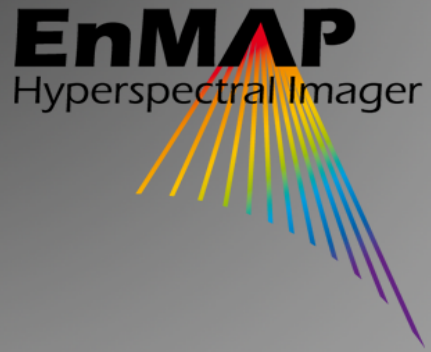


THE ENVIRONMENTAL MAPPING AND ANALYSIS PROGRAM (EnMAP)

Present status and science activities

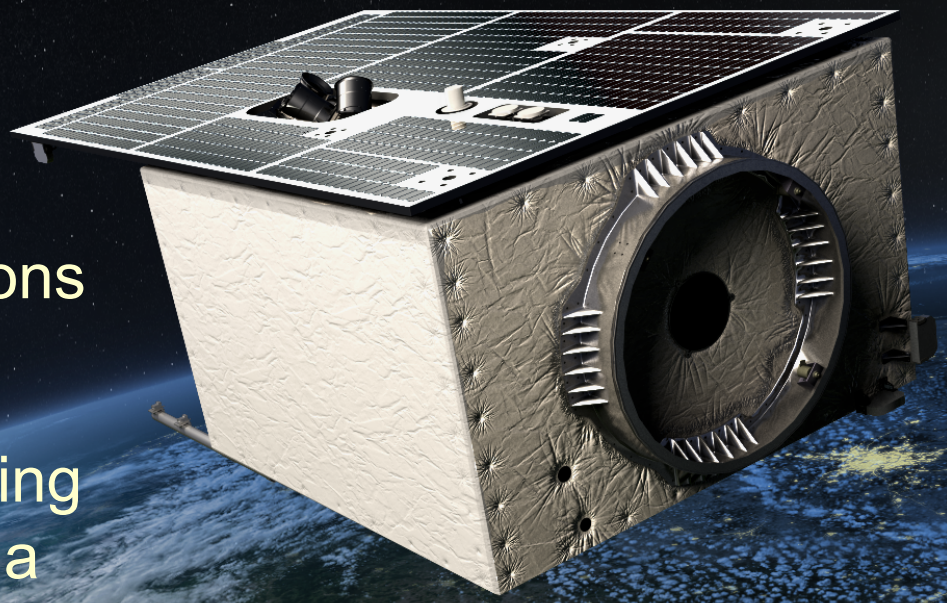
Hermann (Charly) Kaufmann, **Saskia Foerster**, Karl Segl, Theres Kuester, Christian Rogass, Bernhard Sang, Tobias Storch, Andreas Mueller, Godela Rossner, Christian Chlebek

and many others

Introduction

EnMAP mission

- Future scientific hyperspectral satellite mission
- Funded by the German Ministry of Economics and Technology with contributions from GFZ and DLR
- Monitoring and characterizing the Earth‘s environment in a broad range of application fields



Mission consortium

Scientific Principal Investigator
GFZ Potsdam

EnMAP Science Advisory Group

Project Management
DLR Space Administration

Space Segment

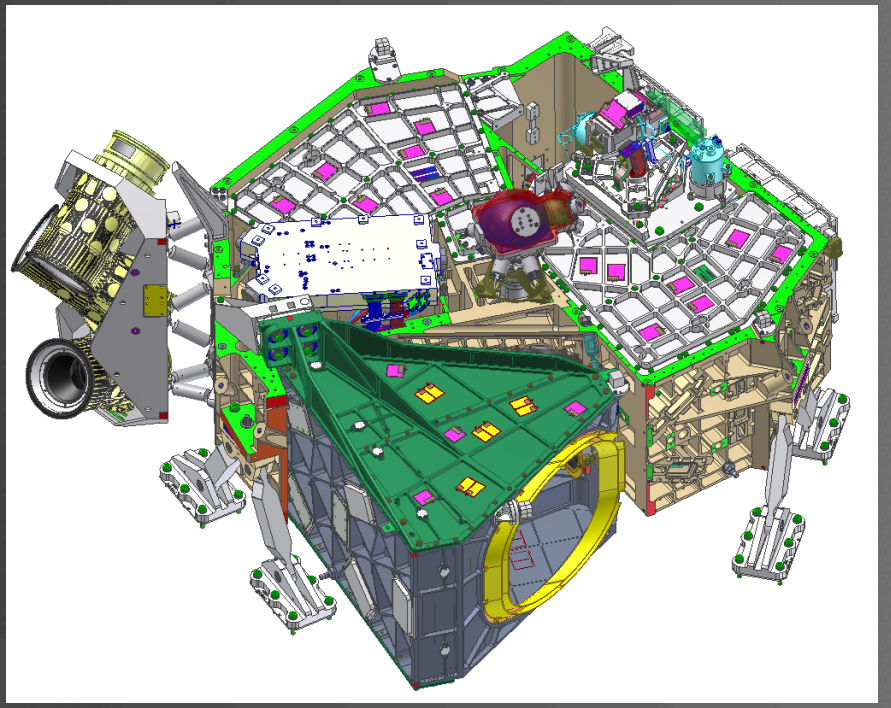
Sensor	Platform
Kayser-Threde	*OHB*

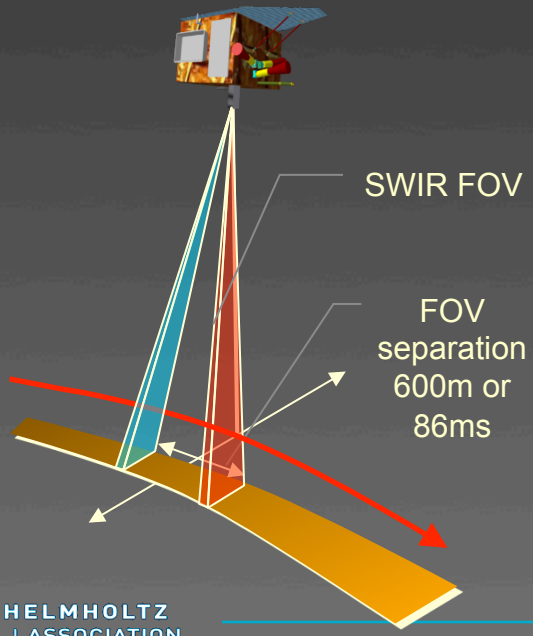
Ground Segment

Operations	Payload	Processing
DLR-GSOC	*DLR-DFD*	*DLR-IMF*

Mission and instrument overview

- Push-broom imager
- Spectral range from
  420 nm to 1000 nm (VNIR) and
  900 nm to 2450 nm (SWIR)
- High spectral resolution of 6.5 nm (VNIR)
  and 10 nm (SWIR); ~ 240 bands
- SNR of 500 @ 495 nm; 170 @ 2200 nm



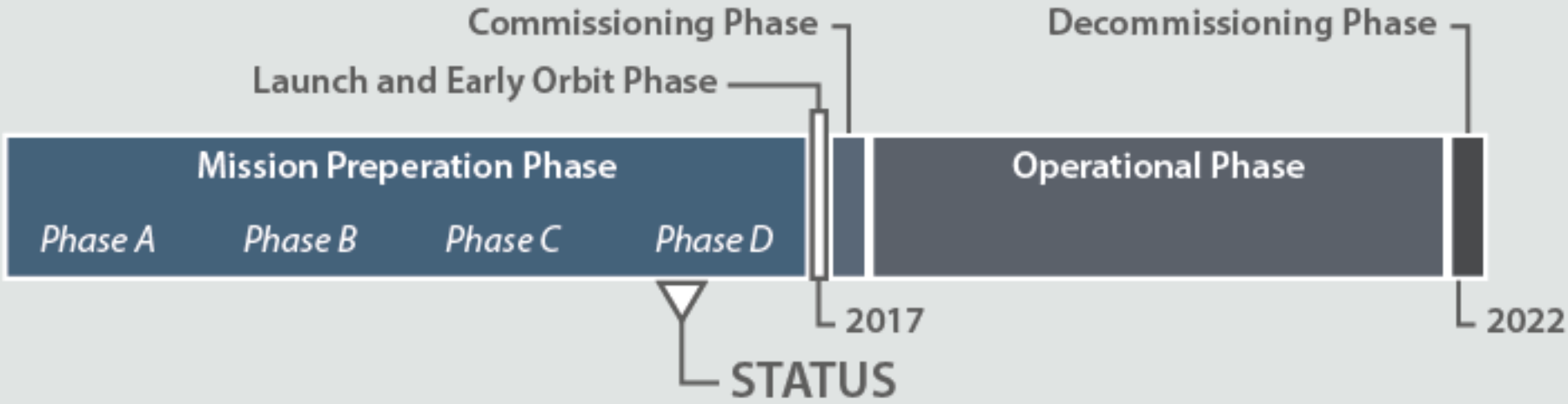


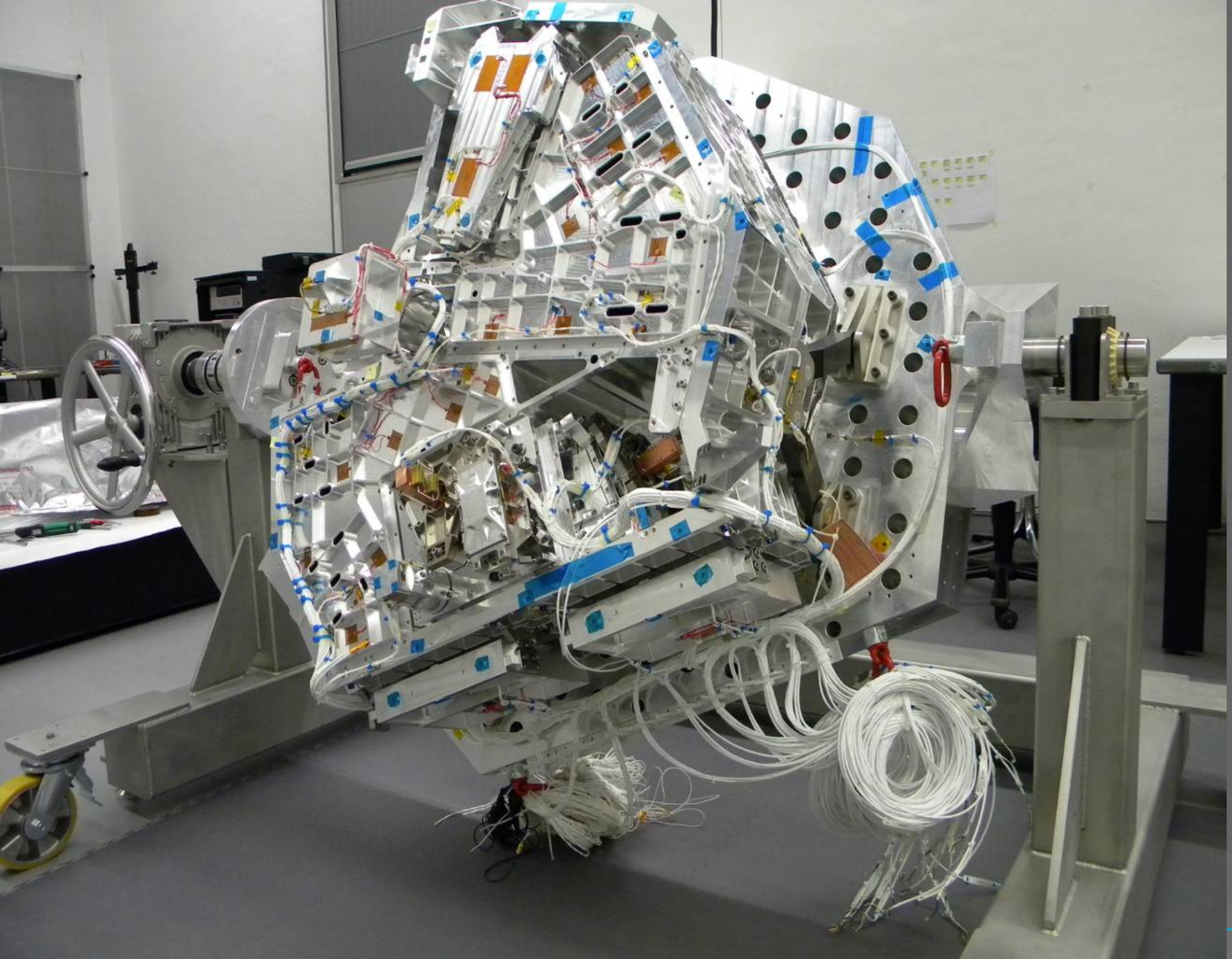
- Swath width 30 km
- GSD 30 m nadir
- Repeat cycle of 27 days
- ± 30°off-nadir pointing for frequent target revisit (≤ 4 days)
- 5,000 km total swath length acquisition per day
- Mission Life Time of 5 years

Status

History and Current Status

- 2005 Phase A study accomplished
- 2006 Start of phase B
- 2007 End of phase B
- 2008 Start of phase C/D
- 2010 CDR Ground Segment
- 2012 System CDR
- **2013 Start Phase D**
- **2017 Launch date**





KAYSER-THREDE

GFZ
Helmholtz Centre
Potsdam

Science activities

EnMAP Science Advisory Group (EnSAG)

Principal Investigator and Chair	*EnMAP Application Focus*
Hermann Kaufmann (GFZ Potsdam)	Geology and Soil Science

Members	
Michael Rast (ESA)	General mission advisor
Karl Staenz (Uni Lethbridge)	General mission advisor
Roland Doerffer (HZG)	Coastal and Inland Waters
Joachim Hill (Uni Trier)	Forests
Patrick Hostert (HU Berlin)	Ecosystems and gradual transitions
Wolfram Mauser (LMU München)	Agriculture
Andreas Müller, Uta Heiden (DLR)	Urban areas

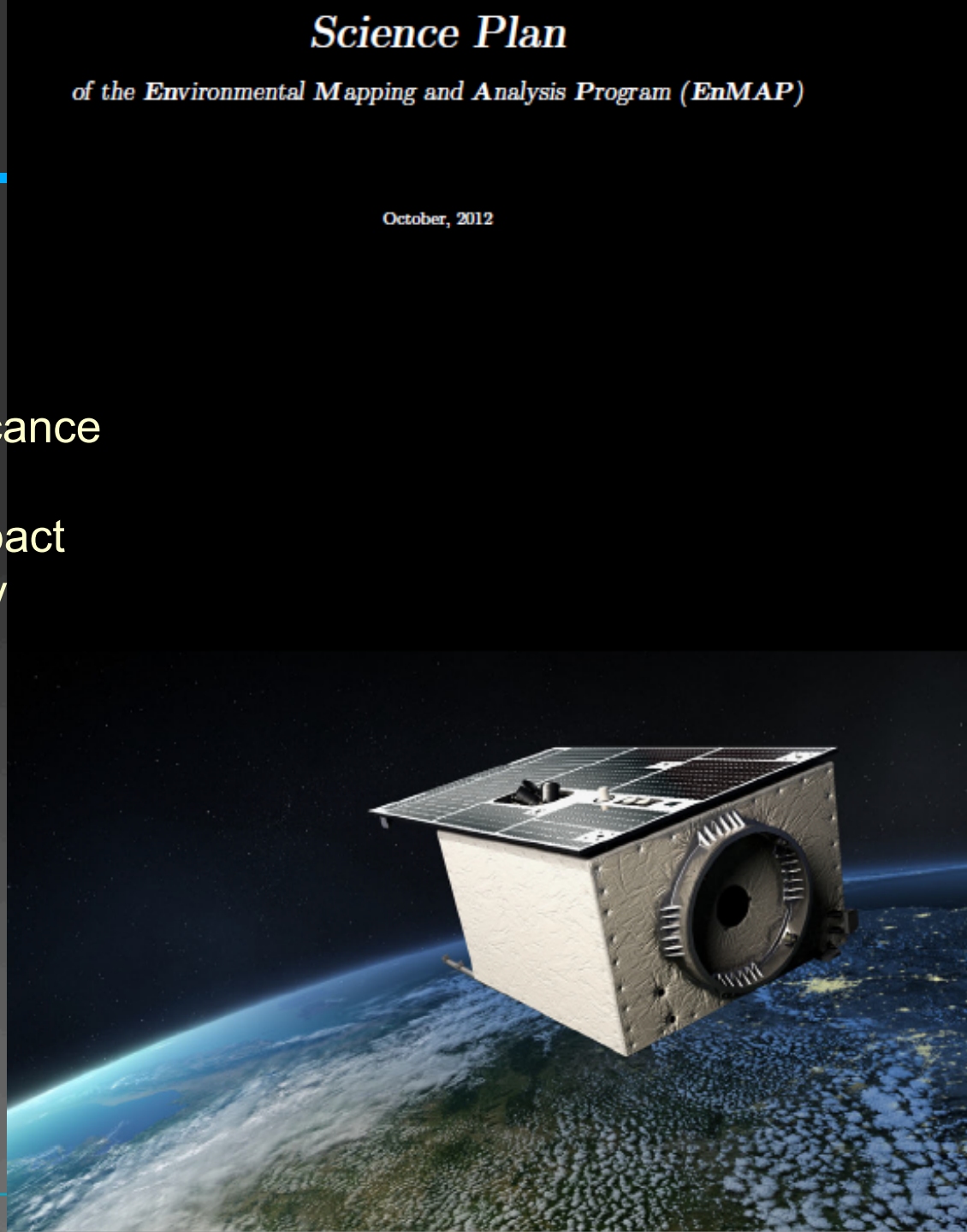
Science activities

EnMAP Science Plan

Content

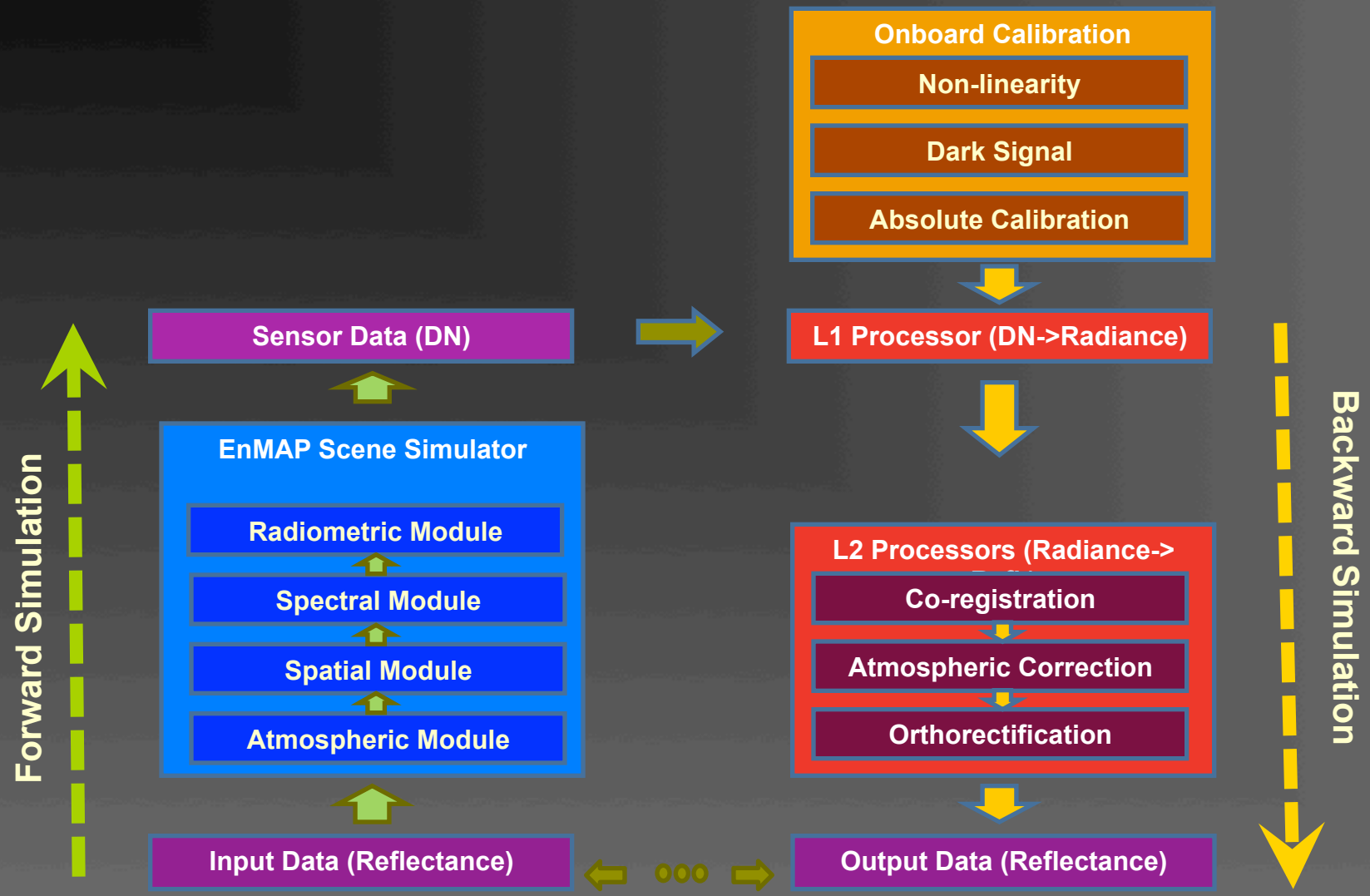
- Research context and significance
- General mission framework
- EnMAP perspectives and impact
- Scientific exploitation strategy

www.enmap.org



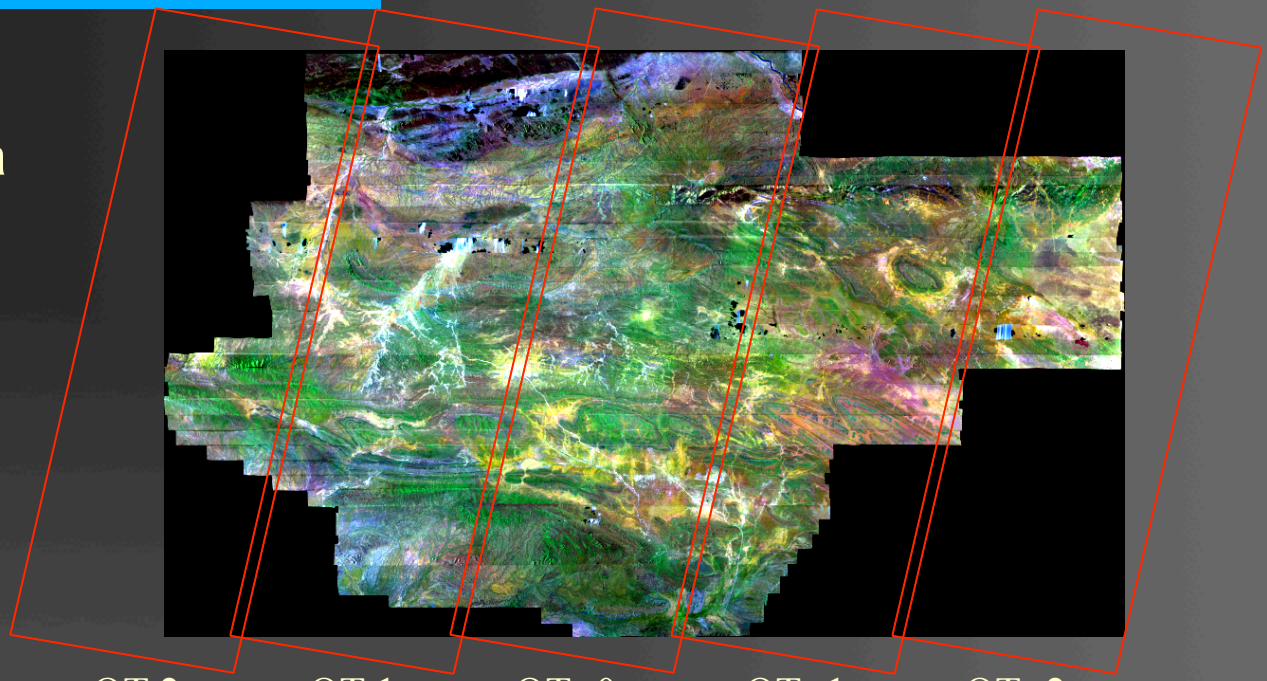
EnMAP End to End Simulator (Eetes)

Segl et al. 2012

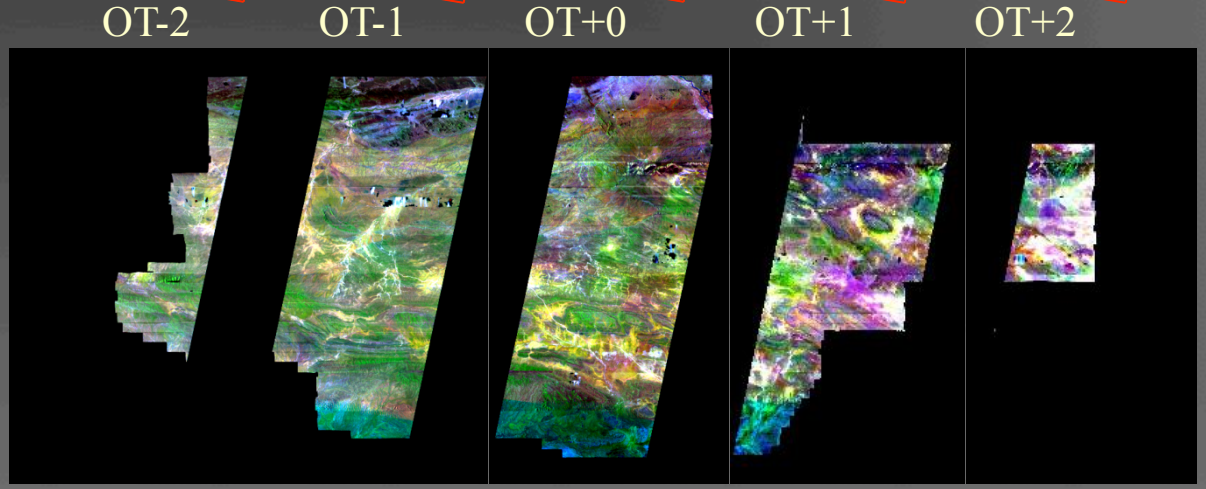


EeTeS simulation: multiple orbital tracts

Testsite: North Namibia
Data: Hymap mosaic
Size: 122 km x 75 km
R/G/B: 2.2/0.8/0.4 µm

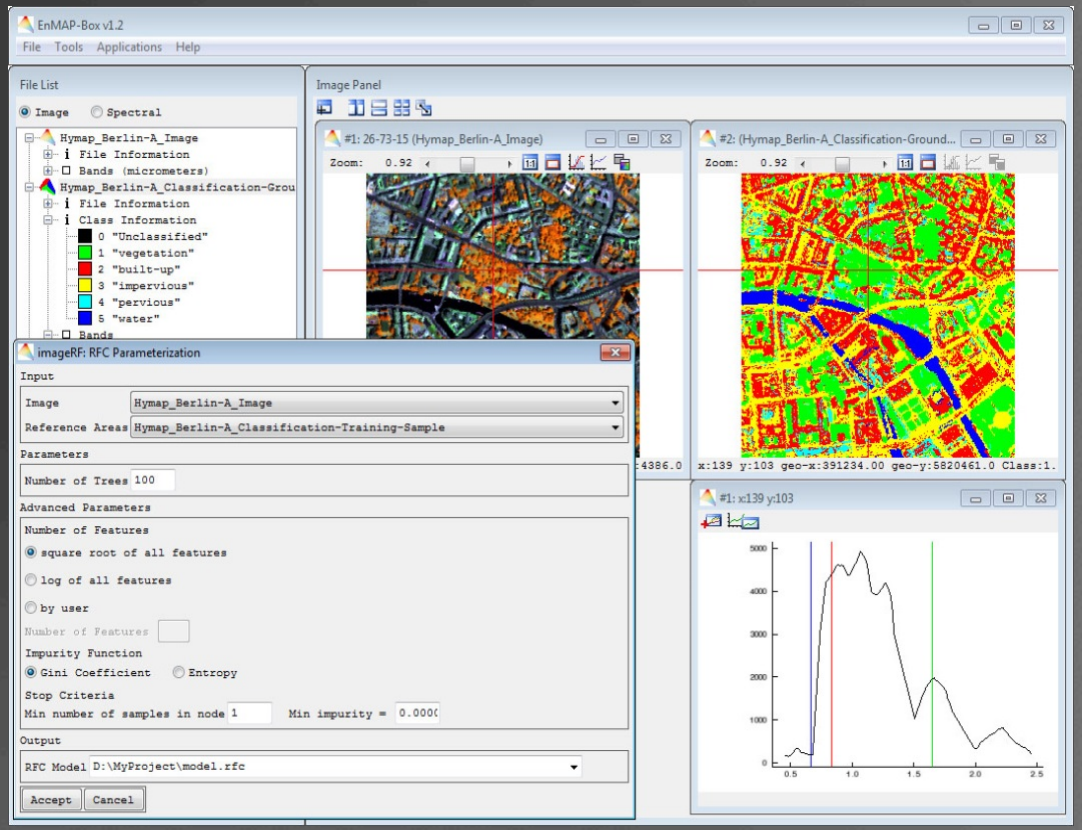


EnMAP L2 images
R/G/B: 2.2/0.8/0.4 µm



EnMAP Box

- Easy access to processing tools for hyperspectral data
  - Allows non-experts to explore EnMAP data
  - support for training courses
  - state-of-the art IS algorithms
- Contains individual preprocessing tools for EnMAP data
- Platform to test and exchange new and innovative algorithms
- Free, open source and platform independent
- Download from www.enmap.org



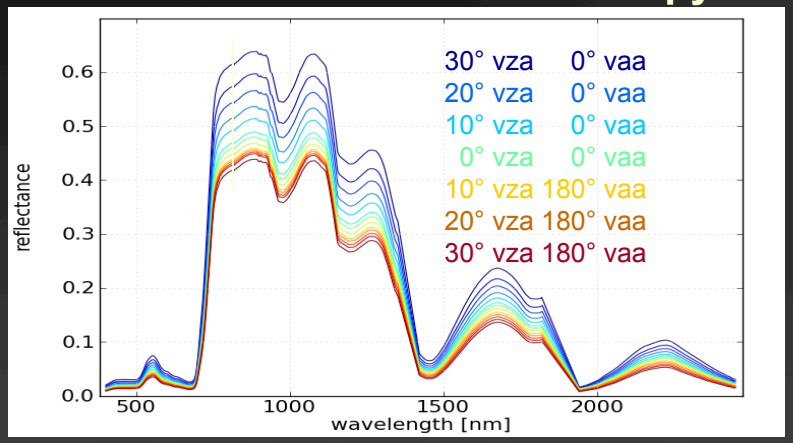
Humboldt University, 2012

Science activities

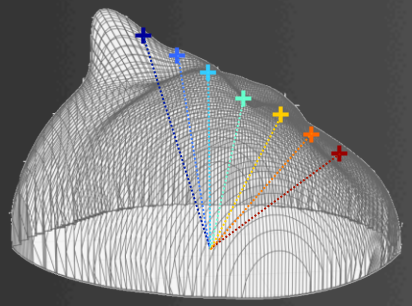
Correction for anisotropic reflectance

Kuester et al. 2013

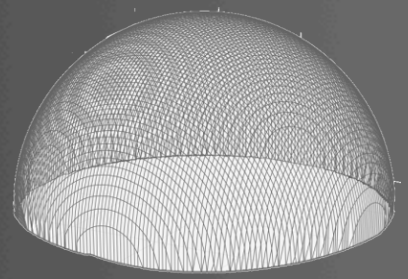
Reflectance of winter wheat canopy



anisotropic reflectance

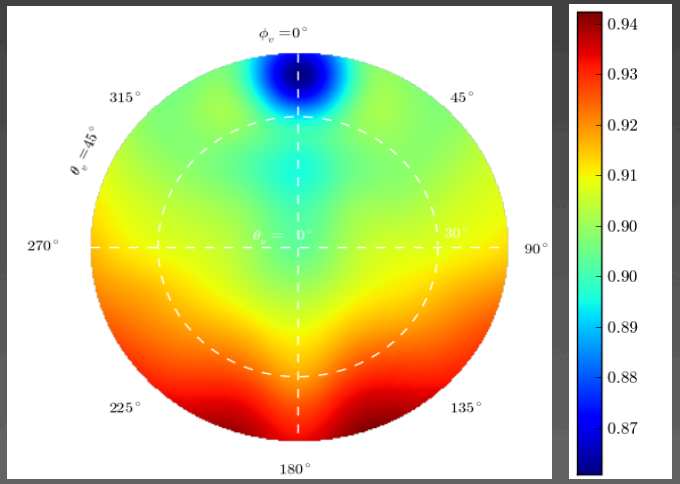


ideally diffuse reflectance



BRDF (λ= 900nm; sza=40°; saa=136°)

BRDF of a Lambert reflector



NDVI (*BRDF (λ= 900nm; sza=40°; saa=136°)*)

Reflectance dependent on observation geometry
➞ VI (e.g. NDVI) values also varying
Each VI value should characterize one canopy stand

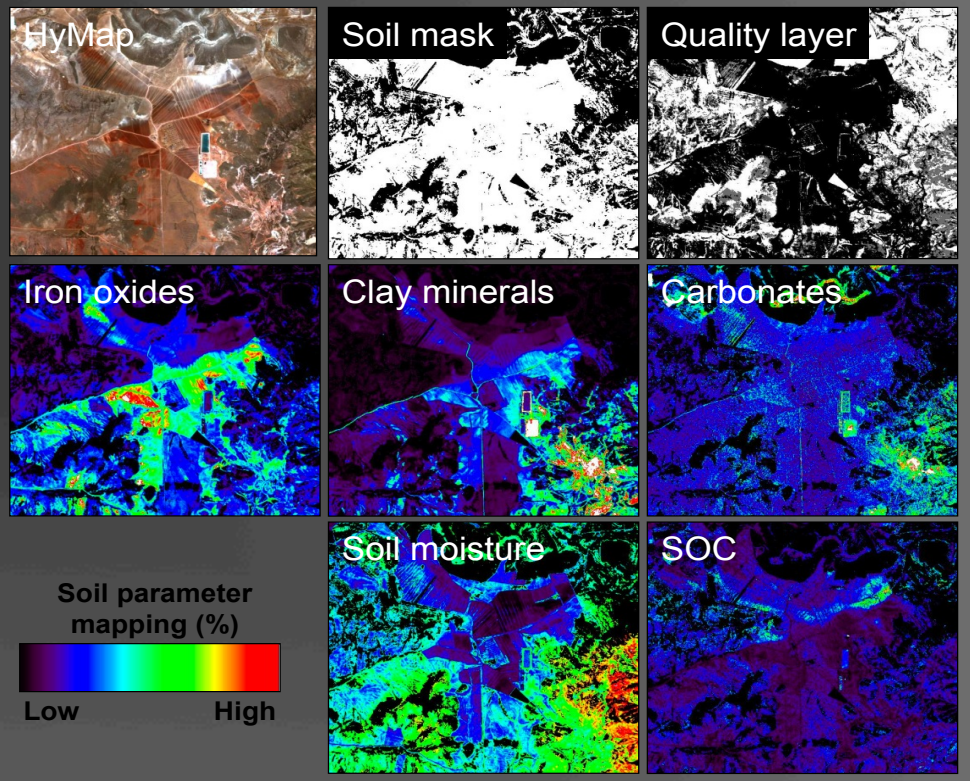
➞Simulation of canopy reflectance under different observation geometry for several crop types

➞Basis for development of a correction algorithm of anisotropic reflectance

EnSoMAP

Chabrillat et al.

- Expert system for soil mapping
- Automatic generation of semi-quantitative soil maps (Soil moisture content, organic carbon, iron oxides, clays, carbonates content) + quality layer map
- User custom option for fully quantitative soil mapping
- Currently distributed for airborne users: www.gfz-potsdam.de/hysoma

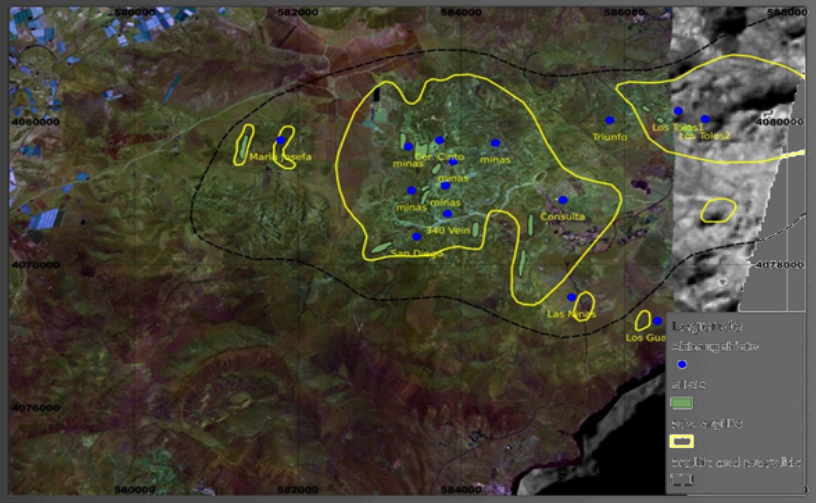


Example L3 soil products

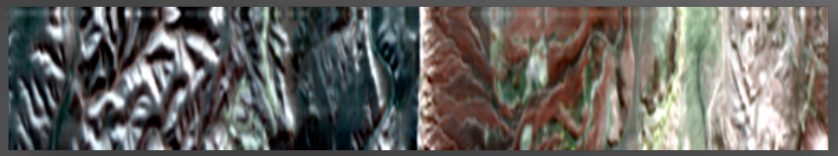
EnGeoMAP

Rogass et al. 2013

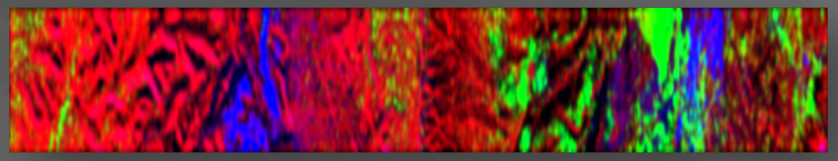
- Expert system for geological mapping of resource deposits and monitoring of mine waste
- Full mineral identification and semi-quantification



Gold mining sites Rodalquilar Caldera; Spain; HyMAP, Hyperion; Geology after Arribas (1989)



Hyperspectral image



L3-Product: abundant minerals (red-carbonates, blue – epidotes, green-clays

Science activities

YoungEnMAP

EnMAP summer school participants 2011

Science activities

PhD Program 2010-2013

Agriculture

- Forage quality of grassland (Andreas Freyaldenhoven, Uni Bonn)
- Biomethanpotential of maize (Christian Bossung, Uni Trier)
- Crop biomass (Benjamin Mack, Uni Bonn)
- Biochemical crop and topsoil parameters (Bastian Siegmann, Uni Osnabrück)
- Plant physiological status (Mathias Locherer, LMU München)

Forest Ecosystems

- Forest damage and above ground biomass (Fabian Fassnacht, Uni Freiburg)
- Forest biodiversity (Anne Clasen, TU Berlin)
- Forest structure (Henning Aberle, Uni Göttingen)
- Biophysical and structural forest parameters (Pyare Püschl, Uni Trier)

Science activities

PhD Program 2010-2013

Monitoring Ecosystem Transitions

- Arctic tundra communities along environmental gradients (Marcel Buchhorn, AWI Potsdam)
- Vegetation stress along environmental gradients (Sebastian Preidl, UFZ Leipzig)

Coastal and Inland Waters

- Kelp mapping (Florian Uhl, Uni Kiel)
- Coastal and inland water quality (Ulrike Kleeberg, HZG Geesthacht)

Soils and Geology

- Climate-driven erosion processes (Sven Borchard, Uni Potsdam)
- Mineral deposit and mine waste mapping (Christian Mielke, GFZ Potsdam)

Science activities

Airborne campaign 2010-2013

- Airborne acquisitions 2010-2013 (supporting PhD program and EnMAP science team) in Germany and Iberian Peninsula
- New airborne acquisitions planned for 2014-2017 with focus on multi-temporal data
- Data available from enmap.org

Summary + Outlook

Summary:

- EnMAP – first German imaging spectroscopy satellite mission
- Currently in Phase D – Launch planned for 2017
- Simulation software for EnMAP-like data
- Strong science activities on-going: EnSAG, EnMAP Box, PhD program, etc.

Outlook:

- Next PhD program starting soon
- International EnMAP workshop planned for 2015
- Explore synergies between EnMAP and other missions

Thank you for the attention

Federal Ministry of Economics and Technology

GFZ Helmholtz Centre Potsdam

DLR

www.enmap.org

Hermann Kaufmann
GFZ Potsdam

Saskia Foerster
GFZ Potsdam

Data Products

Product	Product Characterisation	Comment
Level 0	Transcription	Stored in DIMS (no delivery)
Level 1	Radiance	Processing on Demand; Meta Data updated for User Proc.
Level 2geo	Georectification + Radiance	Geometric Correction with Sensor Model Refinement
Level 2atm	Co-Registration + Reflectance	Atmospheric Correction for Land / Water Targets
Level 2	Georectification + Reflectance	Geometric and Atmospheric Corrected Product

Overall Mission Goals

- To provide high-quality calibrated data and products to be used as inputs for improved modeling and understanding of biospheric /geospheric processes
- To provide high-spectral resolution observations on a global basis
- To significantly contribute to environmental research studies, notably in the fields of ecosystem functions, natural resource management, natural hazards and Earth system modelling
- To develop new concepts and techniques for data extraction and assimilation to achieve synergies with other sensors

Science activities

Theme I: Terrestrial Ecosystems

Focus: Habitat fragmentation, Ecosystem services, Biodiversity loss, Species migration, Agricultural and forest ecosystems, Urban growth

- Quantifying the impact of human activities such as land use/cover change and environmental pollution on ecosystems, their services and biodiversity
- Quantifying the rate and consequences of ecosystem changes (e.g. biodiversity loss, species migration).
- Monitoring measures to combat biodiversity loss and improve ecosystem stability (e.g. REDD+)
- Assessing the impact of soot and dust on snow and glacial melt and the consequences for the hydrological cycle
- Analysing the state and development of urban compositions and growth