Boundary-layer Air Quality-analysis Using Network of Instruments Supersite

June 2016: WP of ESA - IDEAS+ project
March 2019: ESA - BAQUNIN Project

www.baqunin.eu

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BAQUNIN Summary

- BAQUNIN Super Site description
- Cal/Val Activities
- Products examples
- Involvement in QA4EO
Rome is an urban site, with about 3.0 million of inhabitants, 25 km east from the Mediterranean Sea, in the middle of an undulating plain.

The atmosphere is affected by traffic emission as well as by semi-rural particulates and, especially during summer season, by sea breeze and desert dust advection from the Saharan region.
<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>APL</strong></td>
<td>Atmospheric Physics Laboratory Sapienza University</td>
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<tr>
<td><strong>CNR - ISAC</strong></td>
<td>Institute of Atmospheric Sciences and Climate</td>
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<tr>
<td><strong>CNR - IIA</strong></td>
<td>Institute for Atmospheric Pollution</td>
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<tr>
<td>BAQUNIN instruments</td>
<td>PI Affiliation</td>
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<tr>
<td>Pandora 2S #115</td>
<td>Serco</td>
</tr>
<tr>
<td>#117</td>
<td></td>
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<tr>
<td>#138</td>
<td></td>
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<tr>
<td>Cimel</td>
<td>LOA (Laboratoire d'Optique Atmosphérique)</td>
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<tr>
<td>Prede Pom 01</td>
<td>ISAC</td>
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<tr>
<td>Brewer Meteorological Sensors</td>
<td>Sapienza</td>
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<td>MFRSR</td>
<td>Sapienza</td>
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<td>Pyranometer</td>
<td>Serco</td>
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<td>Skycam</td>
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<td>LIDAR</td>
<td>Sapienza</td>
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<td>SODAR</td>
<td>Sapienza</td>
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<td>WRF Model</td>
<td>Sardegna Clima Serco</td>
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### BAQUNIN Super-Site products & instruments

<table>
<thead>
<tr>
<th>BAQUNIN PRODUCTS</th>
<th>INSTRUMENTS</th>
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<tr>
<td>O3 surface, tropospheric and total column</td>
<td>PANDORA 2S ‡, BREWER</td>
</tr>
<tr>
<td>NO2 surface, tropospheric and total column</td>
<td>PANDORA 2S ‡, BREWER</td>
</tr>
<tr>
<td>SO2 surface, tropospheric and total column</td>
<td>PANDORA 2S ‡</td>
</tr>
<tr>
<td>HCOH surface, tropospheric and total column</td>
<td>PANDORA 2S ‡</td>
</tr>
<tr>
<td>H2O total column, profile</td>
<td>CIMEL, LIDAR, PANDORA 2S ‡, PREDE ‡, MFRSR</td>
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<tr>
<td>Aerosol Optical Depth (AOD)</td>
<td>CIMEL, PREDE ‡, MFRSR, LIDAR, PANDORA 2S ‡</td>
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<tr>
<td>Aerosol backscattering and extinction profiles</td>
<td>LIDAR, CEILOMETER</td>
</tr>
<tr>
<td>Ångström Exponent</td>
<td>CIMEL, PREDE ‡, PANDORA 2S ‡, LIDAR</td>
</tr>
<tr>
<td>Single Scattering Albedo (SSA), Volume size distribution (VSD), Real and imaginary part of Refractive Index (Refr. Indx), Phase Function (PF)</td>
<td>CIMEL, PREDE ‡</td>
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<tr>
<td>Solar Irradiance</td>
<td>PYRANOMETER</td>
</tr>
<tr>
<td>Spectral Radiance</td>
<td>PANDORA 2S ‡</td>
</tr>
<tr>
<td>UV Dose, UV Index</td>
<td>BREWER</td>
</tr>
<tr>
<td>Cloud top/bottom, Cloud Optical Depth (COD)</td>
<td>LIDAR, CEILOMETER</td>
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<tr>
<td>Cloud mask and fraction</td>
<td>All Sky Camera</td>
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<tr>
<td>Turbulence, Wind Speed and Direction</td>
<td>SODAR</td>
</tr>
<tr>
<td>Surface air temperature, humidity, pressure and wind</td>
<td>Meteorological sensors, WRF</td>
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</tbody>
</table>

† Instruments present in more than one location

Networks collaborations
- Pandonia Global Network
- Aeronet
- ESR/SKYNEX
- Eubrewnet
- Climate Network

In situ/forecasting model

Gases

Aerosol

Solar Radiation

Clouds

Wind
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• *Copernicus S5p* Cal/Val project ID 42807, in collaboration with CNR, ENEA

• *EarthCare* Cal/Val project ID 38811, in collaboration with CNR and ENEA

• Validation of *GCOM-C SGLI AOD* (aerosol optical depth @500nm) using BAQUNIN AERONET and EUROSKYRAD data

• Validation of *GOSAT TANSO-FTS IWV* (Integrated Water vapour) using BAQUNIN–AERONET data
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The synergy between photometers and LIDAR measurements allows the estimation of aerosol LIDAR Ratio (LR) using an iterative algorithm. LR obtained from Aeronet AOD value at 500 nm, converted to 532 nm using AAE from Aeronet (Giles et al., 2019)
Comparison of retrieved AOD and extinction profiles using fixed/variable LR

AOD values retrieved using Fixed and Variable LR measurements are represented with their uncertainty.

Extinction coefficient of the acquired profile at 11.00 utc
- Fixed LR
- Variable LR
Algorithm for the identification of BL height and cloud top and bottom heights, using a signal threshold approach. The algorithm considers the Range Corrected Signal (RCS) and its spatial and temporal variations. (Z. Wang et al., 2001)

Steps description:
1) PBL height detection exploiting the vertical variability of the signal
Algorithm for the identification of BL height and cloud top and bottom heights, using a signal threshold approach. The algorithm considers the Range Corrected Signal (RCS) and its spatial and temporal variations.

Steps description:
1) PBL height detection exploiting the vertical variability of the signal
2) Selection of the pixels with signal above a pre-defined threshold
Algorithm for the identification of BL height and cloud top and bottom heights, using a signal threshold approach. The algorithm considers the Range Corrected Signal (RCS) and its spatial and temporal variations.

Steps description:
1) PBL height detection exploiting the vertical variability of the signal
2) Selection of the pixels with signal above a pre-defined threshold
3) Screening of selected pixels to exclude signal spikes [considering a grid 5x5]
Algorithm for the identification of BL height and cloud top and bottom heights, using a signal threshold approach. The algorithm considers the Range Corrected Signal (RCS) and its spatial and temporal variations.

Steps description:
1) PBL height detection exploiting the vertical variability of the signal
2) Selection of the pixels with signal above a pre-defined threshold
3) Screening of selected pixels to exclude signal spikes [considering a grid 5x5]
4) Bottom and top of cloud heights retrieval
LIDAR analysis: Cloud

Cloud top/bottom product resolution:
Time/Height = 3 x original profile resolution [30 sec / 22.5 m]
SBAM Seagull Borne Atmospheric Monitoring

Last year: first seagull *Hope*

**Development**  
On going

SBAM project approved by Sapienza university.  
Phase 1 Placement of nests on the roof of 3 Departments building  
Phase 2 Sensors inter-calibration: Temperature and Relative humidity  
Phase 3 Development of CO2 sensors  
Phase 4 Installation of the instruments on seagulls  
Phase 5 Seagulls monitoring
The seagull *Hope* positions during last days!
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WP #1

**Use of drone and multi-spectral camera for BRDF angular and spectral measurements**

The aim is to acquire know how on instrumental setup and operation in order to provide experimental data for satellite (e.g. Sentinel-2) validation purposes. The work is performed in collaboration with Engineering Department University Tor Vergata (drone and spectral camera) and CNR-IIA (RT modelling and measurement requirements).

WP #2

**Retrieval of cloud mask, cloud bottom height and, possibly, wind speed at cloud bottom, using two sky-cameras and a ceilometer**

The aim is to exploit the sky-camera images acquired in “stereo mode” and to use the ceilometer data in support of the retrieval scheme developments. The work is performed in the context of ACIX/CIMIX activities, and involves NASA-GSFC (sky-cameras, retrieval methodology) and Brockmann Consult (data analysis).
Retrieval of cloud mask, cloud bottom height and, possibly, wind speed at cloud bottom, using two sky-cameras and a ceilometer

Sky-cameras will be installed on the roof of Marconi and Fermi building of Physics Department
Ceilometer will be installed and operated on the roof of Fermi building
SORBETTO
SOLar Radiation Based Established Techniques for aTmospheric Observations

Organized by ISAC-CNR, Sapienza University of Rome, ESA. Funded by SERCO within the IDEAS project

1° SORBETTO Summer School 2-6 July 2018

2° SORBETTO
Summer School
September 2020

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www.baqunin.eu

Thanks for your attention!!!