P4.6

EarthCARE validation measurements from Italian observatories at two central Mediterranean sites

E. Adirosi, S. Argentini, F. Barnaba, A. Bracci, L. Di Liberto, F. Cairo, M. Campanelli, G. Casasanta, Montopoli, L. Baldini
CNR, Institute of Atmospheric Sciences and Climate, Rome, Italy
G.L. Liberti, G. Giuliano, M. Di Paolantonio, D. Dionisi, *CNR, Institute of Marine Sciences, Rome, Italy*
G. Pace, F. Anello, V. Ciardini, L. De Silvestri, T. Di Iorio, A. di Sarra, P. Grigioni, F. Monteleone, S. Piacentino, C. Scarchilli, D. Sferlazzo, D. Meloni
Laboratory for Observations and Analyses of Earth and Climate, ENEA, Italy
Matteo Picchiani, *Italian Space Agency (ASI), Rome, Italy*

A proposal for coordinating efforts to validate EarthCARE products in 3 atmospheric observatories in Italy is now part of the EarthCARE Validation Team (EVID 11). The observatories are in the island of Lampedusa, more than 100 km from continents (ENEA Station for Climate Observations, 35.5°N, 12.6°E), and in Rome, in the twin sites of Sapienza University (BAQUNIN observatory within the city urban area, 41.90°N,12.50°E), and of Tor Vergata CNR (CIRAS observatory at the Rome SE outskirts, 41.84°N,12.65°E). The 3 observatories can be considered as representative of different Mediterranean climates, namely a clean maritime regime for Lampedusa, and the typical near-coastal urban Mediterranean conditions for Rome, in which the twin sites configuration allows to better investigate the impact of the urban environment.

During the EarthCARE validation rehearsal of 12-23 February 2024, a strategy for collecting correlative EarthCARE measurements has been shaped and relevant examples of correlative measurements are provided and discussed in the poster. During the commissioning and exploitation phases, correlative data collected are expected to automatically feed the Validation Data Center (ECVD) both directly, or through the different networks to which some of the instruments belong. Examples concerning the pre- and post-launch measurements will be shown and critically discussed.

Available devices for direct comparison with EarthCare products in Rome Tor Vergata	Operational mode	Available during rehearsal		Available during EarthCare mission	EarthCare prodcuts
MRR	Automatic	No		Yes	A-ICE, C-TC, C-FMR, C-CD,C-CLD,AC-TC,ACM.CAP
Disdrometer	Automatic	Yes		Yes	C-TC, C-FMR, C-CLD, AC-TC
Wind lidar	Automatic	Yes		Yes	A-FM, A-AER, A-EBD, A-ALD, A-TC, A-CTH, C-TC, AM-ACD, AM-CTH
SKYNET photometer	Automatic	Yes		Yes	A-FM, A-TC, M-AOT, AM-ACD, AC-TC
AERONET photometer	Automatic	Yes		Yes	A-FM, A-TC, M-AOT, AM-ACD, AC-TC
All sky camera	Automatic	No		Yes	A-FM, M-CM
Raman-Mie-Rayleigh Lidar	On-demand	No		Yes	A-FM, A-AER, A-EBD, A-ALD, A-ICE, A-TC, A-CTH, M-CM, M-COP, CTC. AM-CTH, AC-TC. ACM-CAP, ACM-CPM
C-band Doppler weather radar	On-demand	No		To be fixed	A-ICE, C-TC, C-FMR, C-CD, C-CLD, AC-TC, ACM-CAP
CHM15k celiometer	Automatic	Yes		To be fixed	A-FM, A-AER, A-ALD, A-TC, A-CTH, C-TC, AM-ACD, AM-CTH,
Available devices for direct comparison with EarthCare products Lampedusa		**Available during rehearsal**		**Available during EarthCare mission**	**EarthCare prodcuts**
Raman-Mie-Rayleigh Lidar	On-demand	Yes		Yes	A-FM, A-AER, A-EBO, A-ALD, A-ICE, A-TC, A-ACTH, M-CM, M-COP, C-TC, AM-CTH, AC-TC, ACM-CAP, ACM-COM
Cloud Doppler Radar 35 GHz	Automatic	Yes		Yes	C-TC, C-FMR, C-CD, C-CLD,
Disdrometer	Automatic	Yes		Yes	C-TC, C-FMR, C-CLD, AC-TC
CHM15k celiometer	Automatic	Yes		Yes	A-FM, A-AER, A-ALD, A-TC, A-CTH, C-TC, AM-ACD, AM-CTH,
AERONET photometer	Automatic	Yes		Yes	A-FM, A-TC, M-AOT, AM-ACD, AC-TC
All sky camera	Automatic	Yes		Yes	A-FM, M-CM
MWR HATPRO RPG	Automatic	Yes		Yes	A-TC, M-COP, C-CLD, AC-TC, ACM-CAP

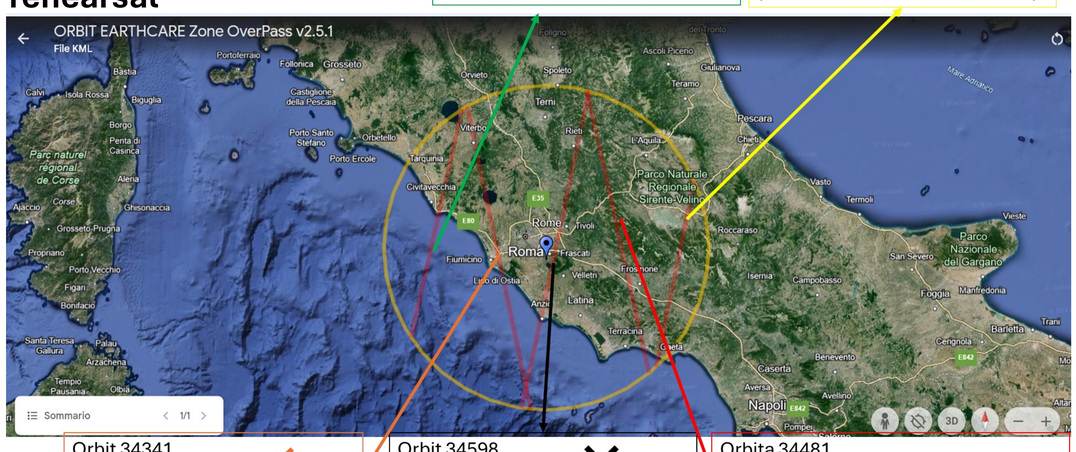
Ground-based instruments installed at Rome (left) and Lampedusa (right) sites

Measurements at the Tor Vergata CNR site, Rome

Overpasses during rehearsal

Orbit 34458
distance 71.2 km
(start time 2024-02-23T13:37:51) ✓

Orbit 34349
distance 82.5 km
(start time 2024-02-16T13:30:33) ✓



Orbit 34341
distance 29.8 km
(start time 2024-02-16T00:45:27) ✓

Orbit 34598
distance 5.4 km
(start time 2024-03-03T13:34:07) ✗

Orbita 34481
(distance 46.3 km
(start time 2024-02-25T00:41:48) ✗

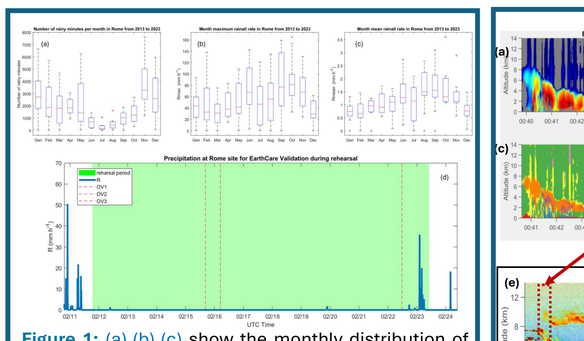
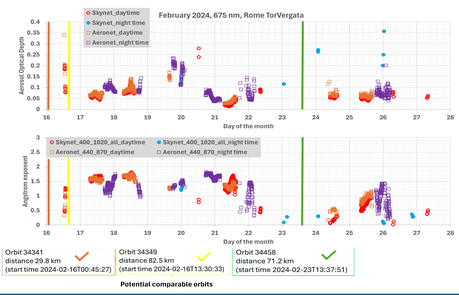
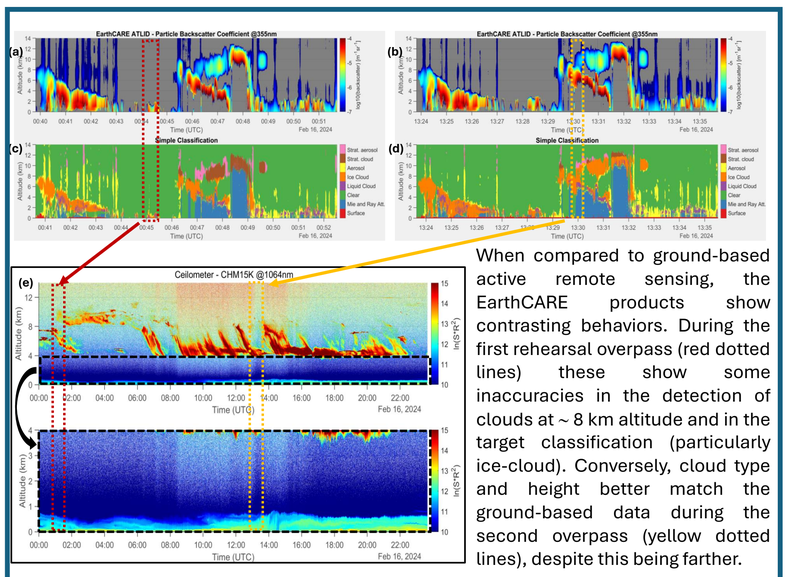


Figure 1: (a),(b),(c) show the monthly distribution of rainy minutes, maximum and mean rainfall rate, obtained from more than 10 years of disdrometer data in Rome. (d) Time series of rainfall rate (blue line) during the rehearsal (the 3 overpasses are the dashed red lines).

Figure 2: Time behaviour of Aerosol optical depth at 675 nm and Ångström exponents from the two co-located Skynet and Aeronet sun-sky-moon photometers





When compared to ground-based active remote sensing, the EarthCARE products show contrasting behaviors. During the first rehearsal overpass (red dotted lines) these show some inaccuracies in the detection of clouds at ~ 8 km altitude and in the target classification (particularly ice-cloud). Conversely, cloud type and height better match the ground-based data during the second overpass (yellow dotted lines), despite this being farther.

Figure 3: (a)(b) show ATLID Particle Backscattering Coefficient (355 nm) during the two overpasses. (c)(d) show the relevant target Classification. (e) depicts measurements from the ground-based lidar-ceilometer for a qualitative comparison with ATLID.

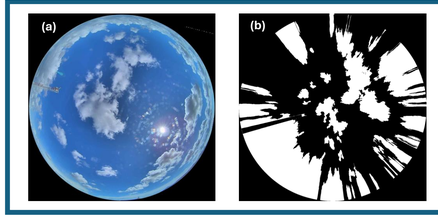


Figure 4: Example image taken by the ASI-16 All Sky Imager installed at CIRAS on 24.04.2024. Panel (a) and (b) shows the original photo and the binary mask as evaluated by the cloud analysis algorithm, respectively. The overall cloud fraction estimated is 0.42.

Figure 5: Wind-lidar measurements during EarthCARE overpasses over Tor Vergata CNR Site on 16 February 2024.

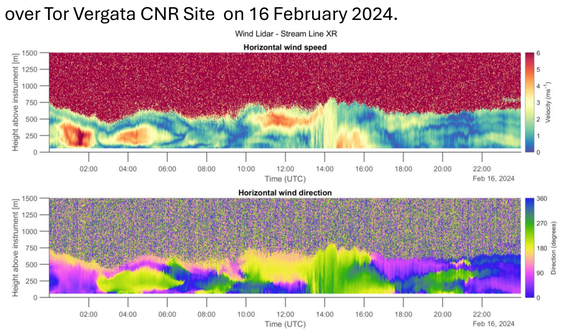
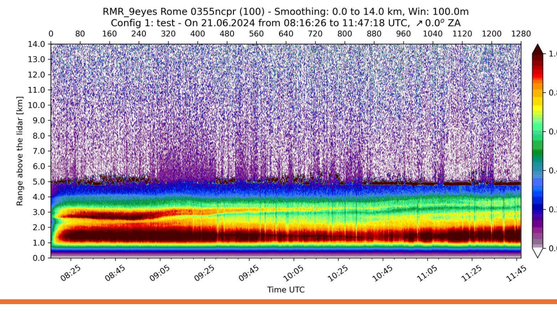


Figure 6: First lidar measurements from the upgraded Rayleigh-Mie-Raman lidar system at Tor Vergata CNR Site. Shown is the contour of range corrected signal measured on **21 June 2024** by the 355 nm near range channel.



Measurements at the ENEA Lampedusa site

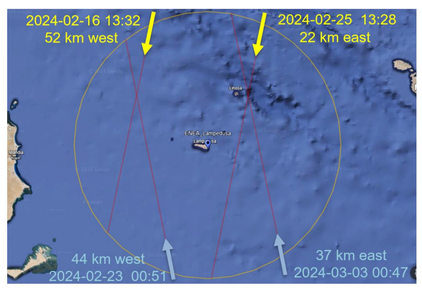


Figure 1: EarthCARE overpasses around Lampedusa island during the rehearsal campaign

During the rehearsal campaign all the instruments were operative. The overpasses closest to the Lampedusa station are shown in Figure 1.

We present an example of analysis of the measurements collected during one simulated overpass of the rehearsal campaign, on 16 February 2024.

The atmospheric conditions around the simulated EarthCARE overpass were characterized by the presence of two distinct cloud layers, as depicted in Figure 2.

Figure 3 shows an example of comparison of the simulated EarthCARE liquid water path (LWP) product and the ground-based measurements.

The vertical profiles of cloud parameters derived from the synergy of ceilometer, Doppler radar, and microwave radiometer are depicted in Figure 4. The two cloud layers contain ice, with a very little presence of liquid water. The presence of some aerosol below 1.5 km is shown by the ceilometer profile.

Figure 5 provides an example of the synergistic analysis of the column AOD and the ceilometer vertical profile applied to a recent case of Saharan dust intrusion on 18 June 2024. The vertical profile of the extinction coefficient at 1064 nm is derived by fixing the lidar ratio value derived using the AERONET photometer AOD.
The AOD at the wavelengths closest to those of EarthCARE (865 and 670 nm) and the Ångström exponent are depicted in Figure 6.

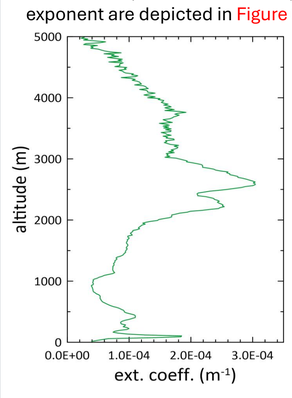


Figure 5: 1-hour (16-17 UT) averaged vertical extinction profile at 1064 nm derived from ceilometer measurements on 18 June 2024

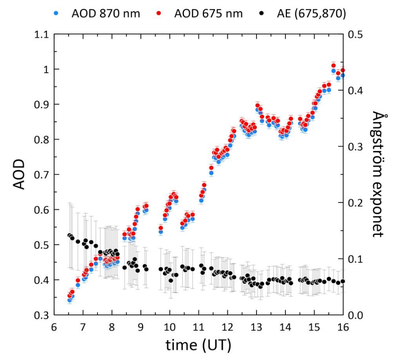


Figure 6: Aerosol optical depth at two EarthCARE wavelengths and Ångström exponent during the Saharan dust event on 18 June 2024. The associated uncertainty is shown.

Figure 2 shows the two cloud layers, one between 4.5 and 6.5 km, and the other between 9.5 and 10.5 km.

The variability of the cloud cover fraction and images of the sky are also shown.

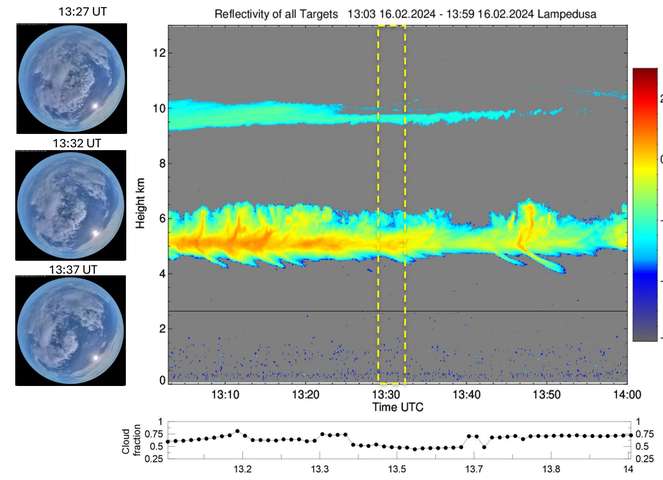


Figure 2: Radar reflectivity on 16 February 2024. The dotted yellow lines show the 10 minutes interval centred over the simulated EarthCAREoverpass. Cloud cover measured by the sky imager is also show at the bottom of figure. On the left, three images at 13:27, 13:32 and 13:37 are shown.

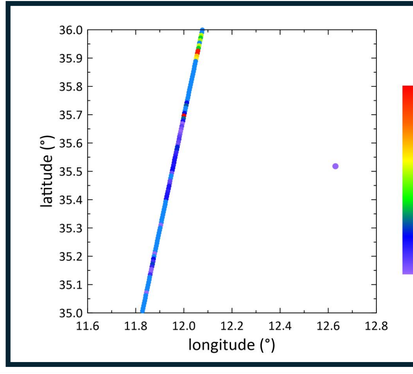


Figure 3: Simulated LWP along the EarthCARE overpass on 16 February 2024 and the corresponding Hatpro radiometer measurement averaged in the 13:27-13:37 interval.

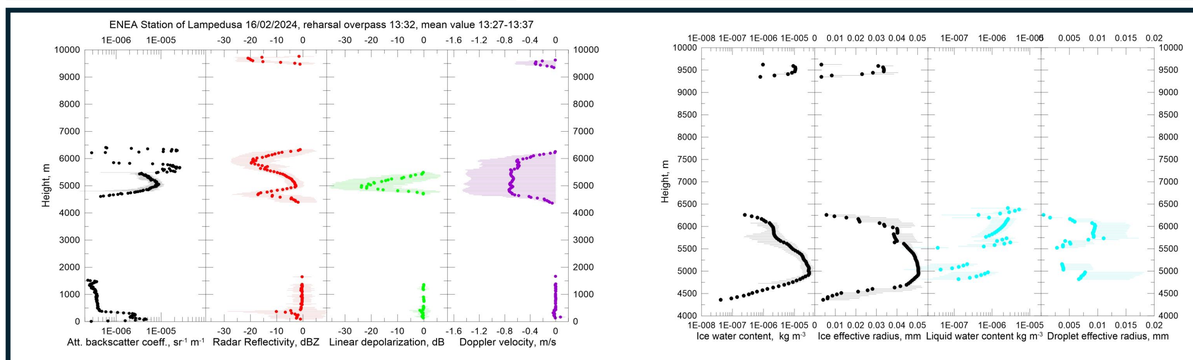


Figure 4: Vertical profiles of cloud properties on 16 February 2024. Mean values of vertical profiles of 10 minutes centred over the overpass time, 13:22 UT, are shown with the associated variability estimated as standard deviation.

Future activities

- There is a **commitment to provide correlative measurements for EarthCARE overpasses** in Rome and Lampedusa sites **improving the meausurement capability** with respect to rehearsal (e.g. availability of upgraded Rayleigh-Mie-Raman lidar system and radar facilities at the Tor Vergata CNR Site).
- Comparing ground and satellite measurements is not straightfordward for the uncertainties involved these being specific of the different targeted geophysical parameter. A goal is also to **disentangle contributions to uncertainty** related to: a) instrumental aspects, b) retrieval methods, c) difference in sampling, d) space-time autocorrelation of measurements (lack of colocation of measurements, **see poster 4.6**), e) site specific aspects.
- Of particular interest are the **new geophysical parameters estimated from space by EarthCARE**, such as those derived from Doppler radar measurements.

Acknowledgments

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a) ESA EarthCARE validation project "An Italian coordinated contribution to the Validation of EarthCARE products from three atmospheric observatories in the Central Mediterranean Sea" (EVID 11)

b) EC-VALMED.it (Contribution to EarthCARE products VALidation during the commissioning phase from atmospheric observatories in Central MEDiterranean in Italy) funded by the Italian Space Agency (ASI)

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