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Network of
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Application
Facilities



ROM SAF

Radio Occultation Meteorology

ROM SAF CDOP-2

Service Specifications

Version 2.7

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Danish Meteorological Institute (DMI)
European Centre for Medium-Range Weather Forecasts (ECMWF)
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1.3	25/02/10	KRL	Version 1.3 for ORR-B close out (RIDS #020, #048, #101 accounted for). New product accuracies and new formatting.
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1.5	13/01/12	KRL	Version 1.5, including ROM SAF offline level 3 climate data based on COSMIC. For ORR2 review.
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2.2	27/3/2014	KBL	Version for ORR_GRM-40_part2; Inserted GRM-40 in SS-01-01; SS-02-01; Inserted GRM-40 table in annex A; Updated SS-02-03 to close OR5 actions 7 and 25 (OR4 action 5 closed in SeSp-v2.0);
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2.4	8/5 2014	KBL	Version submitted for the ORR4 & ORR-B-backlog review; List of updates: tables for GRM-02,03,04,05; 41,42,43,44 added to annex A; SS-01-01, SS-02-01, SS-08-02 updated to include the additional 1D-Var GRM-nn numbers;
2.5	20/5 2014	KBL	Version submitted for re-scoped ORR4 & ORR-B-backlog review with PRD version 2.2draft as baseline. Service Specification tables GRM-04, 05, 43, 44 updated.
2.6	9/7 2014	KBL	Updated for the ORR4 & ORR-B-backlog review with RID 17 implemented. Also implemented: Inserted "daily" in SS-02-03 cf. similar change in PRD-02-03 in PRD version 2.2. Note inserted into GRM-04, 05, 43, 44 about current limitation in the SeSp accuracy due to current limitations in input data. Approved as SG15-Dec-05 (wp July 2014)
2.7	1/12 2016	KBL	Version submitted for ORR8 related to the WO upgrade at EUMETSAT. Slightly changed specifications figures for: GRM-01, 04, 05, 40, 43, 44; Implemented OR7 RID 8 (v2.2 date in this DCR changed to 27/3 2014); Implemented OR7 RID 21 (TanDEM-X added to GRM-16 in Annex A); Approved as SG18-Dec-20 (at SG18 on 1 December 2016)

ROM SAF

The Radio Occultation Meteorology Satellite Application Facility (ROM SAF) is a decentralised processing center under EUMETSAT which is responsible for operational processing of GRAS radio occultation (RO) data from the Metop satellites and radio occultation data from other missions. The ROM SAF delivers bending angle, refractivity, temperature, pressure, humidity, and other geophysical variables in near-real time for NWP users, as well as reprocessed data (Climate Data Records) and offline data for users requiring a higher degree of homogeneity of the RO data sets. The reprocessed and offline data are further processed into globally gridded monthly-mean data for use in climate monitoring and climate science applications.

The ROM SAF also maintains the Radio Occultation Processing Package (ROPP) which contains software modules that aids users wishing to process, quality-control and assimilate radio occultation data from any radio occultation mission into NWP and other models.

The ROM SAF Leading Entity is the Danish Meteorological Institute (DMI), with Cooperating Entities: i) European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading, United Kingdom, ii) Institut D'Estudis Espacials de Catalunya (IEEC) in Barcelona, Spain, and iii) Met Office in Exeter, United Kingdom. To get access to our products or to read more about the ROM SAF please go to: <http://www.romsaf.org>

Intellectual Property Rights

All intellectual property rights of the ROM SAF products belong to EUMETSAT. The use of these products is granted to every interested user, free of charge. If you wish to use these products, EUMETSAT's copyright credit must be shown by displaying the words “copyright (year) EUMETSAT” on each of the products used.

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1. Introduction

1.1 Purpose of Document

This document presents the service specifications (SeSp) of the EUMETSAT Radio Occultation Meteorology (ROM) Satellite Application Facility (SAF), hereinafter referred to as the ROM SAF.

The SeSp document is a document which reflects the current commitments by the ROM SAF to the services and the products provided during the second continuous development and operational phase (CDOP-2). As a result, the product requirements given here in the SeSp (cf. appendix A) are not identical to the target, threshold, or optimal accuracies as listed in the products requirements document (PRD). The SeSp should be compared with the continuously evolving goals for the ROM SAF presented in the PRD. The status of the services and products described in this document is monitored in the biannual operations report.

When possible, references to the PRD are included as the PRD requirement identifier listed in square brackets. This is done to have a common set of references throughout the ROM SAF documentation. The PRD references can be related to the system requirement document SRD and system verification and validation plan (SVVP) through the requirements, verification and validation traceability matrix. All products and services listed in the SeSp are assigned an identifier of the following form: **SS-mm-nn**. The identifier is described in more detail below.

This document and any later issues of the document are subject to approval by the ROM SAF Steering Group. Any suggestions for improvements, to be incorporated into later issues, shall be proposed to the Steering Group.

1.2 Applicable and Reference Documents

1.2.1 Applicable Documents

The following list contains documents with a direct bearing on the contents of this document.

- [AD.1] EPS End-User Requirements Document (EURD); Ref. EPS/MIS/REQ/93001 Issue 4, Rev. 2, 13 October 1997 (also Annex I to EUM/C/36/97/DOC/54)
- [AD.2] CDOP-2 Proposal: Proposal for the Second Continuous Development and Operations Phase (CDOP-2); Ref: SAF/GRAS/DMI/MGT/CDOP2/001 Version 1.1 of 21 March 2011, approved by the EUMETSAT Council in Ref. EUM/C/72/11/DOC/10 at its 72nd meeting on 28-29 June 2011
- [AD.3] CDOP-2 Cooperation Agreement: Agreement between EUMETSAT and DMI on the Second Continuous Development and Operations Phase (CDOP-2) of the Radio Occultation Meteorology Satellite Applications Facility (ROM SAF), approved by the EUMETSAT Council; Ref: EUM/C/72/11/DOC/15 at its 72nd meeting on 28-29 June 2011 and signed on 29 June 2011 in Copenhagen

[AD.4] ROM SAF Products Requirements Document (SAF/ROM/DMI/MGT/PRD/001)

1.2.2 Reference Documents

The following documents provide supplementary or background information, and could be helpful in conjunction with this document.

[RD.1] ROM SAF Traceability Matrix (SAF/ROM/DMI/RQ/TM/001)

[RD.2] ROM SAF System/Software Verification and Validation Plan (SAF/ROM/DMI/RQ/SVVP/001)

[RD.3] ROM SAF Product User Manual (SAF/ROM/DMI/UG/PUM/001)

1.3 Acronyms and Abbreviations

BUFR	Binary Universal Format for the Representation of data (also FM94) (WMO)
CF	Central Facility
CGS	Core Ground Segment (EUMETSAT)
DMI	Danish Meteorological Institute; ROM SAF Leading Entity
ECMWF	The European Centre for Medium-range Weather Forecasts; ROM SAF Cooperating Entity
EPS	EUMETSAT Polar satellite System
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
EUMETCast	EUMETSAT's Data Distribution System
FM94	Form Number 94. See BUFR
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistema (GLObal Navigation Satellite System, Russia)
GNSS	Global Navigation Satellite Systems (generic name for GPS + GLONASS)
GPAC	ROM SAF GNSS Processing and Archiving Center
ROM	GNSS Receiver for Atmospheric Sounding (Metop)
GRM	SAF on Radio Occultation Meteorology
GTS	Global Telecommunication System
IEEC	Institut d'Estudis Espacials de Catalunya; ROM SAF Cooperating Entity
LEO	Low Earth Orbit
Met Office	NMS of the United Kingdom; ROM SAF Cooperating Entity
METOP	METeorological Operational Polar satellite (EUMETSAT)
N/A	Not Applicable or Not Available
NRT	Near Real Time
NWP	Numerical Weather Prediction
OFL	Offline
OR	Operations Report

ORR	Operational Readiness Review
QC	Quality Control
PARF	ROM SAF Product Archive and Retrieval Facility
POD	Precise Orbit Determination
PRD	Products Requirement Document
PUM	Product User Manual
RO	Radio Occultation
ROPP	Radio Occultation Processing Package
RMDCN	Regional Meteorological Data Communications Network
SAF	Satellite Application Facility (EUMETSAT)
SeSp	Service Specifications
UMARF	Unified Meteorological ARchive Facility

1.4 Definitions, Levels, and Types

Timeliness is defined as a delay threshold, calculated as the difference between the observation (sensing) time and the downstream dissemination time from the ROM SAF production. The ROM SAF is committed to disseminate NRT products within the timeliness threshold but cannot account for latencies in the downstream dissemination, e.g latencies internally in the EUMETCast dissemination.

RO data products from the GRAS instrument onboard Metop and RO data from other missions are grouped in *data levels* (level 0, 1, 2, or 3) and *product types* (NRT, Reprocessed, or Offline). The data levels and product types are defined below. The lists of variables should not be considered as the complete contents of a given data level, and not all data may be contained in a given data level.

Data levels:

Level 0: Raw sounding, tracking and ancillary data, and other GNSS data before clock correction and reconstruction;

Level 1A: Reconstructed full resolution excess phases, total phases, pseudo ranges, SNR's, orbit information, I, Q values, NCO (carrier) phases, navigation bits, and quality information;

Level 1B: Bending angles and impact parameters, tangent point location, and quality information;

Level 2: Refractivity, geopotential height, "dry" temperature profiles (level 2A), pressure, temperature, specific humidity profiles (level 2B), surface pressure, tropopause height, planetary boundary layer height (level 2C), ECMWF model level coefficients (level 2D); quality information;

Level 3: Gridded or resampled data, that are processed from level 1 or 2 data, and that are provided as, e.g., daily, monthly, or seasonal means on a spatio-temporal grid, including metadata, uncertainties and quality information.

Product types:

NRT product: Data product delivered less than 80 min (95%; EPS-SG Global), 40 min (95%; EPS-SG Regional) and 3 hours (EPS) after measurement;

Reprocessed product: Climate Data Record (CDR) covering an extended time period of several years, generated using a fixed set of processing software in order to provide a homogeneous data record appropriate for climate usage;

Offline product: Data product which typically extends a CDR from a reprocessing, thus providing an “interim” CDR; delivered from less than 5 days to up to 6 months after measurement depending on the requirements.

1.5 Identification of Product Requirements and Service Specifications

The product requirements referred to in this document are uniquely identified as follows:

PRD-mm-nn

where *mm* represents the requirements group identifier (deliverables) and *nn* is the group requirement number. The following group identifiers are used:

- 01 General, covering all products and services.
- 02 Near-real time sounding product
- 03 Off-line sounding product
- 04 Climate products
- 05 Near-real time validation
- 06 Off-line validation
- 07 Climate validation
- 08 Software deliverables
- 09 User and supporting services
- 10 Re-analysis product
- 11 Reprocessed data sets

The service specification identifier follows the same syntax and shares the same group identifier as the PRD identifier but sequence numbers in group scope can differ:

SS-mm-nn

where *mm* is similar to the group identifier in the PRD references.

1.6 Included PRD References

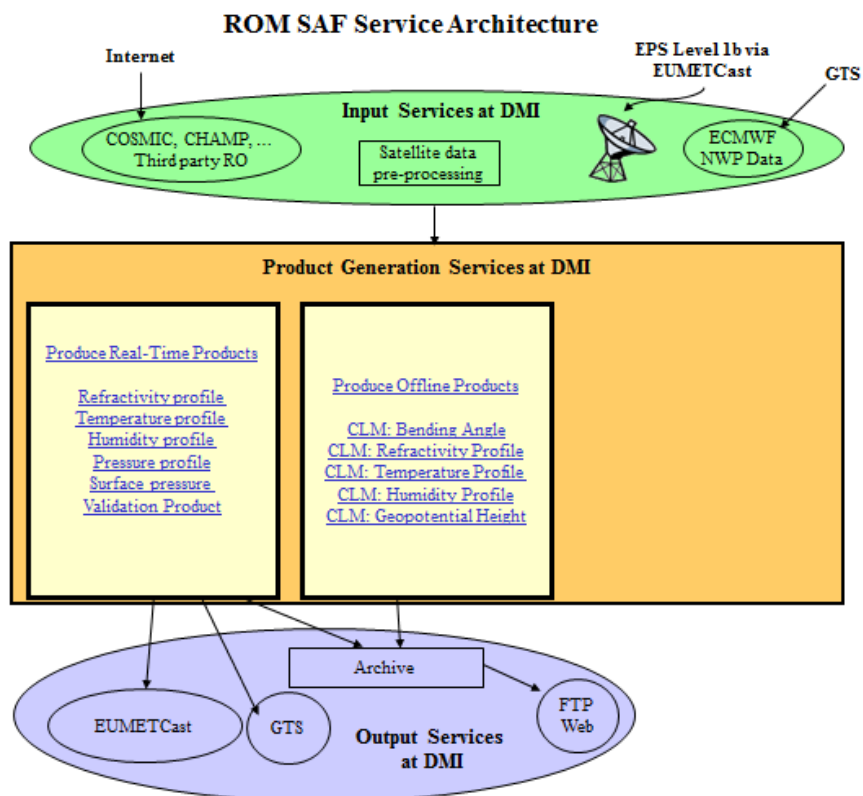
The PRD references listed below are included in this document. The listing can be used as a quick reference for implemented product requirements.

General, covering all products and services	Near-real time sounding product	Near-real time validation	Software deliverables	User and supporting services	Climate products and validation
PRD-01-01	PRD-02-01	PRD-05-01	PRD-08-01	PRD-09-01	PRD-04-01
PRD-01-02	PRD-02-02	PRD-05-02	PRD-08-02	PRD-09-02	PRD-04-02
PRD-01-03	PRD-02-03	PRD-05-03	PRD-08-03	PRD-09-03	PRD-04-03
PRD-01-04	PRD-02-04	PRD-05-04	PRD-08-04	PRD-09-04	PRD-04-04
PRD-01-05	PRD-02-05	PRD-05-05	PRD-08-05	PRD-09-05	PRD-07-01
PRD-01-06	PRD-02-06	PRD-05-06		PRD-09-06	PRD-07-02
PRD-01-07	PRD-02-07	PRD-05-07		PRD-09-07	PRD-07-03
PRD-01-08		PRD-05-08		PRD-09-08	PRD-07-04
PRD-01-10				PRD-09-09	PRD-07-05
PRD-01-11					PRD-07-06
PRD-01-12					PRD-07-07
					PRD-07-08
					PRD-07-09

Table 1: Implemented product requirements (PRD references).

1.7 System Overview and Data Flow

The sole ROM SAF operational centre is located at DMI in Copenhagen. The figure below shows the service architecture currently committed to by the ROM SAF operational processing centre. The system consists of the DMI EUMETCast input facility, the ROM SAF GNSS Processing and Archiving Centre (GPAC) and the ROM SAF webpage (see <http://www.romsaf.org>).



2. Service Specifications

2.1 General

General service specifications currently provided by the ROM SAF regarding products, system capacity, software deliverables and archiving.

- SS-01-01 The ROM SAF shall have an operational capability during CDOP 2 to process CGS Level 1b data and other RO data supported by EU-METSAT CF in near-real time from the ROM instrument on Metop to Level 2 products according to specifications in Annex A, Tables GRM-01,02,03,04,05, GRM-40,41,42,43,44 [PRD-01-01].
- SS-01-02 The ROM SAF shall have an off-line capability during CDOP-2 to re-process CGS Level 1a data from the GRAS instrument on Metop and other RO instruments to Level-2 products according to specifications listed in the PRD [AD.4]. This capability shall be used to regularly generate off-line products and at certain key points, to re-process the complete dataset up to that point to a common best-practice standard [PRD-01-02].
- SS-01-03 The ROM SAF shall have a capability during CDOP-2 to generate products for climate applications, according to the product specifications in Annex A, Tables GRM-17 to GRM-21 [PRD-01-03].
- SS-01-04 The ROM SAF shall develop and maintain during CDOP-2 a software package to support user-assimilation of RO data in NWP models, according to specifications in Annex A, Table GRM-16 [PRD-01-04].
- SS-01-05 ROM SAF near-real time, offline and climate products shall conform to appropriate standards for file formatting [PRD-01-05].
- SS-01-06 ROM SAF Level-2 products shall be made available to users within the timeliness requirements specified in the EURD [AD.1] and via appropriate dissemination methods [PRD-01-06].
- SS-01-07 All ROM SAF deliverables (products, datasets and software) shall be available to users according to EUMETSAT data policy [PRD-01-07].
- SS-01-08 An on-line catalogue of ROM SAF products shall be maintained as part of the EUMETSAT Data Centre to enable off-line bulk data ordering. Requests for bulk data shall be handled within 5 working days [PRD-01-08].
- SS-01-09 ROM SAF shall archive its products for a period of no less than 10 years after the end of the EPS/Metop mission [PRD-01-09].

- SS-01-10 Archived products shall be capable of extraction, with no degradation to the original product quality, on user request, ordered via the EU-METSAT Data Centre [PRD-01-10].
- SS-01-11 Archived products shall be capable of extraction, with no degradation to the original product quality, on user request, ordered via the ROM SAF Product Archive [PRD-01-11].
- SS-01-12 Archived products shall be available to users in the same file formats as used for the original ROM SAF data [PRD-01-12].

2.2 Near-real time sounding products

This section lists the current service specifications of the ROM SAF with respect to the near-real time sounding products listed in Annex A. Refer to the Product User Manual [RD.3] for a detailed description of the products.

- SS-02-01 NRT Sounding products shall contain all required Level-2 parameters with appropriate annotation including date/time and geodetic location, error estimates and quality control flagging. Level-2 NRT product parameter specifications are as presented in Annex A, Tables GRM-01,02,03,04,05, GRM-40,41,42,43,44 [PRD-02-01].
- SS-02-02 NRT Sounding products shall contain a sub-set of required Level-1 parameters selected from CGS NRT products (from which the Level-2 product are derived), including, but not limited to, thinned profiles of bending angle and impact parameter pairs annotated with location and basic POD data [PRD-02-02].
- SS-02-03 Of those Level-1b NRT products with correct instrument operation and available to the ROM SAF within 2h15m, more than 500 shall daily be processed to Level 2 and disseminated to users within 3 hours of observation time. This availability rate shall be calculated over a 1 month period [PRD-02-03].
- SS-02-04 NRT sounding products shall be disseminated via GTS, RMDCN and EUMETCast [PRD-02-04].
- SS-02-05 NRT sounding products disseminated via GTS or RMDCN shall use WMO FM94 (BUFR) encoded format. Other channels shall use standard file formats such as netCDF unless other formats are mandatory [PRD-02-05].
- SS-02-06 Any NRT product delayed by more than 24 hours from observation time shall not be disseminated via GTS as an NRT product, but shall

be available for off-line access [PRD-02-06].

SS-02-07 The near real-time sounding products shall be archived within the ROM SAF leading entity [PRD-02-07].

SS-02-08 Any NRT product delayed by more than 6 hours from observation time shall not be disseminated via EUMETCast as an NRT product, but shall be available for off-line access.

2.3 Climate Products

This section lists the current service specifications of the ROM SAF with respect to the climate products listed in Annex A. Please refer to the Product User Manual [RD.3] for a detailed description of the products.

SS-04-01 Climate products shall be generated from best-quality off-line products from ROM and other RO receivers that are readily available and have high enough quality. Climate product parameter specifications are as presented in Annex A, Tables GRM-17 to GRM-21 [PRD-04-01].

SS-04-02 Climate products shall contain gridded monthly means together with estimates of corresponding errors and contain meta-data providing traceability to the individual occultations and software versions [PRD-04-02].

SS-04-03 Climate products shall be made available to users via appropriate links, channels or media using standard file formats such as netCDF [PRD-04-03].

SS-04-04 The climate products shall be archived within the ROM SAF leading entity [PRD-04-04].

2.4 Near-real time validation

The ROM SAF is obligated to process and make available validation information concerning ROM SAF products. This section provides the current service specifications of the ROM SAF near-real time validation.

SS-05-01 The ROM SAF shall generate, and make publicly available, validation information supporting available RO NRT sounding products using information obtained from NWP fields and other available RO measurements [PRD-05-01].

SS-05-02 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC NRT

product processing [PRD-05-02].

- SS-05-03 Validation shall include statistics on the quality (bias, standard deviation) of key parameters, quantity of products and on the timeliness of NRT product dissemination [PRD-05-03].
- SS-05-04 The validation domain shall be global and over the full vertical domain of the NRT products [PRD-05-04].
- SS-05-05 During CDOP-2, validation statistics shall be generated with a time resolution of 1 day and 1 month, including Metop commissioning periods [PRD-05-05].
- SS-05-06 ROM NRT product validation information shall be made publicly available via the project's website [PRD-05-06].
- SS-05-07 The ROM SAF shall also validate data from other RO instruments available in NRT and present the same information, and in the same way, as for GRAS data [PRD-05-07].
- SS-05-08 The NRT product validation information shall be archived within the ROM SAF leading entity [PRD-05-08].

2.5 Climate Validation

The ROM SAF is obligated to process and make available validation information concerning ROM SAF products. This section provides the current service specifications of the ROM SAF climate products validation.

- SS-07-01 The ROM SAF shall generate, and make publicly available, validation information supporting climate products [PRD-07-01].
- SS-07-02 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC climate product processing [PRD-07-02].
- SS-07-03 Validation shall include statistics on the quality of key parameters and the quantity of products [PRD-07-03].
- SS-07-04 The validation domain shall be global and over the full vertical domain of the climate products [PRD-07-04].
- SS-07-05 Validation statistics shall be generated with a time resolution of 1 calendar month and based on full length of data sets [PRD-07-05].

- SS-07-06 Climate product validation information shall be made available via the project's website [PRD-07-06].
- SS-07-07 The climate product validation information shall be archived within the ROM SAF leading entity [PRD-07-07].
- SS-07-08 The ROM SAF shall generate metrics to monitor the stability of climate data in time [PRD-07-08].
- SS-07-09 The ROM SAF shall generate time-series for the whole length of the data set, and make it available at the web site [PRD-07-09].

2.6 Software Deliverables

ROM SAF deliverables include software to support user applications, such as 1D-Var code and RO observation operators for NWP assimilation, pre-processing algorithms and supporting code for interfacing with various standard file formats. Collectively, this deliverable is known as the 'Radio Occultation processing Package' (ROPP).

- SS-08-01 The ROM SAF shall make available the ROPP software deliverable according to the specifications in Annex A, Table GRM-16. This package shall include key user documentation describing the software deliverable, and shall include: Release notes, User Guide and Reference Manual(s). [PRD-08-01]
- SS-08-02 The ROM SAF shall support user assimilation in NWP models by the provision of associated observation error covariance matrices appropriate to the SAF Level 2 products, according to the specifications in Annex A, table GRM-07, 45. [PRD-08-02]
- SS-08-03 Software deliverables shall be coded in ISO-standard high-level languages (principally Fortran-95) and shall follow programming standards guidelines. The code shall be designed to be portable so as to be capable of being built, installed and run on a variety of different POSIX-compliant platforms and compilers. [PRD-08-03]
- SS-08-04 The ROM SAF shall make the software deliverable and associated supporting documentation and datasets available (to registered users) for download from the project website. [PRD-08-04]
- SS-08-05 During CDOP-2, the software deliverable shall continue to be developed and maintained by the ROM SAF. Maintenance activity shall include fixes to programming errors, improvements to code efficiency, and developments supporting improved scientific processing in re-

sponse to evolving Product Requirements. Updates resulting from development & maintenance shall be released to users according to CDOP-2 plans. [PRD-08-05]

2.7 User and Supporting Services

ROM SAF deliverables include information services such as user documentation, education and Helpdesk and other web-based resources for SAF products, plus supporting users through holding workshops and providing opportunities under the SAF Visiting Scientist programme. This section lists the current service specifications towards user interactions.

- SS-09-01 During CDOP-2, the ROM SAF shall establish and maintain a project website as a service to users. This user service shall include (but not be limited to) news and announcements about, and information and documentation on, ROM SAF products, validation, software and data sets; technical and scientific reports; announcements of seminars, workshops, and visiting scientist opportunities; information on how to contact the SAF; and shall allow a user to search the product catalogue for quick-view and to order products and data sets. [PRD-09-01]
- SS-09-02 The ROM SAF website shall be hosted by the leading entity and shall be an operational element of the ROM SAF, with a maximum of one interruption per week and with an interruption time of one working day as a maximum. [PRD-09-02]
- SS-09-03 The website shall implement a user interface function (Helpdesk) for users to report problems, request help or give other feedback. The Helpdesk facility shall track user interactions, and shall acknowledge receipt of a new contact by automated response. Helpdesk shall answer at least 90% of requests within 3 working days. Resolution of an issue depends on its complexity, and is thus not guaranteed. [PRD-09-03]
- SS-09-04 Access to ROM SAF products (data, software) shall require the user to first register their details. [PRD-09-04]
- SS-09-05 User Services shall include a User Notification service as an option for registered users to be notified by email of changes to operational or off-line products, software or data sets or on their availability via the website, GTS/RMDCN as appropriate to the user. [PRD-09-05]
- SS-09-06 Access to ROM SAF software deliverables shall require the user to agree to a User Licence. [PRD-09-06]

- SS-09-07 Information on the availability, quality and web access statistics, of SAF deliverables shall be reported in a ROM SAF half-yearly Operations Report. [PRD-09-07]
- SS-09-08 The ROM SAF shall organise and hold a 'ROM SAF User and Training Workshop'. [PRD-09-08]
- SS-09-09 The ROM SAF shall encourage and conduct Visiting Scientist activities aimed at improving the information exchange between the ROM SAF team and the scientific community, and at improving the science in, and promoting the use of, ROM SAF deliverables. [PRD-09-09]
- SS-09-10 The ROM SAF shall continuously monitor the quality of the user services in order to continuously improve the services. The following parameters shall be taken into account:
- Problems reported by users and related to user services
 - Compliance in solving or replying to user problems in requested time
- SS-09-11 The DMI controllers shall be available for urgent requests 24/7.


3. List of TDBs and TBCs

None

4. Annex A

The following tables summarize the specifications for each ROM SAF deliverable product. The specifications represent the actual end-to-end performance based on the actual input data quality and the actual system performance. The tables follow the same format as used in the ROM SAF Products Requirements Document.


GRM-01	NRT Refractivity Profile		NRPMEA	SESP_v2.6
Type	Product			
Applications and users	NWP			
Characteristics and Methods	Profile obtained from NRT bending angles using state-of-the-art algorithms. Includes error estimates.			
Comments				
Generation frequency	orbit dump and (when available) half orbits dumps			
Input satellite data	Metop-A/GRAS			
Dissemination				
Format	Means	Type		
BUFR, NetCDF	GTS, EUMETCast	NRT		
Service Specification				
Accuracy				
Interval:	Bias	Standard deviation		
0–8 km:	1.0% (global)	4.0% (global)		
8–30 km:	0.2% (global)	0.8% (global)		
30–40 km:	0.4% (global)	2% (global)		
40–50 km:	1.5% (global)	6% (global)		
Notes	Current version of the data has limited usefulness below 8–10 km due to limitations in the input data			
Verification/Validation method	Vertical averages of absolute deviations from ECMWF short-term forecasts			
Coverage, resolution and timeliness				
Spatial coverage	Spatial resolution	Vertical coverage	Vertical resolution	Timeliness
global	GRAS resolution	10-50 km	500-1400 m	3 h

Ref: SAF/ROM/DMI/RQ/SESP/001 Issue: 2.7 Date: 12 October 2016	ROM SAF CDOP-2 Service Specifications	
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GRM-02	NRT Temperature Profile		NTPMEA	SESP_v2.6
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Service Specification				
Accuracy				
30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K				
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data;			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	model levels (with interpolation); interpolated to 247 fixed levels		

Ref: SAF/ROM/DMI/RQ/SESP/001 Issue: 2.7 Date: 12 October 2016	ROM SAF CDOP-2 Service Specifications	
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GRM-03	NRT Specific Humidity Profile		NHPMEA	SESP_v2.6
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Service Specification				
Accuracy				
0.6 g/kg 10% *				
Notes	* whichever is greater; The interval 0 – 12 km is considered; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data;			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	model levels (with inter- polation); interpolated to 247 fixed levels		

Ref: SAF/ROM/DMI/RQ/SESP/001 Issue: 2.7 Date: 12 October 2016	ROM SAF CDOP-2 Service Specifications	
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GRM-04	NRT Pressure Profile		NPPMEA	SESP_v2.6
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Service Specification				
Accuracy				
a) 0.01 hPa b) 0.25% c) 0.8 hPa *				
Notes	* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data and the service specification (c) is given as the threshold accuracy from the PRD (ra- ther than the target accuracy);			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	model levels (with inter- polation); interpolated to 247 fixed levels		

Ref: SAF/ROM/DMI/RQ/SESP/001 Issue: 2.7 Date: 12 October 2016	ROM SAF CDOP-2 Service Specifications	
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GRM-05	NRT Surface Pressure		NSPMEA	SESP_v2.6
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods				
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Service Specification				
Accuracy				
0.8 hPa *				
Notes	Specification given as an interval due to variations in the analysis field; * Current version of the product may have reduced information content due to limitations in the input data and the service specification is given as the threshold accuracy from the PRD (rather than the target accuracy);			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution			

GRM-07	Error Covariance Matrix for NRT Products	NEMMEA	SESP_v2.6
Type	Information Product		
Applications and Users	NWP		
Characteristics and Methods			
Operational Satellite Input Data	Metop-A/GRAS		
Other Operational Input Data			
Dissemination			
Format	Means	Timeliness	
netCDF	Web	N/A	
Accuracy			
Threshold	Target	Optimal	
N/A	N/A	N/A	
Notes			
Verification/Validation Methods	NWP, other RO		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	N/A		

GRM-16		Radio Occultation Processing Package		ROPP	SESP_v2.6
Type		Software			
Applications and users		NWP RO data suppliers Science			
Characteristics and Methods					
Comments					
Generation frequency		Phased development cycle			
Input satellite data		Metop, COSMIC, CHAMP, GRACE, TerraSAR-X, TanDEM-X ROSA (Any GPS RO instrument with similar characteristics and raw products)			
Dissemination					
Format		Means		Type	
Tar files		HTTP		Offline	
Accuracy					
N/A					
Verification method		Test Folder			
Coverage, resolution and timeliness					
Spatial coverage		Spatial resolution		Vertical resolution	
N/A		N/A		N/A	
				Timeliness	
				N/A	

GRM-17		CLM Bending Angle		CBACO1	SESP_v2.6
Type		Off-line Product			
Applications and Users		Climate and atmosphere researchers			
Characteristics and Methods		Zonal monthly means on 200 m x 5 deg grids; Anomaly timeseries			
Operational Satellite Input Data		COSMIC Post-processed data			
Other Operational Input Data		ECMWF fields (for sampling error calculation)			
Dissemination					
Format		Means		Timeliness	
netCDF		Web		180 d	
Service Specification					
Accuracy					
15 – 40 km: 1.0 μ rad, 0.4 % * 0 – 15 km: 0.4 – 2.0 %					
Notes		* whichever is greater; An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate;			
Verification/Validation Methods		70% percentile of absolute deviations from ECMWF short-term forecasts (co-located zonal monthly means)			
Coverage, Resolution					
Spatial Coverage		Horizontal Resolution		Vertical Resolution	
global		5 deg latitude		200 m	
				Temporal Resolution	
				1 month	

GRM-18	CLM Refractivity	CRGCO1	SESP_v2.6
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids; Anomaly timeseries		
Operational Satellite Input Data	COSMIC Post-processed data		
Other Operational Input Data	ECMWF fields (for sampling error calculation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Service Specification			
Accuracy			
15 – 40 km: 0.3% 0 – 15 km: 0.3 – 1.0 %			
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate;		
Verification/Validation Methods	70% percentile of absolute deviations from ECMWF short-term forecasts (co-located zonal monthly means)		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

GRM-19		CLM Temperature		CTGCO1	SESP_v2.6
Type		Off-line Product			
Applications and Users		Climate and atmosphere researchers			
Characteristics and Methods		Zonal monthly means on 200 m x 5 deg grids; Anomaly timeseries			
Operational Satellite Input Data		COSMIC Post-processed data			
Other Operational Input Data		ECMWF fields (for sampling error calculation)			
Dissemination					
Format		Means		Timeliness	
netCDF		Web		180 d	
Service Specification					
Accuracy					
15 – 40 km: 0.4 K 0 – 15 km: 0.2 K					
Notes					
Verification/Validation Methods		70% percentile of absolute deviations from ECMWF short-term forecasts (co-located zonal monthly means)			
Coverage, Resolution					
Spatial Coverage		Horizontal Resolution		Vertical Resolution	
global		5 deg latitude		200 m	
Temporal Resolution					
1 month					

GRM-20	CLM Specific Humidity	CHGCO1	SESP_v2.6
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids; Anomaly timeseries		
Operational Satellite Input Data	COSMIC Post-processed data		
Other Operational Input Data	ECMWF fields (for sampling error calculation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Service Specification			
Accuracy			
0 – 12 km: 0.05 g/kg, 2% *			
Notes	* whichever is greater		
Verification/Validation Methods	70% percentile of absolute deviations from ECMWF short-term forecasts (co-located zonal monthly means)		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

GRM-21	CLM Geopotential Height	CZGCO1	SESP_v2.6
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids; Anomaly timeseries		
Operational Satellite Input Data	COSMIC Post-processed data		
Other Operational Input Data	ECMWF fields (for sampling error calculation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Service Specification			
Accuracy			
0 – 40 km: 12 gpm			
Notes			
Verification/Validation Methods	70% percentile of absolute deviations from ECMWF short-term forecasts (co-located zonal monthly means)		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

GRM-40	NRT Refractivity Profile		NRPMEB	SESP_v2.6
Type	Product			
Applications and users	NWP			
Characteristics and Methods	Profile obtained from NRT bending angles using state-of-the-art algorithms. Includes error estimates.			
Comments				
Generation frequency	orbit dump and (when available) half orbits dumps			
Input satellite data	Metop-B/GRAS			
Dissemination				
Format	Means	Type		
BUFR, NetCDF	GTS, EUMETCast	NRT		
Service Specification				
Accuracy				
Interval:	Bias	Standard deviation		
0–8 km:	1.0% (global)	4.0% (global)		
8–30 km:	0.2% (global)	0.8% (global)		
30–40 km:	0.4% (global)	2% (global)		
40–50 km:	1.5% (global)	6% (global)		
Notes	Current version of the data has limited usefulness below 8–10 km due to limitations in the input data			
Verification/Validation method	Vertical averages of absolute deviations from ECMWF short-term forecasts			
Coverage, resolution and timeliness				
Spatial coverage	Spatial resolution	Vertical coverage	Vertical resolution	Timeliness
global	GRAS resolution	10-50 km	500-1400 m	3 h

GRM-41	NRT Temperature Profile		NTPMEB	SESP_v2.6
Type		NRT Product		
Applications and Users		NWP		
Characteristics and Methods		model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data		Metop-B/GRAS		
Other Operational Input Data		GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		
Dissemination				
Format		Means	Timeliness	
BUFR BUFR/netCDF		GTS EUMETCast Web	3 h	
Service Specification				
Accuracy				
30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K				
Notes		An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data;		
Verification/Validation Methods		Standard deviation of (1D-Var solution – ECMWF analysis)		
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	model levels (with interpolation); interpolated to 247 fixed levels		

GRM-42		NRT Specific Humidity Profile		NHPMEB	SESP_v2.6	
Type		NRT Product				
Applications and Users		NWP				
Characteristics and Methods		model levels (with interpolation); interpolated to 247 fixed levels				
Operational Satellite Input Data		Metop-B/GRAS				
Other Operational Input Data		GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN				
Dissemination						
Format		Means		Timeliness		
BUFR BUFR/netCDF		GTS EUMETCast Web		3 h		
Service Specification						
Accuracy						
0.6 g/kg 10% *						
Notes		* whichever is greater; The interval 0 – 12 km is considered; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data;				
Verification/Validation Methods		Standard deviation of (1D-Var solution – ECMWF analysis)				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal
global		GRAS resolution		model levels (with interpolation); interpolated to 247 fixed levels		

GRM-43		NRT Pressure Profile		NPPMEB	SESP_v2.6	
Type		NRT Product				
Applications and Users		NWP				
Characteristics and Methods		model levels (with interpolation); interpolated to 247 fixed levels				
Operational Satellite Input Data		Metop-B/GRAS				
Other Operational Input Data		GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN				
Dissemination						
Format		Means		Timeliness		
BUFR BUFR/netCDF		GTS EUMETCast Web		3 h		
Service Specification						
Accuracy						
a) 0.01 hPa b) 0.25% c) 0.8 hPa *						
Notes		* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data and the service specification (c) is given as the threshold accuracy from the PRD (rather than the target accuracy);				
Verification/Validation Methods		Standard deviation of (1D-Var solution – ECMWF analysis)				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal
global		GRAS resolution		model levels (with interpolation); interpolated to 247 fixed levels		

GRM-44		NRT Surface Pressure		NSPMEB	SESP_v2.6
Type		NRT Product			
Applications and Users		NWP			
Characteristics and Methods					
Operational Satellite Input Data		Metop-B/GRAS			
Other Operational Input Data		GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination					
Format		Means		Timeliness	
BUFR BUFR/netCDF		GTS EUMETCast Web		3 h	
Service Specification					
Accuracy					
0.8 hPa *					
Notes		Specification given as an interval due to variations in the analysis field; * Current version of the product may have reduced information content due to limitations in the input data and the service specification is given as the threshold accuracy from the PRD (rather than the target accuracy);			
Verification/Validation Methods		Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution					
Spatial Coverage		Spatial Resolution		Vertical Resolution	
Temporal					
global		GRAS resolution			

GRM-45	Error Covariance Matrix for NRT Products	NEMMEB	SESP_v2.6
Type	Information Product		
Applications and Users	NWP		
Characteristics and Methods			
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data			
Dissemination			
Format	Means	Timeliness	
netCDF	Web	N/A	
Accuracy			
Threshold	Target	Optimal	
N/A	N/A	N/A	
Notes			
Verification/Validation Methods	NWP, other RO		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	N/A		