Data
Models
Inventories

PARIS

Process Attribution of Regional Emissions

GA 101081430, RIA

Calibrated atmospheric N_2O measurements for HUN completed

Milestone MS17	
Delivery due date Annex I	09/30/2023
Actual date of submission	24/10/2023 (upload to ICOS Carbon Portal)
Lead beneficiary: EMPA	Work package: 5 Nature: Dataset Dissemination level: PU
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Internal reviewers	Stephan Henne (Empa, WP5 Lead)
Version: 1	

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

None.

2. Dissemination and uptake

The established dataset proofs the successful installation of N_2O calibration infrastructure at the tall tower site Hegyhátsál (HUN) (https://www.icos-cp.eu/observations/national-networks/hungary) in Hungary.

The dataset is for now internally available, on the ICOS Carbon Portal https://meta.icos-cp.eu/objects/iG7Zxt5xxyuNt0u7a6EMhWHz. Meta data are already public. The full dataset will become publicly available as part of the deliverable D5.1 after a six-month moratorium. The publication date of the full dataset is 1 May 2024.

Observations will continue within PARIS and updated observations will be part of milestone M18 (Complete calendar year of extended and quality controlled N_2O data, including inter-comparability assessment to existing measurements available), which is due in month 14 and will annually update thereafter.

3. Short Summary of results (<250 words)

The milestone has been defined as the implementation of calibrated atmospheric N_2O data measurements from HUN, verified by the upload of publicly available data to the ICOS Carbon Portal.

Continuous, in-situ N_2O observations from the tall tower site Hegyhátsál (HUN), Hungary (https://www.icos-cp.eu/observations/national-networks/hungary), that are not part of the ICOS monitoring program at the site, were re-evaluated and the instruments calibration procedure updated. Observations are ongoing and data up to the end of June 2023 were quality controlled.

The data were compared to the closest ICOS N_2O observation, providing additional evidence of a successful calibration strategy. Data from 2022 onwards were uploaded to the ICOS Carbon Portal for use within PARIS and future open publication. Historical data before 2022 will be re-evaluated within the next year and become part of the next update of this dataset.

4. Evidence of accomplishment

4.1 Introduction | Background of the milestone

Previously, N_2O observations at the tall tower site Hegyhátsál (HUN), Hungary (https://www.icos-cp.eu/observations/national-networks/hungary), were carried out for assessing the local N_2O flux (eddy covariance method). Since the eddy covariance method does not necessarily require absolute calibration of the analyser, a complete calibration setup had not been installed at the site.

As part of PARIS a calibration strategy for the Hegyhátsál N_2O analyser was devised, largely following ICOS recommendations. A quality control procedure was established, and observations automatically and manually check for invalid observations.

4.2 Scope of the milestone

The N_2O time series from Hegyhátsál strategically expands the spatial coverage of the European N_2O observation network (ICOS and others), providing unique coverage towards south-eastern Europe and being representative for typical agricultural regions. The time series will inform inverse models in an otherwise observation-bare region and improve estimates of the European N_2O budget.

4.3 Content of the milestone

The N_2O observations at Hegyhátsál are carried out with a Los Gatos Research Fast N_2O/CO analyser employing Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS) and originally targeting eddy covariance estimates of the local N_2O flux (Fig. 1).

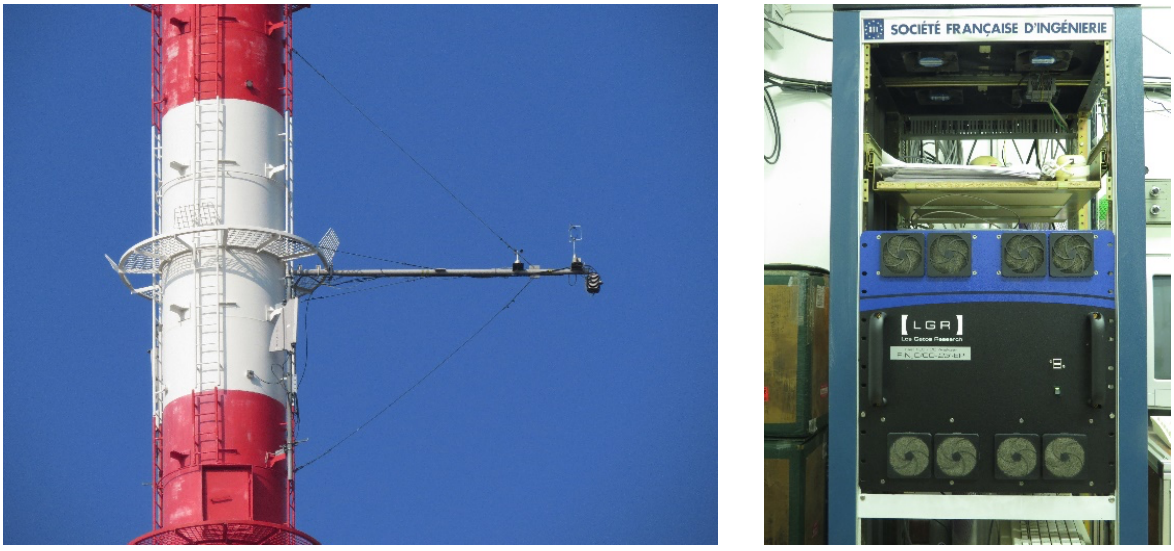

Fig. 1: *Pictures of the air inlet (left) and N_2O analyser (right) at Hegyhátsál tall tower. The air inlet is at 82 m above ground positioned close to a 3D sonic anemometer to allow for eddy covariance measurements. The analyser is located at the bottom of the tower.*

The measurements are performed at 82 m elevation above the ground. The sampling frequency is 5 Hz (Haszpra et al., 2018). Four-point calibration is manually performed every four to five weeks, whereas short-term working gas measurements are performed every 13 hours and used for scale drift corrections. No target gas measurement is currently performed. Calibration standards were obtained from MPI for Biogeochemistry, Jena, and are referenced to the NOAA-2006A scale. Data processing proceeds through calculation of 1-minute averages from the high-frequency raw data and then calculation of hourly means as the arithmetic average of the available minute averages wherever more than 30 valid 1-minute samples are available. Manual quality control is applied on concentration data rejecting all technically false or suspicious data.

Further validation of the HUN N_2O observations was carried out by comparison to the two closest ICOS N_2O observations (Hohenpeissenberg, HPB, Germany, and Kresin u Pacova, KRE, Czech Republic). The general evolution of the three timeseries is similar (Fig. 2) indicating variations both on synoptic and seasonal scales. Besides these common features, individual sites exhibit individual pollution events with different intensity reflecting the more local N2O budget. The HUN and HPB data seem to share a common baseline N_2O level, the lower end of the concentration distributions agree fairly well (Fig. 3, left). This good agreement suggests that the implemented calibration strategy for HUN is working correctly, and HUN is providing data with high accuracy. In contrast the KRE baseline seems to be elevated by approximately 1 ppb. Whether this reflects a calibration issue at KRE or stronger local to regional sources cannot be concluded here. HUN exhibits the largest pollution events of the three sites (longest tail in concentration distribution), most likely representing the intensive agricultural activity around the site. The distribution of the standard deviation of 1-min concentration data (Fig. 3, right) agrees well between HUN and HPB. Indicating the general high quality and precision of the HUN data.

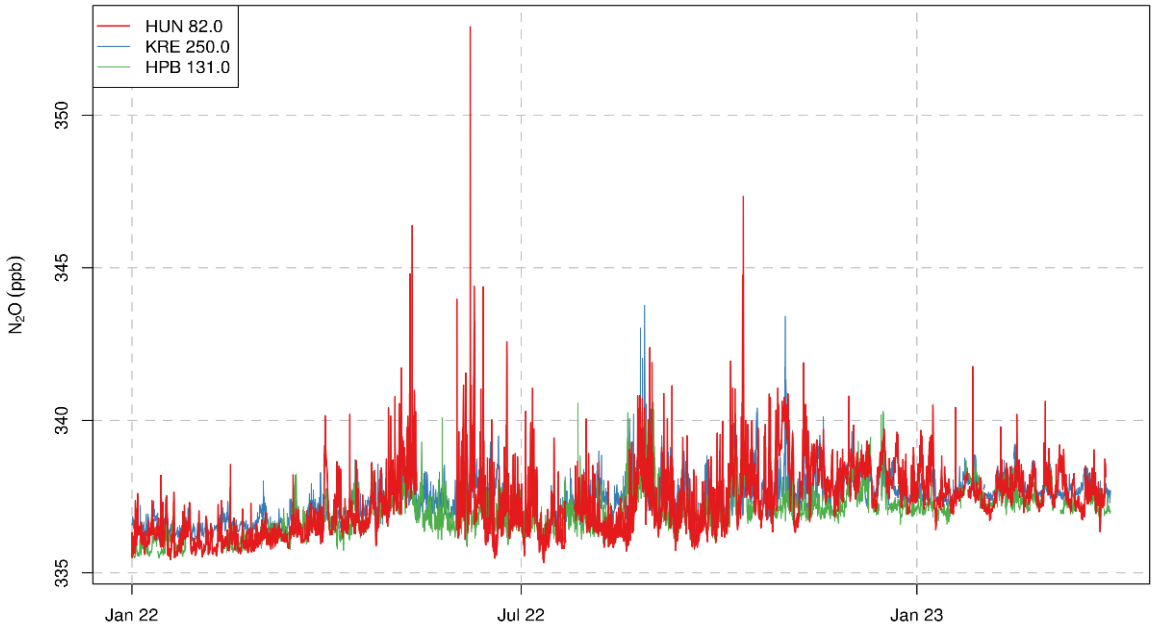

Fig. 2: *Time series of fully calibrated N_2O observations (1-hour averages) from Hegyhátsál (red) compared to those carried out at the ICOS sites HPB (green) and KRE (blue).*

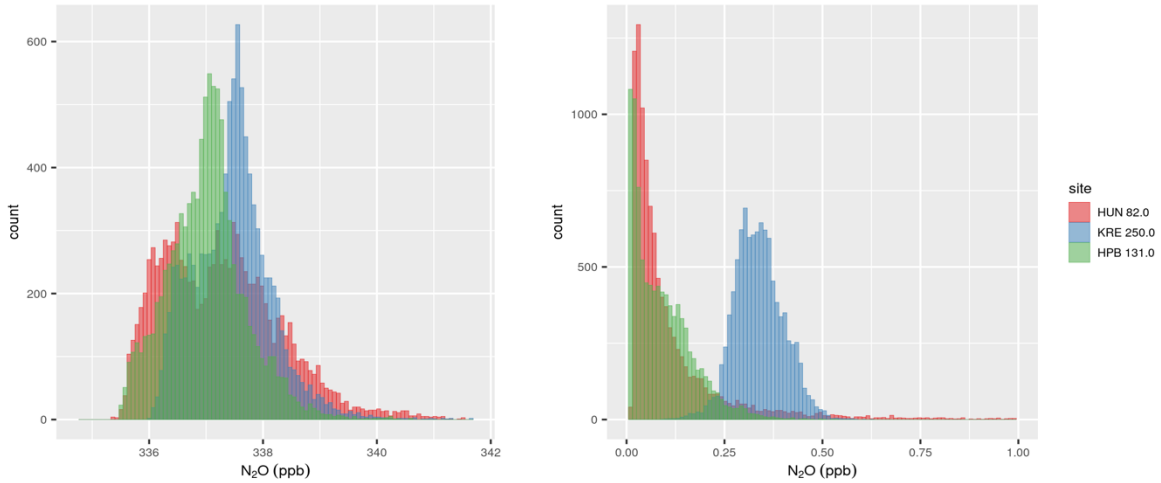

Fig. 3: *(left) Histogram of fully calibrated N_2O observations (1-hour averages) from Hegyhátsál (red) compared to those carried out at the ICOS sites HPB (green) and KRE (blue). (right) Histogram of 1-hour standard deviations of N_2O observations.*

The data were uploaded to the ICOS Carbon Portal following common ICOS data and metadata standards. All necessary information about data and metadata can be found at https://meta.icos-cp.eu/objects/iG7Zxt5xxyuNt0u7a6EMhWHz). A six-month moratorium was assigned at upload of the data set in order to allow PARIS researchers to be the first to make use of the data in time series analysis and inverse modelling. The extension of the N_2O measurement network towards eastern Europe is one of the unique features of the PARIS project and, as such the moratorium assures that this effort can be credited within PAIRS directly.

4.4 Conclusion and possible impact

HUN is a central site for the top-down estimation of the N_2O budget in south-eastern Europe adding essential coverage to the ICOS network. Hence, the data set will be central for inverse modelling in WP5. Comparison to neighbouring ICOS sites supports excellent data quality of HUN measurements (precision and accuracy). The time series will be extended backwards in time by re-evaluating historical data and correcting these where possible and flagging invalid data during period with insufficient calibration information.

4.5 References

Haszpra, L., Hidy, D., Taligás, T., and Barcza, Z.: First results of tall tower based nitrous oxide flux monitoring over an agricultural region in Central Europe, Atmos. Environ., 176, 240-251, doi: 10.1016/j.atmosenv.2017.12.035, 2018.

5. History of the document

Version	Author(s)	Date	Changes / comments
0.1	Stephan Henne	2023-08-22	Initial draft
	Stephan Henne, Laszlo Haszpra	2023-09-26	Complete draft
	Sylvia Walter	2023-10-10	Feedback on complete draft report
	Stephan Henne, Laszlo Haszpra	2023-10-24	Upload dataset to ICOS Carbon Portal
	Sylvia Walter	2023-11-15	Report submission to PO