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HYPERedu- EnMAP Education Initiative

Online learning resources on hyperspectral remote sensing

GFZ German Research Centre
for Geosciences



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Overview



- ❖ Contents:
 - ◆ Annotated slide collections, tutorials, educational films, interactive graphics and video recordings on principles, methods and applications of imaging spectroscopy
 - ◆ Hyperspectral MOOC planned to be opened in 2021
- ❖ Target group: students and professionals at master level (English)
- ❖ Hosting: EO College platform
- ❖ License: Teaching materials are provided free of charge under creative commons license (CC BY-SA 4.0)



HYPERedu on EO college platform



- ❖ Platform adapted to new (hyperspectral) contents
- ❖ First HYPERedu resources published (slide collection and tutorials) online

The screenshot shows the search results for 'spectroscopy' on the EO college platform. The search bar contains 'spectroscopy' and the results show two items:

- ENMAP-BOX**: A resource by HYPER edu, featuring a colorful satellite image with a rainbow spectrum overlay. It has 1 like and 87 views.
- PRINCIPLES OF IMAGING SPECTROSCOPY**: A resource by HYPER edu, featuring a 3D visualization of a hyperspectral cube. It has 3 likes and 120 views.

On the left, there are filter options for ORDER BY (Name), CATEGORY, POST TYPE, SPECTRUM (Hyperspectral checked, Radar 76), and LANGUAGE.

The screenshot shows the resource page for 'Principles of imaging spectroscopy'. The page title is 'Principles of imaging spectroscopy' with a subtitle 'Electromagnetic radiation and its interactions with earth surface materials'. It includes a description, a 3D visualization of a hyperspectral cube, and a 'Unit Description' section. The page is part of a collection of resources.

The screenshot shows the resource page for 'EnMAP-Box'. The page title is 'EnMAP-Box' with a subtitle 'Software Description'. It includes a description of the software, a 3D visualization of a hyperspectral cube, and an 'EnMAP-Box' logo. The page is part of a collection of resources.

Annotated slide collections



- ❖ First annotated slide collection on “Principles of imaging spectroscopy” published in September 2019
- ❖ All slide collections are published in pdf and ppt format following corporate layout and consistent structure

Principles of imaging spectroscopy
Introduction and basics of hyperspectral remote sensing techniques

Published by GFZ German Research Centre for Geosciences

Contents

- 01 Electromagnetic radiation
- 02 Radiation transfer
- 03 Interaction of radiation
- 04 Multispectral vs. hyperspectral
- 05 Surface Reflectance
- 06 Further Reading / Image Credits & References

Image and graphic credits

Layout and Design by Theres Kuester, GFZ German Research Centre for Geosciences

Title and Layout Images from left to right: (1) ESA adapted - Great Barrier Reef, (2) ESA adapted - Mont Sane Miconi (3) ESA adapted - Namib Desert, (4) ESA adapted - Amsterdam, (5) ESA adapted - Luquajay River Wetlands, (6) EUSIESA adapted - Algerian Sands, (7) ESA adapted - Kenya, (8) ESA adapted - Namib Naukluft

Vector Graphic Elements: www.iStock.com, http://www.free-powerpoint-templates-design.com

Slide 7, 8, 12, 16, 18, 20, 25, 29, and 30: indicated images) adapted from Jensen J.R. (2007). Remote Sensing Of The Environment: An Earth Resource Perspective, 2nd Edition, Pearson.

Slide 7, 12, 29, and 30: indicated images) adapted from Lillesand T., Kiefer R.W. & J. Chipman (2008). Remote Sensing and Image Interpretation, 6th Edition

Slide 15: Globe from ESR (2009). Globe, i-cubed satellite imagery. ArcGlobe® from ESR

Slide 20: indicated image from ESA (2009). Great Britain and Ireland. CC BY-SA 3.0 IGO

n radiation – atmosphere (I)

Absorption of electromagnetic radiation is the way by which the energy of a photon is taken up by matter. Thus, the electro-magnetic energy is transformed to other forms of energy, e.g. heat

- ❖ An absorption band is a wavelength range in which electromagnetic radiation is absorbed by a substance (e.g. water vapour) → cumulative effect of several substances can „close“ the atmosphere in certain regions (disadvantage of optical remote sensing)
- ❖ (relatively) permeable wavelength regions are called **atmospheric windows** (e.g. VIS)

Spectral radiance in radiance (W m⁻² sr⁻¹ μm⁻¹)

Solar radiation at the top of the atmosphere

Stack body radiation at 3177 K at distance sun-earth

Solar radiation at sea level

Wavelength [nm]



Contents and structure

- ❖ Learning resources on
 - ◆ Principles
 - ◆ Methods
 - ◆ Applications
 - ◆ Software / data sources
- ❖ Cross-references among slide collections and to tutorials
- ❖ Materials to be extended and updated in the future

HYPERedu

A new online learning platform for hyperspectral remote sensing

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Background

Hyperspectral imagers have demonstrated to be a source of accurate and quantitative information about terrestrial and aquatic ecosystems required in various application fields. While the current availability of hyperspectral image data is still limited in both temporal and spatial coverage, data availability is expected to increase substantially in the near future with a rising number of imaging spectrometers deployed on airborne platforms and the launch of space-borne imaging spectroscopy missions such as EnMAP. In view of these developments, an increasing need for Earth Observation education and training activities with a focus on hyperspectral imagery is expected in the next few years.

Objectives

Therefore, the development of HYPERedu, an online learning platform for hyperspectral remote sensing to be hosted on EO College has started as part of the EnMAP education initiative. HYPERedu will provide presentations, hands-on tutorials and short educational films on principles, methods and applications of imaging spectroscopy at master's level, addressing students as well as professionals in research, companies, and public agencies. The first resources were published in September 2019 and will subsequently be extended. In addition, the development of a hyperspectral MOOC with several modules and certificate is planned to be opened in 2021.

Hosting and Content



EO College platforms hosting HYPERedu

Extract from a published tutorial

Example slides from the first published annotated slide collection

Content and structure of the HYPERedu online learning resources (to be further extended in the future)

Basics

- Principles of imaging spectroscopy
- Principles of sensor technology & data acquisition
- Data preprocessing
- Sensor simulation

Methods

- Demonstratory reduction and transformation
- Classification methods
- Quantification methods

Applications

- Agriculture
- Natural ecosystems and gradients
- Carbon cycling
- Soils
- Geology
- Urban areas
- Water
- Ecological and environmental research
- Atmosphere and gases

Software and data

- Data sources (data, field and imaging spectroscopy)
- EnMAP-Box introduction

HYPERedu in a nutshell

Contents: Annotated slide collections, hands-on tutorials using the EnMAP-Box software, educational films, interactive graphics and videos on principles, methods and applications of imaging spectroscopy (currently under development); Hyperspectral MOOC with several modules (planned to be opened in 2021)

Target group: Students and professionals at master's level (English language)

Hosting: EO College online learning platform (eo-college.org)

License: All content is provided free of charge under a CC BY-SA 4.0 International License

Funding: Within the EnMAP scientific preparation program under the DLR Space Administration with resources from the German Ministry of Economic Affairs and Energy (BMWi)

Developers: GFZ Potsdam, Humboldt-Universität zu Berlin, Universität Jena / EOS with contributions from the EnMAP Science Team and beyond

EnMAP-Box software

All tutorials are based on the EnMAP-Box software that is being developed within the EnMAP science program. The EnMAP-Box is a free and open-source plug-in for GIS for visualizing and processing imaging spectroscopy data and spectral libraries.





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Outlook



- ❖ Publication of further learning materials at EO College, development of hyperspectral MOOC to be opened in 2021 and later shorter MOOCs on selected topics
- ❖ Use of HYPERedu resources in workshops (EnMAP-Box Workshop 2020 und 2022 in Berlin), training courses (e.g. at Copernicus Forum, webinars) and university teaching

Presenter: Dr. Arlena Brosinsky Live Now

Overview of Hyperspectral Remote Sensing
An introduction to basic principles

Presented by:
Arlena Brosinsky
Theres Kuester
Saskia Foerster
Hermann Kaufmann
Karl Segl
Maximilian Brell
Luis Guanter

GFZ German Research Centre for Geosciences

on the basis of a lecture by the German Research Aerospace Establishment DLR

HYPEREDU GFZ

DLR

ARS Outreach Programme

Webinar on hyperspectral remote sensing (organised by ISRO for the CEOS Working Group on Capacity Building & Data Democracy)

7 November 2019

Thank you

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More info: www.eo-college.org
www.enmap.org

EnMAP
Hyperspectral Imager



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