

An overview of Aeolus ESA's wind mission

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Aeolus Industry Teams
Aeolus DISC Teams
Aeolus Flight Control Team
Aeolus Payload Ground Control Team

**ESA-JAXA Pre-Launch EarthCARE
Science and Validation Workshop**

13 - 17 November 2023 | ESA-ESRIN, Frascati (Rome), Italy

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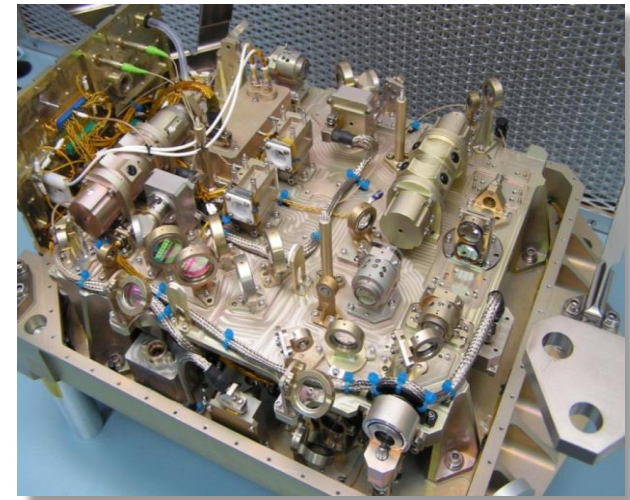




- **Aeolus** is the second Earth Explorer Core Mission of ESA's Directorate of Earth Observation
- **Launch:** 22nd August 2018 from Kourou on a Vega rocket
- **Orbit:** Altitude of 320 km, inclination of 97deg, sun-synchronous, 7-days repeat cycle
- **Designed Mission Life:** 3 years [until end 2021]
- **Line-of-sight (LOS) pointing 35° from nadir** to capture profiles of single component horizontal wind (LOS wind is projected to HLOS)

Main Payload - ALADIN

- Doppler Wind Lidar @355 nm -> $\Delta\lambda = 2.4 \cdot 10^{-15}$ m ($H^+ \approx 1.7 \cdot 10^{-15}$ m)
- One of the most sophisticated instruments ever to be put in orbit and last for such long time
- High-power ultraviolet (UV) laser transmitter containing ~80 optical functions and different wavelength conversion
- Extreme backscatter sensitivity via 1.5m telescope, 80 microns field stop and etalon spectrometers

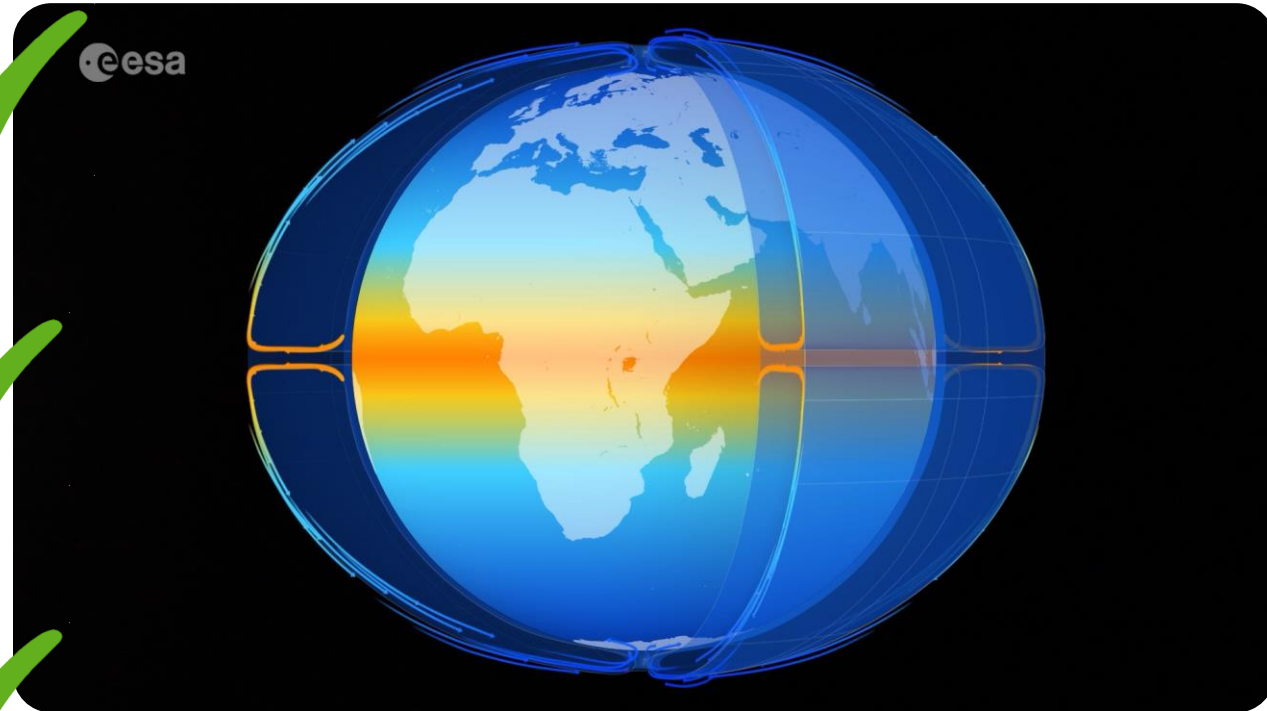


Scientific Objectives

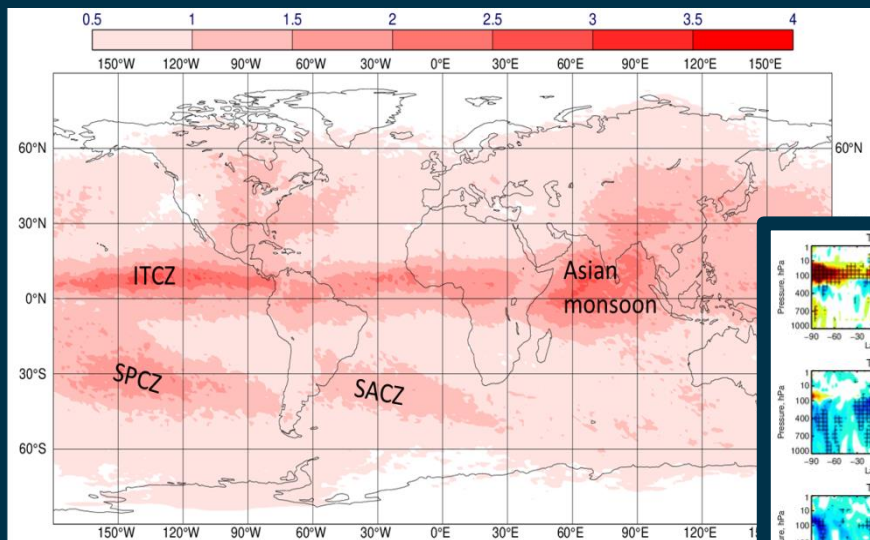
1. To improve the quality of weather forecasts by providing **Global Measurements** of horizontal wind profiles in the troposphere and lower stratosphere
2. To advance our understanding of **atmospheric dynamics** and **climate processes**

Long-term goal

- Demonstrate space-based Doppler Wind LIDARs capability for operational use

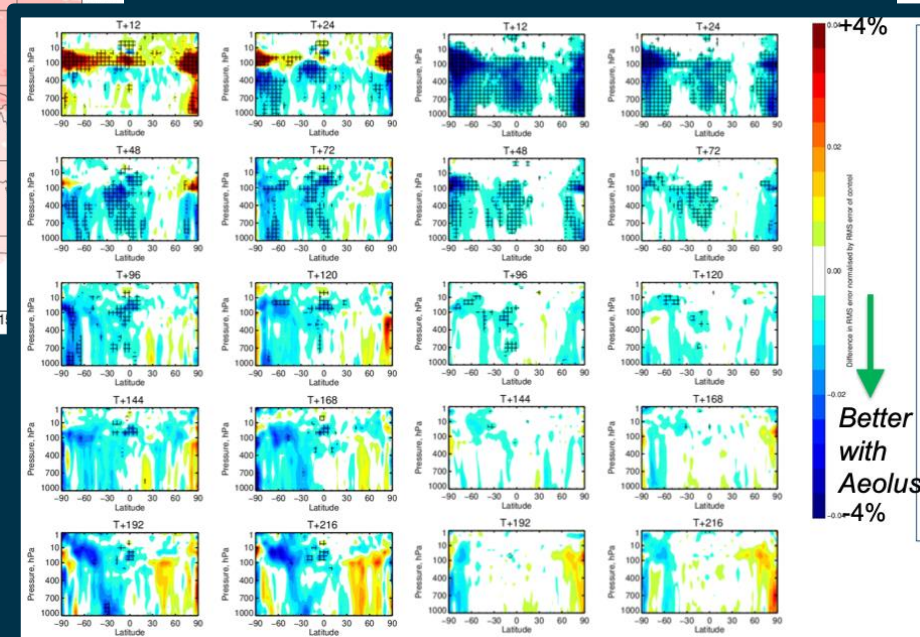
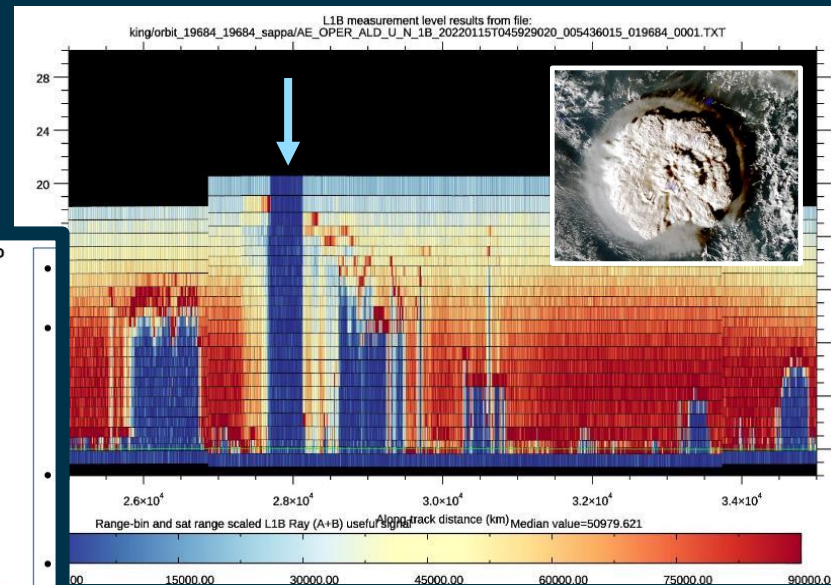


Aeolus Achievements - Examples

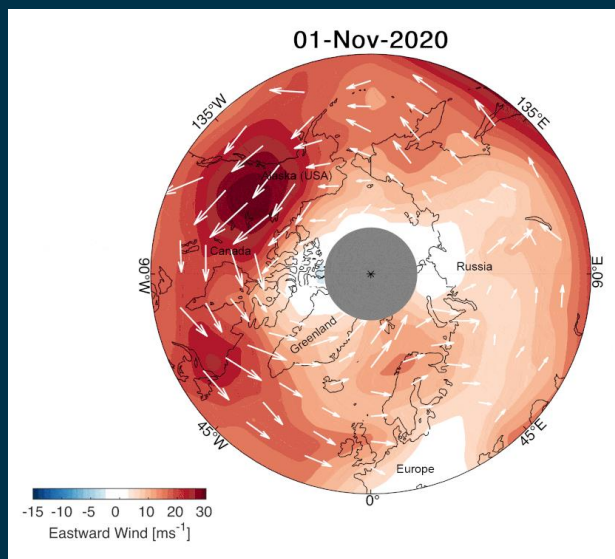


Standard Deviation of Zonal wind where Aeolus is changing the analyses.
Courtesy ECMWF

Aeolus shows the Tonga eruption to rise above 20.5 km, since the lidar signal is totally attenuated

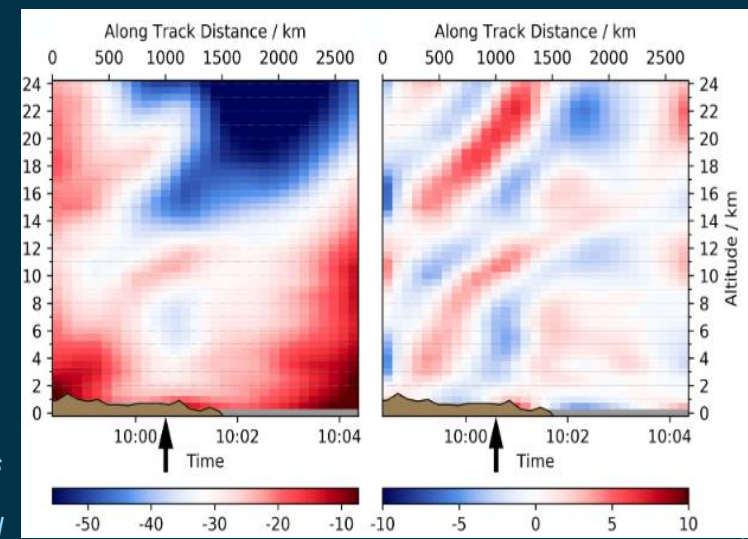


Improved forecast impact over tropical troposphere and lower stratosphere.
Courtesy M. Rennie (ECMWF)



Dynamical and Surface Impacts of the January 2021 Sudden Stratospheric Warming in Novel Aeolus Wind Observations, MLS and ERA5.
Courtesy Corwin J. Wright et al.

Atmospheric Gravity Waves in Aeolus wind lidar observations.
Courtesy T. Banyard et al



STRATEGIC MISSION GOALS [2021-2023]

Goal #1: Support the Tropical Campaign in summer 2021 with best possible performance with Laser B to support both the validation and the science aspect of the campaign

Goal #2: Achieve the designed end of life-time (Dec 2021) with best possible performance on both channels RAY and MIE to complete the prime mission objectives

Goal #3: Achieve within the extended life-time (2022), the best possible performance on both channels or at least on one (e.g. MIE)

Goal #4: Perform technological and science demonstration to support the Aeolus Follow on

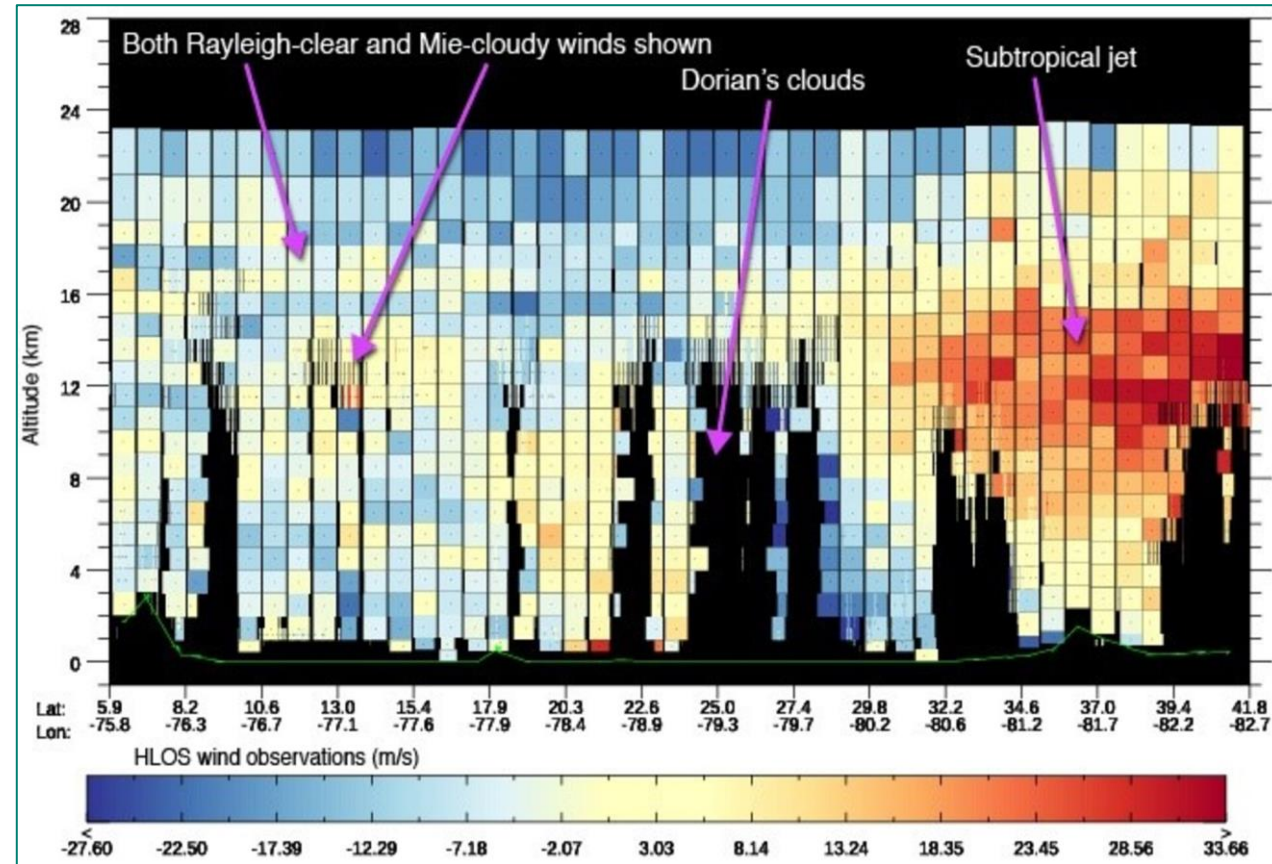




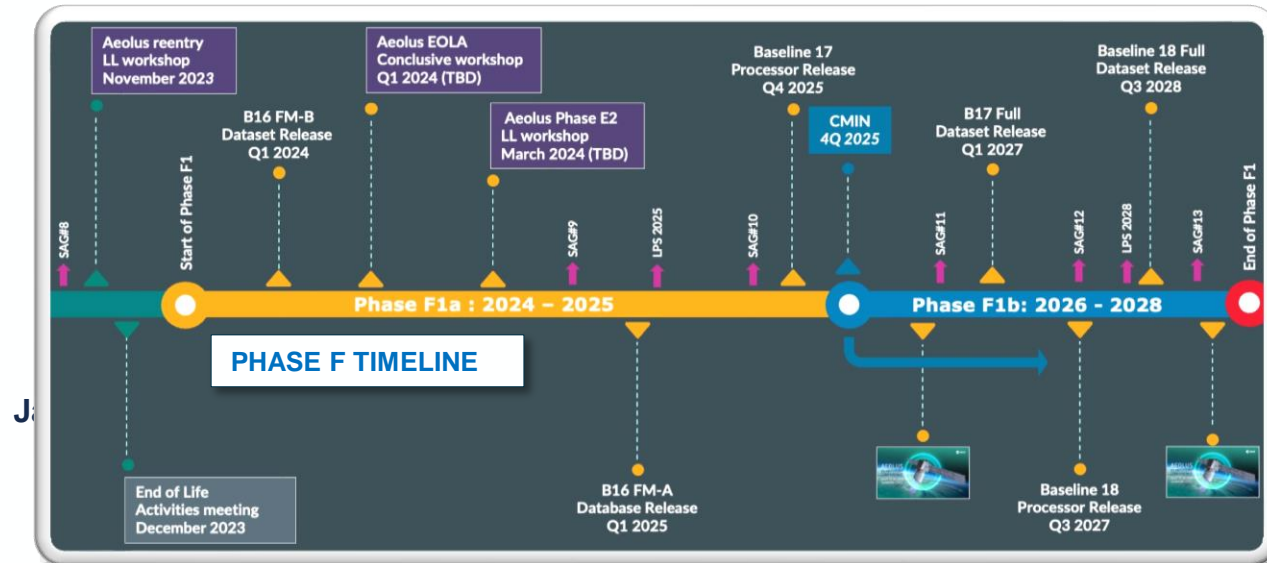
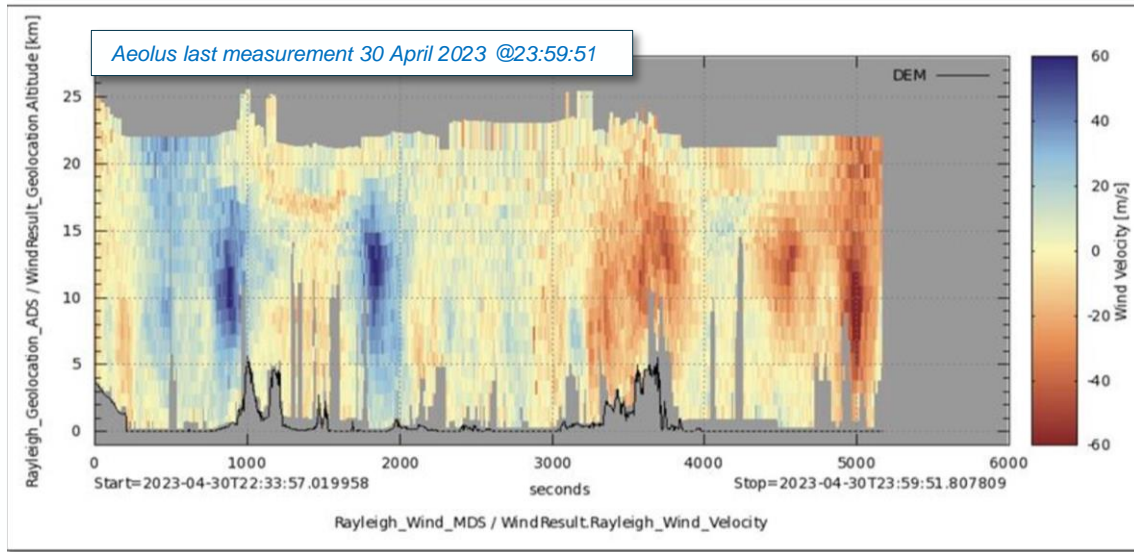
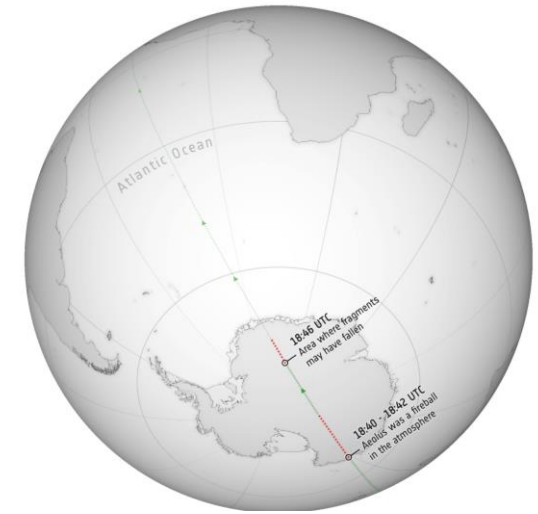
Quality is constantly monitored and improved (random and systematic errors) allowing also for quick reaction to performance issues

- Random errors are primarily affected by lower UV transmitted and emitted energy.
- Biases - originated by different sources - have been kept under control below mission requirements

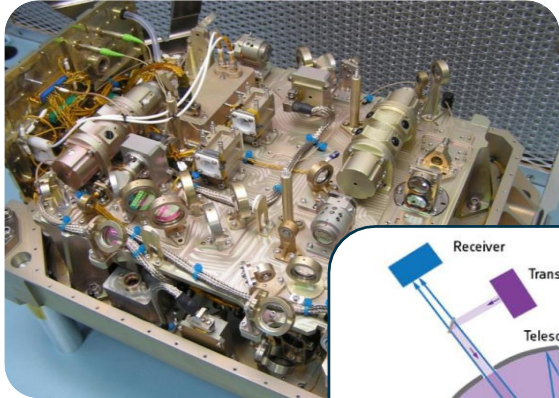
Main Products	Contents
Level 1B	Geolocated preliminary Horizontal Line of Sight (HLOS) wind observations and useful signals for RAY and MIE signals
Level 2B	Ray and Mie wind profiles over the vertical bins
Level 2C	Superset of L2B data with wind fields resulting from NWP assimilation processing
Level 2A	Aerosol/Cloud <i>optical</i> profile products (i.e. backscatter, optical depth, extinction, etc)



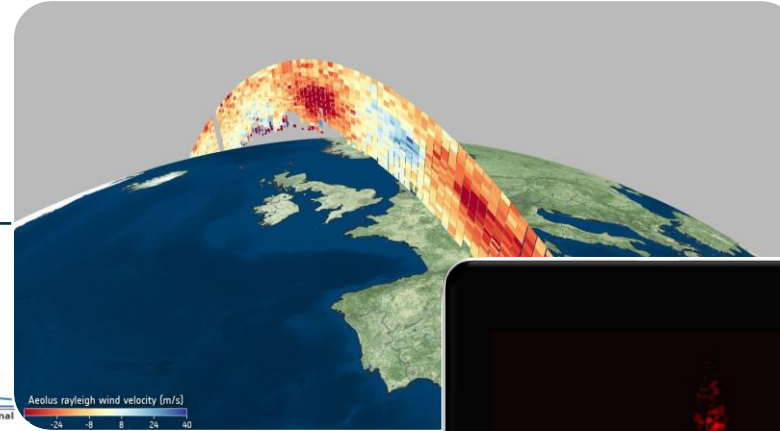
- The final **overall performance** of Aeolus mission has been **beyond** any expectations (e.g. 3-hour Near Real Time delivery of wind products to world-wide meteo centres was **99.23%**).
- The ALADIN instrument operated for around **4.7 years** accumulating some **7.6 billion** laser shots.
- Following the end of mission operations on the **30th April 2023**, Aeolus' altitude started to decay naturally the **19th of June 2023** which allowed an additional number of tests to be performed as part of the **End-of-Life activities**.
- During these tests, FM-B was ramped up **180mJ** and remained stable for more than one day with no sign of degradation, setting a **new worldwide** record for space-borne UV lasers.
- The ALADIN instrument was switched off on the **5th July 2023**. The satellite reentered from space with an *assisted* (i.e. semi-controlled) approach on the **28th July 2023 at 18:46 UTC** over **Antarctica** close to entering the Atlantic corridor
- Transition to **Phase F [2024-2028]** has started and the high-level timeline was consolidated.
- Preparation for the three conclusive **Lessons Learnt Workshops** (i.e Aeolus Reentry, Aeolus End-of-life Activities, Aeolus Phase E2) are ongoing.



Instrument

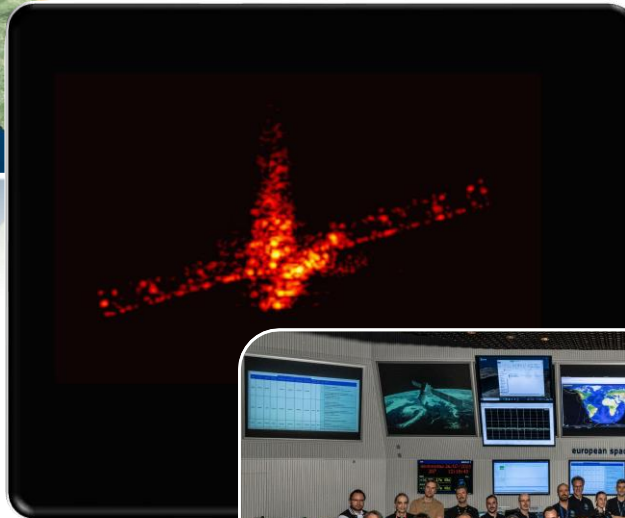
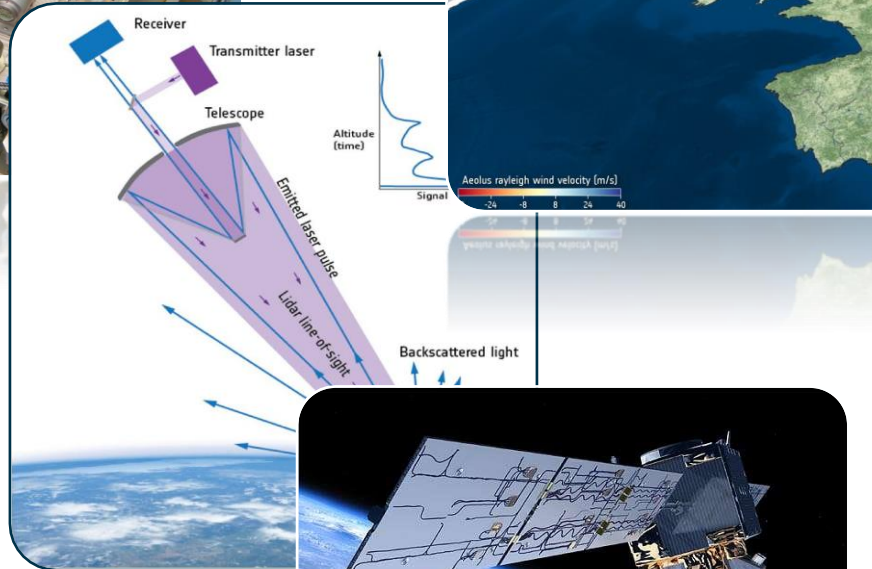


Scientific impact



Innovation

Measurement Principles



Operations



People



The mission has exceeded its designed lifetime (3-years). The overall performance of the mission has been outstanding **beyond any expectations** despite a number of critical problems that have been solved or mitigated thanks to excellent cooperation between ESA and industry

Aeolus has been achieved its main objectives with its meteo forecasting centres in Europe and

It has been a great journey for us and I wish all the best to EarthCARE and his community.

Due to the increase in information" cit. AS... missions ended on **30th** April followed by a unique treasure of information" cit. AS... **successfully** on the 28th of July 2023 over Antarctica.

Aeolus has been an innovative and unique mission. It can be truly considered as **THE PATHFINDER** for future DWL **and** has played a fundamental role in motivating ESA and EUMETSAT to develop EPS-Aeolus which fly in the next decade.