The European preparation activities for the EarthCARE validation in the framework of ACTRIS/ATMO-ACCESS

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Abstract: ACTRIS-related preparations for the validation of EarthCARE have been organized under the EU project ATMO-ACCESS, a project working on sustainable access models for atmospheric research facilities. Specifically, a dedicated pilot access activity has been initiated for international stakeholders such as ESA and EUMETSAT, towards developing ACTRIS Cal/Val services. The preparation activities for EarthCARE are foreseen to make the participating facilities, including stationary and mobile platforms, ready to validate EarthCARE's complex, synergistic products in its short commissioning phase directly after launch and then continue the validation until the end of the mission. In this contribution, we present an overview of the pilot activity, including preparation status and first results from the planned rehearsal campaign.

1. Introduction

The Earth Cloud Aerosol and Radiation Explorer (EarthCARE) is a satellite mission implemented by the European Space Agency (ESA) in cooperation with the Japan Aerospace Exploration Agency (JAXA) to measure vertical profiles of aerosols, clouds, and precipitation properties together with radiative fluxes. This Earth Explorer Mission is scheduled for launch in May 2024 and will perform observations of the atmosphere using a high spectral resolution lidar, a Doppler cloud radar, a multi-spectral imager and a broadband radiometer [1]. It can thus be considered as a space-based equivalent of an ACTRIS aerosol and cloud remote sensing observatory.

The Aerosol, Clouds and Trace Gases Research Infrastructure (ACTRIS) is the pan-European research infrastructure producing high-quality data and information on short-lived atmospheric constituents and on the processes leading to the variability of these constituents in natural and controlled atmospheres. It includes high quality aerosol and cloud remote sensing facilities. Many stations of the European Lidar Network EARLINET [2] and of the European Cloud profiling network Cloudnet [3] are meanwhile part of ACTRIS.

ATMO-ACCESS is a pilot project by the European Commission to address the needs for developing sustainable solutions based on the principles of open access for efficient and effective access provision suited to distributed atmospheric Research Infrastructures – like ACTRIS. In the framework of the ATMO-ACCESS pilot activities for internal stakeholders, a project has been initiated to support the validation of the ESA EarthCARE data products.

2. The project

To meet the extensive validation needs of these novel spaceborne observations, the ATMO-ACCESS pilot scheme was utilized for a dedicated project, resulting in a consortium of 48 participating observatories plus the ACTRIS central facilities, i.e., the ACTRIS Topical Centres CARS & CCRES and the ACTRIS Data Centre Units CLU & ARES. A sketch of the 16-month activity is shown in Fig. 1.

Starting in June 2023, preparation activates took place to be ready for an intense rehearsal campaign to test the newly implemented work

flow in autumn of the same year– more details in Sec. 3.

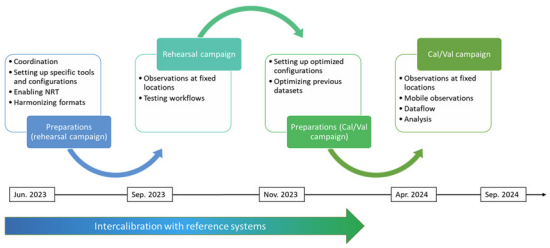

Fig. 1. Time line for the pilot activity with respect to EarthCARE validation.

. Afterwards, an intense analysis and optimization has been taken place before the real Cal/Val campaign is planned to start with the launch of EarthCARE in spring 2024. In parallel to these preparations, intercalibration activities with ESA reference lidars and MPLNet have been scheduled.

To achieve these goals, not only observational platforms (OP – fixed stations) and mobile platforms (MP) but also ACTRIS central facilities (namely the topical centres and data centre units for the specific components of aerosol remote sensing ARS and cloud remote sensing CRS) were part of this initiative as illustrated in Figure 2.

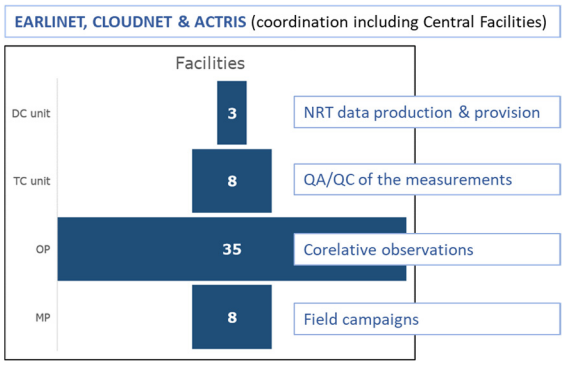

Figure 2. Overview of involved facilities for the ATMO-ACCESS pilot activity and their respective tasks.

3. Rehearsal campaign

A rehearsal campaign using simulated overpasses of EarthCARE (as seen in Fig. 3) was performed from October to November 2023 to test the established workflow and identify potential for improvements.

During the 2-month rehearsal campaign, the ACTRIS aerosol and cloud remote sensing facilities and some associated facilities (like MPLNet stations [4] or mobile UAV-in-situ facilitates [5]) performed observations according to a specific schedule defined by simulated overpasses.

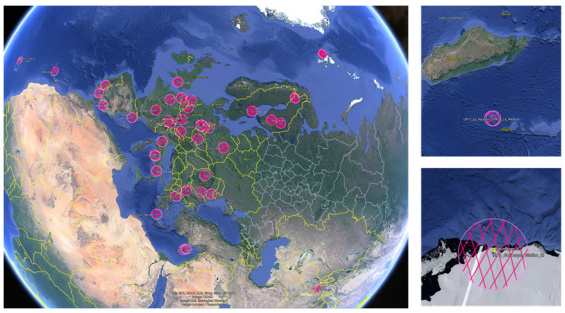

Figure 3: Simulated overpasses for participating stations within a radius of 100 km around the site as used for the rehearsal campaign.

An overview of the 2-month campaign by means of performed and uploaded measurements (to the data centres) is shown in Fig. 4.

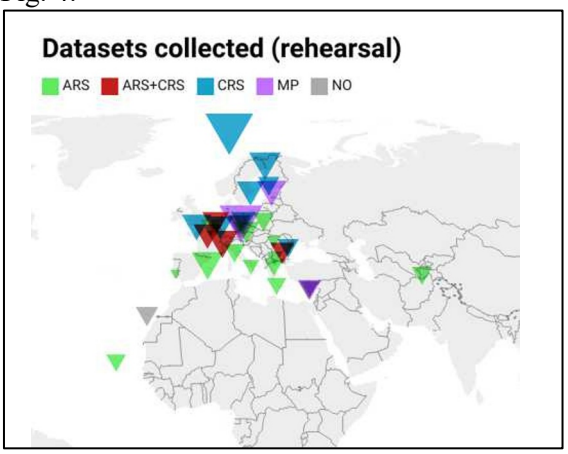

Figure 4: Visual representation of data sets collected during the rehearsal campaign in October and November. ARS and CRS are the aerosol and cloud remote sensing components, respectively. MP are ACTRIS mobile platforms and “NO” are associated measurements, e.g., from MPLNet or UAV.

Naturally, due to the time of the year in European autumn, many cloud observations have been collected in the northern and central part of Europe, while aerosol remote sensing observations are mainly available in the Mediterranean and at the outside-Europe ACTRIS stations in the tropical Atlantic and Central Asia.

Also, mobile facilities participated already in the rehearsal, to mention particularly the ACTRIS mobile facility OCEANET which was at this time operating in Antarctica and also the uncrewed automated vehicles (UAV) for in-situ

aerosol collection in Cyprus. An overview of the collected data sets separated by operational and mobile facilities and their focus atmospheric species is given in Fig. 5.

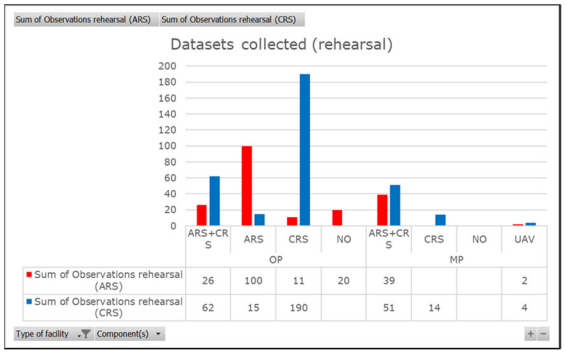

Figure 5. Number of data sets collected and uploaded to the ACTRIS Data Centres with respect to aerosol remote sensing (ARS), cloud remote sensing (CRS) separated by fixed observational platforms (OP) and mobile facilities (MP) including UAV flights.

Most of the cloud remote sensing (cloud profiling) data were already delivered to EVDC in near-real-time during the whole rehearsal period. The complex QA/QC and central processing for lidars (ARS) delayed the process at the beginning of the rehearsal, but data were still made accessible to EVDC. On the EVDC side, it was demonstrated that an ACTRIS harvester system was successfully set up and operated according to plan, which proves the concept of the established workflow.

In the time until launch, further optimization of the configuration, workflows and quality control procedures will take place before the real validation activities start with the launch of EarthCARE.

4. Conclusions and Outlook

In conclusion, ACTRIS and its collaborators could show within this ATMO-ACCESS initiative already its potential as an operational research infrastructure for satellite validation applications.

The coordinated EarthCARE Cal/Val preparation by ACTRIS facilities and stations, including associated EARLINET and Cloudnet stations, has achieved ‘validation readiness’ already months prior to launch and thus can immediately start with correlative measurements once EarthCARE instruments are switched on in orbit.

The real validation activities will start a few weeks after launch and will include the deployment of mobile facilities directly under the EarthCARE orbit and also limited validation data analysis. Unfortunately, the pilot activity will end already in 2024, but given the successful operation and the convincing results, efforts to continue such efforts are on the way.

5. Acknowledgements

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6. References

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7. Appendix - list of participating platforms

#	Site	Country	Facility/Institution	Component	Lat	Lon	Alt (m)
1	Antikythera	Greece	PANGEA	ARS	35.86	23.31	193
2	Barcelona	Spain	Barcelona lidar station	ARS	41.39	2.12	115
3	Bucharest	Romania	RADO-Bucharest	ARS+CRS	44.34	26.01	83
4	Bujassot	Spain	University Valencia	ARS	39.50	-0.42	30
5	Cabauw	Netherlands	Cabauw	ARS+CRS	51.97	4.93	-1
6	Chilbolton	UK	NCAS	CRS	51.14	-1.44	85
7	Cluj	Romania	RADO-Cluj	ARS	46.77	23.58	352
8	Dushanbe	Tajikistan	TROPOS	ARS	38.56	68.86	864
9	El Arenosillo	Spain	ARN	MPLNet	37.10	-6.70	59
10	Eriswil	Switzerland	LACROS	ARS+CRS	47.07	7.87	921
11	Evora	Portugal	EVASO	ARS	38.58	-7.91	290
12	Galați	Romania	RADO-Galati	CRS	45.44	28.04	40
13	Granada	Spain	AGORA	ARS+CRS	37.16	-3.61	680
14	Hohenpeißenberg	Germany	DWD	ARS	47.80	11.00	974
20	Kosetice	Czech R.	NAOK	ARS	49.57	15.08	536
21	La Reunion	France	OPAR-Moufia	ARS	-20.90	55.49	84
22	La Reunion	France	OPAR-Maïdo	other	-21.08	55.38	2160
23	Leipzig	Germany	TROPOS	ARS	51.35	12.44	126
24	Leipzig LIM	Germany	LIMMACO	CRS	51.33	12.39	125
25	Lille	France	ATOLL	ARS	50.61	3.14	32
26	Limassol	Cyprus	CARO	ARS+CRS	34.68	33.04	3
27	Lindenberg	Germany	DWD	CRS	52.21	14.12	104
28	Madrid	Spain	CIEMAT	ARS	40.46	-3.73	669
29	Melpitz	Germany	TROPOS	ARS+CRS	51.53	12.93	83
30	Mindelo	Cabo Verde	CVAO	ARS+CRS	16.88	-25.00	13
31	Neumayer Station III	Antarctica	OCEANET	ARS+CRS	-70.64	-8.27	20
32	Nicosia	Cyprus	CAO	UAV+ other	35.14	33.38	180
33	Norunda	Sweden	Norunda	CRS	60.09	17.48	46
34	Ny-Ålesund	Norway	University Cologne	CRS	78.93	11.93	19
35	Ny-Ålesund	Norway	AWI	ARS	78.9	11.92	19
36	Orounda	Cyprus	USRL, Cyprus	UAV	35.10	33.08	330
37	Palaiseau	France	SIRTA	ARS+CRS	48.72	2.21	156
38	Pallas	Finland	FMI	CRS	68.00	24.20	345
39	Payerne	Switzerland	PAY	ARS+CRS	46.81	6.94	491
40	Potenza	Italy	CIAO	ARS+CRS	40.60	15.72	760
41	Puy de Dôme	France	COPDD	ARS	45.76	3.11	410
42	Rome	Italy	ARTE	ARS	41.88	12.68	107
43	Rome	Italy	AEROLAB+CIRAS	Other	41.9	12.51	75
44	San Pietro Capo	Italy	CMN-PV	ARS	44.19	10.70	2165
45	Sofia	Bulgaria	Sofia, Bulgaria	ARS	42.65	23.39	620
46	Thessaloniki	Greece	Thessaloniki, Greece	ARS	40.63	22.95	60
47	Vehmasmäki/Kuopio	Finland	FComLab	ARS+CRS	62.74	27.54	190
48	Warsaw	Poland	University Warsaw	ARS	52.21	20.98	112