

Service Specifications

Version 3.4

4 March 2021

ROM SAF Consortium

Danish Meteorological Institute (DMI)
European Centre for Medium-Range Weather Forecasts (ECMWF)
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DOCUMENT CHANGE RECORD

<i>Version</i>	<i>Date</i>	<i>By</i>	<i>Description</i>
0.1	09/05/08	KRL	draft version
1.0	16/05/08	KRL	version 1.0
1.1	02/09/08	KRL	version 1.1 updated for ORR-A close out RIDS #32, #34
1.2	12/05/09	KRL	Version 1.2 for ORR-B, referenced to PRD document instead of URD and inclusion of new products.
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.
1.4	07/02/11	KRL	Version 1.4, including GRM-2, GRM-3, GRM-4, GRM-5 threshold values. Added definition of timeliness to new section. Modified vertical resolution and added vertical coverage.
1.5	13/01/12	KRL	Version 1.5, including ROM SAF offline level 3 climate data based on COSMIC. For ORR2 review.
2.0	04/04/13	KRL	Version 2.0, prepared for ORR2 closeout. Closes all ORR2 SeSp RIDS (#070, #071, #072, #073, #074, #075, #076 (by ref. to #041), #077, #078, #079, #080, #081 (by ref. to #015), #082 (by ref. to #015), #083, #084);
2.1	17/5/2013	KBL	Version closing Action 1, point 17) [by A.K.S] in Annex 2 of the Minutes from the ORR2 Closeout; implemented some editorial changes to the tables GRM-17, ..., 21 in Annex A; Approved as SG12-Dec-10

Version	Date	By	Description
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);
2.3	30/4/2014	KBL	Implemented ORR_GRM-40_part2 RIDs: AvE03; OR6 action 12 implemented (Sect. 1.4); Approved as SG14-Dec-06
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)
2.8draft	13/6 2018	KBL	Version prepared for the DRR-RE1 and ORRs review. List of changes: <ul style="list-style-type: none"> - Various changes to text (adaptations from CDOP-2 to CDOP-3) - Added SeSp tables for CDR v1.0 products: GRM-28-R1, 29-R1, 30-R1, 32-R1, 33-R1 - Added SeSp tables for offline Metop L1B and 2 products: GRM-08 to 13, 24, 46 - 51, 101, 103

Version	Date	By	Description
			<ul style="list-style-type: none"> - Added SeSp tables for offline Metop L3 products: GRM-53 to 59, 93 - 99 Added new Sections 3.3, 3.6, 3.10 with SS specifications
2.9	3/9 2018	KBL	Updated version implementing the following RIDs and Recommendations from the DRR-RE1 & ORRs review: <ul style="list-style-type: none"> - RID 620: Dry pressure SeSp values for GRM-59 and GRM-99 corrected - RID 623: Products in development removed from the overview tables in Annex A1 and A2 - RIDs 624, 628: Editorial/minor changes implemented - Recommendation 001: Note, table for GRM-33-R1 was included in version 2.8draft - Recommendation 004: Table for GRM-28-R1 removed - Recommendation 010: implemented (cf. RID 623 above) Approved as SG23-Dec-04 (wp 6 Feb 2019)
3.0	26/1 2019	KBL	Updated version implementing: <ul style="list-style-type: none"> - Updated Sec. 1.4 Definitions - ICDR products included (GRM-29-11) - Offline Level 3 TPH products included, Metop-A, B, Multimission (GRM-191, 192, 194) - Multimission offline Metop Level 3 products included (GRM-83 to 89) Approved as SG23-Dec-04 (wp 6 Feb 2019)
3.1	12/2 2019	KBL	Updated version implementing: <ul style="list-style-type: none"> - NRT Metop-C operational products (GRM-60, 61, 62, 63, 64, 65) Approved as SG23-Dec-12 (wp 21 Feb 2019)
3.2	3/5 2019	KBL	<ul style="list-style-type: none"> - Added GBBP version 1 (GRM-92) - Inserted SS-01-13, SS-08-06, SS-08-07 - inserted text in the opening paragraph of Sec. 3.8 - Inserted GBGP in the list in Annex A, Section A1 - Inserted table for GBGP in Annex A, Section A2) Approved as SG24-Dec-07 (wp 25 November 2019)
3.3	22/9 2020	KBL	Updated version prepared for the ORR12 review: <ul style="list-style-type: none"> - Offline Metop-C profiles added: GRM-66 to 71, 105

Version	Date	By	Description
			<ul style="list-style-type: none"> - Offline Metop-C grids added: GRM-73 to 79, 193 - Specifications updated in tables for Metop-A & B profiles according to Validation Reports submitted for ORR12: GRM-08 to 13, 46 to 51, 101, 103 - Specifications updated in tables for Metop-A & B grids according to Validation Reports submitted for ORR12: GRM-53 to 59, 83 to 89, 93 to 99, 191, 192, 194 - Offline COSMIC grids removed (SG23-Dec-19): GRM-17 to 21 - SS-10-01 to 06 added (and previous SS-10-nn renamed to SS-11-nn) - Definition of NRT in Section 1.4 updated <p>Updated version implementing the following ORR12 RIDs:</p> <ul style="list-style-type: none"> - SeSp table for GRM-53, etc: Metop-C ids corrected from GRM-93, ... to GRM-73, ... [RID 096] - Details added in the DCR regarding changed values for Metop-A & B profiles and grids [RID 120] - SeSp table for GRM-08, ... and table for GRM-09, ... : validation method corrected from “ERA-Interim forecasts” to “ERA5 forecasts” [RID 120] - Corrected ERA-I to ERA5 in GRM-09, 47, 67, 101, 103, 105 <p>Further updates based on decisions agreed at SG25 on 1 September 2020:</p> <ul style="list-style-type: none"> - SG25-Dec-04 (wp 11 August 2020): Decision related to Checkpoint ICDR v1.1 recommendation 02 regarding the updated specification for GRM-29-I1 for product version 1.1 (noting that this decision will approve SeSp version 3.3. regarding the contents about ICDR v1.1) - SG25-Dec-16: Decision related to OR12 recommendation 01, RID 028, about removing error estimates from SS-02-01 and GRM-01, 40, 60 <p>Approved as SG26-Dec-08 (20 Nov 2020)</p>
3.4	4/3 2021	KBL	<p>Updates based on ROPP-10 DRR:</p> <ul style="list-style-type: none"> - SG26-Dec-11: Decision related to ROPP-10 DRR recommendation 02 regarding updating SeSp SS-08-05 by inserting a sentence about the duration of the user

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<i>Version</i>	<i>Date</i>	<i>By</i>	<i>Description</i>
			support Update based on delta DRR-RE1 review: - RID 003: Re-inserted table for GRM-28-R1 (table was removed in version 2.9) Approved as SG27-Dec-05 (wp 4 June 2021)

ROM SAF

The Radio Occultation Meteorology Satellite Application Facility (ROM SAF) is a decentralised processing centre under EUMETSAT which is responsible for operational processing of radio occultation (RO) data from the Metop and Metop-SG 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 Climate Data Records (CDRs) and Interim Climate Data Records (ICDRs) for users requiring a higher degree of homogeneity of the RO data sets. The CDRs and ICDRs 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 aid 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>

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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).

The SeSp document is a document which reflects the current commitments by the ROM SAF to the services and the products provided during the current continuous development and operational phase. As a result, the product requirements given here in the SeSp (cf. Annex A) are not identical to the target, threshold, or optimal accuracies as listed in the products requirements document (PRD) [AD.3]. 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] CDOP-3 Proposal: Proposal for the Third Continuous Development and Operations Phase (CDOP-3); Ref: SAF/ROM/DMI/MGT/CDOP3/001 Version 1.2 of 31 March 2016, Ref: EUM/C/85/16/DOC/15, approved by the EUMETSAT Council at its 85th meeting on 28-29 June 2016
- [AD.2] CDOP-3 Cooperation Agreement: Agreement between EUMETSAT and DMI on the Third Continuous Development and Operations Phase (CDOP-3) of the Radio Occultation Meteorology Satellite Applications Facility (ROM SAF), Ref. EUM/C/85/16/DOC/19, approved by the EUMETSAT Council and signed at its 86th meeting on 7 December 2016

[AD.3] ROM SAF Products Requirements Document, Ref:
SAF/ROM/DMI/MGT/PRD/001

[AD.4] 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)

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 Product User Manual: Level 1B and 2 products,
Ref: SAF/ROM/DMI/UG/PUM/001

[RD.2] ROM SAF Product User Manual: Level 3 gridded data,
Ref: SAF/ROM/DMI/UG/GRD/001

1.3 Acronyms and Abbreviations

BUFR	Binary Universal Format for the Representation of data (also FM94) (WMO)
CF	Central Facility (EUMETSAT)
CDR	Climate Data Record
CGS	Core Ground Segment (EUMETSAT)
DMI	Danish Meteorological Institute; ROM SAF Leading Entity
ECMWF	European Centre for Medium-range Weather Forecasts; ROM SAF Cooperating Entity
EDC	EUMETSAT Data Center (formerly UMARF)
EPS	EUMETSAT Polar satellite System
EUMETCast	EUMETSAT's Data Distribution System
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
FM94	Form Number 94. See BUFR
GBGP	Ground Based GNSS Package
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistema (GLObal Navigation Satellite System, Russia)
GNSS	Global Navigation Satellite Systems (generic name for GPS and other systems)
GPAC	ROM SAF GNSS Processing and Archiving Center
GRAS	GNSS Receiver for Atmospheric Sounding (Metop)
GRM	ROM SAF product id
GTS	Global Telecommunication System
GPS	Global Positioning System

IEEC	Institut d'Estudis Espacials de Catalunya; ROM SAF Cooperating Entity
LEO	Low Earth Orbit
N/A	Not Applicable or Not Available
Met Office	NMS of the United Kingdom; ROM SAF Cooperating Entity
Metop	METeorological Operational Polar satellite (EUMETSAT)
NMS	National Meteorological Service
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
SRD	System Requirements Document
UMARF	Unified Meteorological ARchive Facility

1.4 Definitions

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 Metop and Metop-SG satellites and RO data from other missions are grouped in *data levels* (level 0, 1, 2, or 3) and *product types* (NRT, offline, CDR, or ICDR). The data levels and product types are defined below¹. The lists

¹Note that the level definitions differ partly from the WMO definitions:
http://www.wmo.int/pages/prog/sat/dataandproducts_en.php

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, SNRs, 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: (i) 3 hours after measurement (ROM SAF Level 2 for EPS); (ii) 150 min after measurement (ROM SAF Level 2 for EPS-SG Global Mission); (iii) 125 min after measurement (ROM SAF Level 2 for EPS-SG Regional Mission);

Offline product: Data product delivered from less than 5 days to up to 6 months after measurement, depending on the requirements. The evolution of this type of product is driven by new scientific developments and subsequent product upgrades;

CDR: Climate Data Record generated from a dedicated reprocessing activity using a fixed set of processing software². The data record covers an extended time period of several years (with a fixed end point) and constitutes a homogeneous data record appropriate for climate usage;

ICDR: An Interim Climate Data Record (ICDR) regularly extends in time a (Fundamental or Thematic) CDR using a system having optimum consistency with and lower latency than the system used to generate the CDR³.

1.5 Overview of this document

The structure of the chapters of this document is as follows:

² (i) GCOS 2016 Implementation Plan; (ii) <http://climatemonitoring.info/home/terminology/>

³ <http://climatemonitoring.info/home/terminology/> (the ICDR definition was endorsed at the [9th session of the joint CEOS/CGMS Working Group Climate Meeting on 29 March 2018](#))

Chapter 1 contains the introduction.

Chapter 2 defines the notation and contains link to PRD requirement ids.

Chapter 3 contains the list of specifications.

Chapter 4 contains the list of TBCs and TBDs.

Annex A contains tables with detailed service specifications for all products.

2. Link to PRD references

2.1 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 Offline and ICDR sounding product
- 04 Climate products
- 05 Near-real time validation
- 06 Offline and ICDR 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.

2.2 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.

Table 1: Implemented product requirements (PRD references)

PRD section	PRD references included in SeSp	PRD references currently not included in SeSp
2.1 General	PRD-01-01 to PRD-01-13	
2.2 Near-real time sounding product	PRD-02-01 to PRD-02-07	

PRD section	PRD references included in SeSp	PRD references currently not included in SeSp
2.3 Offline and ICDR sounding products	PRD-03-01 to PRD-03-06	
2.4 Gridded products	PRD-04-01 to PRD-04-04	
2.5 Near-real time validation	PRD-05-01 to PRD-05-08	
2.6 Offline and ICDR validation	PRD-06-01 to PRD-06-07	
2.7 Gridded validation	PRD-07-01 to PRD-07-09	
2.8 Software deliverables	PRD-08-01 to PRD-08-07	
2.9 User and supporting services	PRD-09-01 to PRD-09-09	
2.10 Re-analysis dataset	PRD-10-01 to PRD-10-06	
2.11 Reprocessed data records	PRD-11-01 to PRD-11-13	

3. Service Specifications

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

3.1 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 to process CGS Level 1B data and other RO data supported by EUMETSAT Secretariat in near-real time from the GRAS 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, GRM-60,61,62,63,64. [PRD-01-01]
- SS-01-02 The ROM SAF shall have an offline capability to process CGS Level 1A data from the GRAS instrument on Metop and other RO instruments to Level-2 products according to specifications listed in Annex A, Tables GRM-08 to 13, 24, 46 – 51, 66 – 71, 101, 103, 105. This capability shall be used to regularly generate offline 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 to generate products for climate applications, according to the product specifications in Annex A, Tables GRM-53 – 59, 73 – 79, 83 – 89, 93 – 99, 191, 192, 193, 194, 29-11. [PRD-01-03]
- SS-01-04 The ROM SAF shall develop and maintain a software package (“ROPP”) 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 EPS EURD 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 offline 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 EUMETSAT 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]
- SS-01-13 ROM SAF shall develop and maintain a software package (“GBGP”) containing tools for formatting of GNSS ground-based data, according to specifications in Annex A, Table GRM-92. [PRD-01-13]

3.2 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.1] 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 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, GRM-60,61,62,63,64. [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 ob-

ervation 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 offline 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 offline access. [no PRD ref]

3.3 Offline and ICDR sounding products

- SS-03-01 Offline and ICDR products shall be generated to take advantage of RO NRT data not meeting the timeliness requirements for NRT products (delayed LEO, ground-based GPS for differencing, improved POD data, NWP analyses etc.) and/or using improved algorithms not appropriate to the NRT requirements. Level 1B and 2 offline product parameter specifications are as presented in Annex A, Tables GRM-08 to 13, 24, 46 - 51, 66 - 71, 101, 103, 105, 29-11. [PRD-03-01]
- SS-03-02 The ROM SAF shall have the capability to process data from RO instruments other than onboard EUMETSAT missions to generate offline and ICDR Level 1B and Level 2 products to the same specification (within the limits of the available data) as the EUMETSAT missions RO products. [PRD-03-02]
- SS-03-03 Offline and ICDR products shall at least contain identical parameters to the near-real time products, although domain, sampling, accuracy and numbers of occultations may be improved to meet climate requirements. [PRD-03-03]
- SS-03-04 More than 500 (EPS) of all available occultation events with correct

instrument operation shall daily be processed to Level 1B and Level 2 sounding products and shall be available to users within 30 days of observation time. This availability rate shall be calculated over a 1 month period. [PRD-03-04]

SS-03-05 Offline and ICDR products shall be made available to users via appropriate links, channels or media using standard file formats such as netCDF and BUFR. [PRD-03-05]

SS-03-06 The offline and ICDR sounding products shall be archived within the ROM SAF leading entity. [PRD-03-06]

3.4 Gridded Products

This section lists the current service specifications of the ROM SAF with respect to the gridded products listed in Annex A. Please refer to the Product User Manual [RD.2] for a detailed description of the products.

SS-04-01 Gridded products shall be generated from best-quality offline products from GRAS and other RO receivers that are readily available and have high enough quality. Gridded product parameter specifications are as presented in Annex A, Tables GRM-53 - 59, 73 – 79, 83 – 89, 93 – 99, 191, 192, 193, 194, 29-11. [PRD-04-01]

SS-04-02 Gridded 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 Gridded 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 gridded products shall be archived within the ROM SAF leading entity. [PRD-04-04]

3.5 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 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]

3.6 Offline and ICDR Validation

- SS-06-01 The ROM SAF shall generate, and make publicly available, validation information supporting available RO offline and ICDR sounding products using information obtained from NWP fields and other measurements (COSMIC, COSMIC-2). [PRD-06-01]
- SS-06-02 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC offline and ICDR product processing. [PRD-06-02]
- SS-06-03 Validation shall include statistics on the quality of key parameters and the quantity of products and on their improvement with respect to the equivalent NRT products. [PRD-06-03]
- SS-06-04 The validation domain shall be global and over the full vertical domain of the offline products. [PRD-06-04]

- SS-06-05 Validation statistics shall be generated with a time resolution of 1 calendar month, excluding Metop commissioning periods. [PRD-06-05]
- SS-06-06 Offline and ICDR product validation information shall be made available via the project's website. [PRD-06-06]
- SS-06-07 The offline and ICDR product validation information shall be archived within the ROM SAF leading entity. [PRD-06-07]

3.7 Gridded 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 gridded 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 gridded 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 gridded 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 Gridded product validation information shall be made available via the project's website. [PRD-07-06]
- SS-07-07 The gridded 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 gridded 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]

3.8 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). The software deliverables also include tools for formatting Ground-based GNSS data; this deliverable is known as the “Ground Based GNSS Package” (GBGP).

- 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, 65. [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 The ROPP 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 response to evolving Product Requirements. Updates resulting from development & maintenance shall be released to users according to plans. The support shall be provided at least until the Software is superseded by a new series or until the Licence is terminated, whichever is earlier [PRD-08-05]
- SS-08-06 The ROM SAF shall make available the GBGP software deliverable according to the specifications in Annex A, Table GRM-92. This package shall include key user

documentation describing the software deliverable, and shall include:
Release
notes, User Guide and Reference Manual(s). [PRD-08-06]

- SS-08-07 The GBGP software deliverable shall continue to be maintained by the ROM SAF. Maintenance activity shall include fixes to programming errors. [PRD-08-07]

3.9 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 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

offline 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

[no PRD ref]

SS-09-11 The DMI controllers shall be available for urgent requests 24/7. [no PRD ref]

3.10 Reanalysis dataset

SS-10-01 With the ERA5 system, ECMWF shall generate a GNSS-RO global reanalysis dataset for the 2007-2015 period by assimilating reprocessed GNSS-RO measurements and conventional measurements that do not require bias correction. The reprocessed measurements will be provided by ECMWF as part of the ERA CLIM project. [PRD-10-01]

SS-10-02 The processing shall use the ECMWF reanalysis system run at T159 resolution, to produce daily, gridded reanalyses at 00Z and 12Z. The daily reanalyses and the corresponding departure statistics of both active and passive observations shall be archived. [PRD-10-02]

SS-10-03 The quality of the dataset shall be monitored using the departure statistics with respect to both active and passive observations, and by comparison with other global reanalyses. [PRD-10-03]

- SS-10-04 Three dimensional and zonally averaged Monthly Mean Climatologies (MMCs) of various variables, including temperature, humidity and geopotential height, shall be derived from the daily reanalyses. Time-series of climate indicators will be computed, stored and made available to users. [PRD-10-04]
- SS-10-05 The dataset and derived data shall be archived at ECMWF. [PRD-10-05]
- SS-10-06 The dataset and derived data shall be made available to users in standard formats, such as GRIB fields, via appropriate links such as at the ROM SAF web site. [PRD-10-06]

3.11 Reprocessed data records

- SS-11-01 Reprocessed climate data records shall be generated to take advantage of improved algorithms not available at the original time of processing. Original products are the ROM SAF Offline Level 1B, 2 and 3 products. Product parameter specifications for reprocessed data records are as presented in Annex A, Tables GRM-28-R1, 29-R1, 30-R1, 32-R1, 33-R1. [PRD-11-01]
- SS-11-02 The ROM SAF shall have the capability to reprocess data from RO instruments other than Metop/GRAS to generate reprocessed Level 1B, 2, and 3 climate data records to the same specification (within the limits of the available data) as the Metop/GRAS products. [PRD-11-02]
- SS-11-03 Reprocessed climate data records shall contain identical parameters to the original products, although domain, sampling, accuracy and numbers of occultations may be improved. [PRD-11-03]
- SS-11-04 Reprocessed climate data records shall be made available to users via appropriate links, channels or media using standard file formats such as netCDF and BUFR. [PRD-11-04]
- SS-11-05 Reprocessed climate data records shall be archived within the ROM SAF leading entity. [PRD-11-05]
- SS-11-06 The ROM SAF shall generate, and make publicly available, validation information supporting reprocessed products using information obtained from NWP fields and other measurements. [PRD-11-06]
- SS-11-07 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC

reprocessing. [PRD-11-07]

- SS-11-08 Validation shall include statistics on the quality of key parameters and the quantity of products and on their improvement with respect to the original products. [PRD-11-08]
- SS-11-09 The validation domain shall be global and over the full vertical domain of the reprocessed climate data records. [PRD-11-09]
- SS-11-10 Reprocessed climate data records validation information shall be made available via the project's website. [PRD-11-10]
- SS-11-11 Reprocessed climate data records validation information shall be archived within the ROM SAF leading entity. [PRD-11-11]
- SS-11-12 Validation statistics for reprocessed climate data records shall be generated with a time resolution of 1 calendar month and based on full length of data sets. [PRD-11-12]
- SS-11-13 The ROM SAF shall generate reprocessed time series for the whole length of the climate data records and make it available at the web site. [PRD-11-13]

4. List of TDBs and TBCs

None

Annex A Service Specification Tables

The following tables summarize the specifications for each ROM SAF 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. [AD.3]

A1 Product Groups

ROM SAF products are divided into the following groups:

- Level 1B Bending Angle (GRM-08, GRM-46, GRM-66)
- Level 2A Refractivity (GRM-01, GRM-09, GRM-40, GRM-47, GRM-60, GRM-67)
- Level 2A Dry Temperature (GRM-101, GRM-103, GRM-105)
- Level 2B, 2C Temperature, Pressure, and Humidity (GRM-02 to GRM-05, GRM-10 to GRM-13, GRM-41 to GRM-44, GRM-48 to GRM-51, GRM-61 to GRM-64, GRM-68 to GRM-71)
- Level 2C Tropopause Height (GRM-24)
- Level 3 Gridded Data (GRM-53 to GRM-59, GRM-73 to GRM-79, GRM-83 to GRM-89, GRM-93 to GRM-99, GRM-191, GRM-192, GRM-193, GRM-194)
- Reprocessed Data Records (Climate Data Records) (GRM-28-R1, GRM-29-R1, GRM-30-R1, GRM-32-R1, GRM-33-R1)
- ICDR products (GRM-29-I1)
- ROPP Software (GRM-16)
- GBGP Software (GRM-92)

A2 Overview list of all GRM ids for reprocessed data records

<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
GRM-28-R1	Reprocessed Multi-Mission climate data record (Metop, COSMIC, CHAMP, GRACE L3)	REPMUL
GRM-28-L3-B-R1	Reprocessed Bending Angle Grid	RBGMUL
GRM-28-L3-R-R1	Reprocessed Refractivity Grid	RRGMUL
GRM-28-L3-D-R1	Reprocessed Dry Temperature Grid	RDGMUL
GRM-28-L3-Y-R1	Reprocessed Dry Pressure Grid	RYGMUL
GRM-28-L3-Z-R1	Reprocessed Dry Geopotential Height Grid	RZGMUL
GRM-28-L3-T-R1	Reprocessed Temperature Grid	RTGMUL
GRM-28-L3-H-R1	Reprocessed Specific Humidity Grid	RHGMUL
GRM-28-L3-C-R1	Reprocessed Tropopause Height Grid	RCGMUL
GRM-29-R1	Reprocessed Metop climate data record (Metop-A/B L1, L2, L3)	REPMET
GRM-29-L1-B-R1	Reprocessed Bending Angle	RBAMET
GRM-29-L2-R-R1	Reprocessed Refractivity Profile	RRPMET
GRM-29-L2-D-R1	Reprocessed Dry Temperature Profile	RDPMET
GRM-29-L2-T-R1	Reprocessed Temperature Profile	RTPMET
GRM-29-L2-H-R1	Reprocessed Specific Humidity Profile	RHPMET
GRM-29-L2-P-R1	Reprocessed Pressure Profile	RPPMET
GRM-29-L2-S-R1	Reprocessed Surface Pressure	RSPMET
GRM-29-L2-C-R1	Reprocessed Tropopause Height	RCHMET
GRM-29-L3-B-R1	Reprocessed Bending Angle Grid	RBGMET
GRM-29-L3-R-R1	Reprocessed Refractivity Grid	RRGMET
GRM-29-L3-D-R1	Reprocessed Dry Temperature Grid	RDGMET
GRM-29-L3-Y-R1	Reprocessed Dry Pressure Grid	RYGMET
GRM-29-L3-Z-R1	Reprocessed Dry Geopotential Height Grid	RZGMET
GRM-29-L3-T-R1	Reprocessed Temperature Grid	RTGMET
GRM-29-L3-H-R1	Reprocessed Specific Humidity Grid	RHGMET
GRM-29-L3-C-R1	Reprocessed Tropopause Height Grid	RCGMET
GRM-30-R1	Reprocessed COSMIC-1 climate data record (COSMIC-1 L1, L2, L3)	REPCO1
GRM-30-L1-B-R1	Reprocessed Bending Angle	RBACO1
GRM-30-L2-R-R1	Reprocessed Refractivity Profile	RRPCO1
GRM-30-L2-D-R1	Reprocessed Dry Temperature Profile	RDPCO1
GRM-30-L2-T-R1	Reprocessed Temperature Profile	RTPCO1
GRM-30-L2-H-R1	Reprocessed Specific Humidity Profile	RHPCO1

<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
GRM-30-L2-P-R1	Reprocessed Pressure Profile	RPPCO1
GRM-30-L2-S-R1	Reprocessed Surface Pressure	RSPCO1
GRM-30-L2-C-R1	Reprocessed Tropopause Height	RCHCO1
GRM-30-L3-B-R1	Reprocessed Bending Angle Grid	RBGCO1
GRM-30-L3-R-R1	Reprocessed Refractivity Grid	RRGCO1
GRM-30-L3-D-R1	Reprocessed Dry Temperature Grid	RDGCO1
GRM-30-L3-Y-R1	Reprocessed Dry Pressure Grid	RYGCO1
GRM-30-L3-Z-R1	Reprocessed Dry Geopotential Height Grid	RZGCO1
GRM-30-L3-T-R1	Reprocessed Temperature Grid	RTGCO1
GRM-30-L3-H-R1	Reprocessed Specific Humidity Grid	RHGCO1
GRM-30-L3-C-R1	Reprocessed Tropopause Height Grid	RCGCO1
GRM-32-R1	Reprocessed CHAMP climate data record (CHAMP L1, L2, L3)	REPCHA
GRM-32-L1-B-R1	Reprocessed Bending Angle	RBACHA
GRM-32-L2-R-R1	Reprocessed Refractivity Profile	RRPCHA
GRM-32-L2-D-R1	Reprocessed Dry Temperature Profile	RDPCHA
GRM-32-L2-T-R1	Reprocessed Temperature Profile	RTPCHA
GRM-32-L2-H-R1	Reprocessed Specific Humidity Profile	RHPCHA
GRM-32-L2-P-R1	Reprocessed Pressure Profile	RPPCHA
GRM-32-L2-S-R1	Reprocessed Surface Pressure	RSPCHA
GRM-32-L2-C-R1	Reprocessed Tropopause Height	RCHCHA
GRM-32-L3-B-R1	Reprocessed Bending Angle Grid	RBGCHA
GRM-32-L3-R-R1	Reprocessed Refractivity Grid	RRGCHA
GRM-32-L3-D-R1	Reprocessed Dry Temperature Grid	RDGCHA
GRM-32-L3-Y-R1	Reprocessed Dry Pressure Grid	RYGCHA
GRM-32-L3-Z-R1	Reprocessed Dry Geopotential Height Grid	RZGCHA
GRM-32-L3-T-R1	Reprocessed Temperature Grid	RTGCHA
GRM-32-L3-H-R1	Reprocessed Specific Humidity Grid	RHGCHA
GRM-32-L3-C-R1	Reprocessed Tropopause Height Grid	RCGCHA
GRM-33-R1	Reprocessed GRACE climate data record (GRACE L1, L2, L3)	REPGRA
GRM-33-L1-B-R1	Reprocessed Bending Angle	RBAGRA
GRM-33-L2-R-R1	Reprocessed Refractivity Profile	RRPGRA
GRM-33-L2-D-R1	Reprocessed Dry Temperature Profile	RDPGRA
GRM-33-L2-T-R1	Reprocessed Temperature Profile	RTPGRA
GRM-33-L2-H-R1	Reprocessed Specific Humidity Profile	RHPGRA
GRM-33-L2-P-R1	Reprocessed Pressure Profile	RPPGRA
GRM-33-L2-S-R1	Reprocessed Surface Pressure	RSPGRA


<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
GRM-33-L2-C-R1	Reprocessed Tropopause Height	RCHGRA
GRM-33-L3-B-R1	Reprocessed Bending Angle Grid	RBGGRA
GRM-33-L3-R-R1	Reprocessed Refractivity Grid	RRGGRA
GRM-33-L3-D-R1	Reprocessed Dry Temperature Grid	RDGGRA
GRM-33-L3-Y-R1	Reprocessed Dry Pressure Grid	RYGGRA
GRM-33-L3-Z-R1	Reprocessed Dry Geopotential Height Grid	RZGGRA
GRM-33-L3-T-R1	Reprocessed Temperature Grid	RTGGRA
GRM-33-L3-H-R1	Reprocessed Specific Humidity Grid	RHGGRA
GRM-33-L3-C-R1	Reprocessed Tropopause Height Grid	RCGGRA

A3 Overview list of all GRM ids for ICDRs


<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
GRM-29-I1	Metop Interim Climate Data Record (Data Levels L1B, L2, L3)	ICDRMET
GRM-29-L1-B-I1	ICDR Bending Angle	IBAMET
GRM-29-L2-R-I1	ICDR Refractivity Profile	IRPMET
GRM-29-L2-D-I1	ICDR Dry Temperature Profile	IDPMET
GRM-29-L2-T-I1	ICDR Temperature Profile	ITPMET
GRM-29-L2-H-I1	ICDR Specific Humidity Profile	IHPMET
GRM-29-L2-P-I1	ICDR Pressure Profile	IPPMET
GRM-29-L2-S-I1	ICDR Surface Pressure	ISPMET
GRM-29-L2-C-I1	ICDR Tropopause Height	ICHMET
GRM-29-L3-B-I1	ICDR Bending Angle Grid	IBGMET
GRM-29-L3-R-I1	ICDR Refractivity Grid	IRGMET
GRM-29-L3-D-I1	ICDR Dry Temperature Grid	IDGMET
GRM-29-L3-Y-I1	ICDR Dry Pressure Grid	IYGMET
GRM-29-L3-Z-I1	ICDR Dry Geopotential Height Grid	IZGMET
GRM-29-L3-T-I1	ICDR Temperature Grid	ITGMET
GRM-29-L3-H-I1	ICDR Specific Humidity Grid	IHGMET
GRM-29-L3-C-I1	ICDR Tropopause Height Grid	ICGMET

A4 Service Specification tables


(See the following pages)

Ref: SAF/ROM/DMI/RQ/SESP/001 Version: 3.4 Date: 4 March 2021	Service Specifications	
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GRM-01	NRT Refractivity Profile		NRPMEA	SESP_v3.4
Type	Product			
Applications and users	NWP			
Characteristics and Methods	Profile obtained from NRT bending angles using state-of-the-art algorithms			
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 Version: 3.4 Date: 4 March 2021	Service Specifications	
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GRM-02	NRT Temperature Profile		NTPMEA	SESP_v3.4
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 Version: 3.4 Date: 4 March 2021	Service Specifications	
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GRM-03	NRT Specific Humidity Profile		NHPMEA	SESP_v3.4
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 Version: 3.4 Date: 4 March 2021	Service Specifications	
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GRM-04		NRT Pressure Profile		NPPMEA	SESP_v3.4	
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 speci- fication (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 inter- polation); interpolated to 247 fixed levels		


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GRM-05	NRT Surface Pressure		NSPMEA	SESP_v3.4
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_v3.4
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		

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GRM-08	Offline bending angle (Metop-A)	OBAMEA	SESP_v3.4
GRM-46	Offline bending angle (Metop-B)	OBAMEB	
GRM-66	Offline bending angle (Metop-C)	OBAMEC	
Type	Offline Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Hi-res wave optics retrieval and ionospheric correction		
Operational Satellite Input Data	Metop-A, B, C Level 1A from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF operational and ERA5 FC, AN		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	30 d	
Service Specification			
Bias	Standard deviation		
0 – 8 km: 0.5 % 8 – 30 km: 0.1 % 30 – 40 km: 0.5 % 40 – 50 km: 0.6 % 50 – 60 km: 3.5 %	0 – 8 km: 7.5 % 8 – 30 km: 1.5 % 30 – 40 km: 2.0 % 40 – 50 km: 5.0 % 50 – 60 km: 15 %		
Notes	The values are based on the comparison to ERA5 forecasts from January 2017 to October 2019.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA5 forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution

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GRM-09	Offline refractivity profile (Metop-A)	ORPMEA	SESP_v3.4
GRM-47	Offline refractivity profile (Metop-B)	ORPMEB	
GRM-67	Offline refractivity profile (Metop-C)	ORPMEC	
GRM-101	Offline dry temperature profile (Metop-A)	ODPMEA	
GRM-103	Offline dry temperature profile (Metop-B)	ODPMEB	
GRM-105	Offline dry temperature profile (Metop-C)	ODPMEC	
Type	Offline Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Statistical optimization, Abel transform, and hydrostatic integration		
Operational Satellite Input Data	Metop-A, B, C Level 1A from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF operational and ERA-I FC, AN		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	30 d	
Service Specification			
Bias	Standard deviation		
Refractivity Profile			
0 – 8 km: 0.3 % 8 – 30 km: 0.1 % 30 – 40 km: 0.4 % 40 – 50 km: 0.8 % 50 – 60 km: 3.0 %	0 – 8 km: 1.8 % 8 – 30 km: 0.5 % 30 – 40 km: 1.0 % 40 – 50 km: 3.0 % 50 – 60 km: 8.0 %		
Dry temperature Profile			
0 – 8 km: 0.6 K 8 – 30 km: 0.15 K 30 – 40 km: 1.4 K 40 – 50 km: 1.8 K 50 – 60 km: 10 K	0 – 8 km: 4.2 K 8 – 30 km: 1.2 K 30 – 40 km: 4.0 K 40 – 50 km: 10 K 50 – 60 km: 18 K		
Notes	The values are based on the comparison to ERA5 forecasts from January 2017 to October 2019.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA5 forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution


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GRM-10	Offline Temperature Profile (Metop-A)	OTPMEA	SESP_v3.4
GRM-11	Offline Specific Humidity Profile (Metop-A)	OHPMEA	
GRM-12	Offline Pressure Profile (Metop-A)	OPPMEA	
GRM-13	Offline Surface Pressure (Metop-A)	OSPMEA	
GRM-48	Offline Temperature Profile (Metop-B)	OTPMEB	
GRM-49	Offline Specific Humidity Profile (Metop-B)	OHPMEB	
GRM-50	Offline Pressure Profile (Metop-B)	OPPMEB	
GRM-51	Offline Surface Pressure (Metop-B)	OSPMEB	
GRM-68	Offline Temperature Profile (Metop-C)	OTPMEC	
GRM-69	Offline Specific Humidity Profile (Metop-C)	OHPMEC	
GRM-70	Offline Pressure Profile (Metop-C)	OPPMEC	
GRM-71	Offline Surface Pressure (Metop-C)	OSPMEC	
Type	Offline Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var based on refractivity; model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-A, B, C Level 1A from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF operational and ERA5 FC, AN		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	30 d	
Service Specification			
0-30 degrees North / South	30-60 degrees North / South	60-90 degrees North / South	
Temperature profile			
30 – 50 km: 0.75 K 0 – 30 km: 0.75 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	
Specific humidity profile			
0 – 12 km: 30 %	0 – 12 km: 35 %	0 – 12 km: 25 %	
Pressure profile			
0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.2 % 0 – 50 km: c) 0.5 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.2 % 0 – 50 km: c) 0.6 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.2 % 0 – 50 km: c) 0.6 hPa **)	
Surface pressure			
0.5 hPa	0.6 hPa	0.6 hPa	
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate **) Whichever is greatest of (a) and (b) but not greater than (c);		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA5 analysis). For profile products (temperature, specific humidity and pressure), the SeSp's are compared to the monthly STDV of the 1D-Var solution minus ERA5 (S-A) on fixed altitude levels. If the SeSp are violated at one level, the product is violating the SeSp for the given month, latitude range and altitude range.		

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Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels (with interpolation); interpolated to 247 fixed levels	RO resolution

GRM-16	Radio Occultation Processing Package	ROPP	SESP_v3.4
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	Timeliness
N/A	N/A	N/A	N/A


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GRM-24	Tropopause Height	TPH	SESP_v3.4
Type	NRT and Offline Product		
Applications and Users	NWP, Climate and atmosphere researchers		
Characteristics and Methods	One scalar value based on the dry temperature lapse rate		
Operational Satellite Input Data	ROM SAF RO products		
Other Operational Input Data	ECMWF fields		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
1 km			
Notes			
Verification/Validation Methods	Monthly standard deviation of (Product - ERA Interim analysis) based on all nominal dry temperature lapse rate tropopause retrievals in the latitude range		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
30 degree south to 30 degree north	RO resolution	scalar	RO resolution


GRM-28-L3-B-R1	Reprocessed bending angle grid	RBGMUL	SESP_v3.4
GRM-28-L3-R-R1	Reprocessed refractivity grid	RRGMUL	
GRM-28-L3-D-R1	Reprocessed dry temperature grid	RDGMUL	
GRM-28-L3-Y-R1	Reprocessed dry pressure grid	RYGMUL	
GRM-28-L3-Z-R1	Reprocessed dry geopotential height grid	RZGMUL	
GRM-28-L3-T-R1	Reprocessed temperature grid	RTGMUL	
GRM-28-L3-H-R1	Reprocessed specific humidity grid	RHGMUL	
GRM-28-L3-C-R1	Reprocessed tropopause height grid	RCGMUL	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Reprocessed level 1A Metop, CHAMP, GRACE, COSMIC data from EUMETSAT Secretariat and UCAR		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
Bending angle			
25 – 50 km: 0.2 % or 0.4 μ rad*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0– 0.20 %			
Refractivity			
25 – 50 km: 0.08 % or 0.004 N-units*) 8 – 25 km: 0.08 % 0 – 8 km: 0.8 – 0.08 %			
Dry temperature			
25 – 50 km: 0.2 – 2.0 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K			
Dry pressure			
25 – 50 km: 0.08 – 0.40 % 8 – 25 km: 0.08 % 0 – 8 km: 0.40 – 0.08 %			
Dry geopotential height			
25 – 50 km: 4 – 40 m 8 – 25 km: 4 m 0 – 8 km: 4 m			
Temperature			
25 – 50 km: 0.2 – 2.0 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K			
Specific humidity			

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8 – 12 km: 3.0 % 0 – 8 km: 3.0 %			
Tropopause Height			
0.1 km			
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate. *) whichever is greater		
Verification/Validation Methods	Nine broad latitude-height regions (tropics, mid-latitudes, high latitudes and low, middle, high altitudes) are defined. The absolute values of the differences between the monthly-mean RO data and the ERA-Interim reanalysis data are computed on the Level 3 grid. Each value is compared to the service specification valid for that altitude. The compliance with the Service Specifications is determined, within each region and for each calendar month, by requiring that 60% of the absolute differences are smaller than the corresponding specification.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-29-L1-B-R1		Reprocessed bending angle		RBAMET	SESP_v3.4
Type		Reprocessed Data Set			
Applications and Users		Climate and atmosphere researchers			
Characteristics and Methods		Hi-res wave optics retrieval and ionospheric correction			
Operational Satellite Input Data		Reprocessed level 1A Metop from EUMETSAT Secretariat			
Other Operational Input Data		ECMWF ERA Interim fields			
Dissemination					
Format		Means		Timeliness	
netCDF BUFR		Web		n/a	
Service Specification					
Bias			Standard deviation		
0 – 8 km: 1.5% 8 – 30 km: 0.1% 30 – 40 km: 0.3% 40 – 50 km: 0.6% 50 – 60 km: 1.5%			0 – 8 km: 7.5% 8 – 30 km: 1.5% 30 – 40 km: 2.2% 40 – 50 km: 6.5% 50 – 60 km: 25%		
Notes		The bias in the 8 - 30 km interval is based on ERA Interim only after 2009, excluding Dec 2013.			
Verification/Validation Methods		First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.			
Coverage, Resolution					
Spatial Coverage		Spatial Resolution		Vertical Resolution	
Global		RO resolution		Hi-res wave optics sampling; interpolated to 247 fixed levels	
				Temporal resolution	
				RO resolution	

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GRM-29-L2-R-R1	Reprocessed refractivity profile	RRPMET	SESP_v3.4
GRM-29-L2-D-R1	Reprocessed dry temperature profile	RDPMET	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Statistical optimization, Abel transform, and hydrostatic integration		
Operational Satellite Input Data	Reprocessed level 1A Metop from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Service Specification			
Bias		Standard deviation	
Refractivity profile			
0 – 8 km: 0.5%		0 – 8 km: 1.8%	
8 – 30 km: 0.06%		8 – 30 km: 0.55%	
30 – 40 km: 0.3%		30 – 40 km: 1.0%	
40 – 50 km: 0.5%		40 – 50 km: 3.0%	
50 – 60 km: 1.5%		50 – 60 km: 8.0%	
Dry temperature profile			
0 – 8 km: 1.0K		0 – 8 km: 4.2K	
8 – 30 km: 0.1K		8 – 30 km: 1.2K	
30 – 40 km: 0.75K		30 – 40 km: 4.0K	
40 – 50 km: 2.8K		40 – 50 km: 10K	
50 – 60 km: 6.0K		50 – 60 km: 18K	
Notes	The bias in the 8 - 30 km interval is based on ERA Interim only after 2009, excluding Dec 2013.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution


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GRM-29-L2-T-R1	Reprocessed temperature profile	RTPMET	SESP_v3.4
GRM-29-L2-H-R1	Reprocessed specific humidity profile	RHPMET	
GRM-29-L2-P-R1	Reprocessed pressure profile	RPPMET	
GRM-29-L2-S-R1	Reprocessed surface pressure	RSPMET	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1A Metop from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF ERA Interim fields.		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
0-30 degrees North / South	30-60 degrees North / South	60-90 degrees North / South	
Temperature profile			
30 – 50 km: 1 K – 2 K 0 – 30 km: 1 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	
Specific humidity profile			
0 – 12 km: 0.9 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 40% *)	0 – 12 km: 0.3 g/kg or 20% *)	
Pressure profile			
0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.40% 0 – 50 km: c) 1.2 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)***)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)	
Surface pressure			
1.2 hPa	0.8 hPa	0.8 hPa	
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate *) Whichever is greater) Whichever is greatest of (a) and (b) but not greater than (c);) If the sampling is restricted to mid latitudes at a single hemisphere in wintertime, the normalized STDV specification has to be raised to 70 % between 8 and 12 km		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis). For profile products (temperature, specific humidity and pressure), the SeSp's are compared to the monthly STDV of the 1D-Var solution minus ERA-I (S-A) on fixed altitude levels. If the SeSp are violated at one level, the product is violating the SeSp for the given month, latitude range and altitude range.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels	RO resolution


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GRM-29-L2-C-R1		Reprocessed tropopause height		RCHMET	SESP_v3.4	
Type		Reprocessed Data Set				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		Dry temperature lapse rate				
Operational Satellite Input Data		Reprocessed level 1A Metop, from EUMETSAT				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF		Web		n/a		
Service Specification						
1 km						
Notes						
Verification/Validation Methods		Monthly standard deviation of (Product - ERA Interim analysis) based on all nominal dry temperature lapse rate tropopause retrievals in the latitude range.				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
15 deg. south to 15 deg. north		RO resolution		scalar		RO resolution


GRM-29-L3-B-R1	Reprocessed bending angle grid	RBGMET	SESP_v3.4
GRM-29-L3-R-R1	Reprocessed refractivity grid	RRGMET	
GRM-29-L3-D-R1	Reprocessed dry temperature grid	RDGMET	
GRM-29-L3-Y-R1	Reprocessed dry pressure grid	RYGMET	
GRM-29-L3-Z-R1	Reprocessed dry geopotential height grid	RZGMET	
GRM-29-L3-T-R1	Reprocessed temperature grid	RTGMET	
GRM-29-L3-H-R1	Reprocessed specific humidity grid	RHGMET	
GRM-29-L3-C-R1	Reprocessed tropopause height grid	RCGMET	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Reprocessed level 1A Metop data from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
Bending angle			
25 – 50 km: 0.2 % or 0.4 μ rad*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0 – 0.2 %			
Refractivity			
25 – 50 km: 0.08 % or 0.004 N-units*) 8 – 25 km: 0.08 % 0 – 8 km: 0.8 – 0.08 %			
Dry temperature			
25 – 50 km: 0.2 – 2.0 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K			
Dry pressure			
25 – 50 km: 0.08 – 0.40 % 8 – 25 km: 0.08 % 0 – 8 km: 0.40 – 0.08 %			
Dry geopotential height			
25 – 50 km: 4 – 40 m 8 – 25 km: 4 m 0 – 8 km: 4 m			
Temperature			
25 – 50 km: 0.2 – 2.0 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K			
Specific humidity			
8 – 12 km: 3.0 %			

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0 – 8 km: 3.0 %			
Tropopause height			
0.1 km			
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate. *) whichever is greater		
Verification/Validation Methods	Nine broad latitude-height regions (tropics, mid-latitudes, high latitudes and low, middle, high altitudes) are defined. The absolute values of the differences between the monthly-mean RO data and the ERA-Interim reanalysis data are computed on the Level 3 grid. Each value is compared to the service specification valid for that altitude. The compliance with the Service Specifications is determined, within each region and for each calendar month, by requiring that 60% of the absolute differences are smaller than the corresponding specification.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-30-L1-B-R1		Reprocessed bending angle		RBACO1	SESP_v3.4
Type		Reprocessed Data Set			
Applications and Users		Climate and atmosphere researchers			
Characteristics and Methods		Hi-res wave optics retrieval and ionospheric correction			
Operational Satellite Input Data		Reprocessed level 1A COSMIC from UCAR CDAAC			
Other Operational Input Data		ECMWF ERA Interim fields			
Dissemination					
Format		Means		Timeliness	
netCDF BUFR		Web		n/a	
Service Specification					
Bias			Standard deviation		
0 – 8 km: 1.0%			0 – 8 km: 7.5%		
8 – 30 km: 0.1%			8 – 30 km: 1.5%		
30 – 40 km: 0.3%			30 – 40 km: 2.2%		
40 – 50 km: 0.6%			40 – 50 km: 7.5%		
50 – 60 km: 1.5%			50 – 60 km: 30%		
Notes		The bias in the 8 - 30 km interval is based on ERA Interim only after 2009, excluding Dec 2013.			
Verification/Validation Methods		First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.			
Coverage, Resolution					
Spatial Coverage		Spatial Resolution		Vertical Resolution	
Global		RO resolution		Hi-res wave optics sampling; interpolated to 247 fixed levels	
				Temporal resolution	
				RO resolution	

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GRM-30-L2-R-R1	Reprocessed refractivity profile	RRPCO1	SESP_v3.4
GRM-30-L2-D-R1	Reprocessed dry temperature profile	RDPCO1	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Statistical optimization, Abel transform, and hydrostatic integration		
Operational Satellite Input Data	Reprocessed level 1A COSMIC from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Service Specification			
Bias		Standard deviation	
Refractivity Profile			
0 – 8 km: 0.5%		0 – 8 km: 1.8%	
8 – 30 km: 0.06%		8 – 30 km: 0.5%	
30 – 40 km: 0.25%		30 – 40 km: 1.2%	
40 – 50 km: 0.4%		40 – 50 km: 4.0%	
50 – 60 km: 1.5%		50 – 60 km: 10.0%	
Dry temperature Profile			
0 – 8 km: 1.0K		0 – 8 km: 4.2K	
8 – 30 km: 0.1K		8 – 30 km: 1.3K	
30 – 40 km: 1.0K		30 – 40 km: 4.5K	
40 – 50 km: 3.0K		40 – 50 km: 12K	
50 – 60 km: 6.0K		50 – 60 km: 22K	
Notes	The bias in the 8 - 30 km interval is based on ERA Interim only after 2009, excluding Dec 2013.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution


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GRM-30-L2-T-R1	Reprocessed temperature profile	RTPCO1	SESP_v3.4
GRM-30-L2-H-R1	Reprocessed specific humidity profile	RHPCO1	
GRM-30-L2-P-R1	Reprocessed pressure profile	RPPCO1	
GRM-30-L2-S-R1	Reprocessed surface pressure	RSPCO1	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1A COSMIC from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields.		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
0-30 degrees North / South	30-60 degrees North / South	60-90 degrees North / South	
Temperature profile			
30 – 50 km: 1 K – 2 K 0 – 30 km: 1 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	
Specific humidity profile			
0 – 12 km: 0.9 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 40% *)	0 – 12 km: 0.3 g/kg or 20% *)	
Pressure profile			
0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.40% 0 – 50 km: c) 1.2 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)***)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)	
Surface pressure			
1.2 hPa	0.8 hPa	0.8 hPa	
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate *) Whichever is greater) Whichever is greatest of (a) and (b) but not greater than (c);) If the sampling is restricted to mid latitudes at a single hemisphere in wintertime, the normalized STDV specification has to be raised to 70 % between 8 and 12 km		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis). For profile products (temperature, specific humidity and pressure), the SeSp's are compared to the monthly STDV of the 1D-Var solution minus ERA-I (S-A) on fixed altitude levels. If the SeSp are violated at one level, the product is violating the SeSp for the given month, latitude range and altitude range.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels	RO resolution


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GRM-30-L2-C-R1		Reprocessed tropopause height		RCHCO1	SESP_v3.4	
Type		Reprocessed Data Set				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		Dry temperature lapse rate				
Operational Satellite Input Data		Reprocessed level 1A COSMIC from UCAR CDAAC				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF		Web		n/a		
Service Specification						
1 km						
Notes						
Verification/Validation Methods		Monthly standard deviation of (Product - ERA Interim analysis) based on all nominal dry temperature lapse rate tropopause retrievals in the latitude range				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
15 deg. south to 15 deg. north		RO resolution		scalar		RO resolution


GRM-30-L3-B-R1	Reprocessed bending angle grid	RBGCO1	SESP_v3.4
GRM-30-L3-R-R1	Reprocessed refractivity grid	RRGCO1	
GRM-30-L3-D-R1	Reprocessed dry temperature grid	RDGCO1	
GRM-30-L3-Y-R1	Reprocessed dry pressure grid	RYGCO1	
GRM-30-L3-Z-R1	Reprocessed dry geopotential height grid	RZGCO1	
GRM-30-L3-T-R1	Reprocessed temperature grid	RTGCO1	
GRM-30-L3-H-R1	Reprocessed specific humidity grid	RHGCO1	
GRM-30-L3-C-R1	Reprocessed tropopause height grid	RCGCO1	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Reprocessed level 1A COSMIC data from UCAR		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
Bending angle			
25 – 50 km: 0.2 % or 0.4 μ rad*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0– 0.2 %			
Refractivity			
25 – 50 km: 0.08 % or 0.004 N-units*) 8 – 25 km: 0.08 % 0 – 8 km: 0.8 – 0.08 %			
Dry temperature			
25 – 50 km: 0.2 – 2.0 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K			
Dry pressure			
25 – 50 km: 0.08 – 0.40 % 8 – 25 km: 0.08 % 0 – 8 km: 0.40 – 0.08 %			
Dry geopotential height			
25 – 50 km: 4 – 40 m 8 – 25 km: 4 m 0 – 8 km: 4 m			
Temperature			
25 – 50 km: 0.2 – 2.0 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K			
Specific humidity			
8 – 12 km: 3.0 %			

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0 – 8 km: 3.0 %			
Tropopause Height			
0.1 km			
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate. *) whichever is greater		
Verification/Validation Methods	Nine broad latitude-height regions (tropics, mid-latitudes, high latitudes and low, middle, high altitudes) are defined. The absolute values of the differences between the monthly-mean RO data and the ERA-Interim reanalysis data are computed on the Level 3 grid. Each value is compared to the service specification valid for that altitude. The compliance with the Service Specifications is determined, within each region and for each calendar month, by requiring that 60% of the absolute differences are smaller than the corresponding specification.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-32-L1-B-R1		Reprocessed bending angle		RBACHA	SESP_v3.4
Type		Reprocessed Data Set			
Applications and Users		Climate and atmosphere researchers			
Characteristics and Methods		Hi-res wave optics retrieval and ionospheric correction			
Operational Satellite Input Data		Reprocessed level 1A CHAMP from UCAR CDAAC			
Other Operational Input Data		ECMWF ERA Interim fields			
Dissemination					
Format		Means		Timeliness	
netCDF BUFR		Web		n/a	
Service Specification					
Bias			Standard deviation		
0 – 8 km: 2.0%			0 – 8 km: 7.0%		
8 – 30 km: 0.2%			8 – 30 km: 1.7%		
30 – 40 km: 0.5%			30 – 40 km: 3.5%		
40 – 50 km: 1.0%			40 – 50 km: 14%		
50 – 60 km: 2.5%			50 – 60 km: 50%		
Notes		The values are based on ERA Interim before 2009.			
Verification/Validation Methods		First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.			
Coverage, Resolution					
Spatial Coverage		Spatial Resolution		Vertical Resolution	
Global		RO resolution		Hi-res wave optics sampling; interpolated to 247 fixed levels	
				Temporal resolution	
				RO resolution	

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GRM-32-L2-R-R1	Reprocessed refractivity profile	RRPCHA	SESP_v3.4
GRM-32-L2-D-R1	Reprocessed dry temperature profile	RDPCHA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Statistical optimization, Abel transform, and hydrostatic integration		
Operational Satellite Input Data	Reprocessed level 1A CHAMP from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Service Specification			
Bias	Standard deviation		
Refractivity Profile			
0 – 8 km: 0.6%	0 – 8 km: 1.8%		
8 – 30 km: 0.14%	8 – 30 km: 0.55%		
30 – 40 km: 0.5%	30 – 40 km: 1.5%		
40 – 50 km: 1.0%	40 – 50 km: 5.0%		
50 – 60 km: 1.5%	50 – 60 km: 12.0%		
Dry temperature Profile			
0 – 8 km: 1.2K	0 – 8 km: 4.2K		
8 – 30 km: 0.3K	8 – 30 km: 1.3K		
30 – 40 km: 0.6K	30 – 40 km: 5.0K		
40 – 50 km: 3.5K	40 – 50 km: 14K		
50 – 60 km: 7.0K	50 – 60 km: 25K		
Notes	The values are based on ERA Interim before 2009.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution


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GRM-32-L2-T-R1	Reprocessed temperature profile	RTPCHA	SESP_v3.4
GRM-32-L2-H-R1	Reprocessed specific humidity profile	RHPCHA	
GRM-32-L2-P-R1	Reprocessed pressure profile	RPPCHA	
GRM-32-L2-S-R1	Reprocessed surface pressure	RSPCHA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1A CHAMP from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields.		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
0-30 degrees North / South	30-60 degrees North / South	60-90 degrees North / South	
Temperature profile			
30 – 50 km: 1 K – 2 K 0 – 30 km: 1 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	
Specific humidity profile			
0 – 12 km: 0.9 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 40% *)	0 – 12 km: 0.3 g/kg or 20% *)	
Pressure profile			
0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.40% 0 – 50 km: c) 1.2 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)***)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)	
Surface pressure			
1.2 hPa	0.8 hPa	0.8 hPa	
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate *) Whichever is greater) Whichever is greatest of (a) and (b) but not greater than (c);) If the sampling is restricted to mid latitudes at a single hemisphere in wintertime, the normalized STDV specification has to be raised to 70 % between 8 and 12 km		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis). For profile products (temperature, specific humidity and pressure), the SeSp's are compared to the monthly STDV of the 1D-Var solution minus ERA-I (S-A) on fixed altitude levels. If the SeSp are violated at one level, the product is violating the SeSp for the given month, latitude range and altitude range.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels	RO resolution


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GRM-32-L2-C-R1		Reprocessed tropopause height		RCHCHA	SESP_v3.4	
Type		Reprocessed Data Set				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		Dry temperature lapse rate				
Operational Satellite Input Data		Reprocessed level 1A CHAMP from UCAR CDAAC				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF		Web		n/a		
Service Specification						
1 km						
Notes						
Verification/Validation Methods		Monthly standard deviation of (Product - ERA Interim analysis) based on all nominal dry temperature lapse rate tropopause retrievals in the latitude range				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
15 deg. south to 15 deg. north		RO resolution		scalar		RO resolution


GRM-32-L3-B-R1	Reprocessed bending angle grid	RBGCHA	SESP_v3.4
GRM-32-L3-R-R1	Reprocessed refractivity grid	RRGCHA	
GRM-32-L3-D-R1	Reprocessed dry temperature grid	RDGCHA	
GRM-32-L3-Y-R1	Reprocessed dry pressure grid	RYGCHA	
GRM-32-L3-Z-R1	Reprocessed dry geopotential height grid	RZGCHA	
GRM-32-L3-T-R1	Reprocessed temperature grid	RTGCHA	
GRM-32-L3-H-R1	Reprocessed humidity grid	RHGCHA	
GRM-32-L3-C-R1	Reprocessed tropopause height grid	RCGCHA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Reprocessed level 1A CHAMP data from UCAR		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
Bending angle			
25 – 40 km: 0.4 % or 0.8 μ rad*) 8 – 25 km: 0.4 % 0 – 8 km: 4.0 – 0.4 %			
Refractivity			
25 – 40 km: 0.2 % or 0.008 N-units*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0 – 0.2 %			
Dry temperature			
25 – 40 km: 0.4 – 4.0 K 8 – 25 km: 0.4 K 0 – 8 km: 2.0 – 0.4 K			
Dry pressure			
25 – 40 km: 0.2 – 1.0 % 8 – 25 km: 0.2 % 0 – 8 km: 1.0 – 0.2 %			
Dry geopotential height			
25 – 40 km: 8 – 80 m 8 – 25 km: 8 m 0 – 8 km: 8 m			
Temperature			
25 – 40 km: 0.4 – 4.0 K 8 – 25 km: 0.4 K 0 – 8 km: 2.0 – 0.4 K			
Specific humidity			
8 – 12 km: 6.0 %			

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0 – 8 km: 6.0 %			
Tropopause Height			
0.3 km			
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate; Product may have reduced information content below 8 km due to limitations in the CHAMP closed loop data;) whichever is greater		
Verification/Validation Methods	Nine broad latitude-height regions (tropics, mid-latitudes, high latitudes and low, middle, high altitudes) are defined. The absolute values of the differences between the monthly-mean RO data and the ERA-Interim reanalysis data are computed on the Level 3 grid. Each value is compared to the service specification valid for that altitude. The compliance with the Service Specifications is determined, within each region and for each calendar month, by requiring that 60% of the absolute differences are smaller than the corresponding specification.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-33-L1-B-R1	Reprocessed bending angle	RBAGRA	SESP_v3.4
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Hi-res wave optics retrieval and ionospheric correction		
Operational Satellite Input Data	Reprocessed level 1A GRACE from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Service Specification			
Bais	Standard deviation		
0 – 8 km: 1.8% 8 – 30 km: 0.1% 30 – 40 km: 0.3% 40 – 50 km: 0.6% 50 – 60 km: 1.5%	0 – 8 km: 7.0% 8 – 30 km: 1.6% 30 – 40 km: 3.0% 40 – 50 km: 12% 50 – 60 km: 40%		
Notes	The bias in the 8 - 30 km interval is based on ERA Interim only after 2009, excluding Dec 2013.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
Global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution

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GRM-33-L2-R-R1	Reprocessed refractivity profile	RRPGRA	SESP_v3.4
GRM-33-L2-D-R1	Reprocessed dry temperature profile	RDPGRA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Statistical optimization, Abel transform, and hydrostatic integration		
Operational Satellite Input Data	Reprocessed level 1A GRACE from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Service Specification			
Bias	Standard deviation		
Refractivity Profile			
0 – 8 km: 0.5%	0 – 8 km: 1.8%		
8 – 30 km: 0.06%	8 – 30 km: 0.5%		
30 – 40 km: 0.2%	30 – 40 km: 1.3%		
40 – 50 km: 0.4%	40 – 50 km: 4.5%		
50 – 60 km: 1.5%	50 – 60 km: 11.0%		
Dry temperature Profile			
0 – 8 km: 1.0K	0 – 8 km: 4.2K		
8 – 30 km: 0.12K	8 – 30 km: 1.25K		
30 – 40 km: 1.0K	30 – 40 km: 4.5K		
40 – 50 km: 3.0K	40 – 50 km: 13K		
50 – 60 km: 6.0K	50 – 60 km: 25K		
Notes	The bias in the 8 - 30 km interval is based on ERA Interim only after 2009, excluding Dec 2013.		
Verification/Validation Methods	First calculation of profiles of mean and standard deviation of (Product – ERA Interim forecasts). Bias is then calculated as the absolute value of the mean. Bias and standard deviation are then averaged linearly over vertical intervals.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution


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GRM-33-L2-T-R1	Reprocessed temperature profile	RTPGRA	SESP_v3.4
GRM-33-L2-H-R1	Reprocessed specific humidity profile	RHPGRA	
GRM-33-L2-P-R1	Reprocessed pressure profile	RPPGRA	
GRM-33-L2-S-R1	Reprocessed surface pressure	RSPGRA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1A GRACE from UCAR CDAAC		
Other Operational Input Data	ECMWF ERA Interim fields.		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
0-30 degrees North / South	30-60 degrees North / South	60-90 degrees North / South	
Temperature profile			
30 – 50 km: 1 K – 2 K 0 – 30 km: 1 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	30 – 50 km: 0.75 K – 2 K 0 – 30 km: 0.75 K	
Specific humidity profile			
0 – 12 km: 0.9 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 40% *)***)	0 – 12 km: 0.3 g/kg or 20% *)	
Pressure profile			
0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.40% 0 – 50 km: c) 1.2 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)	0 – 50 km: a) 0.01 hPa 0 – 50 km: b) 0.25% 0 – 50 km: c) 0.8 hPa **)	
Surface pressure			
1.2 hPa	0.8 hPa	0.8 hPa	
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate *) Whichever is greater) Whichever is greatest of (a) and (b) but not greater than (c);) If the sampling is restricted to mid latitudes at a single hemisphere in wintertime, the normalized STDV specification has to be raised to 70 % between 8 and 12 km		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis). For profile products (temperature, specific humidity and pressure), the SeSp's are compared to the monthly STDV of the 1D-Var solution minus ERA-I (S-A) on fixed altitude levels. If the SeSp are violated at one level, the product is violating the SeSp for the given month, latitude range and altitude range.		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels	RO resolution


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GRM-33-L2-C-R1		Reprocessed tropopause height		RCHGRA	SESP_v3.4	
Type		Reprocessed Data Set				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		Dry temperature lapse rate				
Operational Satellite Input Data		Reprocessed level 1A GRACE from UCAR CDAAC				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF		Web		n/a		
Service Specification						
1 km						
Notes						
Verification/Validation Methods		Monthly standard deviation of (Product - ERA Interim analysis) based on all nominal dry temperature lapse rate tropopause retrievals in the latitude range				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
15 deg. south to 15 deg. north		RO resolution		scalar		RO resolution


GRM-33-L3-B-R1	Reprocessed bending angle grid	RBGGRA	SESP_v3.4
GRM-33-L3-R-R1	Reprocessed refractivity grid	RRGGRA	
GRM-33-L3-D-R1	Reprocessed dry temperature grid	RDGGRA	
GRM-33-L3-Y-R1	Reprocessed dry pressure grid	RYGGRA	
GRM-33-L3-Z-R1	Reprocessed dry geopotential height grid	RZGGRA	
GRM-33-L3-T-R1	Reprocessed temperature grid	RTGGRA	
GRM-33-L3-H-R1	Reprocessed humidity grid	RHGGRA	
GRM-33-L3-C-R1	Reprocessed tropopause height grid	RCGGRA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Reprocessed level 1A GRACE data from UCAR		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Service Specification			
Bending angle			
25 – 40 km: 0.3 % or 0.6 μ rad*) 8 – 25 km: 0.3 % 0 – 8 km: 3.0 – 0.3 %			
Refractivity			
25 – 40 km: 0.12 % or 0.006 N-units*) 8 – 25 km: 0.12 % 0 – 8 km: 1.2 – 0.12 %			
Dry temperature			
25 – 40 km: 0.3 – 3.0 K 8 – 25 km: 0.3 K 0 – 8 km: 1.5 – 0.3 K			
Dry pressure			
25 – 40 km: 0.12 – 0.60 % 8 – 25 km: 0.12 % 0 – 8 km: 0.60 – 0.12 %			
Dry geopotential height			
25 – 40 km: 6 – 60 m 8 – 25 km: 6 m 0 – 8 km: 6 m			
Temperature			
25 – 40 km: 0.3 – 3.0 K 8 – 25 km: 0.3 K 0 – 8 km: 1.0 – 0.3 K			
Specific humidity			
8 – 12 km: 4.0 %			

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0 – 8 km: 4.0 %			
Tropopause Height			
0.2 km			
Notes	An interval means a linearly changing quantity between the two values over the given vertical coordinate; Product may have reduced information content below 8–10 km due to limitations in the GRACE closed loop data;) whichever is greater		
Verification/Validation Methods	Nine broad latitude-height regions (tropics, mid-latitudes, high latitudes and low, middle, high altitudes) are defined. The absolute values of the differences between the monthly-mean RO data and the ERA-Interim reanalysis data are computed on the Level 3 grid. Each value is compared to the service specification valid for that altitude. The compliance with the Service Specifications is determined, within each region and for each calendar month, by requiring that 60% of the absolute differences are smaller than the corresponding specification.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-41	NRT Temperature Profile		NTPMEB	SESP_v3.4
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		

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GRM-42	NRT Specific Humidity Profile		NHPMEB	SESP_v3.4
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 inter- polation); interpolated to 247 fixed levels		

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GRM-43		NRT Pressure Profile		NPPMEB	SESP_v3.4	
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 speci- fication (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 inter- polation); interpolated to 247 fixed levels		

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GRM-44	NRT Surface Pressure	NSPMEB	SESP_v3.4
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		

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GRM-45	Error Covariance Matrix for NRT Products	NEMMEB	SESP_v3.4
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		

GRM-53	Offline bending angle grid	OBGMEB	SESP_v3.4
GRM-54	Offline refractivity grid	ORGMEB	
GRM-55	Offline temperature grid	OTGMEB	
GRM-56	Offline humidity grid	OHGMEB	
GRM-57	Offline dry geopotential height grid	OZGMEB	
GRM-58	Offline dry temperature grid	ODGMEB	
GRM-59	Offline dry pressure grid	OYGMEB	
GRM-192	Offline tropopause height grid	OCGMEB	
GRM-73	Offline bending angle grid	OBGMEC	
GRM-74	Offline refractivity grid	ORGMEC	
GRM-75	Offline temperature grid	OTGMEC	
GRM-76	Offline humidity grid	OHGMEC	
GRM-77	Offline dry geopotential height grid	OZGMEC	
GRM-78	Offline dry temperature grid	ODGMEC	
GRM-79	Offline dry pressure grid	OYGMEC	
GRM-193	Offline tropopause height grid	OCGMEC	
GRM-83	Offline bending angle grid	RBGMET	
GRM-84	Offline refractivity grid	RRGMET	
GRM-85	Offline dry geopotential height grid	RZGMET	
GRM-86	Offline temperature grid	RTGMET	
GRM-87	Offline specific humidity grid	RHGMET	
GRM-88	Offline dry temperature grid	RDGMET	
GRM-89	Offline dry pressure grid	RYGMET	
GRM-194	Offline tropopause height grid	RCGMET	
GRM-93	Offline bending angle grid	OBGMEA	
GRM-94	Offline refractivity grid	ORGMEA	
GRM-95	Offline temperature grid	OTGMEA	
GRM-96	Offline humidity grid	OHGMEA	
GRM-97	Offline dry geopotential height grid	OZGMEA	
GRM-98	Offline dry temperature grid	ODGMEA	
GRM-99	Offline dry pressure grid	OYGMEA	
GRM-191	Offline tropopause height grid	OCGMEA	
Type	Offline Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Offline level 1A Metop-A, B, C data from EUMETSAT Secretariat		
Other Operational Input Data	ECMWF ERA5 (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	30 d	
Service Specification			
Bending angle			
25 – 50 km: 0.3 % or 0.6 μ rad*) 8 – 25 km: 0.3 % 0 – 8 km: 3.0 – 0.3 %			


Refractivity			
25 – 50 km: 0.24 % or 0.012 N-units*) 8 – 25 km: 0.24 % 0 – 8 km: 2.4 – 0.24 %			
Dry temperature			
25 – 50 km: 0.3 – 3.0 K 8 – 25 km: 0.3 K 0 – 8 km: 1.5 – 0.3 K			
Dry pressure			
25 – 50 km: 0.12 – 0.60 % 8 – 25 km: 0.12 % 0 – 8 km: 0.60 – 0.12 %			
Dry geopotential height			
25 – 50 km: 6 – 60 m 8 – 25 km: 6 m 0 – 8 km: 6 m			
Temperature			
25 – 50 km: 0.3 – 3.0 K 8 – 25 km: 0.3 K 0 – 8 km: 1.0 – 0.3 K			
Specific humidity			
8 – 12 km: 4.0 % 0 – 8 km: 4.0 %			
Tropopause Height			
0.2 km			
Notes		An interval means a linearly changing quantity between the two values over the given vertical coordinate; *) whichever is greater	
Verification/Validation Methods		Nine broad latitude-height regions (tropics, mid-latitudes, high latitudes and low, middle, high altitudes) are defined. The absolute values of the differences between the monthly-mean RO data and the ERA5 reanalysis data are computed on the Level 3 grid. Each value is compared to the service specification valid for that altitude. The compliance with the Service Specifications is determined, within each region and for each calendar month, by requiring that 60% (bending angle, temperature, humidity, tropopause height) or 50% (refractivity, dry variables) of the absolute differences are smaller than the corresponding specification.	
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-60	NRT Refractivity Profile		NRPMEC	SESP_v3.4
Type	Product			
Applications and users	NWP			
Characteristics and Methods	Profile obtained from NRT bending angles using state-of-the-art algorithms			
Comments				
Generation frequency	orbit dump and (when available) half orbits dumps			
Input satellite data	Metop-C/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

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GRM-61	NRT Temperature Profile		NTPMEC	SESP_v3.4
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-C/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		

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GRM-62	NRT Specific Humidity Profile		NHPMEC	SESP_v3.4
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-C/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		

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GRM-63		NRT Pressure Profile		NPPMEC	SESP_v3.4	
Type		NRT Product				
Applications and Users		NWP				
Characteristics and Methods		model levels (with interpolation); interpolated to 247 fixed levels				
Operational Satellite Input Data		Metop-C/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 speci- fication (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 inter- polation); interpolated to 247 fixed levels		

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GRM-64	NRT Surface Pressure	NSPMEC	SESP_v3.4
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods			
Operational Satellite Input Data	Metop-C/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		

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GRM-65	Error Covariance Matrix for NRT Products	NEMMEC	SESP_v3.4
Type	Information Product		
Applications and Users	NWP		
Characteristics and Methods			
Operational Satellite Input Data	Metop-C/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-92	Ground Based GNSS Package	GBGP	SESP_v3.4
Type	Software Product		
Applications and Users	Analysis Centres and NWP		
Characteristics and Methods	Routines for handling ground-based GNSS (ZTD, IWV)		
Operational Satellite Input Data	Output of ground-based GNSS processing		
Other Operational Input Data			
Dissemination			
Format	Means	Timeliness	
tarballs	Web	N/A	
Accuracy			
Threshold	Target	Optimal	
N/A	N/A	N/A	
Notes			
Verification/Validation Methods	Test Folder		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
N/A	N/A		

GRM-29-I1	Metop Interim Climate Data Record (Data Levels L1B, L2, L3)	ICDRMET	SESP_v3.4	
GRM-29-L1-B-I1	ICDR Bending Angle	IBAMET		
GRM-29-L2-R-I1	ICDR Refractivity Profile	IRPMET		
GRM-29-L2-D-I1	ICDR Dry Temperature Profile	IDPMET		
GRM-29-L2-T-I1	ICDR Temperature Profile	ITPMET		
GRM-29-L2-H-I1	ICDR Specific Humidity Profile	IHPMET		
GRM-29-L2-P-I1	ICDR Pressure Profile	IPPMET		
GRM-29-L2-S-I1	ICDR Surface Pressure	ISPMET		
GRM-29-L2-C-I1	ICDR Tropopause Height	ICHMET		
GRM-29-L3-B-I1	ICDR Bending Angle Grid	IBGMET		
GRM-29-L3-R-I1	ICDR Refractivity Grid	IRGMET		
GRM-29-L3-D-I1	ICDR Dry Temperature Grid	IDGMET		
GRM-29-L3-Y-I1	ICDR Dry Pressure Grid	IYGMET		
GRM-29-L3-Z-I1	ICDR Dry Geopotential Height Grid	IZGMET		
GRM-29-L3-T-I1	ICDR Temperature Grid	ITGMET		
GRM-29-L3-H-I1	ICDR Specific Humidity Grid	IHGMET		
GRM-29-L3-C-I1	ICDR Tropopause Height Grid	ICGMET		
Type	Interim Climate Data Record			
Applications and Users	Climate and atmosphere researchers			
Characteristics and Methods	<p>1) Regularly extends in time CDR GRM-29-R1 using a system having optimum consistency with the system used to generate CDR GRM-29-R1;</p> <p>2) The extension in time will continue until the release of CDR GRM-29-R2 which will cover both the GRM-29-R1 and GRM-29-I1 time periods;</p>			
Operational Satellite Input Data	Operational Level 1A/1B Metop files from EUMETSAT Secretariat			
Other Operational Input Data	ECMWF ERA Interim fields and ERA5 fields			
Dissemination				
Format	Means	Timeliness		
netCDF BUFR	Web	Two months		
Service Specification				
Accuracy				
GRM-29-R1				
Notes				
Verification/Validation Methods	Same methods as used for CDR GRM-29-R1			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution	
GRM-29-R1	GRM-29-R1	GRM-29-R1	GRM-29-R1	