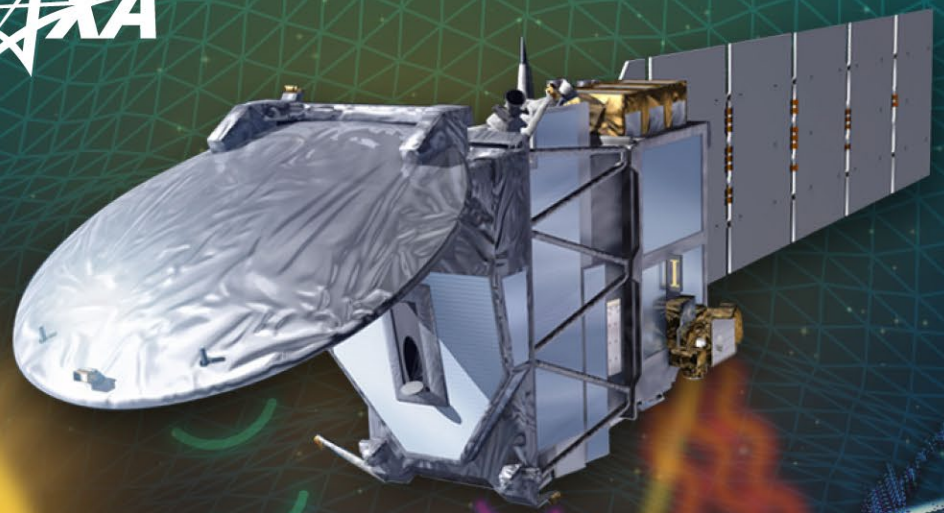


ESA-JAXA Pre-Launch EarthCARE Science and Validation Workshop

13 – 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

ACROSS: EarthCARE Cal/Val experiment in the Mediterranean

E. Marinou and the ACROSS team

National Observatory of Athens, Greece

ACROSS need and objectives

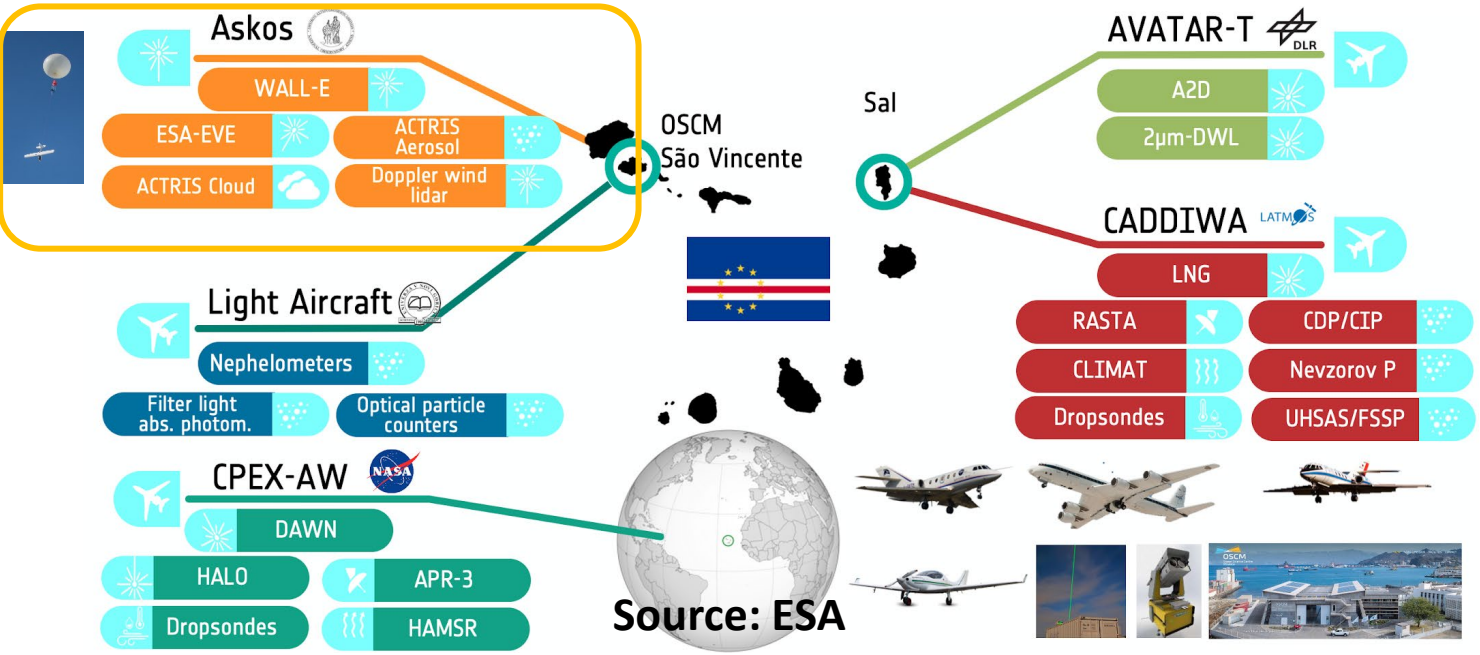
EarthCARE needs strong sub-orbital synergies to address Cal/Val and science objectives

The Mediterranean basin provides the complex aerosol-cloud environment needed to exploit EarthCARE capabilities

ACROSS is a proposition for an extended experiment that would increase synergies towards achieving the following objectives:

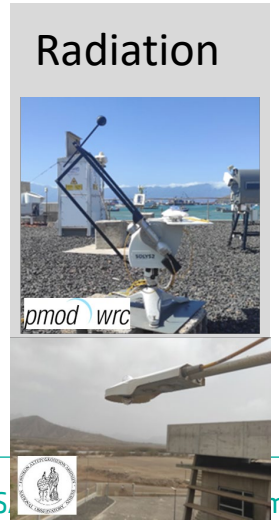
1. **Validate the EarthCARE aerosol and cloud products using state-of-the-art ground-based and airborne facilities**
2. **Implement science studies targeting radiation closures, ACI, and data assimilation experiments**
3. **Provide information for harmonizing and bridging past and future missions, to deliver Climate Data Records on aerosols and clouds**

JATAC campaign for Aeolus & pre-EarthCARE (2021&2022)



ASKOS Science Objectives:

- **Aeolus Validation using** an unprecedented amount of quality assured datasets
- **Science** (e.g., dust effect on cloud formation, radiation, deposition)



In situ measurements onboard UAVs

OPCs measurements (0.1 – 80 µm)
GPAC Impactor sampling (up to 100 µm)
Collected samples for chemical analysis

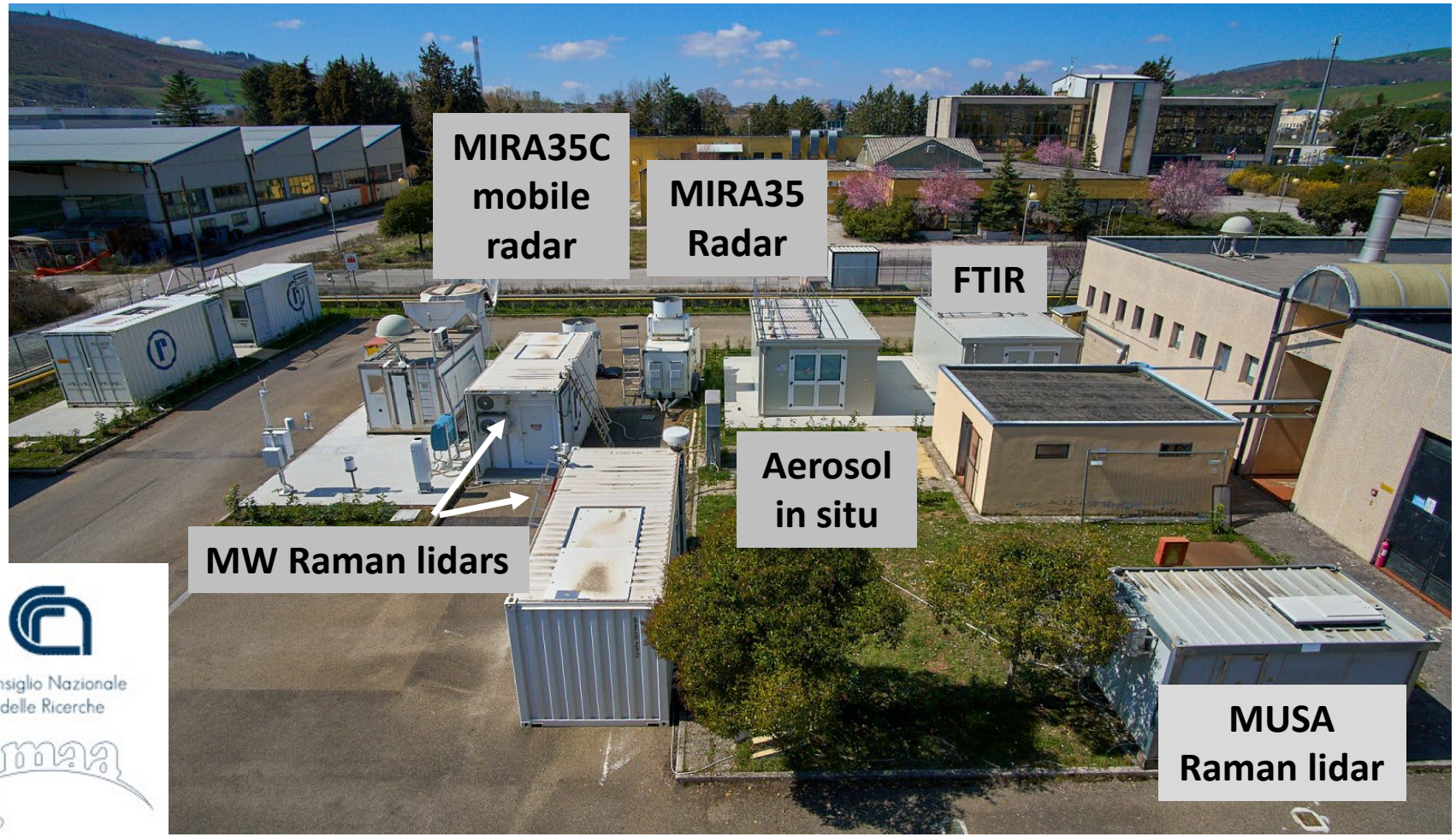
ACROSS Mediterranean campaign locations

3 Intensive Observational Periods of 3 months each, including targeted large-scale field experiments in the Mediterranean

Set up will follow ASKOS example:

- ACTRIS Aerosol and Cloud remote sensing facilities in Potenza/Italy, Cyprus and PANGEA/Greece.
- Radiation remote sensing measurements for closure studies
- UAV in-situ flights collocated with the RS measurements

ACROSS Campaign: CNR-IMAA Aerosol and Cloud facility



Consiglio Nazionale delle Ricerche

imaa

- ACTRIS Aerosol & Cloud remote sensing facilities
- Aerosol in situ
- FTIR

+ mobile cloud radar

ACROSS Campaign: TROPOS, CyI, Eratosthenes Center facilities

TROPOS
Leibniz Institute for Tropospheric Research

ACTRIS Aerosol & Cloud remote sensing facilities

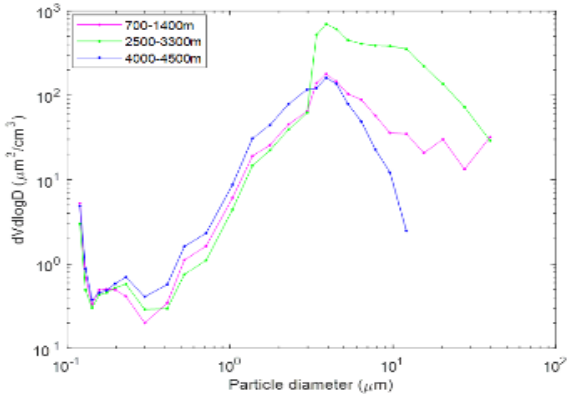
Airborne measurements
Reaching altitudes > 5 km ASL

The Cyprus Institute

Skywalker UAV

GPAC Impactor sampling (up to 100 µm)

POPs & UCASS OPCs measurements (0.1 – 80 µm)



ACROSS Campaigns: PANGEA Aerosol, Cloud radiation facilities

PANGEA observatory

Background conditions representative for the Mediterranean

PollyXT lidar

+ eVe lidar scanning mobile platform, placed under an EarthCARE cross point

Cloud radar

Radiometer

Pyranometer

MWR

Aeronet

- ACTRIS Aerosol and Cloud remote sensing
- Longwave and Shortwave radiometers

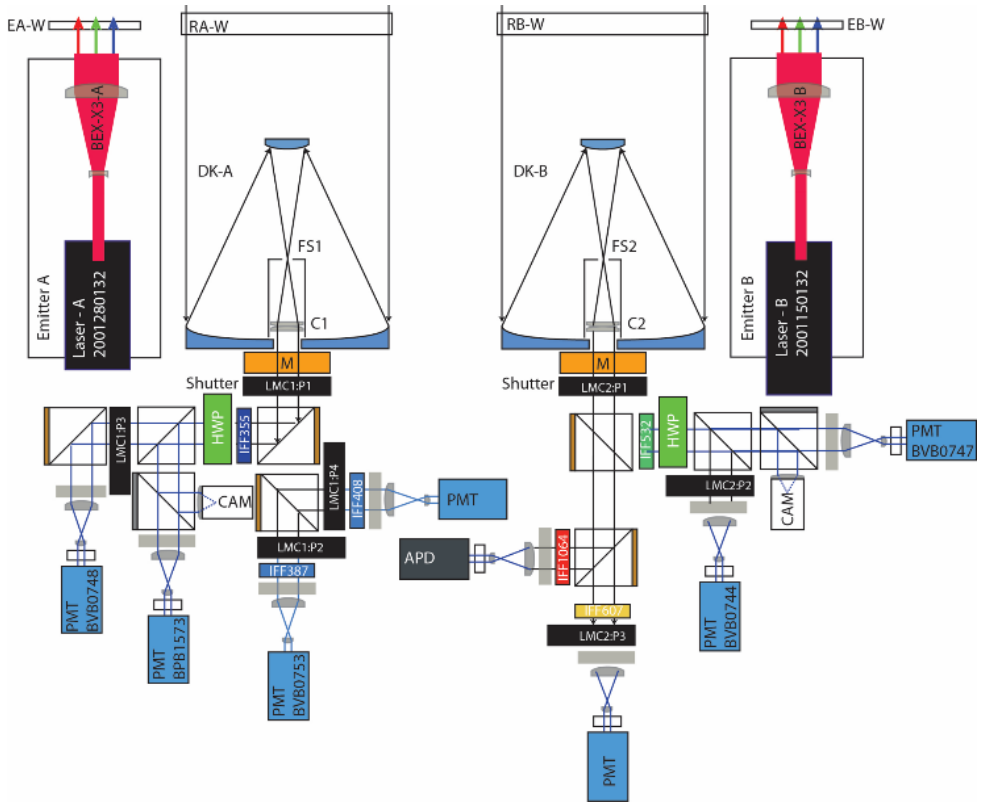
eVe lidar upgrade & intercomparison with reference systems

Plans:

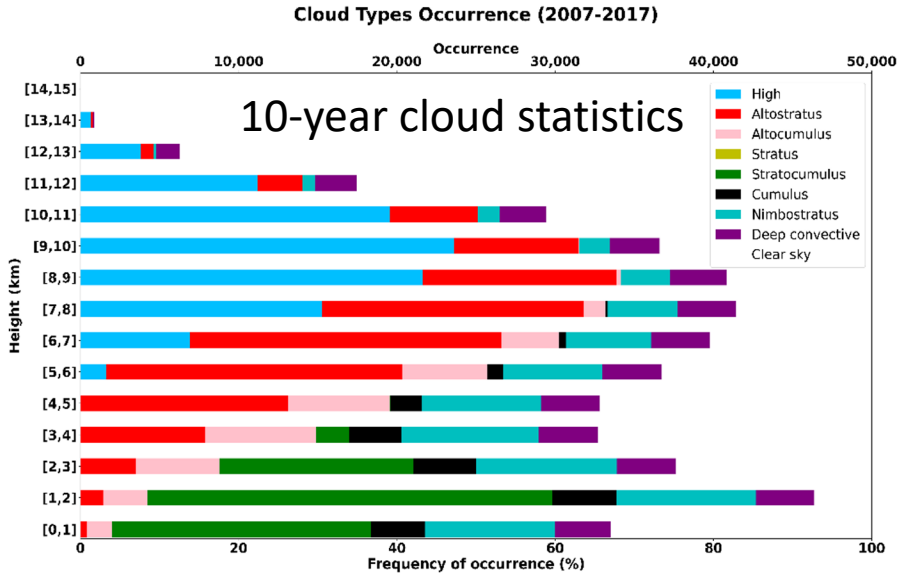
- upgrade eVe towards a lidar tailored for the Cal/Val of ALTID lidar
- investigate the possibility of setting a Fiducial Reference Measurement (FRM) standard for lidar extinction and respective QA/QC products

Status/Next steps:

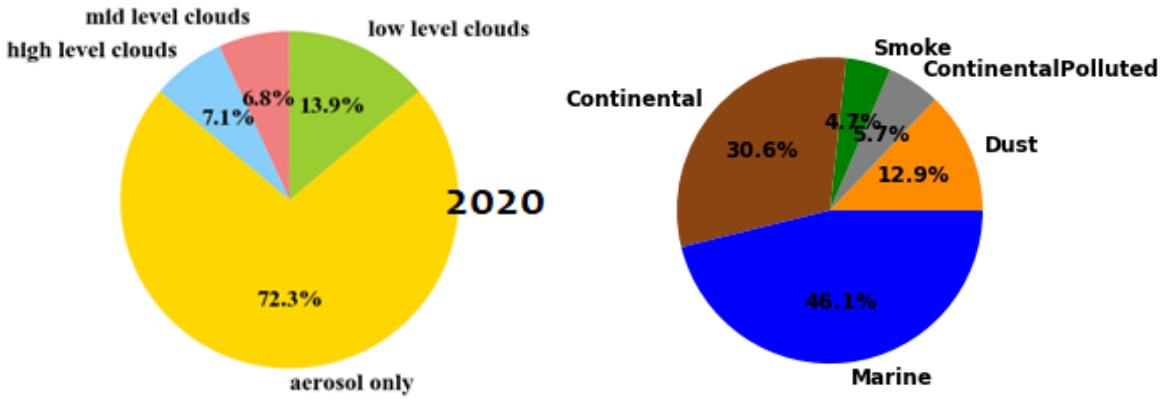
- Ongoing discussions with ESA and industry for the upgrade of eVe lidar towards enhancing the ATLID/EarthCARE Cal/Val
- Plans for characterization of the system against ACTRIS reference lidar system based to ACTRIS QA standards by summer 2024



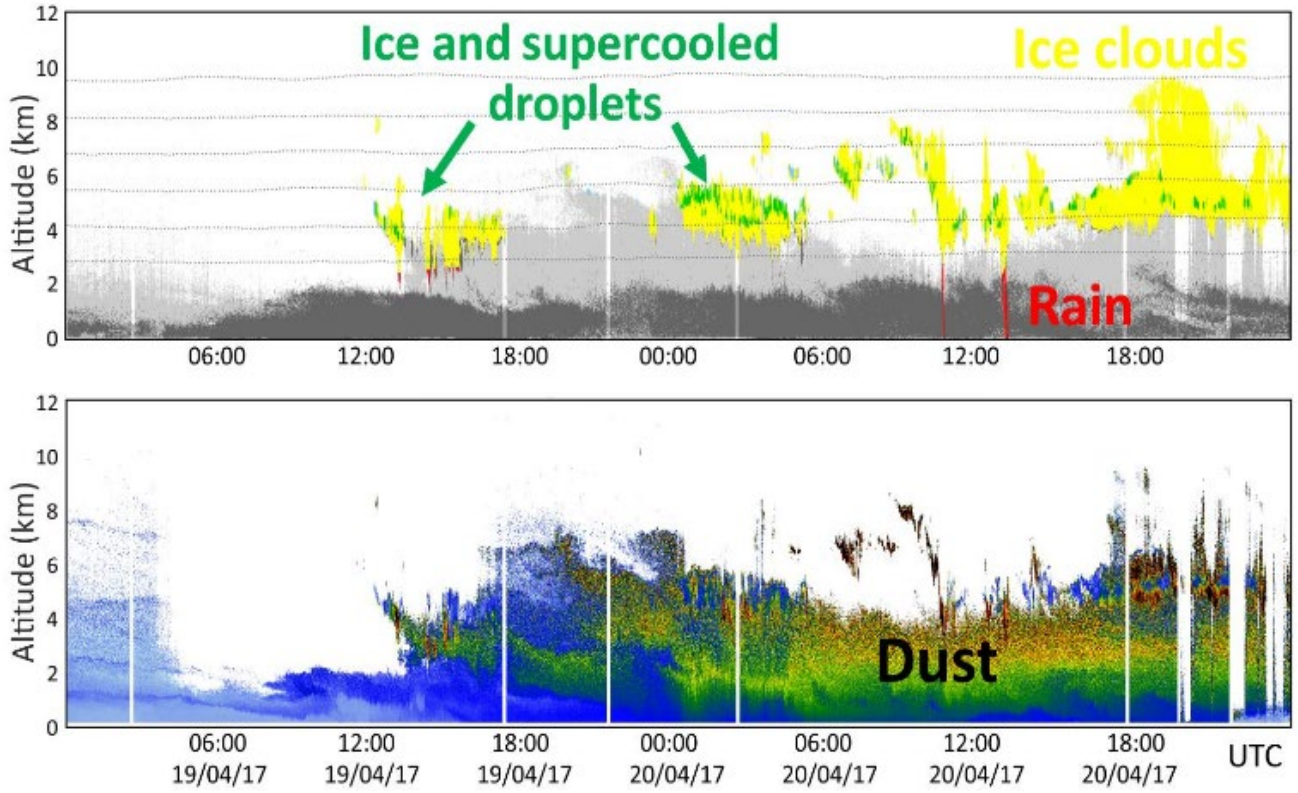
Aerosol & Cloud occurrence in PANGEA



Aerosol & Cloud abundance in Spring



Dust – Cloud interactions



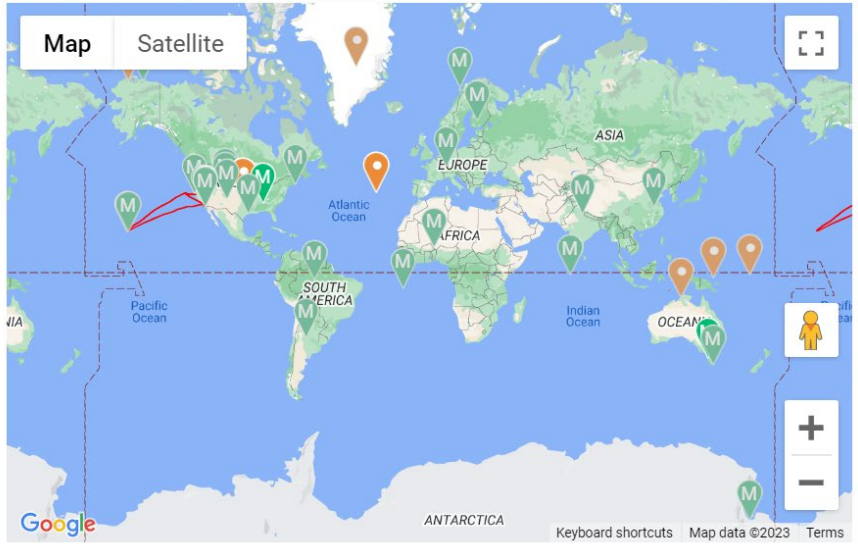
Opportunity to enhance ACROSS with ARM instrumentation

New call for proposals for field campaigns has been launched yesterday!

The ACROSS partners aim to submit a proposal to ARM

Time window: September 2026 – October 2027

OBSERVATORY LOCATIONS AT A GLANCE



MARKER DEFINITIONS

- ARM site
- ARM site – inactive
- Mobile site
- Mobile site – inactive

USING THE MAP

- Pan and zoom using buttons in bottom right corner.
- Mouse over a marker to view observatory name.
- Click on a map marker to zoom in on an observatory and view more information.
- Double-click anywhere on map to return to global view.

Preproposals Now Being Accepted!

Submit a preliminary proposal today for a field campaign using the

Atmospheric Radiation Measurement (ARM) User Facility

- Atmospheric observatories in Alaska, Oklahoma, and the Azores
- Mobile observatory can be deployed to a domestic, international, or ship-based location
- Freely available data

Deadline February 9, 2024

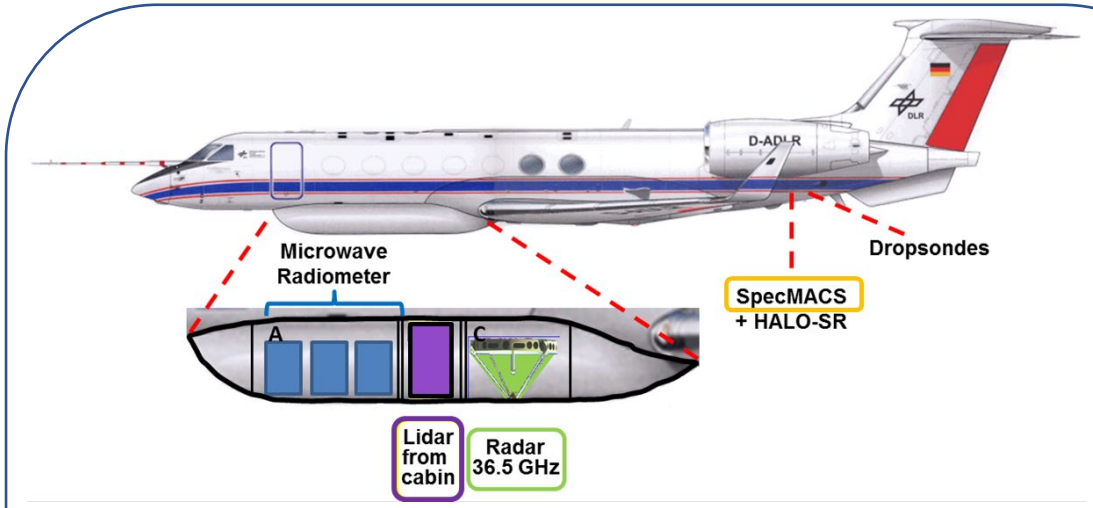
ARM

www.arm.gov

ACROSS airborne activities: DLR

EarthCARE-related measurements on HALO

Silke Gross and DLR team: Autumn 2024



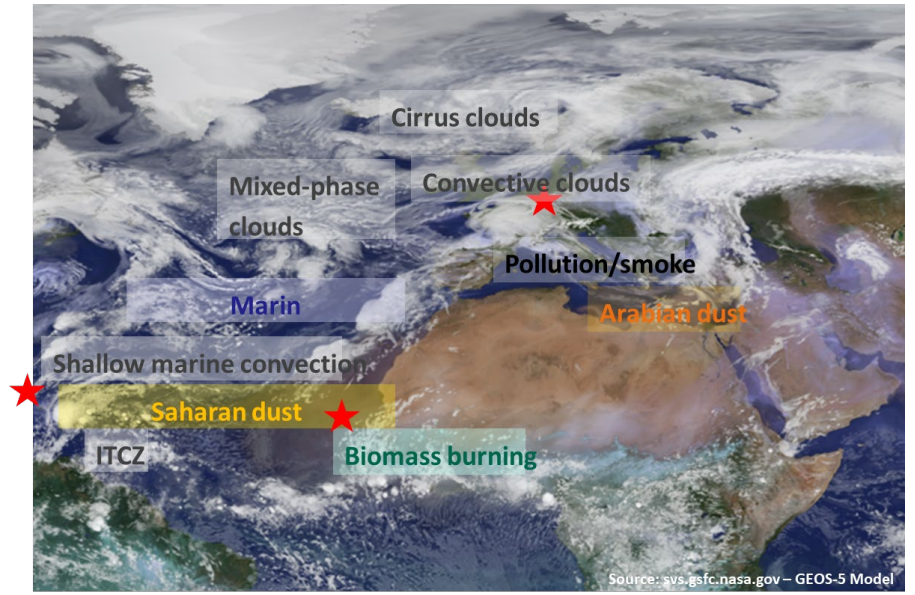
Instrumentation:

HSRL-Lidar (WALES) + WV DIAL

Cloud-Profiling Radar (MIRA35)

Hyper-Spectral Imager (specMACS) / VELOX

Microwave Radiometer (HAMP)



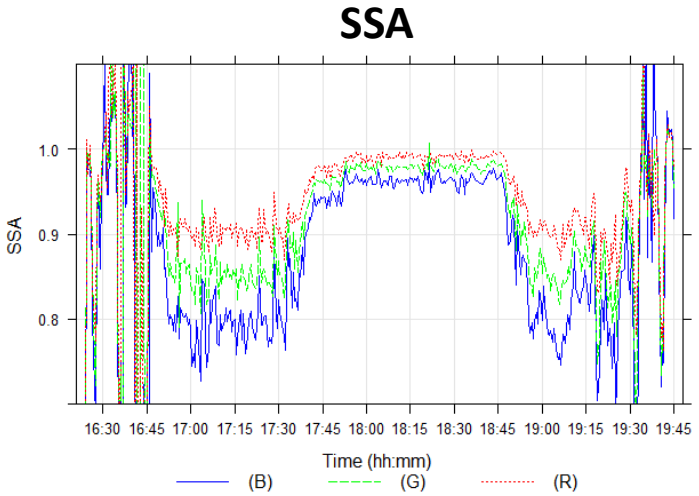
Dedicated validation flights out of Oberpfaffenhofen:

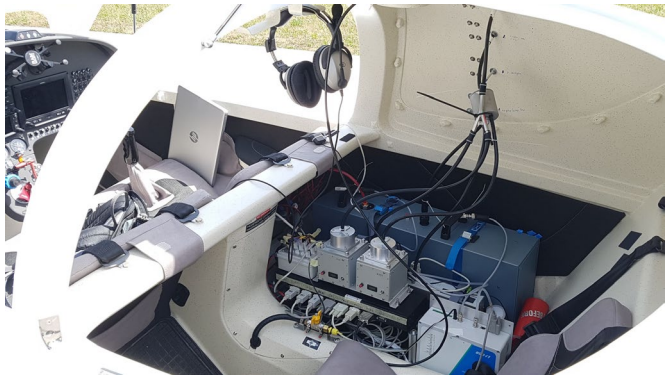
- Overpasses over ground stations (e.g. ACROSS – PANGEA)
- Characterization of general measurement situation

ACROSS airborne activities

ACROSS will be enhanced with additional measurements in the broader area in Spring/September 2025/2026

Griša Močnik: light aircraft with **airborne** **in-situ @ 0 – 3 km, absorption, scattering, collected samples, solar irradiance.**





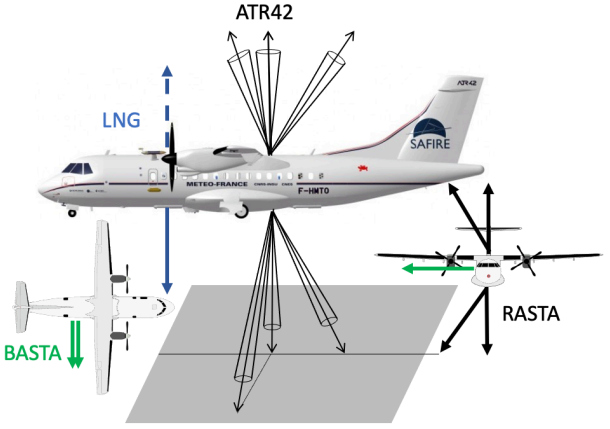
Hugh Coe, Philip Stier, Kamil Mroz: airborne **in situ measurements, W-band radar, wind lidar, elastic backscatter lidar, available in 2026 & 2027**

Airborne overflights during ACROSS

Enhanced with airborne measurements in the broader area in Spring/September 2025/2026

Julien Delanoë, Cyrille Flamant: Airborne payload similar to **MAESTRO/THINICE** i.e., **HSRL/backscatter lidar (3b+α+δ), RASTA/BASTA 95GHz Doppler radars, SW & LW radiation, Aerosol and cloud in situ, ATR42 available in Spring 2025 (April & May), Spring 2026 (March – Mid June), September 2026.**

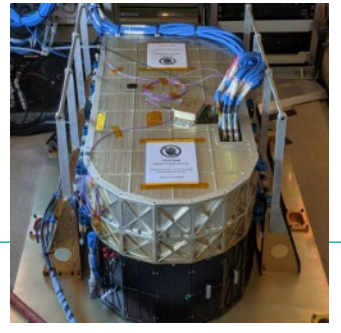
https://rali.aeris-data.fr



ATR42 - SAFIRE

Chris Hostetler, Simone Tanelli, Ed Nowottnick: Airborne measurements with **HSRL2 lidar (3b+2α+3δ), APR-3 radar (13, 35, and 94 GHz) Doppler dual-polarization radar system, RSP polarimeter, available 2026 /2027.**

HSRL-2



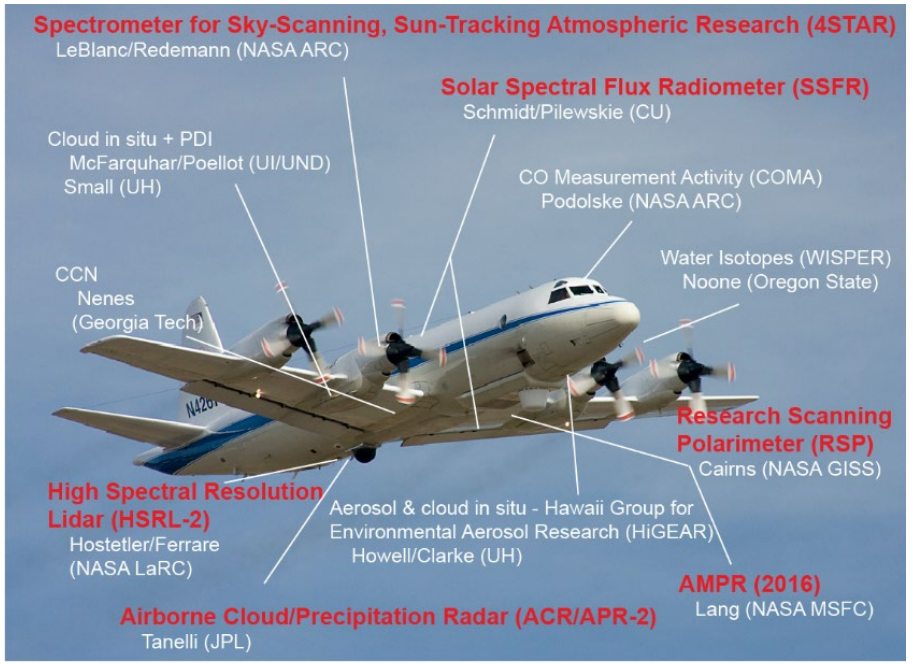
APR-3

Airborne overflights similar to ORACLES

Science Objectives	Scientific Measurement Requirements: Parameter	Accuracy	Instrument Functional Requirements (**bold** indicates instruments that are required to address threshold science objectives)
Aerosol direct effects: / Aerosol semi-direct effects:	**Aerosol:**		
	AOD at UV-VIS-SWIR	±0.02 or 5%	**4STAR (0.01-0.02)**, RSP(0.02), AirMSPI, HSRL-2(0.01), eMAS, AERONET(0.01-0.02) O1-1 O1-2
	AAOD at UV-VIS-SWIR	±0.02 for AOD>0.1	**4STAR+SSFR (0.02)**, RSP, AirMSPI, HSRL-2,eMAS,HiGEAR,AERONET(0.02) O1-1 O1-2 O2-2
	Aerosol spectral refractive index at UV-VIS-SWIR	±0.02 for real part	**4STAR+SSFR**, RSP, AirMSPI, HSRL-2, eMAS, **AERONET(0.02)** O1-1
	Aerosol/CCN size distribution, r_{eff}	±0.07µm±7%	**HiGEAR(10% number, 5% size)**, CCN, RSP O1-1 O3-1
	Aerosol number conc.	50%	**HiGEAR(10%)**, HSRL-2 O1-1 O3-1
	Chemical composition	Speciation (BC, volatile, refract.)	**HiGEAR-AMS(35%), SP2(25%)**, RSP O1-1 O3-1
	Aerosol extinction /absorption profile	±0.025 km^{-1} in ext	**HiGEAR(0.005 in ext), HSRL-2(0.01 in ext), PTI (0.003 in abs)**, 4STAR O1-1 O2-1
	Single scattering albedo (profile or layer), ϖ_o	±0.028	**HiGEAR (0.03)**, HSRL-2, RSP, AirMSPI, 4STAR+SSFR (0.02 in midvis), AERONET(~0.03) O1-1 O1-2 O2-1 O2-2
	Gases:		
	CO, CO2, H2O, O3	10 ppbv CO	COMA(2ppbv CO), Facility, HiGEAR O3-1 O1-1
	Cloud/Drizzle/Precipitation:		
	Cloud fractional cover	±0.05	eMAS (0.05), ACR+APR-2, AirMSPI (0.05), **MODIS/SEVIRI (0.05)** O2-3 O1-2
	Cloud top/bottom height	±100m	**APR-3 (60m),** HSRL-2 (33m), AirMSPI A O1-2
Aerosol indirect effects:	Droplet Size Distribution	20%	**CAPS-CAS, PDI (20%)**, CDP O3-2 O2-2 O2-3
	COD	10%	eMAS(5-10%),**SSFR**, RSP, AirMSPI,4STAR O2-3 O2-2 O3-2 O3-3
	r_{eff}	20%	eMAS (10-20%), RSP, AirMSPI, SSFR, 4STAR, **in situ probes (20%)**
	Liquid water content/path (LWC/LWP)	0.05 gm^{-3} / 10 gm^{-2}	**King probe, CAPS-LWC, PDI (20%LWC), APR-3+AMPR (10gm^{-2}LWP)** O2-3 O3-2 O3-3
	Winds & Thermodynamics	±0.3 m/s (vertical)	**TAMMS (±0.2 m/s)**, Facility O2-3
	Precipitation microphysics/rate	0.4 mm/day (rate)	**2D-S, CAPS-CIP (0.2mm/day),** eMAS+APR-3 (0.2mm/day) O3-3
	Radiation:		
	Spectral Solar Flux	3%	**SSFR (3%, 0.5-1% for differentials)** O1-1 O2-2
	Visible-SWIR Degree of Linear Polarization	0.5%	RSP (0.2%), AirMSPI (0.5%) O1-2 O2-2 O3-2
	Visible, SWIR, Thermal IR Radiance / Brightness T	5-10% in radiance, 0.5K for IR	eMAS (5% in radiance, 0.5K for mid- and window-IR, 1-2K for 13+ µm) O2-3

NASA P-3 in-situ + remote sensing

Contact point: Jens Rendemann



- Active & Passive Remote Sensing
- In situ observations of radiation, aerosol & cloud microphysics

Possibly required EarthCARE CalVal adjustments:

"Dust-capable" inlet; ice cloud properties & IN; remove "some" remote sensing

Conclusions

- ACROSS needs strong networking and coordination between the airborne and ground components
- The time periods would be defined after examining the feasibility of the airborne components under discussion
- The initial plan is to keep operational stations running and initiate IOPs whenever an aircraft facility operates in the Mediterranean region