ICOS Cities

@ GGMT2022

Claudio D'Onofrio et al, 2022 September 19-21
claudio.donofrio@nateko.lu.se

ICOS Cities, aka Pilot Applications in Urban Landscapes - Towards integrated city observatories for greenhouse gases (PAUL), has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037319

ICOS Integrated Carbon Observation System

ICOS Carbon Portal

Empa Materials Science and

Organisation météorologique mondiale

INRAE

European Social Survey

ELSINGIN YLIOPISTO

TNO innovation for life

cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici

Technical University of Munich

UAB Universitat Autònoma de Barcelona

cnrs

Aalto University

ECMWF

cea

LUNDS UNIVERSITET

FINNISH METEOROLOGICAL INSTITUTE

SciencesPo

UNIVERSITY OF COPENHAGEN

Stadt Zürich Umwelt- und Gesundheitsschutz

Universiteit Antwerpen

Universität Basel

Consiglio Nazionale delle Ricerche

AIRPARIF

MAX-PLANCK-GESELLSCHAFT

AGH

KIT Karlsruher Institut für Technologie

gesis Leibniz-Institut für Sozialwissenschaften

NATIONAL OBSERVATORY ATHENS

universidade de aveiro

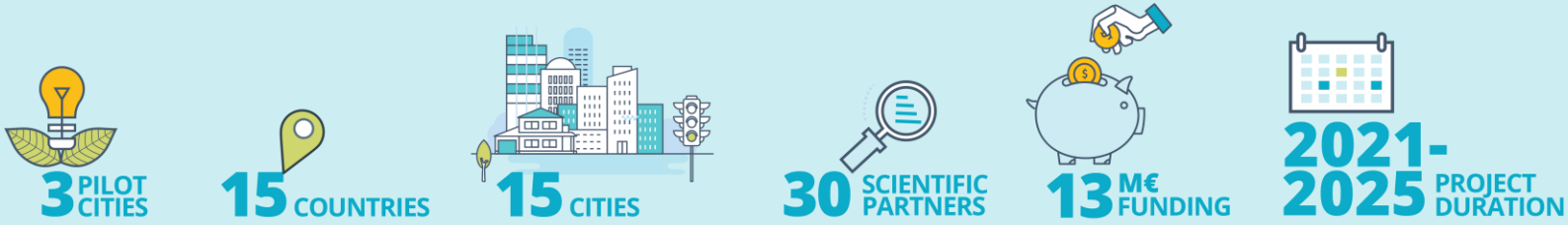
origins earth

CzechGlobe Ústav výzkumu globální změny AV ČR, v. v. i.

ICOS Cities

PAUL – ICOS Cities project

- **P**ilot **A**pplication in **U**rban **L**andscapes – towards integrated city observatories for greenhouse gases
- Urban green-house gas observation
  - ICOS Cities bring together and evaluate the most innovative measurement approaches of greenhouse gas emissions in densely populated urban areas.
  - The project supports the European Green Deal and aims at developing useful tools and services for cities in support of their local climate action plans.
  - The project aims at creating data services that have societal impact.



KEY OBJECTIVES

1

RELIABLE DATA

Develop and test comprehensive greenhouse gas measurement observatories and technologies in urban environments, to produce reliable data for cities

2

PILOT STUDIES

Conduct pilot studies in large, medium and small cities, and later implement the same methods in multiple European cities

3

SERVICES & TOOLS

Develop services and tools based on the needs of cities, for processing and analysing the observation data, while raising awareness and engaging citizens

4

SUPPORTING THE EUROPEAN AMBITION

Provide the future backbone of an urban GHG monitoring system in Europe and contribute to the European ambitious climate strategy to meet the targets of the Paris Agreement.

5

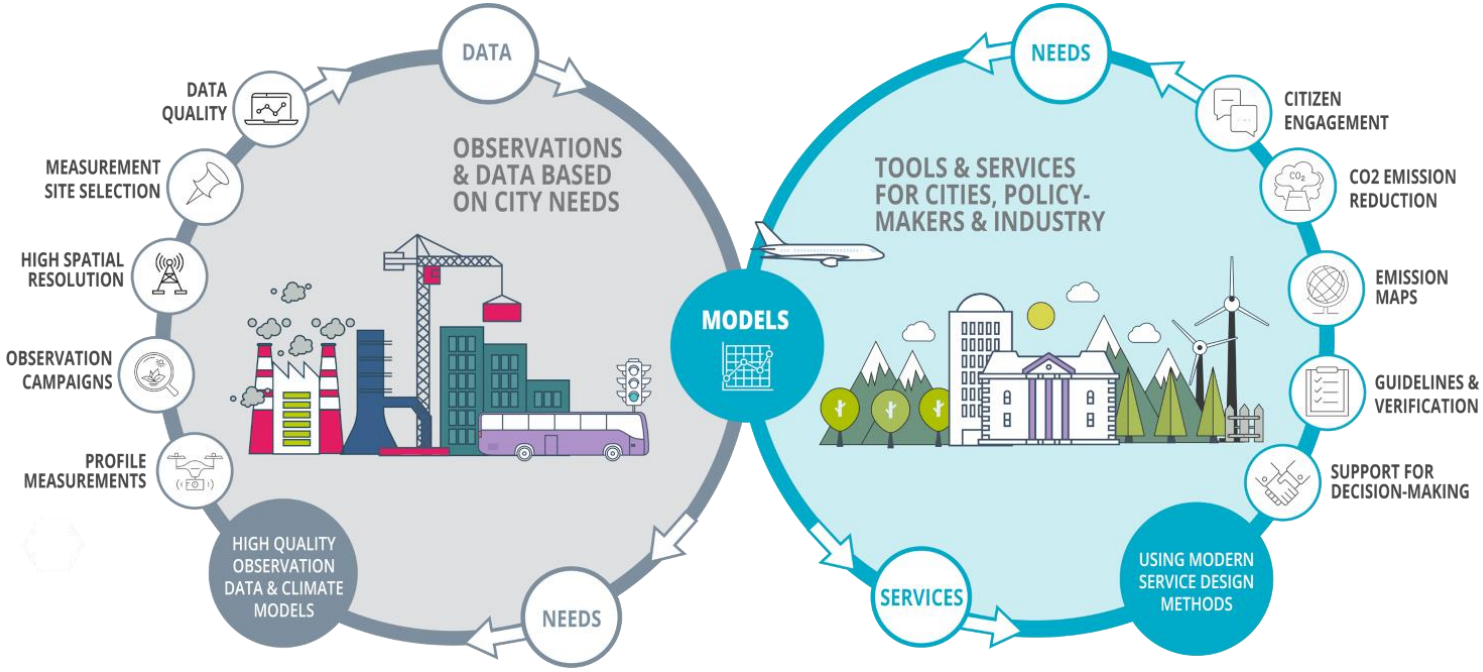
RESEARCH IN SUPPORT OF CITIES

Design a concept for an upgraded Research Infrastructure able to support cities in implementing their climate action plans

ICOS Cities

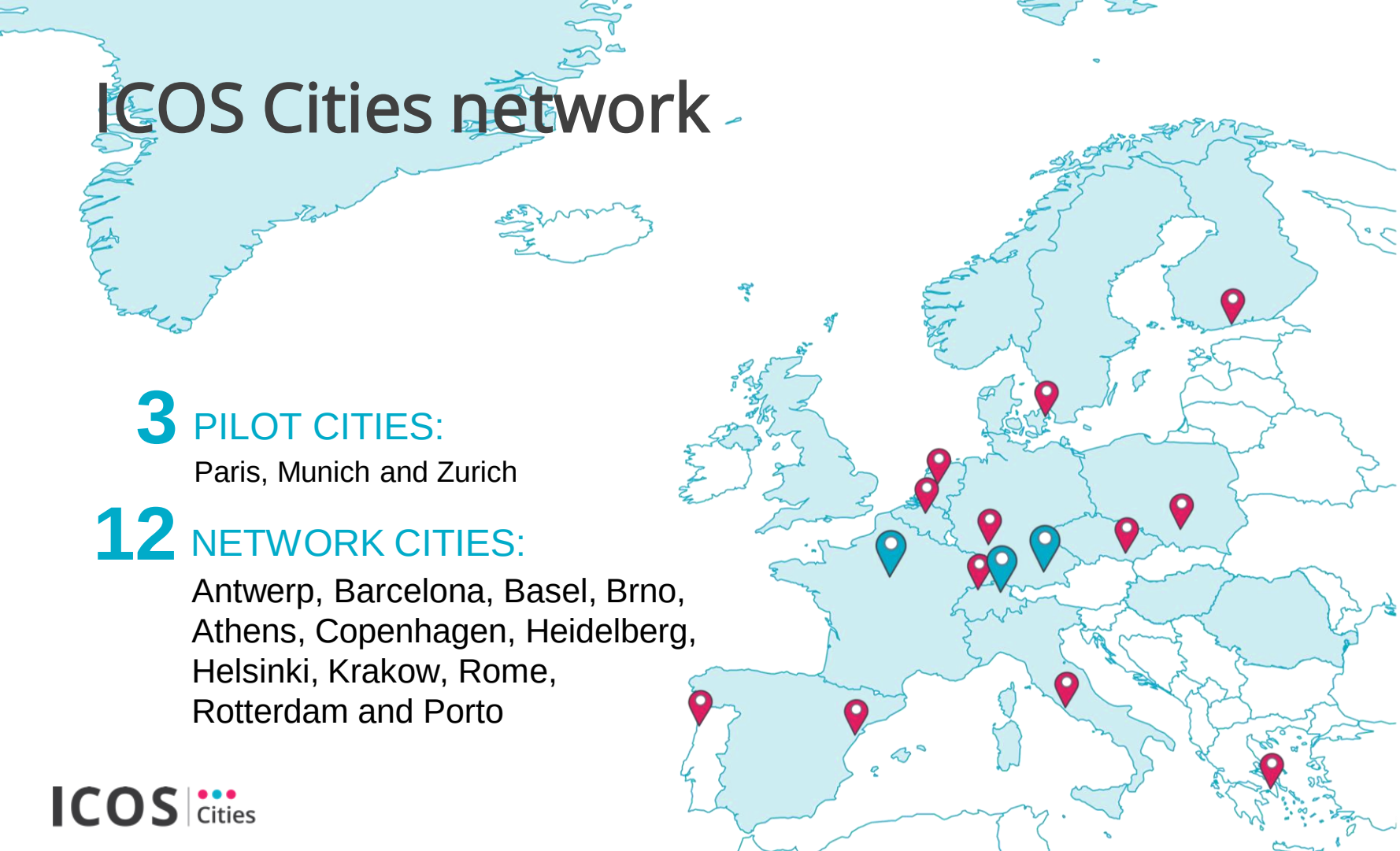
ICOS Cities brings together European citizens, policy makers and top scientiststo co-design pioneer greenhouse gas measurement methodologies and services for cities in support of climate action.

From needs to data to services



ICOS Cities

ICOS Cities network



3 PILOT CITIES:

Paris, Munich and Zurich

12 NETWORK CITIES:

Antwerp, Barcelona, Basel, Brno, Athens, Copenhagen, Heidelberg, Helsinki, Krakow, Rome, Rotterdam and Porto

ICOS Cities

Pilot cities & city network

Three pilot cities selected by an international panel of scientists

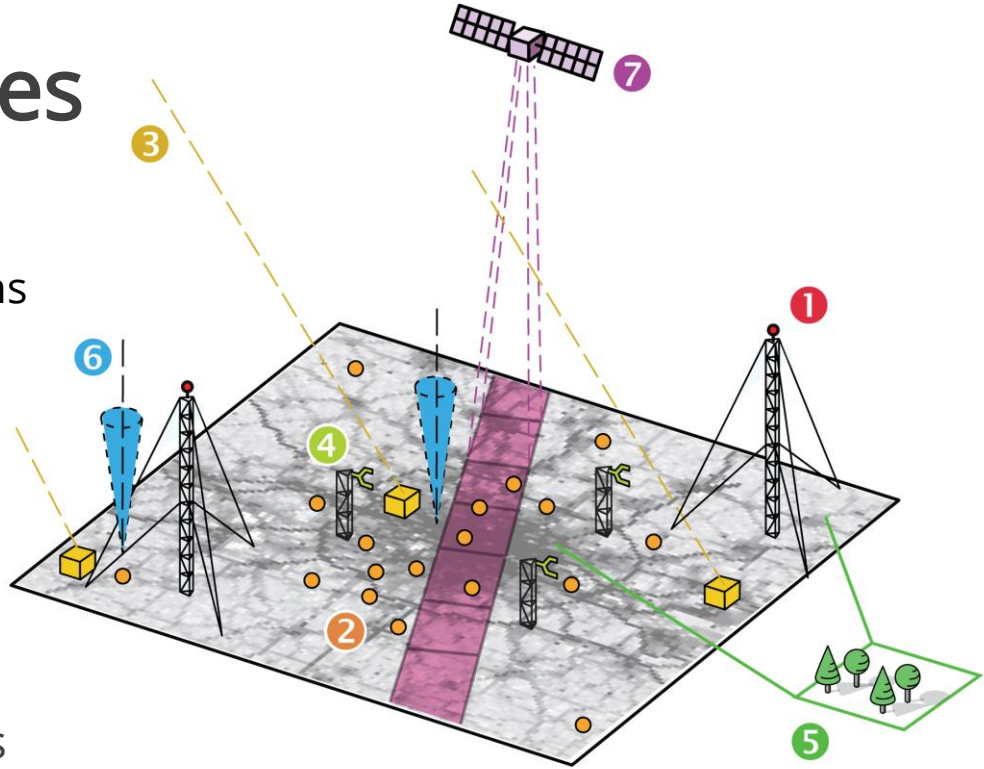
- The cities were selected based on their climate action plans, current policies and climate ambition, in addition to their contribution to improve the existing greenhouse gas inventories
- The project closely collaborates with the cities in order to design relevant climate services and tools based on the city needs

City network

- 12 additional cities covering the European continent
- The cities provide a diversity of profiles in terms of geography, population, and economic activity
- They give feedback and share experiences throughout the project, while highlighting the needs of European cities in terms of climate action

Observation strategies

1. High-precision tall tower concentrations
2. Roof- and street-level networks
3. Ground-based total column network
4. Tall eddy covariance towers
5. Biogenic process observations
6. Ground-based wind and meteorology
7. Satellite total column observations



- Comparing techniques
- Identify synergies between approaches and scales
- In three cities (metropolitan, large, mid-size)

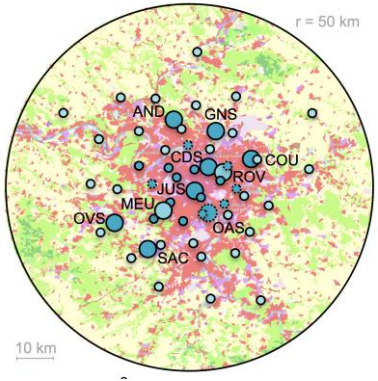
ICOS Cities

Concentration measurements

High-precision **atmospheric concentration networks** on **tall towers, roof-level** and street-**level** measurement networks will allow exploring options for urban- and local-scale inverse modelling.

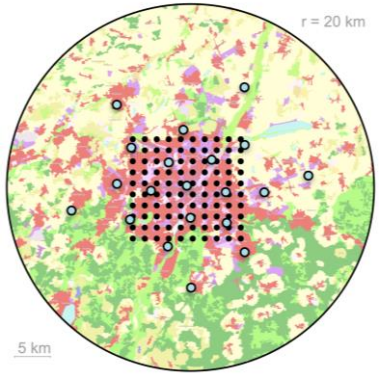
Paris

10 high-precision sites
30 roof-level sensors



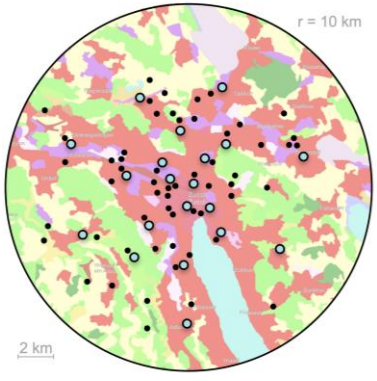
Munich

20 roof-level sensors
100 street-level sensors



Zurich

20 roof-level sensors
60 street-level sensors

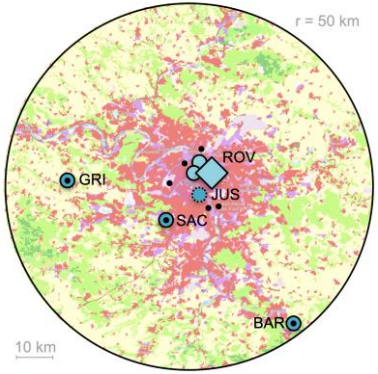


ICOS Cities

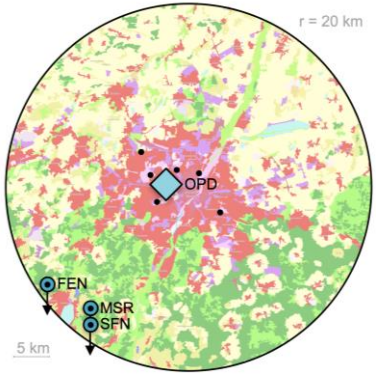
Eddy covariance and biogenic fluxes

Tall-tower **eddy-covariance** systems in urban and rural areas, including co-emitted species, enable the **separation of fossil-fuel and biogenic CO_2**. The modelling of urban biogenic fluxes is supported by process monitoring of **urban vegetation and soils.**

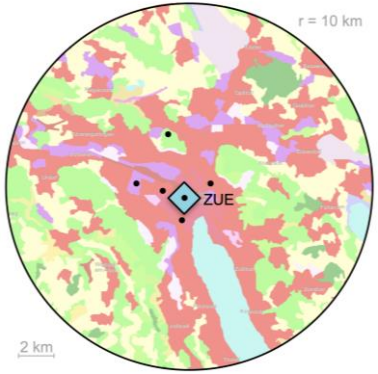
Paris
1 Tall-tower EC, 6 local-scale EC
8 soil and 6 sap-flow sites



Munich
1 Tall-tower EC
7 soil and 6 sap-flow sites



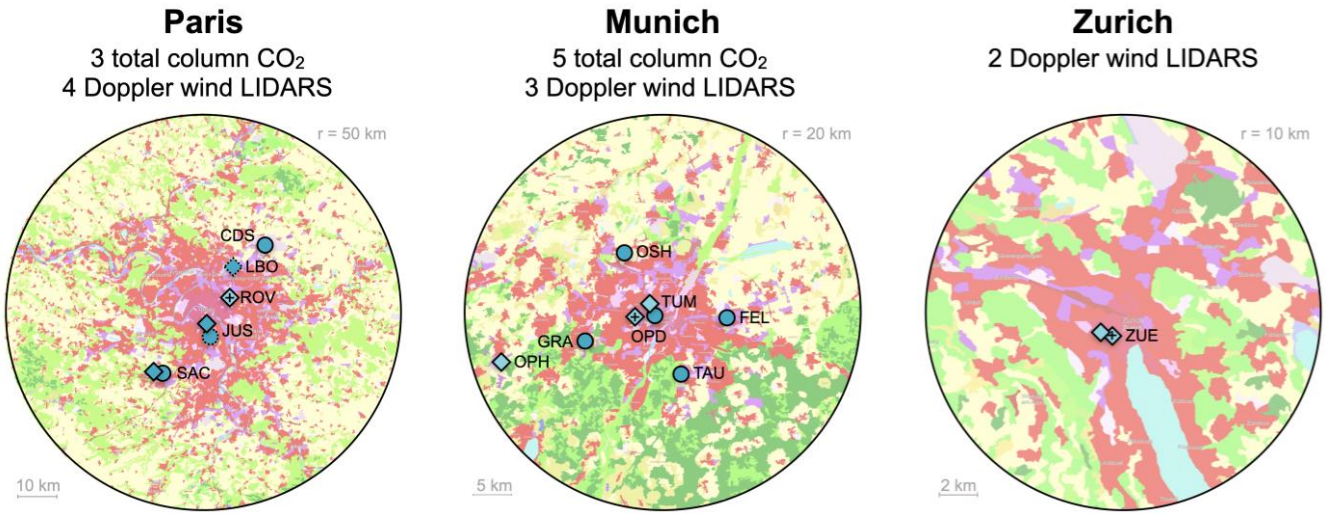
Zurich
1 Tall-tower EC
6 soil and 6 sap-flow sites



ICOS Cities

Remote sensing and transport

Ground-based remote sensing systems allow for total column observations of CO_2 and wind turbulence, upwind, and downwind of cities.

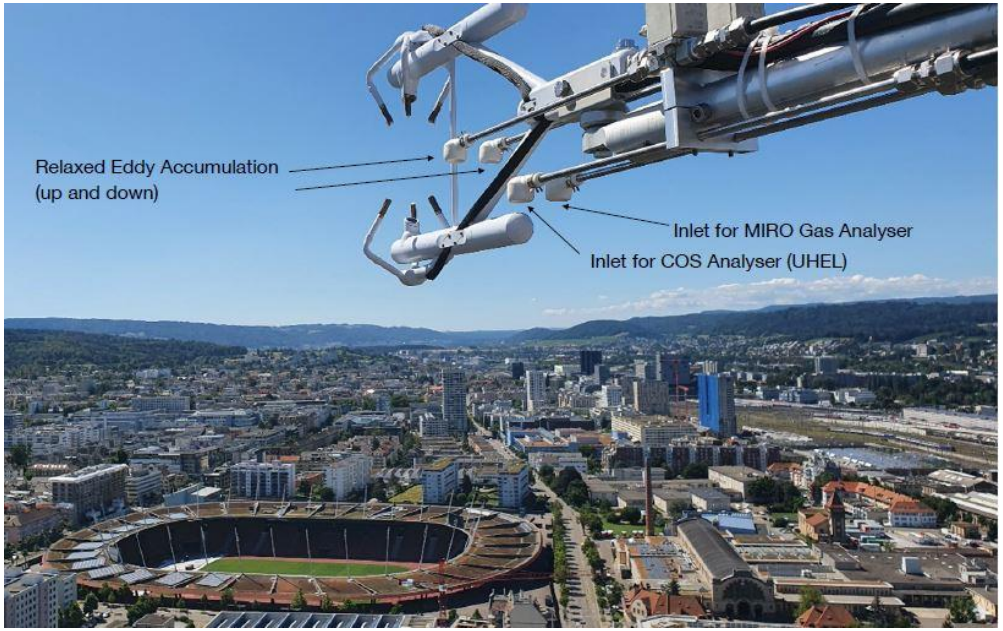


ICOS Cities

Are we operational?

- Biogenic measurement campaign started in Zurich
- Zurich EC and Talltower operational
- Zurich low cost sensor operational
- Paris Talltower operational, EC tower installation in progress as we speak
- Remote sensing operational
- MIRO will be sent to all three cities to capture the growing season, now in Zurich
- Munich build up of tall tower and EC

Zurich Hardau



Head of the IRGASON and inlets for the REA system, MIRO and COS analyzer installed in Zurich. Picture by Roland Vogt, University of Basel, modified by Andreas Christen, University of Freiburg.

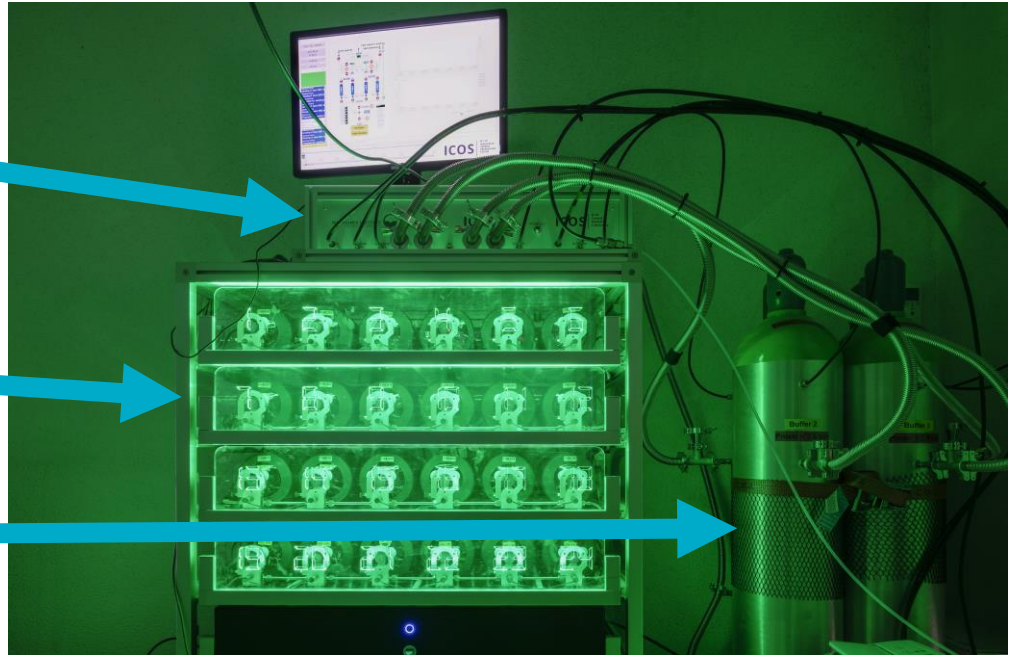
ICOS Cities

ICOS flask sampler extension: Relaxed Eddy Accumulation (REA)

REA module

ICOS flask sampler

50L buffers

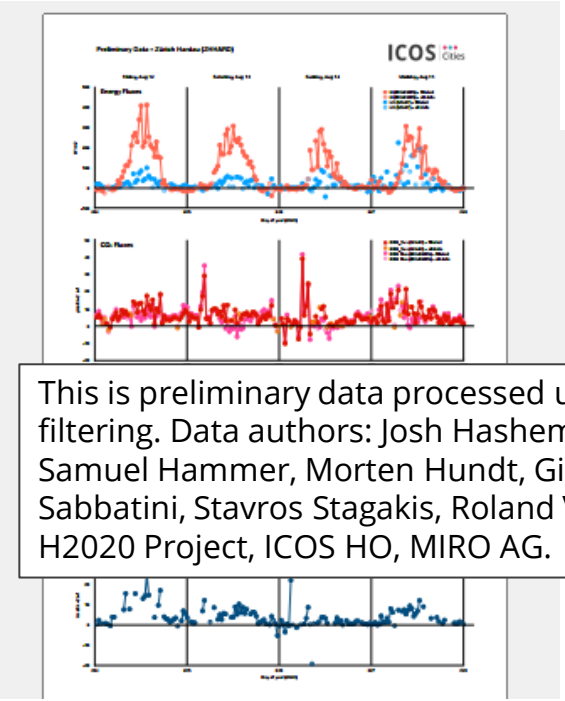


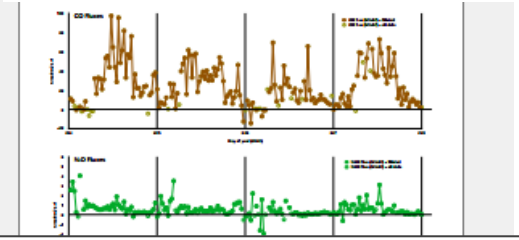
Initial REA QC results from Zurich

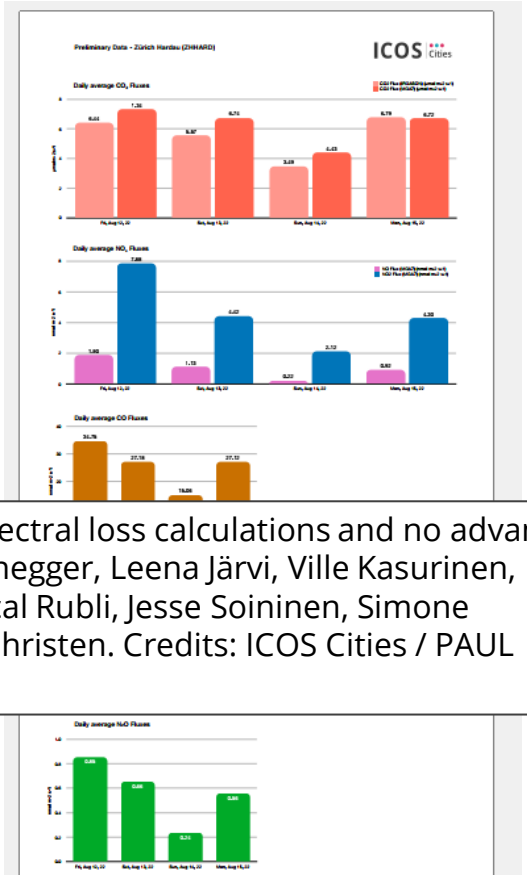
	Upwind line	Downwind line	Regular sampling line
ppm CO_2	456.44 ± 0.04	456.45 ± 0.04	
	431.95 ± 0.05	431.94 ± 0.03	431.91 ± 0.05
	423.57 ± 0.05	423.62 ± 0.02	423.53 ± 0.02

ICOS Cities

First results







This is preliminary data processed using Eddy Pro without detailed spectral loss calculations and no advanced filtering. Data authors: Josh Hashemi, Dominik Brunner, Lukas Emmenegger, Leena Järvi, Ville Kasurinen, Samuel Hammer, Morten Hundt, Giacomo Nicolini, Dario Papale, Pascal Rubli, Jesse Soininen, Simone Sabbatini, Stavros Stagakis, Roland Vogt, Matthias Zeeman, Andreas Christen. Credits: ICOS Cities / PAUL H2020 Project, ICOS HO, MIRO AG.

ICOS Cities

Operation of the ICOS-Cities urban CO_2 sensor network in Zürich, Switzerland

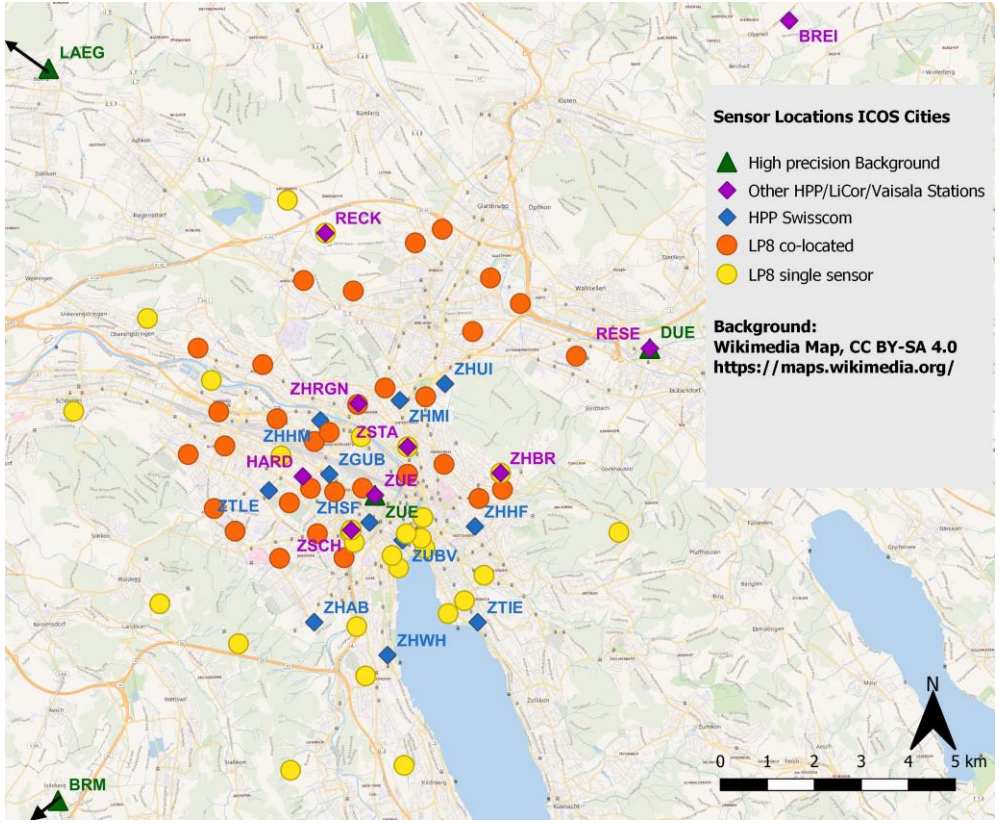
ICOS Science Conference 2022

Stuart K. Grange[1,2,*], Simone Baffelli[1], Christoph Hueglin[1], Pascal Rubli[1], Andrea Fischer[1], and Lukas Emmenegger[1]

Presented on September 15, 2022, Utrecht, the Netherlands

[1]Empa, Swiss Federal Laboratories for Materials Science and Technology, 8600 Dübendorf, Switzerland
[2]Wolfson Atmospheric Chemistry Laboratories, University of York, York, YO10 5DD, United Kingdom
*stuart.grange@empa.ch

Zurich Sensor Network



ICOS Cities

Low & Mid cost sensor

Photos of a low-cost CO_2 sensor (left) and mid-cost CO_2 sensor with its two reference gas cylinders (right).

ICOS Cities

Slides from the ICOS SC 2022 talk

https://drive.google.com/file/d/1-Xs0hwXBphmvClwAoCAH9g3xFtzvBIxT/view

Grange et al., 2022. Operation of the ICOS-Cities urban CO2 sensor network in Z¨urich, Switzerland

ICOS Cities

Remote Sensing in Paris

EM27, Saclay
south west of Paris

Wind Lidar
Doppler Jussieu
(90m asl)

EM27, Gonesse,
northern Paris

ICOS Cities

Mid-cost sensor @ Montmartre - Paris

Inlet and Analyser

ICOS Cities

Ensuring the solutions fit the need

- Co-designing the services based on users' needs: user involvement e.g. through interviews of city officials and policy-makers, co-design workshops etc.
- Results of attitude surveys of the pilot city citizens feed into the solutions and concepts created
- Policy briefs and guidelines for cities and national policy-makers
- Creation of educational materials for schools

ICOS Cities

message to take home

- Create a blueprint for Urban GHG measurements
- Provide the knowledge to create tools and services for Cities, Citiziens, Policy makers, and Education

ICOS Cities, aka Pilot Applications in Urban Landscapes - Towards integrated city observatories for greenhouse gases (PAUL), has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101037319

Acknowledgement

- Sam Hammer, University of Heidelberg
- Olivier Laurent LSCE, Paris
- Michel Ramonet, LSCE , Paris
- Roland Vogt, University of Basel
- Andreas Christen, University of Freiburg
- Stuart Grange, EMPA, Duebendorf
- Pascal Rubli, EMPA , Duebendorf
- Alex Vermeulen, ICOS Carbon Portal, Lund

questions?
they are here at the GGMT2022, talk to them

ICOS Cities

ICOS Cities

http://www.icos-cities.eu ICOS_RI #ICOSCities

ICOS Cities

Pilot Applications in Urban Landscapes

“Cities are where the climate battle will largely be won or lost.”

António Guterres, Secretary-General, United Nations

Speech at C40 World Mayors Summit (Copenhagen), 11.10.2019

ICOS Cities, aka Pilot Applications in Urban Landscapes - Towards integrated city observatories for greenhouse gases (PAUL), has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101037319