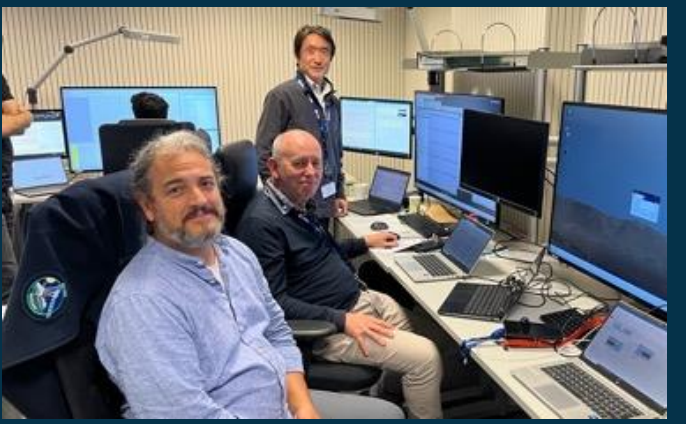
Commissioning Phase Summary

Validation workshop 14 Jan 2024

Kotska Wallace, ESA Commissioning Manager

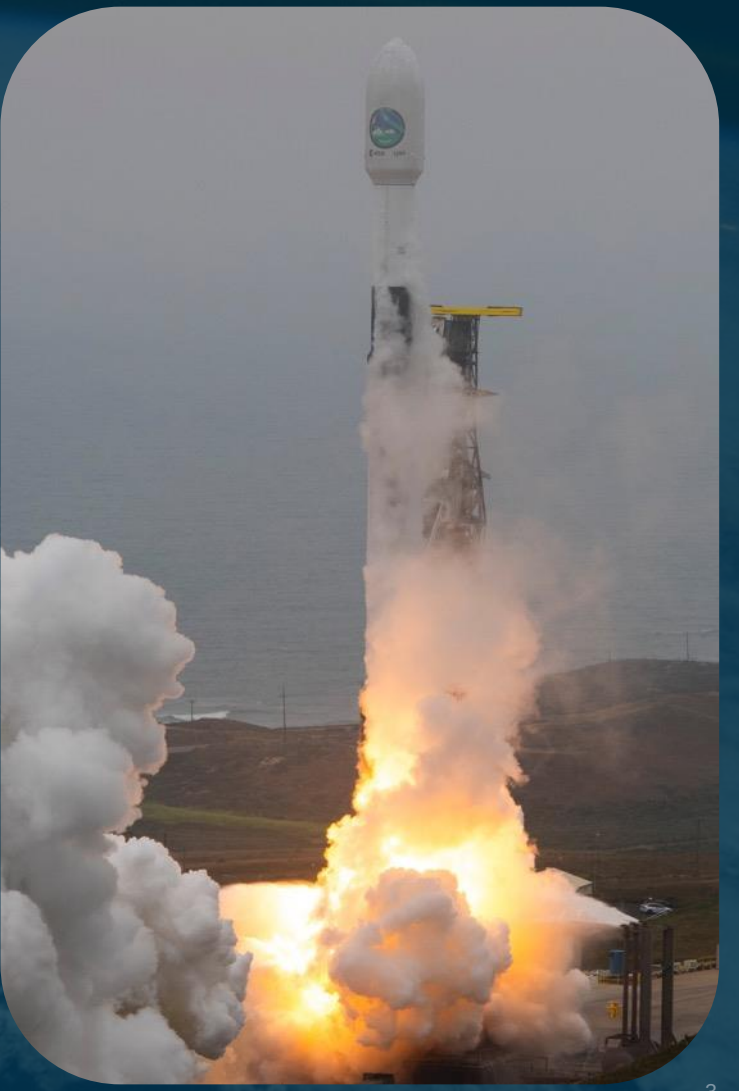
LEOP and commissioning summary

- EarthCARE LEOP completed 1.5 days afer launch
- 1 week later, EarthCARE encountered a safe mode due to anomalous thrust behaviour, which was recovered the next day
  - Some weeks of the commissioning were dedicated to tests to investigate and identify new RCS control parameters
  - Routine manoeuvres are now performed weekly, since ending an extended orbit drift phase in Sept.
  - Nevertheless, coordination has ensured CPR external calibration opportunities, instrument availability for numerous validation campaigns and ground track data to campaign teams
- CPR measurement mode after 15 days, RFCO 2 August
  - CPR anomaly has caused 15 refuse modes to date, software update anticipated
- BBR measurement mode after 21 days, RFCO 26 July
- MSI measurement mode after 7 weeks, RFCO 26 July
- ATLID laser switch on after 8 weeks, RFCO 10 August
  - Within 12 weeks, first image articles were published for all four instruments
  - Within 16 weeks, data synergy article published



RFCO = Release for Corellative Observations

Successful launch campaign



Launched 22:20 UTC, 28 May, from Vandenberg Space Force Base, on a SpaceX Falcon 9

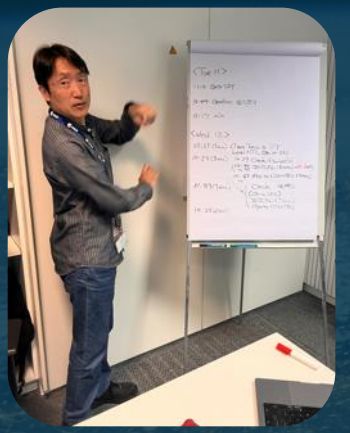
Early operations & start of commissioning

- Launch and Early Operations Phase
  - Separation detection after 11 minutes
  - Acquisition of signal and **deployment of Solar Array**
  - **CPR antenna deployment** after 24 hr
  - Critical platform systems check out
  - Less than 5 hr after launch, heaters on emission baffles protect ATLID exit optics from outgassed materials
  - ATLID Loop Heat Pipes unexpected operation(!)
  - LEOP complete after 1.5 days, 4 shifts

→ Operators move out of the Main Control Room

→ Platform commissioning, followed by instrument commissioning

Commissioning



September: Successful IOV Checkpoint

IOCR end 2024

Platform commissioning almost complete

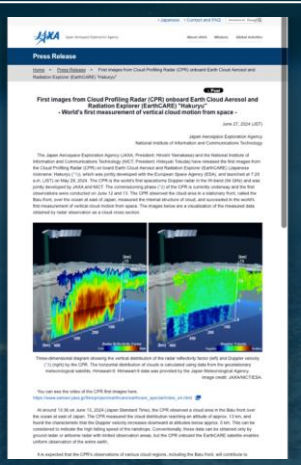
- Unexpected thruster plume impingement on the solar array delayed some activities related to orbit control

Payload commissioning

- All instruments switched on, decontaminations complete (instrument specific period), switched into measurement mode, **first science data produced**
- Initial calibrations complete, including two passes over CPR external calibration station --> complicated by orbit drift period
- **Four first image articles published**
- First L1 processor updates addressed minor bug fixes by 12 August
- **Level 1 data release to Validation Teams** staged through September, L2a phased releases will follow shortly

Project team now supporting Flight Control Team remotely on need basis

CPR first images, Baiu Front, published 27 June

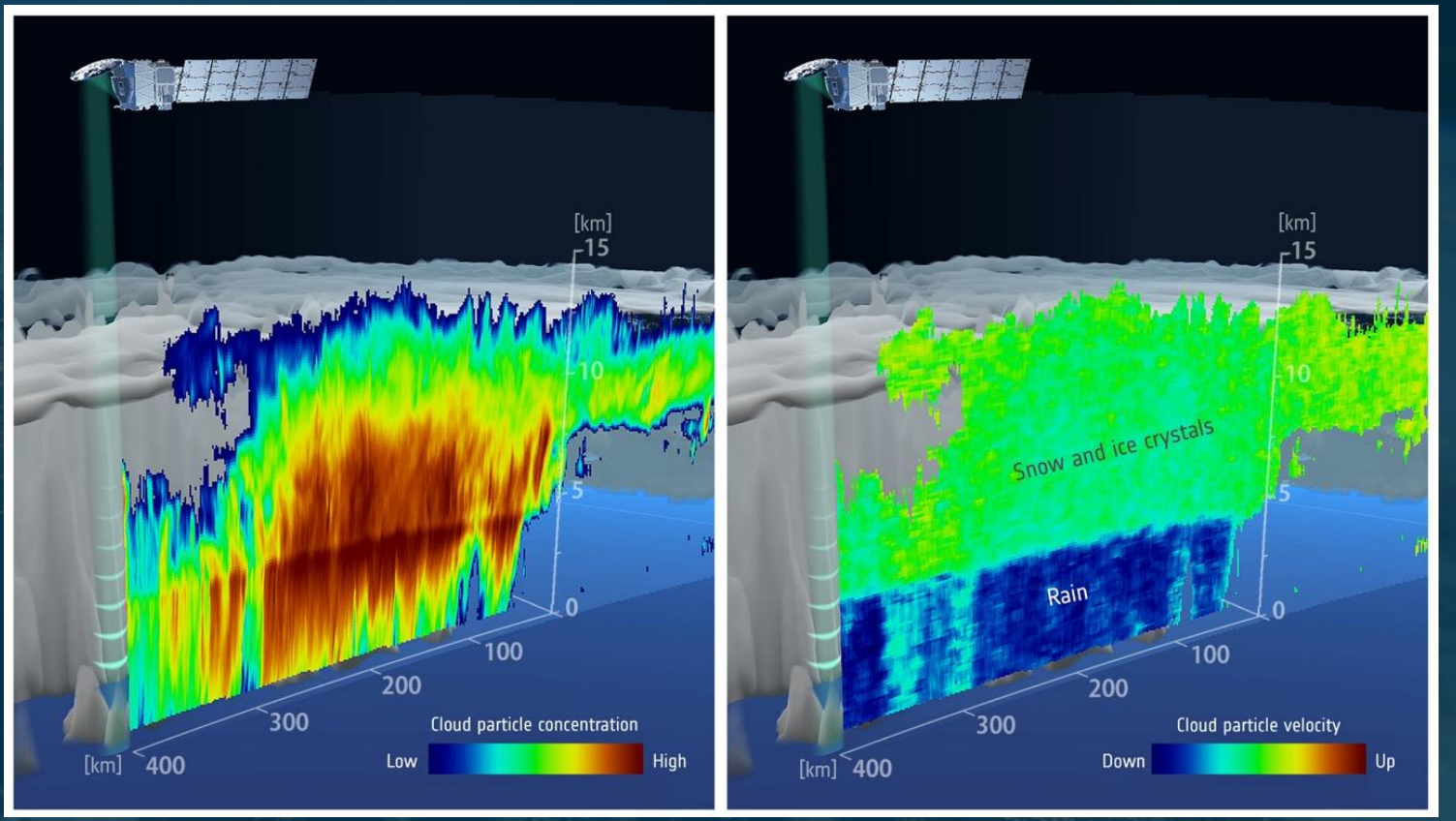


Producing (uncalibrated) data from a few days after switch on, although an autorestart ‘feature’ causes occasional non-availability.

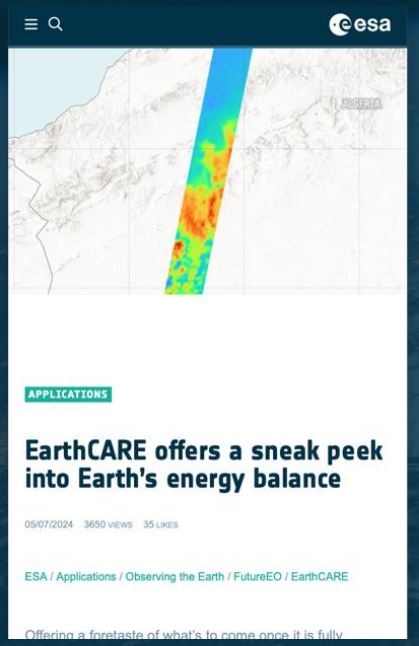
Calibration delayed ±1mo due to:

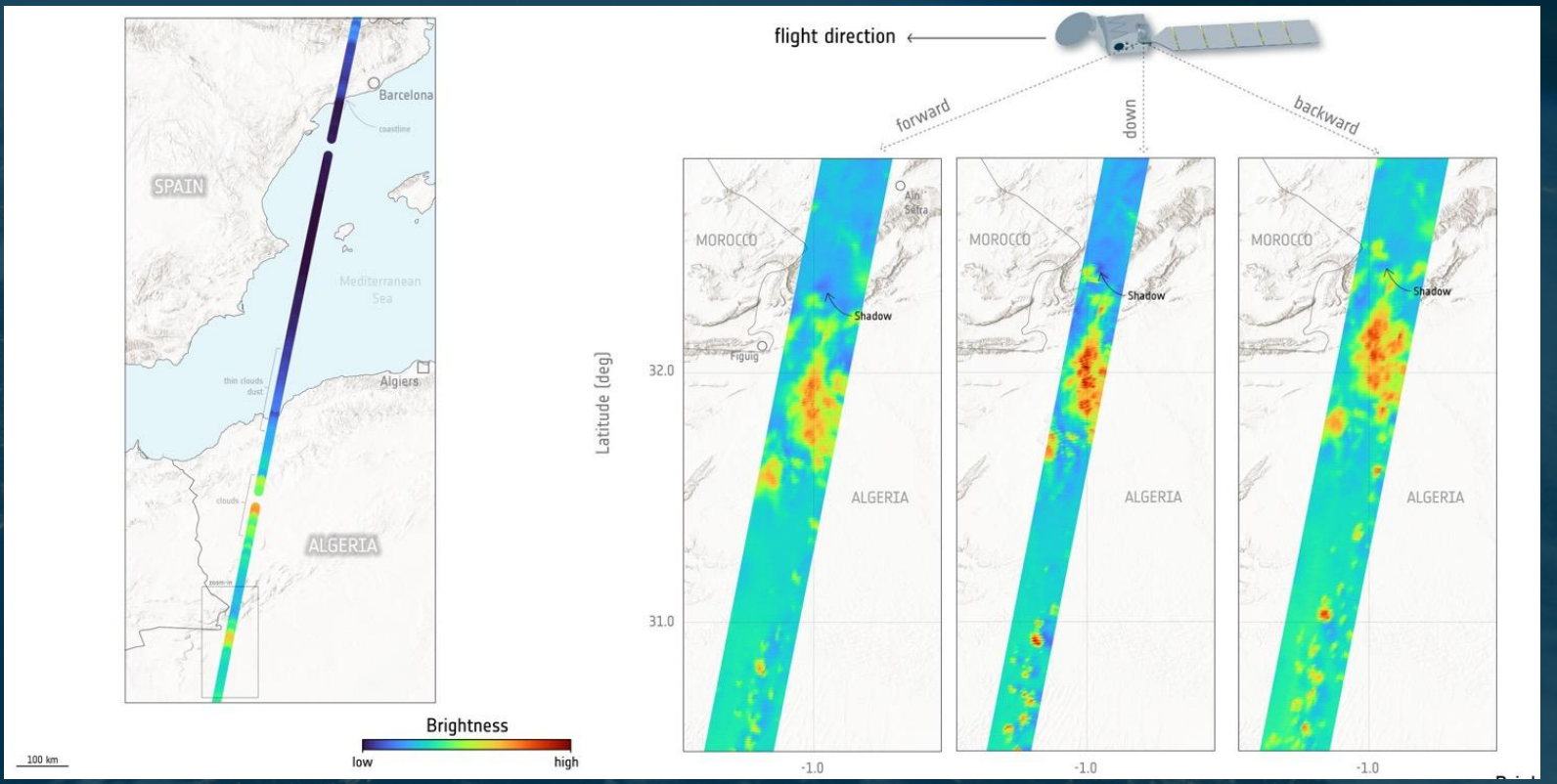
- Many commissioning activities repeated on the second redundancy configuration
- Now back on the nominal configuration

→ **Producing great data!**



BBR first images, Med./ N. Africa, published 5 July





Producing data from a few days after switch on, **data quality is good**.

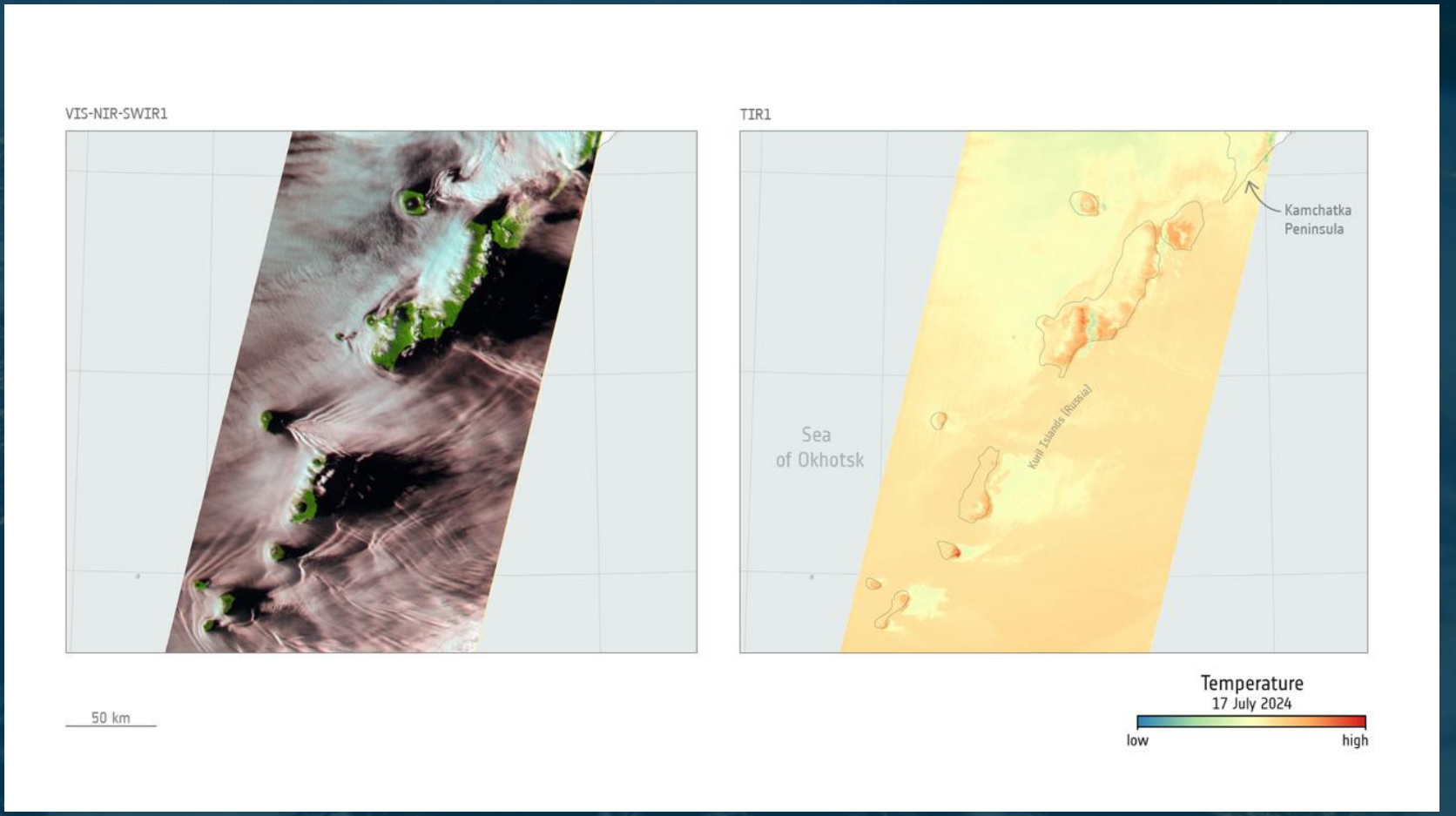
- 2 out of 3 monitor photodiodes, used to monitor optics aging, have an incorrect gain setting. Solved operationally with modified calibration timing.

MSI first images, Rome, Kuril Islands, published 24 July

Producing (uncalibrated) data shortly after 5 weeks decontamination.

- Small update of co-registration and pointing files.
- Small updates in radiometric response and solar diffuser calibration files.

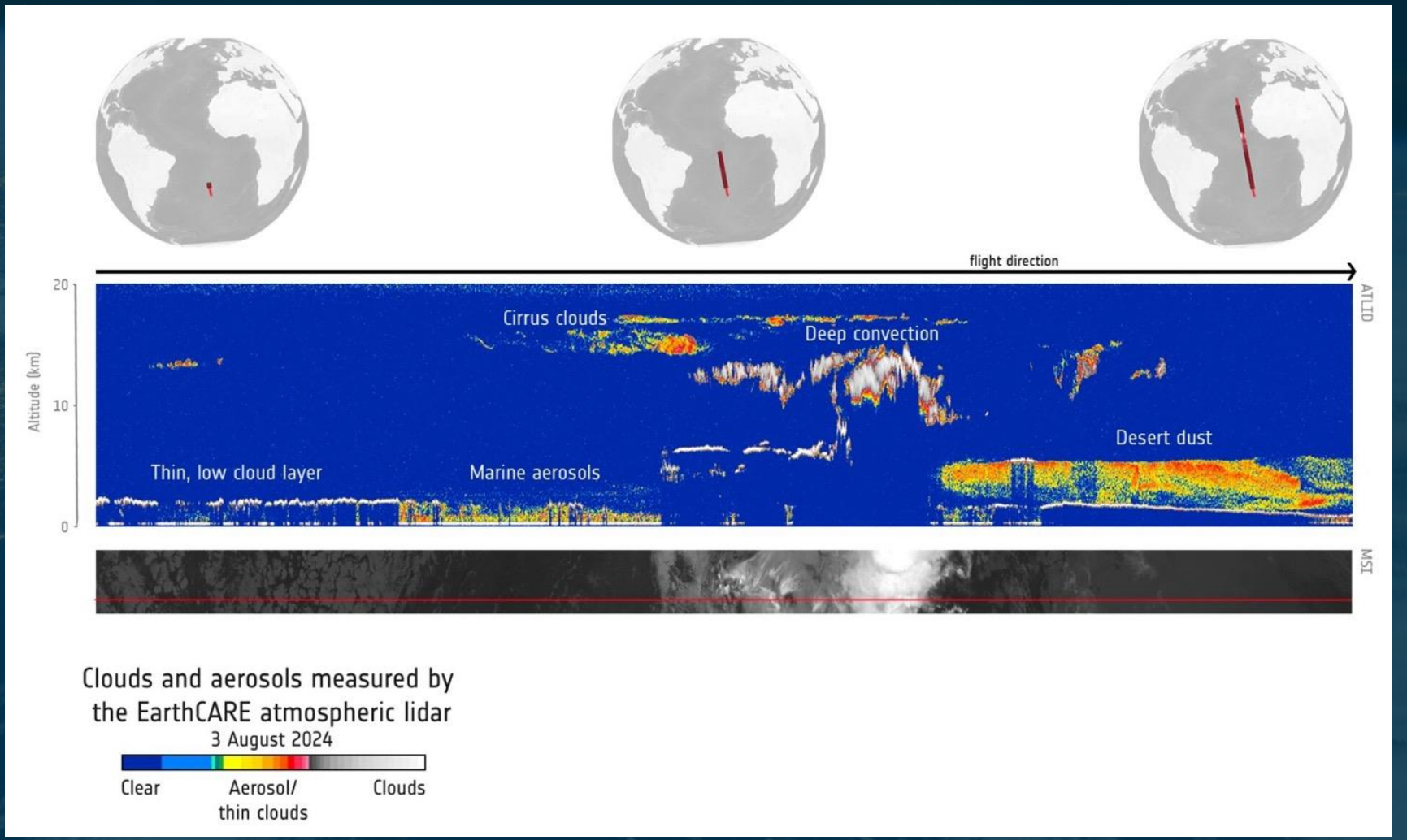
Imminent processor updates expected to resolve these small issues, otherwise quality is good.



ATLID first images, USA, Tropical Atlantic, published 21 August

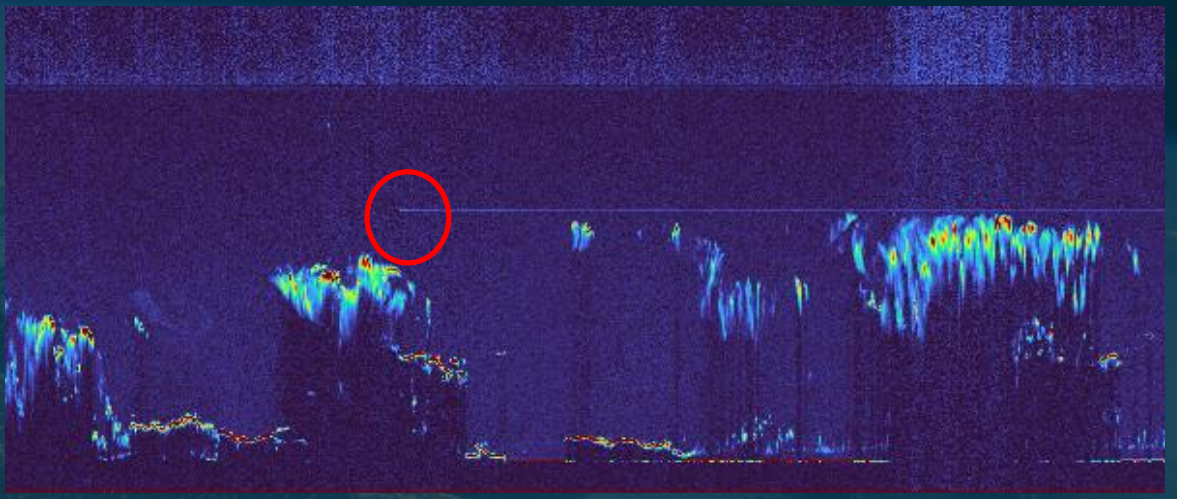
Scientists very happy with the data from ATLID!

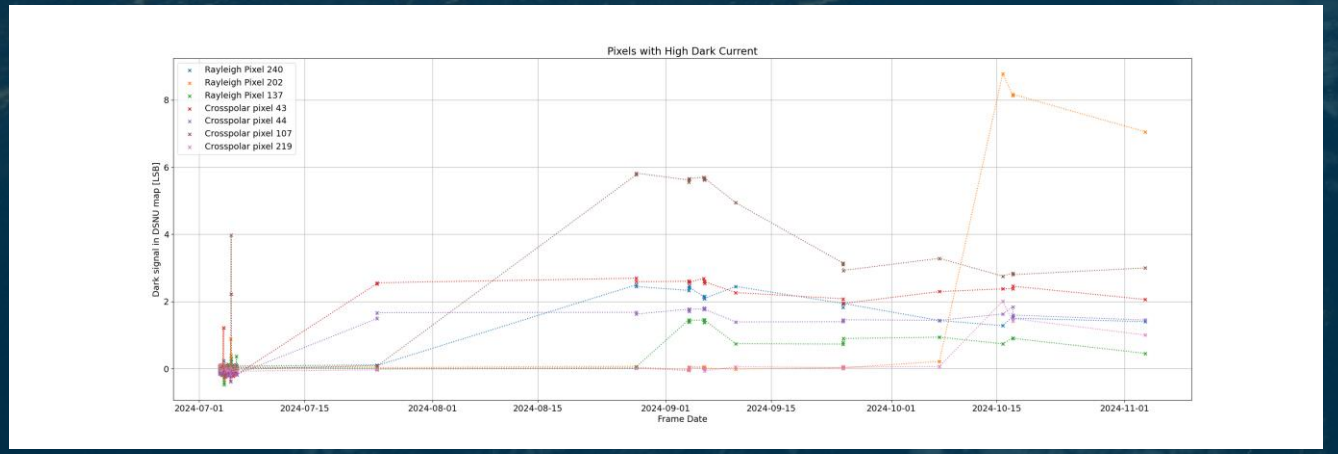
- 4 weeks decontamination. Complex start-up operations of cooling system, then laser switch on.
- Producing instrument calibrated data 2-3 weeks later (detector checks, co-alignment check, spectral calibration, emission beam defocus).
- Further commissioning activities improved data quality with updated processor (not instrument) settings.
- Laser energy stable, pressure release from nominal and redundant laser units fully compatible with lifetime (good margin)
- Calibrations well understood, lessons learned from Aeolus, little operational overhead once running.

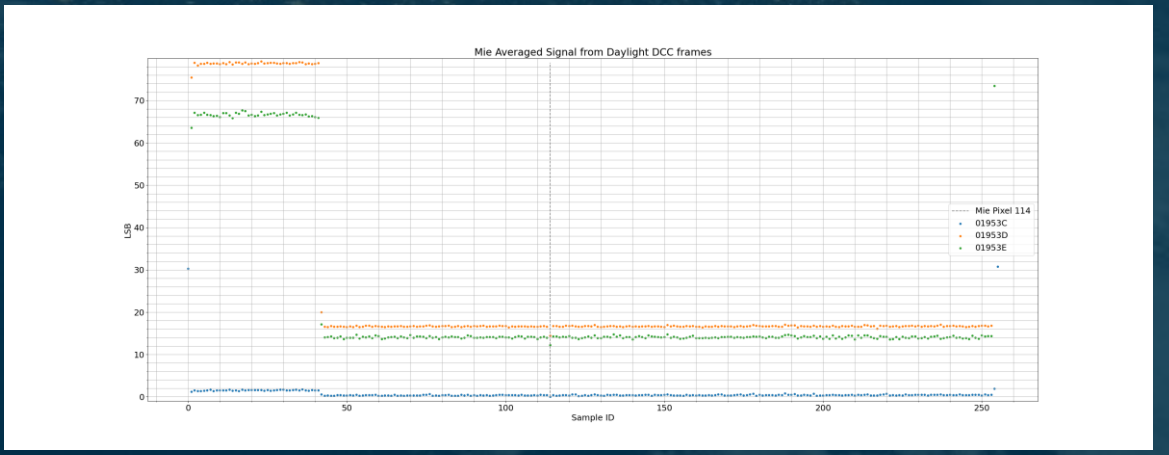


Zapped pixels from high proton irradiation

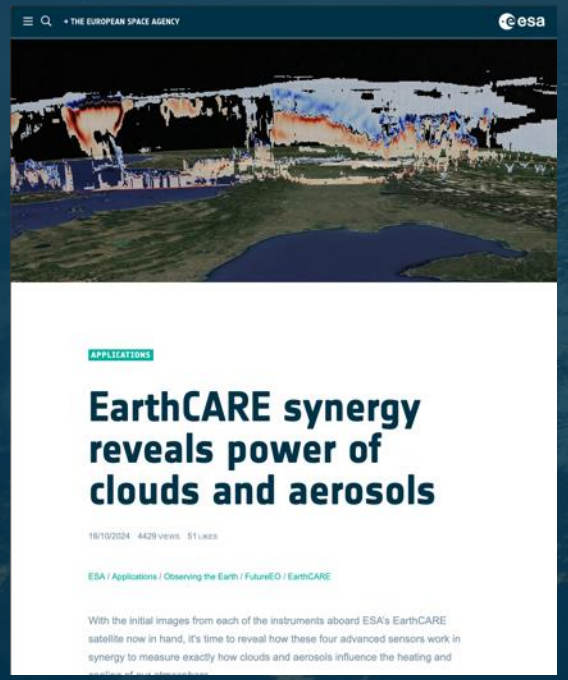
- Launch and operation near solar max. activity.
- Abnormality usually appears after a "spike" in the channel (possibly from high proton impact on detector).
- Currently there are 3 HP on Rayleigh, 4 HP on cross-polar and 0 HP on Mie. Bottom left graph DCC results.
- 1 "Colder" pixel in Mie (possible current leak in substrate), bottom right graph DCC results.
- Small self-annealing effect visible in "step" decreases.
- More frequent dark current calibration possible with 'TUBA'.

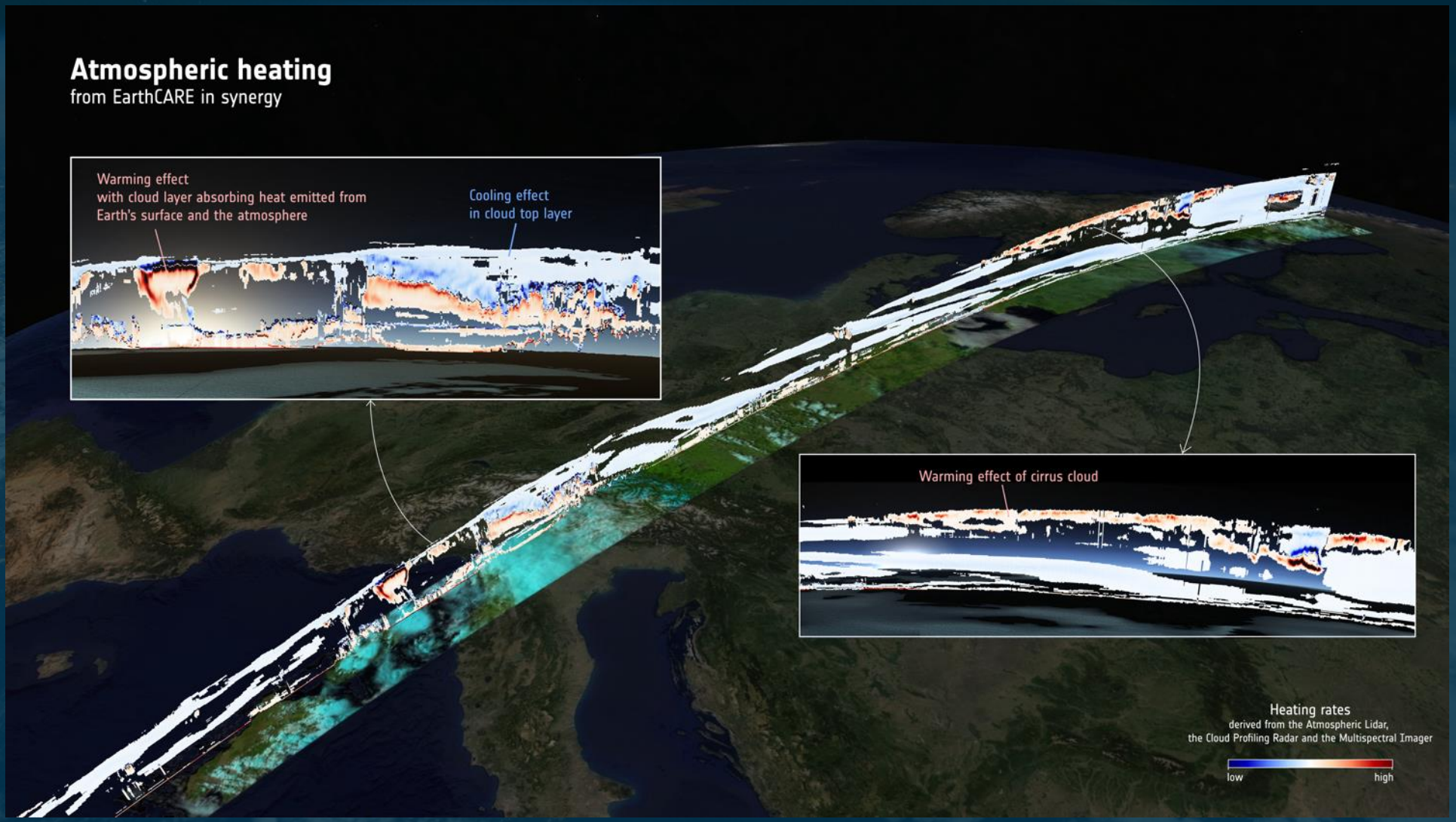






Synergy images, published 16 October





Main issues during commissioning

Reaction Control System

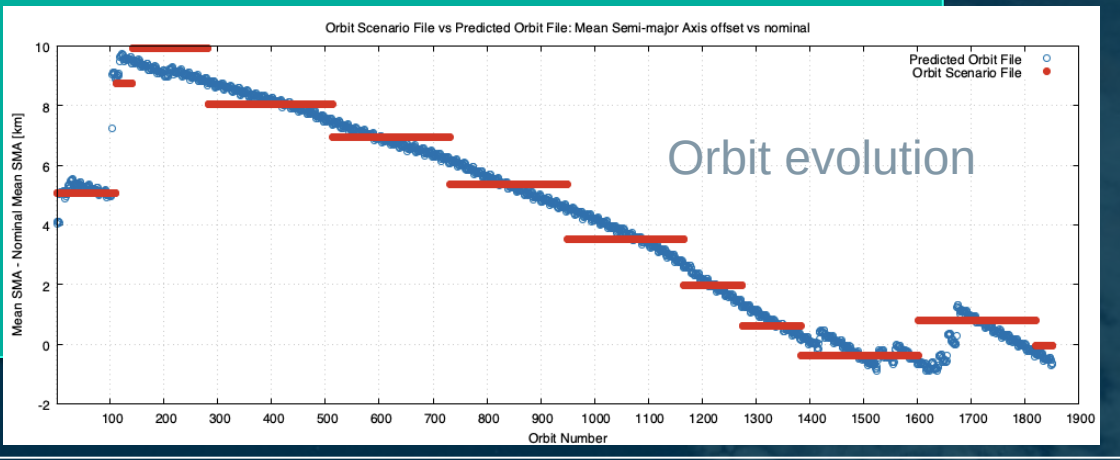
- During first Orbit Control Manoeuvre the system reconfigured onto the redundant reaction control system, followed by a safe mode.
- A consequence was the orbit was raised to approximately 10 km above the planned reference orbit height.
- Unexpected levels of plume impingement on the Solar Array affected thruster performance.
- Nominal thrusters now used for regular manoeuvres.

→ Software update planned to manage the redundant thrusters

CPR autorestart 'feature'

- 15 restarts since switch on, software update anticipated March

→ "Annoying", but not critical



Thank you for your support of EarthCARE!

"While major advances in the understanding of cloud processes have increased the level of confidence and decreased the uncertainty range for the cloud feedback by about 50% compared to AR5, clouds remain the largest contribution to overall uncertainty in climate feedbacks (high confidence)."
(IPCC, 2021)

"EarthCARE [..] will give us a step change in terms of how we represent the clouds."
(R.Forbes, ECMWF, in New Scientist, "*We're finally solving the puzzle of how clouds will affect our climate*", 7-Sep-2024)