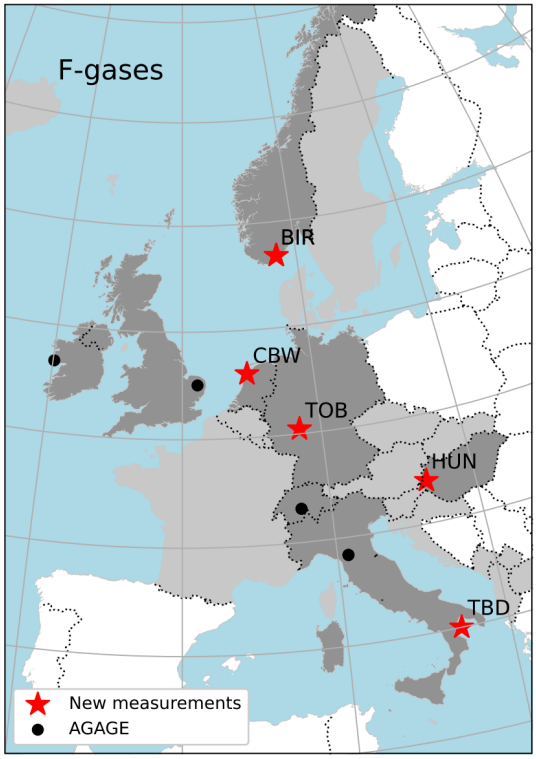

Fig. 1: F-gas measurement sites
Existing high-frequency measurement stations are shown as black dots (AGAGE and affiliated). New high-frequency measurements will be installed at Taunus (TOB). New flask sampling is proposed at the locations indicated by a red star, at Birkenes (BIR), Cabauw (CBW), Hegyhátsál (HUN) and a site in southern Italy (TBD). Countries shown in light grey are those where national emissions inferences are likely to be possible, and focus countries are shown in dark grey. PARIS focuses on the most important PFCs, and the F-gas climate forcers in Europe (HFC-134a, -143a, -125, -32, -227ea, -365mfc, -152a, HFC-23, HFC-245fa, HFC-43-10mee, PFC-14, -116, -218, -318, NF_3, SF_6).

In this project, Taunus (Germany) has been added as an in-situ station that is fully integrated into the AGAGE network, making 2-hourly measurements of approximately 50 F-gases using the AGAGE GC-MS system. PARIS has also expanded new flask-sampling activities to Birkenes (Norway) and Hegyhátsál (Hungary), continued sampling at Cabauw (Netherlands) and established the new site Capo Granitola in southern Italy. Except for the measurements at Cabauw and Taunus Observatory, the new observations are not part of this first data release as they only started in early 2023, as planned.

Measuring F-gases is critical as they are strong greenhouse gases, with emissions regulated under international treaties such as the Kigali Amendment to the Montreal protocol. The verification of bottom-up estimates can be achieved by implementing regional observations, but due to their low concentrations in the atmosphere measurements are difficult and require high accuracy as expected changes are small. Continuous measurements by in-situ gas chromatography coupled with mass spectrometry provide the best opportunity to collect dense and high-quality data. However, this approach requires very expensive, specialized equipment and significant maintenance work to ensure high data quality. A particularly effective instrument is the MEDUSA system which is the standard used in the AGAGE (Advance Global Atmospheric Gas Experiment, https://agage.mit.edu/) network.

A new MEDUSA system was installed at Taunus Observatory in Germany in early February 2023, and it has been providing high quality data since then. This data is being used e.g., in the inverse modelling work as part of PARIS. Fig. 1 shows the observational network extended by PARIS, highlighting Taunus Observatory (TOB) as a new continuous station running the MEDUSA instrument. This data release includes measurements from the AGAGE stations Taunus, Mace Head, Tacolneston, Zeppelin, Monte Cimone and Jungfraujoch, with the latter station not being a project partner.

4.2 Scope of the deliverable

The deliverable consists of the upload of all data including the additional new data. These data are the basis for the derivation of emissions using top-down methods and are available for the inverse modelling, which will improve the top-down estimate of emissions, staring in the year 2023.

The data set includes the target gases of PARIS specified in the proposal, i.e. HFC-134a, -143a, -125, -32, -227ea, -365mfc, -152a, HFC-23, HFC-245fa, HFC-43-10mee, PFC-14, -116, -218, -318, NF_3 and SF_6 from the stations Taunus, Mace Head, Tacolneston, Zeppelin, Monte Cimone and Jungfraujoch with a typical time resolution between 12 and 16 measurements per day. It also includes data from measurements on samples collected at the Cabauw station.

Metadata: The dataset is accompanied by comprehensive metadata, detailing information such as the measured species, the measurement units, station name, calibrations scales and height of the air inlet. It also includes contact information of the submitters.

Findability: The dataset can be accessed via the ICOS carbon portal. A link to the data base is available on the PARIS website https://horizoneurope-paris.eu/data/.

Accessibility: The dataset will become publicly accessible but is currently embargoed until April 2025 as it forms the basis of the inversions which be released at that time. Users are, however, advised to refer to the data set available via the AGAGE network, as this will have undergone further quality checks by the time of release. This is specified in the data disclaimer.

AGAGE data are available at https://agage2.eas.gatech.edu/data_archive/agage/gc-ms-medusa/event/taunus/netcdf/

Interoperability: The dataset is supplied as netCDF, facilitating interoperability with other datasets and platforms.

Reusability: the data set is derived from standardized data evaluation process and error estimates as well as calibration scales are supplied, ensuring that the data are reusable as the can be linked to internationally accepted standard scales.

4.3 Content of the deliverable

PARIS focuses on the most important F-gas climate forcers in Europe (HFC-134a, -143a, -125, -32, -227ea, -365mfc, -152a, HFC-23, HFC-245fa, HFC-43-10mee, PFC-14, -116, -218, -318, NF_3, SF_6), all of which can be observed by the MEDUSA system run at the AGAGE stations. Within the frame of the PARIS project the measurements from the new AGAGE station at Taunus Observatory in Germany have been integrated into the network in order to expand the observational network.

The uploaded data set is based on the new instrument at Taunus Observatory, which has been running continuously with some interruptions due to technical problems. Fig. 2 and 3 show the measurements for some selected PARIS target gases for the year 2023 in for the European AGAGE stations which are closely linked to the PARIS project (thus without Jungfraujoch). The new measurements thus extend the network as planned. Especially for SF_6, it Is clearly visible that more pollution events with enhanced mixing ratios are observed at Taunus Observatory than at other stations. This shows that the added site Taunus Observatory is a site which is well suited to derive atmospheric emissions.

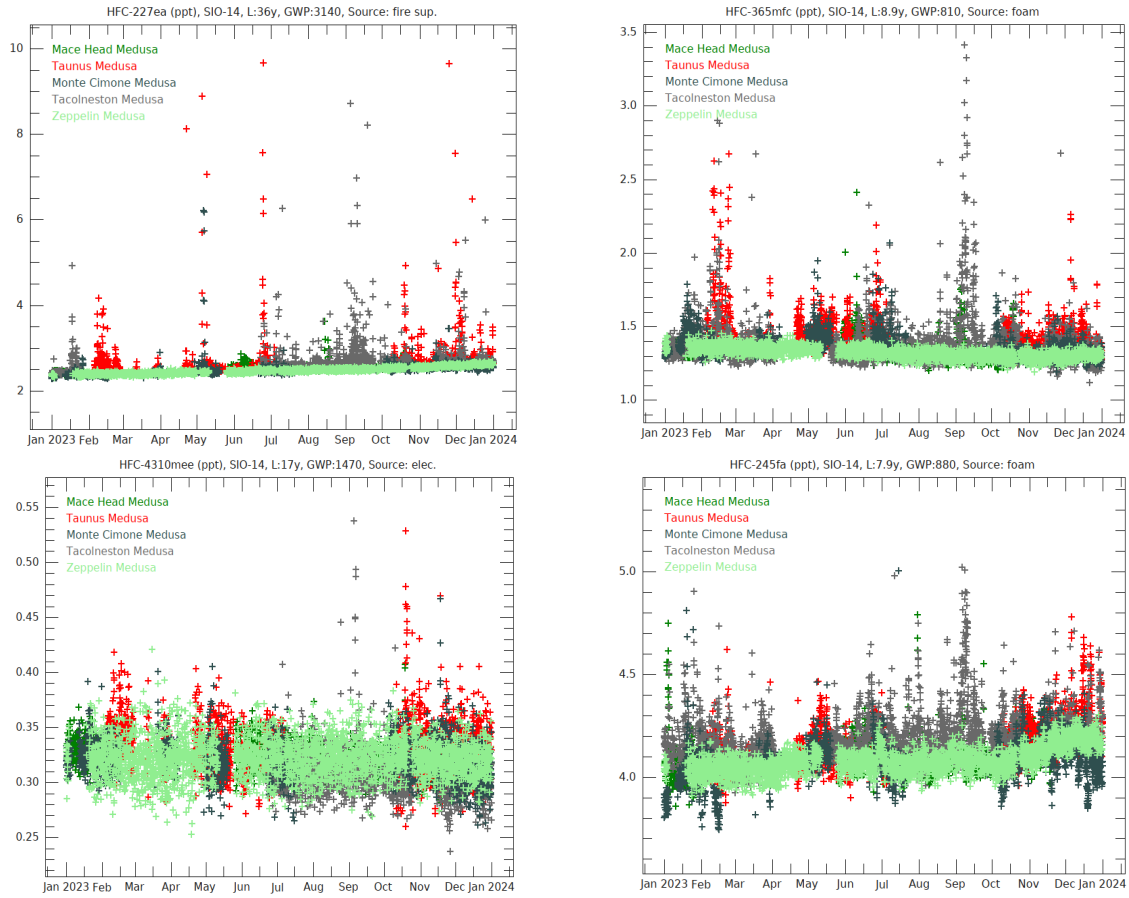

Fig. 2: Full year of extended F-gas observations.
Measurements of some major HFCs for the year 2023 at AGAGE stations linked to the PARIS project, including the new measurement at Taunus Observatory (shown in red).

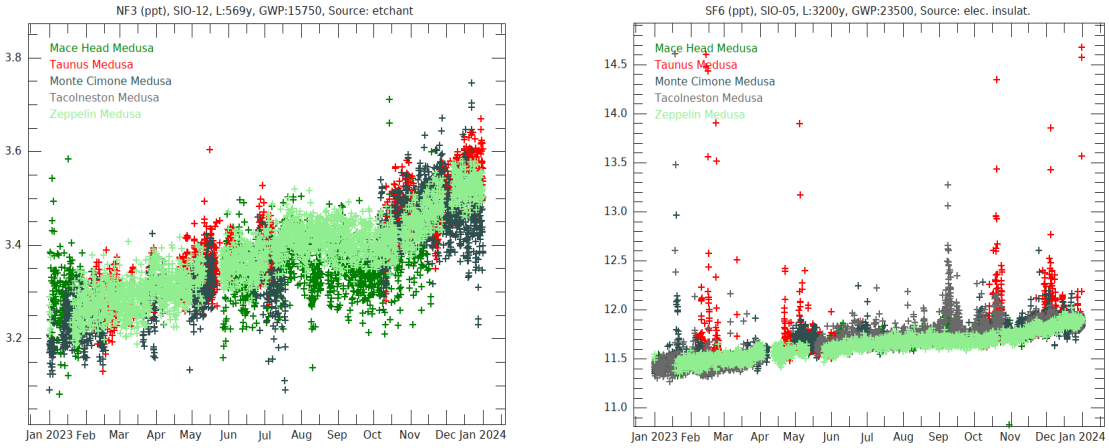

Figure 3: Full year of extended F-gas observations.
Measurements of NF_3 and SF_6 for the year 2023 at AGAGE stations linked to the PARIS project, including the new measurement at Taunus Observatory (shown in red)..

4.4 Conclusion and possible impact

The quality control procedures established under the AGAGE network have been applied for the PARIS data, ensuring that the new data are of high quality. The data are thoroughly documented, and this release captures the state of the data used for inversion calculations in the PARIS project. This data release represents the best available data set for halogenated greenhouse gases in Europe. It includes data from stations classified as atmospheric background, as well as from stations located in moderately polluted environments, thereby providing a comprehensive representation of different atmospheric conditions in Europe.

4.5 References

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5. History of the document

Version	Author(s)	Date	Changes
1	A. Engel	02.08.2024	Set-up, first feedback round
	S. Walter	26.08.2024	feedback
	A. Engel	29.08.2024	Adjusted version
	S. Walter	03.09.2024	Finalized and submitted

6. Annex

Data disclaimer for PARIS data uploaded to the Carbon portal.

Data Policy

These data are a combination of data from the European stations of the AGAGE Network (https://www-air.larc.nasa.gov/missions/agage/) and additional data which are part of the EU project PARIS (GA 101081430, https://horizoneurope-paris.eu/). All data have been quality controlled, but only part of the data have undergone the whole AGAGE data review process. Therefore, these data should only be used in order to produce inversions for comparison with the PARIS inversions for which these data are the basis.

Please refer to the original AGAGE data files (accessible through https://www-air.larc.nasa.gov/missions/agage/data/) if you want to use these files in a scientific study and follow the AGAGE data policy which can be found under https://www-air.larc.nasa.gov/missions/agage/data/policy.

These data are embargoed (i.e. they should not be made public before that date) until April 2025.