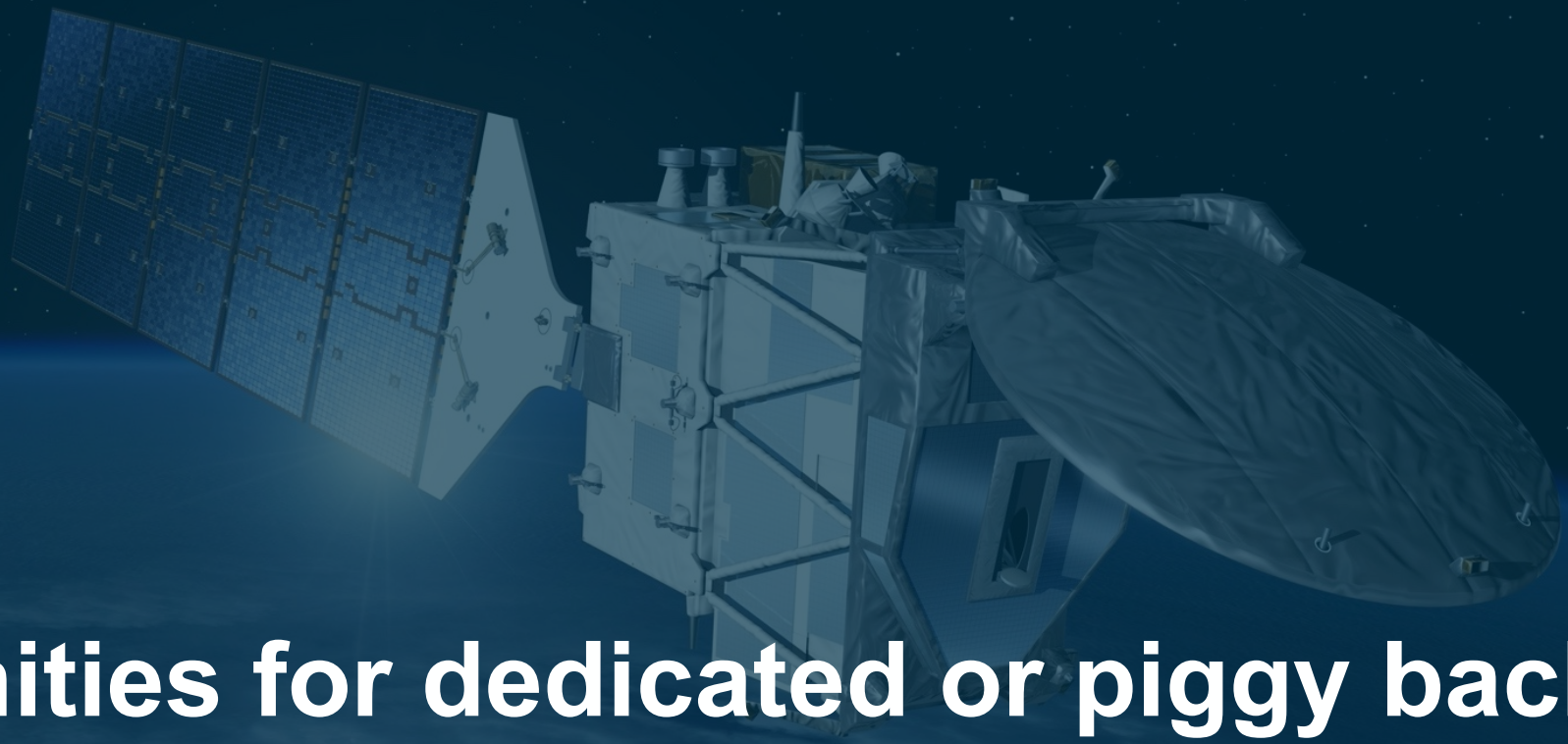


Opportunities for dedicated or piggy back campaigns

2nd ESA EarthCARE Validation Workshop

25-28 May 2021 (online)

Proposals including campaign activities – airborne

AOID	PI	activities	location	time
38018	Marenco	**1-2 potential ad hoc research flights** compatible with other experiments with **FAAM**; preferentially combined with multiple aircraft	High-latitudes (CCREST) and UK	CCREST winter 2023/2024 UK in summer 2023
38188	Wandinger	Airborne campaign dedicated to EC validation (ECVAL) with **EarthCARE-like payload on HALO** – potential of **combined ATR42 measurements (Delanoë)**	Portugal (tbd)	Summer 2024
		Airborne campaign with 2-3 dedicated cal/val flights with **EarthCARE-like payload on HALO** (TOOC)	Barbados	Summer 2024
		Airborne **lidar and in-situ** measurements on **HALO** during **ASCCI** and **HALO-south**	High-Latitudes	2025
			NZ	2025
38810	Delanoë	Airborne **EarthCARE-like + in-situ measurements** (CCREST + NAWDIC) as opportunity campaign	High-latitudes	Winter 2023/2024
			Extra-tropical NA	2025
?	Nicolae / Stachlewska	Airborne campaign with MULTIPLY (multi-wavelength HSRL) system	Romania / Mediterranean	
39821	Qu	Airborne measurements		
60799	Phillips	Airborne radar measurements in combination with satellites		

Proposals including campaign activities – Balloon and UAV

AOID	PI	activities	location	time
38810	Delanoë	**Balloon-borne radar X + W-Band radar**	TBD	2023/2024
38809	Renard	**Balloon-borne lidar** measurements	Launch site in France	
39067	Hu	**UAV** measurements with **dropsondes, radiometer and THz Radar and lidar** for cloud observations	Chinese South Sea	Every summer
	Voelker	**Balloon-borne in-situ** measurements (in combination with ground-based lidar)	Northern Sweden	On occasion

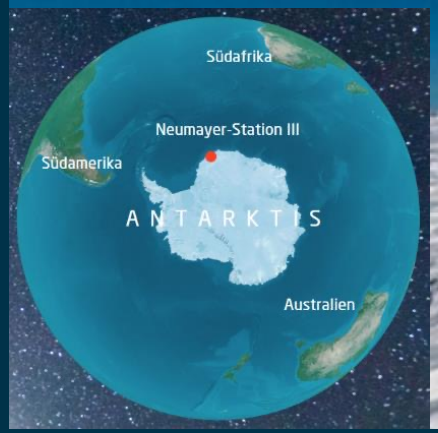
Proposals including campaign activities – ground-based

AOID	PI	activities	location	time
38810	Delanoë	**Mobile ground systems – BASTA (W-Band radar) and BALI (scanning BASTA + ulidar)**	mobile	Already running (on demand)
		Scanning **C-Band (POLDIRAD) and W-Band (BASTA)** radar	Southern Germany	Starting 2022
38623	Genthon	**Ceilometer measurements**	Antarctica	
38909	Gausa	**Radar and lidar measurements**	Northern Norway	ongoing
	Voelker	**Lidar** measurements (in combination with balloon in-situ measurements)	Northern Sweden	On occasion
39183	Amiridis	Ground-based PANGEA station (**lidar, cloud radar, MWR, Radiation**)	Eastern Mediterranean	ongoing
	Sicard	**Lidar** deployments during different campaigns		
	Stachlewska	**Lidar measurements** in Poland and possibility for campaign participation in Romania	Eastern Mediterranean	ongoing
38188	Wandinger	**Cloud Radar, MW-Lidar, MWR, Radiation measurements**	Cape Verde	ongoing
			Melpitz	ongoing
			Antarctica	2022-2024
		Mobile **LACROS** system (Radar, MWL, Radiation)		

Proposed dedicated EarthCARE Validation Campaigns – COALA

Continuous Observations of Aerosol- cLoud interaction in Antarctica

Proposed schedule: late 2022 to early 2024
Location: Neumayer III research station
Instruments: OCEANET Container (Polly-XT, cloud radar, HATPRO → Cloudnet dataset



Tasks:

- vertical distribution of aerosol conditions
- cloud-relevant aerosol parameters (CCN and INP)
- statistics of clouds and precipitation
- response of microphysical properties of cloud droplets and ice crystals on the presence of aerosol particles
- profiles of water vapor mixing ratio

Proposed dedicated EarthCARE Validation Campaigns – LOSTECCA

Lidar Observations of Spatio-TEmporal Contrasts in Clouds and Aerosols in Lauder NZ

Leipzig Aerosol and Cloud Remote Observations System (LACROS)

Instruments: PollyXT mutiwavelength polarization Raman lidar, HALO Doppler lidar

Location: Bluff (Invercargill, southern tip of South Island)

Schedule: Planned for boreal spring 2021. Postponed due to COVID-19. **Probably 1 March – 15 April 2022**

Lauder Atmospheric Research Station

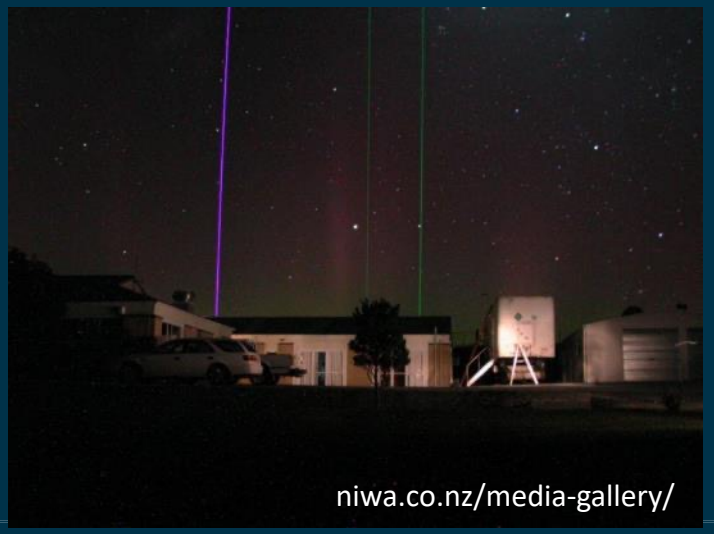
(NIWA: National Institute of Water and Atmospheric Research (Taihoro Nukurangi) of New Zealand)

Unique 27 year lidar data set with 11 years of polarization lidar data (2009-2020)

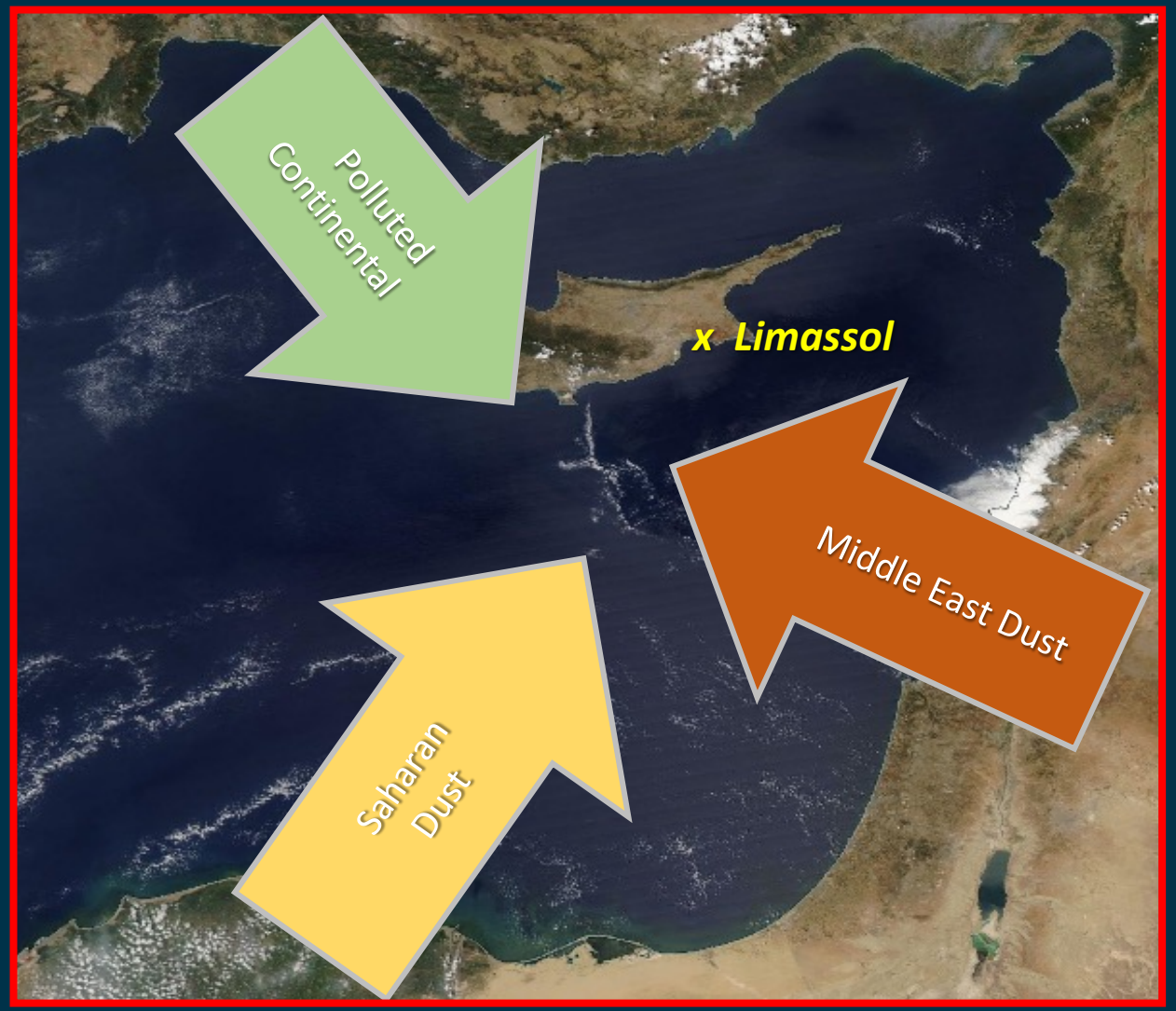
(532 nm, 532 nm depolarization, 1064 nm, DIAL)

Goal: evaluate inter-hemispheric contrasts in the cloud-relevant properties of aerosols and impacts on the microphysical properties of clouds

google.de/maps


niwa.co.nz/media-gallery/

Proposed to have an EarthCARE Validation Campaigns in the Eastern Mediterranean

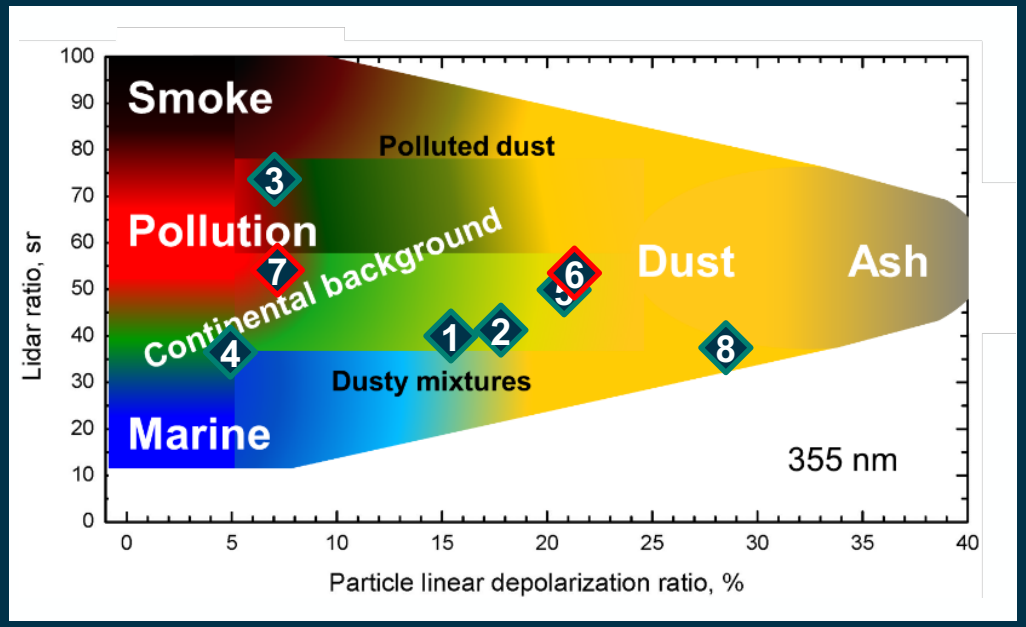


Idea

- Improving aerosol and cloud products
- Test bed for optimizing retrievals
- adapted range bin setting in a small area

Requirements

- Heavy aerosol load
- Small box in Eastern Mediterranean



Proposed to have an EarthCARE Validation Campaigns in the Eastern Mediterranean

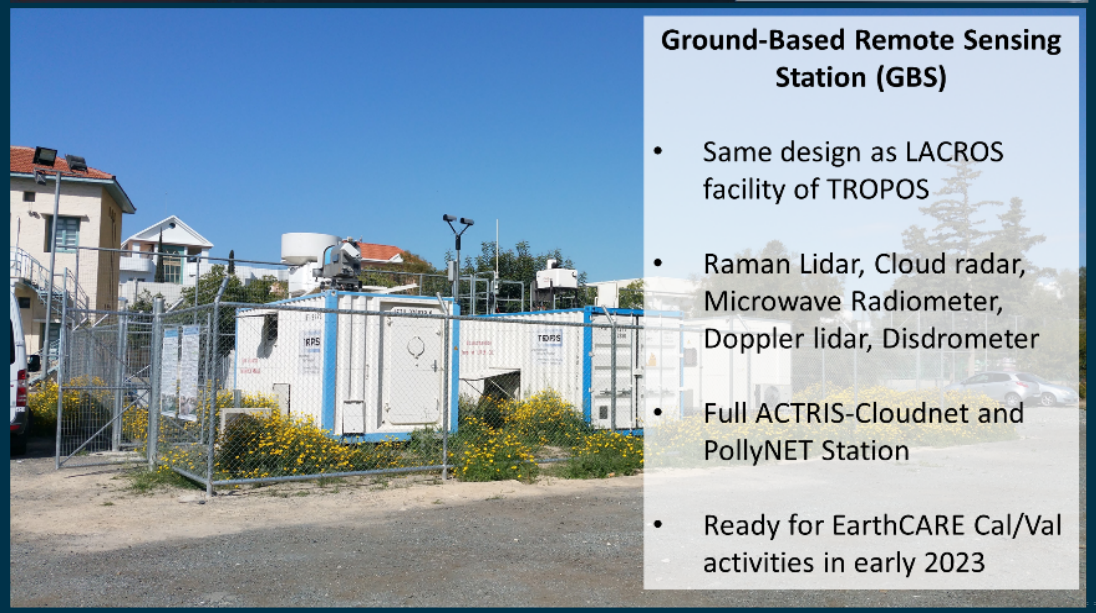
EXCELSIOR

Cyprus University of Technology

DLR

TROPOS
Leibniz Institute for Tropospheric Research

The Cyprus Institute
RESEARCH·TECHNOLOGY·INNOVATION



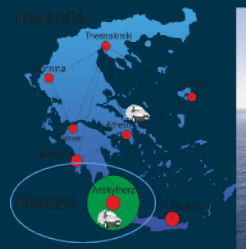
Ground-Based Remote Sensing Station (GBS)

- Same design as LACROS facility of TROPOS
- Raman Lidar, Cloud radar, Microwave Radiometer, Doppler lidar, Disdrometer
- Full ACTRIS-Cloudnet and PollyNET Station
- Ready for EarthCARE Cal/Val activities in early 2023

Great Infrastructure

- ERATOSTHENES Center of Excellence (ECoE)
- Cyprus Institute
- PANACEA observatory in Antikythera
- Several airports – airborne Cal/Val possible

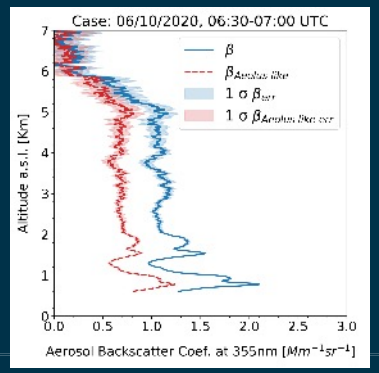
PANGEA

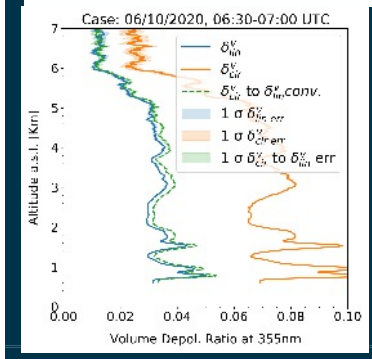


Measurements in PANGEA **since September 2018**

- AERONET station
- Polly XT-NOA EARLINET lidar:
  3 backscatter coefficient (355, 532,1064nm)
  2 extinction coefficient (355, 532nm)
  2 depolarization ratios (355/387, 532/607nm)
  1 water vapor mixing ratio (407/387nm)
  + near field channels
- Real time quicklooks (https://polly.tropos.de/)
- Products in EARLINET database

The station will be upgraded within 2022 to include multi-frequency radars (X-G-Ka-band) and MWR





MULTIPLY – airborne HSRL

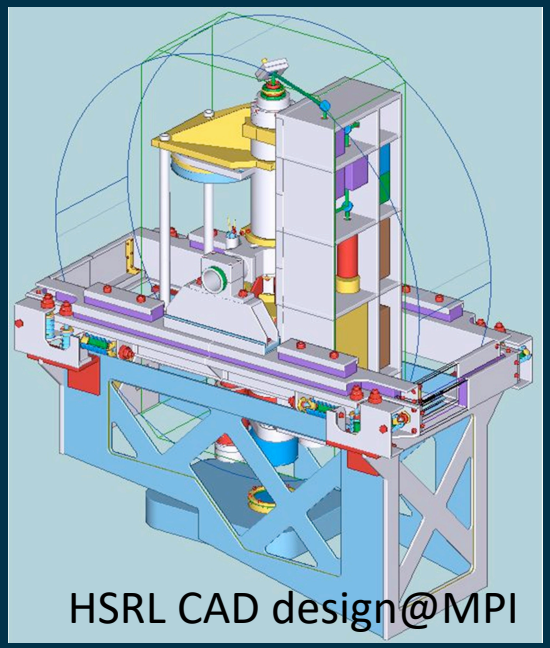
MULTIPLY is an ESA-ESTEC project for the development of a novel multi-wavelength HSRL system (3b + 2a + 3d) for both ground based (ready in 2022-phase 1) and airborne operation (phase 2: 2023-2024).
Partners: National Institute of Research and Development for Optoelectronics (Romania), Max-Plank Institute (Germany), National Observatory of Athens (Greece), Warsaw University (Poland)

Target of the HSRL: better than EarthCARE specifications

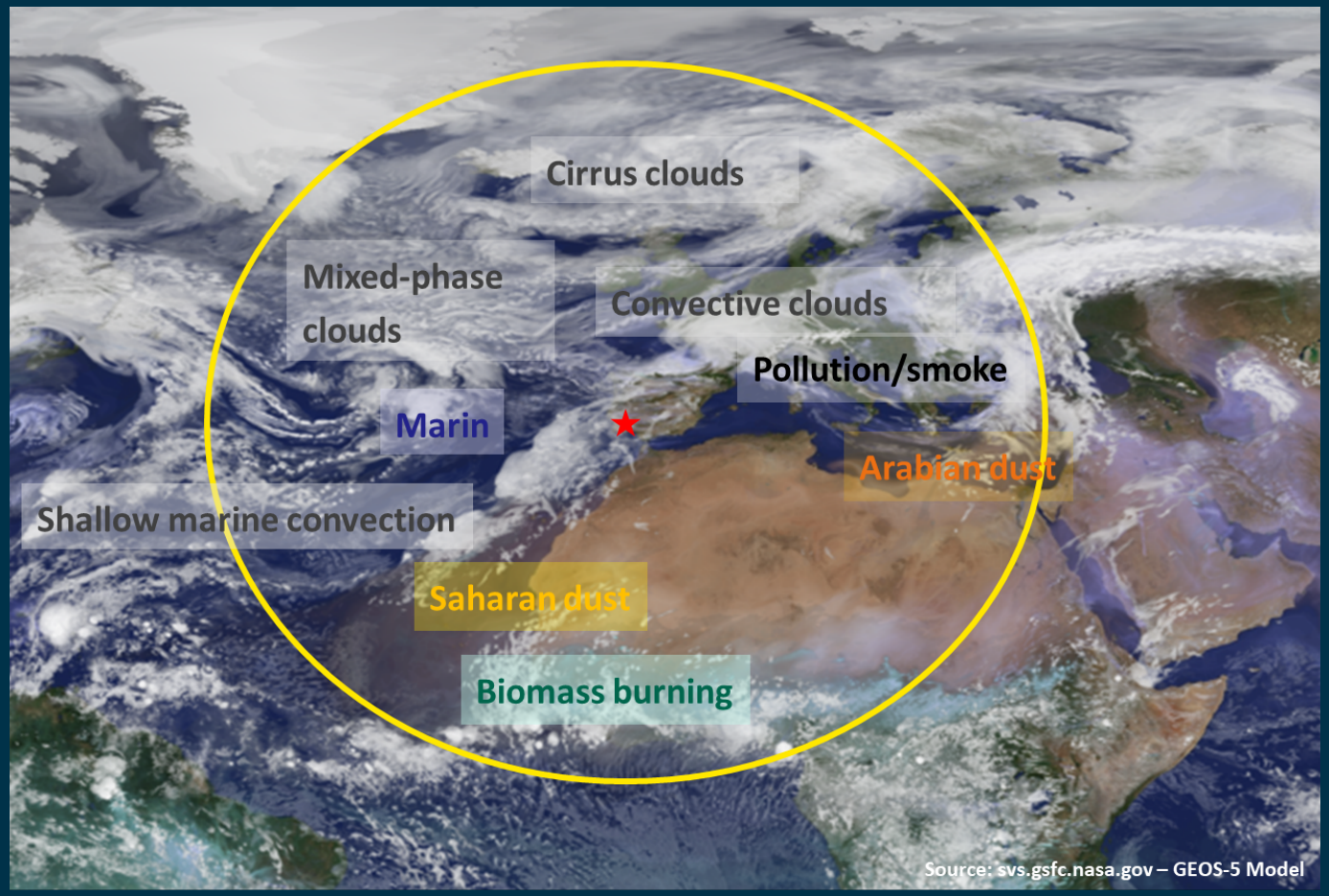
- raw signals:
  - 7.5 m vert. res.
  - 50 m horizontal res.
  - 1-1.5% accuracy
- backscatter
  - 7.5 m vert. res.
  - 500 m horizon.res.
  - 10% accuracy
  - detectability 0.0005-0.0008
- extinction
  - 100 m vert. res.
  - 5000 m horizontal res.
  - 10-15% accuracy
  - detectability 0.02-0.05
- depolarization
  - 7.5 m vert. res.
  - 500 m horizontal res.
  - 10% accuracy
  - detectability 0.02

Main features: 3β + 3α + 3d

- Implementing Fabry-Pérot Interferometers for HSR filtering at 355 and 1064 nm
- Implementing iodine filtering technique at 532nm
- Narrow field-of-view receiving
- Low laser pulse energy (to conform the eye-safety requirements).
- High laser pulse repetition rate (to increase the total number of sounding photons emitted to
- measure individual lidar profile).
- Decoupling spectral separation unit (interferometers, iodine filter) from telescope with optical
- fibers (to allow better mechanical stability).
- Implementing extra telescopes for depolarization channels.
- Additional “near”-range telescope (to extend dynamic range).



Proposed dedicated EarthCARE Validation Campaigns – ECVAL



→ Additional measurements planned during TOOC in (sub-)tropics

→ Coordination with other aircraft, ground-based measurements and ship-measurements planned

Campaign period – Second half of 2024:

Campaign duration – 3 weeks of active measurements

- ~70 flight hours
- 8 measurement flights of 6-8 hours

Campaign location – Faro, Portugal:

- Optimal infrastructure and experience from DLR-FX
- Location influenced by different aerosol and cloud situations
  - extensive validation in different aerosol types / cloud regimes
  - many ground-based stations in the flight distance of HALO

Remote sensing measurement on HALO and ATR42

Airborne tandem-platforms

HALO

Aircraft:

- Modified Gulfstream G550 business jet
- Endurance: **> 10 flight hours**
- Maximum cruising altitude: **> 15 km**

Payload:

- **High spectral resolution lidar** (532 nm) and water vapor DIAL
- **Doppler Cloud Radar** (35 GHz)
- Hyper-spectral **radiometer (specMACS)**
- **Microwave** radiometer
- Radiation measurement (IR measurements newly added)

SAFIRE

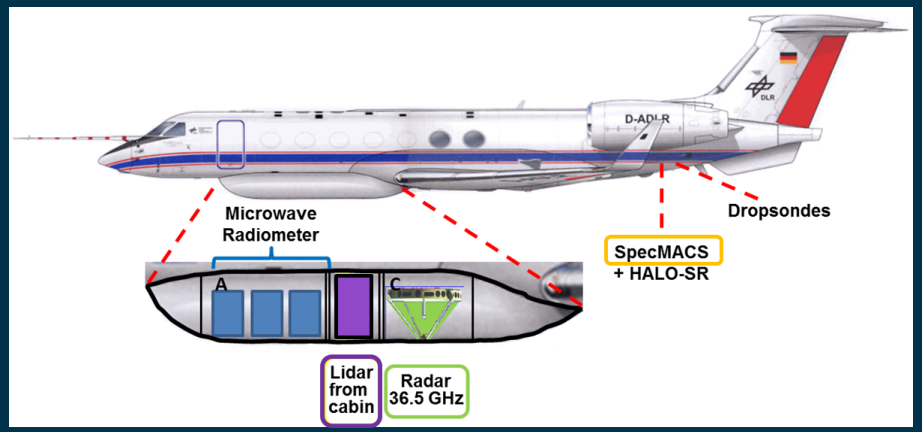
Aircraft:

- ATR 42-320
- Endurance: **3.5 (max 6) flight hours**
- Maximum cruising altitude: **7.5 km**

Payload:

- **High spectral resolution Doppler lidar** (355 nm)
- **Doppler Cloud Radar** (94 GHz) up- and down-ward looking
- Sideward looking W-band Doppler radar
- IR radiometer
- Large in-situ payload

Proposed dedicated EarthCARE Validation Campaigns – ECVAL



Co-located measurements

(HSRL at 532 nm / CPR at 35 GHz)

(HSRL at 355 nm / CPR at 95 GHz)

Evaluation of EarthCARE data products

Instrumentation:

- EarthCARE-like payload on HALO

Coordinated measurement:

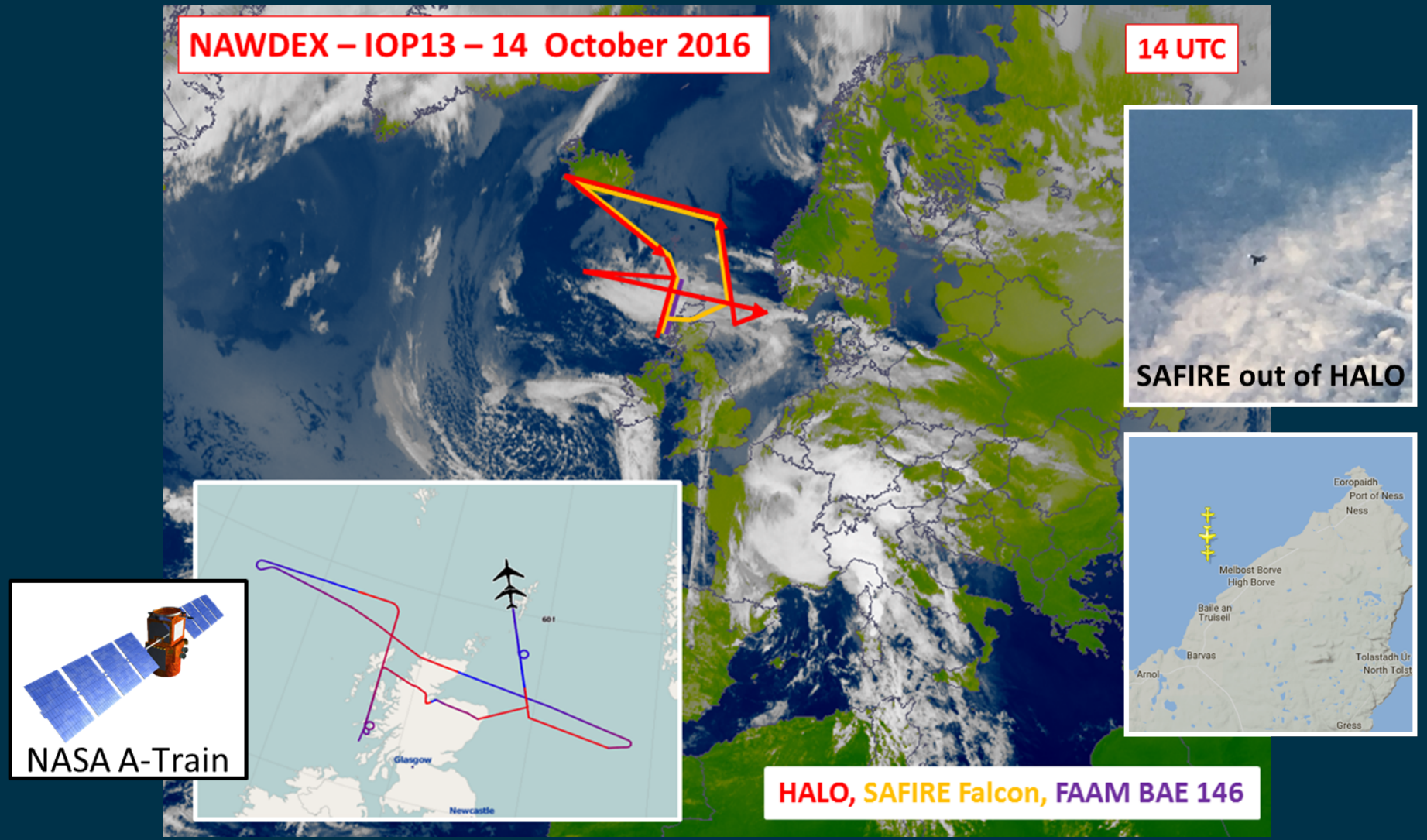
- Possibility of coordinated flights with ATR42 (radar + lidar + in-situ) and/or additional in-situ aircraft measurements
- Coordination with ground-based (mobile) sites is aspired (e.g. BALI / LACROS)

Measurement strategy:

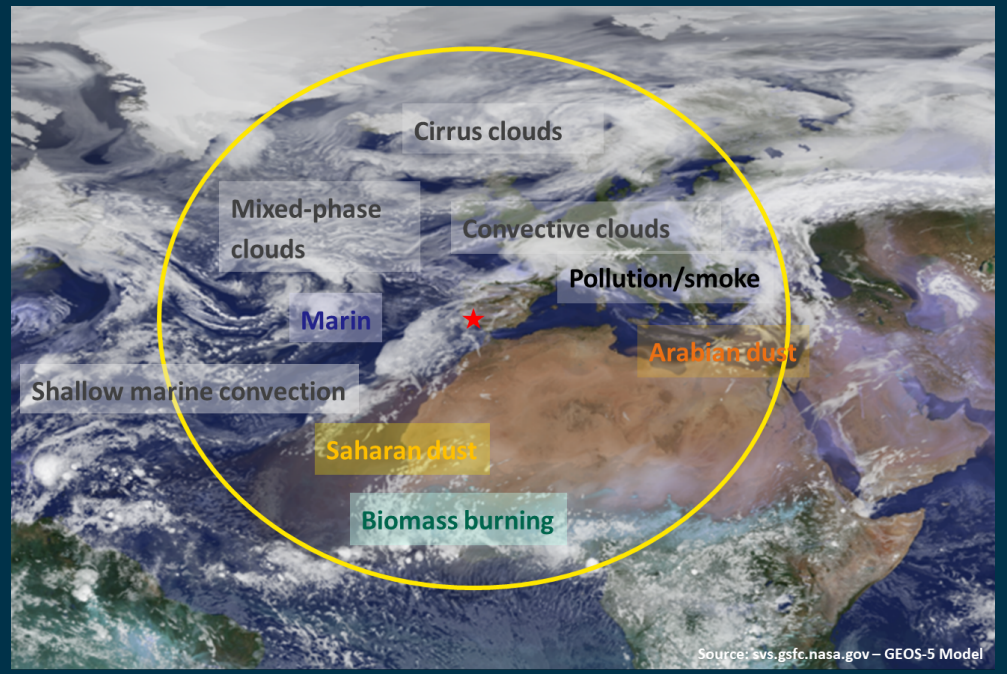
- Dedicated (coordinated) underflights with systems at different wavelengths, resolution and sensitivity
- Overpasses over ground-based stations
- Characterization of the general situation

Experience / preparation for validation

Coordinated HALO – FF20 flight + A-Train underpass



Proposed dedicated EarthCARE Validation Campaigns – ECVAL



- → Good coverage of ground-based lidar and radar network station over Europe, Mediterranean, Eastern Atlantic regions
- → Good coverage of different aerosol and cloud situations
- → 'Limited restrictions' of flight strategies (all directions)
- → Mobile platforms could be deployed at strategic locations (intercalibration, filling gaps)

Needs from L2-developers for cal/val

- Lidar measurements of Mie and Rayleigh signal preferable at 355 nm
- Simultaneous lidar measurements of low depol and high depol measurements
- Depolarization measurements at 355 nm (532 would work with potential additional uncertainties during conversion)
- Macrophysical properties (PBL height, multi-layer aerosol scenarios, broken clouds and aerosols, multi-layer cloud scenarios
- Run L2 algorithms on airborne and ground-based measurements
- Simulation of non-EC products e.g. to compare with measurements at different wavelengths
- Extinction and IWC/LWC needed (for simulations / closure)
- AOT measurements from ground (e.g. AERONET) and satellite (e.g. MODIS, VIIRS, …)
- Ground-based remote sensing along flight track
- Imager measurements
- Synoptic observations
- In-situ measurements (underflights along EC flight track)
- Airborne microwave measurements
- Polarization radar measurements and precipitation radar scans

Summary/Thoughts from updated proposals and from 1st Cal/Val Workshop:

- Many activities in the mid- or high latitudes
- TOOC one of the few campaigns in (sub-)tropic regions
- Multiply aircraft campaigns (different WL, combined RS and in-situ) needed
- Connecting airborne measurements with ground-based stations; locating mobile facilities at strategic locations (campaign base) or to be used for intercalibration
- Flights over land and over ocean needed
- Funding often still open → those activities may change depending on funding!

Questions?

- How to best combine airborne and ground-based measurements (+ satellites?)
- Best locations for measurements?
- Which / how many mobile facilities would be available?
- How to best combine remote sensing and in-situ measurements (airborne + ground-based)?
- Which regions are missing? And how can the gaps be filled?