The Boundary-layer Air Quality-analysis Using Network of Instruments (BAQUNIN) Super-Site for Satellite Atmospheric Chemistry Products Validation

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2) Physics Department, “Sapienza” University of Rome
3) CNR-ISAC
4) ARPA Valle d'Aosta, Saint-Christophe, Aosta
5) ESA/ESRIN

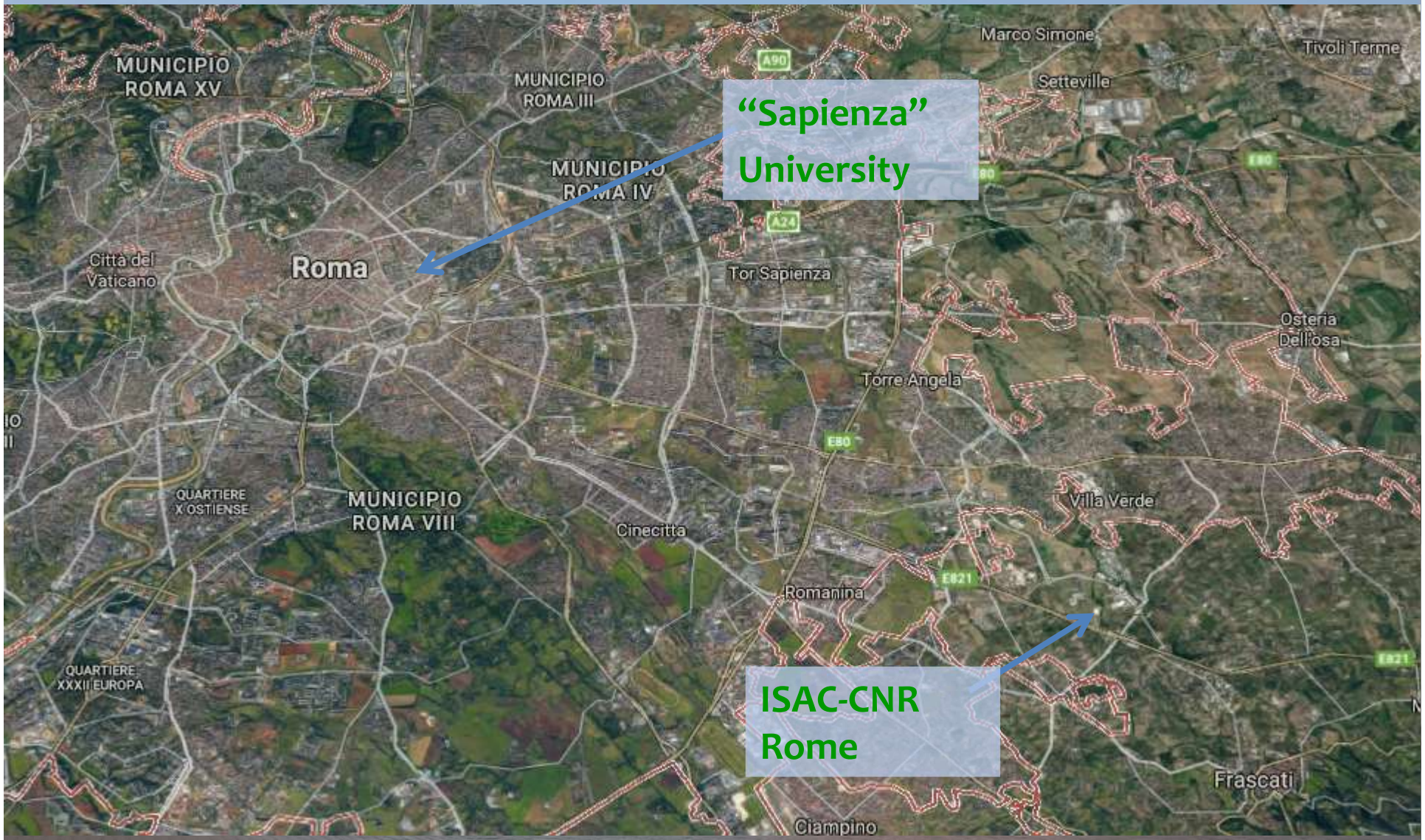
BAQUNIN Super-Site

Context: IDEAS+ support contract (ESA/ESRIN SPPA) and PANDONIA project (ESA)

Purpose: Joint instrumental suite for validating the satellite atmospheric composition and optical products (level 2), and for Planetary Boundary Layer (PBL) studies.

Super Site concept: Ground based active and passive remote sensing instruments are operating in synergy, offering quantitative and qualitative information for a wide range of atmospheric parameters for atmospheric chemistry (satellite) validation activities and Planetary Boundary Layer (PBL) studies

BAQUNIN Super-Site



Distance ~ 10 Km

BAQUNIN Super-Site instruments

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

[290 - 900] nm

O_3, NO_2

(Other trace gases, H_2O, AOD)

Pandonia Network

http://www.pandonia.net

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomer #646

H_2O, AOD

[340, 380, 440, 500, 675, 870, 1020] nm

Aeronet Network

http://aeronet.gsfc.nasa.gov/

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomers

Prede Pom 01 L Sun-sky radiometer

[340, 400, 500, 675, 870, 940, 1020] nm

Aeorosols:

Optical depth, Angstrom coefficient,

Volume size distribution, Asymmetry factor,

Refractive index, (Column amount of H_2O)

Euroskyrad network

http://www.euroskyrad.net/

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomers

Prede Pom 01 Sun-sky radiometer

Multi Filter Rotating Shadow-band Radiometer

AOD [496, 624, 670, 878] nm

(O_3, H_2O)

Integration time 1 min

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomers

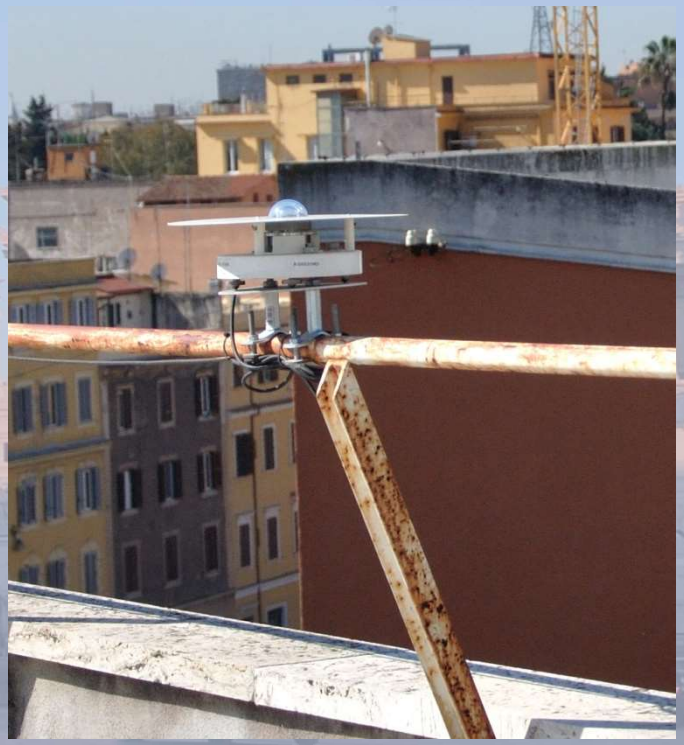
Prede Pom 01 Sun-sky radiometer

MFRSR Radiometer

Pyranometer Radiometer

Solar Irradiance

[290 -3000] nm



BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomers

Prede Pom 01 Sun-sky radiometer

MFRSR Radiometer

Pyranometer Radiometer

Brewer Spectrophotometer

[286-363] nm

O_3, NO_2, UV Dose, UV Index

EuBrewnet

http://rbcce.aemet.es/eubrewnet

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115
Pandora 2S Spectrometer #117
Cimel Photomers
Prede Pom 01 Sun-sky radiometer
MFRSR Radiometer
Pyranometer Radiometer
Brewer Spectrophotometer
Yes Broad-band UV Radiometer

[280-320] nm
UV radiation

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomers

Prede Pom 01 Sun-sky radiometer

MFRSR Radiometer

Pyranometer Radiometer

Brewer Spectrophotometer

Yes Broad-band UV Radiometer

Meteorological Sensors

Air temperature and relative humidity

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115

Pandora 2S Spectrometer #117

Cimel Photomers

Prede Pom 01 Sun-sky radiometer

MFRSR Radiometer

Pyranometer Radiometer

Brewer Spectrophotometer

Yes Broad-band UV Radiometer

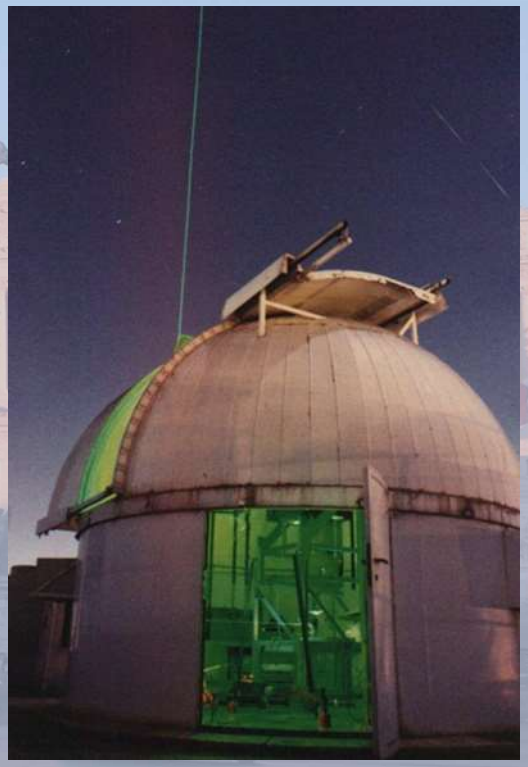
Meteorological Sensors

LIDAR Raman and elastic

[355, 532, 1064] nm

Aerosol and H_2O profiles

Top and bottom heights of clouds



BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115
Pandora 2S Spectrometer #117
Cimel Photomers
Prede Pom 01 Sun-sky radiometer
MFRSR Radiometer
Pyranometer Radiometer
Brewer Spectrophotometer
Yes Broad-band UV Radiometer
Meteorological Sensors
LIDAR Raman and elastic
SODAR

Wind speed and direction profiles in PBL

BAQUNIN Super-Site instruments

Pandora 2S Spectrometer #115
Pandora 2S Spectrometer #117
Cimel Photomers
Prede Pom 01 Sun-sky radiometer
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Pyranometer Radiometer
Brewer Spectrophotometer
Yes Broad-band UV Radiometer
Meteorological Sensors
LIDAR Raman and elastic
SODAR

BAQUNIN Super-Site instruments

Product	Instruments
O3 columnar	PANDORA 2S, BREWER
NO2 columnar	PANDORA 2S, BREWER
H2O columnar	CIMEL, Raman LIDAR, *PANDORA 2S, PREDE, MFRSR*
Aerosol Optical Depth (AOD)	CIMEL , PREDE, MFRSR, Elastic LIDAR, *PANDORA 2S*
Scattering and Absorption Ångström Exponent (SAE & AAE)	CIMEL
Angstrom Exponent (AE)	PREDE
Single Scattering Albedo (SSA)	CIMEL, PREDE
Real and imaginary part of Refractive Index (Refr. Indx)	CIMEL , PREDE
Volume size distribution (VSD)	CIMEL, PREDE
Phase Function (PF)	PREDE
Solar Irradiance	PYRANOMETER
UV Dose, UV Index	BREWER
Aerosol backscattering and extinction profiles	Elastic LIDAR
H2O profile	Raman LIDAR
Cloud boundary	Elastic LIDAR
Thermal Turbolence	SODAR
Wind Speed and Direction	SODAR
Surface air temperature, relative humidity, pressure and wind	Meteorological sensors

BAQUNIN Super-Site data

The atmospheric data acquired during BAQUNIN lifetime will be made available to the scientific community, and will contribute to the validation of the aerosol and tropospheric trace gases products produced by the Copernicus Sentinel-5p, Sentinel-4 and Sentinel-5 and by the ESA Third Party Missions (TPM), such as the Ozone Monitoring Instrument (OMI).

- All data files in the same format -> NETCDF
- Info about instrument, site, measurements…
- Omogeneuos parameters (names, units)

Easier comparison between the instruments and the products

Planetary Boundary Layer studies

Surface elevation of the Tiber valley

B -> BAQUNIN Site

C -> CNR Site

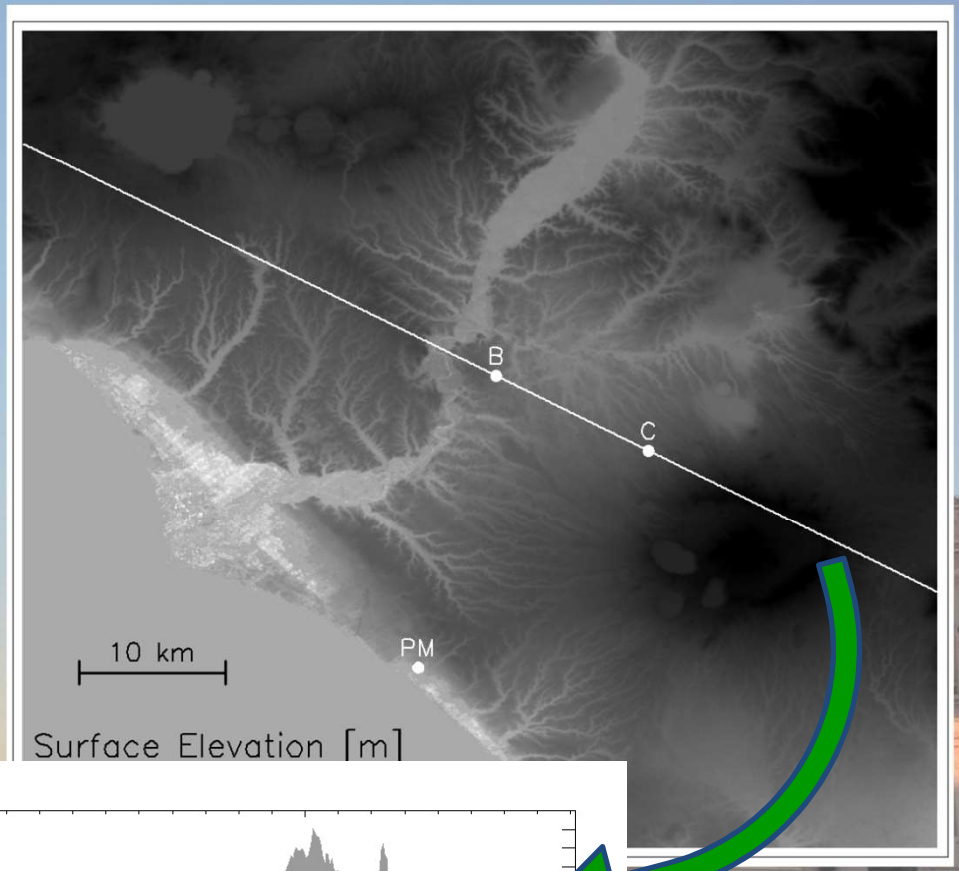
PM -> Sounding Station, Pratica di Mare

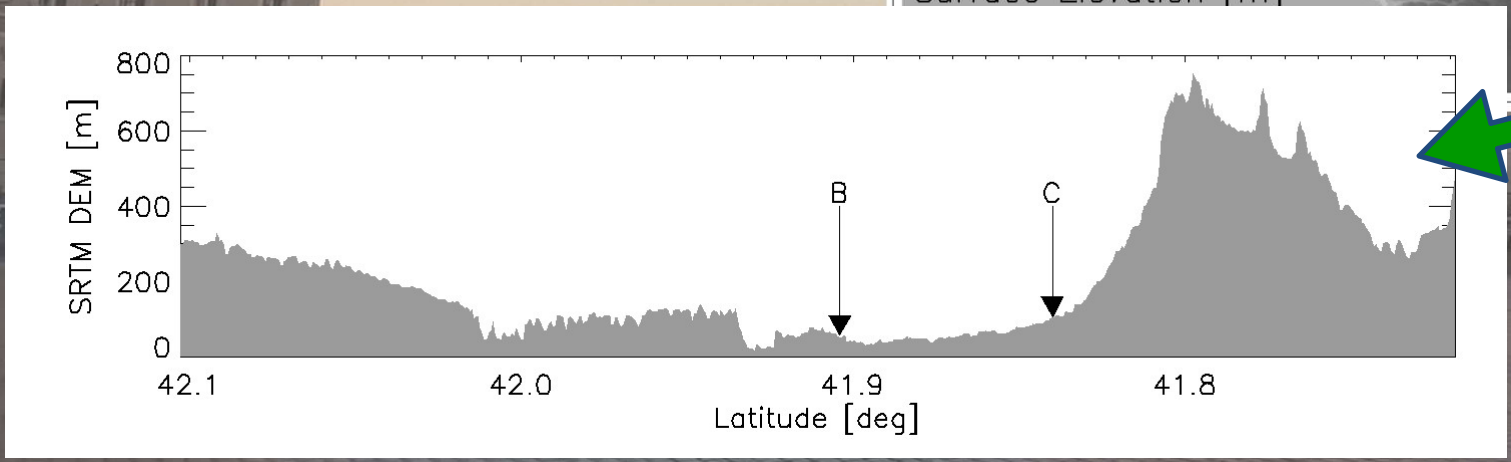
CIRAS

CNR-ISAC Rome Atmospheric Supersite

Tor Vergata (Rome)

http://www.isac.cnr.it/en/infrastructures/ciras-cnr-isac-rome-atmospheric-supersite





BAQUNIN & CIRAS

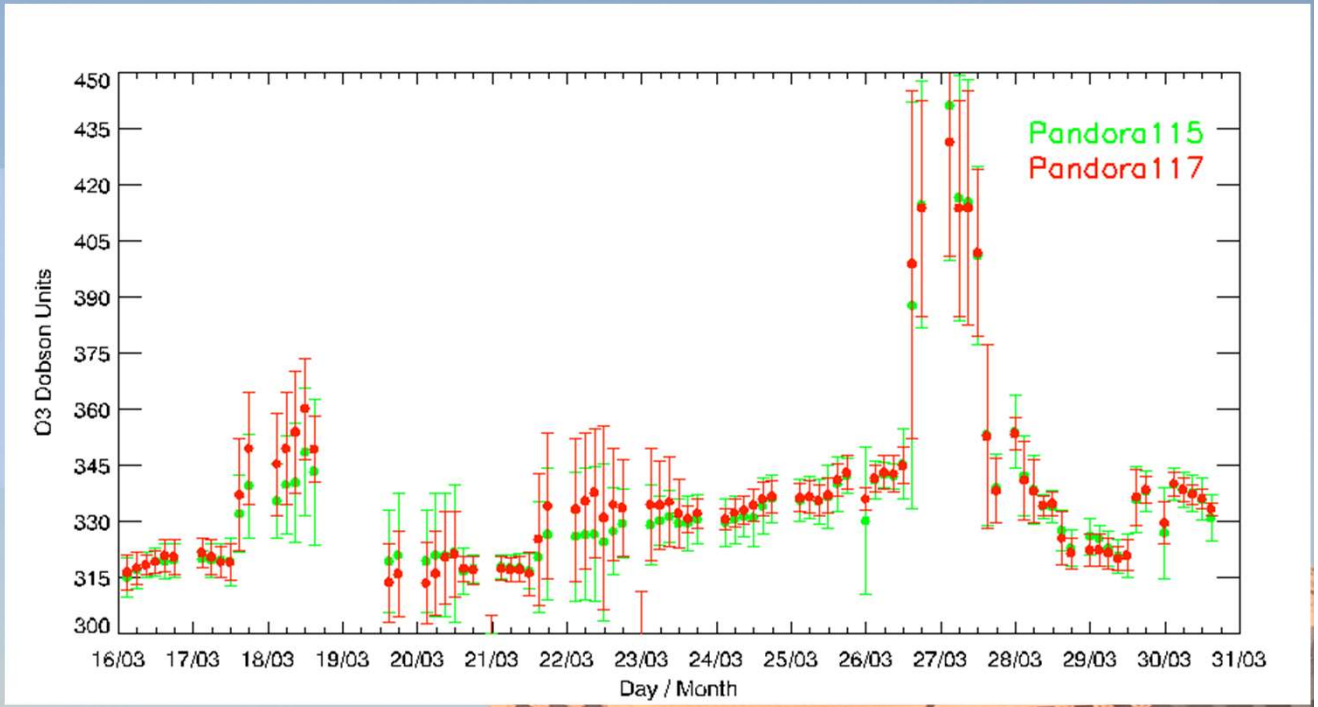
Instrument type	Products
Pandora	Total Column of NO2, O3, HCHO, others
CIMEL	Total column of AOD and H2O, SAE, AAE, SSA, Refr. Indx, VSD
Elastic and Raman LIDARs	Aerosol backscattering and extinction, H2O profiles, AOD, cloud boundaries
SODAR	Thermal turbulence, wind speed and direction profiles
Meteorological sensors	Air temperature, RH, pressure, wind

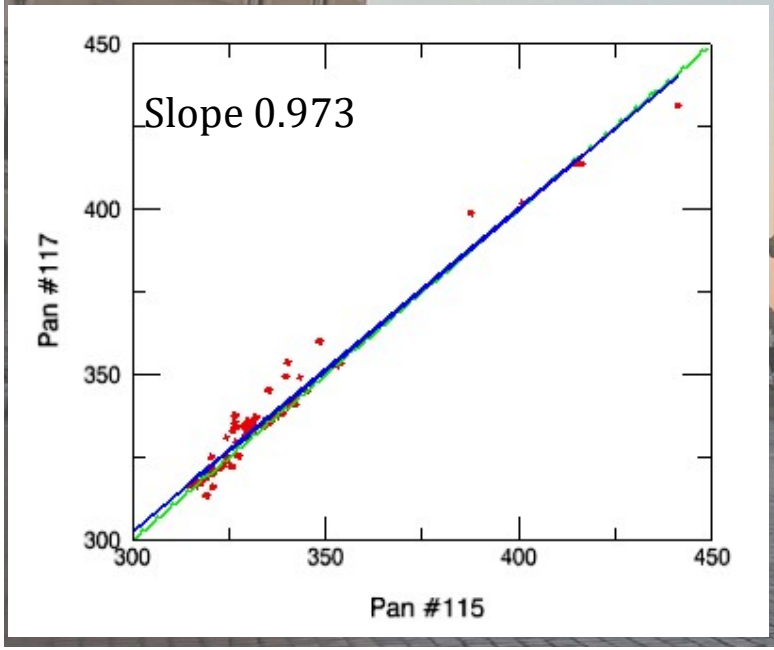
O3

Pandora 2S #115

Pandora 2S #117

Avarege time 3 hours





27/03/2017

Higher O3 value

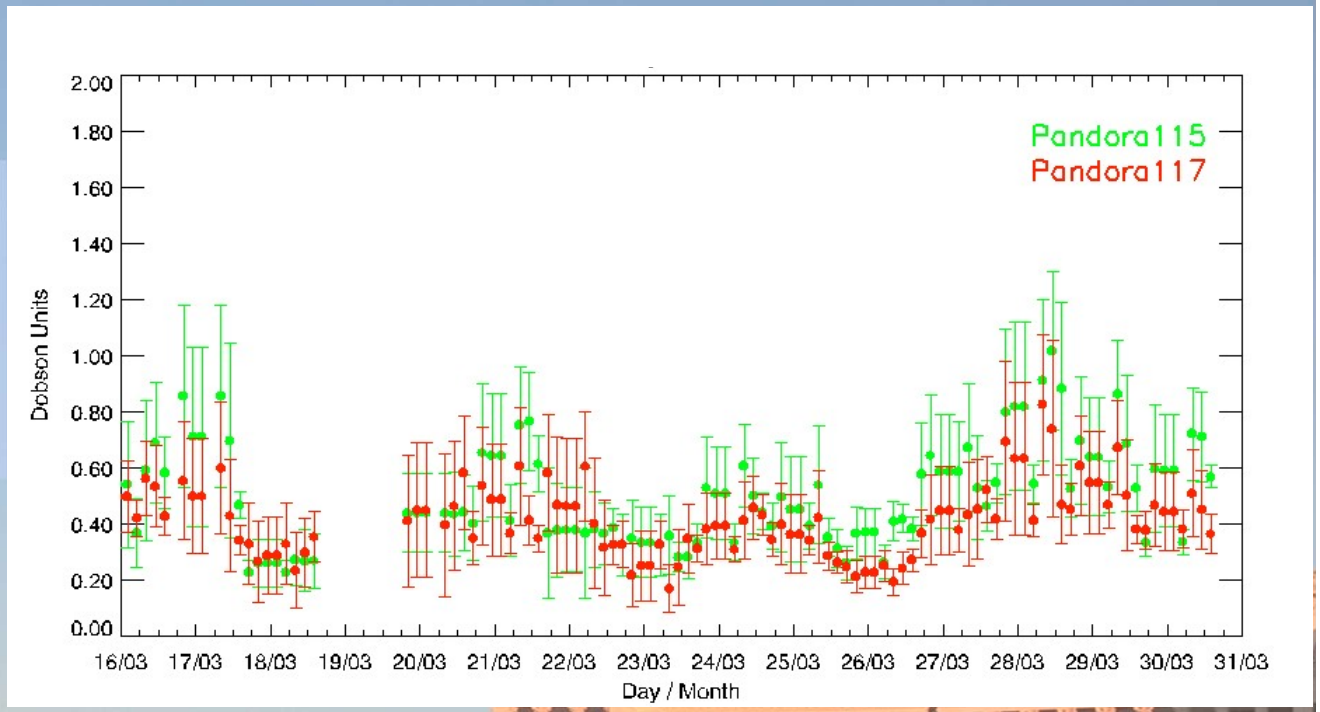
- Cloud screening?
- Geophysical reasons?

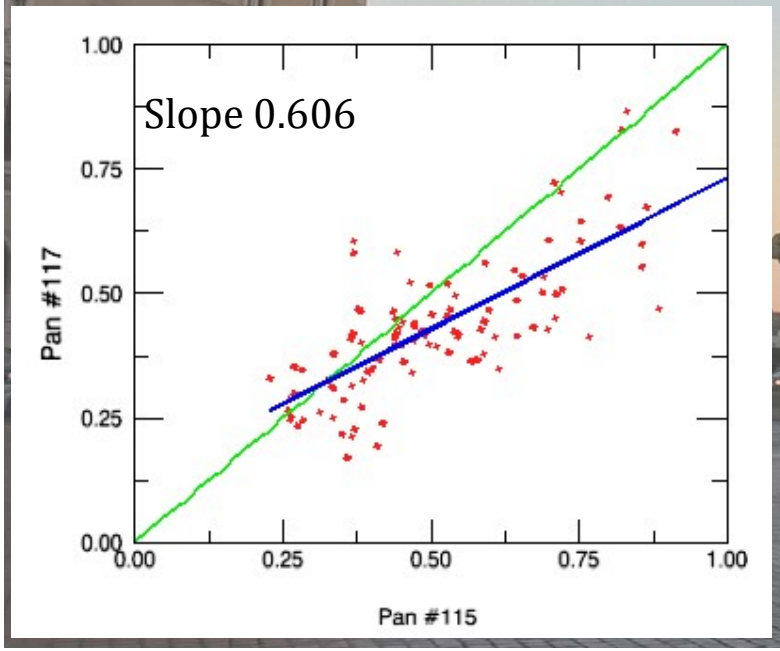
NO2 (SP1)

Pandora 2S #115

Pandora 2S #117

Avarege time 3 hours





Higher NO2 value for Pandora #115

- **Why?**

Elastic LIDAR

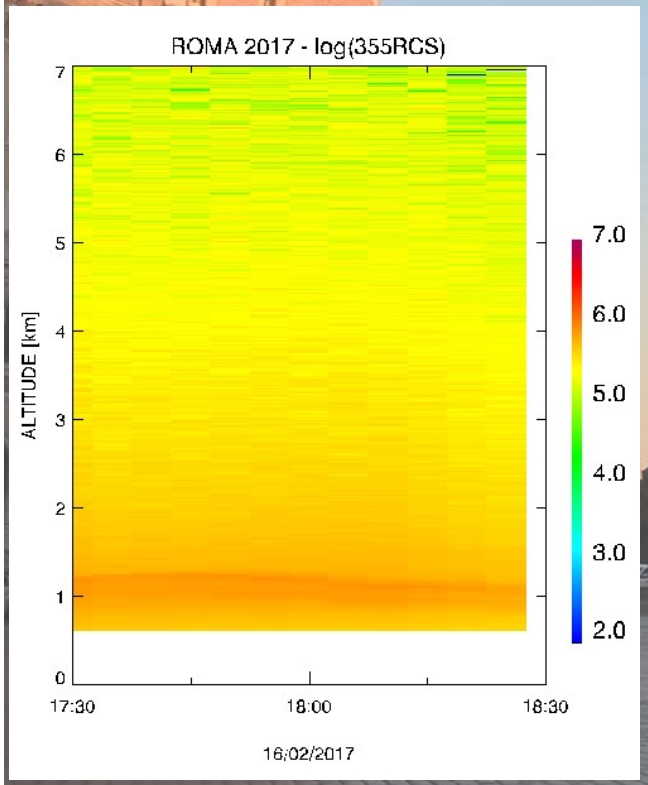
Date: 16/02/2017

17:30 – 18:30 UTC

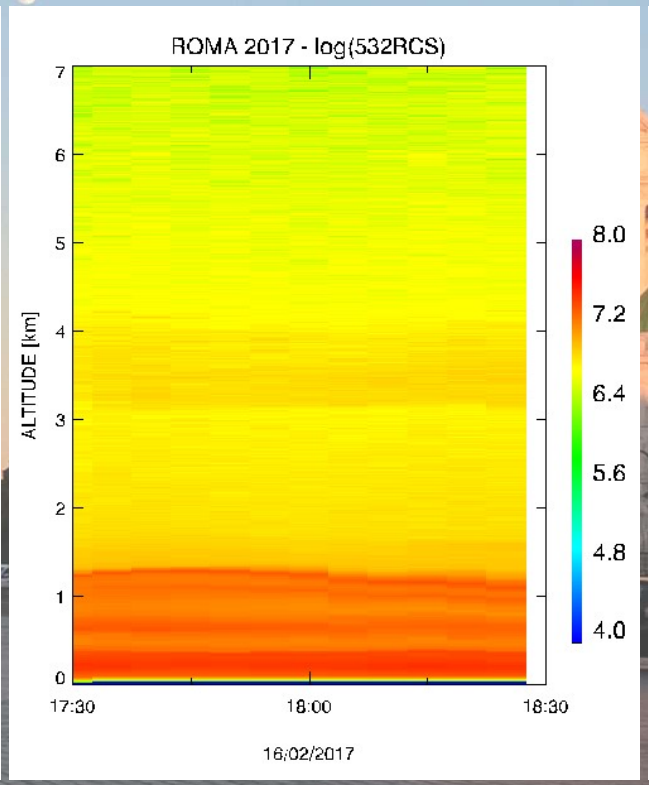
Avarege time: 5 minute

Log(Range Corrected Signal)

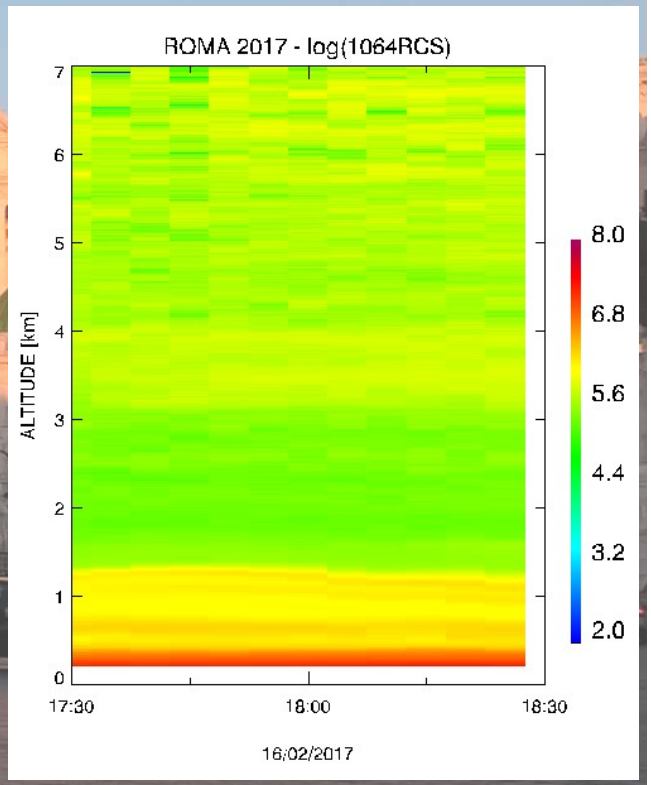
355nm



532nm



1064nm



Elastic LIDAR

Date: 16/02/2017

17:30 – 18:30 UTC

Backscattering Coefficient profiles

Avarege time: 1 hour

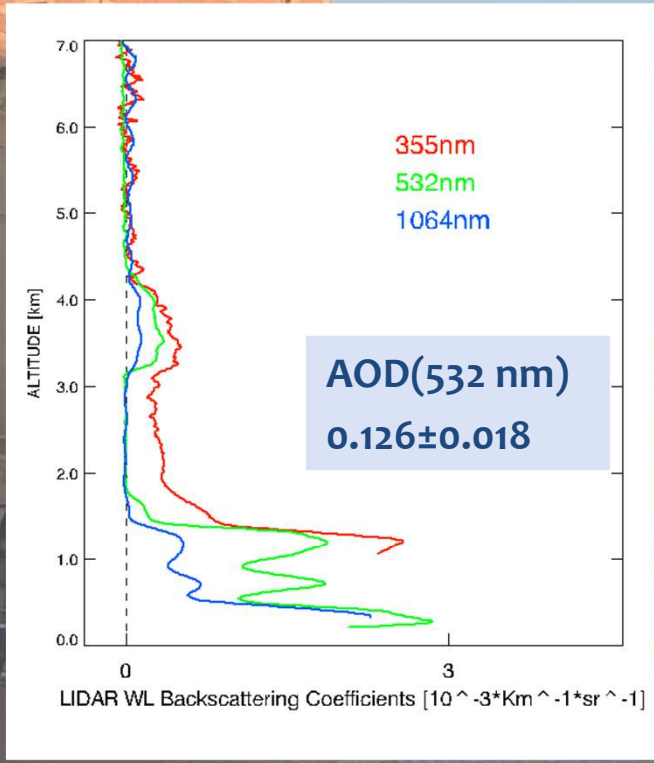
MFRSR Radiometer

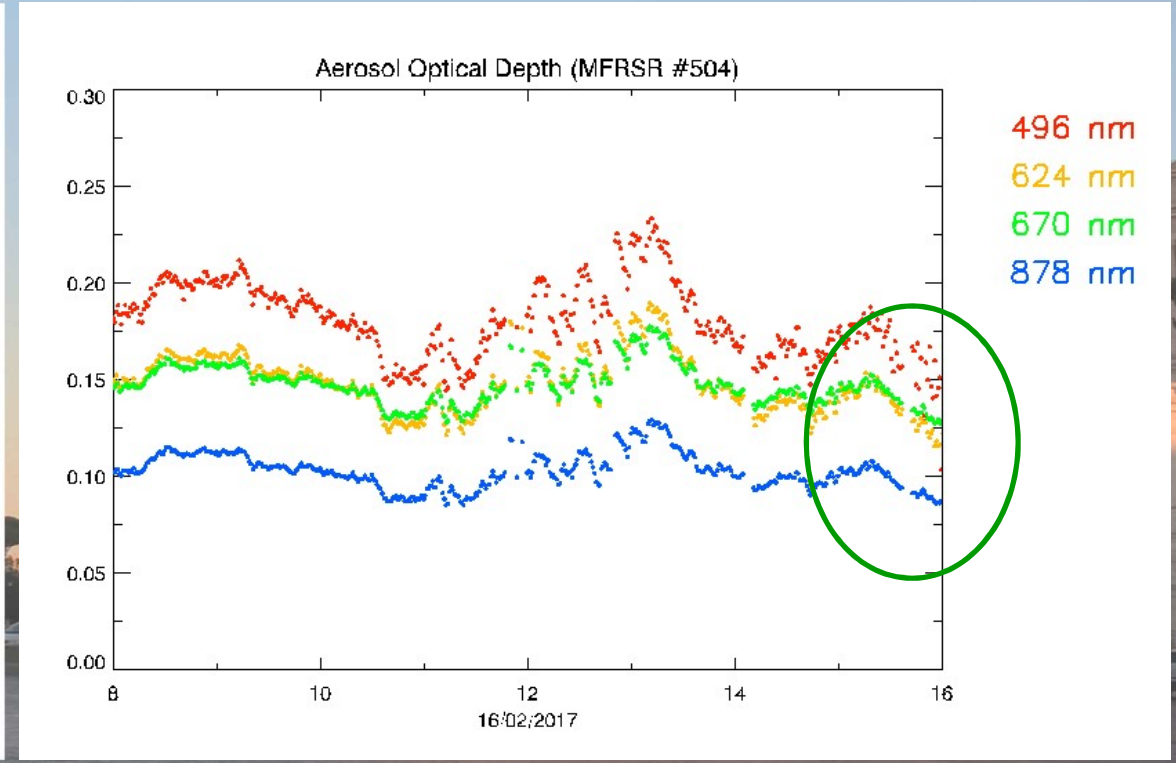
Date: 16/02/2017

8:00 – 16:00 UTC

Aerosol Optical Depths

Avarege time: 1 minute





Comparison between BAQUNIN & CIRAS LIDARs

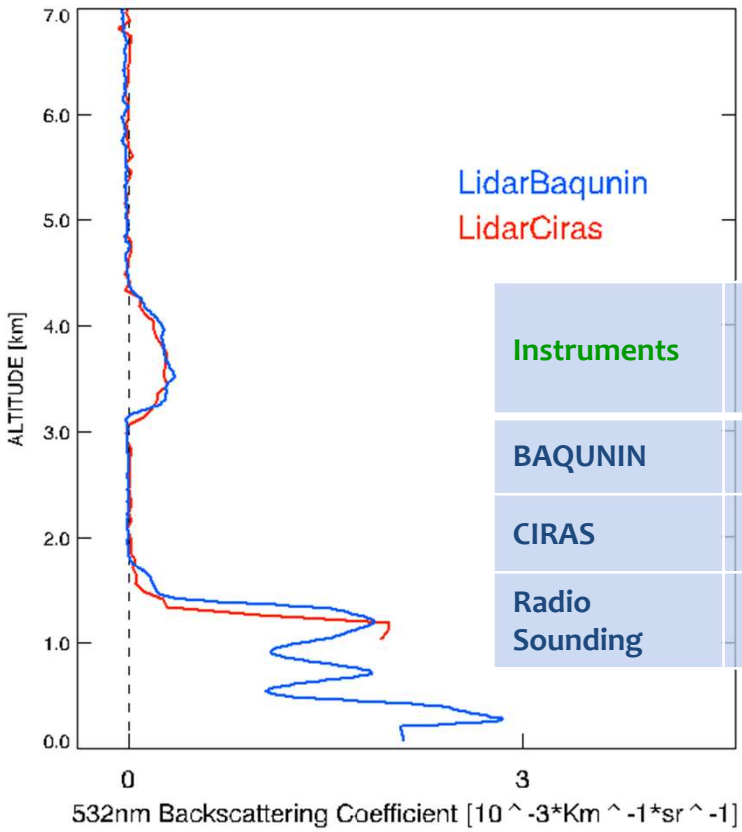
Date: 16/02/2017

17:30 – 18:30 UTC

Avarege time: 1 hour

Elastic LIDARs

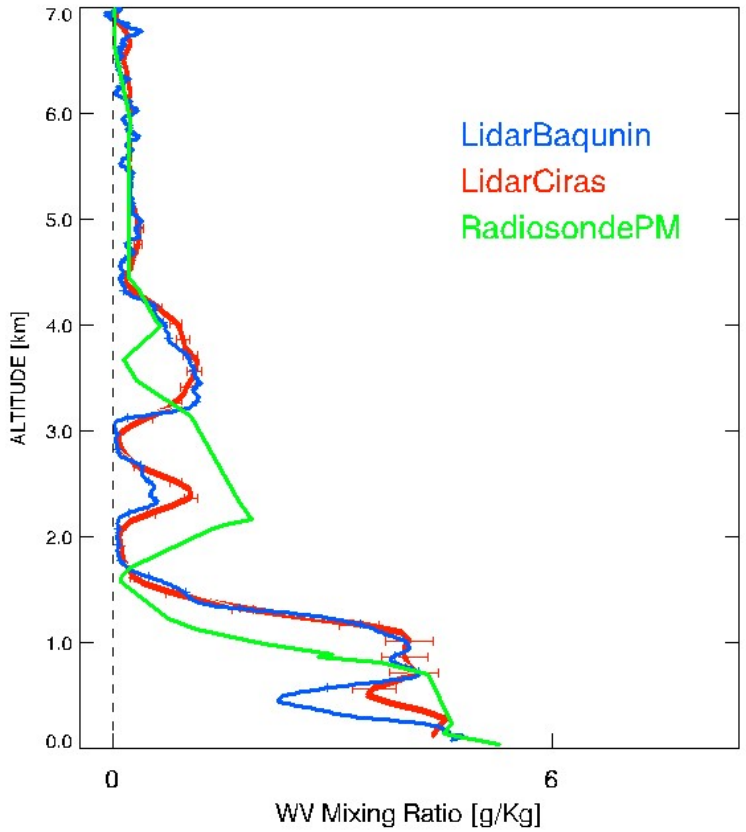
Backscattering Coefficient profiles (532 nm)



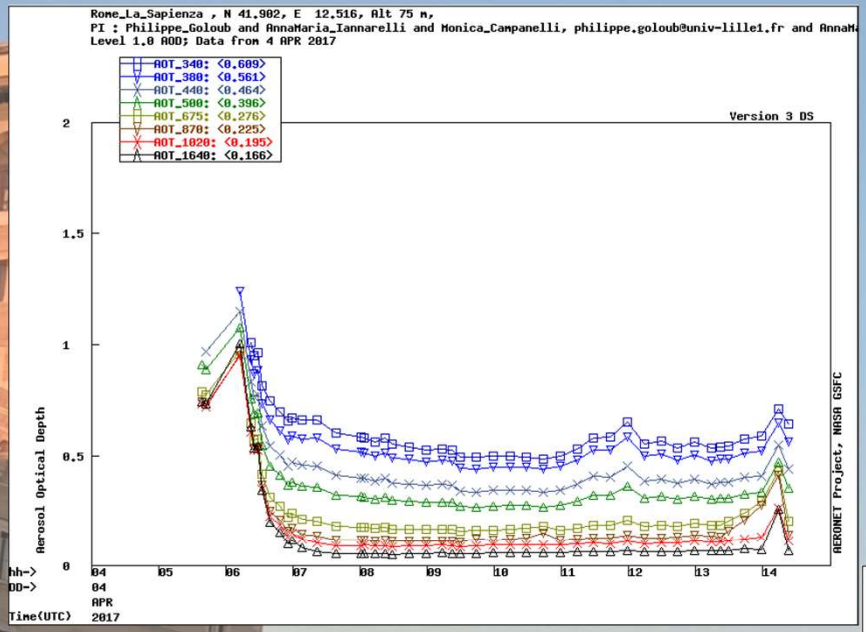
Instruments	Water Vapor columnar content (cm)
BAQUNIN	0.71 ± 0.03
CIRAS	0.79 ± 0.07
Radio Sounding	0.75 (12.00 utc)

Raman LIDARs

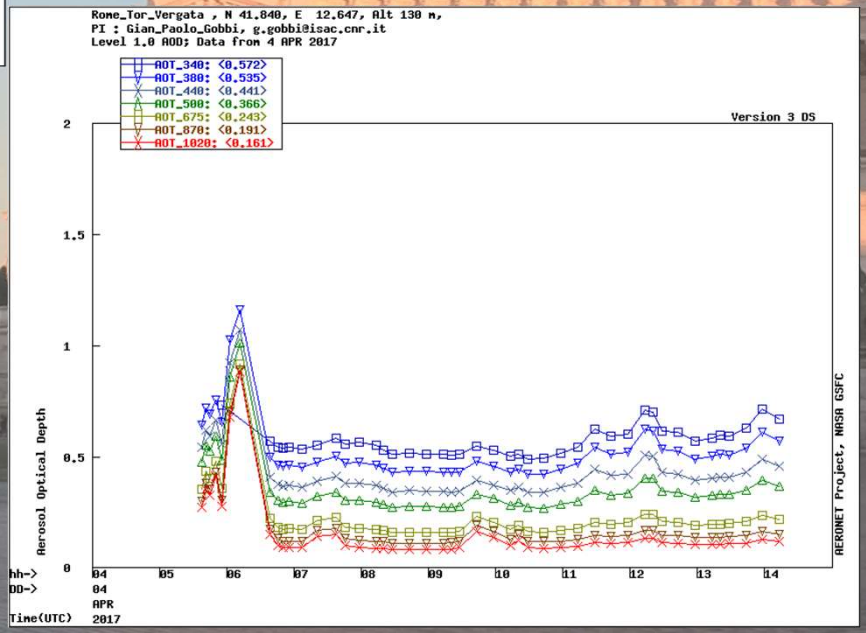
Water Vapor mixing ratio profiles



CIMEL #646



CIMEL #232



BAQUNIN Super-Site strategy

Strategy for Satellite Validation

- All instruments (except Lidars) operate continuously
- Synchronisation of Lidar acquisitions with Satellite(s) overpass
  (2 hours before and after overpass time)
- Pandora operated in order to maximise FOV overlap at overpass
- Most of the acquired data processed in near-real-time
- BAQUNIN data stored on 16 TB NAS

Strategy for PBL studies

- Campaign-based
  - LMRC Campain, May
  - EMERGE Campain, July
- All instruments operate continuously (Lidar day&night)
- Off-line processing
- Data analysis

BAQUNIN Super-Site strategy

Conclusions

- Some instruments to be properly calibrated
- Inter-calibration between the instruments (LIDAR-Prede-Pandora 2S)
- Other products from the instruments will be available

- Measurements strategy for Satellite Atmospheric Chemistry Validation
- Urban Boundary Layer studies (in collaboration with ISAC-CNR)

- The overall system should be ready by the end of June
- All BAQUNIN products in NETCDF format
- Website for BAQUNIN data download

- The Neural network Aerosol Typing Algorithm based on LIdar data (NATALI) will be applied to LIDAR datasets to classify aerosols

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Thank you for your attention!