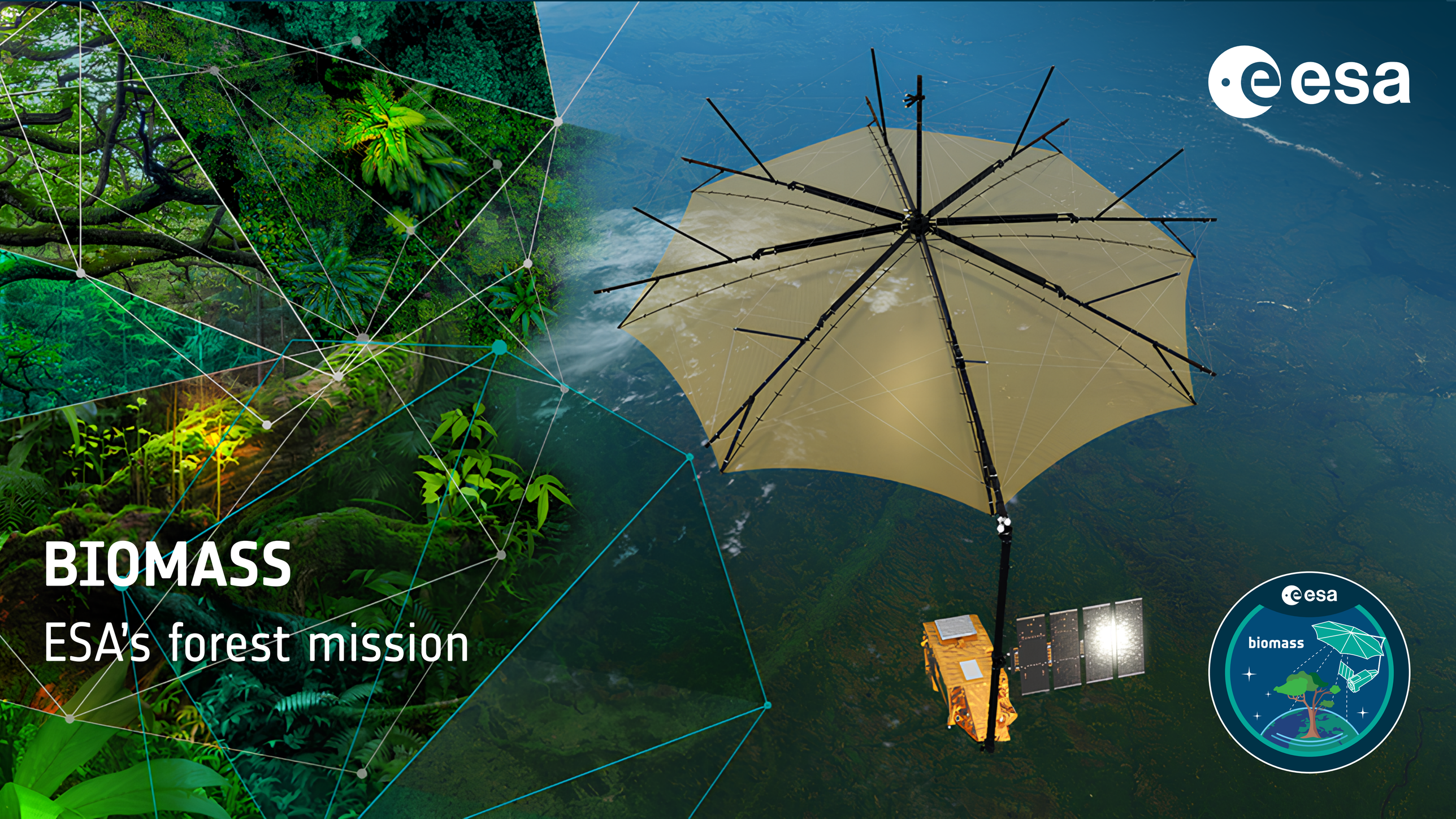

esa
BIOMASS
ESA's forest mission
esa
biomass

THE BIOMASS MISSION

ESA's Biomass satellite uses cutting-edge space technology to provide fresh insights into the state of our forests and how they are evolving. Crucially, this new Earth Explorer mission enhances our understanding of the role that forests play in the carbon cycle, and therefore their importance in the climate system.

Biomass is the first satellite equipped with a P-band synthetic aperture radar, which can penetrate the forest canopy to measure the 'biomass' – the woody trunks, branches and stems, which is where trees store most of their carbon.

LAUNCH DATE
29 April 2025

SITE
ESA's Spaceport in Kourou, French Guiana

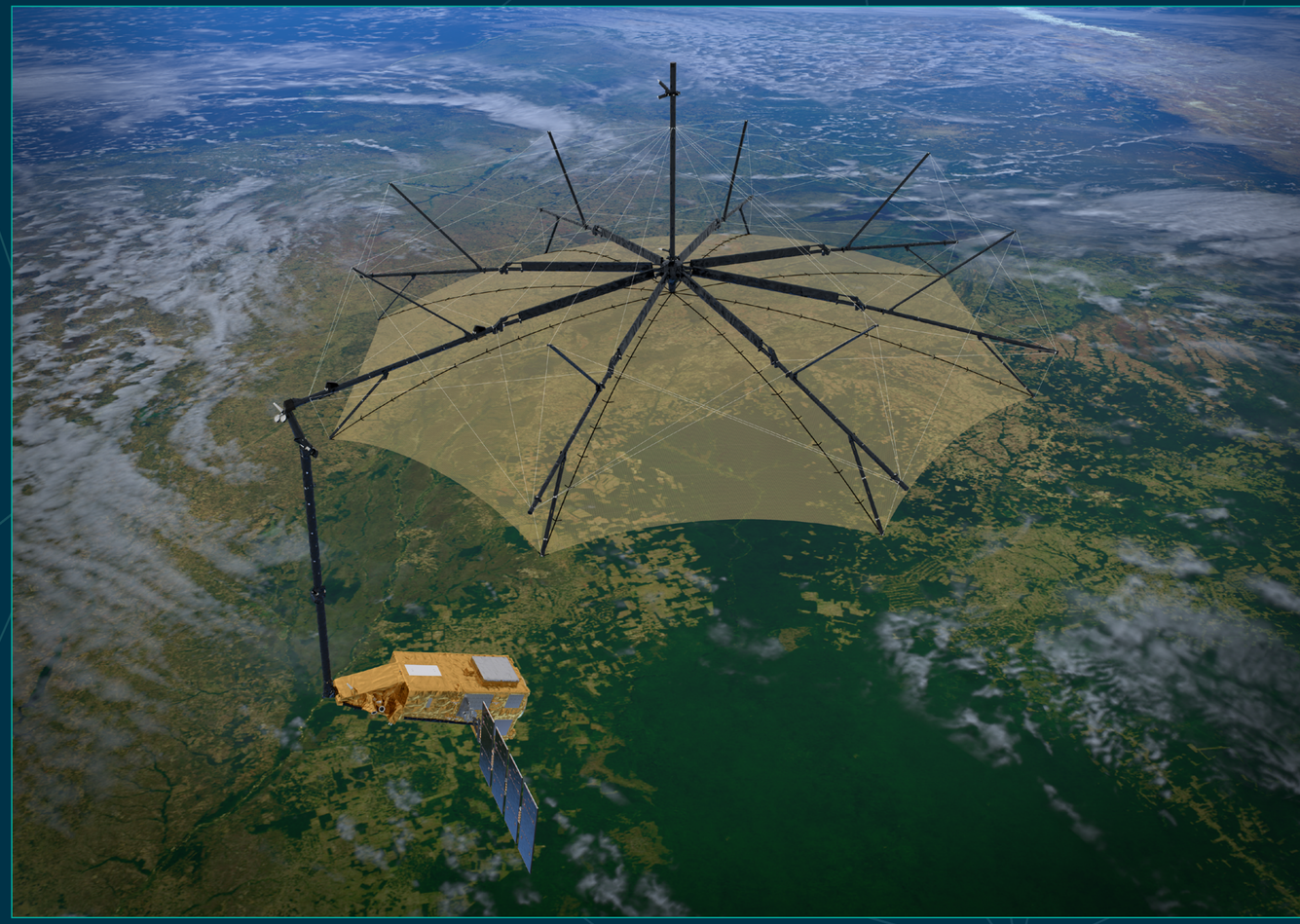
ROCKET
Vega-C

UNPRECEDENTED INSIGHT INTO FORESTS

Forests are vital to the health of our planet for multiple reasons, but particularly for their role in the carbon cycle. Through photosynthesis, trees absorb carbon dioxide from the atmosphere and store it in their trunks, branches, leaves and roots. This natural process helps regulate atmospheric carbon dioxide levels, contributing to climate stability.

However, significant uncertainties remain regarding the total amount of carbon stored in the world's forests and how these carbon stocks are changing over time. Factors such as rising temperatures, increasing atmospheric carbon dioxide concentrations and human activities – including deforestation for agriculture and urban expansion – affect forest carbon dynamics in ways that are not yet fully understood.

ESA's Biomass mission has been developed to address these uncertainties by providing critical data on carbon stocks and fluxes. This includes tracking carbon changes related to land-use shifts, forest degradation and regrowth, ultimately improving our understanding of forests' role in the global carbon cycle.



PIONEERING SCIENCE MISSIONS FOR EARTH

The Earth Explorer research missions are central to ESA's FutureEO programme, which fosters innovation in Earth observation by developing pioneering satellite missions and novel data applications. This forward-thinking approach drives scientific excellence and provides critical insights to tackle the environmental challenges of the future.

Since the launch of the first Earth Explorer in 2009, these missions have consistently exceeded expectations. They showcase how cutting-edge technology can unlock groundbreaking scientific discoveries about our planet, reinforcing the vital role of Earth observation in addressing both current and emerging global challenges.

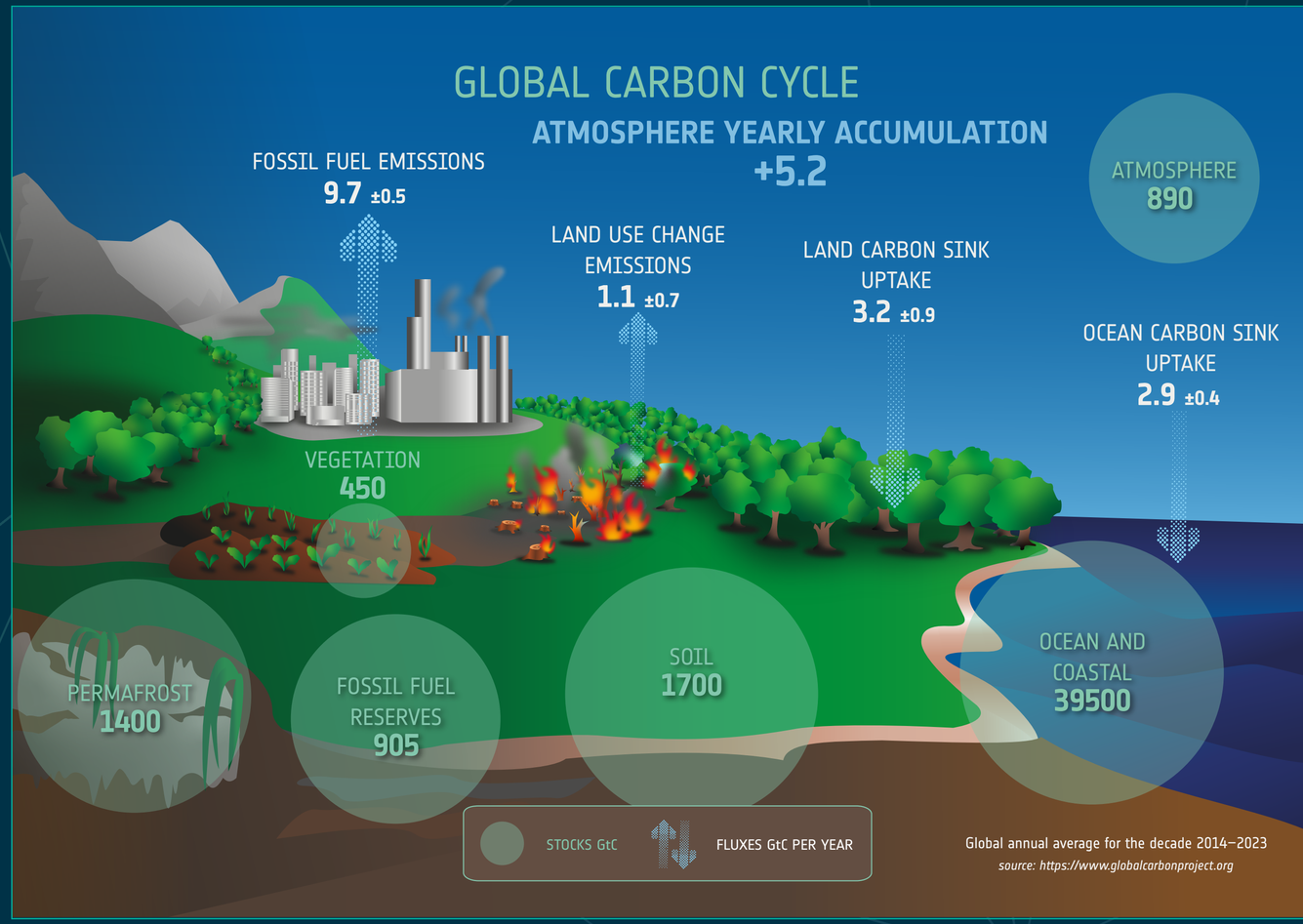
Next in this legacy of world-class research missions is ESA's Biomass forest mission, poised to deliver transformative data and further advance our understanding of Earth's dynamic systems.

ADVANCING KNOWLEDGE OF THE CARBON CYCLE

Human activities, particularly fossil fuel combustion and deforestation, have driven atmospheric carbon dioxide levels to 50% above pre-industrial levels of 1850, with profound consequences for Earth's climate. While reducing greenhouse gas emissions is crucial in mitigating climate change, significant gaps remain in our understanding of how carbon moves between Earth's surface and the atmosphere – the carbon cycle.

A comprehensive understanding of this global cycle requires precise knowledge of carbon stocks – the amount of carbon stored in the atmosphere, oceans and terrestrial biosphere – as well as the fluxes, or the rates at which carbon moves between these reservoirs. The graphic highlights that the terrestrial components of the carbon cycle, particularly emissions from land-use change and carbon uptake by land ecosystems, remain the most uncertain, underscoring our current limitations in accurately quantifying these processes.

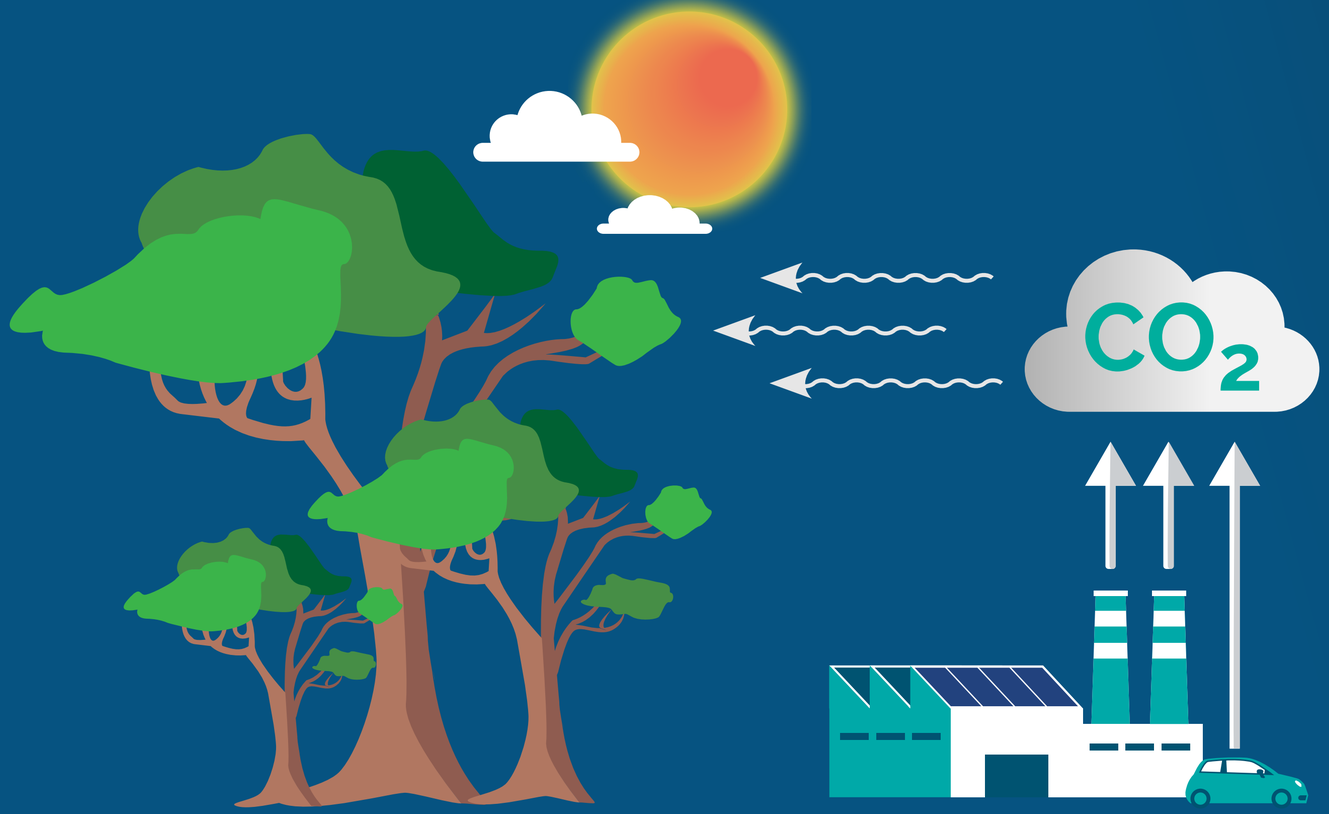
ESA's Biomass mission is set to help close these gaps in our knowledge by providing critical estimates of forest biomass, which serves as a key indicator of stored carbon. The mission will enhance our ability to assess carbon stocks and fluxes, improving our overall understanding of the terrestrial carbon cycle.



A schematic representation of the overall perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally in gigatonnes of carbon (GtC) over 2014–2023.

THE ROLE OF FORESTS

Forests cover nearly one third of Earth's land and play a key role in Earth's carbon cycle and climate system. Assessing forest carbon storage and change is key to understanding Earth's carbon cycle, which plays a major role in our climate.

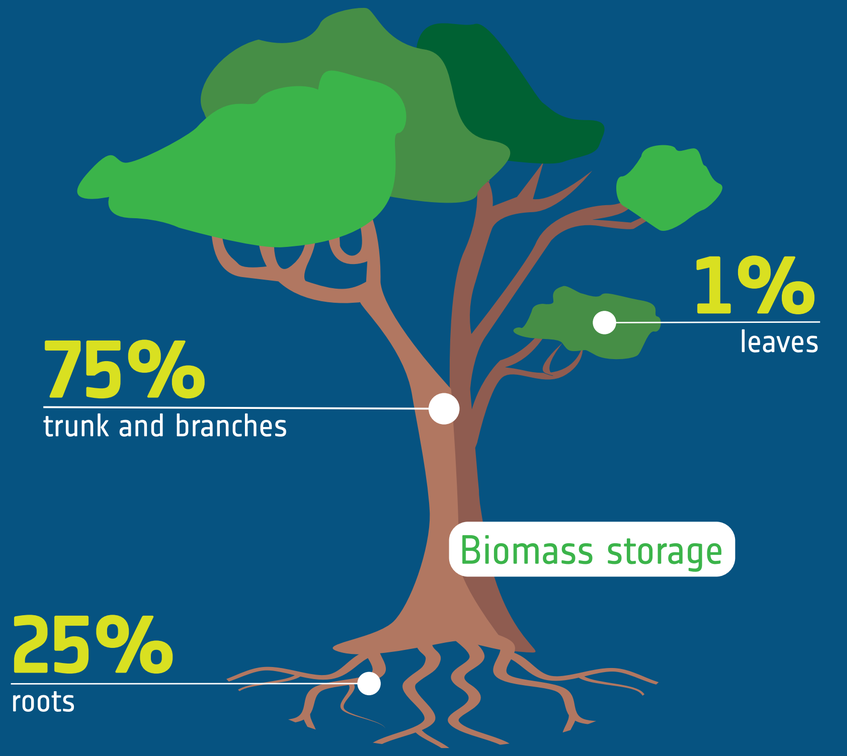


Every year, forests absorb around **8 billion tonnes** (net) of carbon dioxide from the atmosphere

Forests cover nearly **1/3** of Earth's land

THE ROLE OF FORESTS

Forests are vital to the health of our planet. Forest degradation impacts Earth's carbon cycle, environmental health and human well-being.



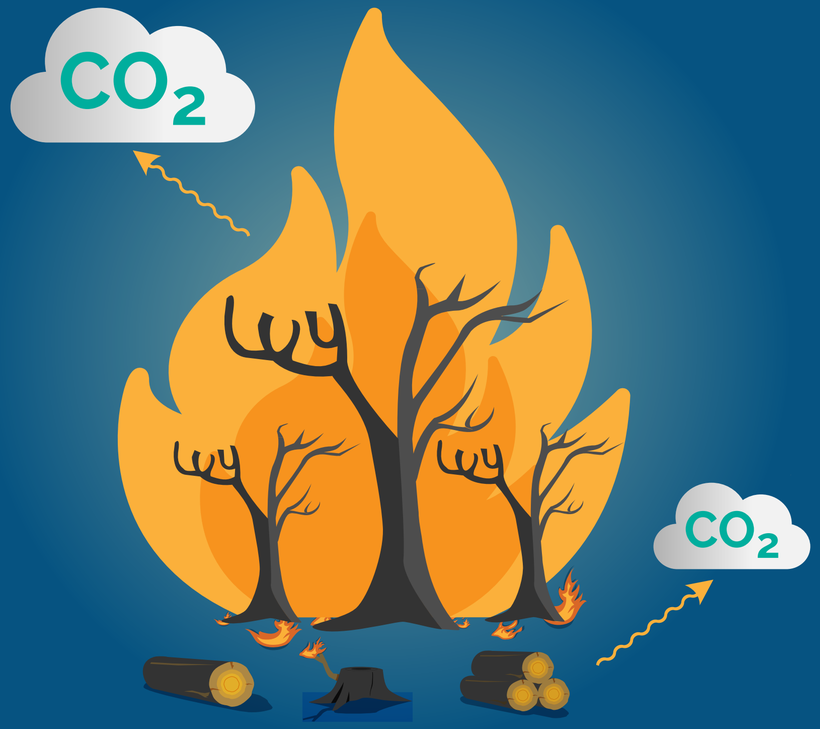
Most of the world's forest is located in the Tropics

As a rule of thumb 50% of the weight of a tree is carbon, stored within its woody biomass

70% of Earth's land biomass is held in tropical forest and this is where most changes are happening

THE ROLE OF FORESTS

The measurement of forest biomass can be used as a proxy for stored carbon, the quantification of which is the main objective of the Biomass mission.



When trees are removed or burned, much of the stored carbon is released back into the atmosphere intensifying climate change

Forest degradation impacts environmental health and human well-being

Over 1.6 billion people worldwide depend on forests directly for timber, food, fuel, jobs and shelter

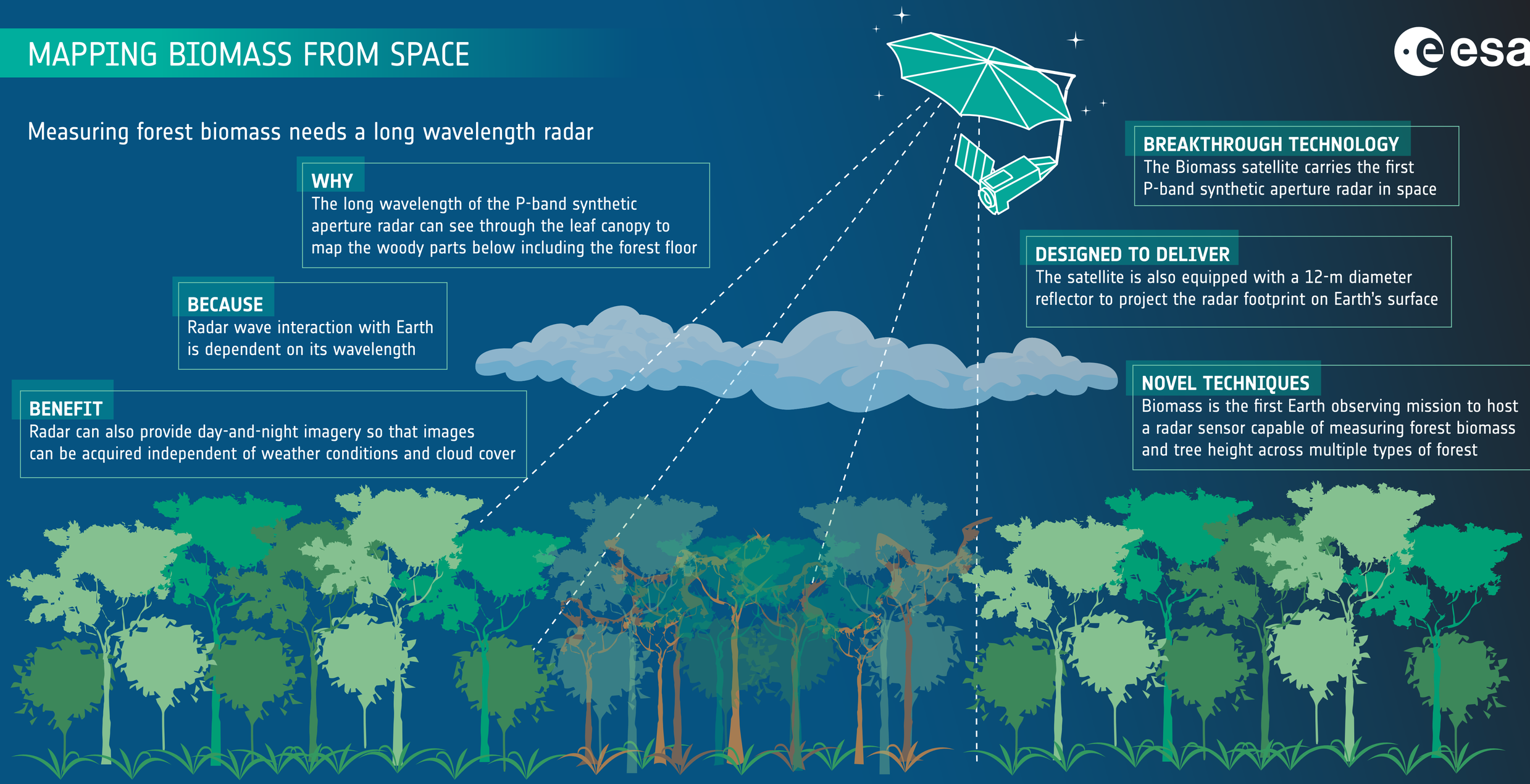
MAPPING BIOMASS FROM SPACE

Measuring forest biomass needs a long wavelength radar

WHY
The long wavelength of the P-band synthetic aperture radar can see through the leaf canopy to map the woody parts below including the forest floor

BECAUSE
Radar wave interaction with Earth is dependent on its wavelength

BENEFIT
Radar can also provide day-and-night imagery so that images can be acquired independent of weather conditions and cloud cover



BREAKTHROUGH TECHNOLOGY
The Biomass satellite carries the first P-band synthetic aperture radar in space

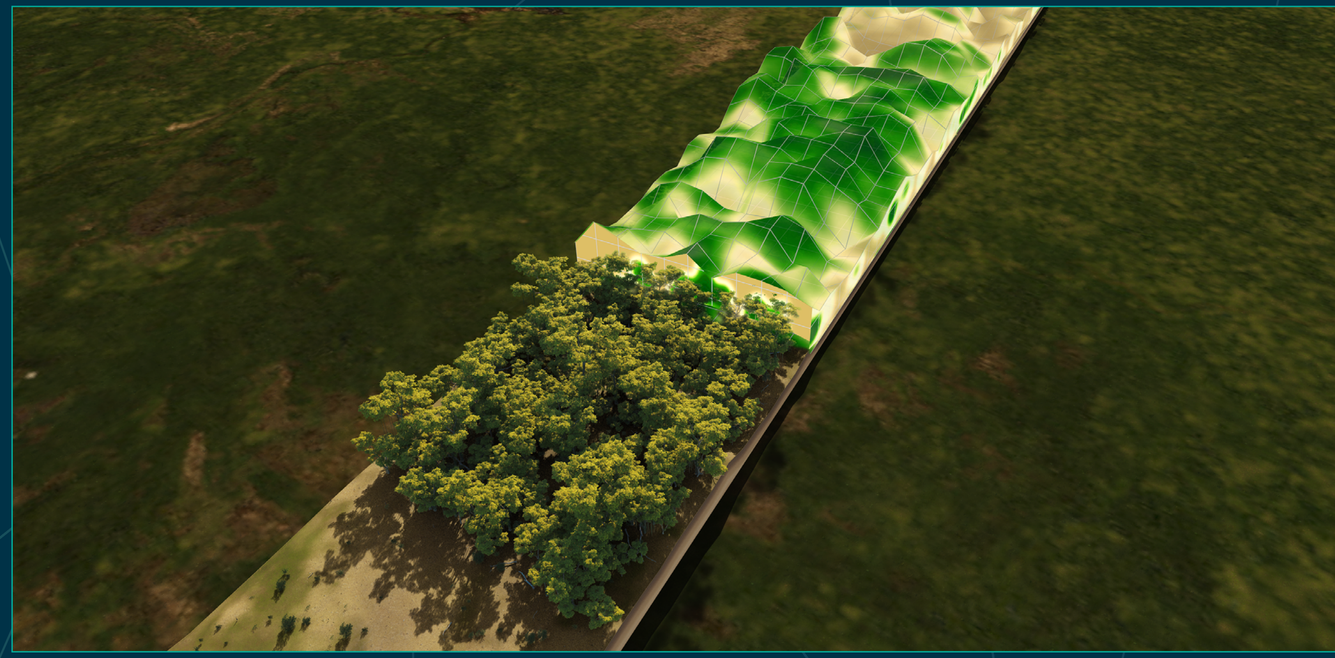
DESIGNED TO DELIVER
The satellite is also equipped with a 12-m diameter reflector to project the radar footprint on Earth's surface

NOVEL TECHNIQUES
Biomass is the first Earth observing mission to host a radar sensor capable of measuring forest biomass and tree height across multiple types of forest

BIOMASS ON BIOMASS

Measuring forest mass from space is a complex challenge. However, the Biomass satellite's P-band radar can penetrate the entire forest layer, with its signal reflecting off different parts of the canopy. These data provide crucial insights into forest structure, enabling scientists to estimate biomass, height and, ultimately, carbon content.

While the concept may seem straightforward, over its 5.5 year planned life in orbit, the mission is operated in two phases to ensure it fulfils its goal: the tomographic phase at the beginning followed by the interferometric phase.



TOMOGRAPHIC PHASE

- The technique is comparable to a CT scan which combines several images to reveal information of the inner structure of a forest
- The tomographic phase takes place at the beginning of the mission and lasts around 18 months, resulting in a single global map
- It yields 3D information at 15–20 m vertical resolution and 200 m spatial resolution

Biomass is the first mission that will systematically explore this observation technique from space

INTERFEROMETRIC PHASE

- A single observation provides an initial view of the forest canopy and forest density, with multiple observations over the same area to allow forest height and above-ground biomass to be estimated
- The interferometric phase takes around four years
- During this phase around five global maps will be acquired

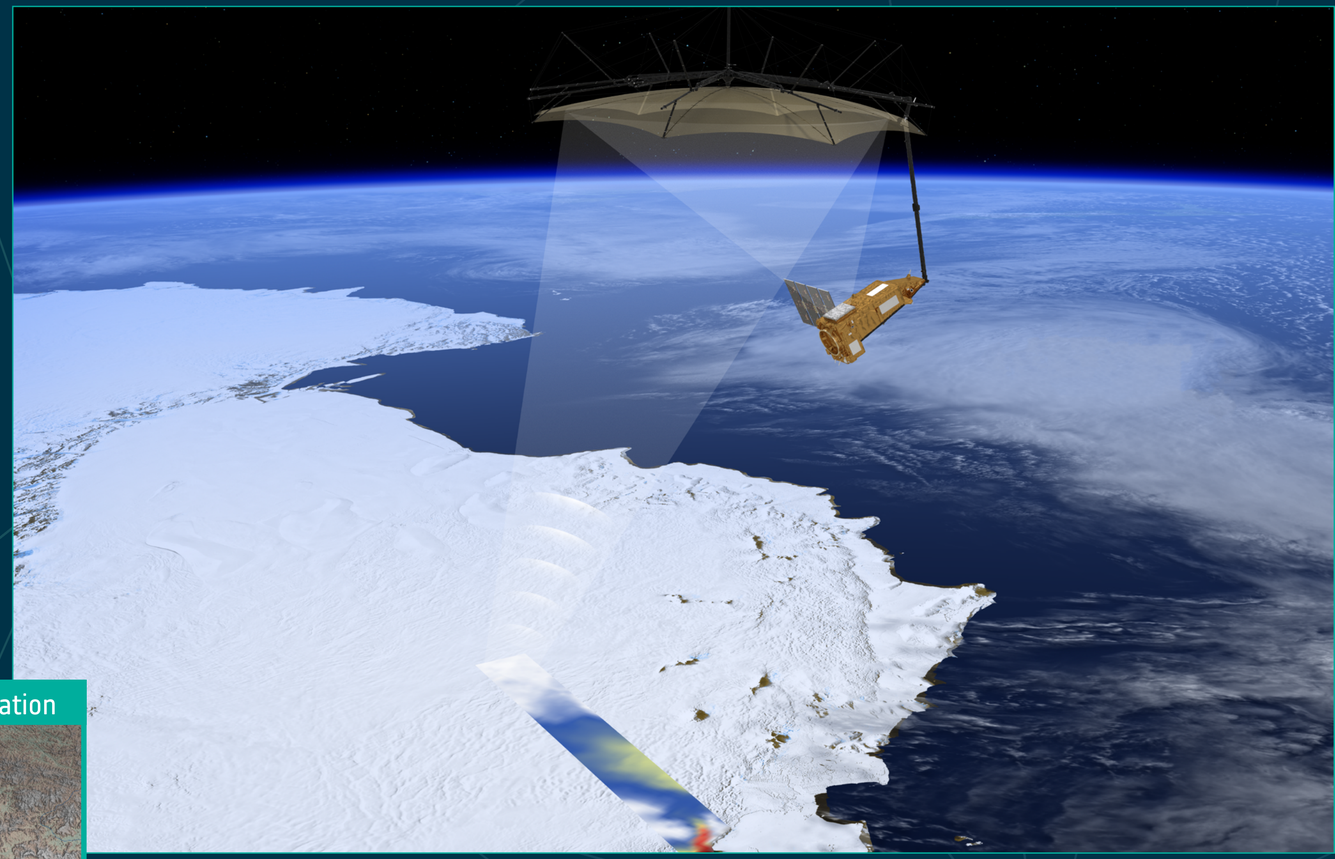
Change in forest biomass is the crucial variable needed for quantifying carbon fluxes and their effects on climate

BEYOND FORESTS

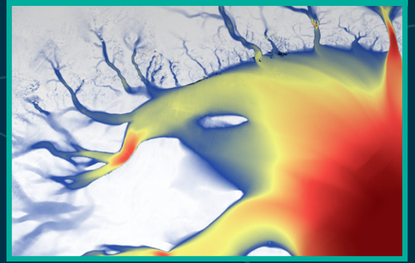
The long wavelength of P-band can also penetrate deep into ice, making it less affected by surface melt and snowfall, which can distort space-based measurements. Biomass will measure glacier and ice-sheet velocities in regions where shorter wavelength radars struggle and will be the first P-band mission to map Antarctica.

P-band can also penetrate up to five metres through dry sand, enabling Biomass to map sub-surface geological features such as ancient riverbeds and lakes. This will help study past climates and locate fossil water resources in deserts.

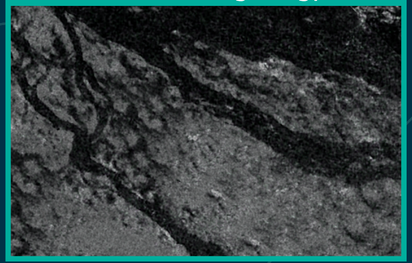
Additionally, Biomass will reveal terrain height beneath dense forests, correcting biases in digital elevation models created by shorter wavelength radars.



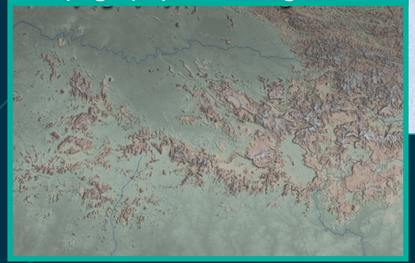
Glacier and ice-sheet velocities



Sub-surface geology



Topography under vegetation



TEAMWORK

Airbus (UK)
prime contractor

20
European countries
+ Canada & the USA

50
subcontracts

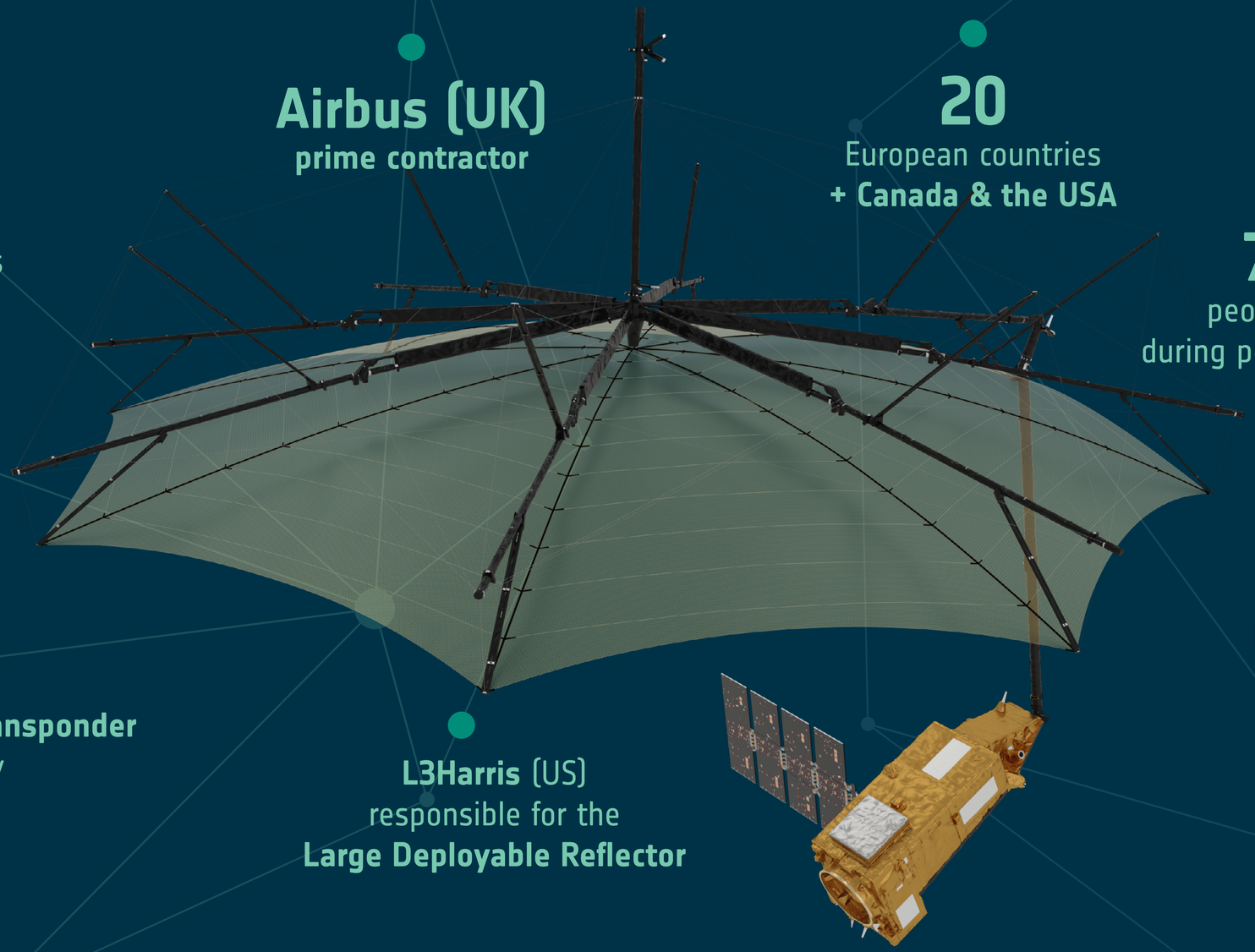
700+
people involved
during peak development

9 years
to develop,
build and test the satellite

Airbus (DE)
prime for the
P-band radar

Ground calibration transponder
developed by
C-CORE (CA)

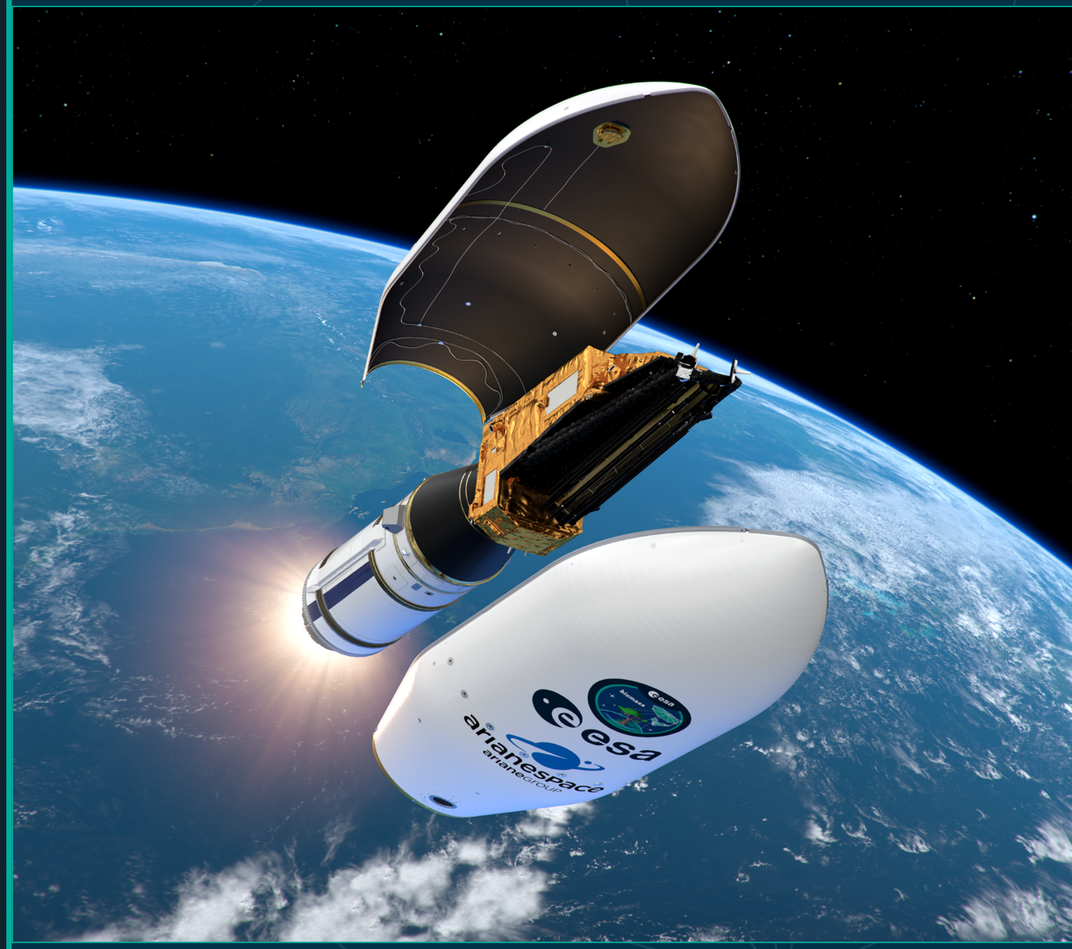
L3Harris (US)
responsible for the
Large Deployable Reflector



TAKING BIOMASS INTO ORBIT

At 35 m tall and weighing over 200 tonnes on the launch pad, Europe's Vega-C rocket can launch satellites up to 2300 kg into space. It reaches orbit with three solid-propellant-powered stages before the fourth liquid-propellant stage takes over for precise placement of satellites into their orbit around Earth.

Vega-C is the evolution of the Vega family of rockets and delivers increased performance, greater payload volume and improved competitiveness. Complementing the Ariane family to launch all types of payloads, Vega-C ensures that Europe has versatile and independent access to space. ESA owns the Vega-C programme, working with Avio as the prime contractor and design authority.



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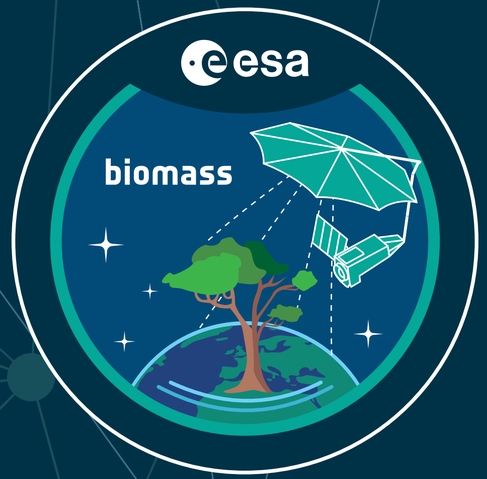

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- VIDEOS FOR PROFESSIONALS

THE EUROPEAN SPACE AGENCY

ELEVATING THE FUTURE OF EUROPE

Established in 1975, ESA now has 23 Member States and cooperates with many others.
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Our mission is the peaceful exploration and use of space for the benefit of everyone. We watch over Earth, develop and launch inspiring and unique space projects, fly astronauts and push the boundaries of science and technology, seeking answers to the big questions about the Universe.

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