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PARIS

Process Attribution of Regional Emissions

GA 101081430, RIA

**MS9 - Flask sampling established at Hegyhátsál
(Hungary), Birkenes (Norway), Cabauw
(Netherlands) and southern Italy**

MS9

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1. Changes with respect to the DoA (Description of the Action)

It was originally intended to set up flask sampling sites at Hegyhátsál (Hungary), Birkenes (Norway), and at a site to be determined in Southern Italy to complement the existing European observations of F-gases. In addition, flask sampling at Cabauw (the Netherlands) was going to be continued.

The chosen Italian site is Capo Granitola. Due to advantages and availability, a continuous measurement system was installed instead of setting up a flask sampling system. By this data density is increased by more than a factor of 10. The sampling at Hegyhátsál started in January 2024, the sampling in Birkenes in March 2024. Continuous measurements at Capo Granitola in Sicily in Southern Italy have started in April 2024. The milestone was thus slightly delayed, but all measurements have been established by April 2024.

2. Dissemination and uptake

The results from the sampling will be used to improve top-down emission estimate for F-gases in several European countries. The results for the first year are expected being available by June of the following year for inclusion in inverse modelling calculation. The data will also be publicly available through the [ICOS carbon portal](#), linked by the [PARIS website](#).

3. Short Summary of results

OSSEs (Observing System Simulation Experiments) for three possible Italian sites have been conducted by both EMPA and MO. The simulations show that all three sites should expect rather similar distributions of pollution. Due to the positioning of the station with respect to very nearby local pollution, and the capability to sample air from northern Africa, the site of Capo Granitola in Sicily was finally chosen.

Flasks are now (May 2024) regularly collected at Hegyhátsál (Hungary), Birkenes (Norway), and at Cabauw (the Netherlands). Continuous measurements are being performed at Capo Granitola (Italy).

All systems are operational, and the establishment of quality control measures is ongoing. This will lead to the expected extension of the observational network for halogenated greenhouse gases, In particular F-gases.

4. Evidence of accomplishment

4.1 Introduction | Background of the milestone

Measurements of fluorinated greenhouse gases, the so-called F-gases, are important as these highly contribute to global warming. The emissions of F-gases are regulated within international treaties - in particular the Kigali amendment to the Montreal protocol - for which the verification of bottom-up estimates can be achieved by implementing regional observations.

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However, because of the low concentrations in the atmosphere measurements are difficult and at the same time require high accuracy as expected changes are small.

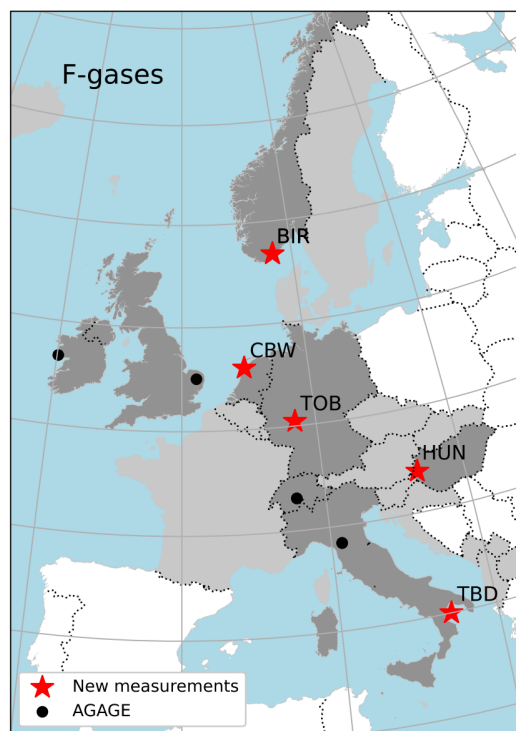


Fig. 1: F-gas measurement sites

Existing high-frequency measurement stations are shown as black dots (AGAGE and affiliated). New high-frequency measurements will be installed at Taurus (TOB). New flask sampling is proposed at the locations indicated by a red star, at Birkenes (BIR), Cabauw (CBW), Hegyhátsál (HUN) and Capo Granitola (Sicily).

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 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, NF₃, SF₆).

Due to the difficulty of the measurements, there are only few observational sites in Europe capable to provide high-quality F-gas measurements. This limits the ability of regional attribution of emissions. A convenient and cost-effective way of enhancing the density of the observational network is by establishing additional flask measurements, i.e. collecting flask sampling at additional sites which are analysed by laboratories which have already implemented a high level of quality control.

All the analysing laboratories are part of the AGAGE (Advance Global Atmospheric Gas Experiment, <https://agage.mit.edu/>) network and have thus access to high quality internationally accepted standards. Fig. 1 shows the expected improvement in the observational network as well as those countries for which an improved top-down emission estimate is expected (light grey) and which are specific target countries (United Kingdom, Ireland, the Netherlands, Norway, Germany, Switzerland, Italy, Hungary) dark grey).

4.2 Scope of the milestone

Achieving milestone MS9 assures that additional observations for the derivation of emissions using top-down methods are established and will be available for the inverse modelling. This will provide the top-down estimate of emissions, starting in the year 2025.

4.3 Content of the milestone

For the three flask sampling sites the measurement equipment (pumps, flasks, inlet lines) as well as the control set-up were newly installed at Hegyhátsál and in Birkenes. This has already been installed at Cabauw. The new continuous measurement system (in-situ gas chromatograph with mass spectrometry, GC/MS) was installed at Capo Granitola. Logistics for the regular sampling have been established as well as the logistics for the transport of flasks or samplers between the sites and the analysing laboratories. All

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measurements are operational as planned, with samples collected every second day for the flask sampling sites and up to 16 measurements daily for the continuous site.

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Despite these limitations, the new sampling locations will lead to the extension of the observational network and provide better view of the distribution of F-gases in Europe, allowing to clearer identify specific source regions.



Fig. 2: Sampling at Cabauw tall tower (the Netherlands, left) by Univ. Bristol using the ICOS sampler (right). Air samples are collected from an altitude of 207 m and integrated over one hour.

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Fig. 3: Sampling at Hegyhátsál tall tower (Hungary, left) by Univ. Frankfurt using a fully automated sampling system (right). The inlet height is at 115 m.

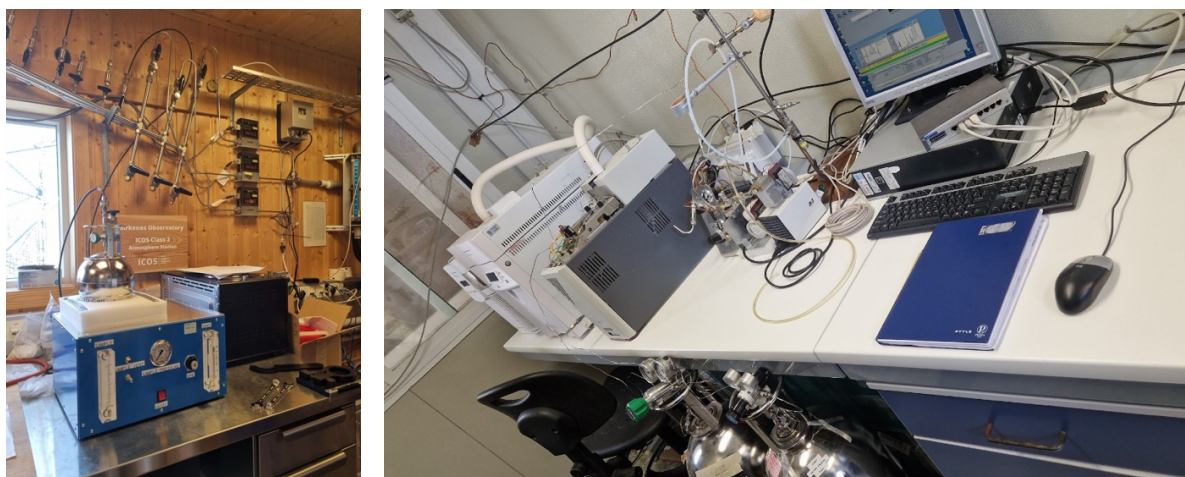


Fig. 4: Sampling at Birkenes ICOS laboratory (Norway) by NILU using a newly build pumping system and stainless-steel flasks, samples are collected from a height of 75 m (left); Automated GC/MS system at Capo Granitola operated by Univ. Urbino, the inlet is located at 15 m above sea level, respectively 5 m above ground (right)

4.4 Conclusion and possible impact

The milestone has been achieved albeit with a slight delay of about three months for the sites Birkenes and Capo Granitola.

The new measurements from the four stations will substantially improve observational coverage of F-gas measurements in Europe (see Fig. 1) and will provide the basis to improve and extend top-down emission estimates, including a better identification of possible sources. These new results will allow for an experimentally based verification of bottom-up derived emission data.



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5. History of the document

Version	Author(s)	Date	Contribution
1	A. Engel	14.05.2024	Set-up