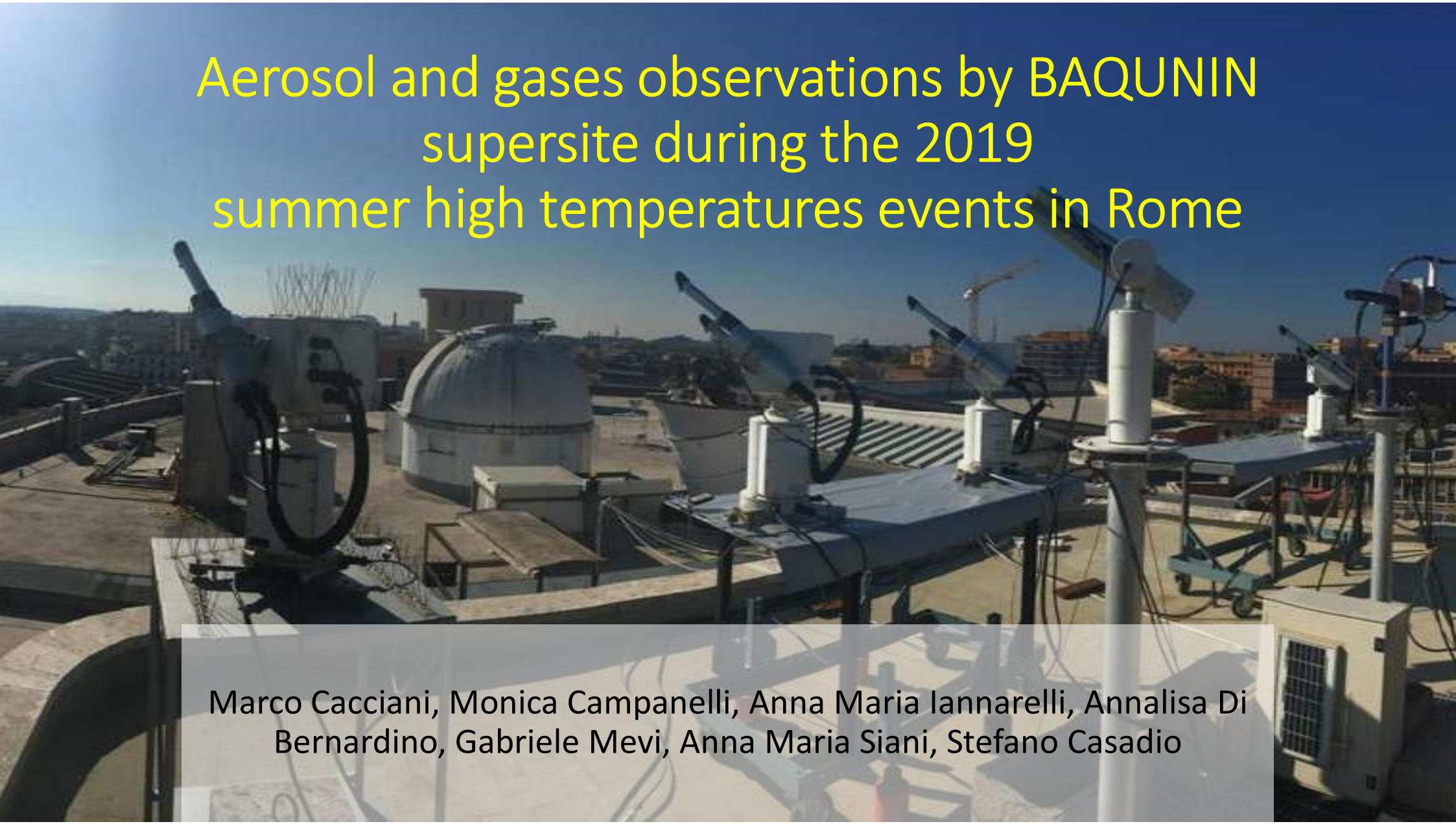


Aerosol and gases observations by BAQUNIN supersite during the 2019 summer high temperatures events in Rome

Marco Cacciani, Monica Campanelli, Anna Maria Iannarelli, Annalisa Di Bernardino, Gabriele Mevi, Anna Maria Siani, Stefano Casadio

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

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

BAQUNIN staff:

SERCO: A.M. Iannarelli, S. Casadio, G. Mevi, M. Cardaci, E. De Grandis
Atmospheric Physics Laboratory Sapienza: M. Cacciani, A.M. Siani, A. Di Bernardino
CNR-ISAC: M. Campanelli
CNR-IIA: C. Bassani
Sardegna Clima Onlus: A. Murgia

BAQUNIN Project mandate:

- Sustain the maintenance and operation of ground based remote sensing instruments for Satellite Cal/Val and Atmospheric Monitoring/Research purposes
- Perform inter-calibration and validation campaigns
- Stimulate research in Urban Atmospheric Boundary Layer physics/chemistry by facilitating inter-connections between research institutes

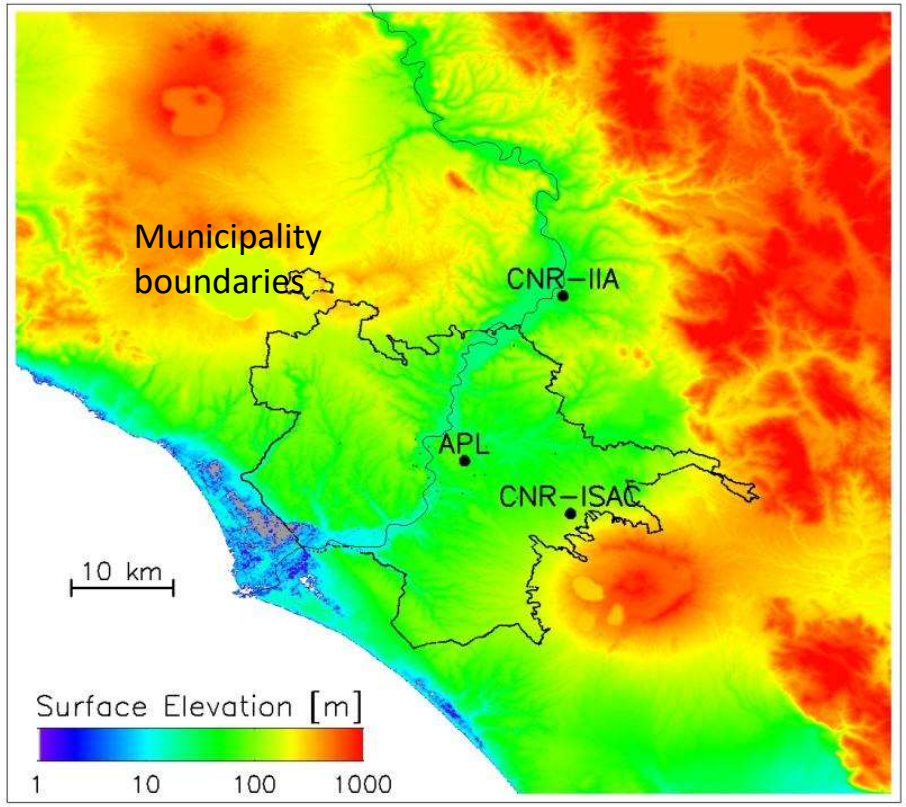
BAQUNIN Super Site Locations

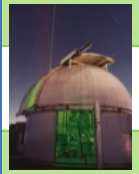
Rome is an urban site, with about **3.0 million of inhabitants**, 25 km east from the Mediterranean Sea, in the middle of an undulating plain.

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.

BAQUNIN Super Site Locations

APL Atmospheric Physics Laboratory Sapienza University	City center
CNR - ISAC Institute of Atmospheric Sciences and Climate	Tor Vergata Southeast of the city, 13 Km from the city center
CNR - IIA Institute for Atmospheric Pollution	Montelibretti Northeast of the city 24.6 Km from the city center.



BAQUNIN instruments	PI Affiliation	LO Affiliation	Owner
   Pandora 2S #115 #117 #138	Serco	ISAC Serco IIA	ESA
  Cimel Prede Pom 01	LOA (Laboratoire d'Optique Atmosphérique) ISAC	ISAC - Serco	LOA PNRA - ISAC
 Brewer Meteorological Sensors	Sapienza	Sapienza	Sapienza Fondazione Osservatorio Meteorologico Milano Duomo
 MFRSR	Sapienza	Serco	Sapienza
  Pyranometer Skycam	Serco	Serco	ESA
 LIDAR	Sapienza	Sapienza -Serco	Sapienza -ESA
 SODAR	Sapienza	Sapienza	Sapienza - ISAC
WRF Model	Sardegna Clima	Sardegna Clima - Serco	Sardegna Clima

BAQUNIN Super-Site products & instruments

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

Networks collaboration

- ✓Pandonia Global Network
- ✓Aeronet
- ✓ESR/SKYNET
- ✓Eubrewnet
- ✓Climate Network

‡ Instruments present in more than one location

BAQUNIN web site

Boundary-layer Air Quality-analysis Using Network of Instruments Super Site

BAQUNIN

Home | Instruments | Products | Live Monitoring | Activities | Documents | Contact Us

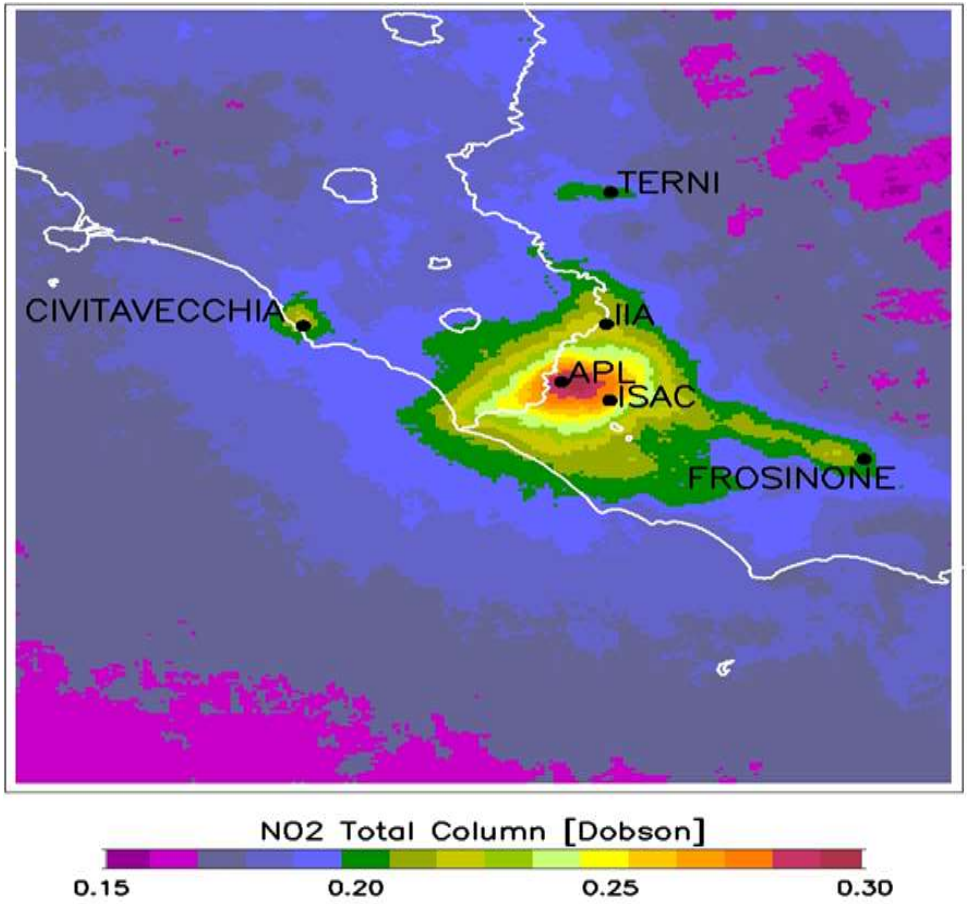
www.baqunin.eu

- ✓ About BAQUNIN Project
- ✓ Measurements campaigns and related projects
- ✓ Instruments and Live monitoring
- ✓ Products, available datasets and download

BAQUNIN for Cal/Val activities: TROPOMI S5p & Pandora

TROPOMI NO2 concentration in the Tiber valley

This map shows the average NO2 **Total Column** field calculated using all cloud-free TROPOMI data from March 9 to June 16, 2018.



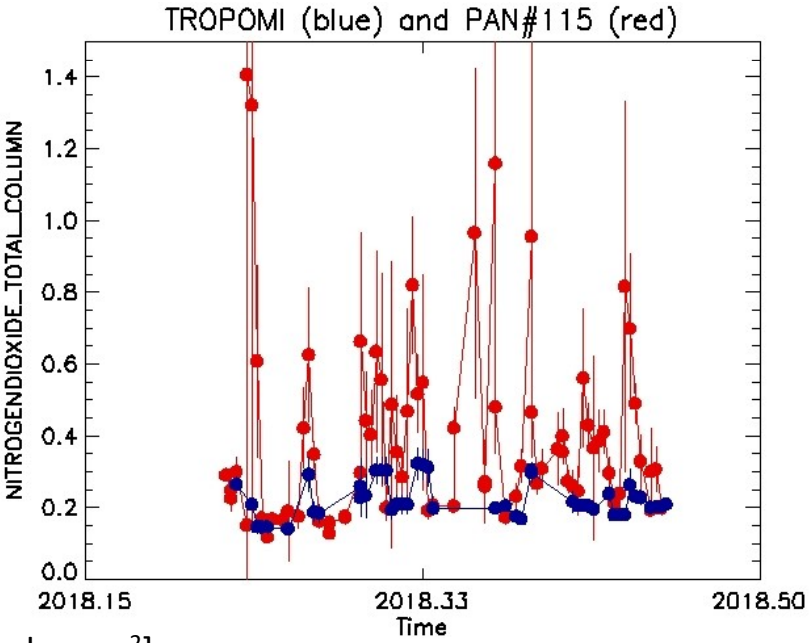
1 Dobson [DU] = 2.6868×10^{16} [molecules cm^{-2}]

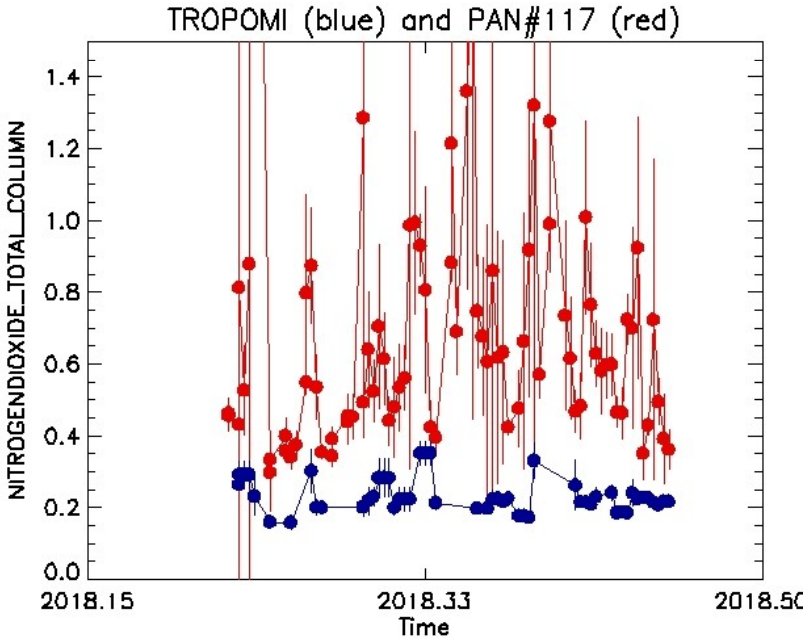
BAQUNIN for Cal/Val activities: TROPOMI S5p & Pandora

TROPOMI NO2 concentration in the Tiber valley

This map shows the average NO2 **Total Column** field calculated using all cloud-free TROPOMI data from March 9 to June 16, 2018.

- Pandora #115 , sub-urban **good** for TC<0.3 DU, **significant underestimation** for larger values
- Pandora #117 , Urban **significant underestimation** with a bias of about 0.2 DU





1 Dobson [DU] = 2.6868×10^{16} [molecules cm^{-2}]

BAQUNIN products correlation studies: Pandora & Sodar

Statistical analysis of 5 months (Nov 2018 – March 2019)

Sodar and Pandora#117 data

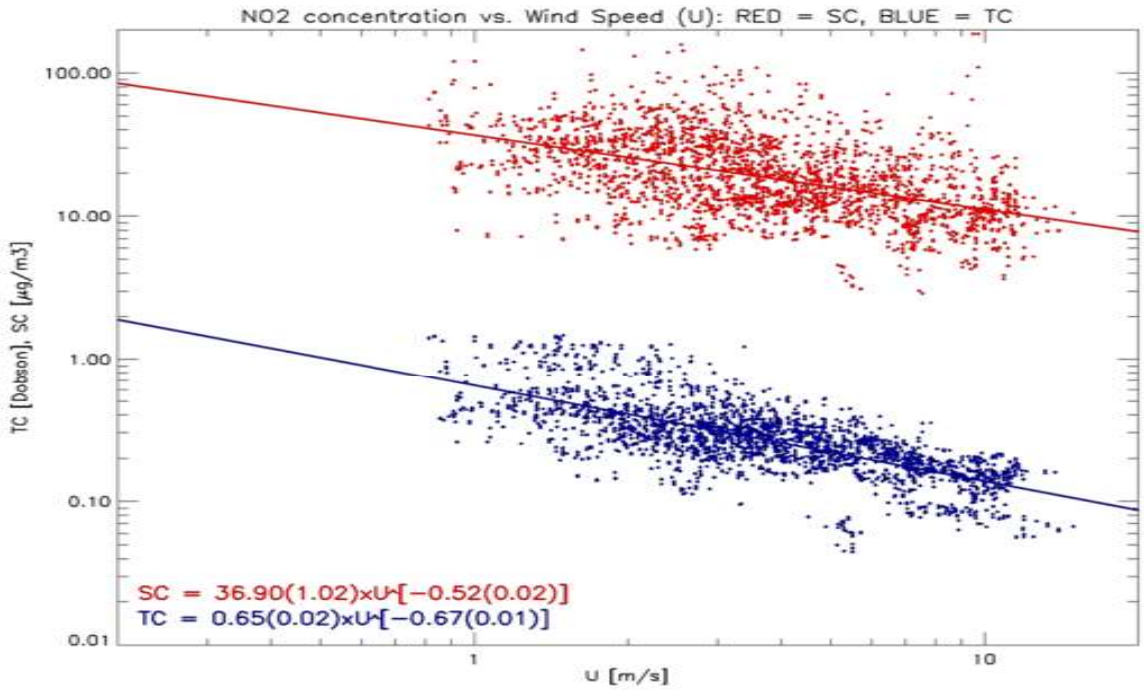
The SODAR horizontal wind speed averaged over the 100-300 m a.m.s.l. range (U).

SC = surface concentration
TC = tropospheric column

Note: the plot is log/log!

The NO2 TC and SC concentrations seen by the Pandora are very well correlated with the wind intensity in the lower urban boundary layer (surface layer).

Given that the Roman NO2 is almost totally due to traffic and produced in the canopy layer, the observed behaviour suggests that only in low-wind/small dissipation conditions the urban pollution is transported upward so that can be probed by PAN#117.



$$C = C_0 \cdot U^{-A}$$

BAQUNIN products correlation studies during special events

TMB (waste facility) fire, 11 Dec 2018

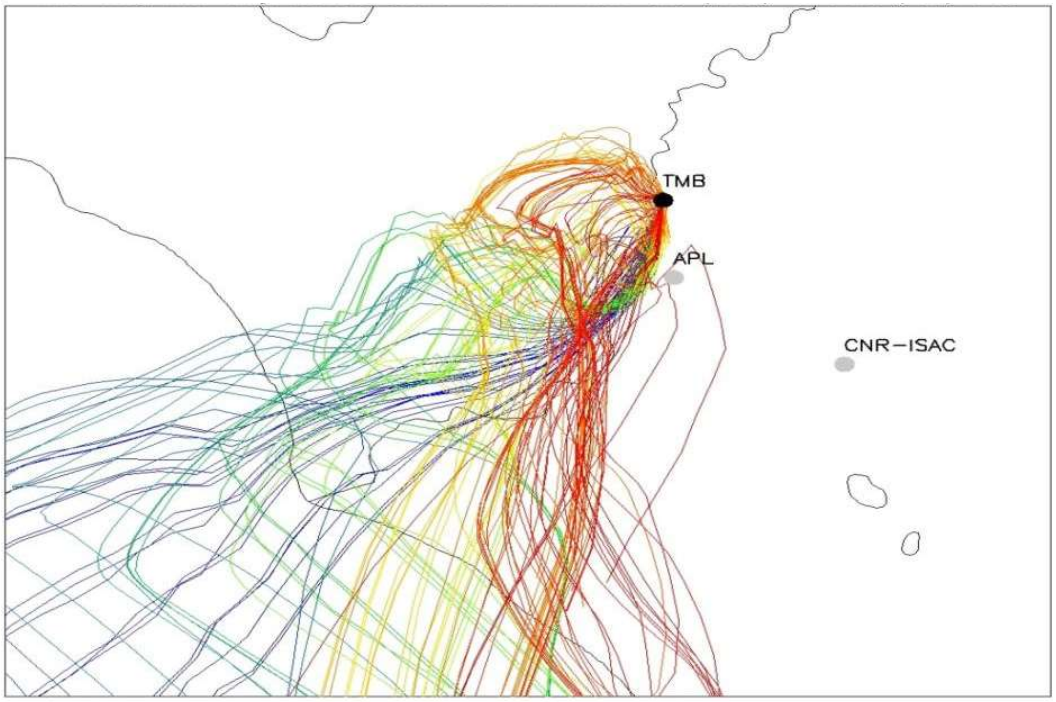
Instruments:

WRF

(ANSA) - Rome, December 11 2018 - A large fire broke overnight at a waste facility managed by Rome municipal trash company AMA. The fire at the 2,000-square-metre rubbish centre produced thick smoke on via Salaria, in the north of the historic capital, and the smell of smoke reached the centre. The city council has advised people in the area to keep their windows closed and refrain from outdoor activities.

The local authority said Lazio's ARPA environmental agency had not registered air-pollution levels outside the permitted parameters.

WRF trajectories from 3.00 am (Blue) to 10.00 am (Red) [UTC]



BAQUNIN products correlation studies during special events

Instruments:

WRF

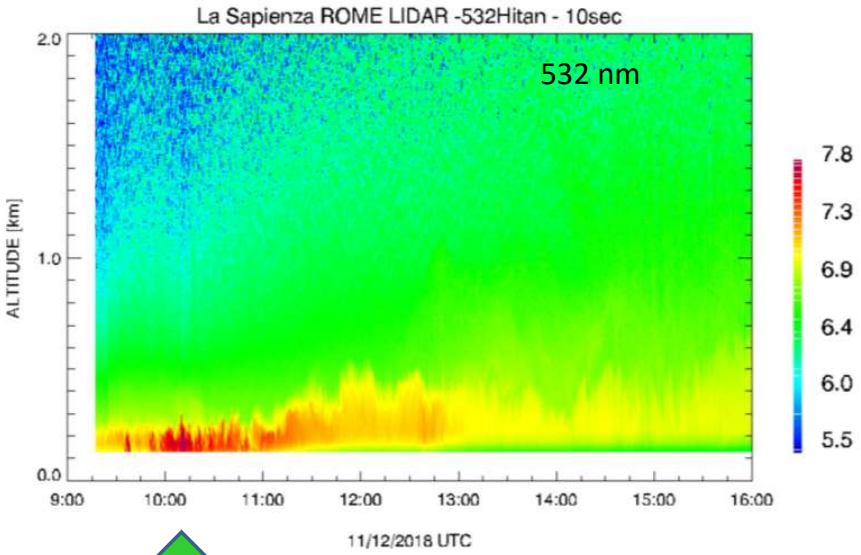
Lidar

MFRSR

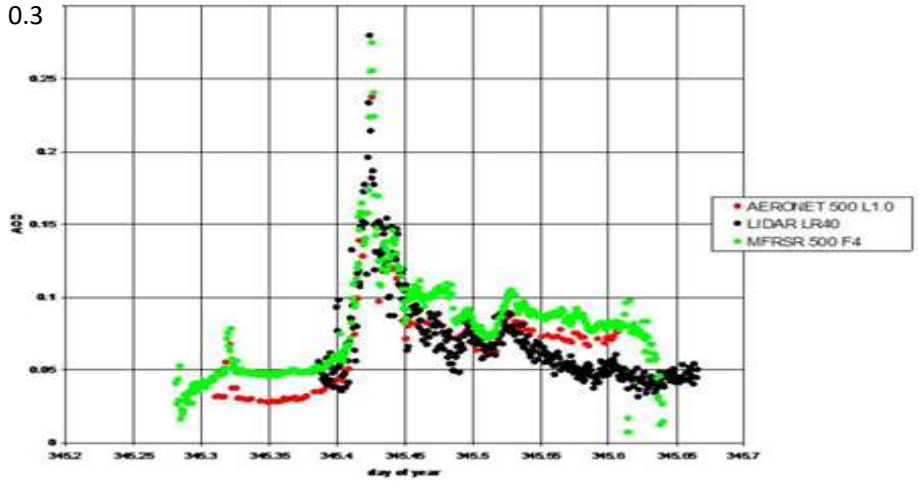
Cimel

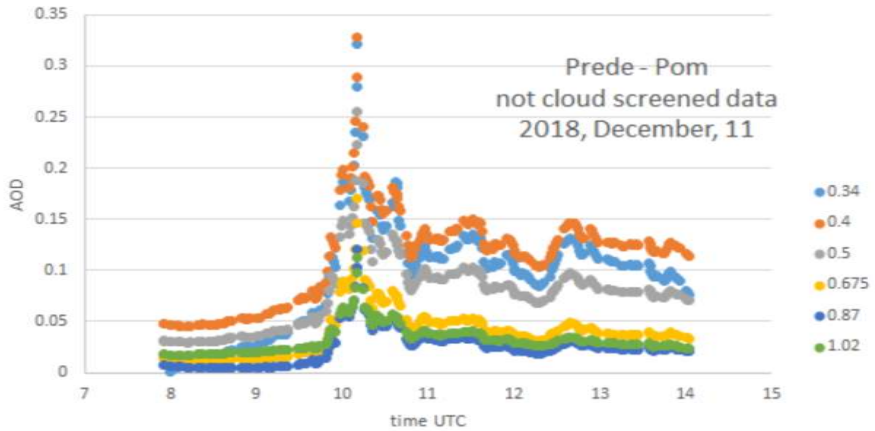
Prede POM

TMB (waste facility) fire, 11 Dec 2018



Toxic plume arrives on APL!





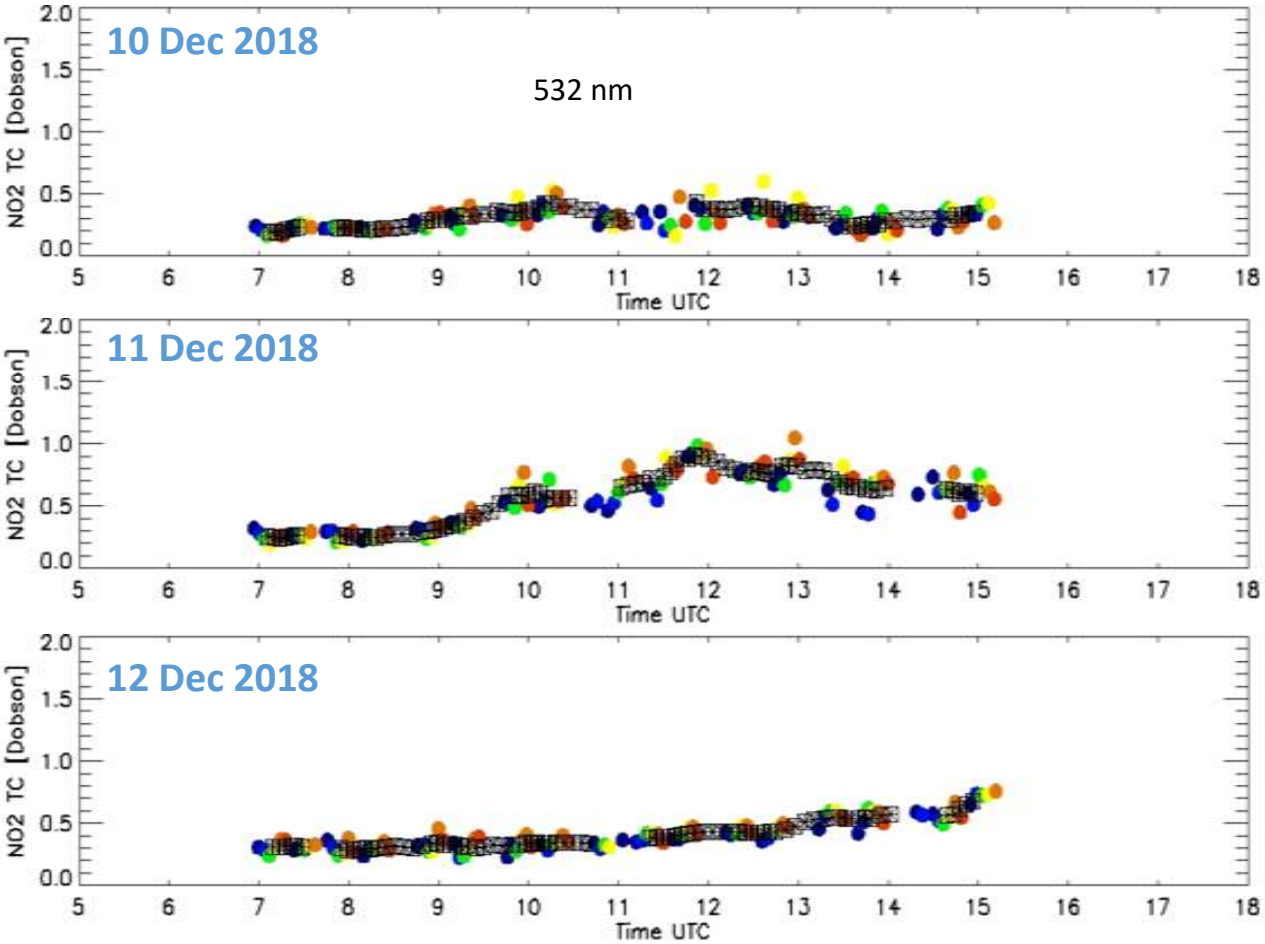
BAQUNIN products correlation studies during special events

Instruments:

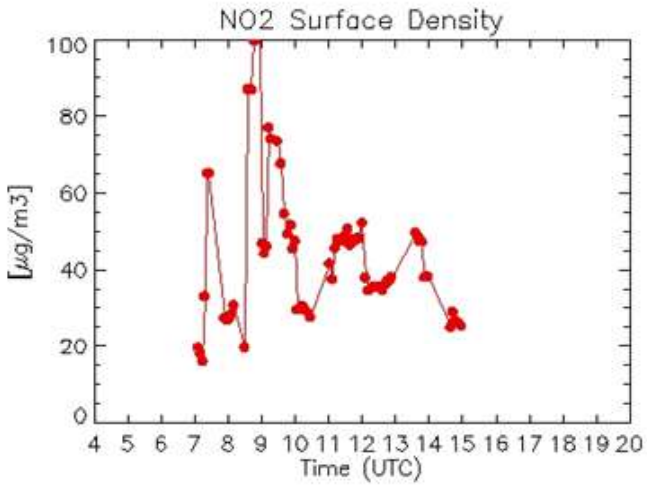
- WRF
- Lidar
- MFRSR
- Cimel
- Prede POM
- Pandora

TMB (waste facility) fire, 11 Dec 2018

Tropospheric column concentration



Surface concentration



Tropospheric NO2 doubled during the event!
Surface NO2 concentration increase!

BAQUNIN Activities

Campaigns

2017 - LRMC- ACTRIS - Lidar&Radiometer Measurement Campaign
Lidar + CIMEL (at CALIPSO overpass)

2017 - EMeRGe - Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales
All instruments (two overpasses, low-thick clouds in both cases!)

2017 - QUATRAM - QUAlity and TRaceabiliy of Atmospheric aerosol Measurements
POM-PREDE, Pandora, Middleton, PFR, CIMEL + Lidar(4 weeks intense operations)

2017 -2018 VIEPI - Valutazione Integrata dell'Esposizione a Particolato in ambiente indoor (VIEPI)
All instruments (continuous operations) +3D Sonic Anemometer,Volumetric sampler, Particle Sizer Spectrometer, Condensation Particle Counter, Sioutas Personal Cascade Impactor, PM10 Particulate Samplers

2019 - QUATRAM2 - QUAlity and TRaceabiliy of Atmospheric aerosol Measurements
POM-PREDE, Pandora, Middleton, PFR, CIMEL

Projects

DIVA ESA Project selected Lidar-CIMEL station (SERCO, SAPIENZA)

PANDONIA ESA Project "POp" and "FRM4AQ" (SERCO, SAPIENZA ,CNR-ISAC/IIA)

EarthCare Validation Proposal ID **38811** (SERCO, ENEA, CNR-ISAC, SAPIENZA)

S5p Validation Proposal ID **42807** (SERCO, ENEA, CNR-ISAC/IIA, SAPIENZA, Sard. Clim.)

Summer schools

2018 SORBETTO Solar Radation Based Established Technique for aTmospheric Observation
18 Speakers from Europe and Japan, 35 Students from Europe, Africa and Asia
(CNR-ISAC, SAPIENZA, SERCO)

BAQUNIN

2019 summer in Rome

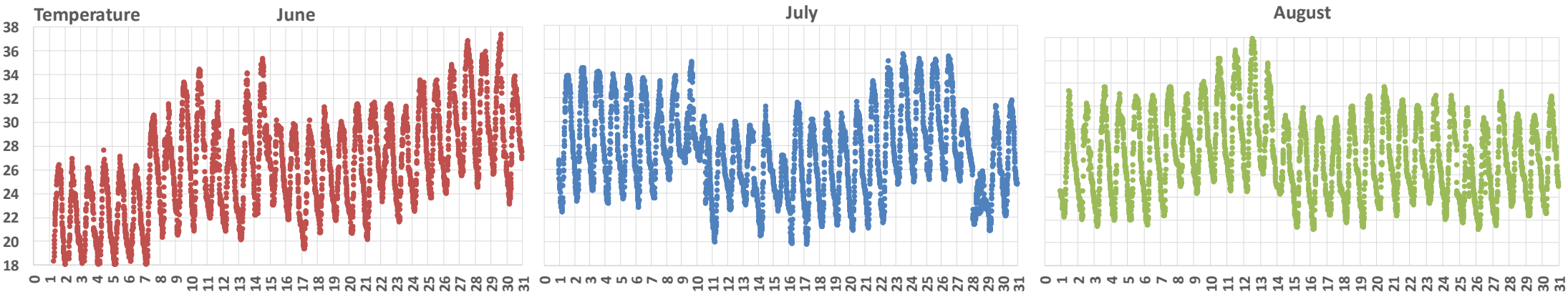
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

From the News & Features home page of NOAA, in September 16, 2019, the following is stated:

Meteorological summer (Northern Hemisphere)

June through August 2019, was the Northern Hemisphere's hottest meteorological summer on record, tied with 2016. The period of June through August, which also marks the Southern Hemisphere's winter, was the planet's second hottest in the 140-year record at about 0.9 C° above the 20th-century average, behind June-August of 2016. The last five June-August periods are the five hottest on record.

2019 summer temperatures in Rome

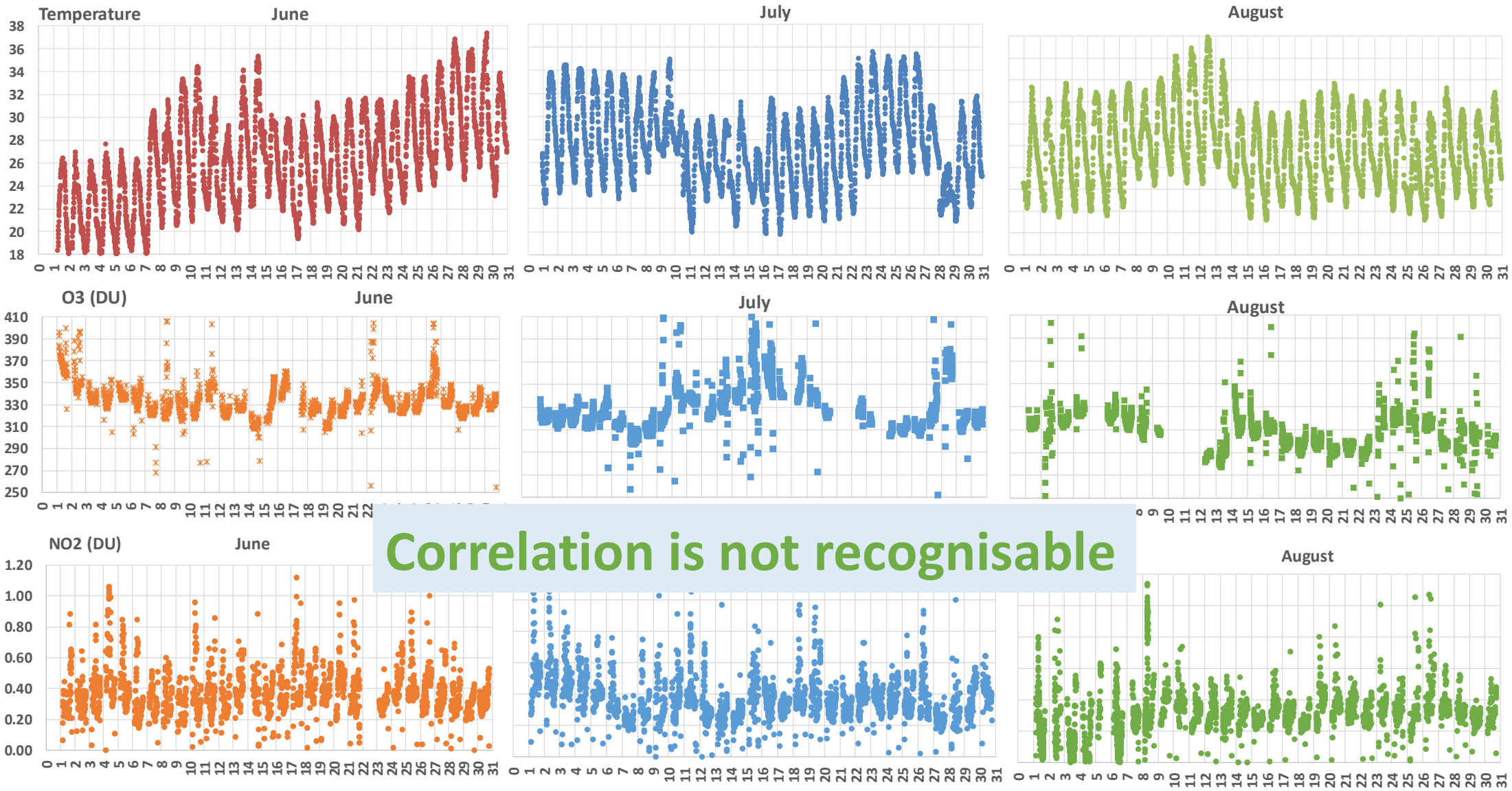


Some correlation with aerosol or trace gases?

O3 and NO2 Pandora

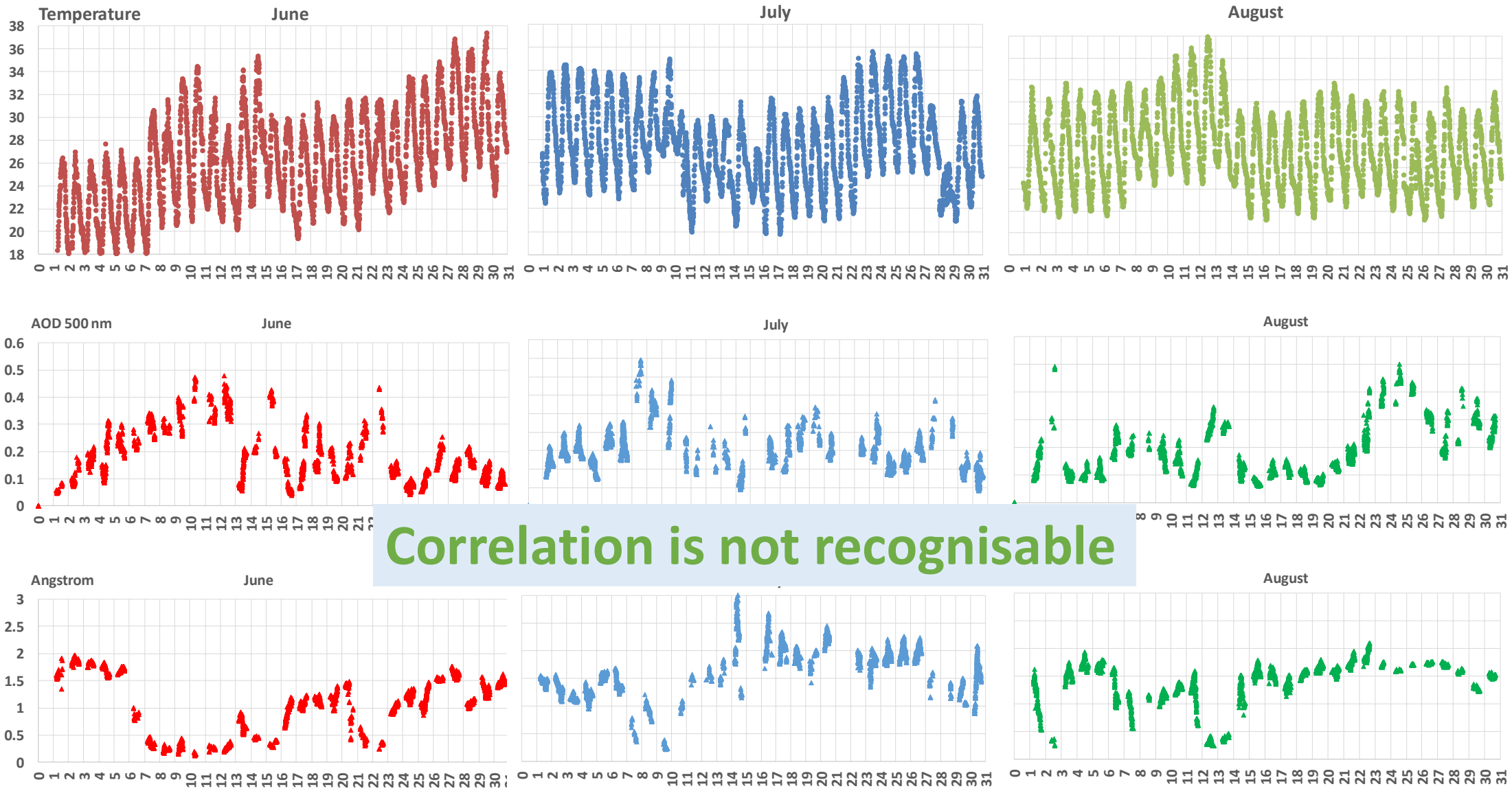
AOD & Angstrom exponent Pom01

2019 summer temperatures in Rome



Correlation is not recognisable

2019 summer temperatures in Rome



Correlation is not recognisable

BAQUNIN

2019 summer temperatures in Rome

0019171-25/06/2019-DGPRE-MDS-P

Ministero della Salute

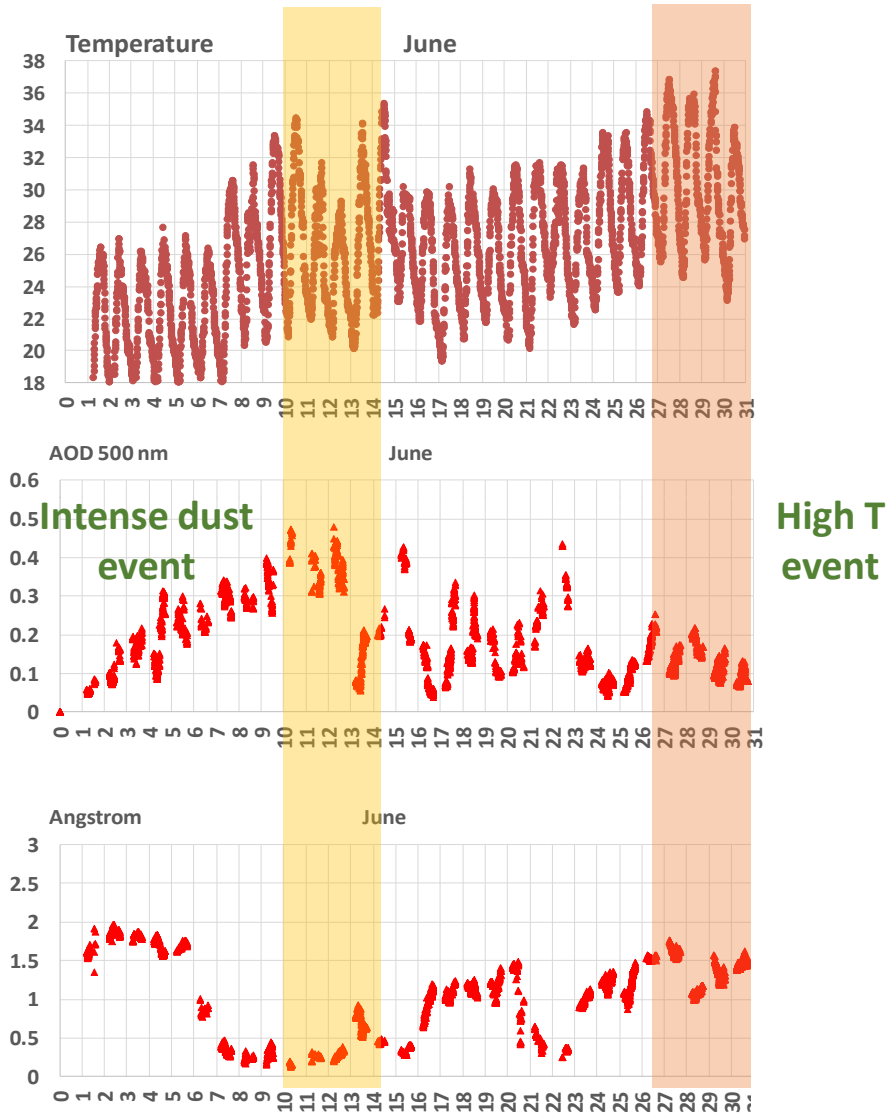
DIREZIONE GENERALE DELLA PREVENZIONE SANITARIA
Ufficio 4 – Prevenzione Rischio Chimico Fisico e Biologico e Promozione salute Ambiente e Sicurezza Luoghi Lavoro
Via Giorgio Ribotta, 5 – 00144 Roma
PEC: *dgprev@postacert.sanita.it*

Ai Comuni
Alle Regioni e Province Autonome
Agli Assessorati alla Sanità
Ai Sig.ri Prefetti
LORO SEDI

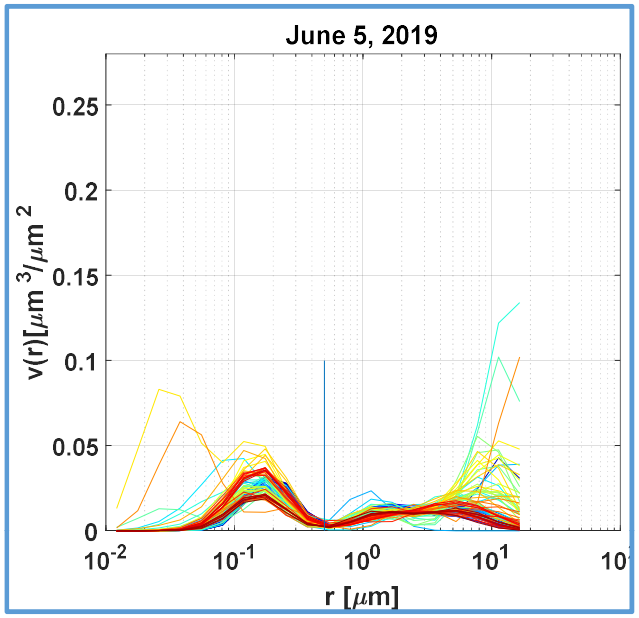
E.p.c.
Al Dipartimento della Protezione Civile
SEDE
protezionevicile@pec.governo.it

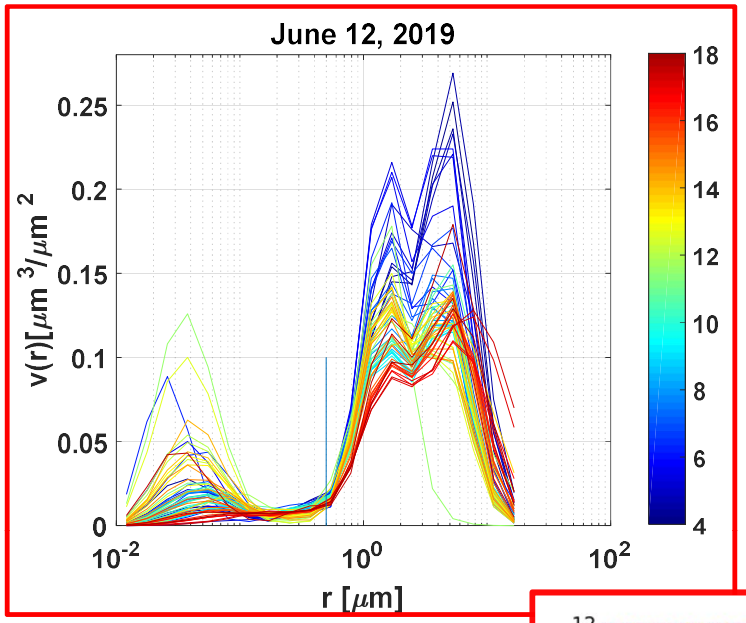
OGGETTO: Piano operativo nazionale di previsione e prevenzione degli effetti del caldo sulla salute – Estate 2019

…the national territory is affected by high pressure conditions which determine high temperatures far above the average for the period. In the coming days, particularly from Thursday 27, there is a further increase of temperatures over the rest of the country with heat wave conditions, severe climatic distress and health risk…

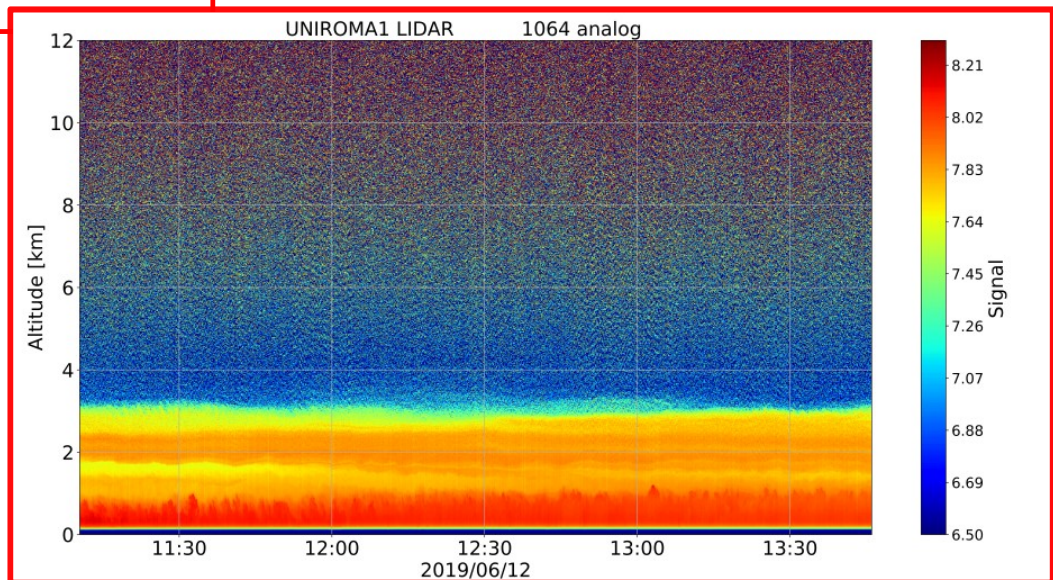


First event: Volume size distributions and Lidar RCS evolution





INTENSE DUST EVENT



During heavy event of DUST temperatures can be not the highest

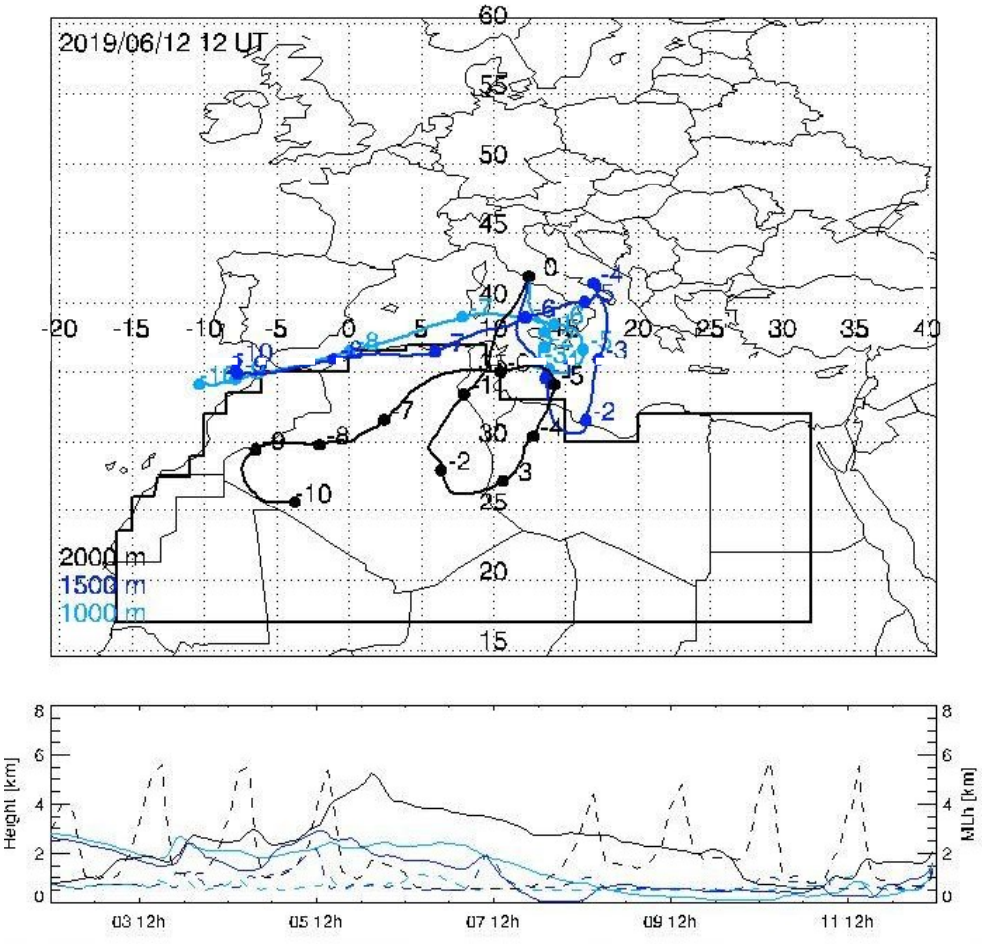
Is it really dust?

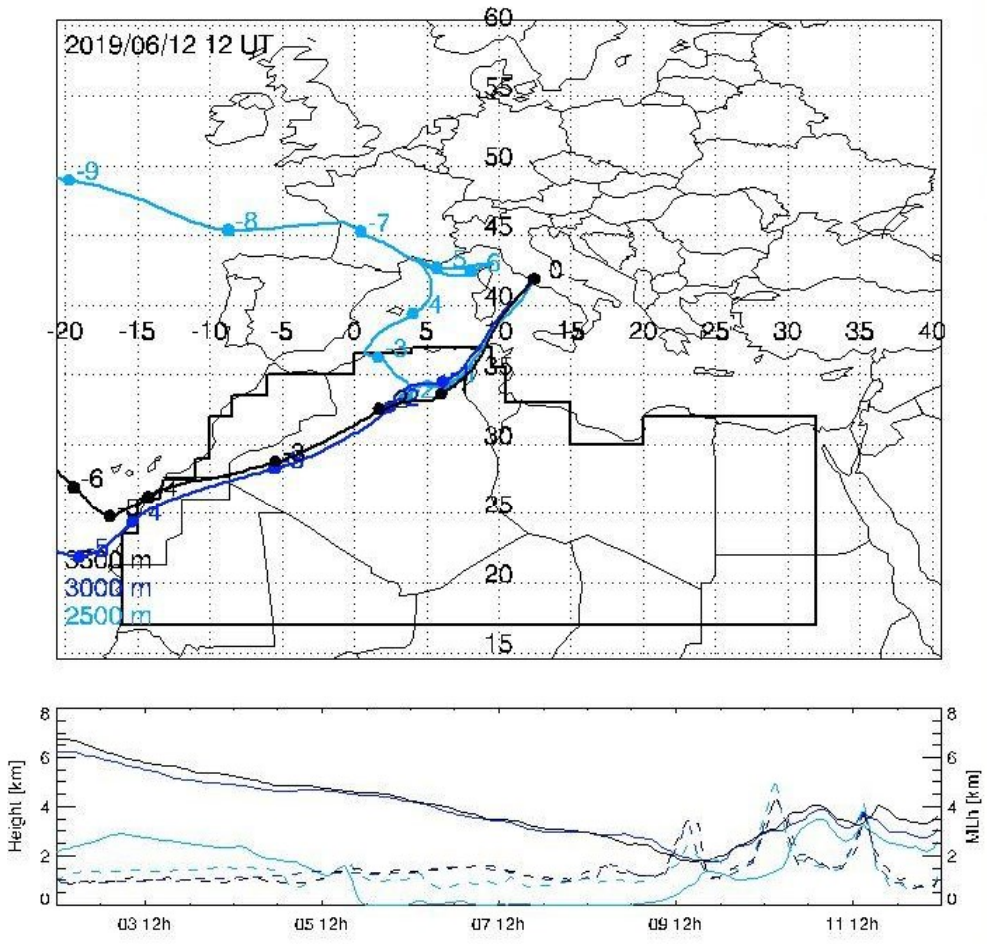
The answer from the method of Di Iorio et al.,JGR,2009 (doi:10.1029/2008JD010593):
From the backtrajectories by hysplit and wind fields downloaded from "NCEP-NCAR Reanalysis 1", it is able to evaluate if the air masses are loaded of Saharan dust or not .

Conditions to be respected are:

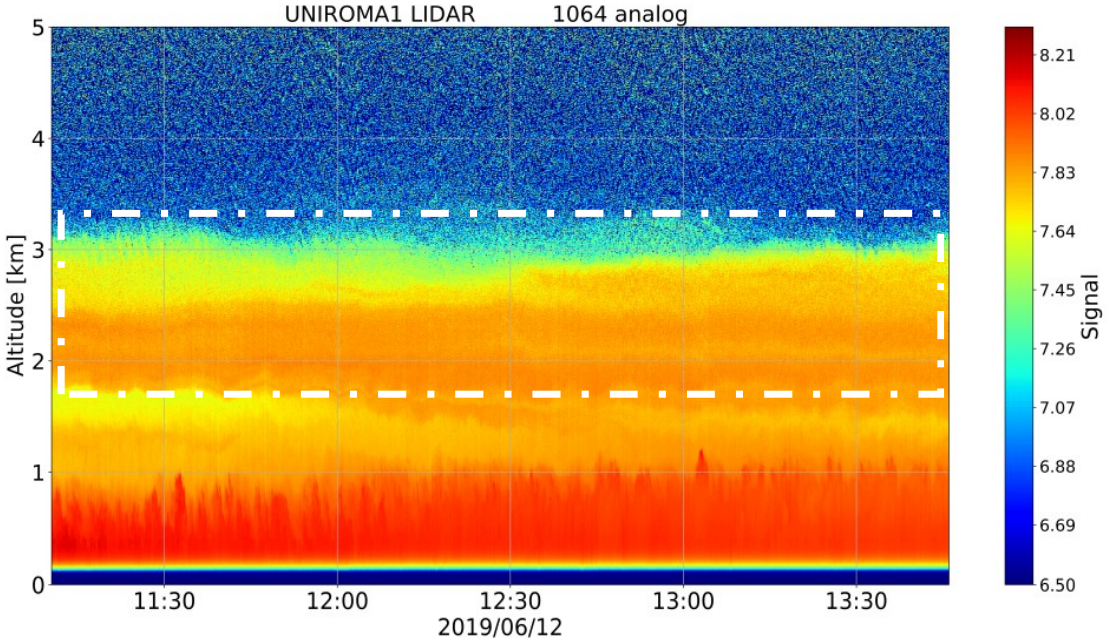
1a) Air mass must have entered the mixing layer (ML) above the desert and simultaneously it have found a surface wind of at least 7 m/s
1b) Alternatively the air mass must have spent above the desert at least 60hr (2.5 days)
2) The Air mass must not have been subjected to rain in the period between dust accumulation and the arrival to destination.
3) No more than 96 hr should have passed from when it is loaded of dust up to the arrival to destination.

12/06/2019 Trajectories analysis





12/06/2019 Trajectories analysis

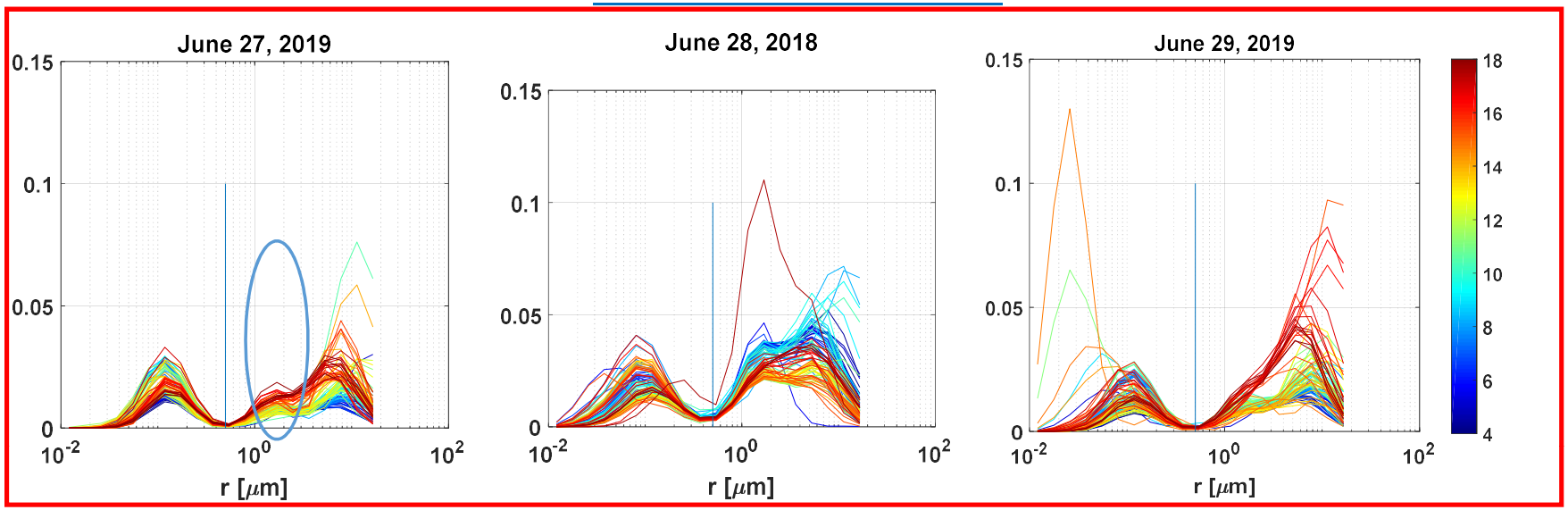


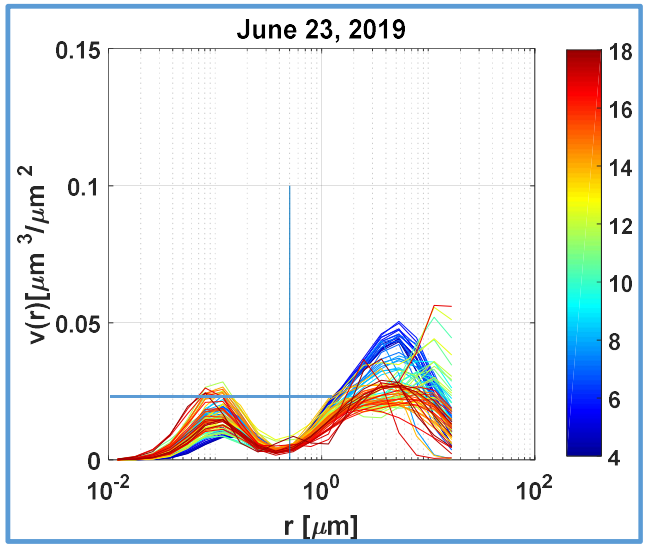
All air masses arriving to Rome between 2 e 3.5 km transport Saharan dust

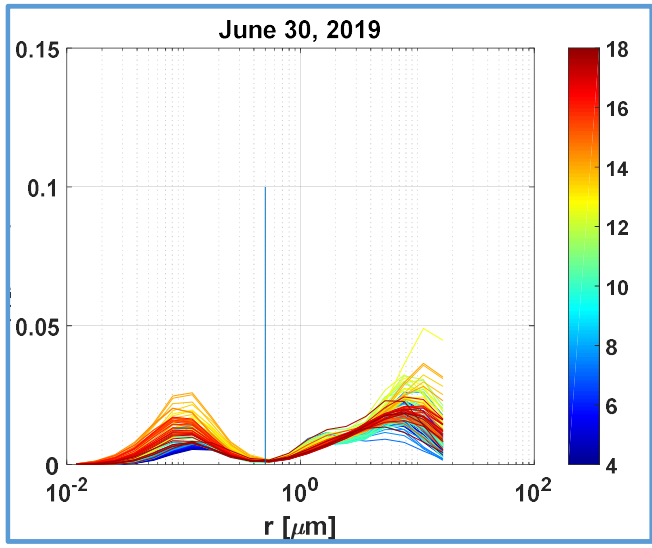
Height	Hour in desert	Rain after desert	Wind max	Last time des	Last time wind mlh	Last time mlh	Flag					
							des	mlh	wind	perm	lag	rain
1000	1	0	-99.99	-208	99.99	99.99	1	0	0	0	0	1
1500	35	0	3.3	-29	99.99	29	1	1	0	0	1	1
2000	191	0	8.36	-17	99.99	19	1	1	1	1	1	1
2500	66	0	5.16	-15	99.99	20	1	1	0	1	1	1
3000	81	0	6.7	-14	99.99	21	1	1	0	1	1	1
3500	84	0	6.7	-12	99.99	21	1	1	0	1	1	1

Second event: Volume size distributions and Lidar RCS evolution

HIGH TEMPERATURE DAYS

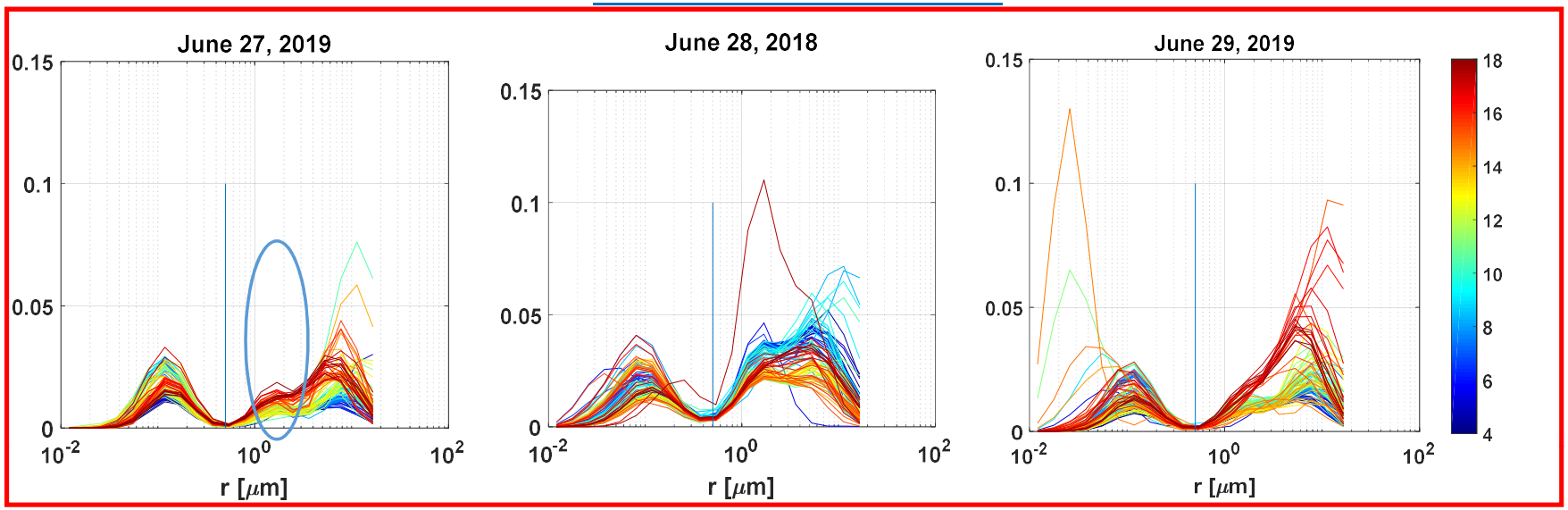




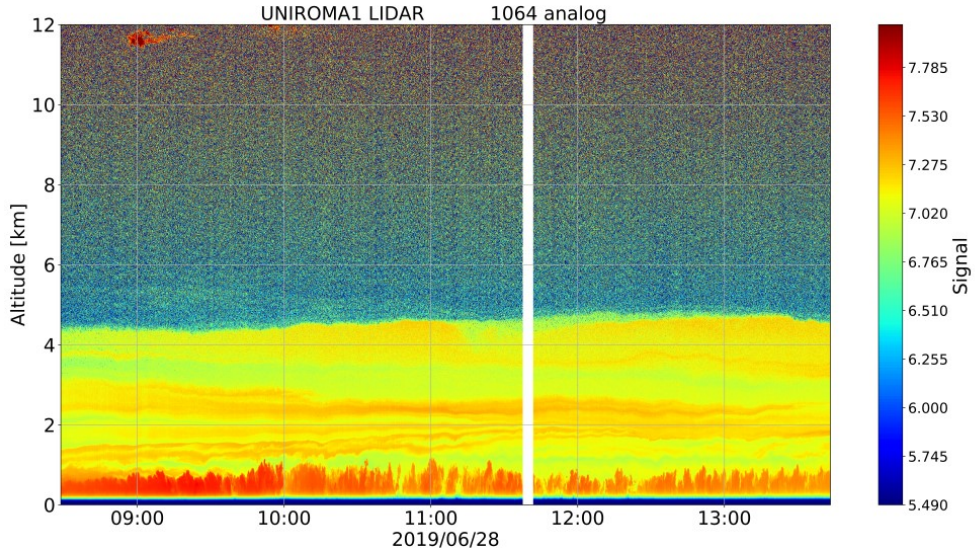


Second event: Volume size distributions and Lidar RCS evolution

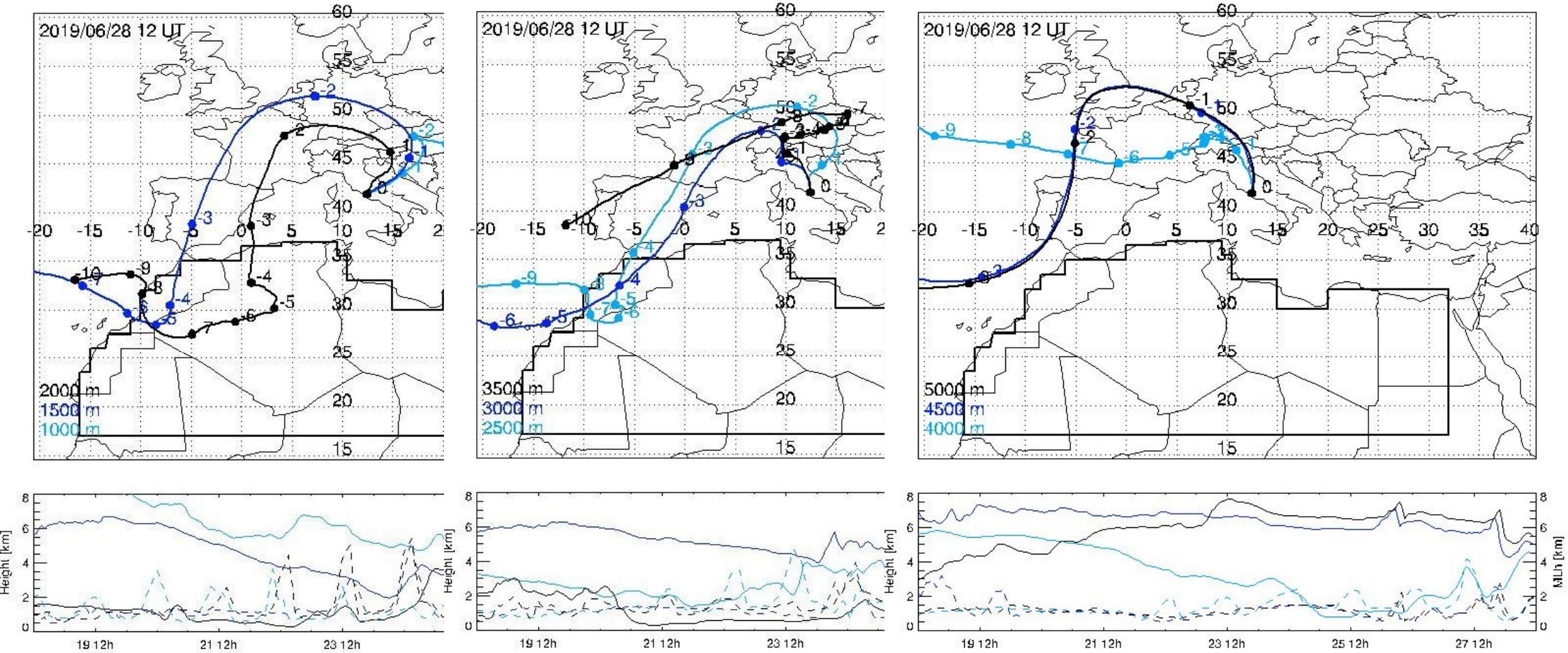
HIGH TEMPERATURE DAYS



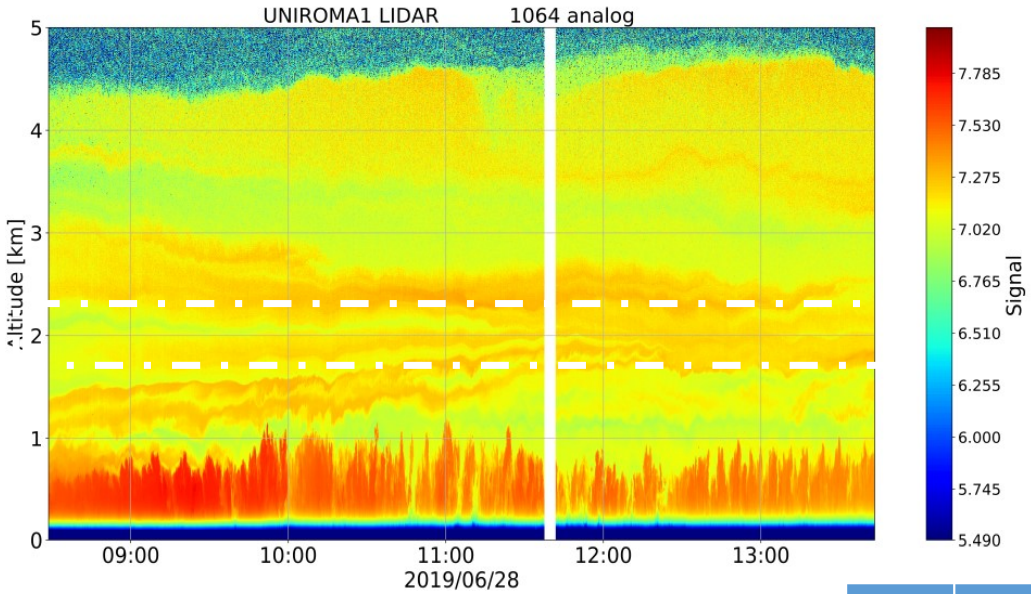
During this high temperature event DUST is present but less than June 12 as recognised by Lidar and photometer size distribution



28/06/2019 Trajectories analysis



28/06/2019 Trajectories analysis



Height	Hour in desert	Rain after desert	Wind max	Last time des	Last time wind mlh	Last time mlh	Flag					
							des	mlh	wind	perm	lag	rain
1000	0	-99.99	-99.99	99.99	99.99	99.99	0	0	0	0	0	0
1500	53	0	6.77	-84	99.99	91	1	1	0	0	1	1
2000	116	0	8.04	-79	99.99	91	1	1	1	1	1	1
2500	94	0	5.73	-98	99.99	114	1	1	0	1	0	1
3000	20	0	-99.99	-88	99.99	99.99	1	0	0	0	1	1
3500	0	-99.99	-99.99	99.99	99.99	99.99	0	0	0	0	0	0
4000	0	-99.99	-99.99	99.99	99.99	99.99	0	0	0	0	0	0
4500	0	-99.99	-99.99	99.99	99.99	99.99	0	0	0	0	0	0
5000	0	-99.99	-99.99	99.99	99.99	99.99	0	0	0	0	0	0

Only the 2 km airmass trasport dust

Boundary-layer **A**ir **Q**uality-analysis
Using **N**etwork of **In**struments
Supersite

Thanks for your attention!!!