OVERVIEW OF THE ENMAP IMAGING SPECTROSCOPY MISSION

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ABSTRACT

The Environmental Mapping and Analysis Program (EnMAP) German imaging spectroscopy mission is intended to fill the current gap in space-based imaging spectroscopy data. An overview of the main characteristics and current status of the mission will be provided in this contribution. The core payload of EnMAP consists of a dual-spectrometer instrument measuring in the optical spectral range between 420 and 2450 nm with a spectral sampling distance varying between 5 and 12 nm and a reference signal-to-noise ratio of 400:1 in the visible near-infrared and 180:1 in the shortwave-infrared parts of the spectrum. EnMAP images will cover a 30 km wide area in the across-track direction with a ground sampling distance of 30 m. An across-track tilted observation capability will enable a target revisit time of up to 4 days at Equator and better at high latitudes. EnMAP will contribute to the development and exploitation of spaceborne imaging spectroscopy applications by making high-quality data freely available to scientific users worldwide.

Index Terms— Imaging spectroscopy, EnMAP, space-based remote sensing

1. INTRODUCTION

Most of the developments in imaging spectroscopy in the last decades have been based on airborne spectrometers covering the visible to near-infrared (VNIR) and, often, shortwave-infrared (SWIR) spectral ranges (roughly, 400–1000 nm and 1000–2500 nm, respectively). In particular, the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) [1], designed and operated by the NASA Jet Propulsion Laboratory in California, has been used since the late 1980s in a large number of imaging spectroscopy experiments and field campaigns. Unfortunately, the recognized potential of imaging spectroscopy is currently not counterbalanced by an equivalent availability of spaceborne imaging spectroscopy data. Two technology demonstration missions, Hyperion onboard NASA's Earth Observing One (EO-1) spacecraft [2] and the Compact High Resolution Imaging Spectrometer (CHRIS) on ESA's Proba-1 microsatellite [3], have been the main providers of space-based hyperspectral data in the last decades.

The Environmental Mapping and Analysis Program (EnMAP) is an imaging spectroscopy mission under development by a consortium of German Earth observation research institutions to fill the current gap in space-based imaging spectroscopy data [4]. EnMAP is designed for the retrieval of bio-, geochemical and physical parameters characterising the Earth surface for applications such as agriculture, land-use, water systems, soil science, and geology.

2. MISSION AND INSTRUMENT REQUIREMENTS

EnMAP relies on a prism-based dual-spectrometer instrument design to cover the 420–2450 nm spectral range. An artistic representation of an EnMAP overpass depicting the field-of-view of the VNIR and SWIR spectrometers and other acquisition details is displayed in Fig. 1. The VNIR spectrometer covers the 420–1000 nm spectral range with a spectral sampling distance (SSD) between 5.5 and 7.5 nm, whereas the SWIR spectrometer covers the 900–2450 nm with an SSD between 8.5 and 11.5 nm. Spectral resolution is required to be about 1.2 larger than the sampling distance. Threshold requirements for the signal-to-noise ratio (SNR) at the ref-

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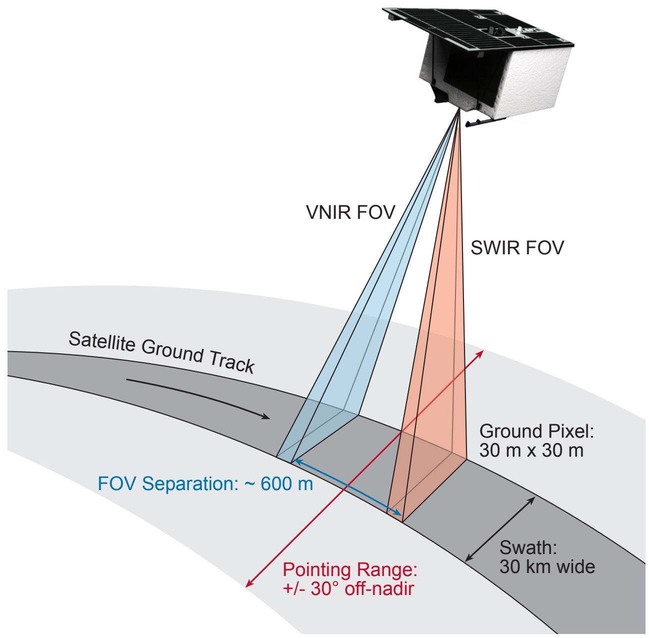

Fig. 1. Representation of an EnMAP overpass featuring the dual-spectrometer instrument concept. The field-of-views (FOVs) of the visible near-infrared (VNIR) and shortwave infrared (SWIR) spectrometers are represented in blue and red, respectively (reproduced from [4]).

erence radiance level, defined by 30% surface albedo, 30° sun zenith angle (SZA), 0.5 km above sea level and 21 km atmospheric visibility, are 400:1 and 180:1 for the VNIR and SWIR ranges, respectively, with a 14-bit radiometric resolution. The required radiometric calibration accuracy is 5%, and the spectral calibration uncertainty is 0.5 nm in the VNIR and 1 nm in the SWIR. Spatial sampling is defined by a ground sampling distance (GSD) of 30 m, a swath width of 30 km and a length in multiples of 30 km up to 1000 km per orbit and 5000 km per day (limitations mostly posed by onboard memory and power consumption constraints). The selected orbit is sun-synchronous, with a local time of 11:00 for the descending node. An off-nadir pointing capability of up to 30° enables a revisit time of 4 days at Equator and better at higher latitudes. The expected mission lifetime is 5 years.

3. GROUND SEGMENT AND DATA PRODUCTS

The setup and operation of the EnMAP ground segment is under responsibility of the Earth Observation Center (EOC) and the German Space Operations Center (GSOC) at the German Aerospace Center (DLR) [5]. The ground segment completed its design phase by successfully passing the critical design review in 2010 and is now in production phase.

The ground segment is organized in 15 systems covering all relevant aspects to assure successful mission operations. This comprises controlling and commanding the satellite using multi-mission infrastructures as well as data reception, hyperspectral data processing including calibration, data archiving, data dissemination, and provision of web-interfaces to the international user community. Two major scenarios of particular interest for the users are addressed next. These are the handling of image acquisitions based on user requests and the generation of standardized products based on acquisitions or archive orders by users.

The EnMAP ground segment will distribute a series of data products with different processing levels as follows:

1. Level 0: Time-tagged instrument raw data with auxiliary information (internal)
2. Level 1B: Radiometrically-corrected, spectrally- and geometrically-characterised radiance
3. Level 1C: Orthorectified level 1B
4. Level 2A: Atmospherically-corrected level 1C

4. ONGOING PREPARATORY ACTIVITIES

Recent activities towards the consolidation of the mission have been focused on the support of industrial developments and the final consolidation of the mission concept. A scene simulator generating EnMAP-like data under realistic conditions has been implemented. It enables the definition of optimal instrument configurations for radiometric, spectral and geometric parameters as well as the evaluation and profiling of data-processing algorithms [6, 7].

In terms of the development of the EnMAP scientific programme, a software environment for the interactive processing of EnMAP data is being jointly designed by the Geomatics lab of the Humboldt University of Berlin and the GFZ. Tools for calibration, pre-processing and the derivation of higher-level biophysical products are to be included in this so-called EnMAP-Box software [8].

5. REFERENCES

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