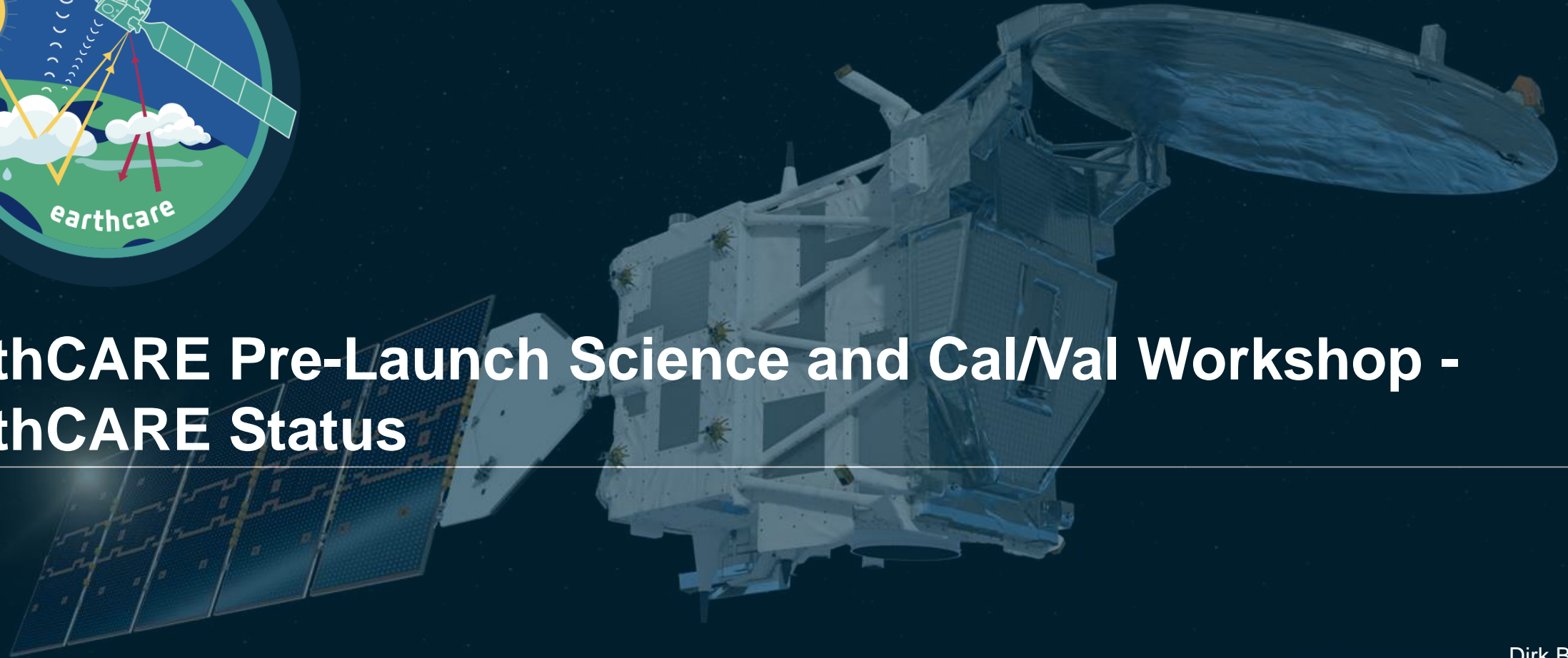




EarthCARE Pre-Launch Science and Cal/Val Workshop - EarthCARE Status



Dirk Bernaerts

ESA ESTEC

13/11/2023

1st May 2024

< 6 months

170 days





Largest uncertainty in projections of the future climate, to be addressed in order to improve numerical weather prediction and climate modelling, comes from cloud, aerosol and radiation interactions.

Systematic provision of vertical profiles of clouds & aerosols, collated with low cloud aerosols and emitted thermal radiation.

How do aerosols and clouds, heat or cool the Earth?
Direct verification of impact of clouds & aerosols on atmospheric heating rates & radiative fluxes.



6th Earth Explorer Mission
Largest, most complex Earth Explorer Mission so far



EarthCARE is cooperation mission between ESA and JAXA



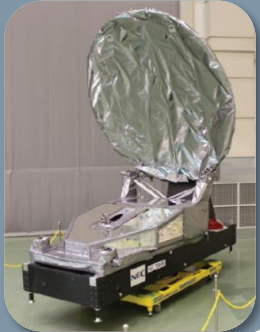
EarthCARE – Space Segment



Cloud Profiling Radar CPR (JAXA)

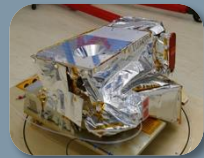
High Power 94GHz Doppler Radar

- *Cloud profiles, rain estimates, particle vertical velocity*



Multi Spectral Imager MSI (SSTL)

- *Context information*
- *Creating 3D cloud-aerosol scenes*



- *VIS, Near IR, SWIR Camera (VNS)*
- *Thermal IR Camera (TIR)*

Atmospheric LIDAR ATLID (Airbus TLS)

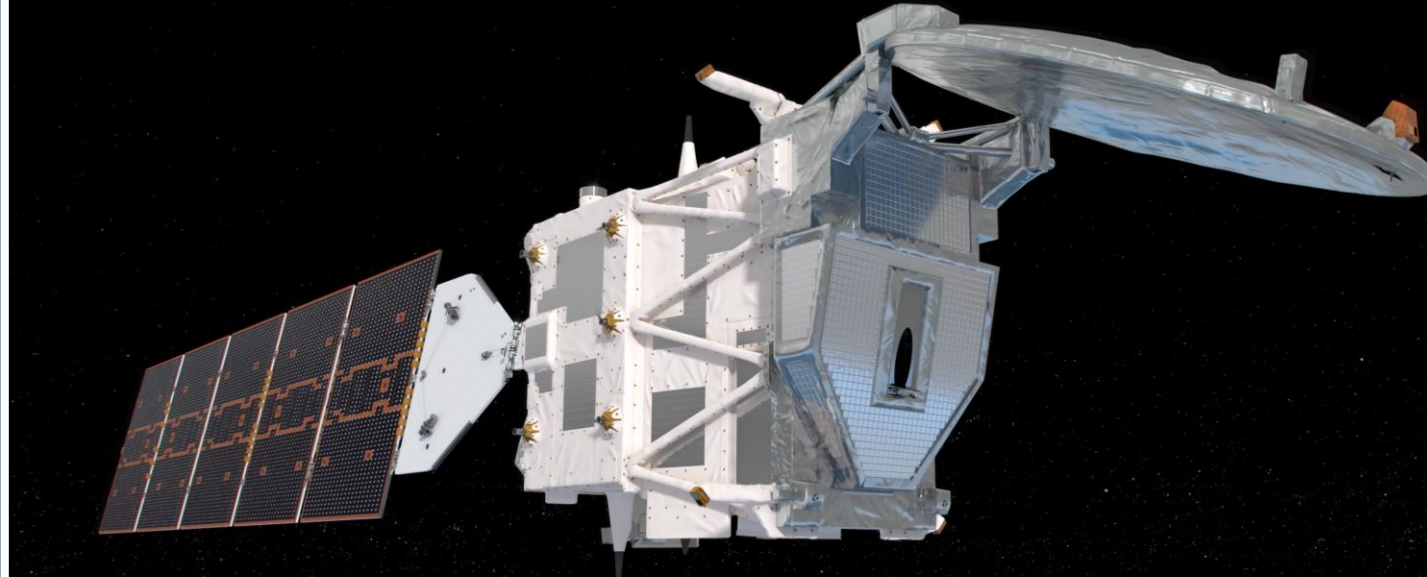
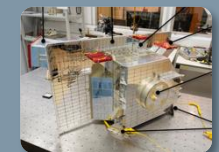
High spectral resolution 355nm LIDAR

- *Vertical profiles of aerosol and (thin) clouds*

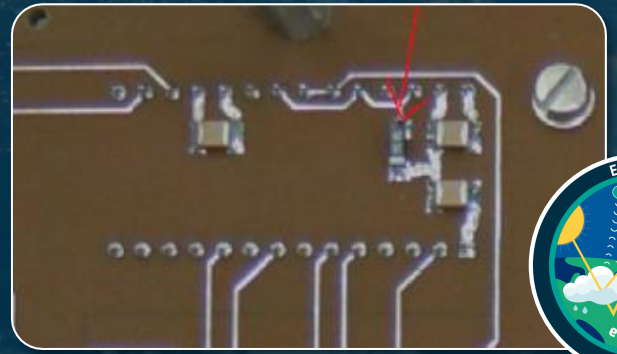
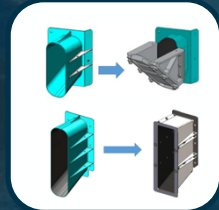
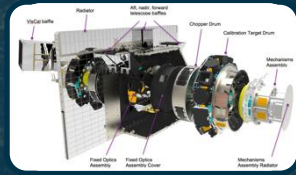
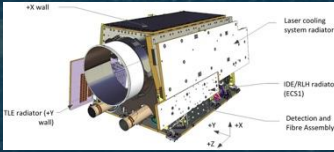
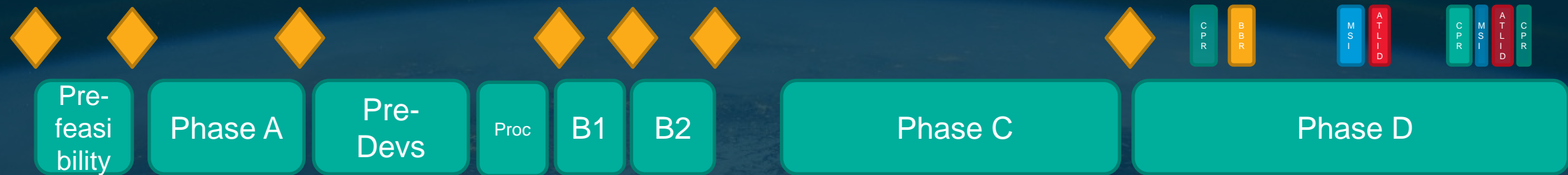


BroadBand Radiometer BBR (TAS-UK)

- *Measurements of reflected solar and emitted thermal radiation*



EarthCARE Status – Space Segment

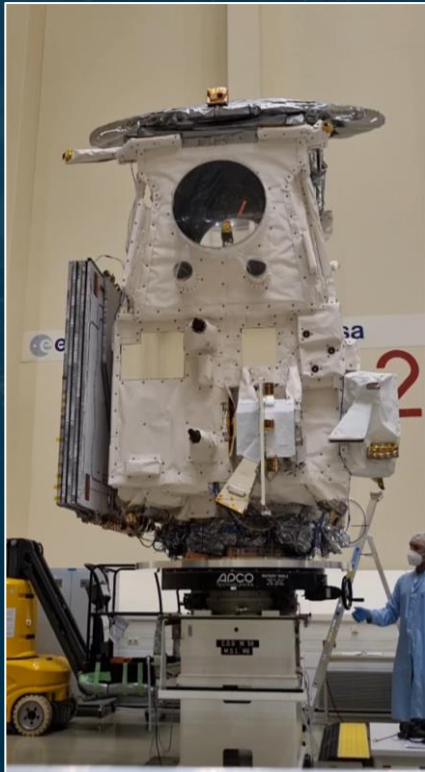


EarthCARE Status – Space Segment

Overall : surprisingly smooth test campaign, fully according to schedule

Main Difficulties encountered:

- Applicable launcher environment not clear
- Absence of Launch vehicle adapter for separation/shock test
- Cleanliness
- Alignment cube



Sept-Nov 2022



EarthCARE Status – Space Segment

Deployment tests and Instrument Performance Checks

Main Difficulties encountered:

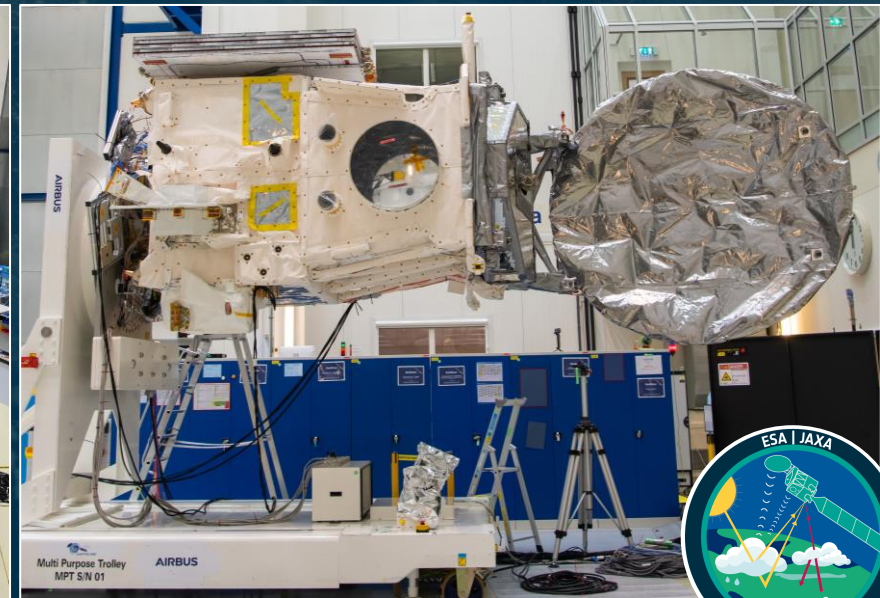
- Solar Array Switches
- Ground Support equipment/harness
- Optical stimuli for ATLID reception chain



Jul 2022, Nov 2022, June 2023



Nov 2022



Nov 2022

EarthCARE Status – Space Segment

Thermal Vacuum/Thermal Balance, EMC, functional and instrument performance checks, recently Launch Vehicle Adapter Separation/Shock test

Main Difficulties encountered:

- Ground Support equipment
- Active instruments operation
- Combination of instrument constraints



Jan-Feb 2023



Apr 2023



June 2023



Satellite Environmental Test Campaign Completed

Last function and instrument performance checks ongoing (high confidence)

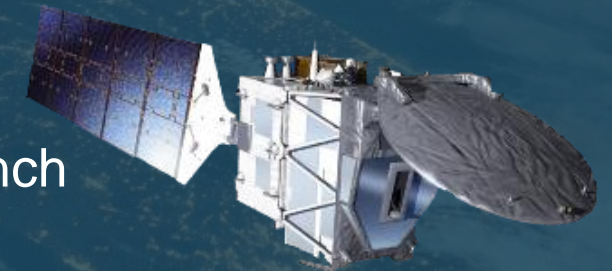
Qualification and Acceptance Review (QAR) completed with actions:

- Resolution of open NCRs and alerts – ATLID Pump Unit (non-flight) NCR on Aeolus Follow-on and Capacitor alert
- Successful execution of separation/shock test + post test verifications
- Verification of launcher compatibility issues: sine vibration notch to protect propellant tank and horizontal transport of fueled spacecraft.

Close-out report at latest in January 2024.

Remaining: preparation for launch campaign/launch
Transport (Antonov booked)

Launch Campaign (March – May 2024)



EarthCARE Status - Launcher

Soyuz from Kourou

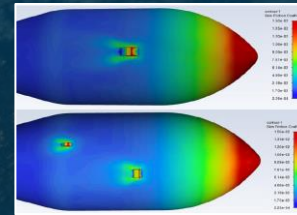
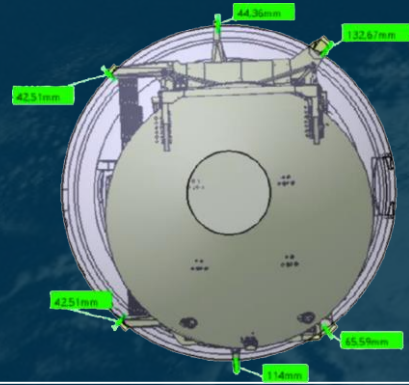
Contract: Oct 2017
However: Feb/Mar 2022 ->
Soyuz not available any
more from Kourou

Vega-C

Contract: Dec 2022 after
feasibility and settlement
However: Dec 2022 launch
failure & April 2023 Fairing
design key point -> Jun
2023 Council decision

Falcon9 from Vandenberg (Cal, USA)

Contract: Sep
2023



Launch Vehicle Adapter for
separation/shock test



Oct 2023

>= Apr 2024

May 2024

Strategy followed: decouple as much as possible from launcher issue. Find alternative launcher in parallel. **OK first time, difficult second time.**



Most difficult topics addressed for EarthCARE:

- Soyuz-VegaC : non availability of launch vehicle adapter
- Vega-C accommodation/fairing modifications
- Environmental levels (shock/acoustic)
- Falcon 9
 - Random vibration
 - Cleanliness for ATLID (and other instruments)

Remaining open points currently in work:

- Sine vibration – propulsion tank notch
- Final coupled load analysis (random vibration spacer)
- Horizontal transport of fueled spacecraft at launcher roll-out
- Final trajectory analysis
- Purge system – cleanliness





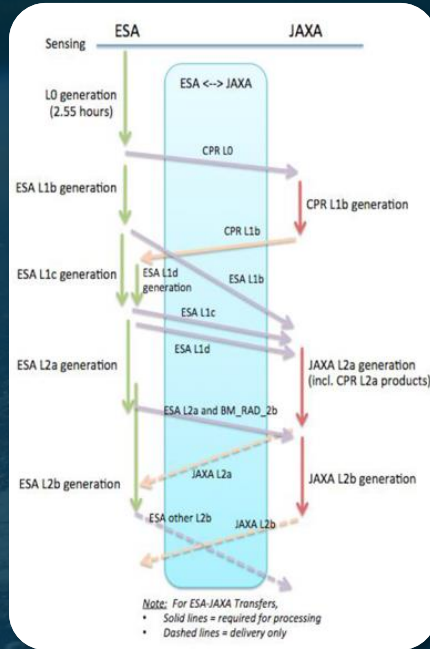
FOS – Flight Operations Segment:

- All System Validation Tests (SVTs) successfully completed, last one in June 2023
ESA – JAXA - Airbus
- LEOP Stations procurement ongoing (was delayed due to unclear launch site/launch date)
- Simulations Campaign Q1 2024 to launch
- LEOP and Commissioning preparations ongoing.

Main Difficulties encountered:

- COVID
- Complexity of operations/contingencies
- Ageing Satellite Ground Support Equipment
- Uncertainty on launch site, date and trajectory

EarthCARE Status – Ground Segment



ESA products

Cloud-top, vertically integrated, layerwise

Aerosol

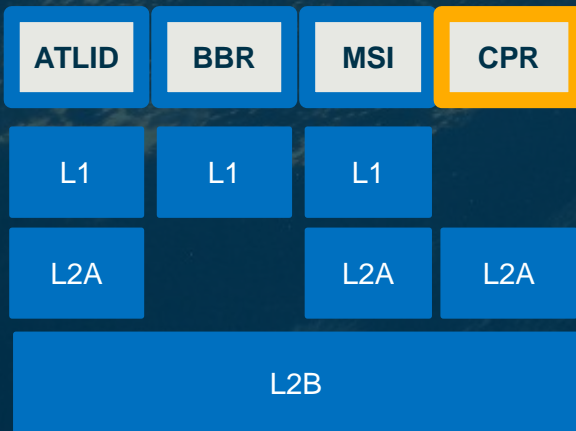
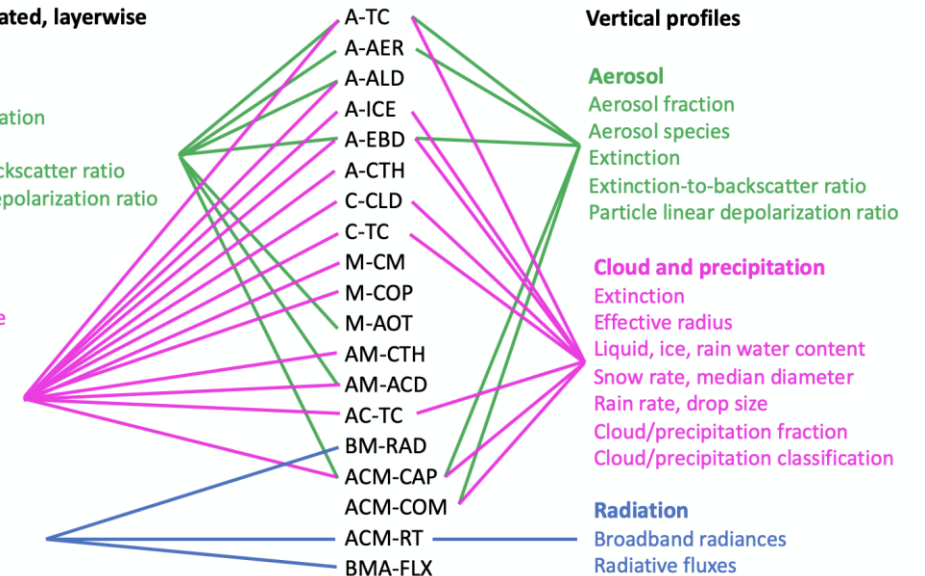
Aerosol layer height, classification
Optical thickness,
Layer-mean extinction-to-backscatter ratio
Layer-mean particle linear depolarization ratio
Angstrom exponent

Cloud and precipitation

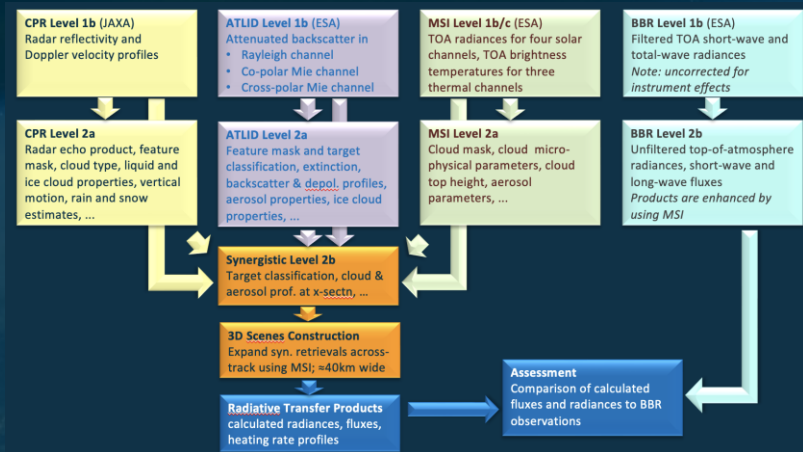
Cloud-top height, phase, type
Optical thickness
Effective radius
Liquid, ice, rain water path
Surface snow rate
Surface rain rate

Radiation

Radiative fluxes at TOA
Broadband radiances at TOA

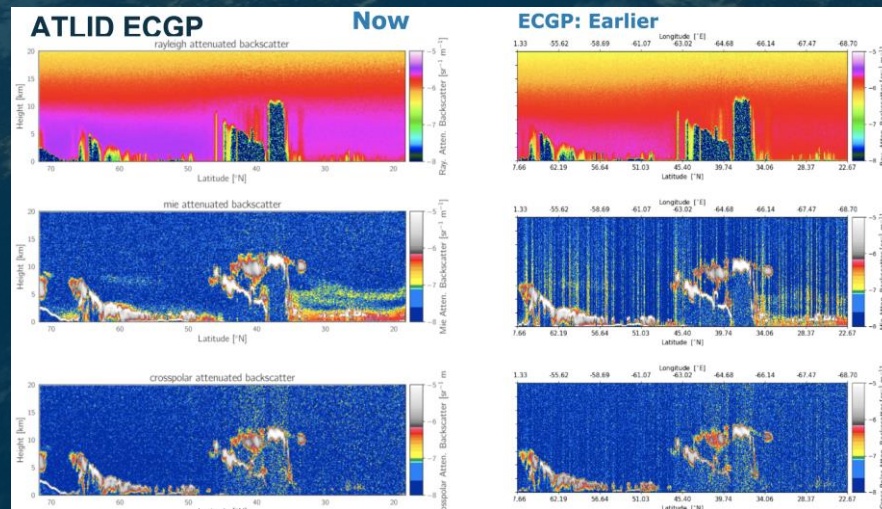


Wehr, T., Kubota, T., Tzeremes, G., Wallace, K., Nakatsuka, H., Ohno, Y., Koopman, R., Rusli, S., Kikuchi, M., Eisinger, M., Tanaka, T., Taga, M., Deghaye, P., Tomita, E., and Bernaerts, D.: The EarthCARE mission – science and system overview, Atmos. Meas. Tech., 16, 3581–3608, <https://doi.org/10.5194/amt-16-3581-2023>, 2023.



PDGS - Processors:

- Ground Segment Overall Validation (GSOV) tests completed ESA-JAXA
- Ground Segment Acceptance Review (GS-AR) ongoing
- L1 and L2 processors: corrections and improvements, both in frame of CARDINAL and satellite contract... still continuing
- PDGS final updates upcoming



Cardinal Consortium

Main Difficulties Encountered:

- Test data sets
- Consistency simulator / test data / L1 – L2 processors
- Algorithms
- Complexity



EarthCARE status - Validation



Geographical groundbased



Validation Team: Principal Investigators

PI	Institution	PI	Institution	PI	Institution
N. Clerbaux	BIRA, BE	E. Welton	NASA-GSFC USA	Z. Qu	Environment Canada
U. Wandinger	Tropos, DE	D. Josset	NRL, USA	C. Hostetler	NASA-LARC, USA
C. Genthon	CNRS, FR	X. Hu	NSMC, CN	P. Völger	IRF, SE
H Baars	TROPOS, DE	M. Flugge	Andøya Space C, NO	G. Kirchengast	UniGraz, AUT
N. Loeb	NASA-LARC, USA	V. Chandrasekar	FMI, FI	V. Philips	Lund Univ, SE
E. Landulfo	IPEN, BR	T. Nishizawa	NIES, JP	L. Sogacheva	FMI, FI
D. Moiseev	Un. Helsinki, FI	V. Amiridis	NOA, GR	Th. Stein	U. Reading, UK
J-B. Renard	LPC2E-CNRS, FR	H. Chepfer	UPMC, FR	K. Stebel	NILU, NO
J. Delanoë	LATMOS, FR	D. Donovan	KNMI, NL	R. Mamouri	Cyprus Institute
G. L. Liberti	CNR-ISAC	S. Tanelli	NASA-JPL, USA	J. Mather	Pacific Northwest National Laboratory, USA
D. Müller	U. Hertfordshire UK	D. Perez-Ramirez	U. Granada, ES	F. Navas	Univ Grenada, ES
A. Apituley	KNMI, NL	Y. Markonis	U. Life Sciences, CZ	D. Cecil	NASA MSFC, USA
Ph. Gouloub	CNRS/Lille, FR	N. Scott	LMD/IPSL, FR		
A. Devasthale	SMHI, SE	D. Winker	NASA-LARC, USA		



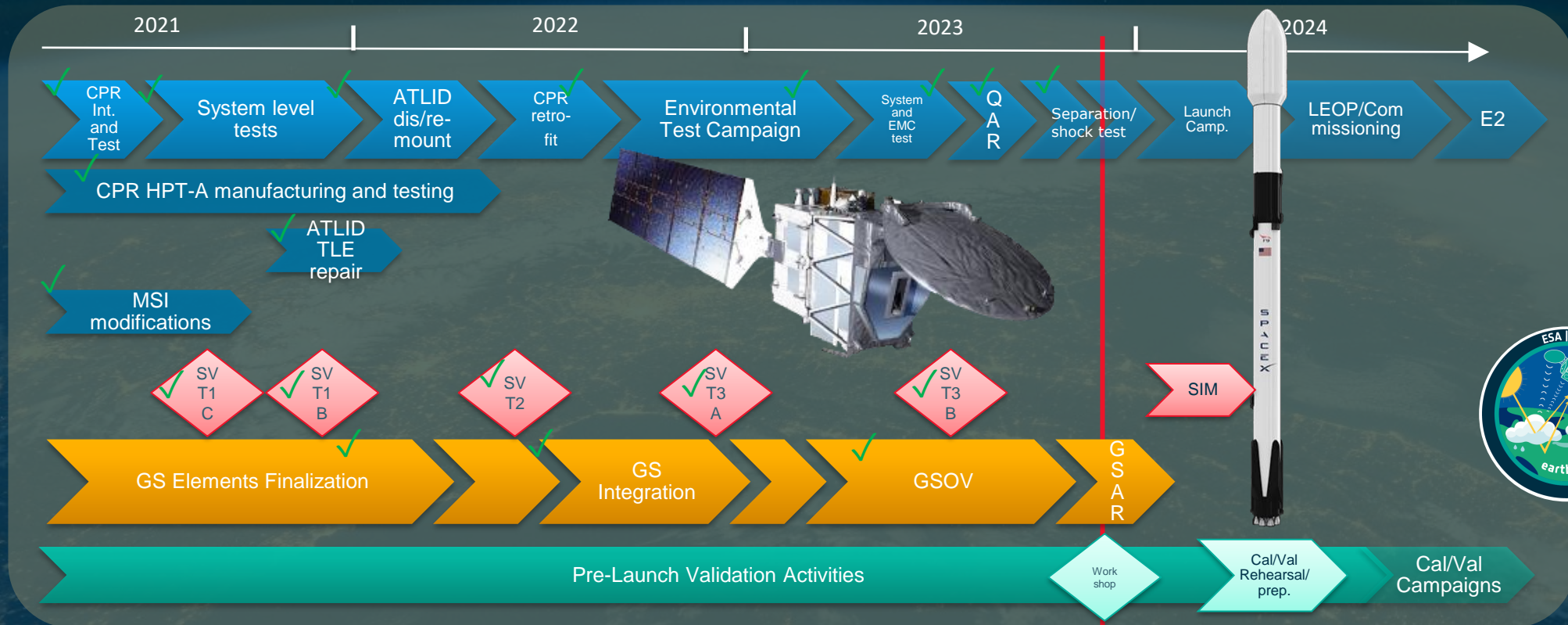
<http://earthcare-val.esa.int>



- Scientific Validation Implementation plan update (V2) in preparation (L-4 months)
- Webinars
- Validation Rehearsal preparations (L-3 months)
- Bi-lateral meetings with national funding agencies continue
- Procurement actions ongoing at ESA with prioritization on critical activities
- Coordination with national agencies (NASA, JAXA, ...) and ATMO-ACCESS pilot
- CEOS best practice protocol for validation of aerosol, cloud and precipitation profiles

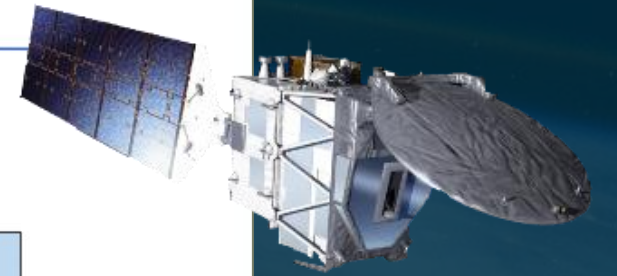
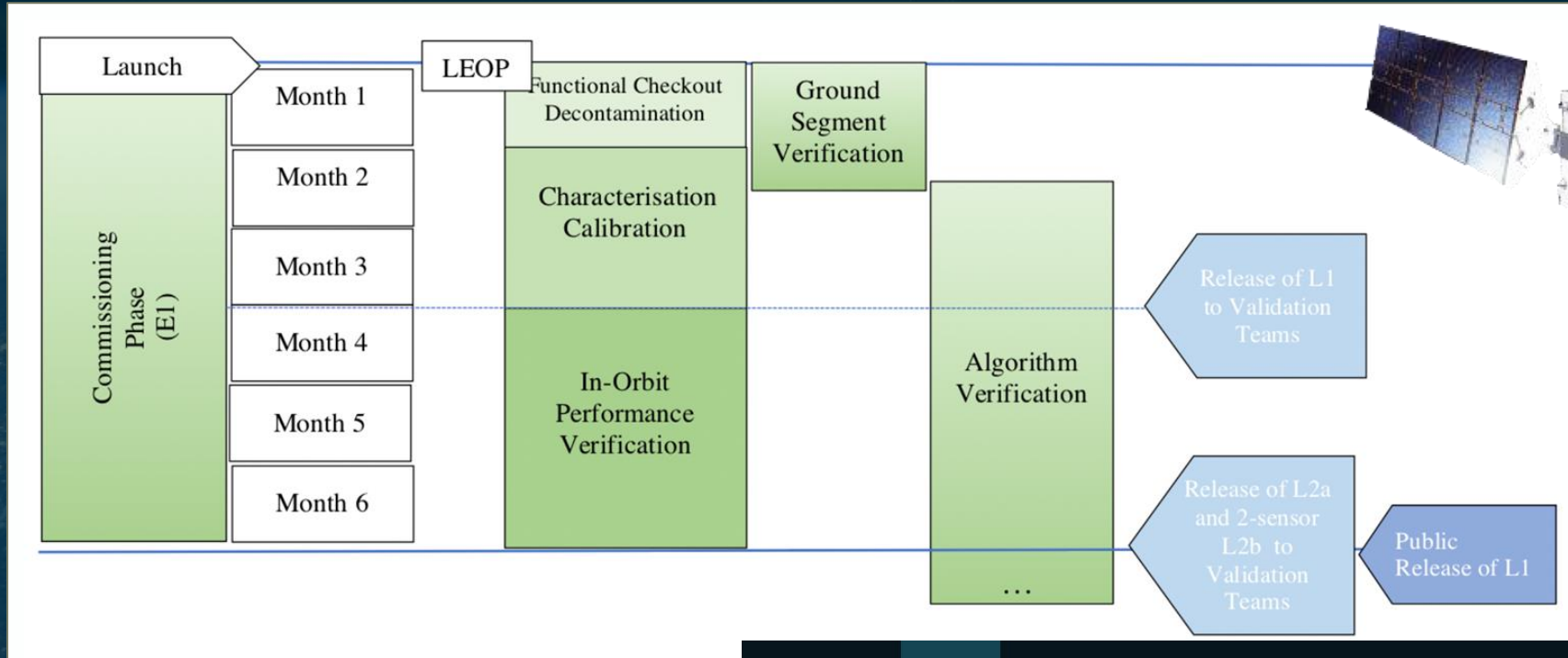
- Difficulties Encountered:
 - Major impact on preparations due to launcher/launch date delay/uncertainty
 - Several national funding agencies delayed or rejected proposals, or approved projects running out of funds, with consequence on funding at PI level. However, **fast recovery visible**
 - Rehearsal: Test data set generation





- Media Day: between mid-January and mid-February. Date TBC
- Launch Campaign March – May 2024
- **Launch May 2024, all parties targeting May 1st 2024**

EarthCARE – Outlook...



- Preparations in full swing
- Instrument Integrated Commissioning Teams

Target data release

Level 1	Level 2 A	Level 2 B
Launch + 6 months	Launch + 9 months	Launch + 18 months

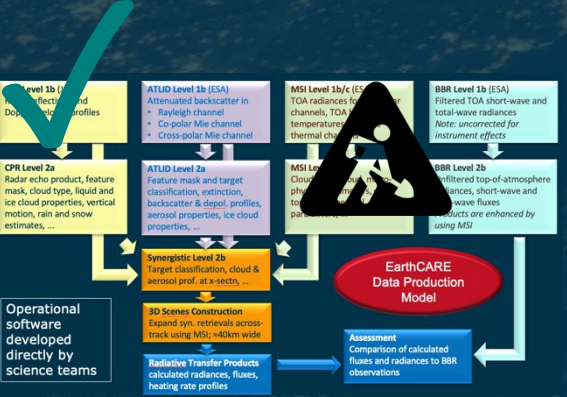
The screenshot shows the 'earth online' website with a navigation menu (MISSIONS, DATA, NEWS, EVENTS, TOOLS, SEE ALL) and a search bar. The main content area features three sections:

- EarthCARE INSTRUMENTS:** Explore instruments used in EarthCARE mission. Includes a button 'EXPLORE INSTRUMENTS'.
- EarthCARE DATA:** EarthCARE data is freely and openly available to everyone. Includes a button 'ACCESS MISSION DATA'.
- EarthCARE TOOLS:** A number of tools are available for visualising, processing and analysing EarthCARE data. Includes a button 'DOWNLOAD TOOLS'.

EarthCARE Status



EarthCARE Status



1st May 2024

< 6 months

170 days



EarthCARE – Looking forward to...



