EUMETSAT

ROM SAF

RADIO OCCULTATION METEOROLOGY

Service Specifications

Version 3.6

19 June 2024

ROM SAF Consortium
Danish Meteorological Institute (DMI)
European Centre for Medium-Range Weather Forecasts (ECMWF)
Institut d'Estudis Espacials de Catalunya (IEEC)
Met Office (UKMO)
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DOCUMENT CHANGE RECORD

Version	*Date*	*By*	*Description*
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: - 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
			- 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: - 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: - Updated Sec. 1.4 Definitions - ICDR products included (GRM-29-I1) - 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: - 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	- 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: - Offline Metop-C profiles added: GRM-66 to 71, 105

Version	Date	By	Description
			- 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 Updated version implementing the following ORR12 RIDs: - 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 Further updates based on **decisions agreed at SG25 on 1 September 2020**: - 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 **Approved as SG26-Dec-08 (20 Nov 2020)**
3.4	4/3 2021	KBL	Updates based on ROPP-10 DRR: - 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

Version	Date	By	Description
			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)**
3.5	26/1 2022	KBL	Implementing decision **SG27-Dec-15** (*The SG endorsed Sentinel-6 NTC ORR Recommendation 04 regarding approving the updates to the SeSp version 3.4 as per Document Change Request, SAF/ROM/DMI/MGR/DCR/001, version 1.1, 25/11 2021, implementing the baseline for Sentinel-6 NTC service specifications: 95% availability requirement for Serntinel-6 NTC products and inclusion of specifications for the Sentinel-6 NTC products (GRM-117 to GRM-129 and GRM-195). (wp 15 December 2021)*) as follows: - SS-01-02: added GRM-117 to GRM-122 - SS-01-03: added GRM-195 - SS-03-01: added GRM-117 to GRM-122 - SS-03-07: requirement added - SS-04-01: added GRM-195 - Annex A: inserted tables for GRM-117 to GRM-122; GRM-123 to GRM-129, GRM-195 Implementing decision **SG27-Dec-20** (*The SG endorsed ROPP-11 DRR Recommendation 03 regarding approving the updates to the Service Specification (SeSp) as per "Document Change Request on Service Specification Document v3.4" (v1.0, SAF/ROM/DMI/MGT/DCR/003, dated 03.12.2021):* *Update of GRM-16 Table to indicate ROPP10;* *Inclusion of GRM-16_v11 product table;* *(wp 20 January 2022)*) as follows: - New SS-nn-mm requirements added: - SS-08-08 - SS-08-09 - SS-08-10 - SS-08-11 - SS-08-12 - SS-08-13 - SS-08-14 - SS-08-15 - Annex A: GRM-16 updated - Annex A: GRM-16_v11 updated

Version	Date	By	Description
			Editorial changes: - Changes in the text for Sentinel-6 - Updated section 1.4 with definition of NTC products Implemented the discussion in ROM SAF SG email on 15 December 2021 related to: - Removing the reference to "3rd party data" from the satellite input data field for the Sentinel-6 product tables in Annex A. **Approved as SG27-Dec-15 (wp on 15 December 2021)** (Reference: ROM-DCR-001, version 1.1, dated 25/11 2021) **Approved as SG27-Dec-20 (wp on 20 January 2022)** (Reference: ROM-DCR-003, version 1.0, dated 3/12 2021)
3.6	19/6 2024	KBL	Implementing the following changes: - Changing AD documents to CDOP 4 Proposal, Agreement, and PRD - Removing Metop-A from all service specification commitments - Removing all PRT tables with Metop-A (GRM-01 to 05, 07, 08 to 13, 93 to 99, 101, 191) - ROM-CDOP4-SG04-Dec-04 regarding updating service specification SS-02-03 **Approved as ROM-CDOP4-SG06-02 (wp on 15 Aug 2024)**

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, iii) Met Office in Exeter, United Kingdom, and iv) Wegener Center, University of Graz, in Graz, Austria. To get access to our products or to read more about the ROM SAF please go to: https://rom-saf.eumetsat.int

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List of Contents

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 4 Proposal: Proposal for the Fourth Continuous Development and Operations Phase (CDOP 4), Ref: SAF/ROM/DMI/MGT/CDOP4/001 (v1.1, 5 April 2021, as approved by the EUMETSAT Council in document reference EUM/C/97/21/DOC/15)

[AD.2] CDOP 4 Cooperation Agreement between EUMETSAT and DMI on the CDOP 4 of the ROM SAF, Ref: EUM/C/97/21/DOC/21, signed on 31 August and 15 September 2021

[AD.3] ROM SAF CDOP 4 Products Requirements Document, Ref: SAF/ROM/DMI/MGT/PRD/004

[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
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
NTC	Non Time Critical
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
UG-WEGC	University of Graz, Wegener Center

1.4 Definitions

RO data products from current and upcoming EUMETSAT satellites and other missions are grouped in data levels (Level 0, 1, 2, or 3) and product types (NRT, Offline, NTC, CDR, or ICDR). The data levels and product types are defined below.[1] The lists of variables should not be considered as the complete contents of a given data level, and not all variables may be contained in a given data level in a given file.

Data levels:

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

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

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

Level 1B: Bending angles and impact parameters, tangent point location, total electron content, 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), electron densities (Level 2E), and 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: Data product delivered less than 3 hours after measurement (ROM SAF Level 2 products for EPS);

Offline, NTC: Data product delivered from about 5 days to up to 6 months after measurement, depending on the applicable 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 software.[2] The data record covers an extended time period of several years (with a fixed end point) and constitutes an apparently homogeneous data record appropriate for climate usage. The CDR may be referred to as Fundamental (e.g. for Level 1B bending angles) or as Thematic (if related to a specific application area);

ICDR: Interim Climate Data Record which regularly extends in time a CDR using a system having optimum consistency with and lower latency than the system used to generate the CDR.[3]

1.5 Overview of this document

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

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

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-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 Sentinel-6 RO instruments to Level-2 products according to specifications listed in Annex A, Tables GRM-24, GRM-46,47,48,49,50,51, GRM-66,67,68,69,70,71, GRM-103, GRM-105, GRM-117,118,119,120,121,122. 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 gridded Level 3 products for climate applications, according to the product specifications in Annex A, Tables GRM-53 to 59, GRM-73 to 79, GRM-83 to 89, GRM-123 to 129, GRM-192, GRM-193, GRM-194, GRM-195, GRM-29-I1. [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-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 nominal instrument operation and

available to the ROM SAF within 2h15m, more than 98% shall be processed to Level 2 and disseminated to users within 3 hours of observation time. This availability rate shall be calculated for each of the Metop satellites 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, TablesGRM-24, 46 to 51, 66 to 71, GRM-103, GRM-105, GRM-29-I1. [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]

SS-03-07 More than 95% of all generated Sentinel-6 Level 2 NTC products shall be available to users within 60 days of observation time. This availability rate shall be calculated over a 1-year period.

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 to 59, 73 to 79, 83 to 89, 123 to 129, 192, 193, 194, 195, GRM-29-I1. [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-45, GRM-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]

SS-08-08 The ROPP software shall contain low-level utility routines (geodesy calculations, date/time conversion, coordinate transformations, error messages).

SS-08-09 The ROPP software shall contain I/O routines (support for intrinsic ROPP netCDF data structure, and its conversion to and from BUFR, tools to read UCAR, GFZ and EUMETSAT Leve1b data in their proprietary formats, ability to process data from the missions listed below, tool to extract background profiles from GRIB files, range-checking, profile thinning).

SS-08-10 The ROPP software shall contain pre-processing routines (tools to generate L1 and L2 channel bending angles from excess phase and amplitude, and to compute ionospheric corrected bending angle and refractivity profiles from L1 and L2 bending angles, 1D and 2D wave optics propagation codes).

SS-08-11 The ROPP software shall contain forward modelling routines (tools to generate refractivities and bending angles from background profiles produced by ECMWF and Met Office models, 1D refractivity operator, 1D and 2D bending angle operators, routines to calculate electron density and L2-L1 bending angle profiles for idealised ionospheres, tangent linear and adjoint counterparts for use in 1D-Var).

SS-08-12 The ROPP software shall contain 1D-Var routines (tools to retrieve solution profiles from ECMWF and Met Office models and refractivity and bending angle profiles, tools to retrieve electron density profiles from L2-L1 bending angle differences, quality control, minimisers, solution diagnostics).

SS-08-13 The ROPP software shall contain applications routines (tools to diagnose tropopause height and boundary layer height from profiles of a variety of observational and model variables).

SS-08-14 The ROPP software shall be tested on the following platforms and

compilers:

(i) All 'compile', 'run' and 'regression' tests shall be carried out on one compiler (probably either gfortran or ifort).

(ii) All 'compile' and all 'run' tests must be performed with at least two compilers (probably ifort and gfortran).

(iii) All 'compile' tests must be performed on at least two platforms (probably linux and Cygwin).

(iv) All 'compile' tests must be performed with at least five compilers.

SS-08-15 The ROPP software shall be tested through verification and validation methods (“Test Folder”) as follows:

(i) Coding and compilation testing (compliance to coding standards; tests of basic functionality ('core tests') on at least 6 commonly available compilers and at least two platforms);

(ii) Module testing for the I/O module (test reading and writing of data is within tolerances, test unit conversion);

(iii) Integration testing for the pre-processing module (test Abel transform, ionospheric correction, excess phase processing, wave optics propagators);

(iv) Integration testing for the forward modelling module (test computed refractivities and bending angles from ECMWF and Met Office background temperature, water vapour and pressure, against independently generated profiles, including at least one test of a full day of data);

(v) Integration testing for the 1D-Var module (test the propriety of the input data, sensitivity to assumed errors, retrievals using real observational data from a variety of sources, including at least one test of a full day of data);

(vi) Integration testing for the applications module (calculated TPH and PBLHs compared against independently calculated reference values);

(vii) Regression testing (for each module, the results of one test are closely compared against those of the immediately preceding ROPP release);

(viii) Portability testing (check that at least one compiler passes as many tests as the default compiler);

(ix) Timing testing (check that code runs in reasonable times or different compilers and platforms);

(x) Documentation testing (check that user guides and reference manuals are clear and correct).

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-46, GRM-66)
- Level 2A Refractivity (GRM-40, GRM-47, GRM-60, GRM-67)
- Level 2A Dry Temperature (GRM-103, GRM-105)
- Level 2B, 2C Temperature, Pressure, and Humidity (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-123 to GRM-129, GRM-192, GRM-193, GRM-194, GRM-195)
- 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

Product ID	*Product Name*	*Product Acronym*
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 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

Product ID	Product Name	Product Acronym
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

Product ID	Product Name	Product Acronym
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

Product ID	*Product Name*	*Product Acronym*
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)

GRM-46 GRM-66	**Offline bending angle (Metop-B) Offline bending angle (Metop-C)**	**OBAMEB OBAMEC**	**SESP_v3.6**
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- 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

GRM-47 **GRM-67** **GRM-103** **GRM-105**	**Offline refractivity profile (Metop-B)** **Offline refractivity profile (Metop-C)** **Offline dry temperature profile (Metop-A)** **Offline dry temperature profile (Metop-B)** **Offline dry temperature profile (Metop-C)**	**ORPMEB** **ORPMEC** **ODPMEB** **ODPMEC**	**SESP_v3.6**

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- 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

GRM-48 **GRM-49** **GRM-50** **GRM-51** **GRM-68** **GRM-69** **GRM-70** **GRM-71**	**Offline Temperature Profile (Metop-B)** **Offline Specific Humidity Profile (Metop-B)** **Offline Pressure Profile (Metop-B)** **Offline Surface Pressure (Metop-B)** **Offline Temperature Profile (Metop-C)** **Offline Specific Humidity Profile (Metop-C)** **Offline Pressure Profile (Metop-C)** **Offline Surface Pressure (Metop-C)**	**OTPMEB** **OHPMEB** **OPPMEB** **OSPMEB** **OTPMEC** **OHPMEC** **OPPMEC** **OSPMEC**	**SESP_v3.6**

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- 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.

Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels (with	RO resolution

		interpolation); interpolated to 247 fixed levels	

GRM-16	**Radio Occultation Processing Package**	**ROPP**	**SESP_v3.6**

Type	Software Product
Applications and Users	NWP, RO data suppliers, scientific users
Characteristics and Methods	Routines for handling RO data - Utilities module - Input/output module - Pre-processing module - Forward modelling module - 1D-Var module - Applications module
Operational Satellite Input Data	Metop (GRAS) Metop-SG COSMIC COSMIC-2 CHAMP GPS/MET GRACE TerraSAR-X TanDEM-X PAZ FY-3 (GNOS)
Other Operational Input Data	NWP model fields

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	N/A	N/A

GRM-16_v11	**Radio Occultation Processing Package**	**ROPP_v11**	**SESP_v3.6**
Type	Software Product		
Applications and Users	NWP, RO data suppliers, scientific users		
Characteristics and Methods	GRM-16; 1D-Var routines tools to retrieve electron density profiles from L2-L1 bending angle differences		
Operational Satellite Input Data	GRM-16		
Other Operational Input Data	GRM-16		

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	N/A	N/A

GRM-24	**Tropopause Height**	**TPH**	**SESP_v3.6**
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_v3.6**
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 μrad*) 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		

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

GRM-29-L1-B-R1	**Reprocessed bending angle**	**RBAMET**	**SESP_v3.6**
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	Temporal resolution
Global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution

GRM-29-L2-R-R1 **GRM-29-L2-D-R1**	**Reprocessed refractivity profile** **Reprocessed dry temperature profile**	**RRPMET** **RDPMET**	**SESP_v3.6**

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% 8 – 30 km: 0.06% 30 – 40 km: 0.3% 40 – 50 km: 0.5% 50 – 60 km: 1.5%	0 – 8 km: 1.8% 8 – 30 km: 0.55% 30 – 40 km: 1.0% 40 – 50 km: 3.0% 50 – 60 km: 8.0%
Dry temperature profile	
0 – 8 km: 1.0K 8 – 30 km: 0.1K 30 – 40 km: 0.75K 40 – 50 km: 2.8K 50 – 60 km: 6.0K	0 – 8 km: 4.2K 8 – 30 km: 1.2K 30 – 40 km: 4.0K 40 – 50 km: 10K 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

GRM-29-L2-T-R1 **GRM-29-L2-H-R1** **GRM-29-L2-P-R1** **GRM-29-L2-S-R1**	**Reprocessed temperature profile** **Reprocessed specific humidity profile** **Reprocessed pressure profile** **Reprocessed surface pressure**	**RTPMET** **RHPMET** **RPPMET** **RSPMET**	**SESP_v3.6**

Type	Reprocessed Data Set
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as back-ground
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

GRM-29-L2-C-R1	Reprocessed tropopause height	RCHMET	SESP_v3.6
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_v3.6**
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 μrad*) 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 %		

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

GRM-30-L1-B-R1	**Reprocessed bending angle**	**RBACO1**	**SESP_v3.6**
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% 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: 7.5% 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	Temporal resolution
Global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution

GRM-30-L2-R-R1 **GRM-30-L2-D-R1**	**Reprocessed refractivity profile** **Reprocessed dry temperature profile**	**RRPCO1** **RDPCO1**	**SESP_v3.6**

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% 8 – 30 km: 0.06% 30 – 40 km: 0.25% 40 – 50 km: 0.4% 50 – 60 km: 1.5%	0 – 8 km: 1.8% 8 – 30 km: 0.5% 30 – 40 km: 1.2% 40 – 50 km: 4.0% 50 – 60 km: 10.0%
Dry temperature Profile	
0 – 8 km: 1.0K 8 – 30 km: 0.1K 30 – 40 km: 1.0K 40 – 50 km: 3.0K 50 – 60 km: 6.0K	0 – 8 km: 4.2K 8 – 30 km: 1.3K 30 – 40 km: 4.5K 40 – 50 km: 12K 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

GRM-30-L2-T-R1 **GRM-30-L2-H-R1** **GRM-30-L2-P-R1** **GRM-30-L2-S-R1**	**Reprocessed temperature profile** **Reprocessed specific humidity profile** **Reprocessed pressure profile** **Reprocessed surface pressure**	**RTPCO1** **RHPCO1** **RPPCO1** **RSPCO1**	**SESP_v3.6**

Type	Reprocessed Data Set
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as back-ground
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

GRM-30-L2-C-R1	Reprocessed tropopause height	RCHCO1	SESP_v3.6
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_v3.6**
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 μrad*) 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 %		

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

GRM-32-L1-B-R1	**Reprocessed bending angle**	**RBACHA**	**SESP_v3.6**
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% 8 – 30 km: 0.2% 30 – 40 km: 0.5% 40 – 50 km: 1.0% 50 – 60 km: 2.5%	0 – 8 km: 7.0% 8 – 30 km: 1.7% 30 – 40 km: 3.5% 40 – 50 km: 14% 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	Temporal resolution
Global	RO resolution	Hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution

GRM-32-L2-R-R1 **GRM-32-L2-D-R1**	**Reprocessed refractivity profile** **Reprocessed dry temperature profile**	**RRPCHA** **RDPCHA**	**SESP_v3.6**
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% 8 – 30 km: 0.14% 30 – 40 km: 0.5% 40 – 50 km: 1.0% 50 – 60 km: 1.5%	0 – 8 km: 1.8% 8 – 30 km: 0.55% 30 – 40 km: 1.5% 40 – 50 km: 5.0% 50 – 60 km: 12.0%
Dry temperature Profile	
0 – 8 km: 1.2K 8 – 30 km: 0.3K 30 – 40 km: 0.6K 40 – 50 km: 3.5K 50 – 60 km: 7.0K	0 – 8 km: 4.2K 8 – 30 km: 1.3K 30 – 40 km: 5.0K 40 – 50 km: 14K 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

GRM-32-L2-T-R1 **GRM-32-L2-H-R1** **GRM-32-L2-P-R1** **GRM-32-L2-S-R1**	**Reprocessed temperature profile** **Reprocessed specific humidity profile** **Reprocessed pressure profile** **Reprocessed surface pressure**	**RTPCHA** **RHPCHA** **RPPCHA** **RSPCHA**	**SESP_v3.6**

Type	Reprocessed Data Set
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as back-ground
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

GRM-32-L2-C-R1	Reprocessed tropopause height	RCHCHA	SESP_v3.6
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 **GRM-32-L3-R-R1** **GRM-32-L3-D-R1** **GRM-32-L3-Y-R1** **GRM-32-L3-Z-R1** **GRM-32-L3-T-R1** **GRM-32-L3-H-R1** **GRM-32-L3-C-R1**	**Reprocessed bending angle grid** **Reprocessed refractivity grid** **Reprocessed dry temperature grid** **Reprocessed dry pressure grid** **Reprocessed dry geopotential height grid** **Reprocessed temperature grid** **Reprocessed humidity grid** **Reprocessed tropopause height grid**	**RBGCHA** **RRGCHA** **RDGCHA** **RYGCHA** **RZGCHA** **RTGCHA** **RHGCHA** **RCGCHA**	**SESP_v3.6**

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 μrad*) 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 %		

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

GRM-33-L1-B-R1	Reprocessed bending angle	RBAGRA	SESP_v3.6
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

GRM-33-L2-R-R1 **GRM-33-L2-D-R1**	**Reprocessed refractivity profile** **Reprocessed dry temperature profile**	**RRPGRA** **RDPGRA**	**SESP_v3.6**
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% 8 – 30 km: 0.06% 30 – 40 km: 0.2% 40 – 50 km: 0.4% 50 – 60 km: 1.5%	0 – 8 km: 1.8% 8 – 30 km: 0.5% 30 – 40 km: 1.3% 40 – 50 km: 4.5% 50 – 60 km: 11.0%
Dry temperature Profile	
0 – 8 km: 1.0K 8 – 30 km: 0.12K 30 – 40 km: 1.0K 40 – 50 km: 3.0K 50 – 60 km: 6.0K	0 – 8 km: 4.2K 8 – 30 km: 1.25K 30 – 40 km: 4.5K 40 – 50 km: 13K 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

GRM-33-L2-T-R1 **GRM-33-L2-H-R1** **GRM-33-L2-P-R1** **GRM-33-L2-S-R1**	**Reprocessed temperature profile** **Reprocessed specific humidity profile** **Reprocessed pressure profile** **Reprocessed surface pressure**	**RTPGRA** **RHPGRA** **RPPGRA** **RSPGRA**	**SESP_v3.6**

Type	Reprocessed Data Set
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as back-ground
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

GRM-33-L2-C-R1	Reprocessed tropopause height	RCHGRA	SESP_v3.6
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_v3.6**
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 μrad*) 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 %		

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

GRM-40	**NRT Refractivity Profile**	**NRPMEB**	**SESP_v3.6**
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-B/GRAS		

Dissemination		
Format	Means	Type
BUFR, NetCDF	GTS, EUMETCast	NRT

Service Specification			
Accuracy			
Interval:	Bias	Standard deviation	
0–8 km:	1.0% (global)	4.0% (global)	
8–30 km:	0.2% (global)	0.8% (global)	
30–40 km:	0.4% (global)	2% (global)	
40–50 km:	1.5% (global)	6% (global)	
Notes	Current version of the data has limited usefulness below 8–10 km due to limitations in the input data		
Verification/Validation method	Vertical averages of absolute deviations from ECMWF short-term forecasts		

Coverage, resolution and timeliness				
Spatial coverage	Spatial resolution	Vertical coverage	Vertical resolution	Timeliness
global	GRAS resolution	10-50 km	500-1400 m	3 h

GRM-41	NRT Temperature Profile	NTPMEB	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		

Dissemination		
Format	Means	Timeliness
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h

Service Specification	
Accuracy	
30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data;
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)

Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	GRAS resolution	model levels (with inter-polation); interpolated to 247 fixed levels	

GRM-42	NRT Specific Humidity Profile	NHPMEB	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		

Dissemination		
Format	Means	Timeliness
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h

Service Specification	
Accuracy	
0.6 g/kg 10% *	
Notes	* whichever is greater; The interval 0 – 12 km is considered; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data;
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)

Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	GRAS resolution	model levels (with inter-polation); interpolated to 247 fixed levels	

GRM-43	NRT Pressure Profile	NPPMEB	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		

Dissemination		
Format	Means	Timeliness
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h

Service Specification	
Accuracy	
a) 0.01 hPa b) 0.25% c) 0.8 hPa *	
Notes	* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered; Current version of the product may have reduced information content below 8–10 km due to limitations in the input data and the service specification (c) is given as the threshold accuracy from the PRD (rather than the target accuracy);
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)

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

GRM-44	NRT Surface Pressure	NSPMEB	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods			
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		

Dissemination		
Format	Means	Timeliness
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h

Service Specification	
Accuracy	
0.8 hPa *	
Notes	Specification given as an interval due to variations in the analysis field; * Current version of the product may have reduced information content due to limitations in the input data and the service specification is given as the threshold accuracy from the PRD (rather than the target accuracy);
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)

Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	GRAS resolution		

GRM-45	Error Covariance Matrix for NRT Products	NEMMEB	SESP_v3.6
Type	Information Product		
Applications and Users	NWP		
Characteristics and Methods			
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data			

Dissemination		
Format	Means	Timeliness
netCDF	Web	N/A

Accuracy		
Threshold	Target	Optimal
N/A	N/A	N/A

Notes	
Verification/Validation Methods	NWP, other RO

Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	N/A		

GRM-53	**Offline bending angle grid**	**OBGMEB**	**SESP_v3.6**
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**	

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- 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 μrad*) 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

GRM-60	**NRT Refractivity Profile**	**NRPMEC**	**SESP_v3.6**
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

GRM-61	NRT Temperature Profile	NTPMEC	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-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 inter-polation); interpolated to 247 fixed levels	

GRM-62	NRT Specific Humidity Profile	NHPMEC	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-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	

GRM-63	NRT Pressure Profile	NPPMEC	SESP_v3.6
Type	NRT Product		
Applications and Users	NWP		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-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 specification (c) is given as the threshold accuracy from the PRD (rather than the target accuracy);
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)

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

GRM-64	**NRT Surface Pressure**	**NSPMEC**	**SESP_v3.6**
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		

GRM-65	Error Covariance Matrix for NRT Products	NEMMEC	SESP_v3.6
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_v3.6

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-117 **GRM-122**	**NTC Refractivity Profile** **NTC Dry Temperature Profile**	**ORPS6** **ODPS6**	**SESP_v3.6**

Type	NTC Level 2 Product
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	Statistical optimization, Abel transform, and hydrostatic integration
Operational Satellite Input Data	Sentinel-6 series (EUMETSAT Secretariat Level 1B Bending Angle Data)
Other Operational Input Data	ECMWF NWP operational fields

Dissemination		
Format	Means	Timeliness
netCDF BUFR	Web	60 d

Service Specification	
Bias	**Standard deviation**
Refractivity	
0 – 8 km: 0.6 % 8 – 30 km: 0.1 % 30 – 40 km: 0.3 % 40 – 50 km: 0.8 % 50 – 60 km: 2.0 %	0 – 8 km: 2.2 % 8 – 30 km: 0.7 % 30 – 40 km: 1.2 % 40 – 50 km: 3.0 % 50 – 60 km: 8.0 %
Dry temperature profile	
0 – 8 km: 1.4 K 8 – 30 km: 0.25 K 30 – 40 km: 1.0 K 40 – 50 km: 3.0 K 50 – 60 km: 5.0 K	0 – 8 km: 5.0 K 8 – 30 km: 1.3 K 30 – 40 km: 4.5 K 40 – 50 km: 10 K 50 – 60 km: 18 K

Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate
Verification/Validation Methods	Standard deviation of (Product – ECMWF forecasts)

Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
Global	RO resolution	hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution
Notes	1) The generation frequency is at least 770 occultations per day (as per Sentinel-6 EURD: R-U-00600). 2) The timeliness based on current operational datastreams is typically better than 3 weeks.		

GRM-118 **GRM-119** **GRM-120** **GRM-121**	**NTC Temperature Profile** **NTC Specific Humidity Profile** **NTC Pressure Profile** **NTC Surface Pressure**	**OTPS6** **OHPS6** **OPPS6** **OSPS6**	**SESP_v3.6**

Type	NTC Level 2 Product
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	NWP model levels
Operational Satellite Input Data	Sentinel-6 series (ROM SAF Level 2A product derived from EUMETSAT Secretariat Level 1B Bending Angle Data)
Other Operational Input Data	ECMWF NWP operational fields

Dissemination		
Format	Means	Timeliness
netCDF BUFR	Web	60 d

Service Specification			
Latitude bands			
	0-30 degrees **North / South**	**30-60 degrees** **North / South**	**60-90 degrees** **North / South**
Temperature			
Altitude STDV(S-A)	0-30 km 1.0 K	0-30 km 1.0 K	0-30 km 1.0 K
Altitude STDV(S-A)	30-50 km 1.0 – 2.0 K	30-50 km 1.0-2.0 K	30-50 km 1.0 – 2.0 K
Specific humidity			
Altitude STDV(S-A)	0 - 12 km 35 %	0 - 12 km 35 %	0 - 12 km 30 %
Pressure			
Altitude: 0 - 50 km STDV(S-A) less max of: - but not larger than:	0 - 50 km 0.01 hPa or 0.3% 1.2 hPa	0 - 50 km 0.01 hPa or 0.3% 0.7 hPa	0 - 50 km 0.01 hPa or 0.3% 0.9 hPa
Surface pressure			
TDV(S-A)	1.2 hPa	0.7 hPa	0.9 hPa

Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF (OPER) analysis)

Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
Global	RO resolution	NWP model levels	RO resolution
Notes	1) The generation frequency is at least 770 occultations per day (as per Sentinel-6 EURD: R-U-00600). 2) The timeliness based on current operational datastreams is typically better than 3 weeks.		

GRM-123 **GRM-124** **GRM-125** **GRM-126** **GRM-127** **GRM-128** **GRM-129** **GRM-195**	**NTC Bending Angle Grid** **NTC Refractivity Grid** **NTC Temperature Grid** **NTC Specific Humidity Grid** **NTC Dry Geopotential Height Grid** **NTC Dry Temperature Grid** **NTC Dry Pressure Grid** **NTC Tropopause Height Grid**	**OBGS6** **ORGS6** **OTGS6** **OHGS6** **OZGS6** **ODGS6** **OYGS6** **OCGS6**	**SESP_v3.6**

Type	NTC Level 3 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	Sentinel-6 series (EUMETSAT Secretariat Level 1B Bending Angle Data and ROM SAF Level 2 products)
Other Operational Input Data	ECMWF NWP operational and reanalyses fields

Dissemination		
Format	Means	Timeliness
netCDF	Web	60 d

Service Specification
Bending angle
25 – 50 km: 0.3 % or 0.6 μrad(*) 8 – 25 km: 0.3 % 0 – 8 km: 3.0 – 0.3 %
Refractivity
25 – 50 km: 0.12 % or 0.006 N-units(*) 8 – 25 km: 0.12 % 0 – 8 km: 1.2 – 0.12 %
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			
200.0 m			
Notes	(*) whichever is greater; An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate		
Verification/Validation Methods	Statistics of differences relative to ECMWF operational data within 9 broad latitude-height regions (low, middle, and high latitudes; low, middle, and high altitudes). Compliance requires that 60% of the absolute differences are smaller than the corresponding accuracy value.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
Global	5 deg latitude	200 m	1 month
Notes	1) The generation frequency is at least 770 occultations per day (as per Sentinel-6 EURD: R-U-00600). 2) The timeliness based on current operational datastreams is typically better than 4 weeks.		

GRM-29-I1	**Metop Interim Climate Data Record (Data Levels L1B, L2, L3)**	**ICDRMET**	**SESP_v3.6**
GRM-29-L1-B-I1 **GRM-29-L2-R-I1** **GRM-29-L2-D-I1** **GRM-29-L2-T-I1** **GRM-29-L2-H-I1** **GRM-29-L2-P-I1** **GRM-29-L2-S-I1** **GRM-29-L2-C-I1** **GRM-29-L3-B-I1** **GRM-29-L3-R-I1** **GRM-29-L3-D-I1** **GRM-29-L3-Y-I1** **GRM-29-L3-Z-I1** **GRM-29-L3-T-I1** **GRM-29-L3-H-I1** **GRM-29-L3-C-I1**	**ICDR Bending Angle** **ICDR Refractivity Profile** **ICDR Dry Temperature Profile** **ICDR Temperature Profile** **ICDR Specific Humidity Profile** **ICDR Pressure Profile** **ICDR Surface Pressure** **ICDR Tropopause Height** **ICDR Bending Angle Grid** **ICDR Refractivity Grid** **ICDR Dry Temperature Grid** **ICDR Dry Pressure Grid** **ICDR Dry Geopotential Height Grid** **ICDR Temperature Grid** **ICDR Specific Humidity Grid** **ICDR Tropopause Height Grid**	**IBAMET** **IRPMET** **IDPMET** **ITPMET** **IHPMET** **IPPMET** **ISPMET** **ICHMET** **IBGMET** **IRGMET** **IDGMET** **IYGMET** **IZGMET** **ITGMET** **IHGMET** **ICGMET**	

Type	Interim Climate Data Record
Applications and Users	Climate and atmosphere researchers
Characteristics and Methods	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; 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;
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