

Validating from within: early Level 2 product intercomparison from CELLO-ORCESTRA

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2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

17 - 20 March 2025 | ESA-ESRIN | Frascati (Rome), Italy

DRCESTRA









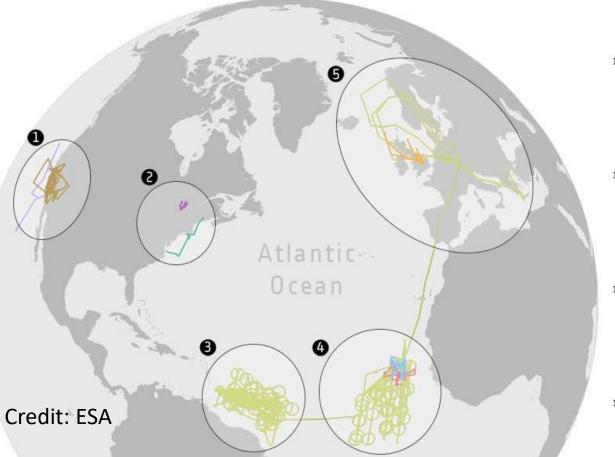


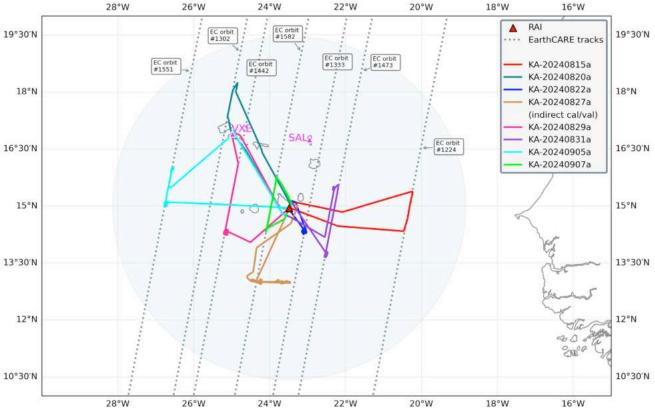












Research flights

August-September 2024

7 targeted EarthCARE orbits

2 flights for indirect cal/val

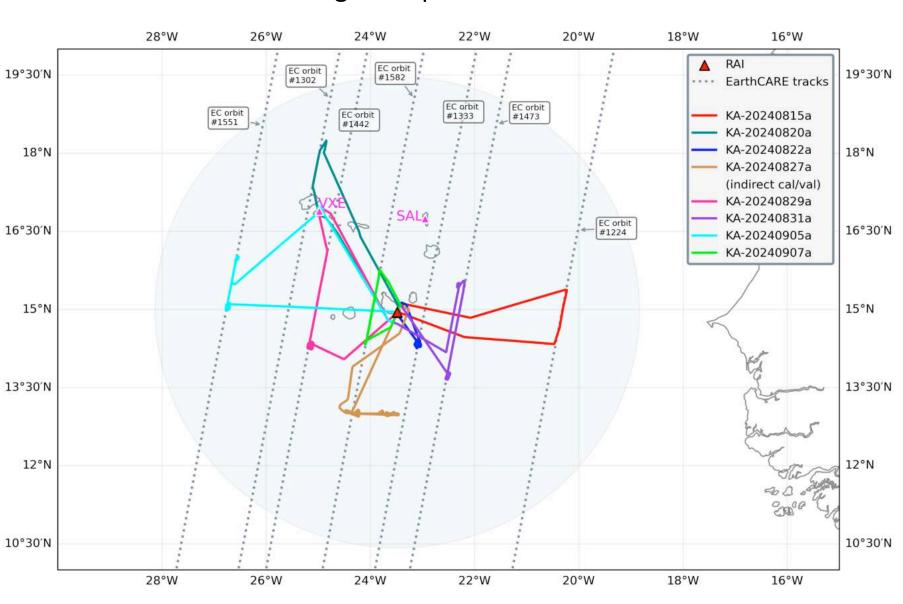
3 aerosol flights underneath EarthCARE

4 flights with in-cloud data underneath EarthCARE

- Liquid-only clouds
- Mixed-phase clouds (down to -19°C)

Coordination

- HALO (4 flights)
- ATR-42 (4 flights)
- Mindelo (3 flights)
- RV Meteor (1 flight)



Instrumentation on the King Air

Aircraft specifics:

Range: 2000 km (4-5 hours)

Science speed: 70 m/s

Transit speed: 125 m/s

In situ probes: SPEC Hawkeye, DMT CAPS

- Cloud droplets (2-50 μm)
- Ice crystals (up to 1.5 mm)
- Aerosols (>0.61 μm)





SPEC Hawkeye probe

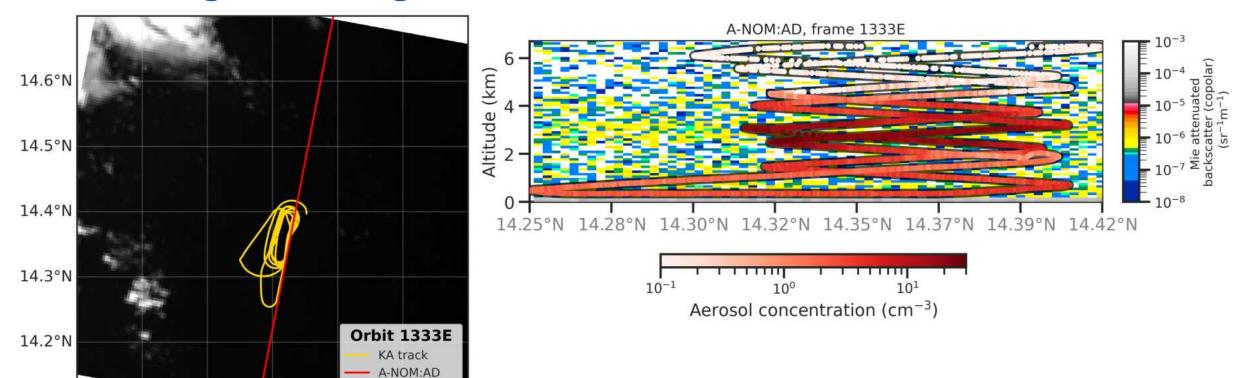




Quicklook of cloud droplets and ice crystals during the flight

Validating ATLID target classification

M-RGR-1C:AF



Flight on 22nd August 2024:

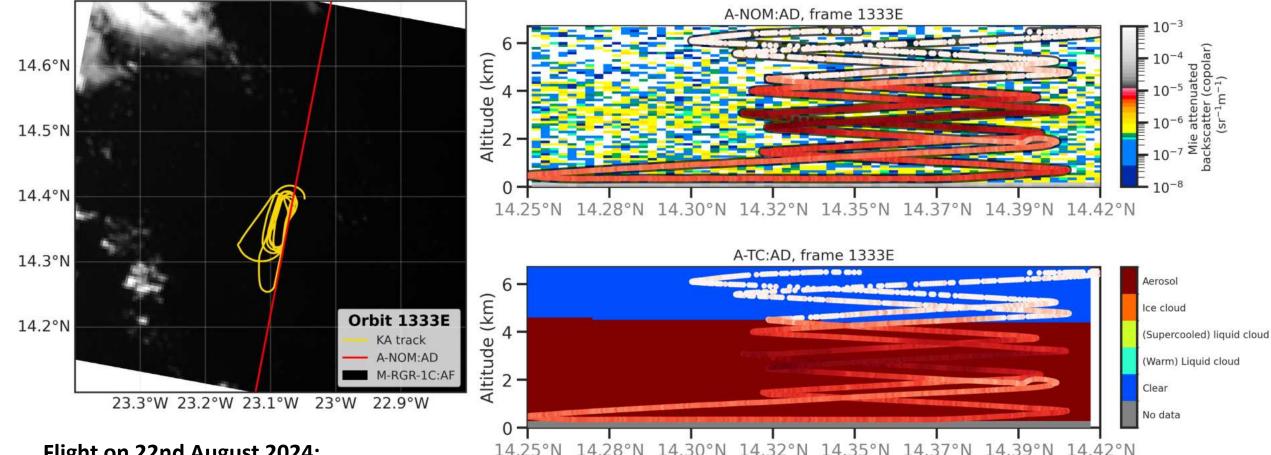
target orbit #1333

Strategy:

EarthCARE overpass (aerosol spirals)
Collocation with ATR-42 and HALO

23.3°W 23.2°W 23.1°W 23°W 22.9°W

Validating ATLID target classification

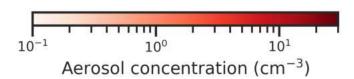


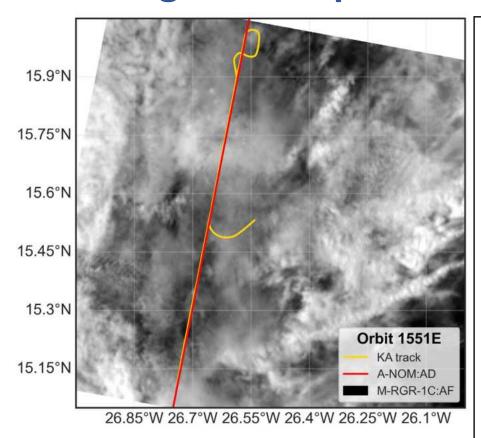
Flight on 22nd August 2024:

target orbit #1333

Strategy:

EarthCARE overpass (aerosol spirals) Collocation with ATR-42 and HALO





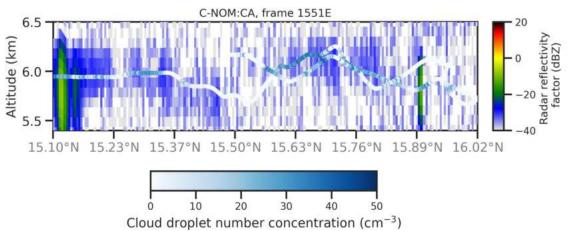
Flight on 5th September 2024:

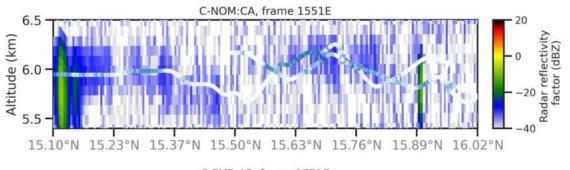
target orbit #1551

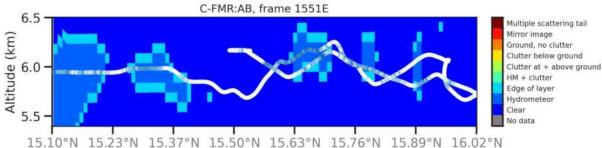
Strategy:

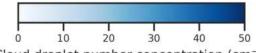
EarthCARE overpass
Porpoising to envelop cloud deck



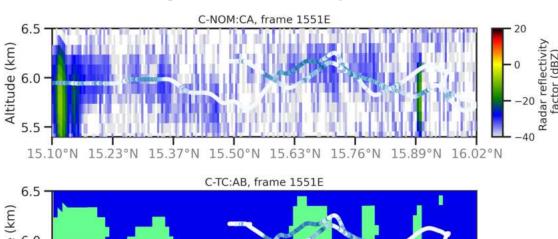


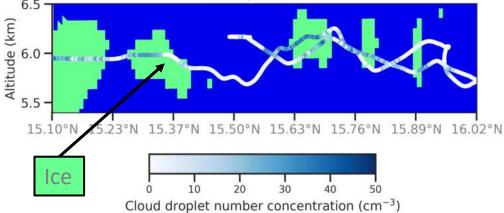


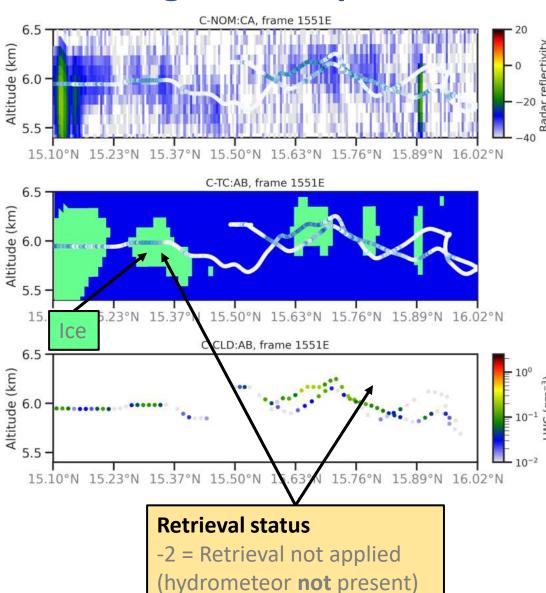


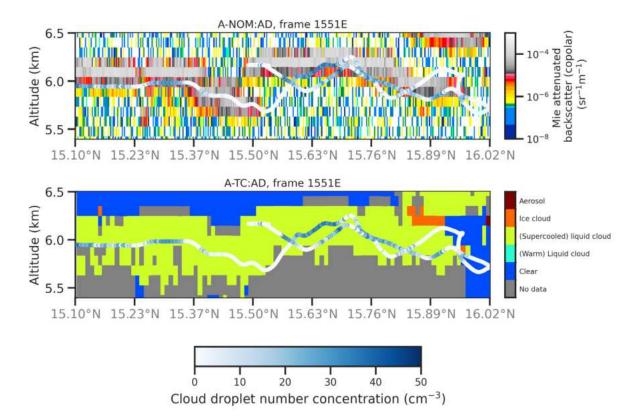


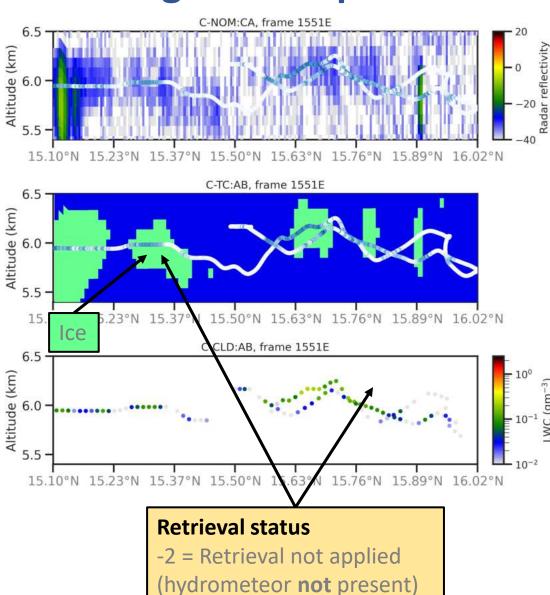
Cloud droplet number concentration (cm⁻³)

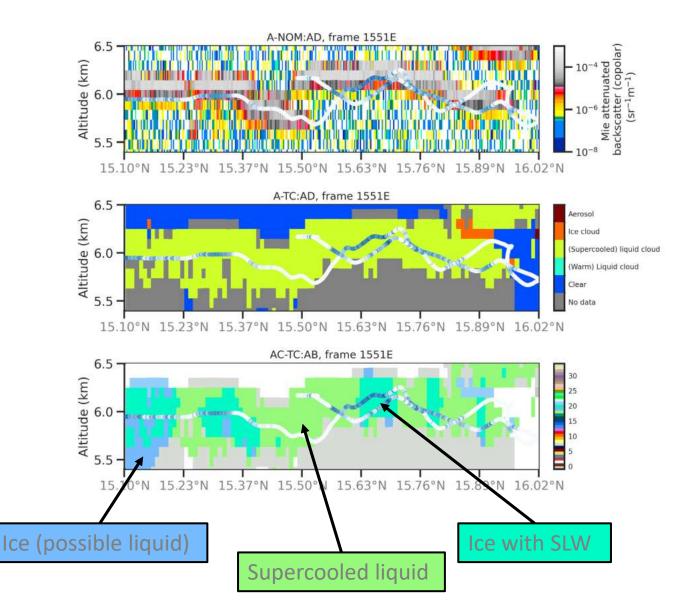


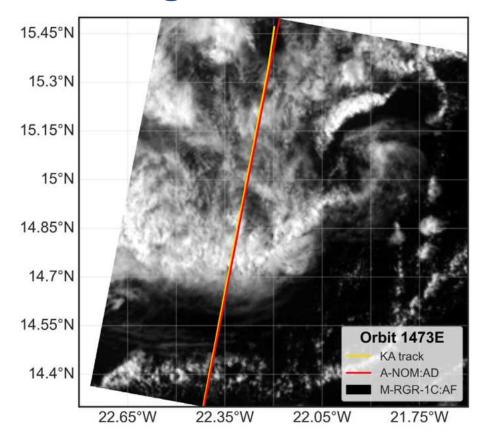


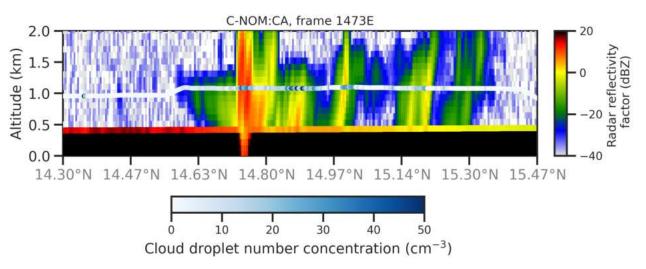








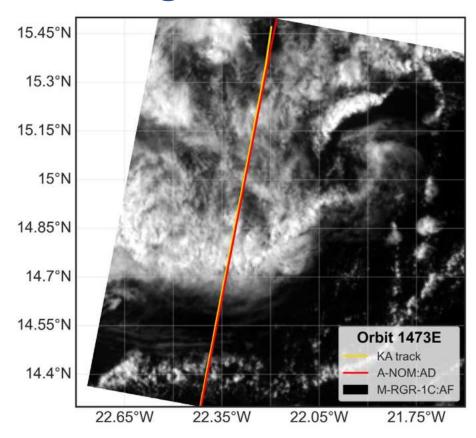


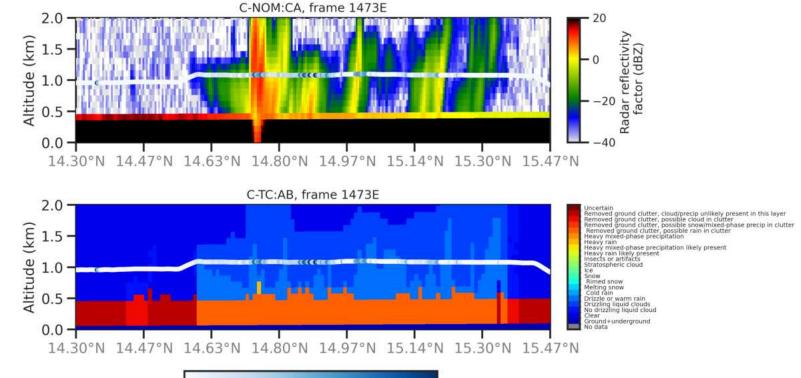


Flight on 31st August 2024:

target orbit #1473

Strategy:



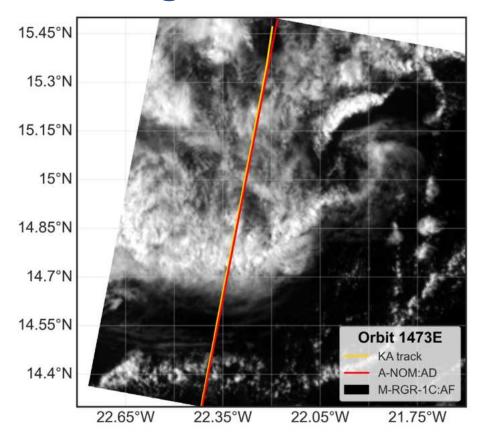


Cloud droplet number concentration (cm⁻³)

Flight on 31st August 2024:

target orbit #1473

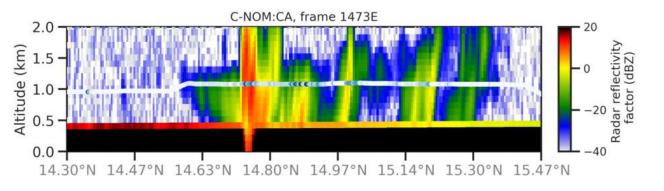
Strategy:

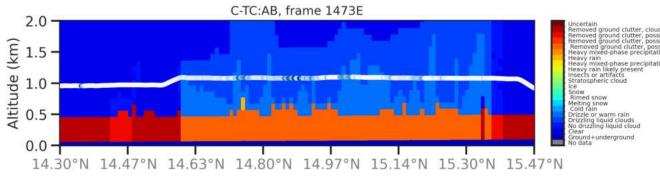


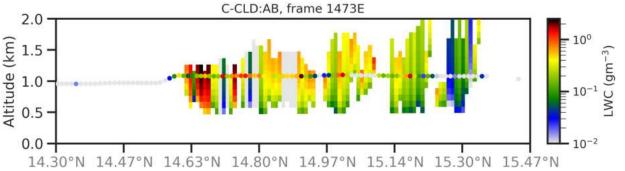
Flight on 31st August 2024:

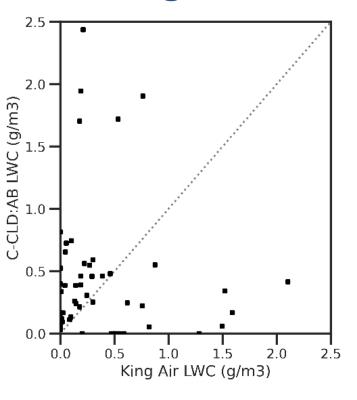
target orbit #1473

Strategy:



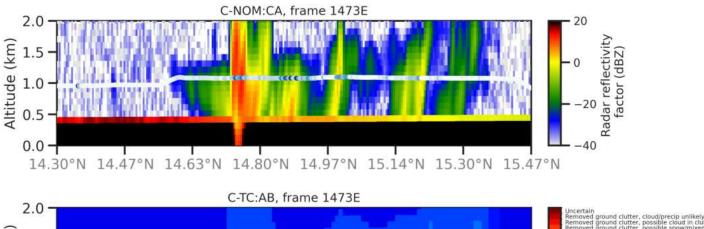


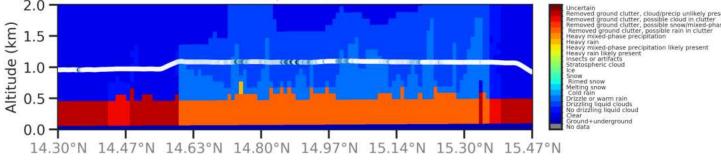


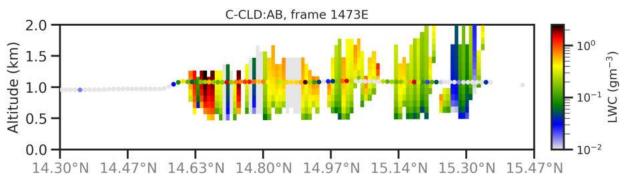


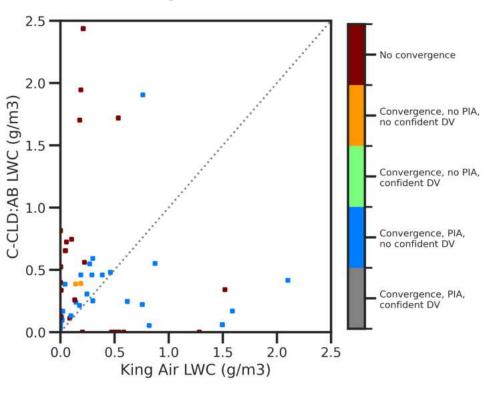
Flight on 31st August 2024: target orbit #1473

Strategy:





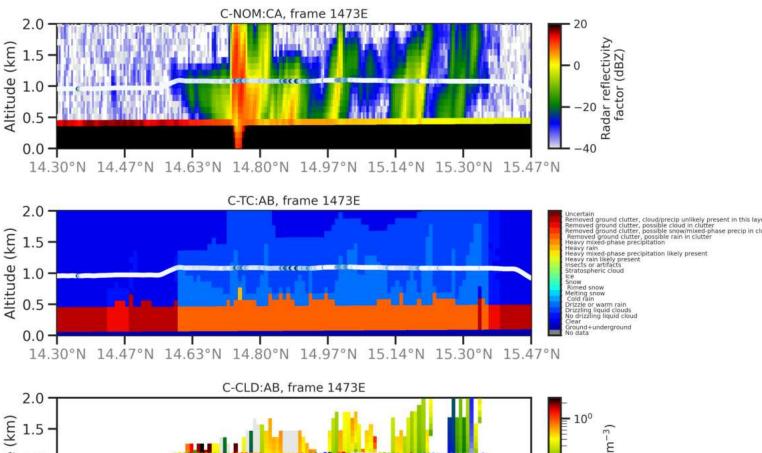


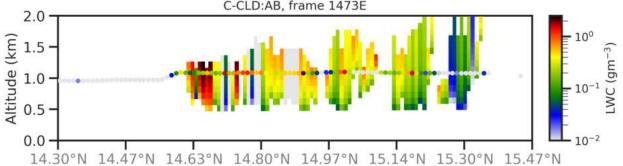


Flight on 31st August 2024: target orbit #1473

target orbit #1-

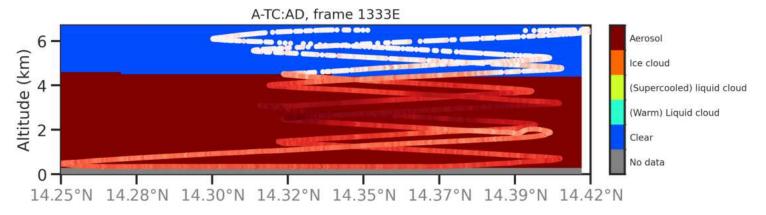
Strategy:

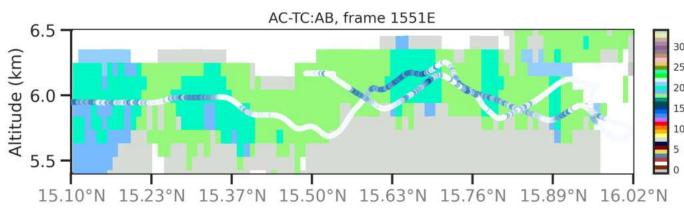




Preliminary takeaways

Aerosol layer height from A-TC:AD matches in-situ observations.





CPR and ATLID retrieve thin cloud.

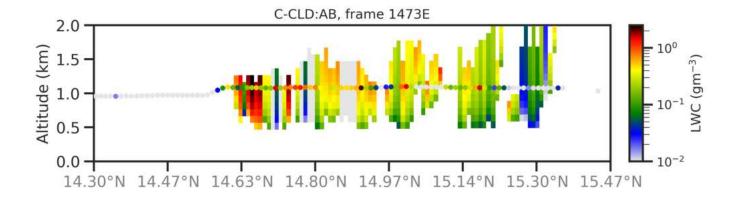
C-TC:AB classifies supercooled liquid cloud as ice, corresponding C-CLD:AB retrieves no water content.

Discrepancy between observed and retrieved C-CLD:AB LWC.

Collocation?

Measurement uncertainty?

Retrieval status?



Preliminary takeaways



Validation of EarthCARE aerosol products using data recorded in Northern-Norway

Mathilde Carbonnel¹, Martin Flügge¹, Tim Carlsen², Robert Oscar David²

The Arctic Lidar Observatory for Middle Atmospheric Research (ALOMAR) is an advanced laboratory, specialized in both passive and active remote sensing of all layers in the Arctic atmosphere. Located north of the Arctic Circle (69°N, 16°EI, ALOMAR is one of the few observatories in this region that routinely measures cirrus clouds, tropospheric aerosol concentrations, stratosoheric ozone, as well as wind speed and temperature in the middle atmosphere using lidar remote sensing. ALOMAR hosts two RMR lidar systems and an ezone lidar system. The RMR lidars are capable of performing measurements during daylight and nighttime. Additionally, ALOMAR hosts a CIMEL sun/moon photometer, which routinely measures acrosol and water vapor content in the troposphere.

urements from the ALOMAR tropospheric lider system (ATL) and CIMEL photometer contribute to validation of EarthCARE products as part of the Cloud and EarthCARE cal./vol. Observations (CELLO) project (EVID 18). The location of Andaya is ideal for the validation of polar orbiting satellites, with a nearby overpasa has 3 - 4 overpasses per week within a 100 km radius of ALOMAR.

As part of the Vesteralen archipolago in Northern Norway, Andeya is situated at the crossroads of air masses entering and leaving the Arctic. This unique location results in frequent encounters with pristine Arctic air masses and elevated polluted layers from long-range transport of wildfire smoke, Saharan dust, and volcanic aerosols. Given the scarcity of high-latitude observatories, remote sensing measurements at ALOMAR offer an excellent opportunity to validate ATUD serosol products. Furthermore, ALOMAR's frequent cirrus cloud occurrences make it an ideal location for Attended to ALOMAR's frequent cirrus. validating EarthCARE's retrievals of Arctic cirrus clouds.



The ALOMAR tropospheric lidar system (ATL)

The ALOMAR tropospheric lidar system uses a seeded Nd:YAG power laser at 1664 nm (primary wavelength), 532 nm (second harmonic) and 355 nm (third harmonic). At 532 nm, the light is polarized and two detectors, one with orthogonal and one with parallel polarization are used to determine the depolarization at 532 nm. The ATL also has a Raman detector at 387 nm. To cover a larger range of distances the ATL uses two simultaneous detection channels for every wavelength (except at 387 nm), an analog mode for stronger signals (especially in the near range) and a photon-counting mode for weaker signals (mostly for the far range). These two channels can be joined through a gluing algorithm.

EarthCARE's ATLID, the outgoing light of the ATL at 355 nm will also ave to be linearly polarized. The ATL receiver will be equipped with orthogonal and parallel polarization channels.

Composition between ATL at ALOHAN and curb CARE			100		
	ATL	ATLID	-	Acres 1	A Bear
levelyingth.	1064, 542, 355 mm	254,8399		All controls	
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nuttes/potarization	Literal	Literar	44000	100	1
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ertical rescription	7.5 (0	103 m (up to 25.2 km)	100	5344	Contract of the Contract of th
rittude range	0.5 - 16 km	-0.5 - 46 km	E-W	-100 B	1000
etection charactels	185 hm, All rim co and 1700s, 1064 mm, 317 mm		48		W.A
		241,401,701	(Left)	7he 47L hour	generator und



eesa

Andøya Space

UNIVERSITETET

The CIMEL CE318-T is a high-precision multiband sun/moon photometer operated by the University of Valladolid (Spain) and Andaya Space. It uses direct measurements of the sun and moon irradiance to determine the attenuation in the air by acrosola and water vapor. By making these measurements at ten different wavelengths a better characterization of the aerosol and their scattering properties can be conducted. Although the CIMEL is capable of measuring radiation from the moon, it is not possible to retrieve the Aerosol Optical Depth at night due to the limited UV radiation reflected by the moon. The instrument is part of the AERONET network.

Correlated measurements between the CIMEL and EarthCARE on 12-SEP-2024 show good

agreement with the EarthCARE ATL ALD 2A optical thickness product for the part of the ATLID

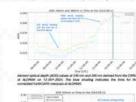
ground truck (descending orbit, 01659C) that was over the ocean. The optical thickness derived

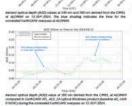
from ATLID data shows an expected increase for the part of the around track that was over land.

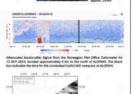
Validation of EarthCARE

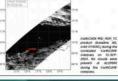
ALOMAR intends to perform correlated EarthCARE measurements with the ATL and the CIMEL at least once per week, if

Product		Validation energies eastweed	Parmerks
Level 2 - Charles	, vertically integrated	and toyer wit	e retrieval product
Taiget classification	Charles seeks	ves	arts for applicably thin dirrus, in alty obser probes
	Comments printe	181	ATL THE VISITION IN THE CHART
	Aerosal teyer height/depth	YES	ATT.
	Aerosal Payer chemification		411.
	Cloud setection, Cloud seroid distribution	YES	-
ice cloud & znow	Optical thickness	185	ATL CHIEL
Annual (per species)	AATSON SQUICES TOCKNOON	YES	ATL CAMEL
(B) (C) (C) (C)	Angeritm exponent	YKS	CANAL.
Level 3 - Vertice p	cuffee at readil	100	
Target classification	Countries president on fraction	100	ATL for come.
ICF CHANT & DIOW	Extraction-to- treatopatter ratio	WI	ATL
Astrone	Particle Steam	YES	Aft. (new 255 channel)









Poster #19

Mathilde Carbonnel, Martin Flügge

Thanks to Shannon Mason (ectools) and Leonard König (oads-download)



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