EUMETSAT Contract No. EUM/CO18/4600002180/JML

EVOLUTIONS STUDIES - AUTOMATED OPTICAL SENSOR REGISTRATION MONITORING TOOL

Requirements Baseline Document

Deliverable D05

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EUMETSAT STUDY CONTRACT REPORT

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ABSTRACT:

The goal of this document is to summarize the baseline requirements for the OSMON software tool to be developed in this project. The tool will assess the geolocation accuracy of medium resolution optical imagers such as AVHRR, Sentinel-3 SLSTR and OCLI and is dedicated for operational use. This document collects and consolidates the requirements for the software tool considering the needs of EUMETSAT.

The work described in this report was done under EUMETSAT Contract. Responsibility for the contents resides in the authors or organization that prepared it.

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DOCUMENT CHANGE LOG

Issue/ Revision	Date	Modification	Modified pages	Observations
1.0	6.3.2019	All new	All	NA
1.1	20.3.2019	Add Spec and Gen requirements	All	Account for RIDs by EUMETSAT. Added Spec and Gen requirements as given in the ITT. Reordering requirements according to Modules
1.2	3.5.2019	Minor revisions in requirements	All	Including comments by EUMETSAT during discussion at PM1.
1.3	27.5.2019	Minor revisions in requirements	All	Including comments by EUMETSAT.
1.4	18.7.2019	Added © EUMETS	All	Added © EUMETSAT in footers of all pages

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APPLICAPLE AND REFERENCE DOCUMENTS

ID	Source
[AD-1]	Generic Statement of Work for Level-1 Product Monitoring Evolution Studies, EUMETSAT ITT 18/216586
[AD-2]	Statement of Work –Automated Optical Sensor Registration Tool. EUM/RSP/SOW/985478, v2, 4 May 2018 EUMETSAT ITT 18/216586
[AD-3]	Proposal in Response to Automated Optical Sensor Registration Tool. ENVEO_OSMON.TMPa 27. August 2018, submitted by ENVEO (Authors: T. Nagler, ENVEO)
[AD-4]	Input Output Data Definition Document (IODD). ENVEO_OSMON_D07.IODD, TBD, in preparation by ENVEO (Authors: S. Scheiblauer T. Nagler, ENVEO)
[AD-5]	Algorithm Theoretical Basis Document (ATBD). ENVEO_OSMON_D08.ATBD, TBD, in preparation by ENVEO (Authors: S. Scheiblauer T. Nagler, ENVEO)
[AD-6]	A guide to establishing validated models, algorithms and software to underpin the Quality Assurance requirements of GEO. QA4EO-QAEO-GEN-DQK-005
[AD-7]	WMO, I., & UNEP, I. (2006). Systematic observation requirements for satellite-based products for climate-Supplemental details to the satellite-based component of the "Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC". Technical Report GCOS-107, WMO/TD No 1338.

Acronyms

AVHRR ....*Advanced Very High-Resolution Radiometer*
GCP...*Ground Control Point*
KOM .... Minutes of *Kickoff meeting*
NDVI .... *Normalized difference vegetation index*
OLCI ....*Ocean and Land Colour Instrument*
PEP ....*Python Enhancement Proposals*
QA4EO .... *Quality assurance framework for earth observation*
SLSTR ....*Sea and Land Surface Temperature Radiometer*
Spec. R. ....*Specific Requirement*

1. INTRODUCTION

The goal of this document is to state the baseline requirements for the OSMON software tool to be developed and implemented within this project. The tool aims to assess the geolocation accuracy of medium resolution optical imagers (MROI) such as AVHRR and Sentinel-3 SLSTR and OLCI and will be demonstrated in a pre-operational environment. This document collects and consolidates the requirements for the development and validation of the software tool as well as operational needs.

1.1. Objective

The main objective of the work is to develop, implement, deliver and demonstrate a platform-independent modular software tool for assessing and monitoring the geolocation accuracy of medium to high resolution optical sensors, expanding proven technology and applying robust algorithms for geolocation assessment against an independent reference data set. The tool will support Level-1 products from current medium resolution EUMETSAT sensors (such as AVHRR, SLSTR, OLCI), and should be extendable to near-future sensors. Automatic and user-specified reporting and analysis tools for checking spatial and temporal agreement and identifying mismatches will be supplied. The software package will provide independent information on geolocation accuracy of MROI sensors which is complementary to other software like PIQMICS and other tools available at EUMETSAT.

1.2. Capabilities of the software tool

Below we summarize the high-level requirements for the OSSMON tool to assess the

- Stand-alone software tools for assessing the geolocation accuracy of moderate to high resolution optical satellite sensors.
- Automatic monitoring and reporting system for detecting and quantifying possible geolocation errors.
- Continuously monitoring geolocation performance of image data as they are acquired and circulated to users.
- Quick and reliable validation of new datasets in case of a change in the processing baseline for optical sensor products that might affect the geolocation accuracy.
- Evaluating the spectral and temporal registration accuracy and stability of EUMETSAT optical sensor payloads by analysing long time series.

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2. OVERVIEW OF THE OSMON SYSTEM

The OSMON system is designed as a modular system and includes two major modules,

- Core Processing Module, which includes
  - the database of global reference targets (GCP-DB)
  - estimation of geolocation accuracy between GCPs and MROI data
  - OSMON data base managing derived geolocation accuracy output
- User Analysis and Reporting Module (Web-based), including tools for
  - statistical analysis of geolocation accuracy for selected settings of GCPs
  - Setting warnings and alarms
  - Trend analysis of geolocation accuracy
  - Visualisation

The system requires access to the archive of MROI data, and optionally to auxiliary data such as DEM, which might be used by the used rectification software.
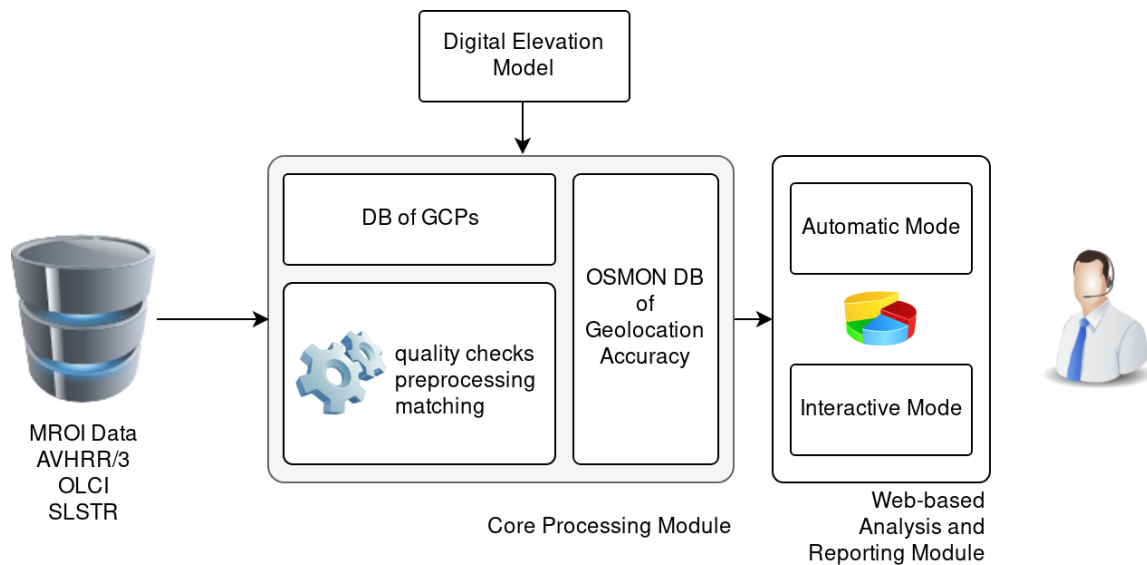

Figure 1 High level modules of OSMON tool

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3. REQUIREMENTS

This section identifies the baseline requirements for the tool to be developed. Each stated requirement is unequable identified with an ID-key and where relevant referenced to the applicable documents.

3.1. *High Level System Requirements*

The aim is to develop a standalone algorithm monitoring the geolocation accuracy of medium to high resolution optical sensors. Functionality of trend monitoring will be included in the analysis and reporting module, which will also allow to set alarms and warnings. The platform-independent tool for processing Level-1 products from current medium resolution sensors must satisfy:

ID	Requirement	Ref.
SW-HIL-0010	The OSMON software tool shall be able to efficiently estimate the geolocation accuracy of Level-1 imagery product of EUMETSAT polar operational optical missions, namely METOP A/B AVHRR, Sentinel-3 OLCI and SLSTR.	Spec. R. 8
SW-HIL-0020	The OSMON software tool shall asses the geolocation accuracy using bands in the visible spectrum and should support thermal bands.	Spec. R. 8
SW-HIL-0030	The OSMON software tool shall be able to access and process MROI data stored on EUMETSATs satellite data archives.	
SW-HIL-0040	The OSMON software tool shall have a modular design, consisting of a Core Module with data base management system and GCP database, and an Analysis and Reporting Module.	Spec. R. 9
SW-HIL-0050	The OSMON software tool shall support access to internet/intranet (for accessing the analysis and reporting tools by the user).	

3.2. Software-Architecture Requirements

The aim is to write the source code in an open source programming language and only utilize open source software packages with the option of adding upcoming sensors. The software architecture must satisfy:

ID	Requirement	Ref
SW-ARC-0010	The OSMON software tool shall asses the geolocation accuracy using one matching algorithm.	
SW-ARC-0020	The OSMON software tool shall be implemented using Open Source software tools as far as possible. The use of commercial software tools shall be discussed and agreed with EUMETSAT.	Gen. R. 11
SW-ARC-0030	For modules implemented in Python, the system shall use Python-3.	KOM
SW-ARC-0040	The Python source code shall follow PEP 8 - Style Guide for Python Code to ensure readable, commented and portable code.	Gen. R. 11
SW-ARC-0050	The source code development and its changes shall be tracked by version-control system preferable git.	KOM
SW-ARC-0060	The software design shall foresee the possibility of adding new sensors/products to be monitored reusing implemented code without addressing and significant changes in the software core.	Spec. R. 9
SW-ARC-0070	Output data/results shall be organized in a way to be easily ingested into an object-relational database.	Spec. R. 17
SW-ARC-0080	The coding of the algorithm and procedure shall be suitable for integration into EUMETSAT's offline environment.	Gen. R. 10
SW-ARC-0090	Physical quantities shall be expressed SI base units.	
SW-ARC-0100	Timestamps shall be stored in UTC following the ISO 8601 format.	

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3.3. Requirements on Core Module

ID	Requirement	Ref
SW-COM-0010	The Core Module shall estimate the 2D shift of MROI data windows versus a reference data sets applying a matching procedure which is, numerically robust and based on well tested image processing matching algorithms.	Gen. R. 4 Spec. R. 6
SW-COM-0020	The Core Module shall provide the estimated 2D shift between the GCP and MROI data set together with quality metrics of matching.	Gen. R. 4 Spec. R. 10
SW-COM-0030	The Core Module shall be capable to estimate the shift between GCP (Landsat-8, Sentinel-2) and MROI (AVHRR, SLSTR, OCLI) better than 1/3-pixel size of the original MROI target resolution (for undisturbed MROI data: no clouds/snow and polar night)	GCOS 2006 [AD-7]
SW-COM-0040	All quality checks shall be performed as a first step during the import of the MROI data.	Gen. R. 12
SW-COM-0050	The Core Module shall map snow or cloud covered MROI pixels using multispectral classification algorithms. Alternatively using external cloud mask and snow products.	Gen. R. 12
SW-COM-0060	The Core Module shall reject input MROI data where the GCP is occluded by cloud cover.	Gen. R. 12
SW-COM-0070	The Core Module shall reject input MROI data where the GCP is occluded by snow cover.	Gen. R. 12
SW-COM-0080	The Core Module shall reject input reflective bands of MROI data acquired at daytime low solar illumination and polar night.	Gen. R. 12
SW-COM-0090	The Core Module shall be capable to store intermediate results of matching process (e.g. image of correlation surface).	

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3.4. Requirements on Analysis and Reporting Module

ID	Requirement	Ref
SW-ARM-0010	The OSMON software tool shall foresee a module to display and analyse results	Spec. R. 18 Spec. R. 21
SW-ARM-0020	The Analysis and Reporting Module shall be completely detached from the processing core module.	Spec. R. 19
SW-ARM-0030	The Analysis and Reporting Module shall allow the selection of reference ground control areas by the user.	Spec. R. 15
SW-ARM-0040	The Analysis and Reporting Module shall support detection of outliers in geolocation accuracy analysis.	Spec. R. 13
SW-ARM-0050	The Analysis and Reporting Module shall have the functionality of detecting trends of geolocation 2d shifts of the MROI data versus reference targets (GCPs).	Spec. R. 5 Spec. R. 10
SW-ARM-0060	The Analysis and Reporting Module shall foresee a functionality to optimize results for web display.	Spec. R. 20
SW-ARM-0070	The Analysis and Reporting Module shall have the option to automatically generate reports using a pre-defined template and user defined time period or full mission.	Spec. R. 22
SW-ARM-0080	The Analysis and Reporting module shall support to set alarms and warnings for geolocation accuracy.	Spec. R. 5 Spec. R. 10
SW-ARM-0090	The Analysis and Reporting Module shall support selection of mission and sensor and data level for statistical analysis	

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3.5. Requirements on Ground Control Points

The assessment of the geolocation accuracy will be performed with globally distributed GCPs satisfying:

ID	Requirement	Ref
SW-GCP-0010	The GCP dataset used for assessing the geolocation shall be globally distributed.	Spec. R. 12
SW-GCP-0020	The GCP dataset used for assessing the geolocation shall contain at least 500+ GCPs per mission with accuracy less than 25 m.	Spec. R. 12
SW-GCP-0030	Each GCP shall be unmistakable distinguishable from its surroundings (lakes, island, NDVI-features or geological features)	
SW-GCP-0040	The GCP dataset should consider also the possibility of including independent reference data in vector format.	Spec. R. 14
SW-GCP-0050	The near infrared (NIR) band B8a (865 nm) with a 20 m spatial resolution of Sentinel-2 A/B shall serve as reference band.	
SW-GCP-0060	The near infrared (NIR) band 5 (0.851-0.879 µm) with a 30 m spatial resolution of Landsat-8 shall serve as primary reference reflectance band.	
SW-GCP-0070	The thermal infrared (TIR) band10 (10.6-11.2 µm) with a 100 m spatial resolution of Landsat-8 shall serve as reference band for TIR.	
SW-GCP-0080	Prior to use the geolocation accuracy of each GCP shall be checked with an independent data set (e.g. vector data set of lake boundaries, island coast lines).	Gen. R. 12
SW-GCP-0090	The GCP image shall not be affected by clouds and seasonal snow.	

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3.6. System Validation and Integration

The aim of the software validation at ENVEO IT is to assess the accuracy and reliability of the implemented matching algorithm, and the statistical analysis and reporting modules. The comparison of the results with independent data will be performed in accordance to QA4EO guidelines.

ID	Requirement	Ref
SW-VSI-0010	A set of automatic system tests shall be defined and implemented to test the correct installation of the system including • Test matching routine works correctly • access, reading, and rectification of MROI data, • access and reading of GCP reference data base, • read/write access to OSMON database	Gen. R. 16 Gen. R. 10
SW-VSI-0020	The OSMON software tool shall be validated with respect to accuracy and possible systematic errors, following QA4EO guidelines [AD-5].	Gen. R. 16
SW-VSI-0030	Where applicable, the OSMON software tool should be evaluated using documented community recognized approaches/ methodologies, as outlined by the QA4EO guidelines [AD-5].	Gen. R. 17
SW-VSI-0040	The OSMON software tool shall evaluated by using the latest versions of the selected datasets in order to assess benefits of new approach in terms of accuracy.	Gen. R. 20
SW-VSI-0050	Comparisons shall also be performed side-by-side with available EUMETSAT and non-EUMETSAT satellite products, when applicable, in order to assess benefits of new approach in terms of accuracy.	Gen. R. 21
SW-VSI-0060	The suitability of the OSMON software tool for operational use shall be demonstrated by processing 5 years of METOP-A/B AVHRR data and 1 year of S3 A/B SLSTR / OLCI.	Spec. R. 24 Gen. R. 4
SW-VSI-0070	The OSMON software tool shall be run in a demonstration environment provided by the contractor with the main aim of highlighting the main capabilities, performances and different scenarios.	Gen. R. 23

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3.7. Interface Requirements

Each module and the interfaces between them will be described in detail in an Input Output Data Definition Document (IODD) and an Algorithm Theoretical Basis Document (ATBD).

ID	Requirement	Ref
SW-INF-0010	The interfaces between the different modules shall be defined in detail in the IODD.	
SW-INF-0020	The EUMETSAT data archive shall be read via authorized access in read only mode. If not accessible an IOError shall be raised.	
SW-INF-0030	GCP data set shall be accessed from local storage in read mode. If not accessible an IOError shall be raised.	
SW-INF-0040	The matching module shall store or update the results in a relational database via an authorized access. If not accessible an IOError shall be raised.	
SW-INF-0050	The analysis and reporting module shall access the relational database via an authorized access in read only mode. If not accessible an IOError shall be raised.	
SW-INF-0060	The web user (human) interface shall require authorization.	
SW-INF-0070	The user shall be able to select GCPs, target sensor, the target band and time period through the web interface.	
SW-INF-0080	The web interface shall support Mozilla Firefox Quantum (64-bit).	
SW-INF-0090	The user interface should support the storage of predefined settings for assessment and visualisation of geolocation accuracy.	
SW-INF-0100	The user interface should support the setup of warnings and alarms for GCP geolocation accuracy.	

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3.8. Computer Resource Requirements

ID	Requirement	Ref
SW-CHR-0010	The Operating System shall be an up to date LTS 64 Bit Linux system (UBUNTU, FEDORA, CENTOS), with recent package versions.	Spec. R. 16
SW-CHR-0020	A minimum of 20 TB free diskspace shall be directly accessible for the software tool.	Spec. R. 16
SW-CHR-0030	The hardware at EUMETSAT shall have at least 128 GB of RAM.	Spec. R. 16
SW-CHR-0040	The system shall have access to the data archives of AVHRR/3 Level 1b (METOP), SLSTR (S3A&B) and OLCI (S3A&B), provided by EUMETSAT. Note: The CODA online rolling archive provides data for Near Real-Time services within three hours after sensing and archives them for one month. Non time critical products are available to users within one month after sensing and will be provided on demand.	Spec. R. 16
SW-CHR-0050	The number of processing cores should be at least 20.	Spec. R. 16

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