The Boundary-layer Air Quality-analysis Using Network of INstruments Supersite for Atmospheric Research and Satellite Validation

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BAQUNIN Mandate

"The requirements for a good validation strategy are simple: continue acquiring new data, go to the right places, take the right measurements at the right time, accumulate enough data, include validation of ancillary data and facilitate data access."

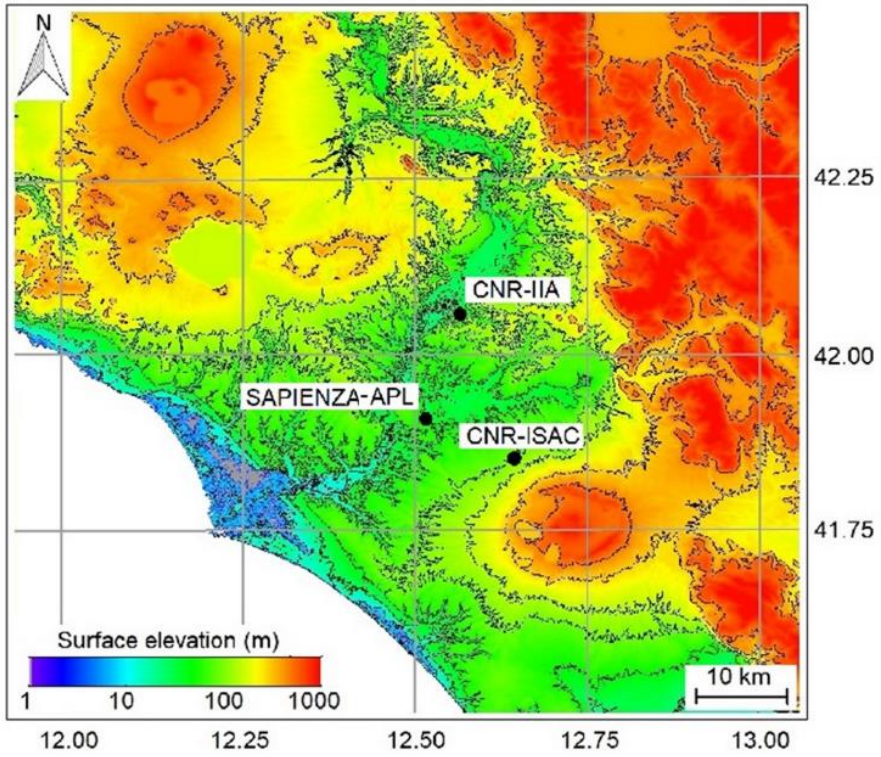
Richter et al., "*Validation strategy for satellite observations of tropospheric reactive gases*"
ANNALS OF GEOPHYSICS, 56, FAST TRACK-1, 2013; 10.4401/AG-6335, ACVE, 13-15 March 2013

Boundary-layer **A**ir **Q**uality-analysis **U**sing **N**etwork of **IN**struments

- Sustain the **maintenance** and **operation** of ground based remote sensing and in situ instruments for Satellite Cal/Val and Atmospheric Monitoring/Research purposes, operating in the Rome area
- Acquire, homogenise and distribute high quality **data**
- Perform inter-calibration and validation **campaigns**
- **Attract/engage** Space/Research/Health Agencies
- Stimulate research in Urban Atmospheric Boundary Layer physics and chemistry by facilitating **inter-connections** between national and international research institutes

BAQUNIN Sites

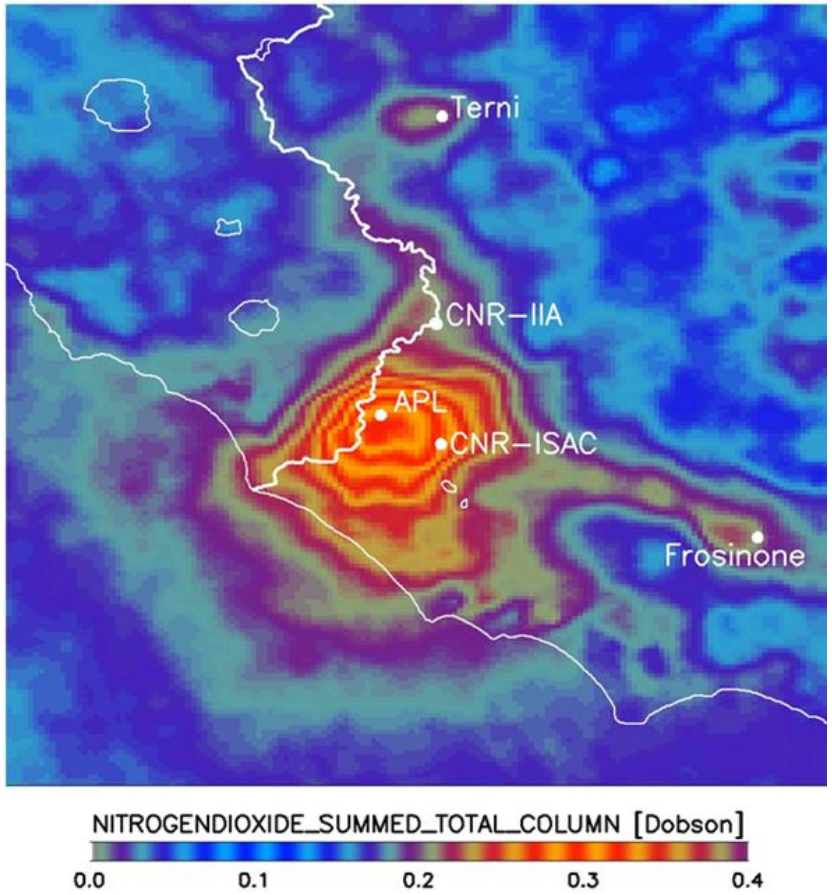
Boundary-layer **A**ir **Q**uality-analysis **U**sing **N**etwork of **IN**struments



URBAN

SEMI-RURAL

RURAL

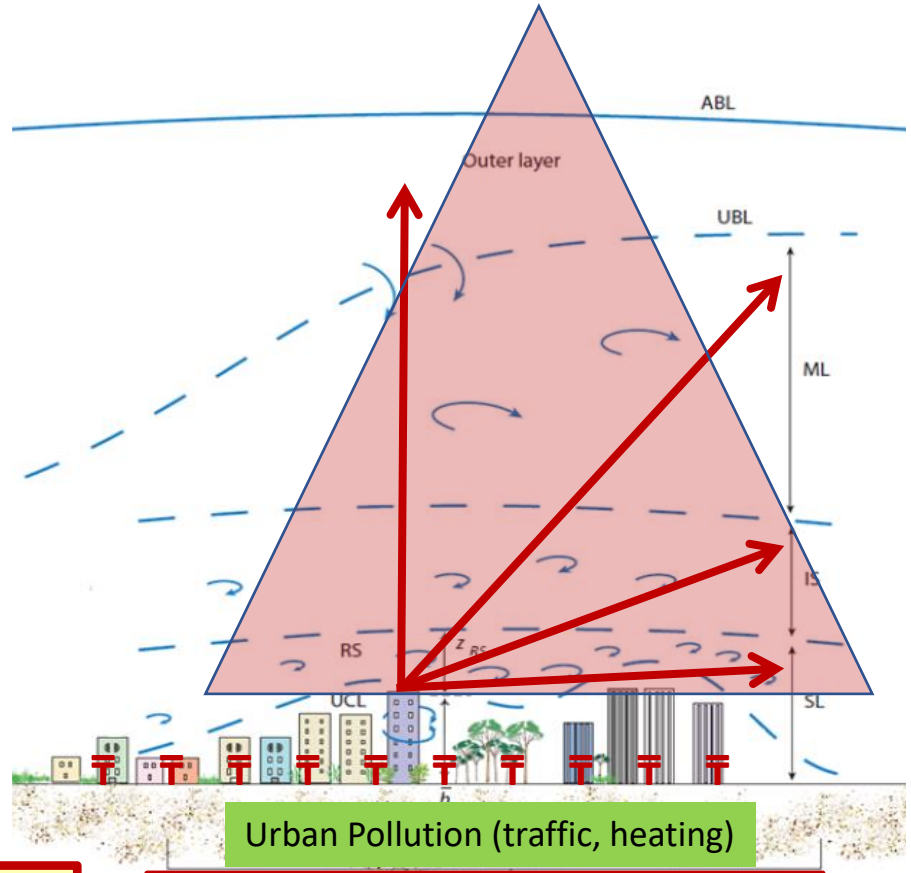


a) *Ground based remote sensing instruments* "see" **upper SL and above**. Good time resolution, large air volumes. However the pollution production layer (**UCL**) **is not probed**. **Clouds can be** a limiting factor, **some** instruments **need sunlight**.

b) *In situ instruments* are **embedded in the UCL** but can only probe the atmosphere in their proximity. **Low** time resolution, **insufficient** coverage, and **no uncertainties** are limiting factors.

c) *Atmospheric Composition Satellite instruments* provide a good **2D description**, but are almost **insensitive** to what happens below the SL (physical limitations). **Clouds are** a limiting factor, **need sunlight**.

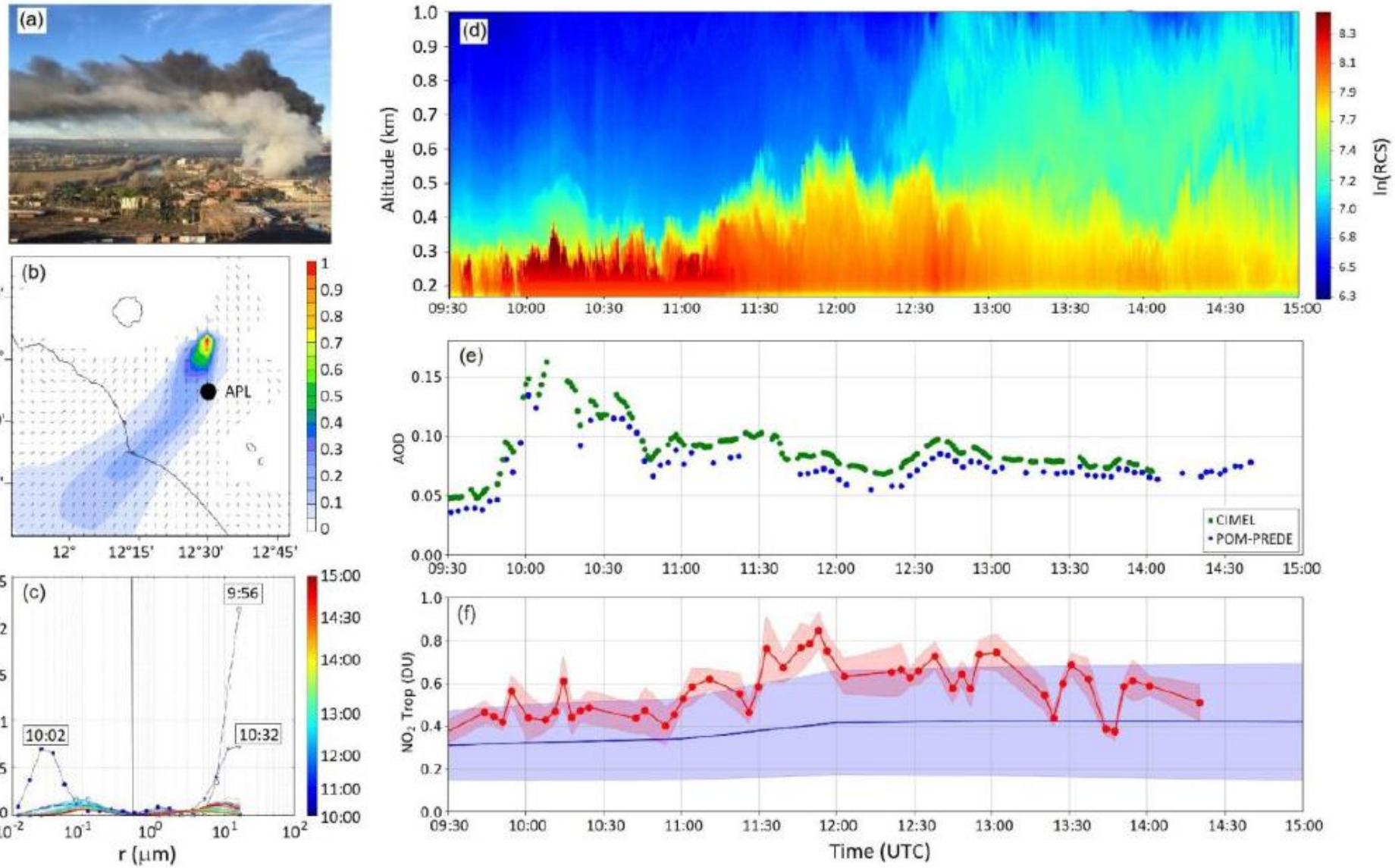
d) Modelling provides a good **4D description**, knowledge of **emission sources** is a limitation, UBL physics/chemistry **too complex**, **no unpredictable events** (e.g. industrial/wild fires)



These techniques are ***fully complementary***
Accurate information on (urban) atmosphere
is obtained from their physically consistent combination

Urban Boundary Layer (UBL)
- Mixed Layer (ML)
- Inertial Sublayer (IS)
- Surface Layer (SL)
  - Roughness Sublayer (RS)
  - Urban Canopy Layer (UCL)

BAQUNIN Approach



Smoke plume analysis

a) Image (drone)
b) WRF plume simulation
c) ASD sun-photometers
d) LIDAR (RCS)
e) AOD sun-photometers
f) NO2 PGN

BAQUNIN Suite

Instrument	Network	Site
POM-PREDE #11	SKYNET-EUROPE	APL
POM-PREDE #22	SKYNET-EUROPE	CNR-ISAC
POM-PREDE Lunar	SKYNET-EUROPE	APL
Air Quality Low Cost		APL
PANDORA #115	PGN	CNR-ISAC
PANDORA #117	PGN	APL
PANDORA #138	PGN	CNR-IIA
Pyranometer		APL
All Sky Camera		APL
MWL-LIDAR		APL
SODAR		APL
MFRSR		APL
BREWER	EUBREWNET	APL
WRF model		ALL
CIMEL	AERONET	APL
Microbarometer		APL
Meteo Station		APL
All Sky Camera “stereo view”		APL
Ceilometer RAP		APL
Ceilometer IIA		CNR-IIA

CNR-ISAC “CIRAS”

- MaxDOAS
- CIMEL
- SODAR

CNR-IIA “Liberti”

- MaxDOAS
- Meteo Station
- Air Quality in situ

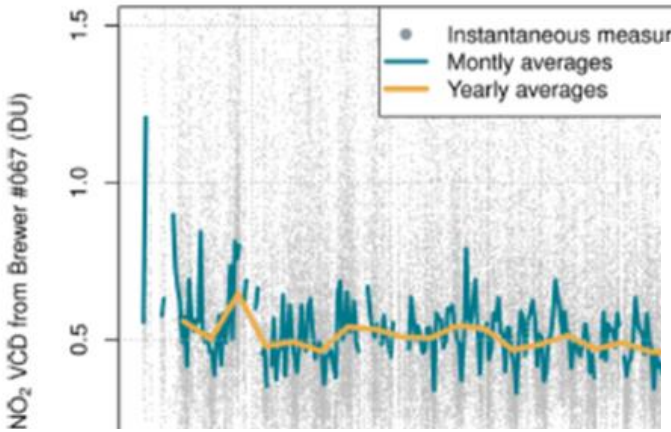
BAQUNIN products

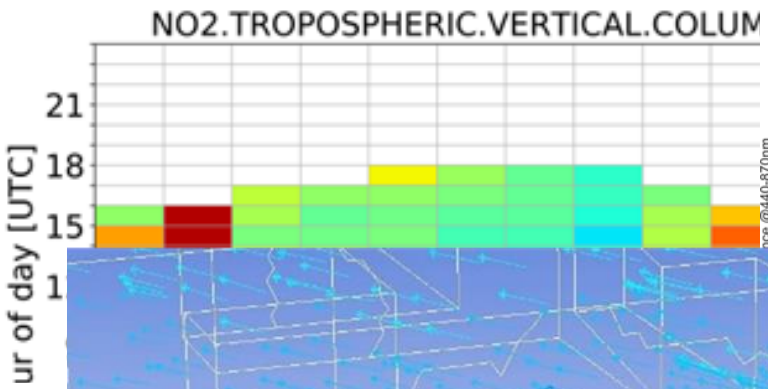
Product	Instrument	References	Data availability
GASES			
O_3 TC	Brewer	Siani et al. 201	
NO_2 Surf, NO_2 Trop	Pandora-2S	Herman et al. 2	
NO_2 TC	Brewer		
H_2O TC	Cimel-C		
AEROSOL			
AOD, AE	Cimel-C		
	Prede-P		
	LIDAR		
AerBack, AerExt profiles	LIDAR		
SAE, AAE	Cimel-C		
SSA, VSD, Refr. Index, PF	Cimel-CE318	Giles et al. 201	
	Prede-POM	Kudo et al. 202	

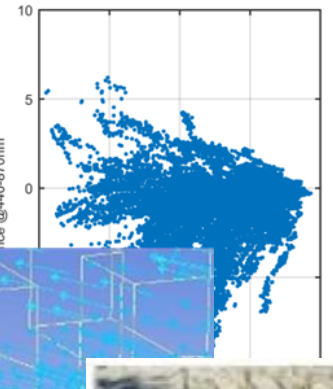
BAQUNIN (https://www.baqunin.eu)
EVDC (https://evdc.esa.int)
AERONET (https://aeronet.gsfc.nasa.gov)
EUBREWNET (http://www.eubrewnet.org/eubrewnet)
PGN (https://www.pandonia-global-network.org)
SKYNET-EUROPE (www.euroskyrad.net)

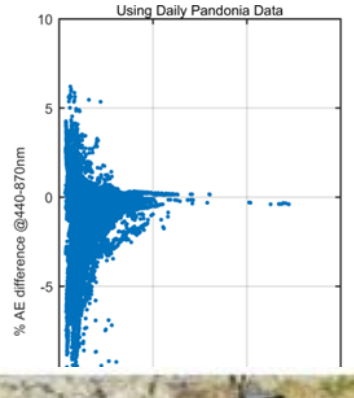
Product	Instrument	References	Data availability
METEO			
		l. 2019	2018-today
		t al. 2021	1996-today
		nd Fiocco	2007-2010, 2017-today
			2019-today
		isala.com/sites/default/files/documents/PTB200_User_Guide_in_English.pdf	2020-today
P	Microbarometer		
RI, DP	Meteorological Station SCO	*n.a.*	2020-today

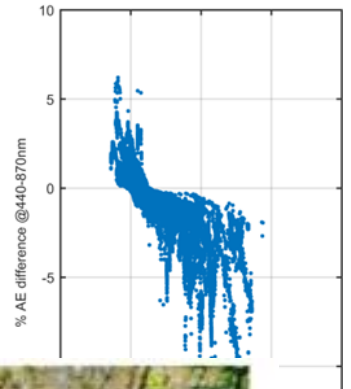
BAQUNIN Activities

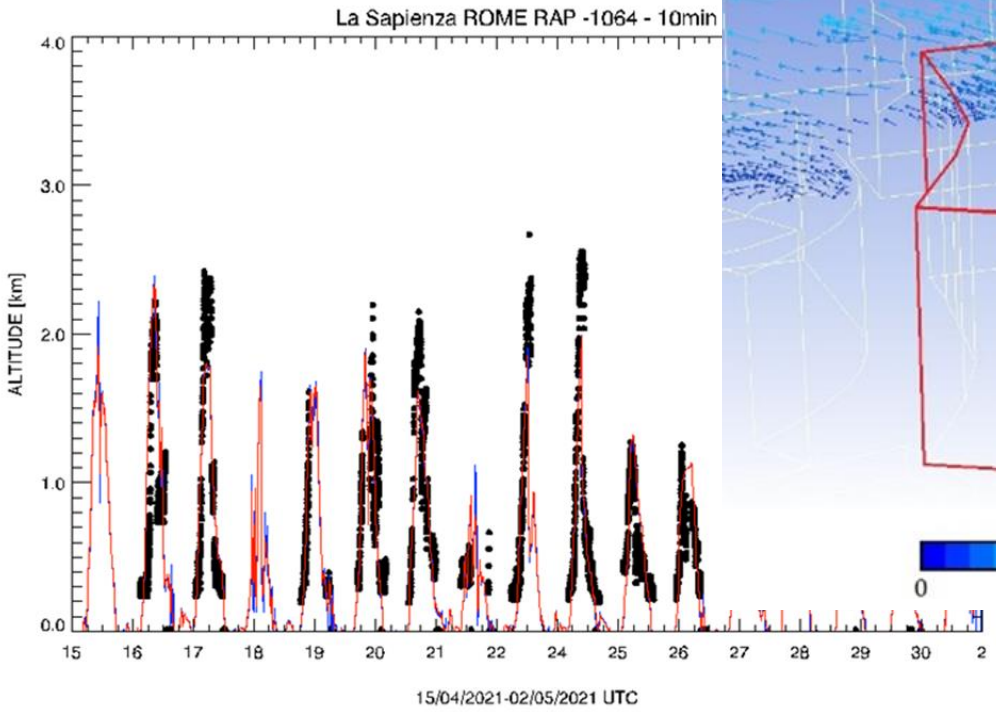


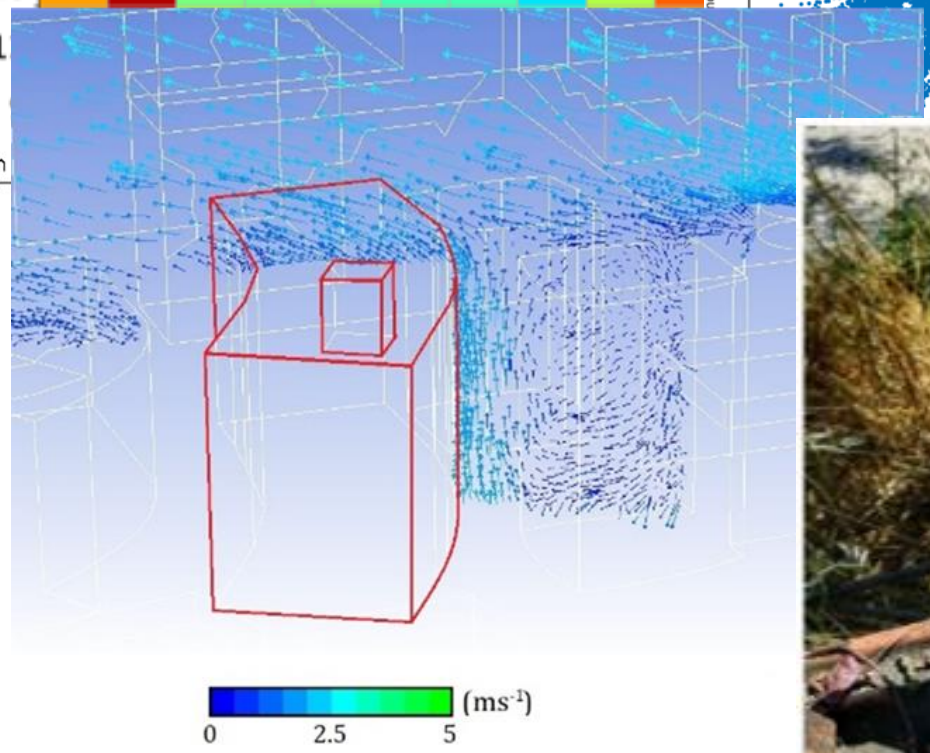




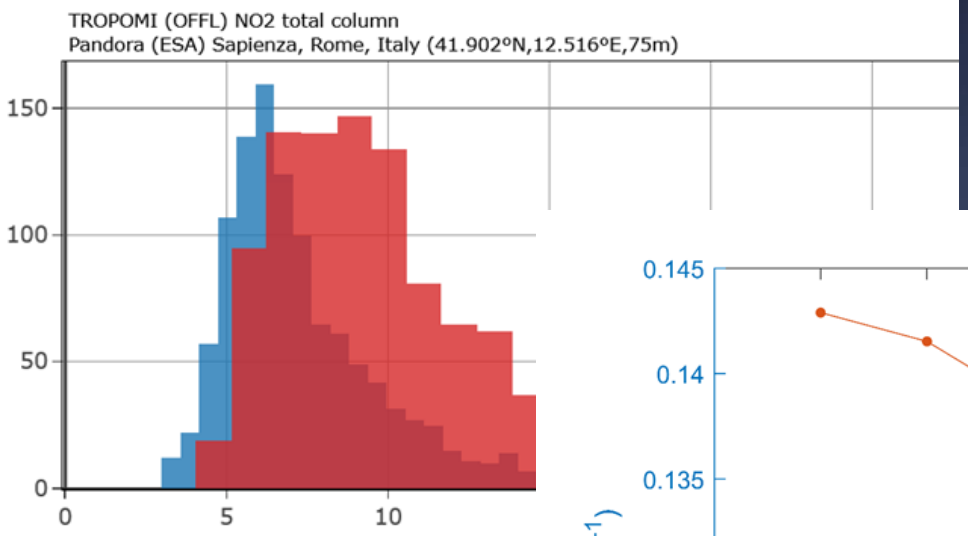


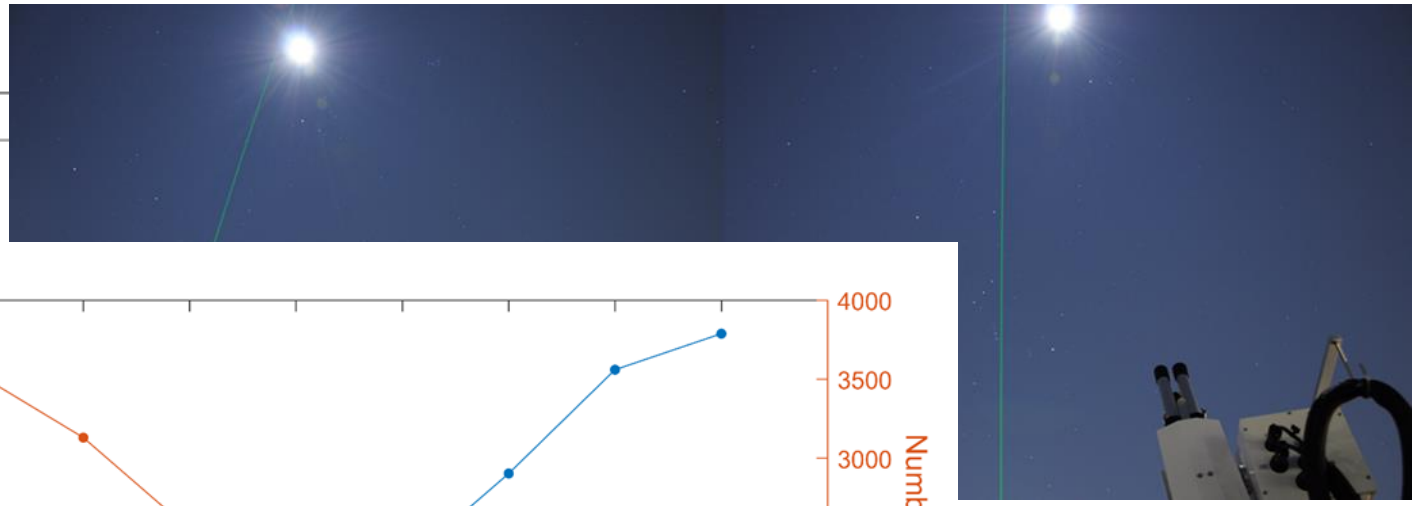


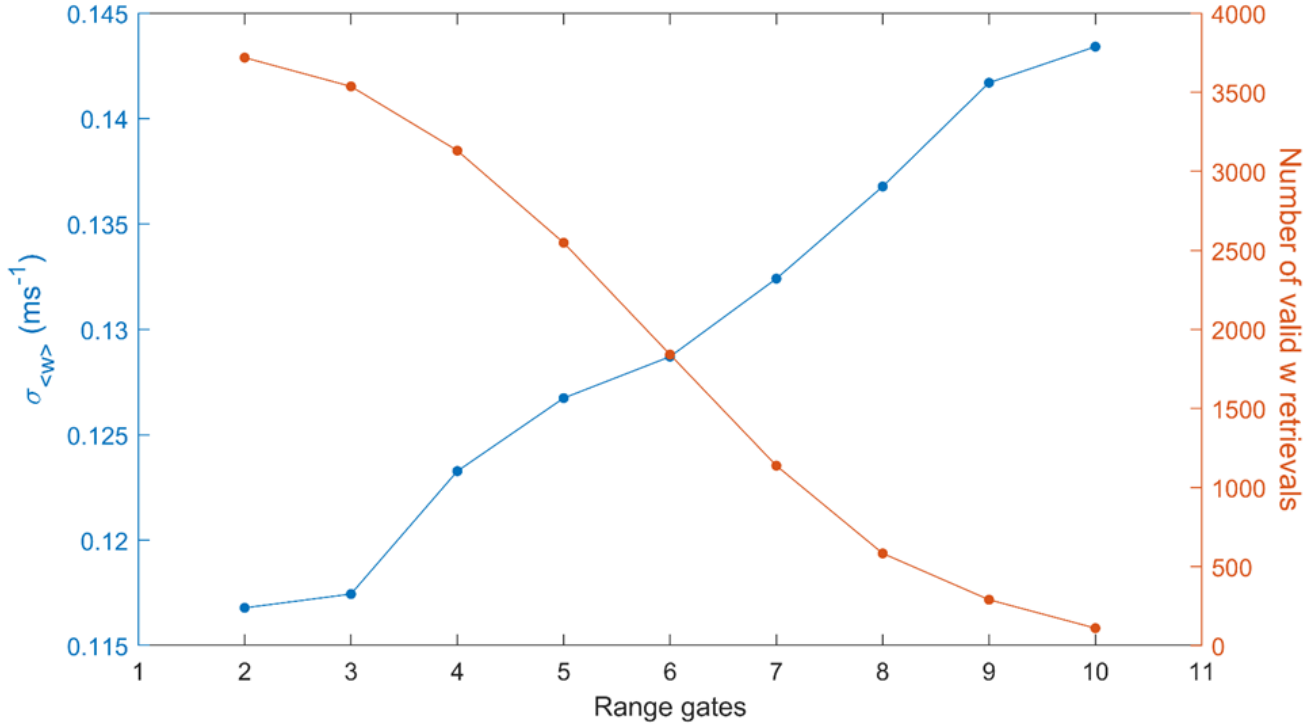


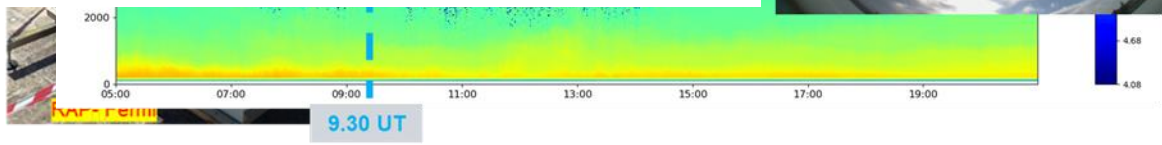


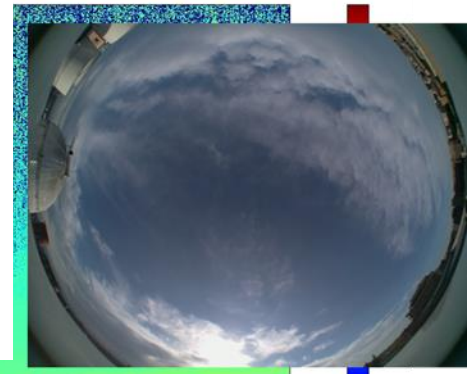
BAQUNIN Activities











BAQUNIN Activities

tation (p, T, RH, rain, UV, wind)

T, SKYRAD (aerosol)
ace gases, aerosol)
lity (T, RH, trace gases, aerosol)

DAR (cloud, aerosol, H_2O)

(wind, turbulence)

meter (solar irradiance)
(aerosol, trace gases)
era (cloud)

DAR (cloud, aerosol)

VNET (trace gases, aerosol)

Meteo Station (T, RH, wind)

Conclusions

- Urban (APL), Semi-Rural (CNR-ISAC), Rural (CNR-IIA) components
- Continuous active/passive remote sensing and in situ instrumentation operation
- Data free dissemination to citizen, scientific and Cal/Val communities

BAQUNIN supersite is suitable for:

- ➢ Testing new instruments and operation modes
- ➢ Hosting long-term inter-calibration/comparison campaigns
- ➢ Education initiatives (e.g. summer schools): hands on instruments!

Next to come:

- ❑ Daytime total Column GHG EM27SUN (from KIT)
- ❑ Night-time NO2 (NO3) DIAL (custom)
- ❑ Air-quality in situ (from ENEA and CNR-IIA)

Looking forward building up new fruitful collaborations!

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