SUPPORT FOR THE ESA BIOMASS MISSION
THE BIOMASS OFFICE

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BIOMASS OFFICE

EEBIOMASS

To support the upcoming ESA Biomass Mission, the project EEBiomass funded by the Federal Ministry of Economics and Technology (BMWi) has been initiated to establish a Biomass Office.

Goals:

- Compile, produce and disseminate relevant information for potential German and international BIOMASS users.
- Identify gaps
- Investigate solutions within the BIOMASS framework
- Establish communication between German and international users to maintain a necessary dialogue in the broader context of the mission.

The Biomass Office is installed at the Max Planck Institute for Biogeochemistry (MPI-BGC) in Jena, Germany. It is a collaboration between the Max-Planck Institute for Biogeochemistry, the Microwaves and Radar Institute (DLR-HR) of the German Aerospace Centre (DLR), the Friedrich Schiller University Jena and the Helmholtz-Centre for Environmental Research – UFZ Leipzig.

The Department of Earth Observation at FSU Jena is responsible for compiling eLearning material about the mission that will be published in EO-College and the project website.

BIOMASS MISSION

Primary Objectives:

- Reduction in Large Uncertainties in Land-use Change Carbon Flux
- Providing Scientific Support for International Treaties and Agreements
- Landscape Carbon Dynamics and Prediction
- Initializing and Testing the Land Element of Earth System Models
- Forest Resources and Ecosystem Services
- Biodiversity and Conservation

Secondary Objectives:

- Subsurface Geology
- Terrain Topography under Dense Vegetation
- Glacier and Ice Sheet Velocities

The ESA Biomass Satellite will be the first operational spaceborne **P-band** Synthetic Aperture Radar (SAR). P-band covers wavelengths from 30 - 100 cm or frequencies from 1 - 0,3 GHz.

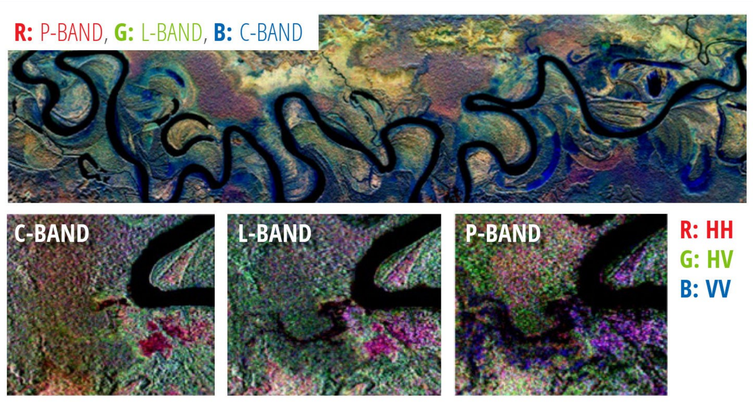

Figure 1
Comparison of different radar bands from C to P-band
(Source: The SAR Handbook, p.217)

Why P-band?

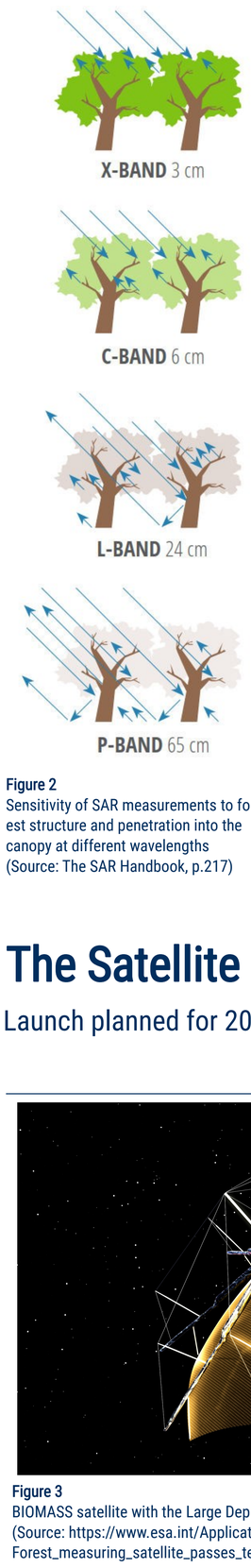

Figure 2
Sensitivity of SAR measurements to forest structure and penetration into the canopy at different wavelengths
(Source: The SAR Handbook, p.217)

P-band radar backscatter:

- Shows highest sensitivity to biomass compared to all other SAR frequencies
- Can penetrate the canopy in all forest biomes and interacts preferentially with the large woody vegetation elements in which most of the biomass resides
- is more sensitive to biomass than at higher frequencies (X-, C-, S- and L-bands); lower frequencies (e.g. VHF) display even greater sensitivity but present formidable challenges for space borne SAR because of ionospheric e□ects
- displays high temporal coherence between passes separated by several weeks, even in dense forest - allows use of Polarimetric interferometric SAR (PolInSAR) to retrieve forest height and use of Tomographic SAR (TomSAR) to retrieve vertical structure
- P-band is highly sensitive to disturbances of the biomass

The Satellite

Launch planned for 2023

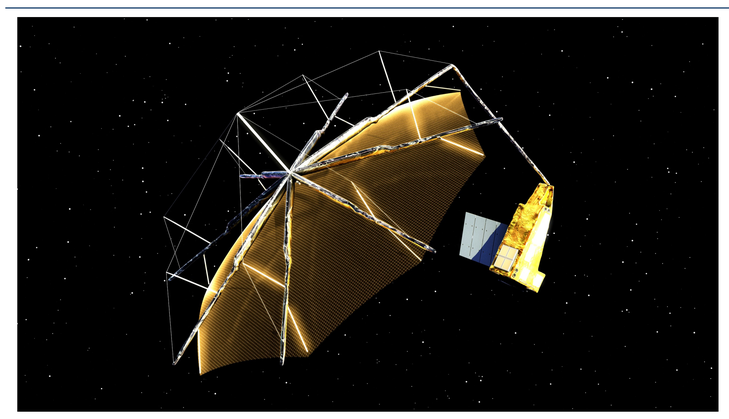

Figure 3
BIOMASS satellite with the Large Deployable Reflector Antenna
(Source: https://www.esa.int/Applications/Observing_the_Earth/FutureEO/Biomass/Forest_measuring_satellite_passes_tests_with_flying_colours, © Airbus)

Parameter	Requirement
Instrument	P-band full polarimetric interferometric SAR
Instrument mass	215 kg
Power consumptiom	250 W
Data rate	
Center frequency	435 MHz or 0.435 GHz (P-band, 70 cm wavelength)
Bandwidth	6 MHz (ITU allocation)
Near incidence angle	>23° (threshold); 25° (goal)
Spatial resolution (≥6 looks)	≤ 60 m (across-track) x 50 m (along-track)
Radiometric stability	≤ 0.5 dB (1σ)
Radiometric bias	≤ 0.3 dB (1σ)

Table 1
Instrument Characteristics

The instrument sensor offers major advances compared to all previous SAR missions because it will use the three techniques **SAR Polarimetry** (PolSAR), **Polarimetric SAR Interferometry** (Pol-InSAR) and **SAR Tomography** (TomoSAR) complementary to provide information on forest characteristics.

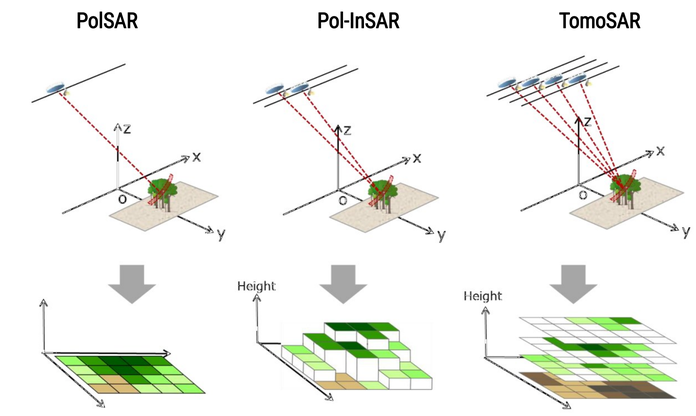

Figure 4
SAR Techniques offered by the Biomass Satellite
(Source: https://directory.eoportal.org/web/eoportal/satellite-missions/b/biomass)

The Products

Level-2 product	Definition	Information Requirements
Forest Above Ground Biomass (AGB)	defined as the dry weight of live organic matter above the soil, including stem, stump, branches, bark, seeds and foliage woody matter per unit area, expressed in t/ha (FAO, 2009). It does not include dead mass, litter and below-ground biomass. Biomass maps will be produced with a grid-size of 200m × 200 m (4 ha).	• 200 m resolution • RMSE of 20% or 10 t ha−1 for biomass • biomass map every observation cycle • lobal coverage of forested areas
Forest height	defined as upper canopy height according to the H100 standard used in forestry expressed in m, mapped using the same 4 ha grid as for biomass. H100 is defined as the average height of the 100 tallest trees/ha (Philip, 1994).	• 200 m resolution • accuracy required is biome-dependent, but RMSE should be better than 30% for trees higher than 10 m • 1 height map every observation cycle • global coverage of forested areas
Severe disturbance	an area where an intact patch of forest has been cleared, expressed as a binary classification of intact vs deforested or logged areas, with detection of forest loss being fixed at a given level of statistical significance.	• 50 m resolution • detection at a specified level of significance • 1 map every observation cycle • global coverage of forested areas

Table 2
Level-2 Primary mission products
(Quegan et al. 2019, Carbone et al. 2021)

Data Dissemination

The European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA) jointly developed the **Multi-Mission Algorithm and Analysis Platform (MAAP)**

MAAP offers seamless access to above ground biomass information derived either from ESA (BIOMASS mission) or NASA (NISAR & GEDI mission) Earth observation data
It is a virtual open and collaborative IT environment

Acknowledgements:

This poster has been compiled within the project EEBiomass, which is funded by the Federal Ministry of Economics and Technology (BMWi) with the project number 50EE1904.

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Supported by:
Federal Ministry of Economics and Technology
on the basis of a decision by the German Bundestag

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Project website: https://eebiomass.org
Twitter: https://twitter.com/eebiomass

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