Living Planet Symposium Vienna, 23-27 June 2025

https://www.baqunin.eu
@BaquninProject

Supported by

The **B**oundary-layer **A**ir **Q**uality analysis **U**sing **N**etwork of **IN**struments supersite: achievements and perspectives

Stefano Casadio[1,8], Anna Maria Iannarelli[1], Annalisa Di Bernardino[2], Monica Campanelli[3], Giampietro Casasanta[3], Henri Diémoz[4], Cristiana Bassani[5], Gabriele Mevi[1], Anna Maria Siani[2], Nicola Ferrante[1], Massimo Cardaci[1], Tatiana di Iorio[6], Stefano Decesari[7], Enrico Cadau[8], Angelika Dehn[8], Philippe Goryl[8]

(1) SERCO Italy, Frascati (RM), Italy
(2) Sapienza University of Rome, Italy
(3) CNR-ISAC Tor Vergata, Rome, Italy
(4) ARPA Valle d'Aosta, Aosta, Italy
(5) CNR-IIA, Monterotondo (RM), Italy
(6) ENEA Casaccia (RM), Italy
(7) CNR-ISAC Bologna, Italy
(8) ESA/ESRIN, Frascati (RM), Italy

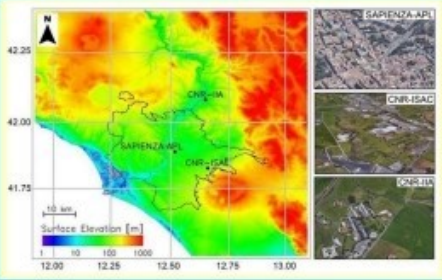
Contact me:
Stefano.Casadio@ext.esa.int
Stefano.Casadio@serco.com

The ***B**oundary-layer **A**ir **Q**uality-analysis **U**sing **N**etwork of **IN**struments* (**BAQUNIN**) super site has been collecting surface and columnar measurements of atmospheric constituents (aerosol, particulate matter, and trace gases) and measurements of meteorological variables since 2017.
The European Space Agency has promoted BAQUNIN to create an experimental research infrastructure to contribute to the validation of present and future satellite atmospheric products and the in-depth investigation of the phenomena characterizing the planetary and urban boundary layer. The peculiarity of the observatory is the involvement of various active and passive remote sensing instruments installed in multiple measurement points, covering a highly urbanized area near the Tyrrhenian coast. Direct and free access to data and related documentation is one of BAQUNIN's requirements and is guaranteed through the website www.baqunin.eu.

+ 25 remote sensing instruments (active and passive)
Weather sensors: temperature, humidity, wind speed and direction, pressure, cloud bottom/top, UV dose and index
Aerosol: in-situ concentrations, vertical profiles, columnar content, optical properties
Trace gases: NO_2, O_3, SO_2, H_2O, HCOH tropospheric and vertical columns, profiles
Greenhouse gases: CO, CH_4, CO_2 and H_2O columnar contents
Temperature and humidity profiles

+ 15 researchers from universities, research institutions and private companies involved
+ 50 products freely available to the scientific community and stakeholders

OBSERVATORIES LOCATION



BAQUNIN consists of three observatories:
- SAPIENZA-APL: **urban** (Rome downtown, Sapienza University Campus)
- CNR-ISAC: **semi-rural** environment
- CNR-IIA: **rural** environment

Colours represent the Shuttle Radar Topography Mission (SRTM) digital elevation model on a logarithmic scale.
The black line depicts the boundaries of Rome municipality.

MAIN RESERACH ACTIVITIES

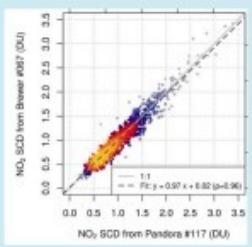
- Analyses of atmospheric dynamics, sea/land breeze, urban heat island, pollution;
- Study of the effects of aerosol transport on aerosols properties;
- Design and development of LIDAR systems and algorithms;
- Testing new instruments and observation modes in urban environment
- Inter-comparison site for remote sensing instruments (ACTRIS);
- Satellite Atmospheric Composition Cal/Val (S5p, S4, S5, EC Validation Teams)

FIELD CAMPAIGNS

The BAQUNIN-APL observatory has been officially appointed as ACTRIS inter-calibration and inter-comparison facility.

Example: Sun-Photometers QUATRAM-3 Campaign (September 2021)

DATA HOMOGENIZATION



Example: comparison of the NO_2 slant column densities (DU) retrieved at BAQUNIN-APL from Brewer #067 and PAN#117 (as the reference).

Diémoz, H.; Siani, A.M.; Casadio, S.; Iannarelli, A.M.; Casale, G.R.; Savastiouk, V.; Cede, A.; Tiefengraber, M.; Müller, M., Advanced NO2 retrieval technique for the Brewer spectrophotometer applied to the 20-year record in Rome, Italy. Earth Syst. Sci. Data 2021, 13, 4929–4950

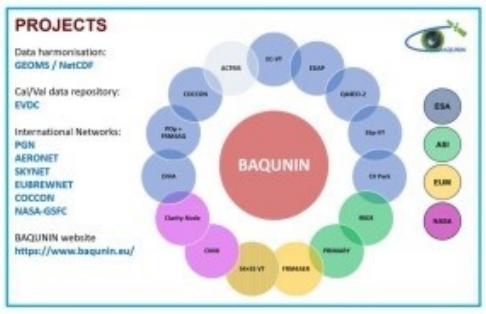
TESTING INSTRUMENTS

BIRA-IASB developed a new type of passive remote sensing instrument , called "NO2-CAMERA", aiming at the estimate of the 2-D distributions of NO2 slant column densities (SCDs) with a high spatiotemporal resolution.
The instrument prototype was installed at BAQUNIN-APL for a two weeks campaign in March 2024 and will be again at APL for a long-term campaign between 2025 and 2026.

Gramme P., Cedric Busschots C., Emmanuel Dekemper E., Pieroux D., Baker N., Casadio S., Iannarelli A.M., Ferrante N., Di Bernardino A., Pettinari P., Castelli E., di Liberto L., Cairo F., Urban pollution monitoring with the AOTF-based NO2 camera: validation with other DOAS instruments, Submitted to Atmos. Meas. Tech.

FEDERATED OBSERVATORIES

BAQUNIN TEAM actively collaborates with other Italian observatories, exchanging knowledge and instrumentation aiming at harmonising data and methods for Cal/Val activities. The current federated observatories are listed below, along with the support provided by the BAQUNIN project.
- CNR-ISAC San Pietro Capofiume (**rural-polluted**, BO): **Pandora**, scientific/technical assistance
https://www.isac.cnr.it/content/campo-sperimentale-giorgio-fea-san-pietro-capofiume
- ARPA Valle d'Aosta (**alpine**, AO): **Pandora**, scientific/technical assistance
https://www.regione.vda.it/gestione/riviweb/templates/aspx/environnement.aspx?pkArt=1345
- Milano-Bicocca (**urban**, MI): **Pandora**, **Cimel**, scientific/technical assistance
https://www.disat.unimib.it/it
- ENEA Lampedusa (**oceanic**, AG): Lidar parts, scientific/technical assistance
https://www.lampedusa.enea.it/index.php?lang=it
- ENEA-INGV THAAO (**arctic**, Pituffik): scientific/technical assistance
https://www.thuleatmos-it.it/



Contribution to Pandonia Global Network

The BAQUNIN team is involved in the installation, maintenance and operation of 5 PGN instruments in Italy.
P138 is used for long term campaigns

District	ID	Start	Env.
AOSTA, ARPA	P275	2025	Alpine
MILANO, MiBi	P138	2025-2026	Urban
BOLOGNA, SPC	P274	2025	Rural polluted
ROMA, TVG	P115	2016	Semi-Rural
ROMA, SAP	P117	2017	Urban
ROMA, MLB	P138	2018 (2026)	Rural pristine

Automated Operation Processes

Automated Instrument Checks

Currently Available Products (more to come!)

Atmospheric Composition Product	Instrument	Data access
GHG total column	EM27/SUN	BAQUNIN DB, COCCON
O_3 total column	Pandora, Brewer	EVDC, PGN, EUBREWNET
NO_2 surface, tropospheric and total column, profile	Pandora	EVDC
	Brewer, Pandora	BAQUNIN DB, EVDC, PGN
SO_2 total column	Pandora	PGN
HCOH surface, tropospheric total column	Pandora	PGN
H_2O surface, tropospheric and total column, profile	CIMEL	AERONET, BAQUNIN DB
	LIDAR	EVDC, BAQUNIN DB
	Pandora	PGN
Aerosol Optical Depth	CIMEL, PREDE	AERONET, SKYNET, BAQUNIN DB
	MFRSR	BAQUNIN DB
	LIDAR	BAQUNIN DB
Aerosol backscattering extinction profiles	LIDAR	EVDC, BAQUNIN DB
Fine – Coarse – Total mode	CIMEL	AERONET, BAQUNIN DB
Angstrom Exponent	CIMEL,PREDE	AERONET, SKYNET, BAQUNIN DB
	LIDAR	BAQUNIN DB
SSA, VSD, RI, PhF	CIMEL, PREDE	AERONET, SKYNET, BAQUNIN DB
Solar Irradiance	Pyranometer	BAQUNIN DB
Spectral Radiance	Pandora	PGN
UV Dose, UV index	Brewer	BAQUNIN DB
Cloud top/bottom	LIDAR	EVDC, BAQUNIN DB
Cloud fraction	All Sky Camera	BAQUNIN_DB
Wind Speed and Direction	Sodar	EVDC, BAQUNIN DB
Temp., hum., pressure and wind	Meteo, WFR	BAQUNIN DB
Satellite CAL/VAL	NO2 TROPOMI	Pandora NO2 VC, TC
	O3 TROPOMI	Pandora O3 VC

Iannarelli, A. M., Di Bernardino, A., Casadio, S., Bassani, C., Cacciani, M., Campanelli, M., Casasanta, G., Cadau, E., Diémoz, H., Mevi, G., Siani, A. M., Cardaci, M., Dehn, A., & Goryl, P. (2022). The Boundary Layer Air Quality-Analysis Using Network of Instruments (BAQUNIN) Supersite for Atmospheric Research and Satellite Validation over Rome Area. *Bulletin of the American Meteorological Society*, 103(2), E599-E618. https://doi.org/10.1175/BAMS-D-21-0099.1