

# WP 3 Observations

Report on the progress and roadmap towards implementation

Andreas Christen, Samuel Hammer, Lukas Emmenegger and the WP3 team

Fossil fuel emissions in the Upper Rhine Valley (Photo: A. Christen)



Funded by



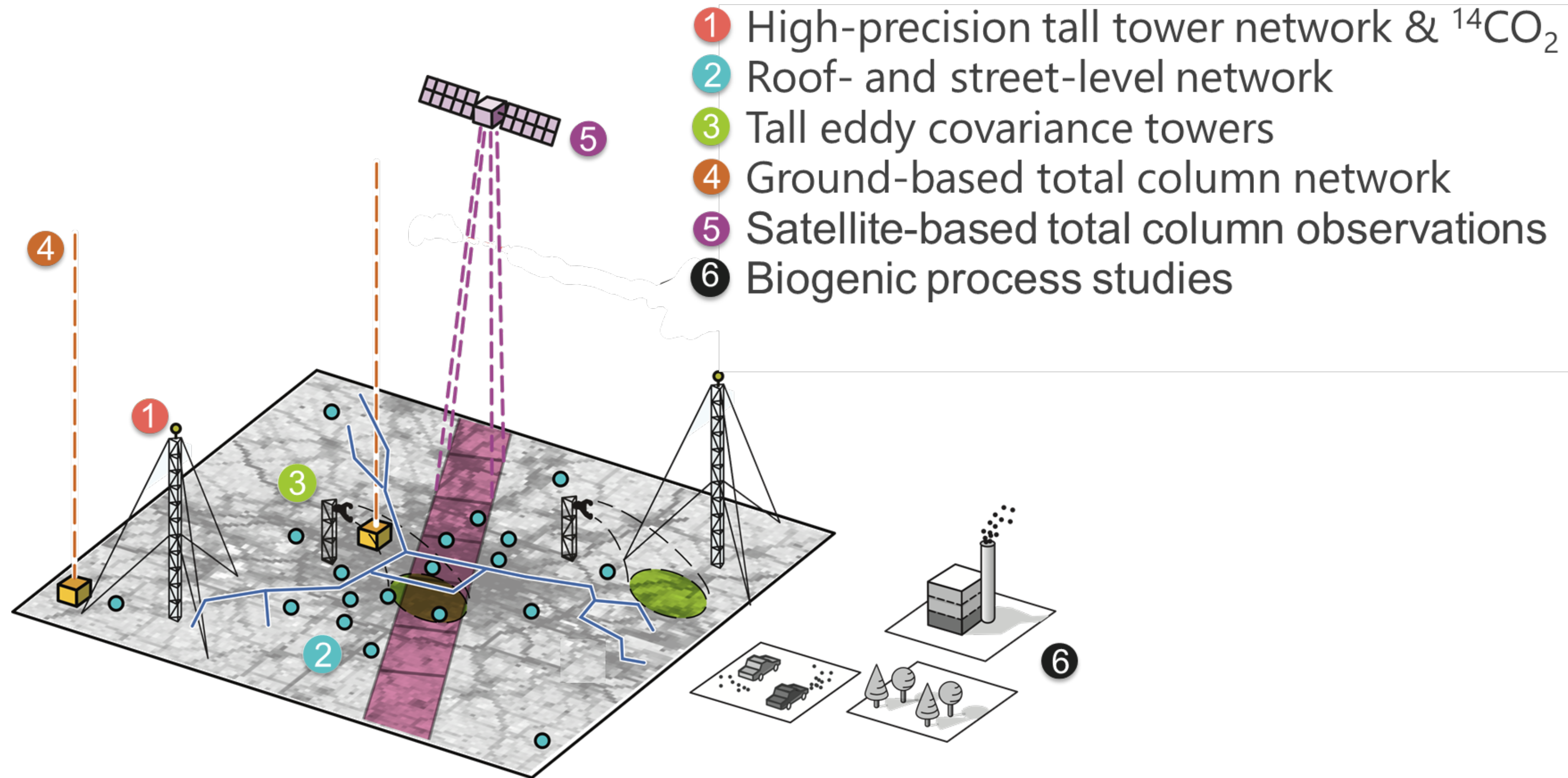


# Why urban observations of GHGs?



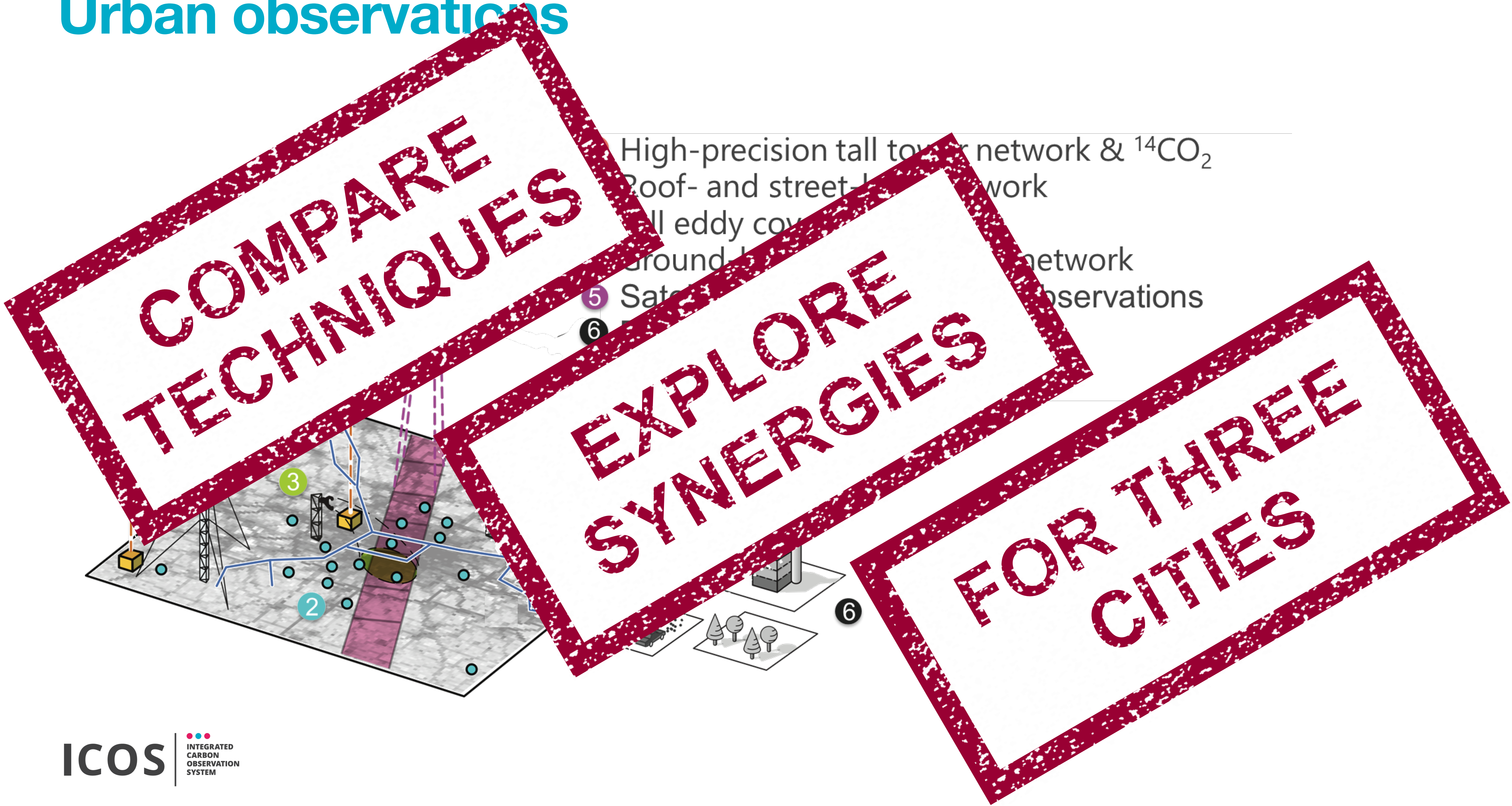


# Urban observations





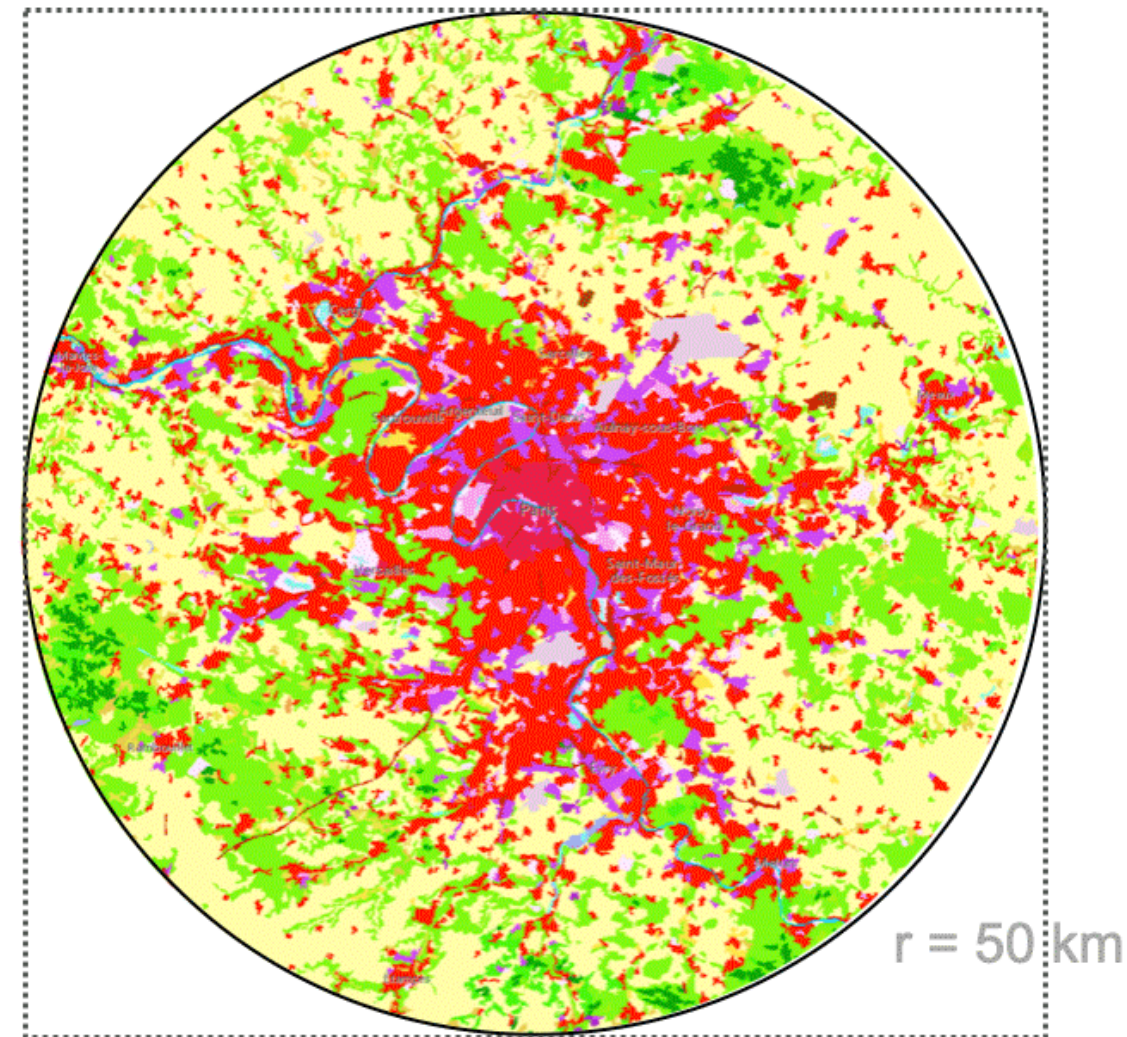
# Urban observations





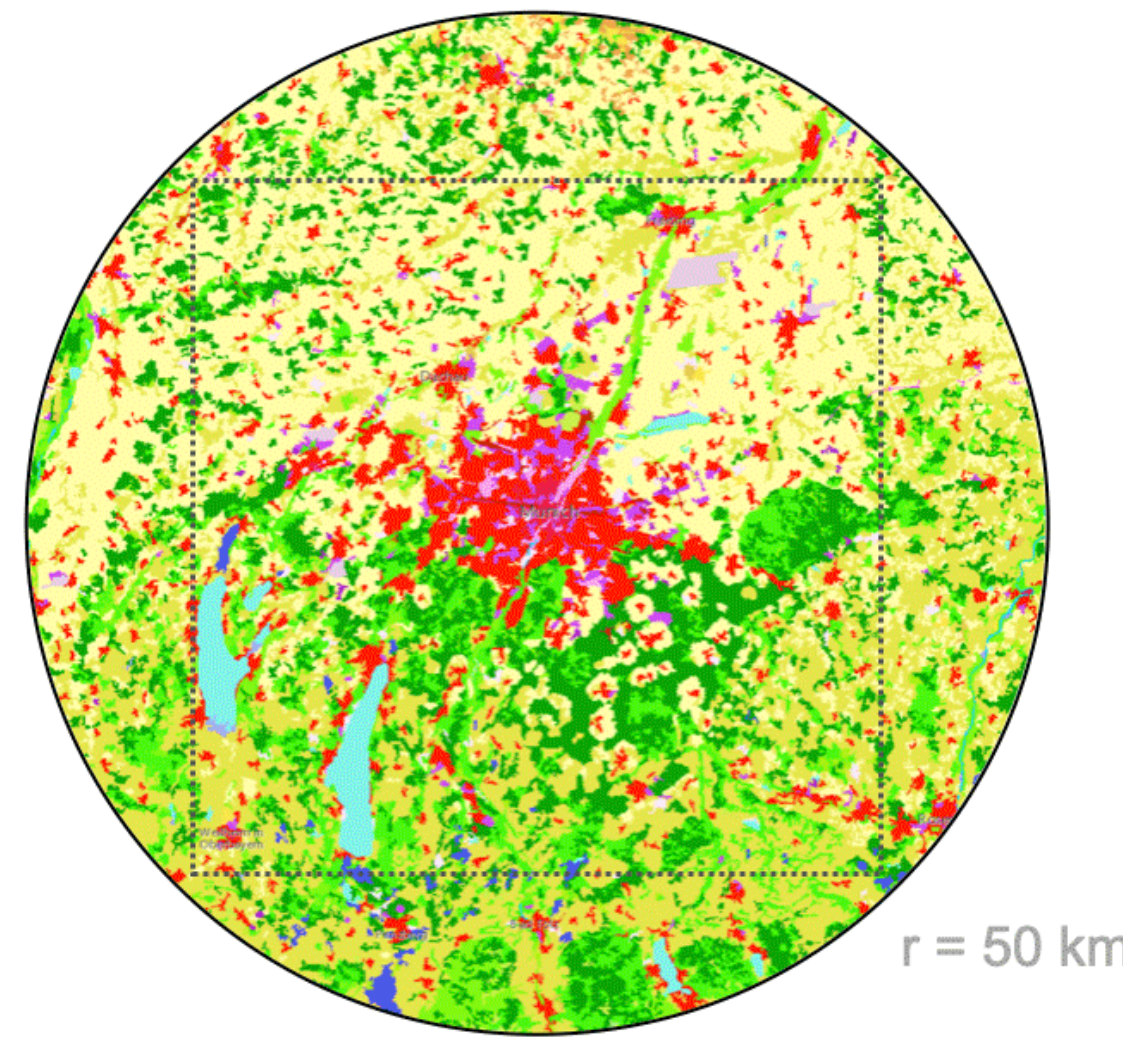
## Paris

Metro 12.6 Mio Inh.  
Urban 10.7 Mio Inh.



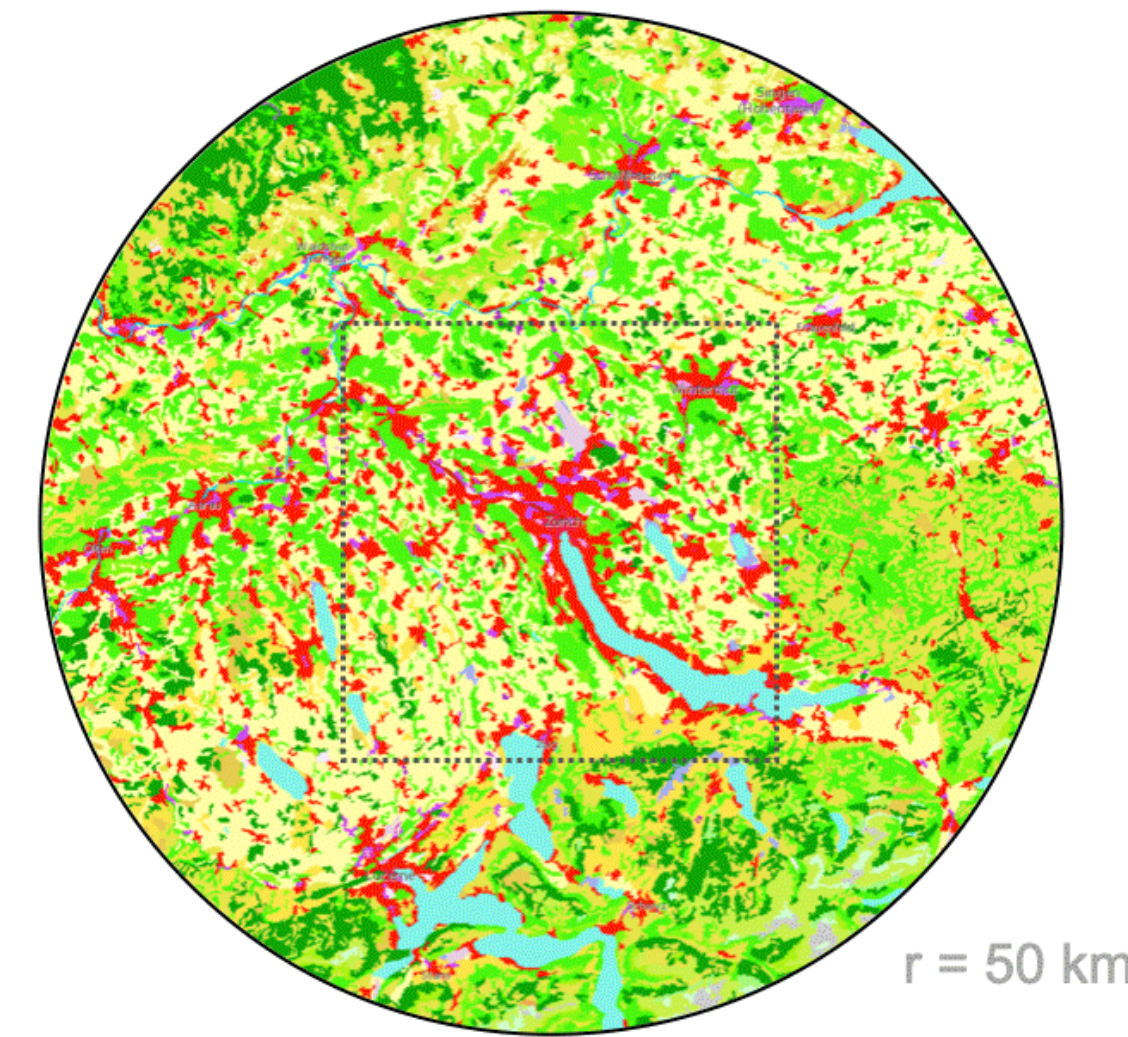
## Munich

5.9 Mio Inh.  
2.6 Mio Inh.



## Zurich

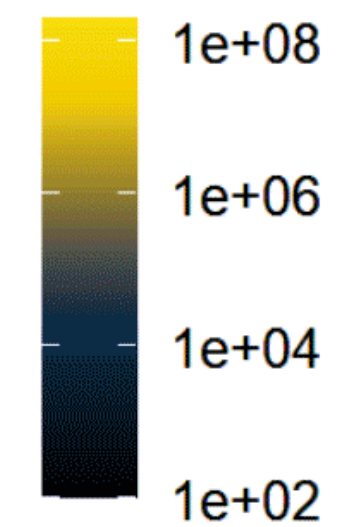
1.6 Mio Inh.  
0.4 Mio Inh.



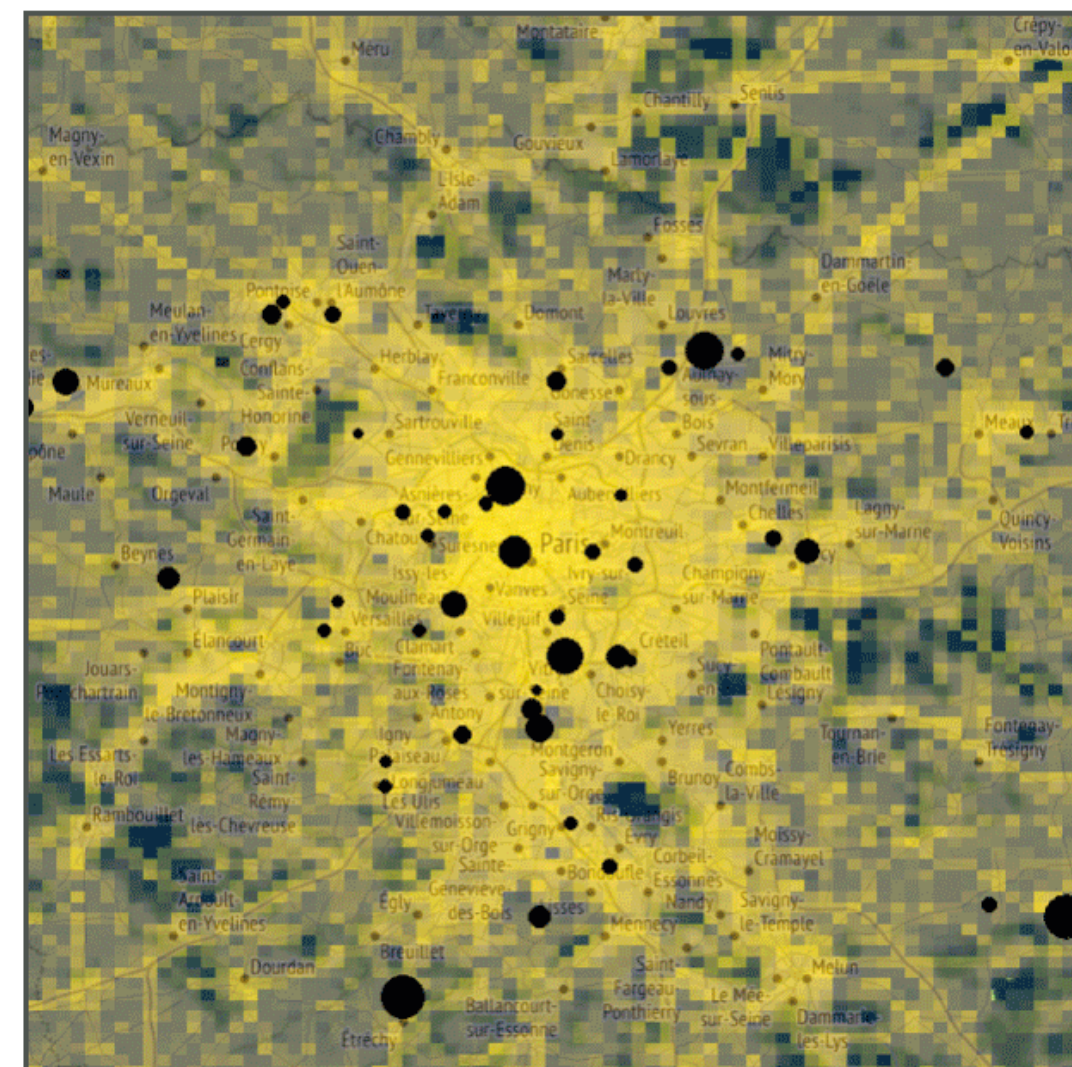
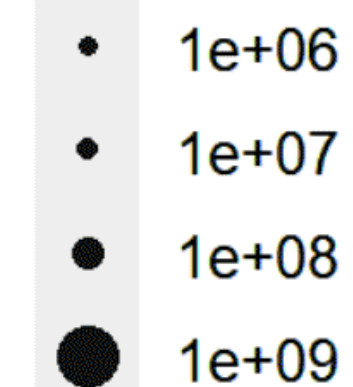
### Land cover

- Urban fabric
- Industrial / commercial
- Transportation
- Croplands
- Pastures
- Broad-leaved / mixed forest
- Coniferous forest
- Water bodies

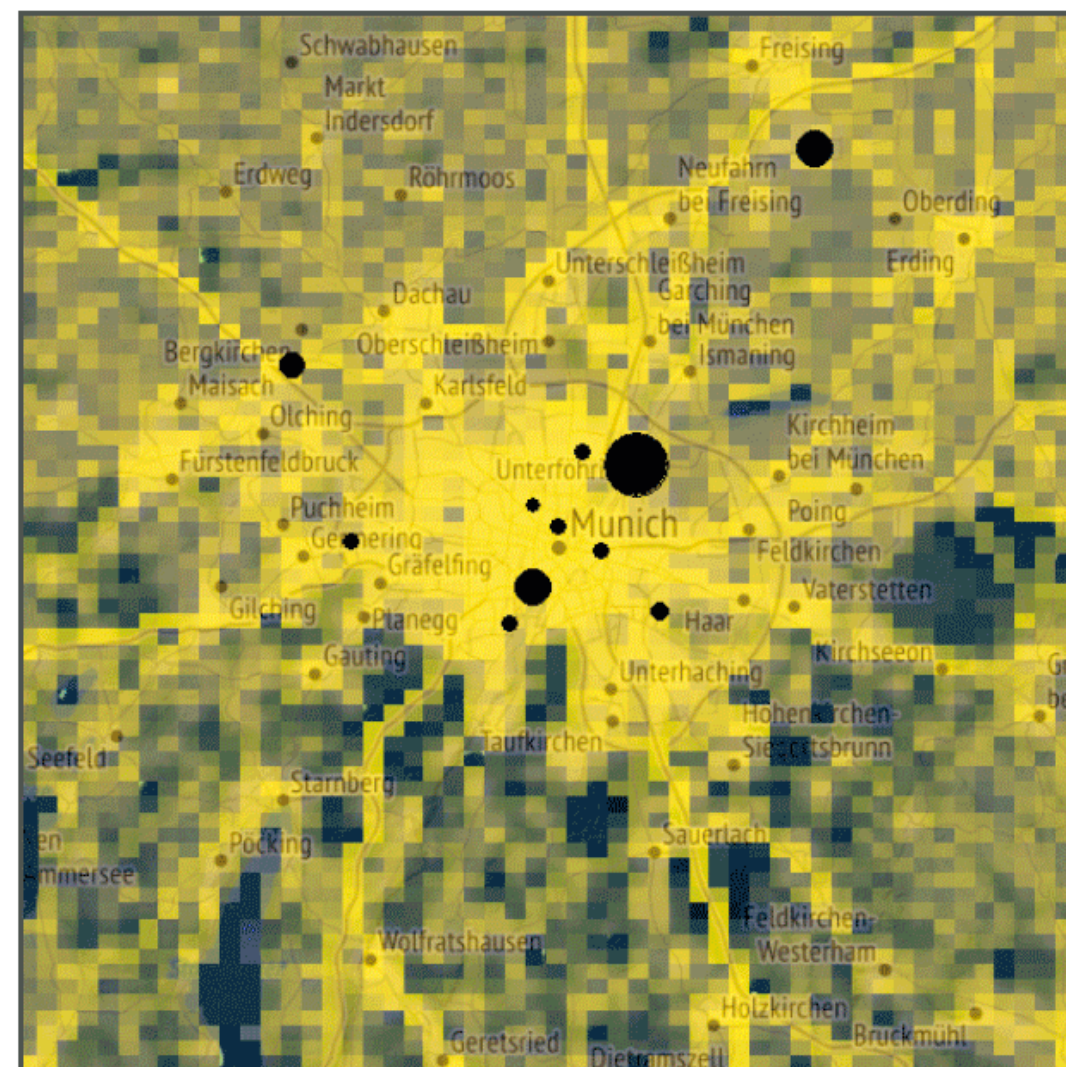
### ffCO<sub>2</sub> Emissions kg yr<sup>-1</sup> km<sup>-2</sup>



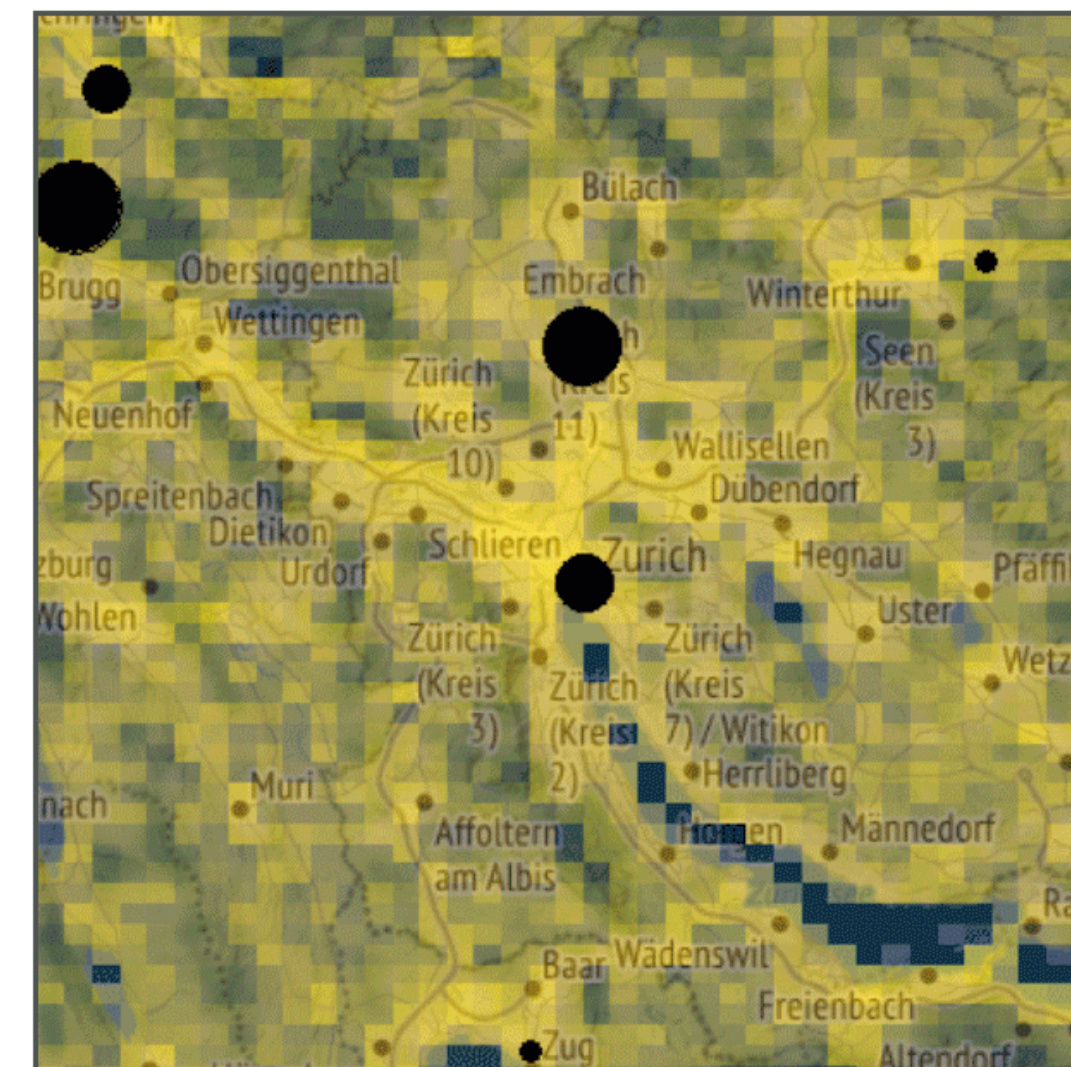
### ffCO<sub>2</sub> Point sources kg yr<sup>-1</sup>



100 x 100 km



70 x 70 km



45 x 45 km



# Long-term (2 years) measurements

Paris  
October 1, 2022

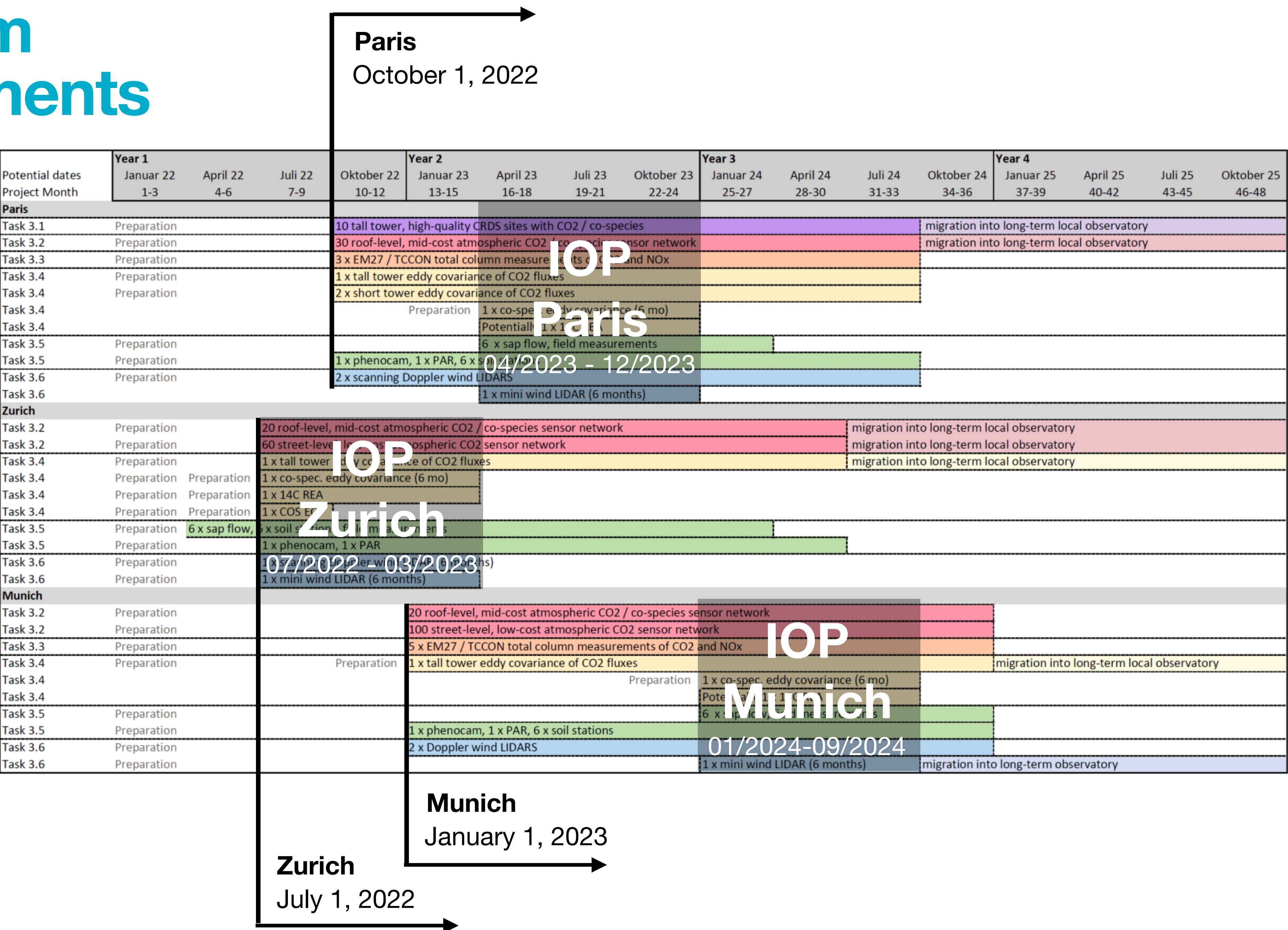
	Year 1					Year 2					Year 3					Year 4					
Potential dates	Januar 22	April 22	Juli 22		Oktober 22	Januar 23	April 23	Juli 23	Oktober 23		Januar 24	April 24	Juli 24	Oktober 24		Januar 25	April 25	Juli 25	Oktober 25		
Project Month	1-3	4-6	7-9		10-12	13-15	16-18	19-21	22-24		25-27	28-30	31-33	34-36		37-39	40-42	43-45	46-48		
Paris																					
Task 3.1	Preparation				10 tall tower, high-quality CRDS sites with CO2 / co-species										migration into long-term local observatory						
Task 3.2	Preparation				30 roof-level, mid-cost atmospheric CO2 / co-species sensor network										migration into long-term local observatory						
Task 3.3	Preparation				3 x EM27 / TCCON total column measurements of CO2 and NOx																
Task 3.4	Preparation				1 x tall tower eddy covariance of CO2 fluxes																
Task 3.4	Preparation				2 x short tower eddy covariance of CO2 fluxes																
Task 3.4					Preparation		1 x co-spec. eddy covariance (6 mo)														
Task 3.4							Potentially 1 x 14C REA														
Task 3.5	Preparation						6 x sap flow, field measurements														
Task 3.5	Preparation				1 x phenocam, 1 x PAR, 6 x soil stations																
Task 3.6	Preparation				2 x scanning Doppler wind LIDARS																
Task 3.6							1 x mini wind LIDAR (6 months)														
Zurich																					
Task 3.2	Preparation				20 roof-level, mid-cost atmospheric CO2 / co-species sensor network										migration into long-term local observatory						
Task 3.2	Preparation				60 street-level, low-cost atmospheric CO2 sensor network										migration into long-term local observatory						
Task 3.4	Preparation				1 x tall tower eddy covariance of CO2 fluxes										migration into long-term local observatory						
Task 3.4	Preparation		Preparation		1 x co-spec. eddy covariance (6 mo)																
Task 3.4	Preparation		Preparation		1 x 14C REA																
Task 3.4	Preparation		Preparation		1 x COS EC																
Task 3.5	Preparation		6 x sap flow,		6 x soil stations, field measurements																
Task 3.5	Preparation				1 x phenocam, 1 x PAR																
Task 3.6	Preparation				1 x scanning Doppler wind LIDAR (6 months)																
Task 3.6	Preparation				1 x mini wind LIDAR (6 months)																
Munich																					
Task 3.2	Preparation						20 roof-level, mid-cost atmospheric CO2 / co-species sensor network														
Task 3.2	Preparation						100 street-level, low-cost atmospheric CO2 sensor network														
Task 3.3	Preparation						5 x EM27 / TCCON total column measurements of CO2 and NOx														
Task 3.4	Preparation				Preparation		1 x tall tower eddy covariance of CO2 fluxes										migration into long-term local observatory				
Task 3.4							Preparation			1 x co-spec. eddy covariance (6 mo)											
Task 3.4										Potentially 1 x 14C REA											
Task 3.5	Preparation									6 x sap flow, field measurements											
Task 3.5	Preparation						1 x phenocam, 1 x PAR, 6 x soil stations														
Task 3.6	Preparation						2 x Doppler wind LIDARS														
Task 3.6	Preparation									1 x mini wind LIDAR (6 months)				migration into long-term observatory							

Munich  
January 1, 2023

Zurich  
July 1, 2022



# Short-term measurements

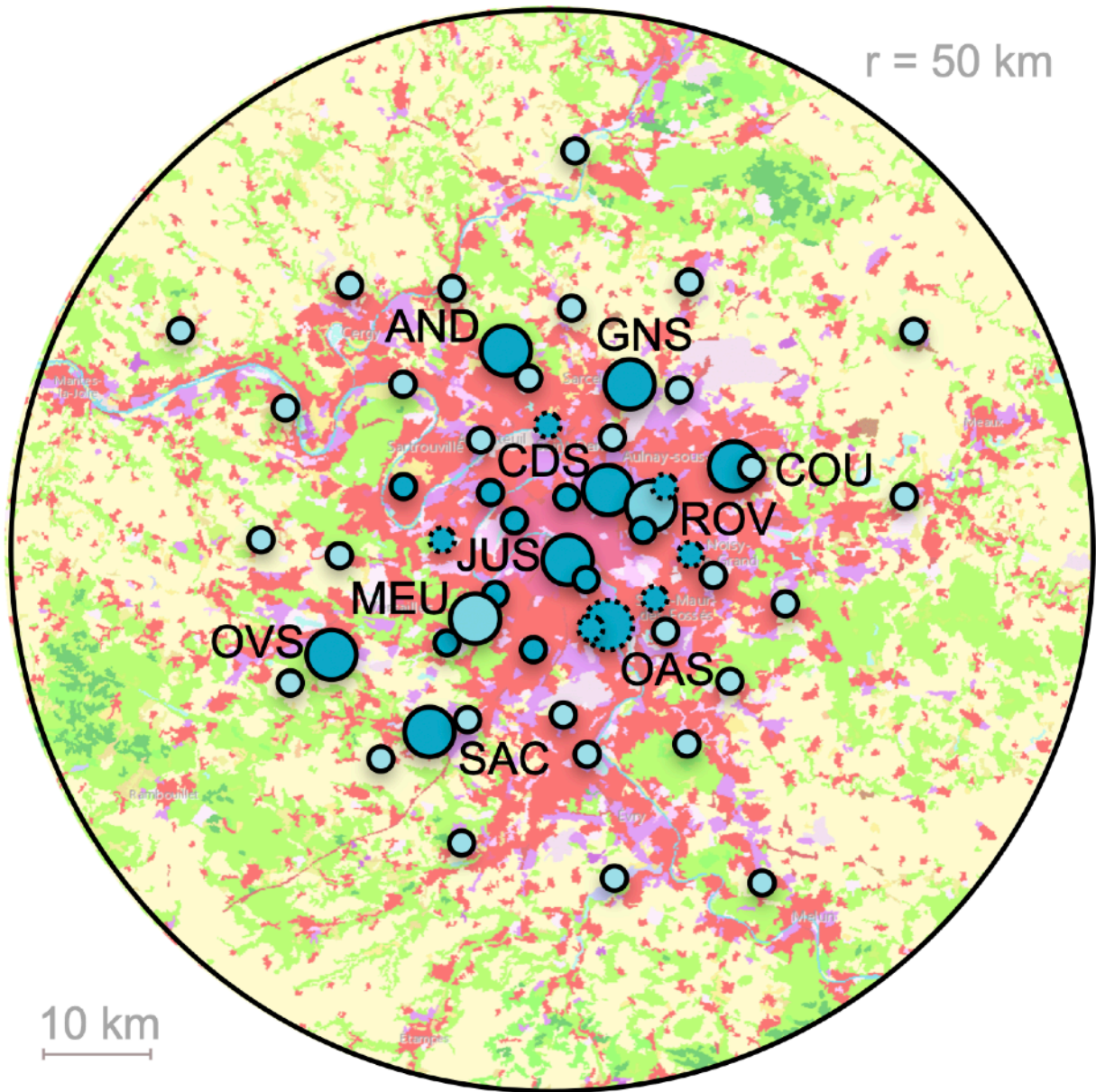




# Tasks 3.1 / 3.2 - Concentration measurements

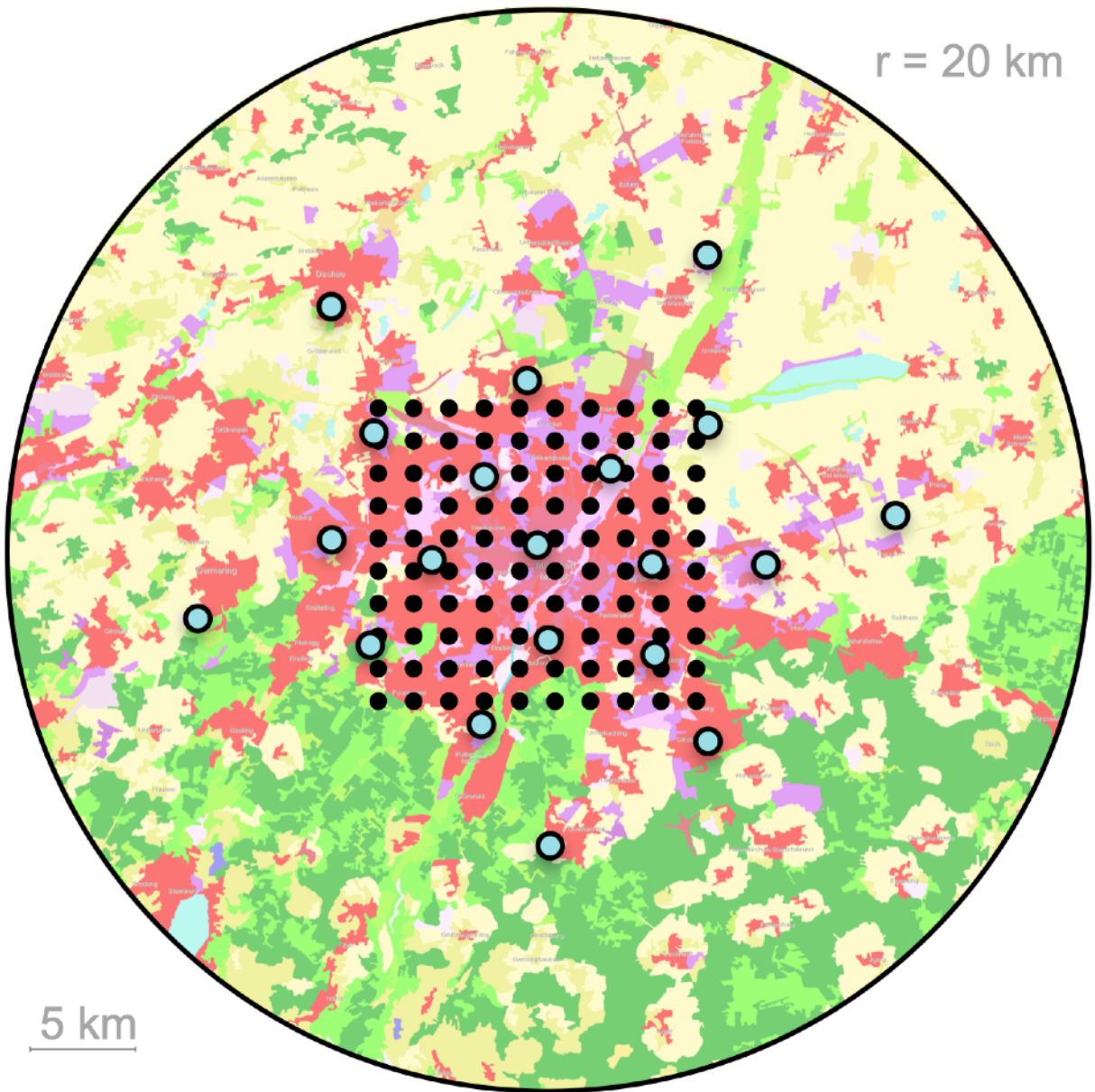
## Paris

10 high-precision sites  
30 roof-level sensors



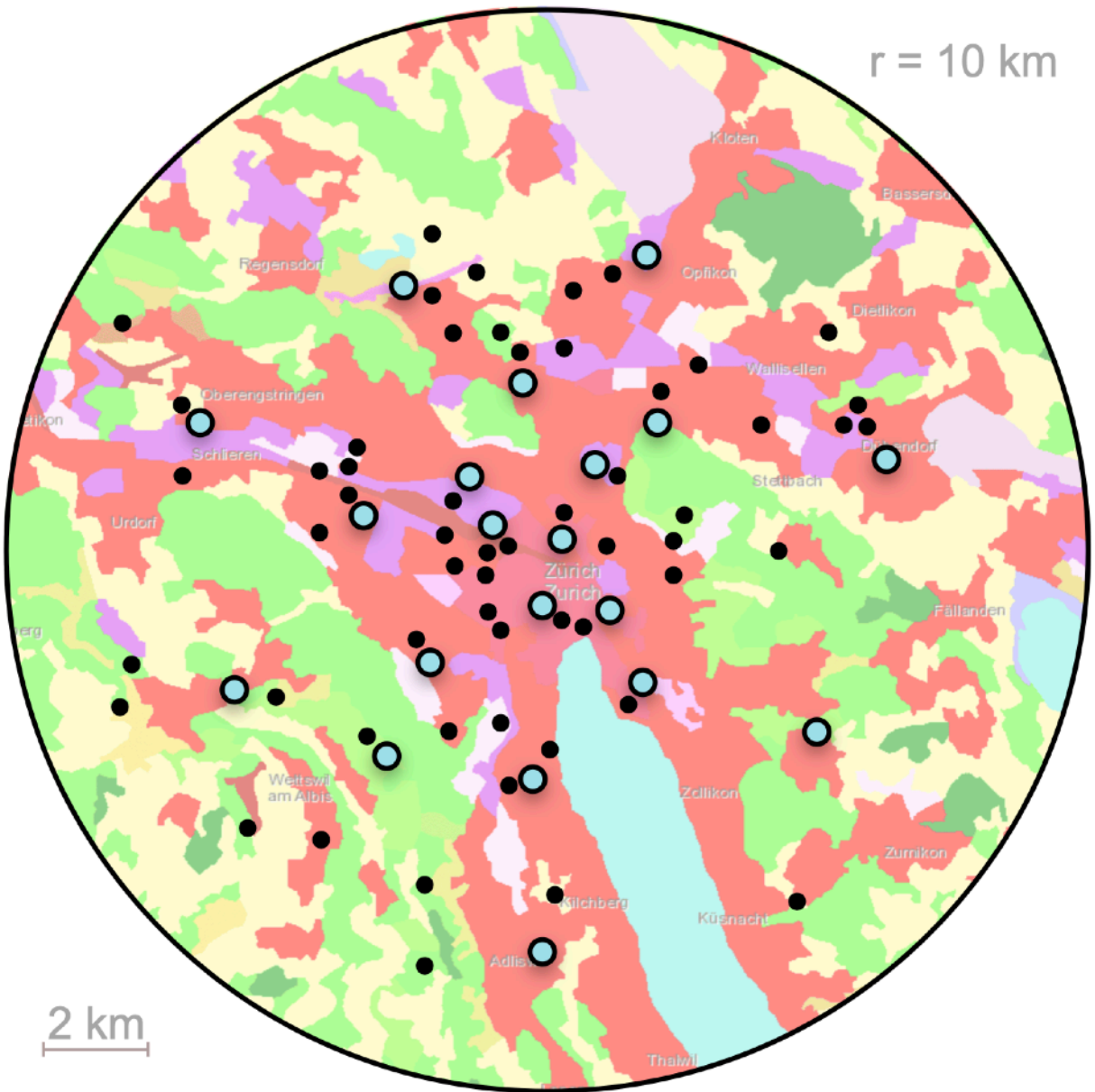
## Munich

20 roof-level sensors  
100 street-level sensors



## Zurich

20 roof-level sensors  
60 street-level sensors



Paris	8 x HP Towers	2 new HP	15 roof level	15 new roof level
Insturments purchased	✓	✓	✓	in Prog.
Sites identified	✓	✓	✓	in Prog.
Sites confirmed	✓	in Prog.	✓	✗
Operational	✓	✗	✓	✗
Responsibility	Chariot	Chariot	Laurent	Laurent

Munich	20 x roof-level	100 x street level
Insturment purchased	in Prog.	in Prog.
Site identified	✗	✗
Site confirmed	✗	✗
Operational	✗	✗
Responsibility	Chen	Chen

Zurich	20 x roof-level	60 street level
Insturment purchased	in Prog.	✓
Site identified	in Prog.	✓
Site confirmed	✗	in Prog.*
Operational	✗	in Prog.
Responsibility	Emenegger	Emenegger

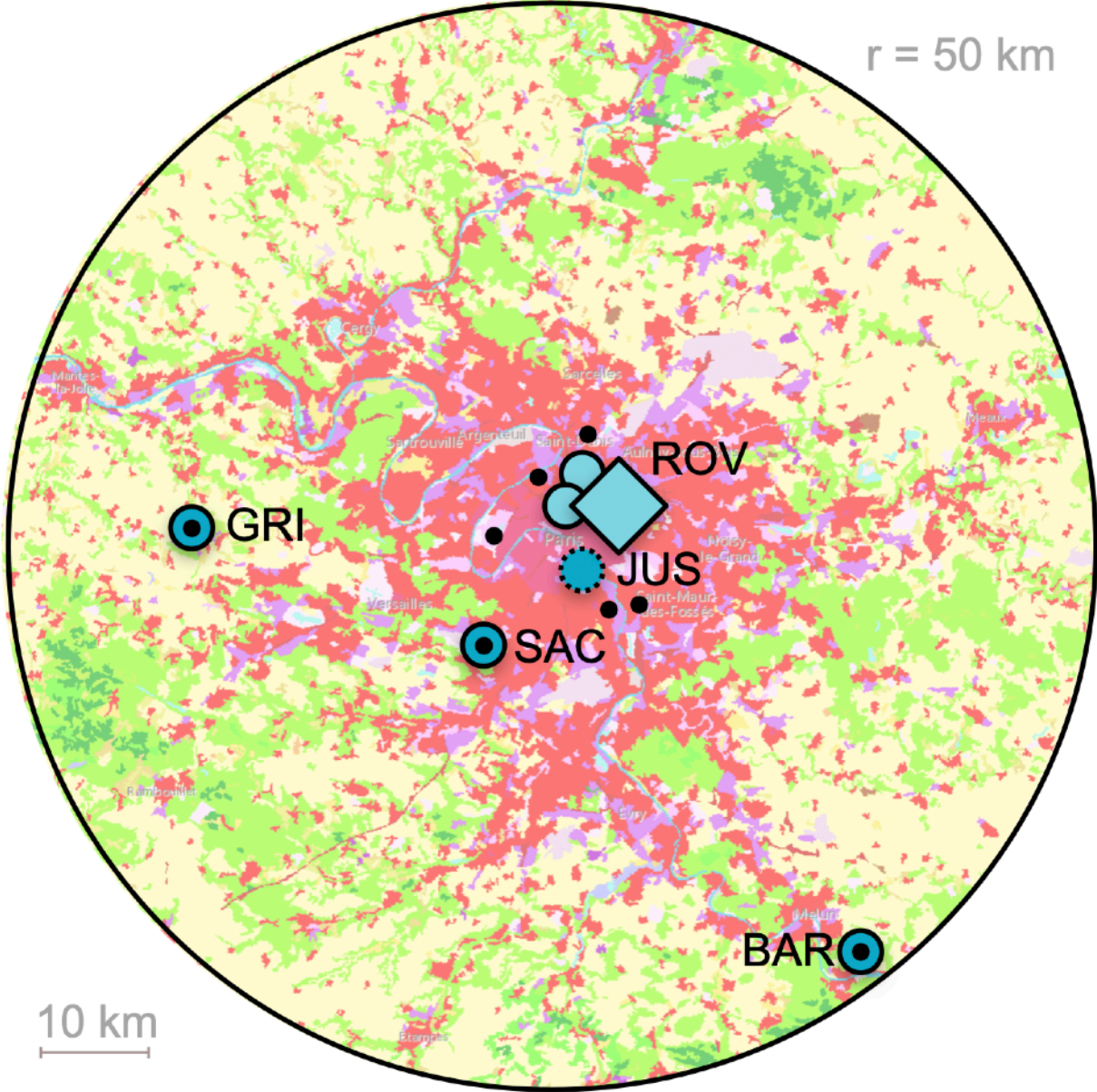
\* requires contract extensions



# Tasks 3.4 / 3.5: Eddy covariance and biogenic fluxes

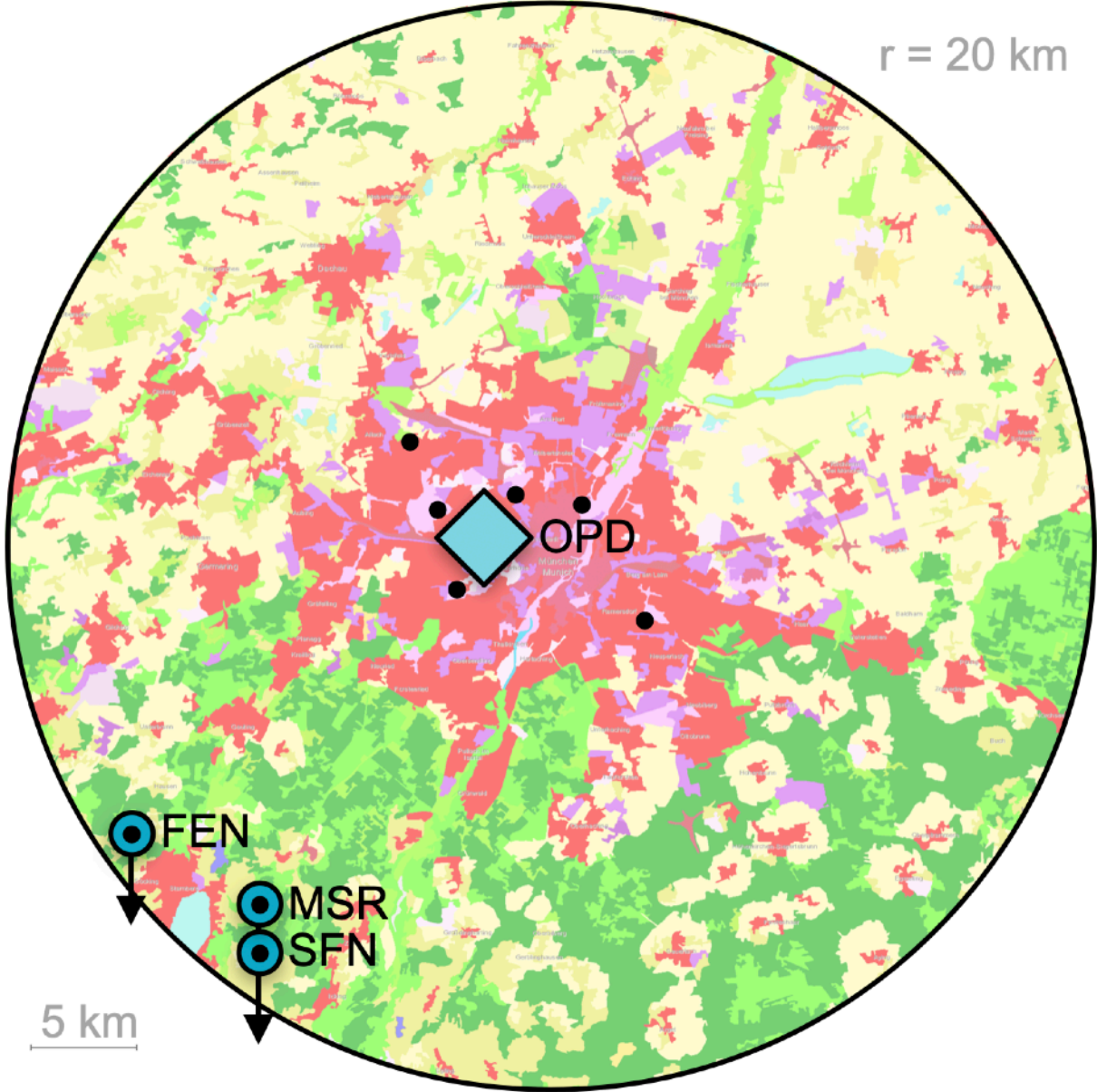
## Paris

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



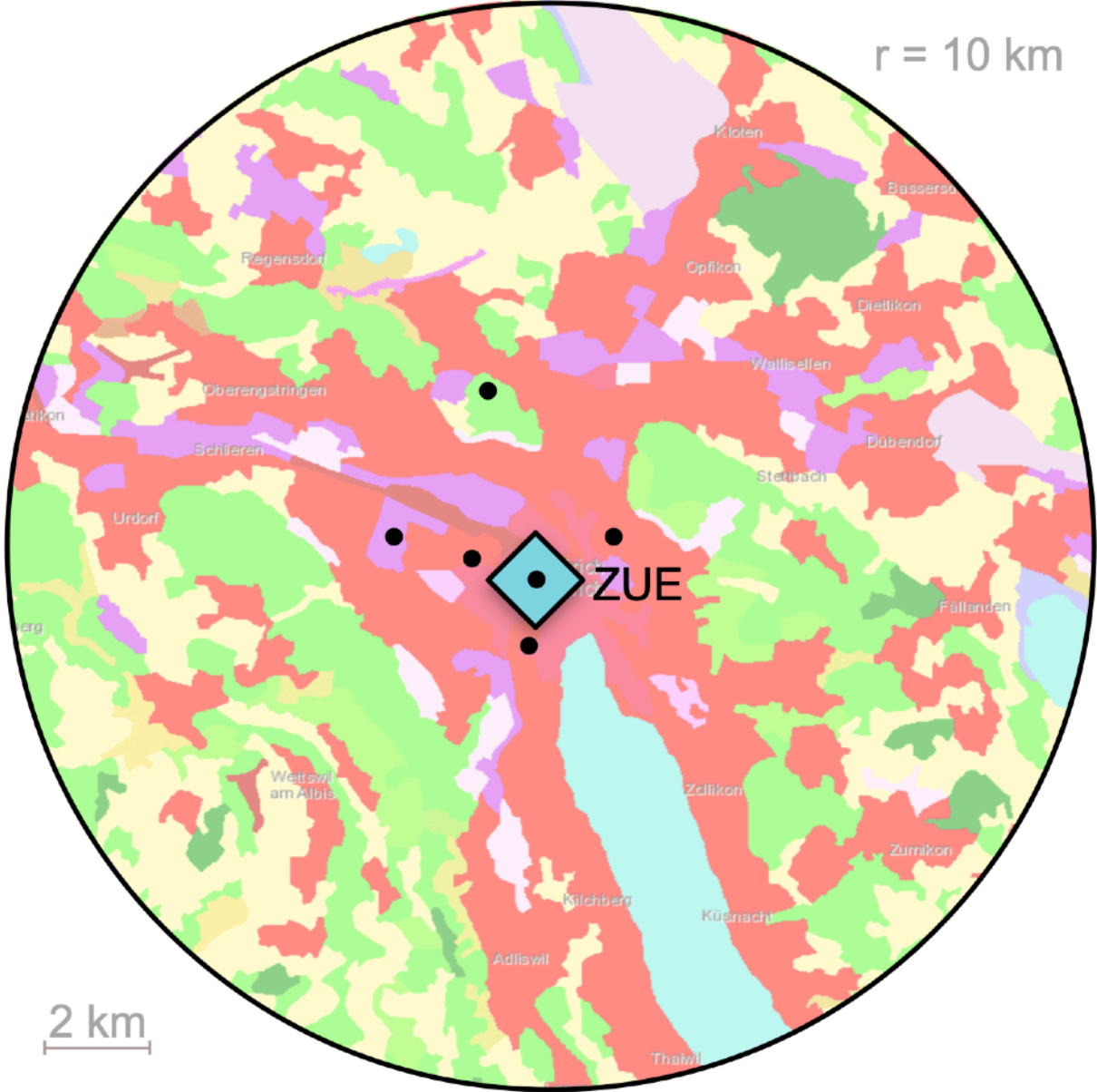
## Munich

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



## Zurich

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



Paris	1 x TT EC	1 x Co-Species	3 x Low EC	6 x Biospher
Insturments purchased	✗	in Prog.	?	in Prog.
Sites identified	✓	✓	in Prog.	✗
Sites confirmed	in Prog.	in Prog.	in Prog.	✗
Operational	✗	✗	✗	✗
Responsibility	Loubet	Christen	Mauder	Stagakis

Munich	1 x TT EC	1 x Co-Species	6 x Biosphere
Insturment purchased	✓	in Prog.	in Prog.
Site identified	✓	✓	✗
Site confirmed	✗	✗	✗
Operational	✗	✗	✗
Responsibility	Mauder	Christen	Stagakis

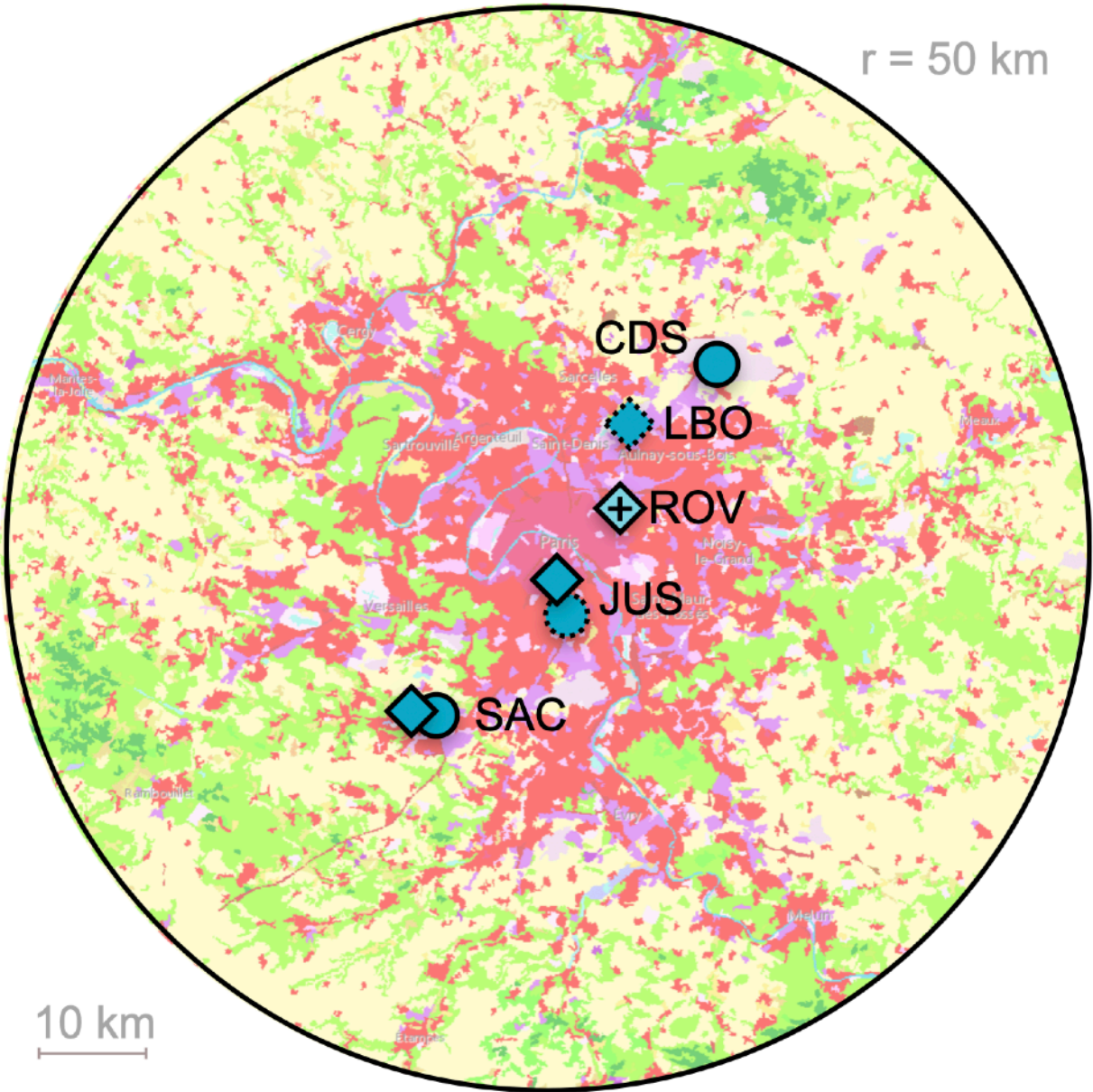
Zurich	1 x TT EC	1 x Co-Species	6 x Biosphere
Insturment purchased	✓	in Prog.	in Prog.
Site identified	✓ (2 Opt)	✓	✗
Site confirmed	in Prog.	in Prog.	✗
Operational	✗	✗	✗
Responsibility	Mauder	Christen	Stagakis



# Tasks 3.3. / 3.6 : Remote sensing and transport

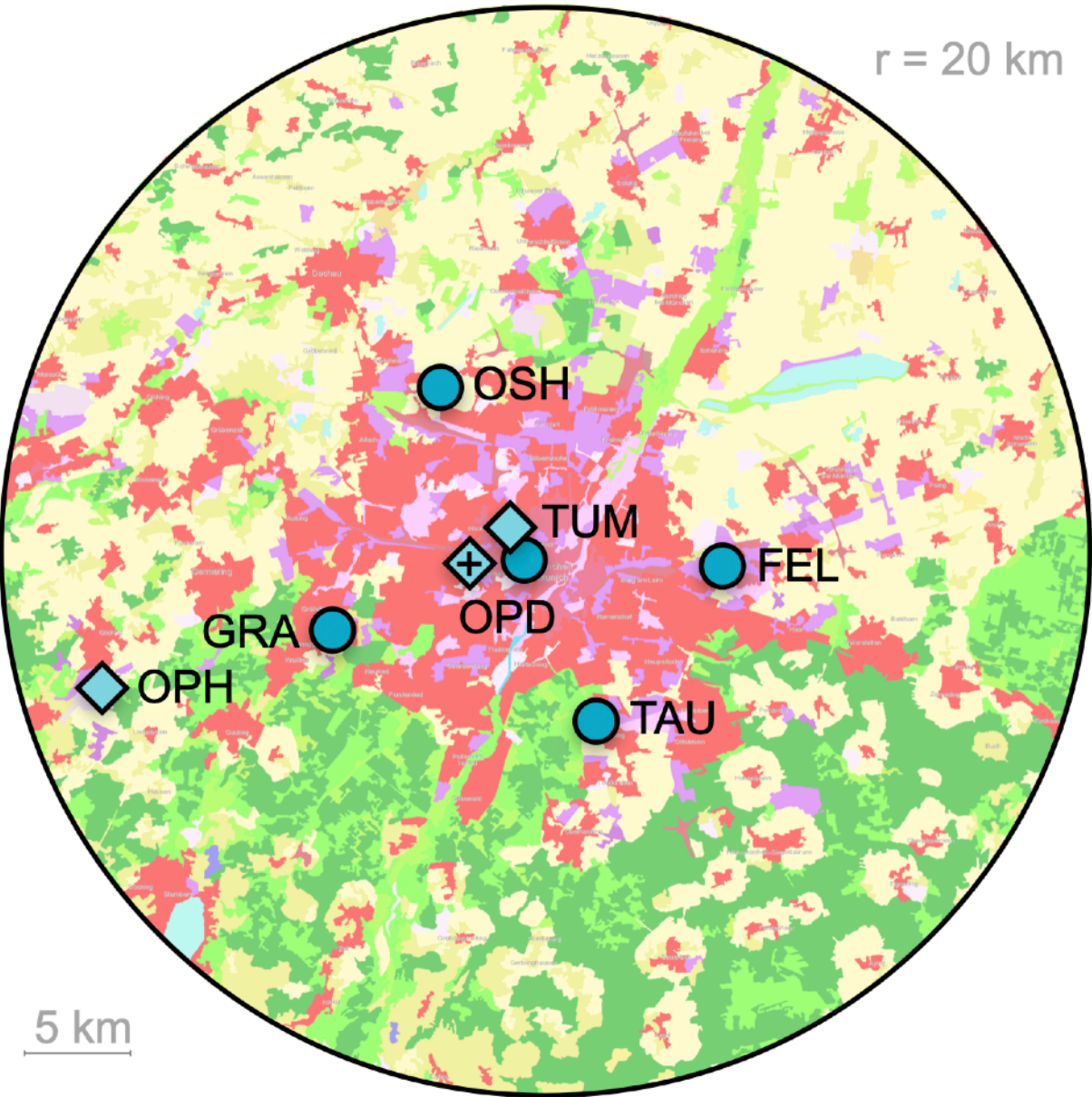
## Paris

3 total column CO<sub>2</sub>  
4 Doppler wind LIDARS



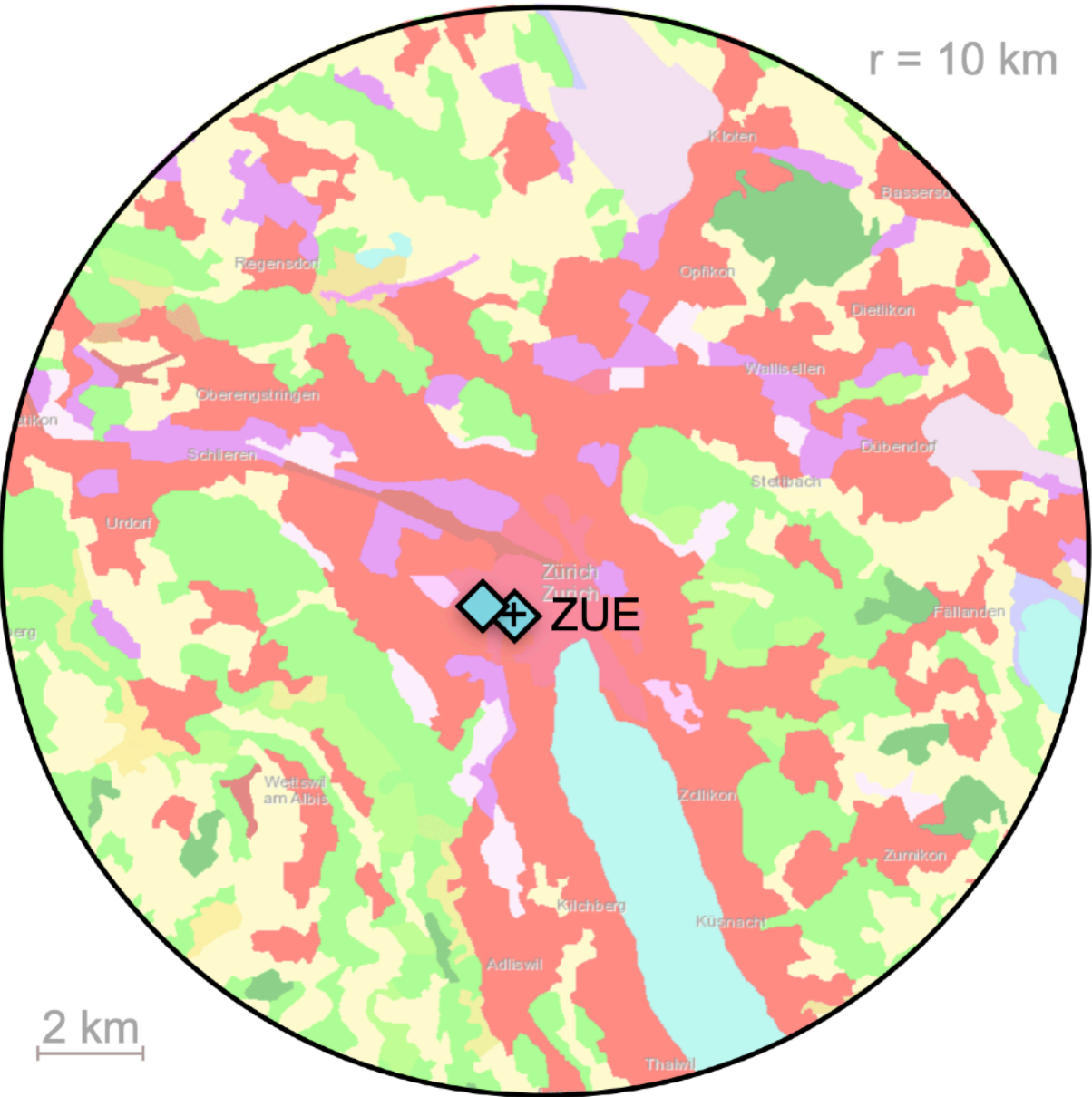
## Munich

5 total column CO<sub>2</sub>  
3 Doppler wind LIDARS



## Zurich

2 Doppler wind LIDARS



Paris	3 x TC CO <sub>2</sub>	3 x DWL	1 x Mini DWL
Insturments purchased	✓	✓	in Prog.
Sites identified	✓	✓	✗
Sites confirmed	✓	✓	✗
Operational	✗	✗	✗
Responsibility	Lopez	Haeffelin	Mauder

Munich	5 x TC CO <sub>2</sub>	3 x DWL	1 x Mini DWL
Insturment purchased	✓	✓	in Prog.
Site identified	✓	✗	✗
Site confirmed	✓	✗	✗
Operational	✓	✗	✗
Responsibility	Chen	Mauder	Mauder

Zürich	3 x DWL	1 x Mini DWL
Insturment purchased	✓	in Prog.
Site identified	in Prog.	✗
Site confirmed	✗	✗
Operational	✗	✗
Responsibility	Mauder	Emenegger



# WP2 - WP3

<div>Call objective</div> <div>Task</div>	A	B	C	D	Pilot cities		
	Core technologies	Co-species and isotopes	Instrumentation prototypes	Low-cost / citizen engagement	Paris	Munich	Zurich
	Extending and upgrading established long-term measurement technologies to enable urban-scale emission monitoring	Assessing the benefits of co-species and isotope information for sectoral attribution of measured emissions	Assessing the benefits of instrumentation (prototypes) for total emission quantification and/or sectoral emission attribution	Assessing the benefits of low-cost systems and citizen engagement for improving total and sectoral emission quantification			
Task 3.1 High-precision atmospheric concentration network	① ③	① ③			✓		
Task 3.2 Roof-level and street-level concentration networks	①	① ②	①	①	✓	✓	✓
Task 3.3 Ground-based remote sensing	①	①	①		✓	✓	
Task 3.4 Eddy covariance flux towers	① ③	① ②	②		✓	✓	✓
Task 3.5 Biogenic flux observations			②	②	✓	✓	✓
Task 3.6 Atmospheric transport	① ③		③		✓	✓	✓

Numbers refer to main categories of data provided where ① - input to inverse models, ② - input to improve inventories and process models, ③ – independent evaluation.



# WP3 - WP4 - Data Streams

City	Task 3.1 High-precision networks	Task 3.2 Mid- and low- cost networks	Task 3.3 Ground-based remote sensing	Task 3.4 Eddy Covariance	Task 3.5 Biogenic fluxes	Task 3.6 Airflow / meteorology
Paris	10 x Tall towers	30 x roof-level systems	3 FTIRs	1 Tall tower EC 3 local-scale EC Co-species	6 soil and sap flow sites 1 Phenocam	3 DWLs 1 Mini Wind LIDAR
Munich	-	20 x roof-level systems 100 x street	5 FTIRs	1 Tall tower EC Co-species <sup>14</sup> C REA	6 soil and sap flow sites 1 Phenocam	2 DWLs 1 Mini Wind LIDAR
Zurich	-	20 x roof-level systems 60 x street level	-	1 Tall tower EC Co-species <sup>14</sup> C REA	6 soil and sap flow sites 1 Phenocam	1 DWLs 1 Mini Wind LIDAR
Formats, Transfer	Rivier	Laurent / Emenegger	Chen	Papale		Mauder
Curation	Data Portal					



Looking forward to collaborate with all institutions involved in observations

- Integrated Carbon Observation System HO (FI)
- Ruprecht-Karls-Universität Heidelberg (DE)
- Helsingin Yliopisto (FI)
- Albert-Ludwigs-Universität Freiburg (DE)
- Fondazione Centro Euro-Mediterraneosui Cambiamenti Climatici (IT)
- Commissariat a l'Energie Atomique et aux Energies Alternatives (FR)
- Eidgenössische Materialprüfungs- und Forschungsanstalt (CH)
- Lunds Universitet (SE)
- Technische Universitaet München (DE)
- Karlsruher Institut für Technologie (DE)
- Universität Basel (CH)
- Centre National de la Recherche Scientifique CNRS (FR)
- Institut National de Recherche pour l'agriculture, l'alimentation et l'environnement (FR)
- Max-Planck-Gesellschaft zur Forderung der Wissenschaften EV (DE)

ICOS

● ● ●  
INTEGRATED  
CARBON  
OBSERVATION  
SYSTEM

We acknowledge funding by the

