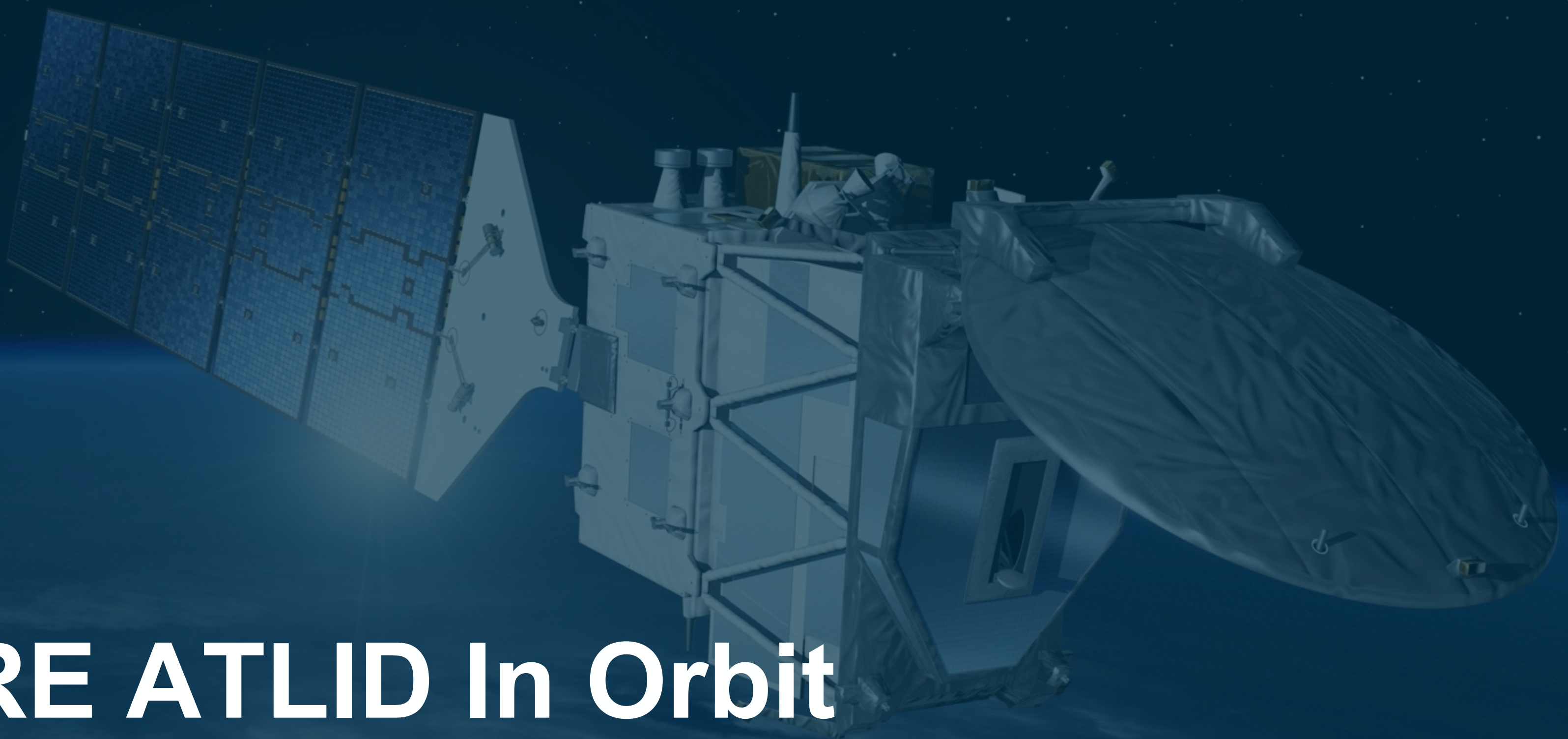


EarthCARE ATLID In Orbit Characterisation, Calibration and Verification

2nd ESA EarthCARE Validation Workshop

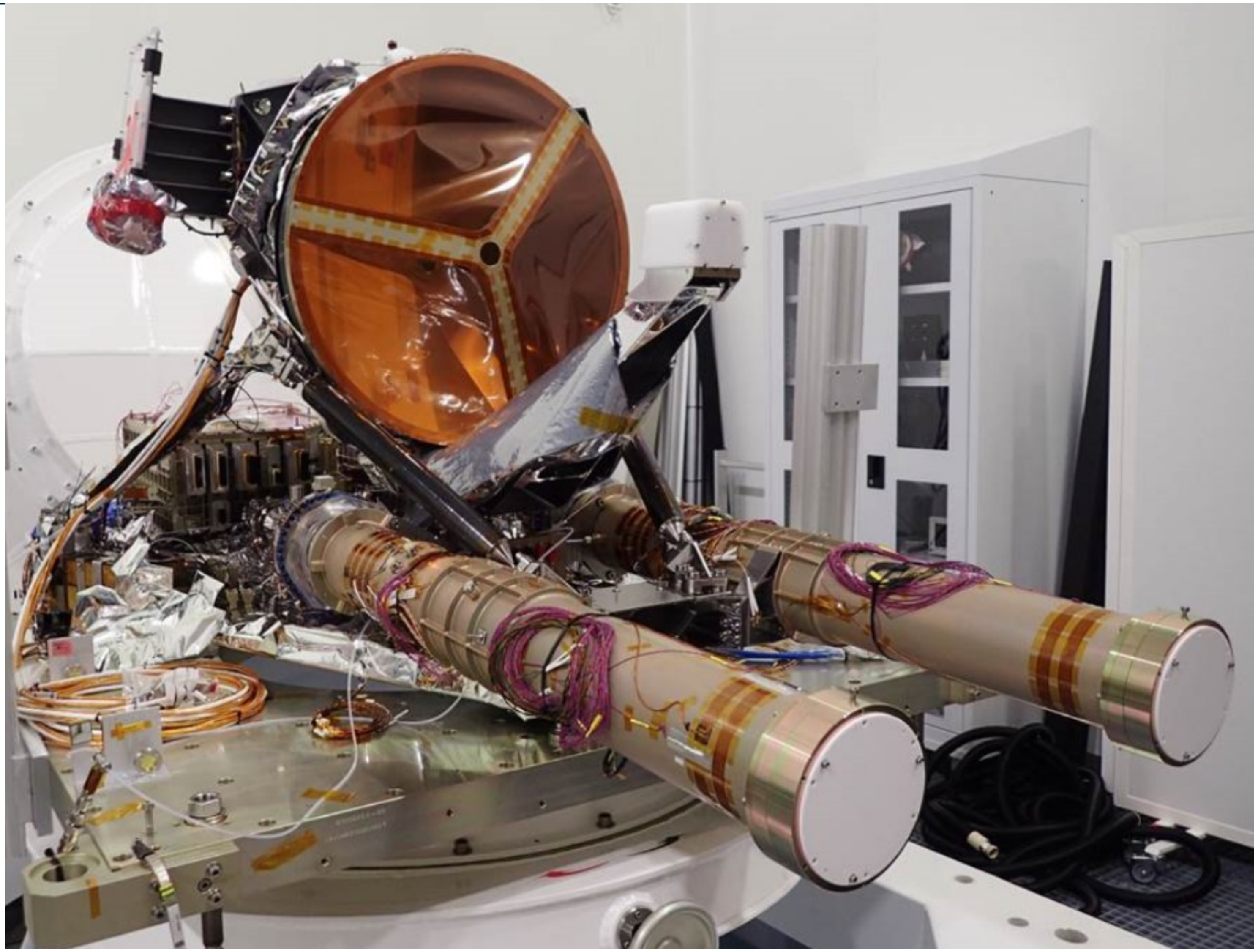
Georgios Tzeremes

25-28 May 2021 (online)

Atmospheric Lidar - ATLID

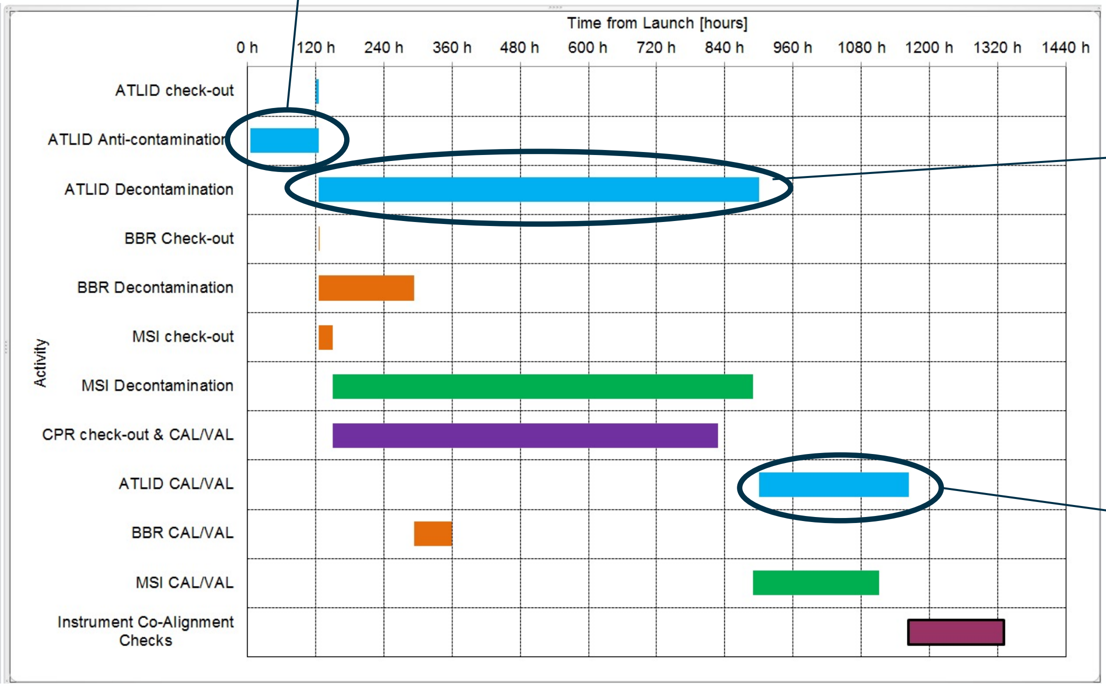
- Atmospheric Lidar
  Laser wavelength λ = 354.8 nm, linearly polarised
- High Spectral Resolution Lidar (HSRL) using Fabry-Perot etalon centred on the laser centre wavelength → separates molecular from particle backscatter signals (lidar ratio measured)
- 3 channels receiver :
  - Rayleigh scatter
  - co-polar Mie
  - cross-polar
- Main products are profiles of
  - molecular backscatter signal
  - cloud and aerosol backscatter signal, co-polar
  - cloud and aerosol backscatter signal, cross-polar
- Sampling: PRF 51 Hz (fixed), along-track 280m (2 shots), vertical 103m up to 20km, 500m from 20 to 40 km
- Mass: 550 kg, Power: 465 W, Data rate 404 kb/s

  Industry: ADST (F) + Leonardo (I)



ATLID Switch on & IOCV activities

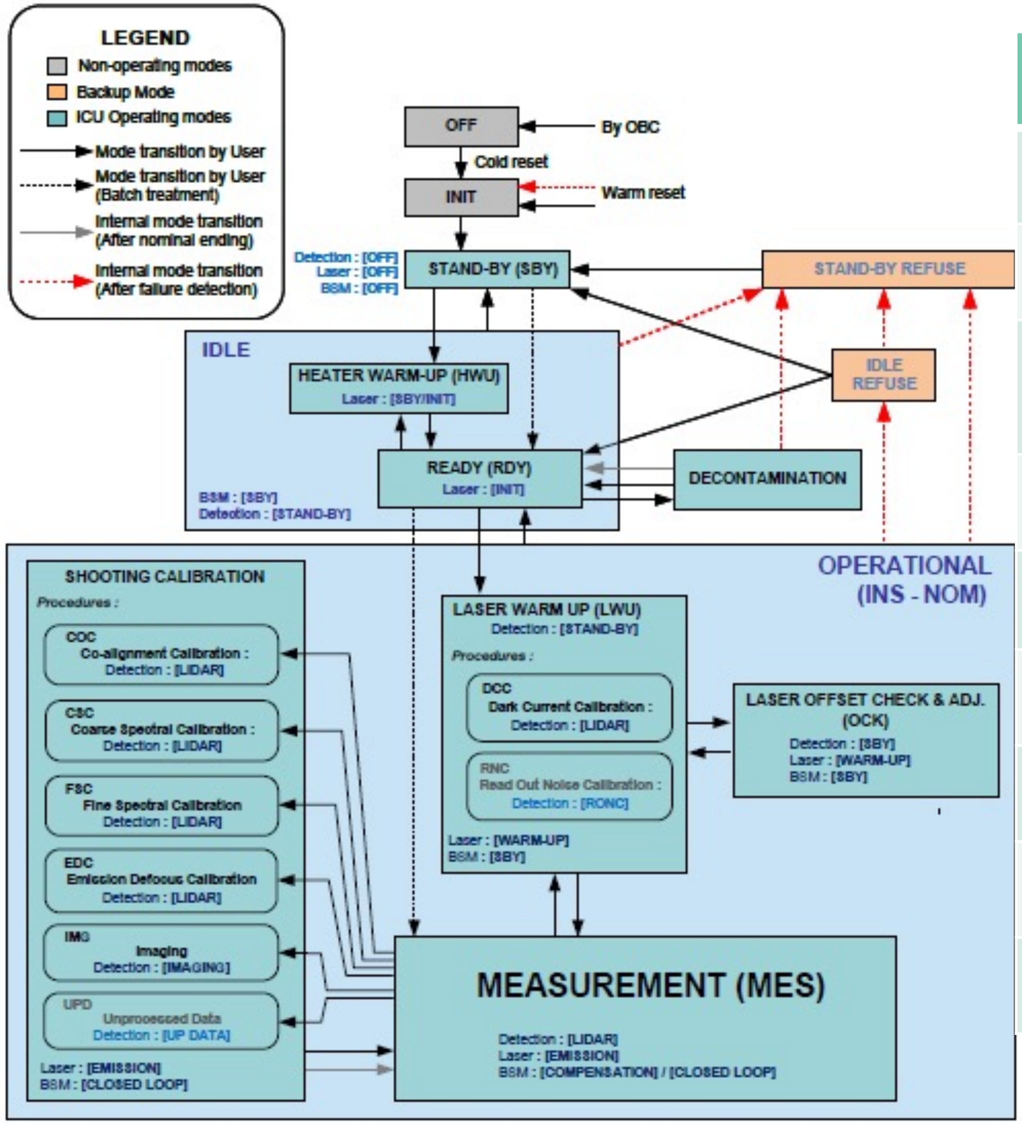
- ~5 days
- ATLID off
- Heaters “protect” E-BEX interface



- ~28 days
- ATLID in INI,SBY,LWU,RDY, DEC,RDY,LWU,MEA
- Instrument Switch on, test of Op modes, Dec mode (heat up E-BEX), certain CAL/VAL activities

- ~10 days (one laser, min reqs)
- ATLID On, MEA mode, calibration modes
- Cal / Val campaign, first ATLID products

Functional - Shooting Calibrations

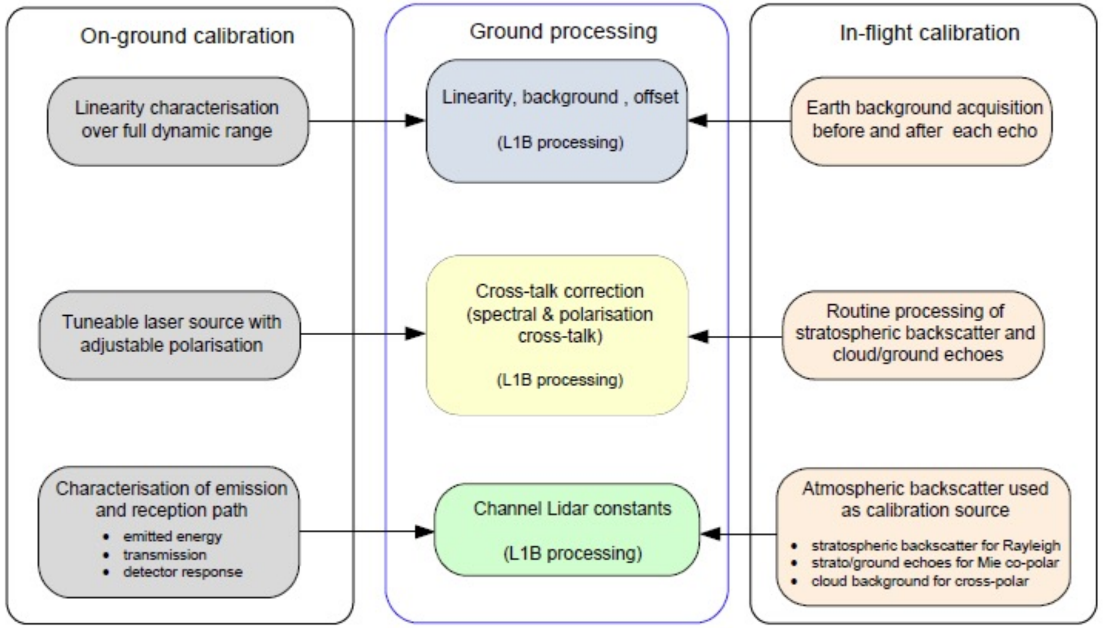


Description	Instrument interruption	Ground processing	Operational constrains	Periodicity & Duration
Dark Current Calibration	Y	On-line processing	S/C eclipse	Monthly/ 5 min
Emitted Energy	N	On ground data calibration	No	Continuous
Coarse co-alignment calibration	Y	Off-line processing	S/C eclipse	Beginning of life/ 20 min
Fine co-alignment calibration	N	Off-line processing	(After COC)	Monthly
Emission defocus calibration	Y	Off-line processing	No	Once per laser initiation/ 70 h
Coarse Spectral calibration	Y	On-line processing	No	Once per laser initiation / 24 min
Fine spectral calibration	Y	On-line processing	(After CSC)	Weekly/ 10 min
* (x-talk verification)	*	*	*	*
Fibre spot position on DFA	Y	Off-line processing	S/C eclipse	Beginning of life /10 min

ATLID Calibration/Validation Overview

ATLID In Orbit Validation has started with an extensive on-ground calibration approach, allowing an initial population of the level 1B algorithms. This sets a preliminary starting point for early in-orbit operation.

Key parameters such as spectral cross-talk, lidar constants are then routinely calibrated in flight in order to improve and correct for in-flight drifts.



	measured pre-flight	measured in-flight	applied in-flight
Dark signal non-uniformity (DSNU)	✓	✓ (mon, cm)	✓ from CCDB
Linearity	✓	✘	✓ from CCDB
Background	✓	✓	✓ **directly**
Spectral cross-talk (χ, ε)	✓	✓	✓ **directly**
Polarisation cross-talk (ψ)	✓	✓	✓ from CCDB
Lidar constant (K) – absolute cal.	✓	✓ (mon)	✓ from CCDB

mon = for monitoring, CCDB updates as needed cm = needs dedicated calibration mode

In-Orbit Radiometric Calibration: Background Signal Subtraction

Mode: Background signal subtraction

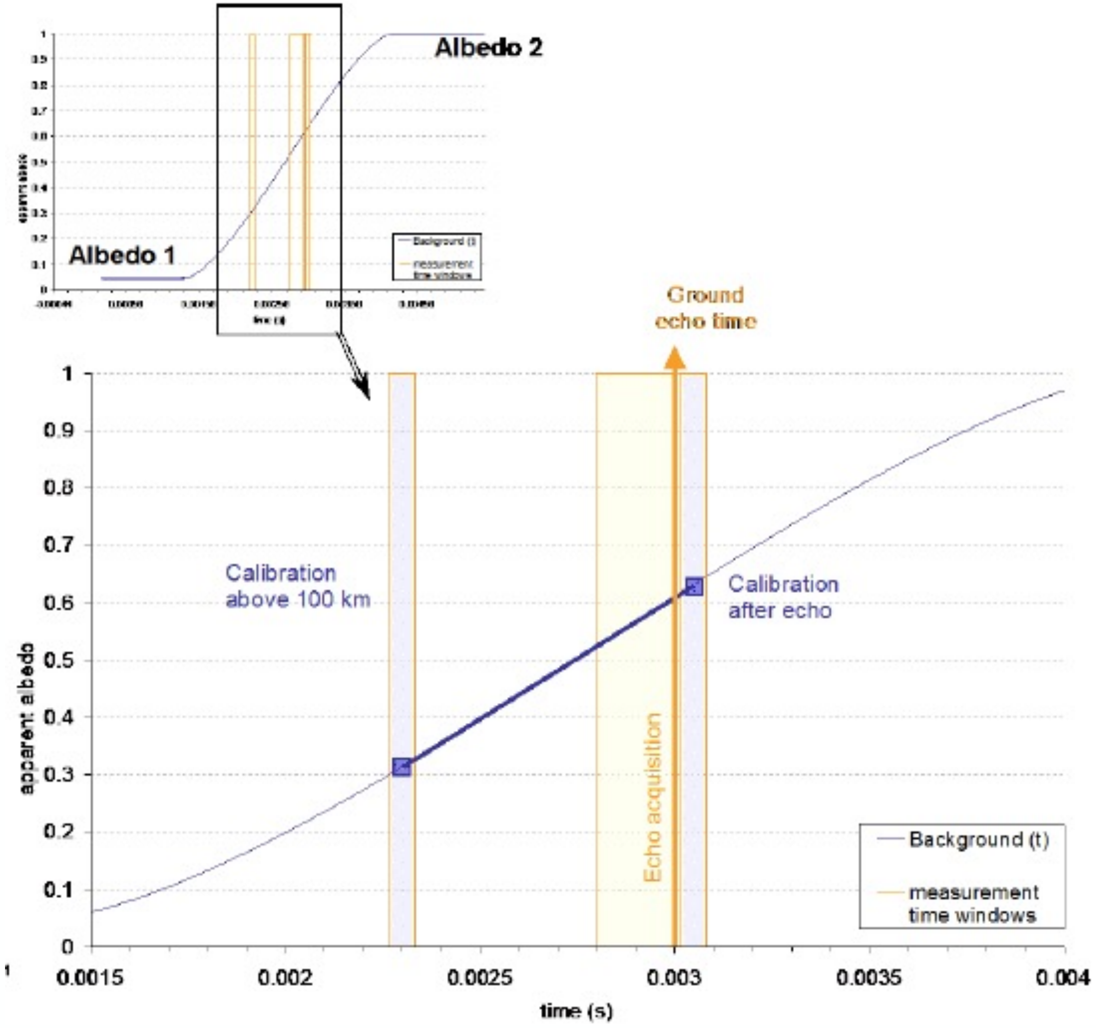
Verification objective: background noise estimation and Subtraction.

Periodicity: At each echo

Instrument mode: MES

Constraints: Background signal is acquired for a time window of 67µs (10 kms long sample) above 100 kms and after echo sample between -2 km and -12 km altitude.

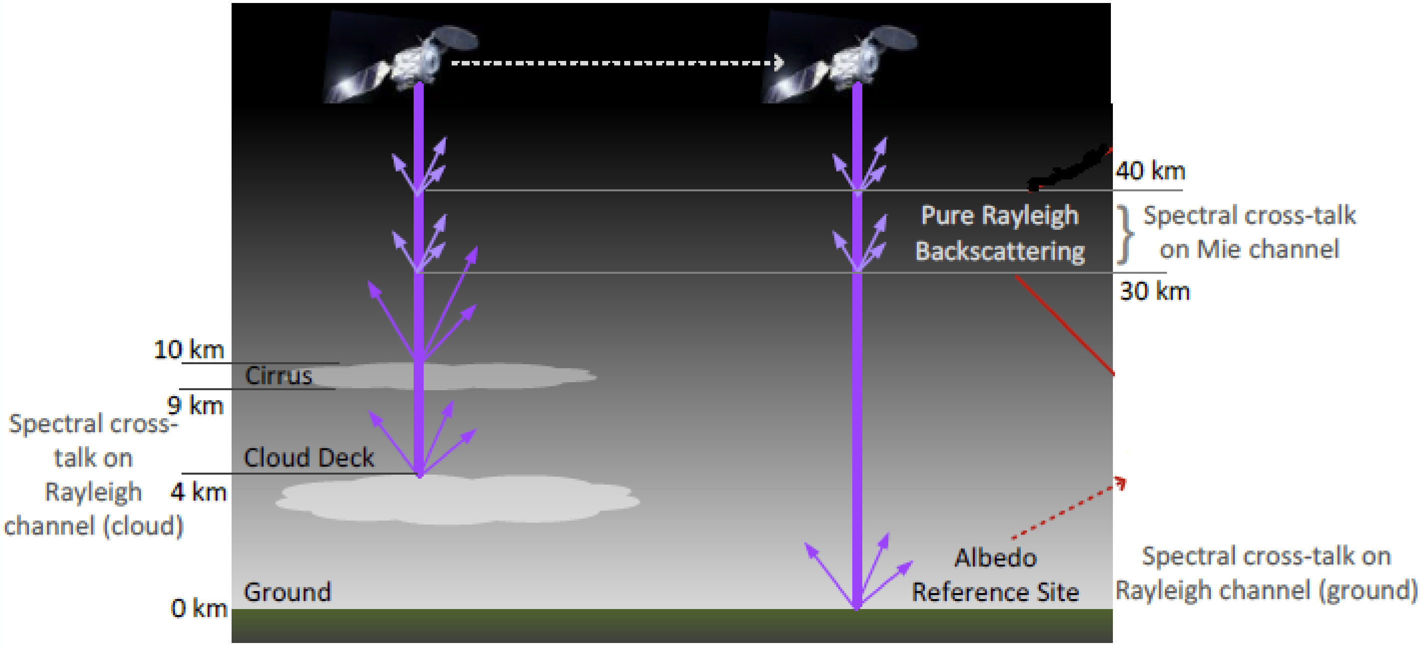
Comment:
- Linear interpolation between the two altitudes allows estimating background level and offset for each echo sample.
- value subtracted from atmospheric echo samples.



In orbit: Spectral cross-talk Calibration

Mie (χ): A pure Rayleigh signal can be measured when observing the high layers of stratosphere (>30 km of altitude) where only molecular backscattering occurs. This calibration of χ can then be performed at each laser shot (500 km averaging).

Rayleigh (ε): A pure "Mie spectrum" can be measured for instance when observing a ground echo or the echo from a dense cloud. In this case, the Rayleigh scattering contribution is negligible, or can be easily subtracted. Each time a sharp echo is recorded, an estimation of e can be calculated, completing the calibration. A filter is applied to reject non-usable echoes.



In-Orbit Absolute Channels Calibration

Rayleigh channel absolute calibration

- measuring the return from high atmospheric layers, between 30 and 40 km altitude.
- continuously monitored over the orbit with signal horizontal averaging over 500 km.
- night data are favored.

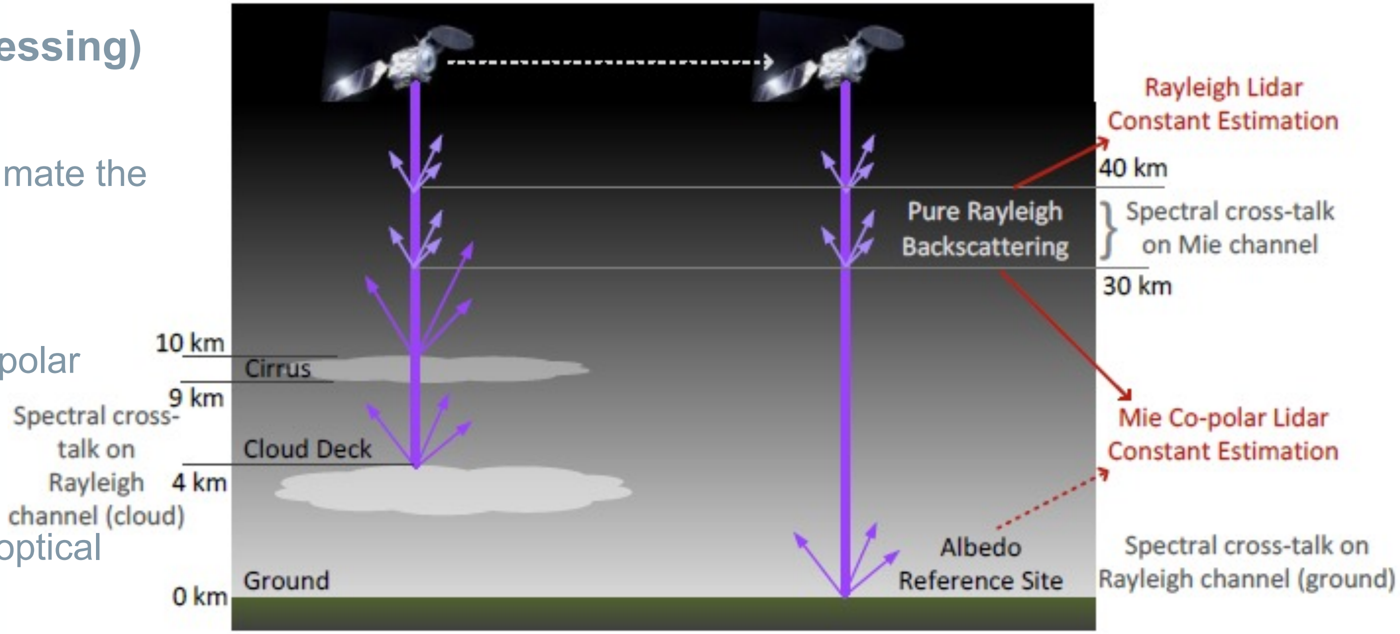
Mie co-polar channel absolute calibration (off-line processing)

Method 1 : absolute calibration for a pure Rayleigh signal :

- the return from stratospheric layers (above 25 km) is used to estimate the Mie co-polar channel response for a pure molecular backscattering.
- Only night data will be used.
- knowledge of the relative transmission of HSR etalon on Mie co-polar and Rayleigh channels for a Rayleigh spectrum

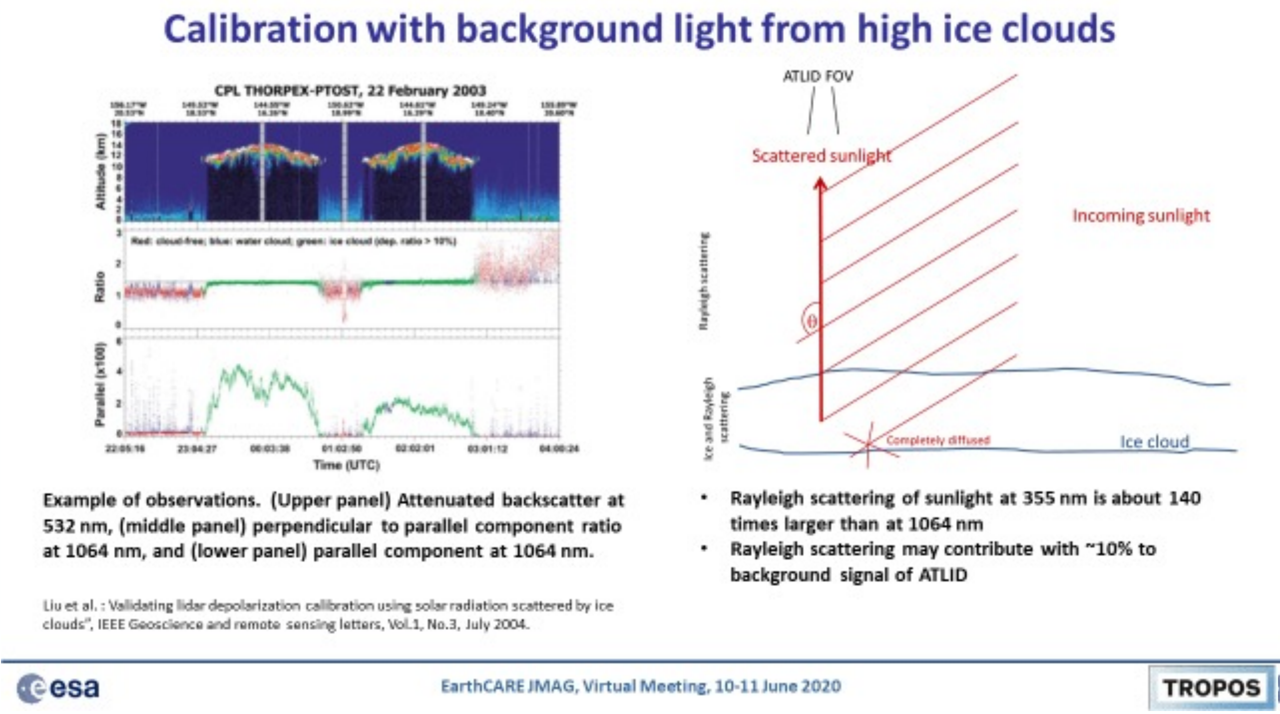
Method 2 : absolute calibration for a pure Mie signal :

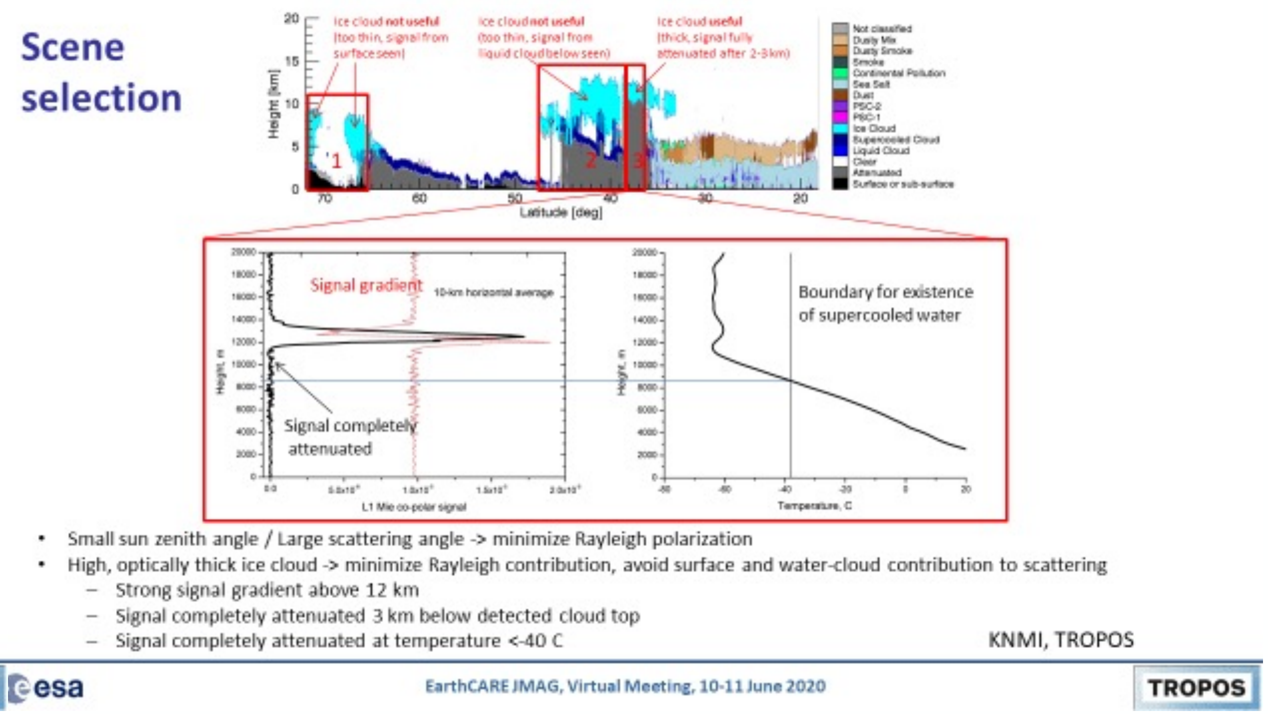
- use of ground echoes from characterised sites (ground albedo, optical thickness of the atmosphere).
- every 6 months and to monitor the trend in between using averaged ground echoes on poles and atmosphere optical thickness knowledge.



In-Orbit Mie cross-polar Channel Calibration

The method proposed for Mie co-polar and Rayleigh channels is not applicable for the cross polar channel as the depolarisation of the scattering target must be characterised. It is thus proposed to calibrate the cross polar channel in relation to Mie co-polar channel using the Earth background light in conjunction with the Mie co-polar channel, as already validated for CALIPSO.





* Proposed approach, synergetic to other EarthCARE instruments.

Thank you

~123 seconds of light