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
Introduction

Mission consortium

Scientific Principal Investigator
GFZ Potsdam

Project Management
DLR Space Administration

EnMAP Science Advisory Group

Space Segment
Sensor
Kayser-Threde
Platform
OHB

Ground Segment
Operations
DLR-GSOC
Payload
DLR-DFD
Processing
DLR-IMF
Remote Sensing Section

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
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
Remote Sensing Section

Principal Investigator and Chair
Hermann Kaufmann (GFZ Potsdam)

Members
Michael Rast (ESA)
Karl Staenz (Uni Lethbridge)
Roland Doerffer (HZG)
Joachim Hill (Uni Trier)
Patrick Hostert (HU Berlin)
Wolfram Mauser (LMU München)
Andreas Müller, Uta Heiden (DLR)

EnMAP Application Focus
Geology and Soil Science

Science activities
EnMAP Science Advisory Group (EnSAG)

General mission advisor
Coastal and Inland Waters
Forests
Ecosystems and gradual transitions
Agriculture
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
Science activities

EnMAP End to End Simulator (Eetes)

Onboard Calibration
- Non-linearity
- Dark Signal
- Absolute Calibration

L1 Processor (DN->Radiance)

L2 Processors (Radiance->Reflectance)
- Co-registration
- Atmospheric Correction
- Orthorectification

Output Data (Reflectance)

Input Data (Reflectance)

EnMAP Scene Simulator
- Radiometric Module
- Spectral Module
- Spatial Module
- Atmospheric Module

Sensor Data (DN)

Segl et al. 2012
Science activities

**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
Science activities

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
Reflectance of winter wheat canopy

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

**Science activities**

**Correction for anisotropic reflectance**

Kuester et al. 2013
Science activities

EnSoMAP

- 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
Science activities

**EnGeoMAP**

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

www.enmap.org

Hermann Kaufmann
GFZ Potsdam

Saskia Foerster
GFZ Potsdam
<table>
<thead>
<tr>
<th>Product</th>
<th>Product Characterisation</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>Transcription</td>
<td>Stored in DIMS (no delivery)</td>
</tr>
<tr>
<td>Level 1</td>
<td>Radiance</td>
<td>Processing on Demand; Meta Data updated for User Proc.</td>
</tr>
<tr>
<td>Level 2geo</td>
<td>Georectification + Radiance</td>
<td>Geometric Correction with Sensor Model Refinement</td>
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<tr>
<td>Level 2atm</td>
<td>Co-Registration + Reflectance</td>
<td>Atmospheric Correction for Land / Water Targets</td>
</tr>
<tr>
<td>Level 2</td>
<td>Georectification + Reflectance</td>
<td>Geometric and Atmospheric Corrected Product</td>
</tr>
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**Introduction**

**Data Products**
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