Paris regional-scale boundary-layer observation campaign 2023 – 2024

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1. Introduction

Problem: General lack of comprehensive observations at regional scale to support the next-generation of urban weather and climate model development.
Focus: (urban) atmospheric boundary layer (BL) and understanding interactions between urban form, urban function and BL for 2023-2024 intensive measurements. This poster focuses on the initial results and the availability of data.

Process captured	Variables used	Instrument used
Intra-urban boundary layer dynamics suitable for next-generation NWP model evaluation	•Boundary layer height •Aerosol profiles •Sensible heat flux •Vertical and horizontal wind	•Automatic Lidars and Ceilometers (ALC, Vaisala) •Doppler wind lidar (Halo Photonics, Vaisala)
Urban plume effects on regional atmosphere	•Boundary layer height •Incoming SW and LW radiation	•ALC (Vaisala) •Radiometers
Boundary layer radiative forcing across the urban-rural continuum	•Incoming SW and LW radiation	•Pyranometer •Pyrgeometer •Pyrheliometer •SOLYS2 sun trackers

2. Measurement network

Number of stations: up to 19 urbisphere measurement stations in total, and five partner stations
Operating period: Autumn 2022 – March 2024
Measurement network design: Along and across predominant wind direction (SW)

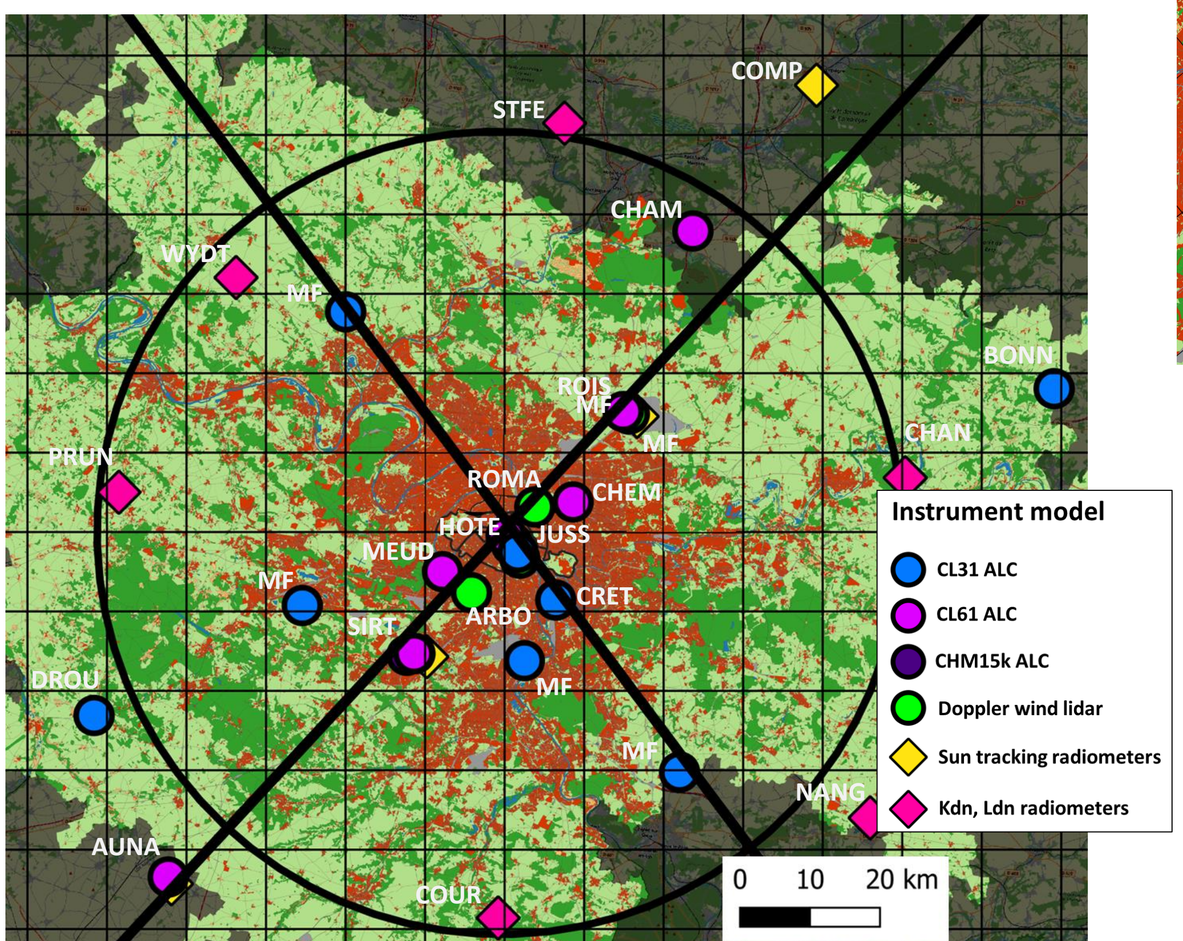

Figure 1. Urbisphere and partner measurement stations in the urbisphere measurement network including Meteo France (MF) ALC stations, with SIRTA ("SIRT") the base ("HQ") for conducting the campaign

2.1 Automatic lidars and ceilometers

- The instruments in the network include 11 *urbisphere* (19 total including PANAME and Meteo France) automatic low-power lidars and ceilometers (ALC) distributed in the city and up to 70 km upwind and downwind of central Paris.
- Seven urbisphere Vaisala CL61 with aerosol backscatter depolarisation ratio allowed for improved boundary layer height calculation with potential for characterising aerosol types/sources and inferring aerosol concentrations.
- After the main campaign, an inter-comparison of all CL61 was conducted at SIRT. Two CL61 then returned for long-term deployment at stations ROIS and HOTE (Figure 2).

ALC data availability

Site	Instrument	Measurement section	2022 Sep	Oct	Nov	Dec	2023 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2024 Jan	Feb	Mar	Apr
AUNA	CL61	50 km (SW)																				
SIRT	CL61	25 km (SW)																				
SIRT	CHM15k	25 km (SW)	←																			→
MEUD	CL61	10 km (SW)																				
HOTE	CL61	0 km	←																			→
CHEM/BOBI	CL61	10 km (NE)																				
ROIS	CL61	25 km (NE)																				→
CHAM	CL61	40 km (NE)																				
DROU	CL31	50 km (WSW)																				
CRET	CL31	0 km																				
BONN	CL31	50 km (ENE)																				
Meteo France	CL31	Various	←																			→

Partner site
CL31 *urbisphere*
CL61 *urbisphere*

Figure 2. ALC data availability by station, with partner contributions

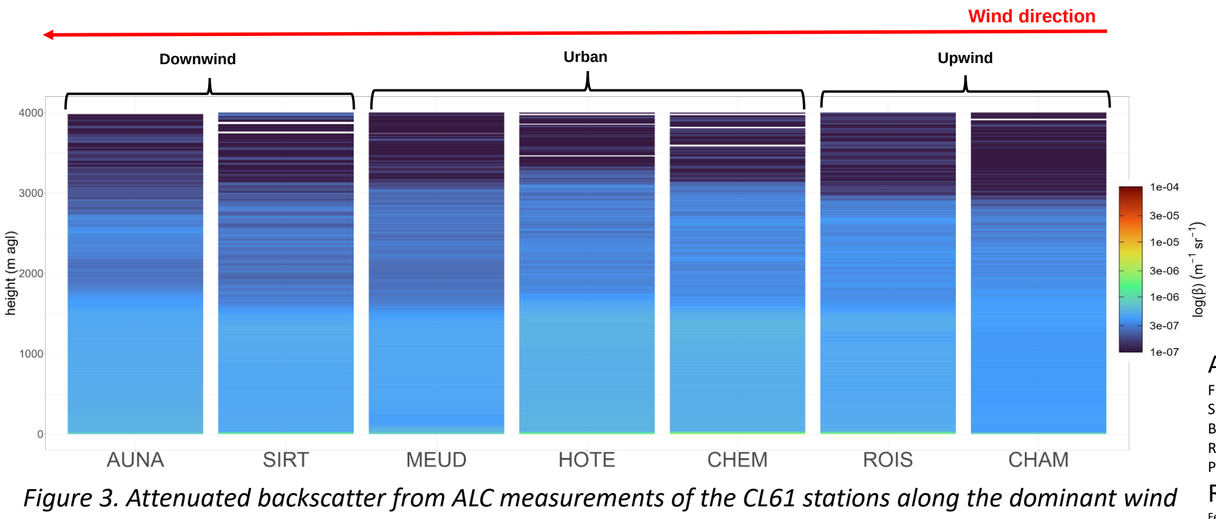

Figure 3. Attenuated backscatter from ALC measurements of the CL61 stations along the dominant wind direction (indicated by red arrow) on September 3, 2023, averaged over an hour from 13:00 to 14:00 UTC.

2.2. Doppler wind lidars

- Linking the ALC measurements are six doppler wind lidars (three Halo Photonics StreamLine managed by urbisphere) installed along a 40 km transect from SW to NE Paris, characterising turbulent structures upwind, over and downwind of the city using vertical and horizontal wind velocity profiles and turbulence statistics.
- UK Met Office operated a StreamLine at station ROIS (Roissy airport) and SIRTA/LMD operate instruments (JUSS, SIRT)
- The data from these observations (Morrison et al., 2024b, in draft) provide crucial inputs to atmospheric transport models, as shown in e.g. the ICOS-cities pilot project. They are also crucial for evaluation of next-generation high-resolution numerical weather prediction (NWP) models (Lean et al., 2019).

Partner site
Urbisphere site

Doppler wind lidar data availability

Site	Instrument	City centre distance	2022 Sep	Oct	Nov	Dec	2023 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2024 Jan	Feb	Mar
SIRT	Halo Photonics	25 km SW																			
SIRT	WLS70	25 km SW	←																		→
ARBO	Halo Photonics	10 km SW																			
JUSS	windcube 400S	0 km	←																		→
LUPD	Halo Photonics	0 km																			
CHEM	Halo Photonics	10 km NE																			
ROIS	Halo Photonics	25 km NE																			

Figure 4. (left, centre) urbisphere Halo Photonics StreamLine doppler wind lidar at station ARBO (right) with data availability through 2022 – 2024. Data availability limited by station access constraints, instrument failure (e.g. overheating, component failure).

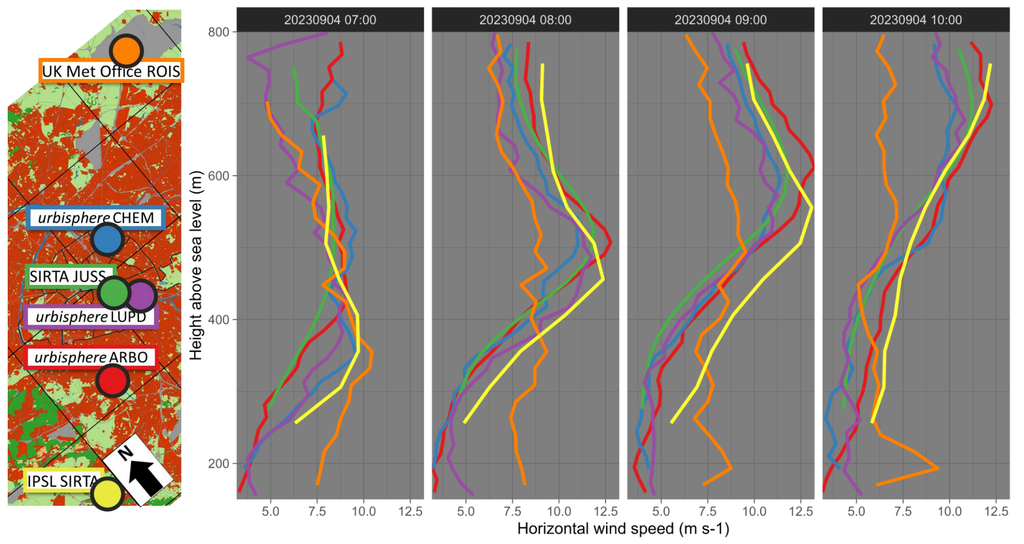

Figure 5. (left) Figure 1 map rotated along predominant wind (SW) showing DWL transect through Paris and (right) horizontal wind speed profiles for each instrument near the start of a heat wave event 4th September 2023 (right) urbisphere Halo Photonics StreamLine doppler wind lidar, ALC and sun tracker at station CHEM

2.3. Radiometers

- The radiative budget and impacts of aerosols on radiative transfer are independently observed with broadband short and longwave radiometers (5 sun tracker stations, 6 unshaded pyranometer-pyrgeometer pairs)
- Radiometers are distributed in a ring around Paris (Figure 1) with an extensive inter-comparison at SIRTA in spring 2024.

Radiometer data availability

Site	Shaded?	City centre distance	2022 Sep	Oct	Nov	Dec	2023 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	2024 Jan	Feb	Mar
STFE	No	50 km N																			
CHAN	No	50 km ENE																			
NANG	No	50 km SE																			
COUR	No	50 km S																			
PRUN	No	50 km W																			
WYDT	No	50 km WNW																			
JUSS	No	Central																			→
AUNA	Yes	50 km SW																			
SIRT	Yes	25 km SW	←																		→
DENF	Yes	0 km																			
CHEM	Yes	5 km NE																			
COMP	Yes	50 km NE																			

Figure 6. (left) Radiometer data availability by measurement station (Figure 1) with (pink) partner station contributions from SIRTA (SIRT) and ICOS-cities (station JUSS, flux tower lower Qualair platform) and radiometer tower inside (right top) COUR and (right bottom) PRUN stations, hosted by Meteo France).

- The number of radiometer stations and separation (1 – 2 h drive from SIRTA adds maintenance demands.
- A mobile radiometer system was developed for comparison with the static stations during each maintenance visit
- Quality controlled products are being developed using the mobile measurements

Figure 7. (left) Mobile radiometer system *(right) with pre-post cleaning at station STFE*

2.3. Phenocams, scintillometers, radiosondes

- Two phenocams (SIRT, ROMA) join the global phenocam network for near-surface remote sensing of canopy phenology (phenocam.nau.edu)
- Two pairs of Scintec large aperture scintillometers have paths through central Paris for long-term (2022 – end of 2024) deployments to determine sensible heat fluxes
- An intensive observation period (IOP) was conducted in Dec 2023/Jan 2024 to study how cities modify winter versions by concurrently launching radiosondes (windsonds) in the city center and at SIRTA

Figure 8. (top left) BLS2000 transmitter at station ROMA (bottom left) phenocam at station SIRT (right) IOP radiosonde launches in Paris city centre

3. Conclusions

A comprehensive measurement campaign was successfully executed in Paris from 2023 – 2024. Raw data and data products are being generated and are becoming available on the zenodo data platform https://zenodo.org/communities/urbisphere.
The work done links with the previous *urbisphere* campaigns in Berlin (2021 – 2022; Fenner et al, in review) and Bristol (2024 – 2025).

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