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 Cities

Towards integrated city observatories for greenhouse gases

Lukas Emmenegger *, Dominik Brunner, Andreas Christen

Samuel Hammer, Werner Kutsch, Claudio D'Onofrio, Emmanuel Salmon, Jia Chen, Markus Eritt, Martial Haeffelin, Leena Järvi, Natascha Kljun, Thomas Lauvaux, Benjamin Loubet, Matthias Mauder, Amewu A. Mensah, Dario Papale, Leonard Rivier, Stavros Stagakis, Alex Vermeulen, Patrick Aigner, Davide Bernasconi, Dominik Brunner, Pauline Buysse, Mali Chariot, Andrea Fischer, Stuart Grange, Joshua Hashemi, Rainer Hilland, Christopher C. Holst, Ville Kasurinen, Simone Kotthaus, Daniel Kühbacher, Ann-Kristin Kunz, Changxing Lan, Olivier Laurent, Morgan Lopez, Andreas Luther, Moritz Makowski, William Morrison, Giacomo Nicolini, Michel Ramonet, Pascal Rubli, Jesse Soininen, Roland Vogt, Adrian Wenzel, Matthias Zeeman,
and many others

*Presenting author: Empa, Lukas.Emmenegger@empa.ch

ICOS Cities project

- brings together and evaluates **measurement and modelling approaches** for monitoring **greenhouse gas emission** in densely populated urban areas.
- supports the European Green Deal and aims at **developing tools** and **services** for cities in support of **assessing emission reduction efforts**.

3 PILOT CITIES

15 COUNTRIES

15 CITIES

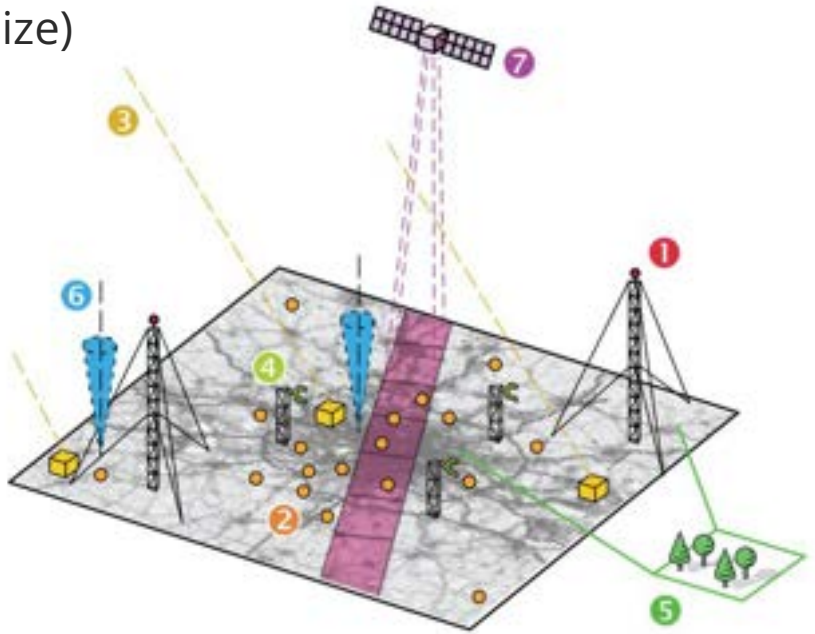
30 SCIENTIFIC PARTNERS

13 M€ FUNDING

2021-2025 PROJECT DURATION

Observation strategies

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



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*

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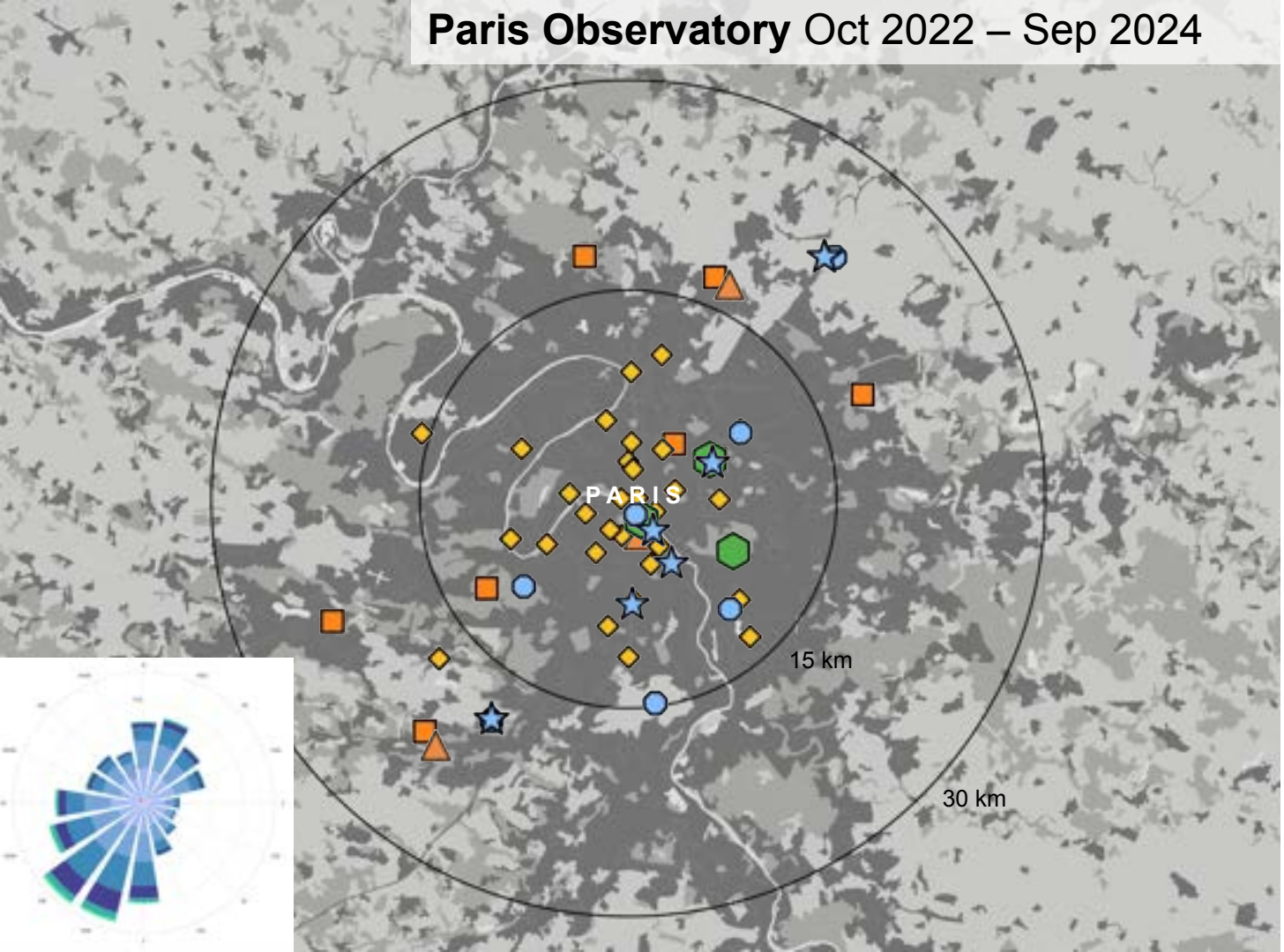
ZURICH

- High-precision background station (2)
- Mid-precision rooftop station (20)
- Low-precision street level station (60)
- Tall-tower eddy covariance (1)
- Doppler wind LIDARs (2)

- Built-up area
- Forests
- Agriculture
- Water bodies

Paris Observatory Oct 2022 – Sep 2024

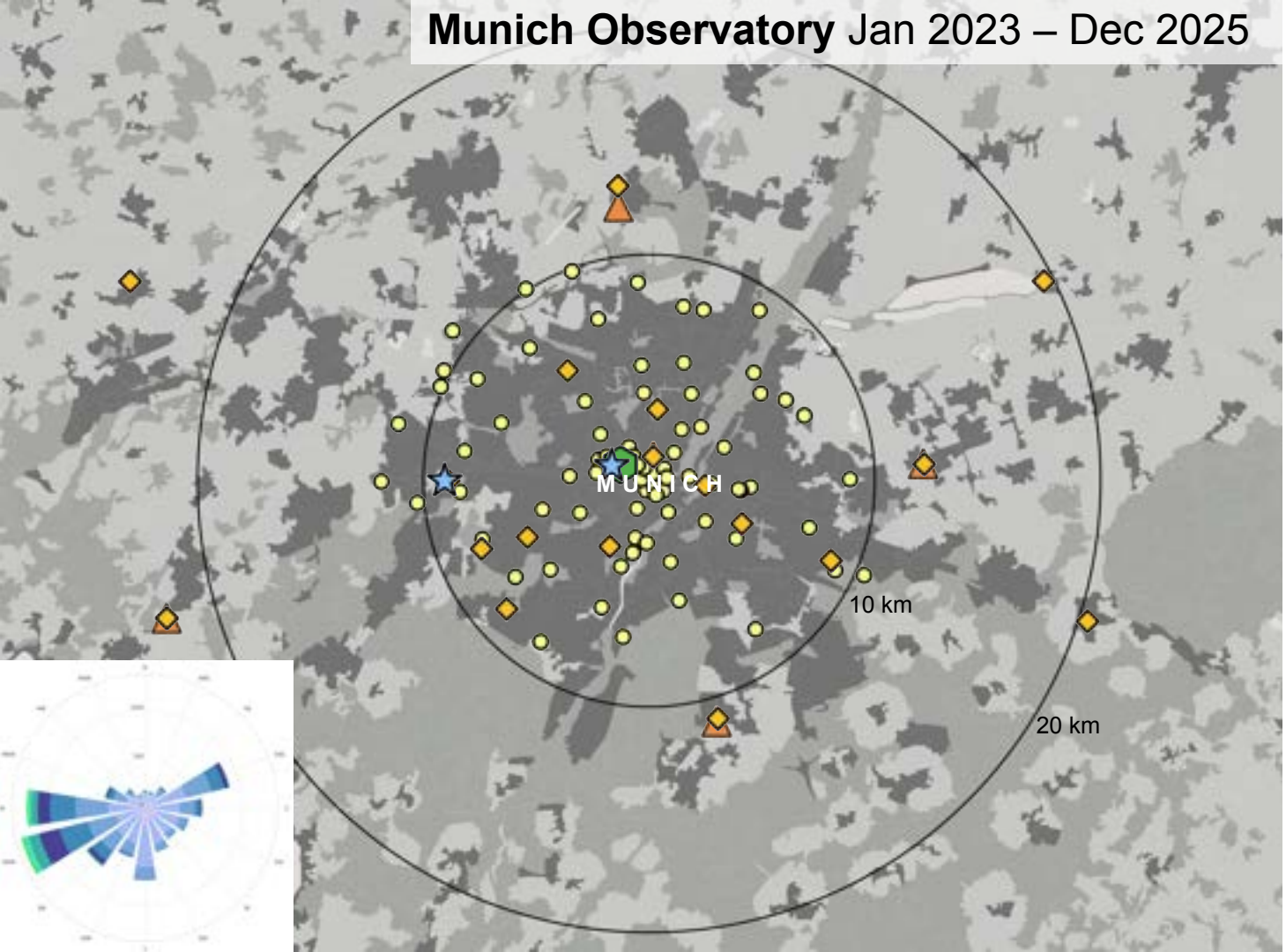


PARIS

- High-precision tall tower stations (10)
- Total column FTIR station (3)
- Mid-precision rooftop station (30)
- Tall-tower and local eddy covariance (4)
- Doppler wind LIDARs (6)
- LIDAR ceilometers (10)

- Built-up area
- Forests
- Agriculture
- Water bodies

Munich Observatory Jan 2023 – Dec 2025



MUNICH

- Total column FTIR station (5)
- Mid-precision rooftop station (20)
- Low-precision street level station (100)
- Tall-tower eddy covariance (1)
- Doppler wind LIDARs (3)

- Built-up area
- Forests
- Agriculture
- Water bodies

Mid- and low-cost sensors

ZURICH

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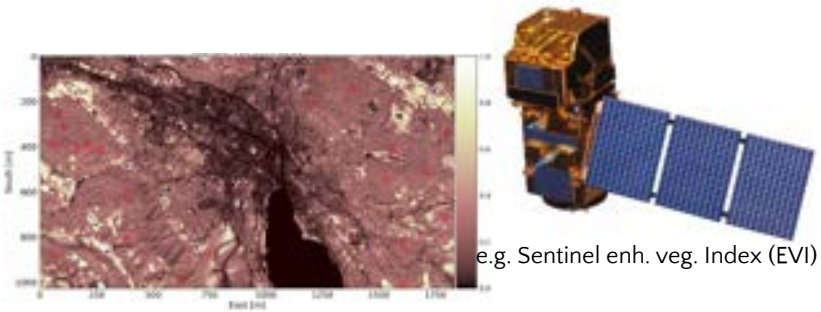
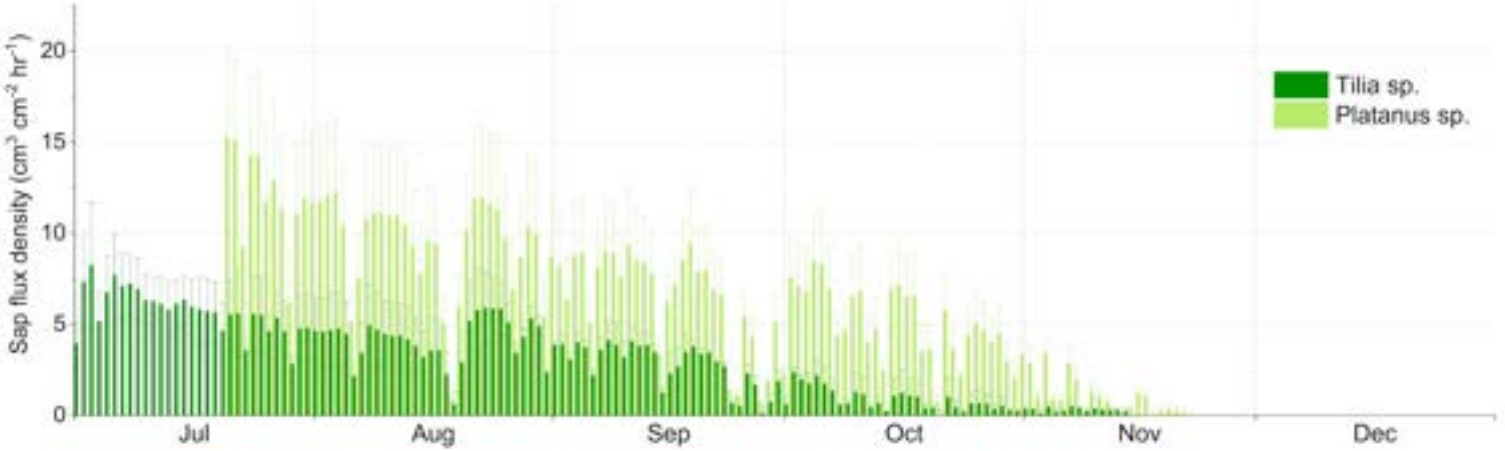
Collaboration: city parks administration

Biogenic activity – from satellite to local observations



e.g. Sentinel enh. veg. Index (EVI)



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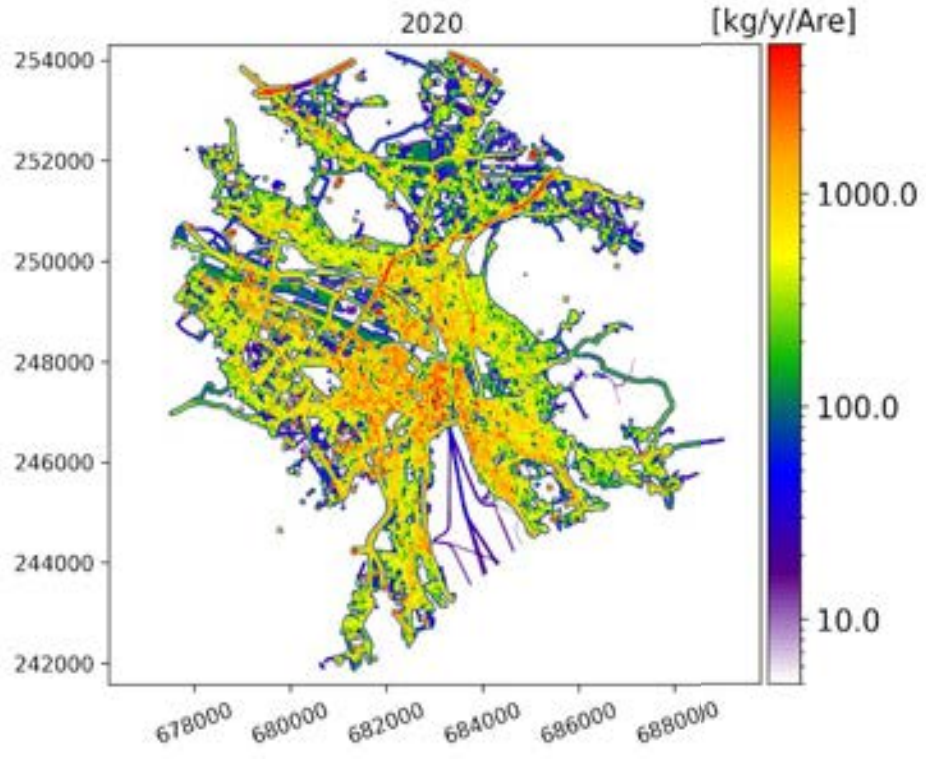
Zurich Emission inventory

- **60 source** categories
- **vector-based** (area, line, point sources)
- **> 20,000** point sources
- **GHG:** CO_2, CH_4, N_2O
- **AQ**: SO_2, NOx, CO, VOC, C_6H_6, PM, NH_3



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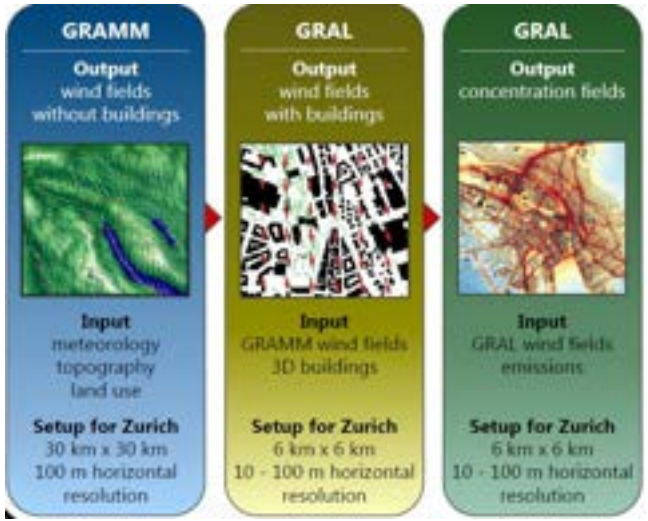
Simulation of air flow and transport



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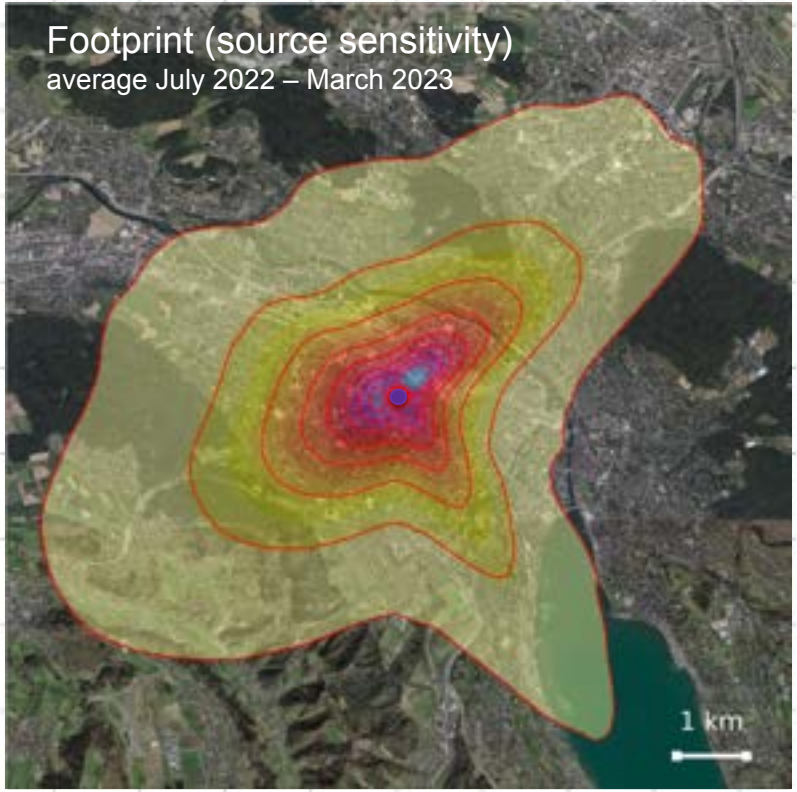
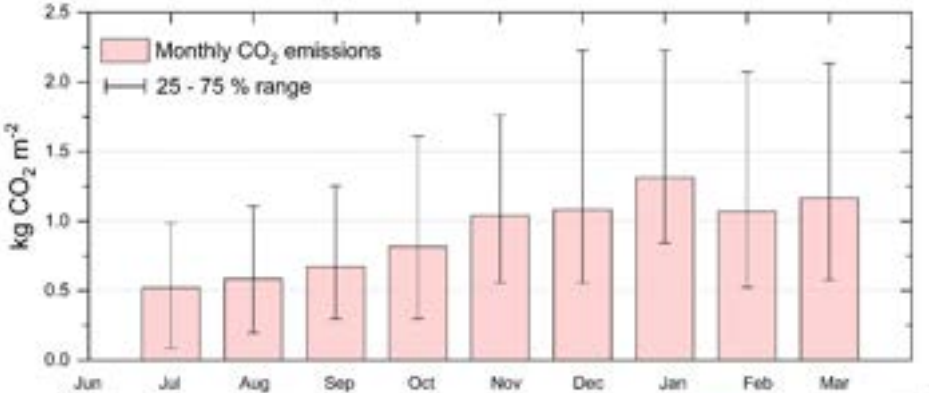
Tall building as observation point

CO_2 emissions observed at the Hardau tower



Eddy-covariance CO_2 emissions



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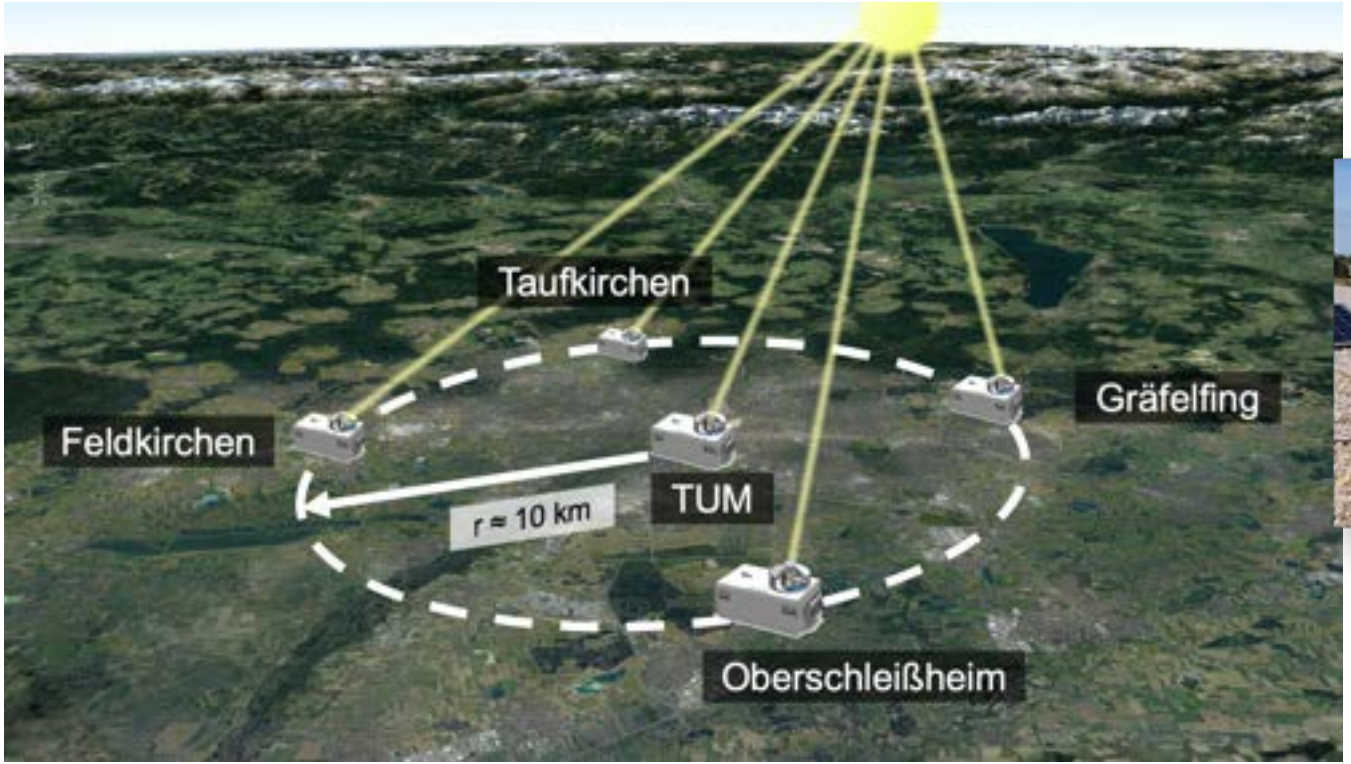
Total column network



MUNICH

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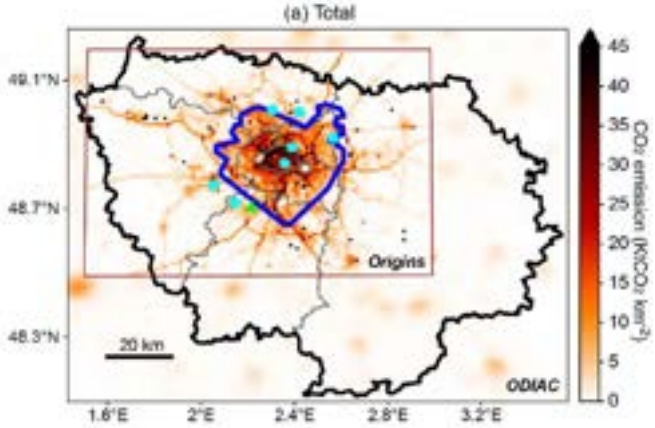
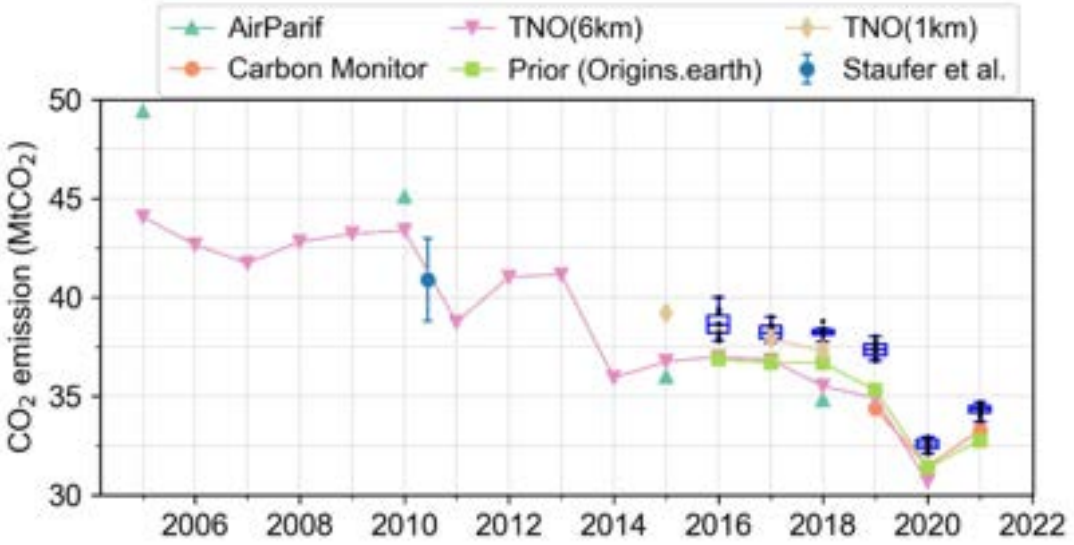
Figure by Chen/F. Dietrich

Atmospheric inversion over Paris



Inventory based emissions and CO_2 measurement stations (cyan circles). Inversions were performed for the Greater Paris region (blue line) and IdF region (black line).

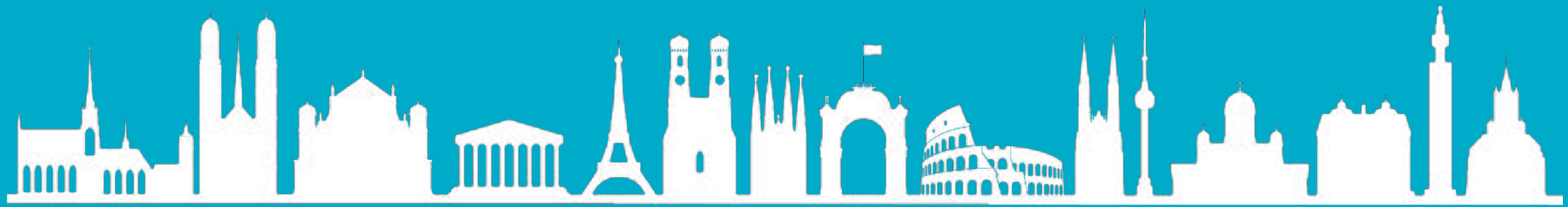


Annual fossil fuel CO_2, IdF 2005 to 2021. Blue boxplots are distribution of posterior CO_2 emissions from an ensemble inversion configurations.

Jinghui Lian et al., EGUsphere preprint (2023), doi.org/10.5194/egusphere-2023-401

ICOS Cities

- **Concurrent observations** with different systems in metropolitan (Paris), large (Munich) and mid-size city (Zurich).
- Exploration of **novel and complementing technologies** (e.g. low-cost sensor networks, co-species eddy fluxes, ^{14}C fluxes)
- Create a blueprint for independent **urban monitoring and attribution of GHG** emission reduction efforts.
- The best and most cost **efficient strategy** will likely depend on **local parameters** and on **local support**.



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http://www.icos-cities.eu

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