THE ENMAP USER INTERFACE AND USER REQUEST SCENARIOS

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ABSTRACT:

EnMAP (Environmental Mapping and Analysis Program) is a German hyperspectral satellite mission providing high quality hyperspectral image data on a timely and frequent basis. Main objective is to investigate a wide range of ecosystem parameters encompassing agriculture, forestry, soil and geological environments, coastal zones and inland waters. The EnMAP Ground Segment will be designed, implemented and operated by the German Aerospace Center (DLR). The Applied Remote Sensing Cluster (DFD) at DLR is responsible for the establishment of a user interface. This paper provides details on the concept, design and functionality of the EnMAP user interface and a first analysis about potential user scenarios.

The user interface consists of two online portals. The EnMAP portal (www.enmap.org) provides general EnMAP mission information. It is the central entry point for all international users interested to learn about the EnMAP mission, its objectives, status, data products and processing chains. The EnMAP Data Access Portal (EDAP) is the entry point for any EnMAP data requests and comprises a set of service functions offered for every registered user. The scientific user is able to task the EnMAP HSI for Earth observations by providing tasking parameters, such as area, temporal aspects and allowed tilt angle.

In the second part of that paper different user scenarios according to the previously explained tasking parameters are presented and discussed in terms of their feasibility for scientific projects. For that purpose, a prototype of the observation planning tool enabling visualization of different user request scenarios was developed. It can be shown, that the number of data takes in a certain period of time increases with the latitude of the observation area. Further, the observation area can differ with the tilt angle of the satellite. Such findings can be crucial for the planning of remote sensing based projects, especially for those investigating ecosystem gradients in the time domain.

1. INTRODUCTION

EnMAP (Environmental Mapping and Analysis Program) is a German hyperspectral satellite mission providing high quality hyperspectral image data on a timely and frequent basis (Mogulsky et al., 2009). The EnMAP mission is a predominantly scientific mission addressing a strongly research oriented EnMAP user community (Guanter et al., 2009; Stuffler et al., 2007). Therefore, mission preparation and operation must have a focus on science related aspects. This will be ensured by the concepts and advices of the Principle Investigator (PI) at the Remote Sensing Section of the German Research Center for Geosciences in Potsdam (GFZ Potsdam) and the EnMAP Scientific Advisory Group (EnSAG). Recently, an EnMAP Core Science Team (ECST) was established. The primary objectives of the ECST are to support the communication with the wider science community of EnMAP and to ensure coordinated scientific data exploitation. The ECST shall be dedicated to the strategic planning and management of scientific algorithm and application development outside the ground processing.

One of the tasks of the EnMAP Ground Segment Project is the development of the user interface including all related processes, e.g. user front end, order management, commanding and payload data processing (Storch et al., 2009). All these systems have to fulfill user requirements and advices made by the EnSAG, PI and ECST. In order to ensure the implementation of such scientific aspects into the EnMAP Ground Segment, a corresponding support function called Application Support (AS) has been established and was assigned to EnMAP Ground Segment Management.

There are two main objectives of Application Support (AS) corresponding to the main mission phases, the mission preparation phase and the mission operation phase. In the mission preparation phase the main objective of AS is the translation of scientific requirements into Ground Segment related concepts. User interface functions have to be designed in order to ensure that EnMAP HSI data will be exploited to the best possible extent. For this purpose a deep understanding of the Ground Segment systems (Müller et al, 2009), subsystems, processes and a substantial knowledge in the analysis and application of imaging spectrometer data is needed.

In the mission operation phase the objective of AS will be the provision of guidance and advice to the international research and application community to ensure that ground segment related questions (e.g. to data products, data quality, preprocessing steps) are answered or delegated to EnMAP Ground Segment experts. Further, control, reporting and implementation of mission requirements, such as data quota and priority requirements, will be ensured. In this phase AS has been established as a service offered by the

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EnMAP mission project to all users of EnMAP data. The AS personnel is composed of a small team of experts in hyperspectral remote sensing covering several fields of applications

2. THE ENMAP USER INTERFACE

The user interface consists of two online portals interfaced with several subsystems of the EnMAP Ground Segment. Fig. 1 depicts the high level architecture of the EnMAP Ground Segment highlighting its web-based interfaces to the user community.

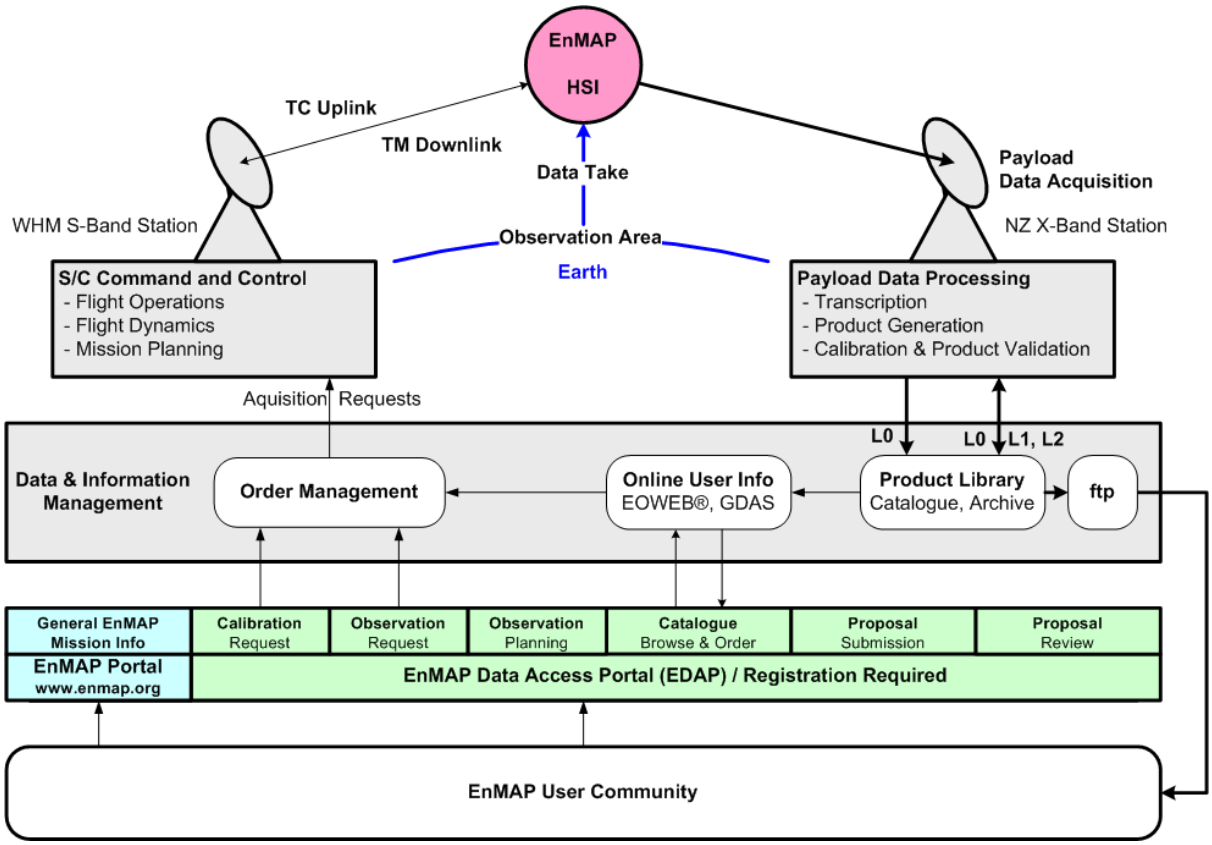

Figure 1. The EnMAP user interfaces

2.1 EnMAP Information Portal

The EnMAP portal (www.enmap.org) provides general EnMAP mission information. It is the central entry point for all international users interested to learn about the EnMAP mission, its objectives, status, data products and processing chains. The platform informs about the conditions and requirements for the EnMAP data access. An important part is dedicated to ongoing scientific programs and activities that are initiated by the Principle Investigator (PI) and the EnMAP Core Science Team. Application Support is responsible for the scientific and editorial management of this portal. No prior registration is required in order to access information published at www.enmap.org.

2.2 EnMAP Data Access Portal functions

The EnMAP Data Access Portal (EDAP) is the entry point for any EnMAP data requests and comprises a set of service functions offered for every registered user (Fig. 1). In the following, the functionalities of these services are explained briefly. Generally three types of requests are available:

- observation request
- calibration request
- catalogue order

Future satellite tasking requested by users are **observation requests (OR)**. An OR provides all information required for scheduling data takes such as location and extension of the observation area, acquisition time frame, sensor look angle, required data products and delivery information.

Calibration Requests (CR) are issued by registered internal users asking for measurements aiming to assess radiometric, spectrometric and geometric characteristics of HSI in orbit. The CR provides all information required for scheduling calibration measurements such as type of calibration, frequency of calibration measurements, time interval and priority. The measurement output of those requests is used to redefine HSI inflight calibration sequences.

Availability of products that have previously been acquired, processed, and archived in a product library is enabled by a multi-mission catalogue browse & order service (EOWEB® portal). Such **catalogue orders (CO)** will be also available by the Geospatial Data Access Service (GDAS). This is a new user service extending the EOWEB® functionality. It provides standardized web services (OGC) for accessing geospatial datasets, enables interoperable data access with software tools and web portals and additionally provides geospatial core datasets (boundaries, land/water mask, infrastructure).
Observation planning is a service offered to all users who plan to issue observation requests. The main functionality is the sensor swath visualization. A user will learn about EnMAP HSI swathes over his Observation Area in the envisaged time period. In Fig. 2 a simulated orbit with possible HSI swathes is shown for Great Britain.

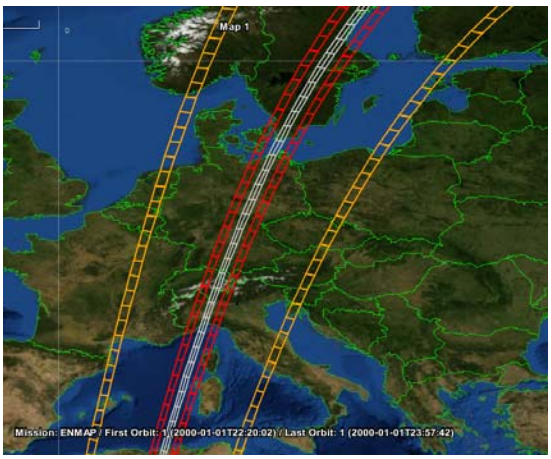

Figure 2: Simulated EnMAP orbit with HSI swathes (generated with ESOV-NG)

The HSI field of view of 2.63° results to a swath width of 30 km at 48° northern latitude. The white center line describes an EnMAP ground track and the white border lines enclose the area covered by a nadir looking swath. The red center and border lines demonstrate an EnMAP swath with a ±5° satellite tilt angle (quasi-nadir). The simulation of a ground track with a satellite tilt angle of ±30° (off-nadir) is demonstrated by orange lines.

Proposal submission is for all users responding to a data Announcement of Opportunity (AO). The proposal portal also accepts unsolicited proposals. The **proposal review** function ensures that all submitted proposals will be reviewed by Ground Segment independent experts under transparent conditions. This function can be accessed by members of the review board only. The lead of the proposal review process is with the PI (GFZ German Research Center for Geosciences).

2.3 Satellite Tasking

An important facility enabling satellite tasking (OR, CR) and catalogue ordering is the Data and Information Management System (DIMS). It is a distributed multi-mission data management solution providing digital product management, production, ordering, delivery and distribution including online user services. DIMS supports the EnMAP Payload Ground Segment (PGS) workflows by either specific configuration extensions on already existing DIMS services or by establishing new service instances on the basis of defined DIMS Service Frameworks. Important functions demonstrating the workflows for satellite tasking and catalogue ordering are shown in Fig. 1.
For satellite tasking the user submits a request to the respective EDAP function. At Order Management function of DIMS observation request information are separated into acquisition information (e.g. observation area, time frame, acquisition angle) and the order information (including processing and delivery details). The acquisition request forms the basis for subsystems of Mission Operation System (MOS) to plan and command a data take via the S-band station in Weilheim, Germany. If the observation area has been recorded, data will be down linked via the X-band station in Neustrelitz, Germany, and forwarded to the processing system. According to a production request (extracted from order information) from DIMS, L0 and if requested higher level product generation has been carried out by the processing system. It also forward the generated L0 product and other related products and metadata to DIMS for long-term archiving in the Product Library. If all image acquisitions for an Acquisition Request have been commanded (including replanning), or if the acquisition time window specified by the AR has been exceeded, MOS Mission Planning System sends an appropriate message to DIMS that forwards it via the EDAP to the user. Finally DIMS generates the delivery for all generated products and sends it online to the user. If a defined part of the data take is clouded, acquisition request will be commanded again..

3. TASKING FOR EARTH OBSERVATIONS

The EnMAP Ground Segment will support two different types of Observation Requests, the Observation Request Single Pass Coverage (OR-SPC) and Observation Request Area Coverage (OR-AC). OR-SPC is the only means by which user can order EnMAP data takes. The OR-AC is restricted to internal uses only. In the following, the OR-SPC will be explained in more detail.

3.1 Single pass coverage

The observation request type “single pass coverage” (OR-SPC) was designed in order to enable the definition of meaningful data requests (Fig. 3). It corresponds to the main objectives of the mission focusing on scientific data exploitation especially on process analyses. The “single pass coverage” will be supported by the EDAP and is the only means by which external users may order data takes.

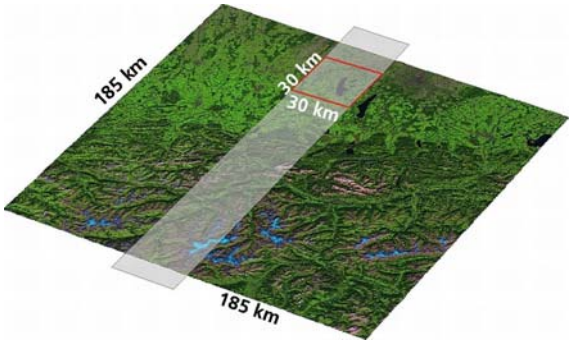

Figure 3: Simulated EnMAP single pass compared with an Landsat ETM + scene

Single pass coverage is defined by the observation area (geographic coordinates), the time window, the tilt angle, information about sunglint will be accepted or not and the data product type. The user can select two types of tilt angles. The selection strongly depends on the application. The quasi-nadir pointing (-5° - +5°) allows observation within an area of about 150 km across track (green area in Fig. 4), where BRDF effects in the resulting data are negligible. The repeat cycle is up to 21 days for the equator region (slightly better in the temperate zones). The off nadir pointing (-30° - +30°) allows observation within around 800 km across track (bright blue area in Fig.4). This tremendously increases the chance to get an cloud free data take in a short time range, because the area of interest can be observed from several orbits. However, this comes with the acceptance of larger BRDF effects in the data.

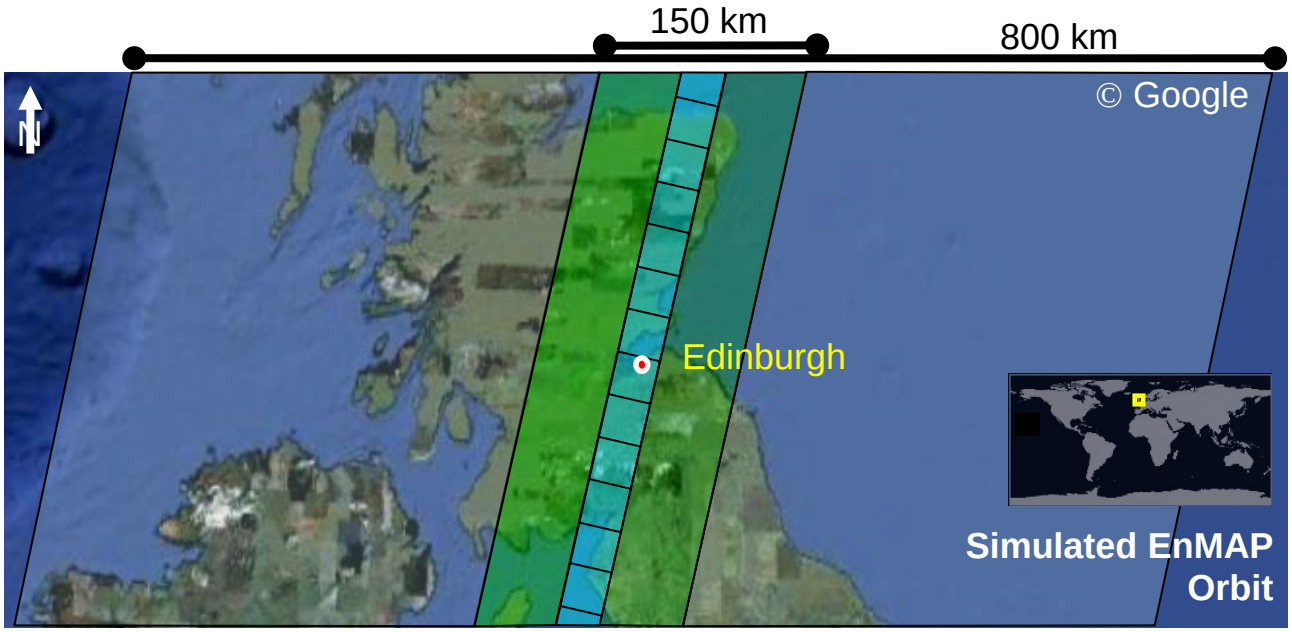

Figure 4: Simulated EnMAP orbit with HSI swath and area of potential visibility according to the maximum tilt angle

3.2 Multispectral observations

Single pass coverage can be also defined for a series of data takes targeting the same observation area. Such multitemporal data takes are well suited to study biophysical and geophysical processes on Earth (Fig. 5). If mapping of large areas is requested, the observation area has to be composed of several single passes until the area is covered. It should be noted that several orbits are needed for such coverage. Even if the repeat rate is four days by accepting a maximum tilt of ± 30 °, the data takes will be characterized by varying viewing angles and can be affected by clouds and seasonal changes of the land use.

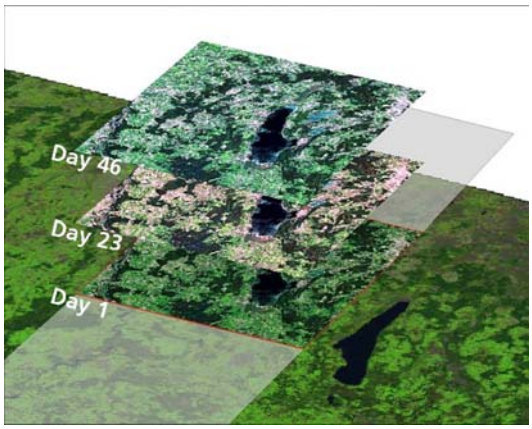

Figure 5: Simulated EnMAP single pass – time series

4. OBSERVATION REQUEST SCENARIOS

Due to the specific tasking possibilities described in section 3, observation request parameters should be defined according to the scientific application. In Fig. 6 potential user scenarios of two areas of interest are demonstrated: Mogadishu, Somalia at 2° N latitude which stands for observations close to the equator and Vaskiny Dachi, Russia, at 70° N latitude that is an example for an extreme observation due to the high latitude. For both scenarios observation length of 120 km (4 EnMAP scenes) and 1020 km (34 EnMAP scenes) is considered. The latter one marks a mission requirements that users shall be able to order observations up to 1000 km length. The observation options are calculated for a time period of 1 month.

Fig. 6 shows just one data take option for Mogadishu in the quasi-nadir observation mode and 9 options for the off-nadir mode. Instead, for Vaskiny Dachi 4 options and 28 options respectively were calculated. In general the number of options increase with higher latitudes. The off-nadir also allow more observations in a certain time period while the cloud probability increases too. An important issue is the shape of the footprint. Near the equator the off-nadir observation options almost completely interfere with each other. For higher latitudes, the intersecting area of all potential off-nadir data take options becomes small especially for long data takes. This has to be considered for multitemporal analysis and while investigating biophysical processes at environmental transition zones.

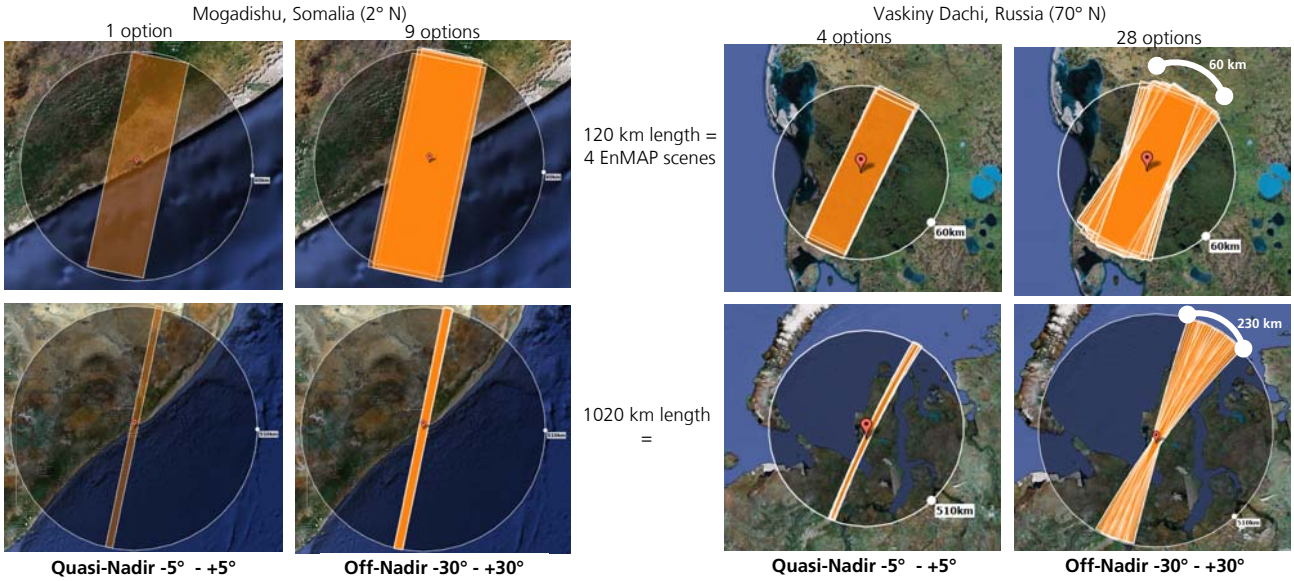

Figure 6: Potential observation request scenarios within a time period of 1 month

5. SUMMARY AND OUTLOOK

This paper describes general conditions and first details on the design of the EnMAP user interface. The user interface consists of two hierarchically structured online portals and several functions supporting the user community in order to ensure that EnMAP HSI data will be exploited to the best possible extent. The design of the observation type “single pass coverage” will be supported by the EnMAP Data Access Portal and is the only means by which external users may order data takes. It corresponds to the main objectives of the mission focusing on the analysis of processes at global scale. The tasking parameters for an observation shall be well planned until it can have large effects on the footprint of the EnMAP data take.

The design on the EnMAP user interface will be continuously refined during the preparation phase of the EnMAP mission. It comprises e.g. the integration of additional interfaces in order to enable EnMAP data distribution via cooperation partners worldwide and the further conceptual development of an appropriate observation planning tool.

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