



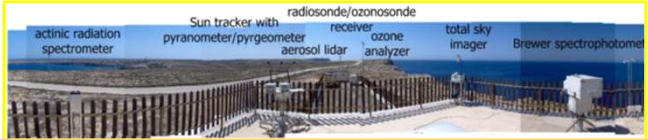
ENEA



An Italian coordinated contribution to the Validation of EarthCARE products from three atmospheric observatories in the Central Mediterranean Sea

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ENEA Station for Climate Observations at Lampedusa
The ENEA Station for Climate Observations at Lampedusa is operational since 1997. Due to the small extension (22 km²) and low elevation of the island (a plateau which degrades from North to South, with a maximum altitude of 133 m) it offers a unique opportunity to provide measurements of atmospheric parameters representative of the open marine background conditions of the Mediterranean. (www.lampedusa.enea.it)



ROME JOINT INSTRUMENTAL SUPER SITE
The Boundary-layer Air Quality Using Network of Instruments (BAQUININ) Super Site, is located at "Sapienza" University, in the center of Rome where ground based active and passive remote sensing instruments are operating for quantitative and qualitative information for a wide range of atmospheric parameters in an urban atmospheric boundary layer. The instrumental suite is used for validating atmospheric, chemical, and optical level 2 satellite products, and for Planetary Boundary Layer studies.

BACKGROUND

- Availability of set of (twin) instruments in all sites
- Well established collaboration (exchange of instruments, know how, personnel) among the teams responsible for the observatories
- Availability of time series (> 10 years) of observations for a robust statistical description of the variables of interest (e.g. Figs.1-2);
- Well characterized sites interested by different aerosols regimes
- Participation to international networks (e.g. NDACC, AERONET, PANDONIA, EARLINET, EUOROSKYRAD, EUBREWNET)
- Experience in Satellites: inversion algorithm development, processing and CAL/VAL activities

Table 1: L2 EarthCARE products (columns) to be validated and ground instruments (rows).

Instrument	Site	EarthCARE L2 Product															
		RMC	RMB	LMP	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR	A-IR
Raman-Mie-Rayleigh Lidar		x	x	x	D	D	D	D	D	D	D	D	D	D	D	D	D
CHM15k lidar ceilometer		x			A	A	A	A	A	A	A	A	A	A	A	A	A
Weather Radar C-band Doppler Dual-Pol		x															
Metek Micro Rain Radar-2 profiler		x															
Laser disdrometers		x															
Pandora		x	x														
Brewer MKII spectrophotometer			x														
SKYNET Sun-Sky radiometer			x														
PREDE-POM 01																	
AERONET Sun-Sky radiometer		x	x	x													
CIMEL-318		x	x	x													
Visible MultiFilter Rotating Shadowband Radiometer (MFRSR-VIS)			x	x													
MWR HATPRO RPG				x													
Scanning mobility particle sampler (SMPS, Tropos)		x															
Aerodynamic Particle Sizer (APS, TSI)		x															
Nephelometer (Ecotech)		x															
Aethalometer (Magee)		x															
Optical Particle Counter (OPC, Grimm)		x															
All Sky Camera			x	x	A	A	A	A	A	A	A	A	A	A	A	A	A
Meteo + Turbulence stations		x	x	x													
Sodar		x	x	x													

Sites: RMC (Rome CIRAS + AEROLAB), RMB (Rome BAQUININ), LMP (Lampedusa)
Measurements: can be used for validation as:
- **Direct** (i.e. comparable geophysical variable)
- **Ancillary** (i.e. Surface pressure for estimation of molecular scattering)
- **Parametric** (i.e. used to interpret the comparison results, e.g. by classifying the comparison statistics on the basis of parametric variables)
Readiness of the algorithms to process the ground based observation is also reported: CAPITAL letters for existing ones, LOWERCASE for algorithms to be developed.

Table 2: Example for Lampedusa site of preliminary definition of characteristics (accuracy, vertical resolution) of the ground based observations for EarthCARE validation

EarthCARE product	Geophysical parameters	Ground based instrument	Accuracy	Vertical resolution
L2a, M-AOT (aerosol)	AOT 355 nm	Cimel CE 318 sun photometer	0.02	Columnar
	AOT 670 nm	Cimel CE 318 sun photometer MFRSR_VIS Multifilter Rotating Shadowband Radiometer	Cimel, 0.01 MFRSR, <0.02	Columnar
	AOT 870 nm (Ocean Only)	Cimel CE 318 sun photometer MFRSR_VIS Multifilter Rotating Shadowband Radiometer	Cimel, 0.01 MFRSR, <0.02	Columnar
L2a, A-AER	extinction, backscatter, particle depolarization at 532 nm	Multichannel multiwavelength Raman-Mie-Rayleigh Lidar	range 0.5-5 km ± 10% (± 30%) for extin. and backsc. (dep.)	range: [100-12000] resolution: 7.5
L2a, A-EBD (cirrus)	extinction, backscatter, particle depolarization at 532 nm	Multichannel multiwavelength Raman-Mie-Rayleigh Lidar	± 15% (± 30%) for extin. and backsc. (dep.) at 532 nm	range: [100-12000] resolution: 7.5
L2a, C-CLD	LWP	Microwave Radiometer + HATPRO G2	LWP, ± 20 g/m ²	Columnar
L2a, M-COP	COT, LWP, Effective radius	MFRSR 412 nm + HATPRO G2	COT, ± 5% COT LWP, ± 20 g/m ²	Columnar
L2a, A-TC, detected targets	Aerosol types Liquid cloud	Cimel + MFRSR + HATPRO G2 + Sky Imager	Desert dust identification Liquid Cloud	Columnar
L2b, ACM-CAP (synergetic retrieval aerosol and cloud)	LWP	Microwave Radiometer HATPRO G2	LWP, ± 20 g/m ²	Columnar

OBJECTIVE: to take full advantage of available instrumentation and knowhow from 3 Italian atmospheric observatories in Central Mediterranean to provide high quality correlative data for validating EarthCARE L1 and L2 products. They are located in

1. the Island of Lampedusa (35.5°N, 12.6°E),
2. Rome city center (BAQUININ 80 asl 41.90°N, 12.50°E)
3. Rome outskirts (CIRAS 110 asl, 41.84°N, 12.65°E)

The three sites samples different regimes/processes of interest for EarthCARE validation. In addition the proposal includes:

4. AEROLAB (the AERosol moBile LABoratory), an "on wheel" mobile laboratory implemented at ISAC-Rome.



PROPOSED APPROACH

- Optimization of Match-up criteria (variable/level/scenario dependent) Fig.3
- Statistical comparison
- Improved estimation of total uncertainty budget contributions for the ground based observations.
- Synergetic (e.g. LIRIC – Chaikovsky et al. 2016) processing of observations from different instruments
- Optimization of comparison statistics and validation tests
- Estimation of the effective impact of urban environment

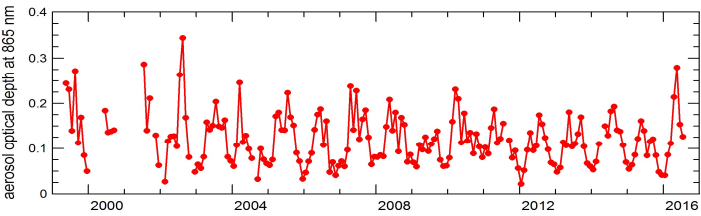


Figure 1a. Time evolution of monthly Aerosol Optical Depth derived from the integration of MFRSR and Cimel data at Lampedusa site

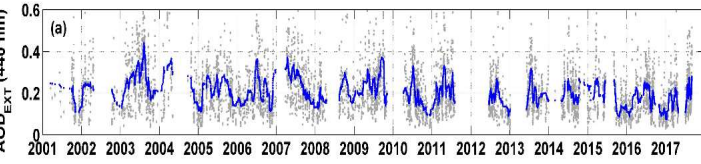


Figure 1b. Time series of AOD from AERONET data, collected at the CIRAS site (Rome). Grey markers show columnar measurements (grey lines indicate error bars), blue markers show the 55 points running mean (Di Ianni et al., 2019).

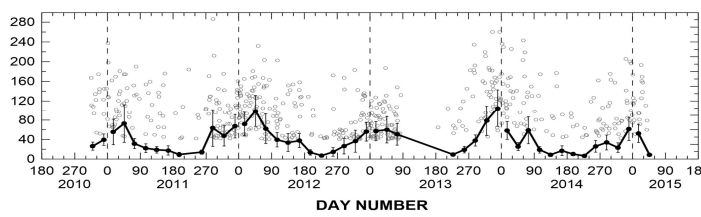


Figure 2. Daily (gray circles) and monthly (black dots and line) mean values of LWP as derived by the HATPRO; error bars correspond to the standard deviation of the daily value at Lampedusa.



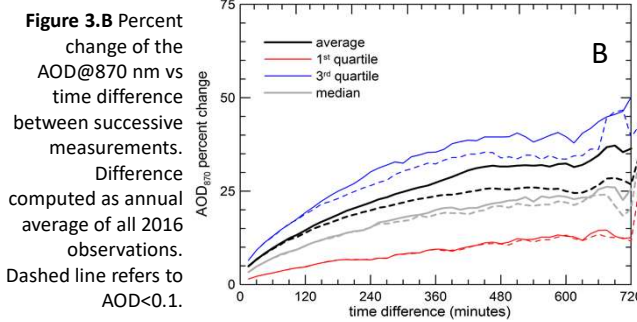
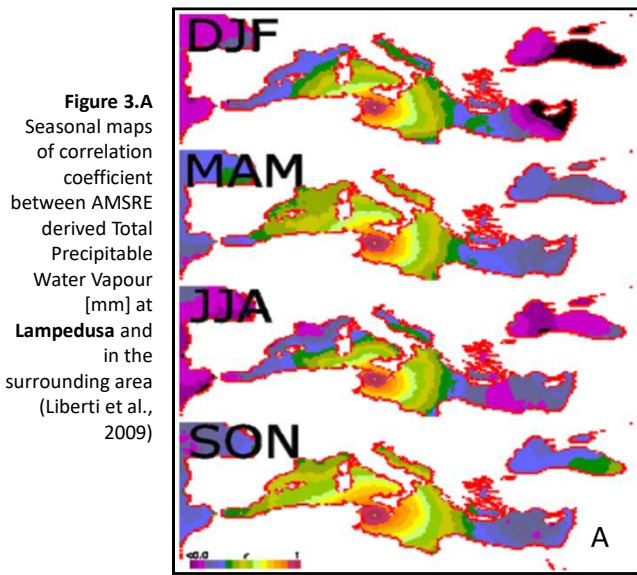
CNR ISAC Rome Atmospheric Supersite
CIRAS is an atmospheric observatory located in a flat, semi-urban environment at the southern outskirts of Rome, Italy. CIRAS began operating in 1997. Current observations address the study of atmospheric composition, boundary layer dynamics, meteorology, and precipitation. Observational methods involve ground-based and satellite remote sensing plus mobile and fixed air monitoring of atmospheric composition and precipitation.



AERosol moBile LABoratory
In early 2016, an upgraded version of the AEROLAB, the ISAC-Rome AERosol moBile LABoratory, was implemented to carry-out in-depth, field characterization of ambient particulate matter. AEROLAB is mounted within a motorhome van to be easily transferred to any road destination, set-up in 2-3 hours, and run, providing also a comfortable working space.

SCIENTIFIC ISSUES

- Adequacy of the adopted aerosols models with emphasis on contribution of desert dust and biomass burning aerosols (Barnaba & Gobbi 2004);
- Impact of the urban environment and of its spatial inhomogeneity in terms of both surface and atmospheric properties. (Dionisi et al. 2018)
- Impact of different aerosol types at the different levels within the atmosphere by synergism between co-located in situ (surface), vertical-resolved, spatially resolved, and total column measurements



Acknowledgments
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Links
CIRAS: <http://www.isac.cnr.it/en/infrastructures/ciras-cnr-isac-rome-atmospheric-supersite>
<http://oplam.artov.isac.cnr.it/oplam/open-database>
CEILOMETERS NETWORK: www.alice-net.eu, <https://ceilometer.e-profile.eu/>
NDACC: <http://ndacc-llidar.org/> PANDONIA: <http://pandonia.net/>
AERONET: https://aeronet.gsfc.nasa.gov/new_web/index.html
EUROSKYRAD: <http://www.euroskyrad.net/> EUBREWNET: <http://www.eubrewnet.org/cost1207/>

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