

The EUMETSAT
Network of
Satellite
Application
Facilities



ROM SAF

Radio Occultation Meteorology

ROM SAF CDOP-2

Product Requirements Document

Version 2.3

30 November 2015

Danish Meteorological Institute (DMI)
European Centre for Medium-Range Weather Forecasts (ECMWF)
Institut d'Estudis Espacials de Catalunya (IEEC)
Met Office (METO)

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DOCUMENT CHANGE RECORD

<i>Issue / Revision</i>	<i>Date</i>	<i>By</i>	<i>Description</i>
0.1	6/8/08	DO	First draft based on Lothar Schueller's template and CM-SAF PRD, for discussion within GRAS SAF Team
0.2	5/11/08	DO	Incorporated comments from DMI after discussion at CDOP-PT4
0.3	19/12/08	DO	Incorporated more comments from KBL
1.0	18/6/09	DO	Incorporated suggestions from Lothar Schueller. Typo in PRD-7-07 and pressure accuracy values corrected. Version submitted to SG for comment; including updates as agreed at CDOP SG5 on 18 June 2009 (KBL)
1.1	13/1/2012	KBL	Cf. CDOP SG7 Decision 3 & SG8 Decision 5: Included Rec. 6 from PCR2: GRM-20 0-20 km; Included Rec. 7 from PCR2: PRD-4-01 and PRD-4-02 are updated, PRD-7-08 added; This version 1.1: used as reference for ORR2. Approved as SG9-Dec-07 (wp Jan 2012);
2.0	22/03/2013	KBL	First CDOP-2 version, based on the PRT table (Annex 1 from the CDOP-2 Proposal). GRAS SAF changed to ROM SAF, new chapters 2.10 & 2.11, new req. PRD-07-09, updates to req. PRD-03-01, 03-03, and 04-01, inclusion of CDOP-2 products in the product specification tables (Annex A); This version when approved will close SG actions SG9-A3, SG9-A4; for details see section 1.6; Sent to SG for approval; Approved as SG12-Dec-04 (wp April 2013)

2.1	8/5 2014	KBL	Version submitted for the ORR4 & ORR-B-backlog review; List of updates: i) Definitions updated in sec. 1.4 (OR6 action 12); ii) Format of accuracy figures in several GRM-nn tables adjusted; Detailed list of all changes related to actions and recommendations is included in section 1.7;
2.2	14/5 2014	KBL	Version submitted to RR4 review (after redefining scope of ORR4 & ORR-B-backlog and introducing a separate RR4 requirements review) and taking into account comments from P. Poli on May 14: (i) Clarified in PRD-02-03 and PRD-03-04 that the figures are for "1 day"; (ii) introduced the surface value requirement in GRM-04, 12, 43, 50. Approved as SG14-Dec-08 (wp May 2014)
2.3	30/11 2015	KBL	Version updated according to CDOP-2 SG15 and SG16 actions. Detailed list of all changes is included in section 1.8; Approved as SG17-Dec-04 (wp Dec 2015)

ROM SAF

The Radio Occultation Meteorology Satellite Application Facility (ROM SAF) is a decentralised processing center under EUMETSAT which is responsible for operational processing of GRAS radio occultation data from the Metop satellites and radio occultation (RO) data from other missions. The ROM SAF delivers bending angle, refractivity, temperature, pressure, and humidity profiles in near-real time and offline for NWP and climate users. The offline profiles are further processed into climate products consisting of gridded monthly zonal means of bending angle, refractivity, temperature, humidity, and geopotential heights together with error and uncertainty estimates.

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

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

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Executive Summary

This document presents the product requirements of the EUMETSAT Satellite Application Facility (SAF) on Radio Occultation Meteorology (ROM), hereinafter referred to as the ROM SAF.

The requirements expressed in this document represent the commitment of the ROM SAF Team for the development under the overall EPS end-user requirements within the Second Continuous Development and Operations Phase (CDOP-2) based on the cooperation agreement between the Leading Entity (DMI) and EUMETSAT. This document is under the authority of the Steering Group, which approves changes and modifications. Any changes substantially changing the product list or other major commitments would need the approval by EUMETSAT Delegate Bodies.

The Product Requirements Document (PRD) is the main reference document for all development related reviews (Operational Readiness Reviews, Product Consolidation Reviews and Delivery Readiness Inspections) and provides the end users of the ROM SAF with a vision of what can be expected at the end of the current ROM SAF phase.

1. Introduction

1.1 Purpose of the Document

This document presents the product requirements of the EUMETSAT Radio Occultation Meteorology (ROM) Satellite Application Facility (SAF), hereinafter referred to as the ROM SAF. The products requirements have been derived from appropriate user-based requirements as specified in the User requirements Document [RD.1].

The requirements expressed in this document represent the commitment of the ROM SAF Team for the development under the overall EPS end-user requirements [AD.1] and within the Second Continuous Development and Operations Phase (CDOP-2) [AD.2] based on the Cooperation Agreement between the Leading Entity (DMI) and EUMETSAT [AD.3]. This document is under the authority of the Steering Group, which approves changes and modifications. Any changes substantially changing the product list or other major commitments would need the approval by EUMETSAT Delegate Bodies.

The Product Requirements Document (PRD) is the main reference document for all development related reviews (Operational Readiness Reviews, Product Consolidation Reviews and Delivery Readiness Inspections) and provides the end users of the ROM SAF with a vision of what can be expected at the end of the current ROM SAF phase.

The requirements stated in this document apply to the nominal mode of operations of the ROM SAF and/or central EUMETSAT ground segment. The nominal mode is characterised by the following:

- Both the EPS/Metop satellite(s) and the ground segment are successfully commissioned and are in an operational status;
- The satellite is outside the outage periods related to manoeuvre and decontamination within its operational tolerances;
- The GRAS instrument is correctly functioning to requirements and is in its nominal operational mode;
- No satellite and ground segment anomaly impacts on the on-ground processing;
- The intra- and inter-SAF data flow and data production operate at the planned capacity and efficiency;

1.2 Applicable and Reference Documents

1.2.1 Applicable Documents

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

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

1.2.2 Reference Documents

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

- [RD.1] User Requirement Document
Ref: SAF/GRAS/METOFFICE/RQ/URD/001

1.3 Acronyms and Abbreviations

BUFR	Binary Universal Format for the Representation of data (also FM94) (WMO)
CDR	Climate Data Record
CGS	Core Ground Segment (EUMETSAT)
DMI	Danish Meteorological Institute; ROM SAF Leading Entity
ECMWF	The European Centre for Medium-range Weather Forecasts; ROM SAF partner
EPS	EUMETSAT Polar satellite System (EUMETSAT)
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
FM94	Form Number 94. See BUFR
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistema (GLObal Navigation Satellite System, Russia)
GNSS	Global Navigation Satellite Systems (generic name for GPS + GLONASS)
GPAC	GNSS Processing and Archiving Center (ROM SAF)
GPS	Global Positioning System (USA)
GPS/MET	Global Positioning System / Meteorology Experiment on Microlab-1 (US)
GRAS	GNSS Receiver for Atmospheric Sounding (EPS/Metop)
GRIB	Gridded Binary format
GTS	Global Telecommunication System
IEEC	Institut d'Estudis Espacials de Catalunya; ROM SAF partner
LEO	Low Earth Orbit
Met Office	United Kingdom Meteorological Office; ROM SAF Partner
METOP	METeorological Operational Polar satellite (EUMETSAT)
NetCDF	Network Common Data Form
NRT	Near-Real Time
NWP	Numerical Weather Prediction
POD	Precise Orbit Determination
RO	Radio Occultation
ROM SAF	Radio Occultation Meteorology SAF (EUMETSAT), former GRAS SAF
RMDCN	Regional Meteorological Data Communications Network
SAF	Satellite Application Facility (EUMETSAT)
TBC	To Be Confirmed
TBD	To Be Determined or To Be Decided
VAR	VARiational analysis; 1D, 2D, 3D or 4D variants (NWP assimilation technique)
WMO	World Meteorological Organisation

1.4 Definitions

RO data products from the GRAS instrument onboard Metop and RO data from other data providers are grouped in levels and are either NRT or Offline products or Climate Data Records (CDRs). The levels and types are defined below. The lists of variables should not be considered as the complete contents of a given data level, and not all data may be contained in a given data level.

Data levels:

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

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

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

Level 2: Refractivity, geopotential height, "dry" temperature profiles (level 2a), pressure, temperature, specific humidity profiles (level 2b), surface pressure, tropopause height, planetary boundary layer height (level 2c), ECMWF model level coefficients (level 2d); quality information;

Level 3: Gridded level 1 and 2 offline profile products in the form of, e.g., monthly and seasonal zonal means, metadata, and quality information;

Product types:

NRT product: Data product delivered less than 3 hours after measurement;

Offline product: Data product delivered less than 30 days after measurement (the timeliness for some offline level 3 products may be up to 6 months);

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

1.5 Identification of Requirements

The requirements in this document are uniquely identified as follows:

PRD-mm-nn

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

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

1.6 Changes in version 2.0

This section contains a description of the actions and recommendations which have been incorporated in version 2.0 of the PRD.

1. Action CDOP-1 SG9-A3:

ORR2 Recommendation 1 on PRD update: Team to update the PRD according to points i, ii, iii, vi, vii.

Suggestion presented for SG11:

- i. We propose to make the Level 3 data products instrument-specific, i.e. to separate into COSMIC-only and Metop-only data products. They would have different GRM numbers, and as a consequence, different requirements. Initially the requirements will have the same numerical values. However, following studies in CDOP-2 we would be able to further constrain them.
- ii. We plan to assess the requirements, particularly the altitude dependence, prior to the first CDOP-2 reprocessing cycle planned for 2014. Until then, the requirements will remain unaltered.
- iii. The requirements for the humidity climate products will be restricted to below 15 kilometers (to be in line with the data product altitude coverage).
- vi. A requirement to generate time series for the web site will be added.
- vii. The ASCII format requirement will be removed.

Decision SG11-Dec-15:

The SG approved the suggestion in action SG9-A3 related to PRD updates for level 3 products. The update should take into account the related discussions at the SG11 meeting.

2. Action CDOP-1 SG9-A4:

ORR2 Recommendation 1 on PRD update: Team to assess points iv and v and suggest what can be done.

Suggestion presented for SG11:

- iv. We suggest changing the timeliness requirement from 30 days to 3-6 months. In the case of COSMIC data, this would allow us to use reprocessed data most of the time (estimated delay of the UCAR processing up to excess-phase data is around 6 weeks, although this cannot be considered a strict requirement).
- v. We suggest continuing using ECMWF as a priori data from the up to the first CDOP-2 reprocessing cycle planned for 2014. For that reprocessing we will consider to use ERA-Interim instead of ECMWF.

Decision SG11-Dec-16:

The SG approved the suggestion in action SG9-A4 related to PRD updates for level 3 products based on COSMIC offline data and ECMWF a priori fields.

3. Regarding ORR2 Recommendation 1 on PRD update: point ii (see 1 above), we have in the current version suggested an update of the bending angle requirement, and related to this made an adjustment of some of the refractivity requirements in order to have consistent bending angle and refractivity requirements (see GRM-17, 18 and 53, 54, 93, 94).

1.7 Changes in version 2.1

This section contains a description of the actions and recommendations which have been incorporated in version 2.1 of the PRD.

1. PRD-02-03 updated to be in line with SeSp version 2.3 (this closes OR5 actions 7 and 25; Ref: EUM/PPS/MIN/13/694051).

2. PRD-03-04 updated to be consistent with the updated formulation in PRD-02-03.
3. A wrong data level number in PRD-01-02, PRD-03-02, PRD-03-04, PRD-11-01 have been corrected (the offline processing is done from level 1a whereas NRT processing is done from level 1b).
4. Accuracy values for 1D-Var products (GRM-02,03,04,05; 10,11,12,13; 41,42,43,44; 48,49,50,51) have been re-assessed based on wave optics data and new values are suggested (Ref: SAF/ROM/DMI/MGT/DOC/010). This closes SG action SG5-A1 (Ref: SAF/GRAS/DMI/MGT/MIN/CSG5/001) and ORR-B Closeout Minutes, Recommendation 2 (Ref: EUM/PPS/MIN/11/0043). Verification method is based on comparing to analysis fields.
5. Added the product requirements for GRM-22,23, GRM-58,59, GRM-98,99 as recommended at the PCR5 Review for these products (Ref: EUM/PPS/MIN/13/700261) and endorsed at SG12 the decision SG12-Dec-06 (Ref: SAF/ROM/DMI/MGT/SG12/002).
6. ORR2 Closeout action 1 (point 11 [by P.P.] in Annex 2 of the Minutes from the ORR2 Closeout) closed by adding to the GRM-nn requirements tables the following note: "An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate".
7. In Annex A: removed the GRM-nn numbers and tables for the non-committed products: GRM-31, 34, 35, 36, 37, 38, 39 (which had been included as placeholders for possible future data sets).

1.8 Changes in version 2.3

This section contains a description of the actions and recommendations which have been incorporated in version 2.3 of the PRD.

1. Section 1.4: Minor update to text in the definition of Level 1a and added definition of CDR
2. TBD requirements on third party missions removed (SG15-Dec-14)
3. TBD requirements on EPS-SG removed (not applicable for CDOP-2 but addressed in the CDOP-3 proposal)
4. PRD-01-01 and PRD-01-02: GRM-07, 15, 45, 52 removed. These are Error-Covariance Matrices and are removed as formal products by CDOP-1 SG8-Dec-11 and transferred to requirement PRD-08-02 on ROPP
5. PRD-01-02: Minor change to text to clarify that data and datasets for offline and reprocessed data includes level 1b, 2, and 3
6. PRD-05-01 and PRD-06-01: ROSA removed from list of other measurements (SG15-Dec-14)
7. PRD-08-01: Release of ROPP-10 (GRM-16_v10) removed (SG15-Dec-15)
8. PRD-08-02: References to formal product ids GRM-07, 15, 45, 52 (Error-Covariance Matrices) removed (CDOP-1 SG8-Dec-11)
9. PRD-11-01: GRM ids updated as agreed at the RR-RE1 review (SG15-Dec-18)
10. PRD-11-02: Text updated to clarify the climate data records covers level 1b, 2, and 3
11. PRD-11-09: Text updated to clarify offline means climate data records

12. PRD-11-12: New requirement as agreed at RR-RE1 review (SG15-Dec-19)
13. PRD-11-13: New requirement as agreed at RR-RE1 review (SG15-Dec-19)
14. Annex A: Updated product tables for GRM-08, 09, 17 – 23, 24, 28-R1 – 32-R1, 46,47, 53-59, 93-93 as agreed at RR-RE1 review (SG15-Dec-19)
15. SG15-Act-09: Implemented through above points 12, 13, and 14 (SG15-Dec-19)
16. SG16-Act-04: Implemented through updated product ids GRM-28-R1 – 32-R1 (SG16-Dec-09)
17. SG15-Act-01: GRM-07, 15, 45, 51 deleted noting these requirements have previously been reclassified as PRD requirements PRD-08-02 on ROPP (CDOP-1 SG8-Dec-11)
18. SG15-Act-05: Implemented through deleting GRM-16_v10 (ROPP-10) (SG15-Dec-15), GRM-26 (PBLH) (SG15-Dec-16) and GRM-27 (RO Reanalysis) (SG15-Dec-17)
19. SG15-Act-08: Section 2.10 updated to reflect that the RO reanalysis product GRM-27 is deleted but that a similar product is planned to be produced with the ERA-5 system at ECMWF (SG15-Dec-17)

2. Requirements

2.1 General

- PRD-01-01 The ROM SAF shall have an operational capability during CDOP-2 to process CGS Level 1b data in near-real time from the GRAS instrument on Metop to Level 2 products according to specifications in Annex A, Tables GRM-01 to 05, 40 to 44.
- PRD-01-02 The ROM SAF shall have an off-line capability during CDOP-2 to process CGS Level 1a data from the GRAS instrument on Metop and other RO instruments to Level 1b and Level 2 products according to specifications in Annex A, Tables GRM-08 to 13, 46 to 51. This capability shall be used to regularly generate off-line products and at certain key points, to re-process the complete Level 1b, 2, and 3 dataset up to that point to a common best-practice standard.
- PRD-01-03 The ROM SAF shall have a capability during CDOP-2 to generate products for climate applications, according to the product specifications in Annex A, Tables GRM-17 to 23, 53 to 59, 93 to 99.
- PRD-01-04 The ROM SAF shall develop and maintain during CDOP-2 a software package to support user-assimilation of RO data in NWP models, according to specifications in Annex A, Table GRM-16, 16_v7, 16_v8, 16_v9.
- PRD-01-05 ROM SAF near-real time, offline and climate products shall conform to appropriate standards for file formatting.
- PRD-01-06 ROM SAF Level 2 products shall be made available to users within the timeliness requirements specified in the EURD [AD.1] and via appropriate dissemination methods.
- PRD-01-07 All ROM SAF deliverables (products, datasets and software) shall be available to users according to EUMETSAT data policy.
- PRD-01-08 An on-line catalogue of ROM SAF products shall be maintained as part of the EUMETSAT Data Centre to enable off-line bulk data ordering.
- PRD-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-01-10 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-01-11 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-01-12 Archived products shall be available to users in the same file formats as used for the original data.

2.2 Near-Real Time Sounding Products

- PRD-02-01 NRT Sounding products shall contain all required Level 2 parameters with appropriate annotation including date/time and geodetic location, error estimates

and quality control flagging. Level 2 NRT product parameter specifications are as presented in Annex A, Tables GRM-01 to 05, 40 to 44.

- PRD-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-02-03 Of those Level 1b NRT products with correct instrument operation and available to the ROM SAF within 2h15m, more than 500 shall daily be processed to Level 2 and disseminated to users within 3 hours of observation time. This availability rate shall be calculated over a 1 month period.
- PRD-02-04 NRT sounding products shall be disseminated via GTS, RMDCN and EUMETCast.
- PRD-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-02-06 Any NRT product delayed by more than 24 hours from observation time shall not be disseminated as an NRT product, but shall be available for off-line access.
- PRD-02-07 The near real-time sounding products shall be archived within the ROM SAF leading entity.

2.3 Offline Sounding Products

- PRD-03-01 Off-line products shall be generated to take advantage of ROM 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 off-line product parameter specifications are as presented in Annex A, Tables GRM-08 to 13, 24, 46 to 51.
- PRD-03-02 The ROM SAF shall have the capability to process data from instruments other than GRAS to generate off-line Level 1b and Level 2 products to the same specification (within the limits of the available data) as the GRAS products.
- PRD-03-03 Off-line 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-03-04 More than 520 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-03-05 Off-line products shall be made available to users via appropriate links, channels or media using standard file formats such as netCDF and BUFR.
- PRD-03-06 The off-line sounding products shall be archived within the ROM SAF leading entity.

2.4 Climate Products

- PRD-04-01 Climate products shall be generated from best-quality off-line products from GRAS and other RO receivers that are readily available and have high enough quality. Climate product parameter specifications are as presented in Annex A, Tables GRM-17 to 23, 53 to 59, 93 to 99.
- PRD-04-02 Climate products shall contain gridded monthly means together with estimates of corresponding errors and contain meta-data providing traceability to the individual occultations and software versions.
- PRD-04-03 Climate products shall be made available to users via appropriate links, channels or media using standard file formats such as netCDF.
- PRD-04-04 The climate products shall be archived within the ROM SAF leading entity.

2.5 Near-Real Time Validation

- PRD-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 measurements (e.g. COSMIC, CHAMP, GRACE, TerraSAR-X, TanDEM-X)
- PRD-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-05-03 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-05-04 The validation domain shall be global and over the full vertical domain of the NRT products.
- PRD-05-05 During CDOP-2, validation statistics shall be generated with a time resolution of 1 day and 1 month, including Metop commissioning periods.
- PRD-05-06 GRAS NRT product validation information shall be made publicly available via the project's website.
- PRD-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.
- PRD-05-08 The NRT product validation information shall be archived within the ROM SAF leading entity.

2.6 Offline Validation

- PRD-06-01 The ROM SAF shall generate, and make publicly available, validation information supporting available RO offline sounding products using information obtained from NWP fields and other measurements (COSMIC, CHAMP, GRACE, TerraSAR-X)
- PRD-06-02 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC off-line product processing.

- PRD-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-06-04 The validation domain shall be global and over the full vertical domain of the off-line products.
- PRD-06-05 During CDOP-2, validation statistics shall be generated with a time resolution of 1 calendar month, excluding Metop commissioning periods.
- PRD-06-06 Off-line product validation information shall be made available via the project's website.
- PRD-06-07 The off-line product validation information shall be archived within the ROM SAF leading entity.

2.7 Climate Validation

- PRD-07-01 The ROM SAF shall generate, and make publicly available, validation information supporting climate products.
- PRD-07-02 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC climate product processing.
- PRD-07-03 Validation shall include statistics on the quality of key parameters and the quantity of products.
- PRD-07-04 The validation domain shall be global and over the full vertical domain of the climate products.
- PRD-07-05 Validation statistics shall be generated with a time resolution of 1 calendar month and based on full length of data sets.
- PRD-07-06 Climate product validation information shall be made available via the project's website.
- PRD-07-07 The climate product validation information shall be archived within the ROM SAF leading entity.
- PRD-07-08 The ROM SAF shall generate metrics to monitor the stability of climate data in time.
- PRD-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.

2.8 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).

- PRD-08-01 The ROM SAF shall make available the ROPP software deliverable according to the specifications in Annex A, Table GRM-16, 16_v7, 16_v8, 16_v9. This package

shall include key user documentation describing the software deliverable, and shall include: Release notes, User Guide and Reference Manual(s).

- PRD-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.
- PRD-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-08-04 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-08-05 During CDOP-2, the software deliverable shall continue to be developed and maintained by the ROM SAF. Maintenance activity shall include fixes to programming errors, improvements to code efficiency, and developments supporting improved scientific processing in response to evolving Product Requirements. Updates resulting from development & maintenance shall be released to users according to CDOP-2 plans.

2.9 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.

- PRD-09-01 During CDOP-2, the ROM SAF shall establish and maintain a project website as a service to users. This user service shall include (but not be limited to) news and announcements about, and information and documentation on, ROM SAF products, validation, software and data sets; technical and scientific reports; announcements of seminars, workshops, and visiting scientist opportunities; information on how to contact the SAF; and shall allow a user to search the product catalogue for quick-view and to order products and data sets.
- PRD-09-02 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-09-03 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-09-04 Access to ROM SAF products (data, software) shall require the user to first register their details.
- PRD-09-05 User Services shall include a User Notification service as an option for registered users to be notified by email of changes to operational or off-line products, software or data sets or on their availability via the website, GTS/RMDCN or EUMETCast as appropriate to the user.

- PRD-09-06 Access to ROM SAF software deliverables shall require the user to agree to a User Licence.
- PRD-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-09-08 The ROM SAF shall organise and hold a 'ROM SAF User and Training Workshop'.
- PRD-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.

2.10 Re-Analysis Product

- PRD-10-01 With the ERA-5 system, ECMWF plan to generate a GNSS-RO global reanalysis product 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-10-02 The processing will 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 will be archived.
- PRD-10-03 The quality of the product will be monitored using the departure statistics with respect to both active and passive observations, and by comparison with other global reanalyses.
- PRD-10-04 Three dimensional and zonally averaged Monthly Mean Climatologies (MMCs) of various variables, including temperature, humidity and geopotential height, will be derived from the daily reanalyses. Time-series of climate indicators will be computed, stored and made available to users.
- PRD-10-05 The product and derived climate products will be archived at ECMWF.
- PRD-10-06 The product and derived climate products will be made available to users in standard formats, such as GRIB fields, via appropriate links such as at the ROM SAF web site.

2.11 Reprocessed Data Sets

- PRD-11-01 Reprocessed data set products 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 to 32-R1.
- PRD-11-02 The ROM SAF shall have the capability to reprocess data from RO instruments other than 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 GRAS products.
- PRD-11-03 Reprocessed products shall contain identical parameters to the original products,

although domain, sampling, accuracy and numbers of occultations may be improved.

- PRD-11-04 Reprocessed products shall be made available to users via appropriate links, channels or media using standard file formats such as netCDF and BUFR.
- PRD-11-05 Reprocessed products shall be archived within the ROM SAF leading entity.
- PRD-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-11-07 The ROM SAF shall generate (for use only by team members and EUMETSAT) validation and monitoring information on the GPAC reprocessing.
- PRD-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-11-09 The validation domain shall be global and over the full vertical domain of the reprocessed climate data records.
- PRD-11-10 Reprocessed product validation information shall be made available via the project's website.
- PRD-11-11 Reprocessed product validation information shall be archived within the ROM SAF leading entity.
- PRD-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-11-13 The ROM SAF shall generate reprocessed time series for the whole length of the data set and make it available at the web site.

3. List of TBD's and TBC's

None

ANNEX A. Product Specifications

The following tables summarize the specifications for each ROM SAF deliverable product:

Definitions:

Threshold Accuracy	The minimum accuracy limit which is needed, so that the product is considered being useful for some user groups
Target Accuracy	The product accuracy that is targeted in the development and the reference in product quality before the (pre-)operational product generation and dissemination.
Optimal Accuracy	The accuracy that can be reached under optimal conditions.

The interpretation of accuracy for a given product is described under the verification and validation method in the following tables.

Product Groups:

ROM SAF products are divided into the following groups:

- Level 1b Bending Angle (GRM-08, 46)
- Level 2a Refractivity (GRM-01, 09, 40, 47)
- Level 2b, 2c Temperature, Pressure, and Humidity (GRM-02 – 05, 10 – 13, 41 – 44, 48 – 51)
- Level 3 Climate Data (GRM-17 – 23, 53 – 59, 93 – 99)
- Reprocessed Data Sets (Climate Data Records) (GRM-28-R1 to 32-R1)
- Tropopause Height (GRM-24)
- ROPP Software (GRM-16, 16_v7, 16_v8, 16_v9)

Overview list of reprocessed datasets

<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
GRM-28-R1	Reprocessed Multi-Mission dataset reference id (Metop, COSMIC, CHAMP, GRACE L3 dataset)	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

<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
GRM-29-R1	Reprocessed Metop dataset reference id (Metop-A/B L1, L2, L3 dataset)	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 dataset reference id (COSMIC L1, L2, L3 dataset)	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
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 dataset reference id (CHAMP L1, L2, L3 dataset)	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

<i>Product ID</i>	<i>Product Name</i>	<i>Product Acronym</i>
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-01		NRT Refractivity Profile		NRPMEA	PRD_v2.3	
Type		NRT Product				
Applications and Users		NWP				
Characteristics and Methods		hi-res wave optics sampling; interpolated to 247 fixed levels				
Operational Satellite Input Data		Metop-A/GRAS				
Other Operational Input Data		GPS orbits (EUM) Metop orbits (EUM)				
Dissemination						
Format		Means		Timeliness		
BUFR BUFR/netCDF		GTS EUMETCast Web		3 h		
Accuracy						
Threshold		Target		Optimal		
30 – 50 km: 0.09 N-units 5 – 30 km: 1.8% 0 – 5 km: 6% – 1.8%		30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%		30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%		
Notes		An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate				
Verification/Validation Methods		NWP, other RO				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal
global		GRAS resolution		hi-res wave optics sampling; interpolated to 247 fixed levels		

GRM-02	NRT Temperature Profile		NTPMEA	PRD_v2.3
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Accuracy				
Threshold	Target	Optimal		
30 – 50 km: 3 K – 30 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K	30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	30 – 50 km: 0.5 K – 5 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 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 (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-03	NRT Specific Humidity Profile		NHPMEA	PRD_v2.3
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Accuracy				
Threshold	Target	Optimal		
1.8 g/kg 30% *	0.6 g/kg 10% *	0.3 g/kg 10% *		
Notes	* whichever is greater; The interval 0 – 12 km is considered			
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-04	NRT Pressure Profile		NPPMEA	PRD_v2.3
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Accuracy				
Threshold	Target	Optimal		
a) 0.03 hPa b) 0.75% c) 2.4 hPa *	a) 0.01 hPa b) 0.25% c) 0.8 hPa *	a) 0.005 hPa b) 0.1% c) 0.7 hPa *		
Notes	* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered			
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-05	NRT Surface Pressure		NSPMEA	PRD_v2.3
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods				
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
BUFR BUFR/netCDF	GTS EUMETCast Web	3 h		
Accuracy				
Threshold	Target	Optimal		
2.4 hPa	0.8 hPa	0.7 hPa		
Notes				
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution			

GRM-08	Offline Bending Angle		OBAMEA	PRD_v2.3
Type	Off-line Product			
Applications and Users	Climate and atmosphere researchers			
Characteristics and Methods	hi-res wave optics retrieval			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
netCDF BUFR	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
35 – 60 km: 4 μ rad 8 – 35 km: 4% 2 – 8 km: 20% - 4%	35 – 60 km: 2 μ rad 8 – 35 km: 2% 2 – 8 km: 10% - 2%	35 – 60 km: 1 μ rad 8 – 35 km: 1% 2 – 8 km: 5% - 1%		
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate BA noise above 60 km is expected to be between 0.5 and 1.5 μ rad;			
Verification/Validation Methods	Standard deviation of (Product – ECMWF forecasts)			
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-09		Offline Refractivity Profile		ORPMEA	PRD_v2.3	
Type		Off-line Product				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		hi-res wave optics retrieval				
Operational Satellite Input Data		Metop-A/GRAS				
Other Operational Input Data		ECMWF FC, AN				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		30 d		
Accuracy						
Threshold		Target		Optimal		
30 – 50 km: 0.06 N-units 5 – 30 km: 1.2% 0 – 5 km: 4% – 1.2%		30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%		30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%		
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		Spatial Resolution		Vertical Resolution		Temporal resolution
global		RO resolution		hi-res wave optics sampling; interpolated to 247 fixed levels		RO resolution

GRM-10		OFL Temperature Profile		OTPMEA	PRD_v2.3	
Type		Off-line Product				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		model levels (with interpolation); interpolated to 247 fixed levels				
Operational Satellite Input Data		Metop-A/GRAS				
Other Operational Input Data		GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		30 d		
Accuracy						
Threshold		Target		Optimal		
30 – 50 km: 3 K – 30 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K		30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K		30 – 50 km: 0.5 K – 5 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 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 (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-11	OFL Specific Humidity Profile	OHPMEA	PRD_v2.3
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels		
Operational Satellite Input Data	Metop-A/GRAS		
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
1.8 g/kg 30% *	0.6 g/kg 10% *	0.3 g/kg 10% *	
Notes	* whichever is greater; The interval 0 – 12 km is considered		
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-12	OFL Pressure Profile		OPPMEA	PRD_v2.3
Type	Off-line Product			
Applications and Users	Climate and atmosphere researchers			
Characteristics and Methods	model levels (with interpolation); interpolated to 247 fixed levels			
Operational Satellite Input Data	Metop-A/GRAS			
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
netCDF BUFR	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
a) 0.03 hPa b) 0.75% c) 2.4 hPa *	a) 0.01 hPa b) 0.25% c) 0.8 hPa *	a) 0.005 hPa b) 0.1% c) 0.7 hPa *		
Notes	* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered			
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-13	OFL Surface Pressure	OSPMEA	PRD_v2.3
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods			
Operational Satellite Input Data	Metop-A/GRAS		
Other Operational Input Data	GPS orbits (EUM) Metop orbits (EUM) ECMWF FC, AN		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
2.4 hPa	0.8 hPa	0.7 hPa	
Notes			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	GRAS resolution		

GRM-16		Radio Occultation Processing Package		ROPP	PRD_v2.3	
Type		Software Product				
Applications and Users		NWP, RO data suppliers, scientific users				
Characteristics and Methods						
Operational Satellite Input Data		Metop-A/GRAS COSMIC CHAMP GPS/MET GRACE TerraSAR-X TanDEM-X Oceansat-2/ROSA Megha-Tropiques PAZ				
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		Spatial Resolution		Vertical Resolution		Temporal
N/A		N/A				

Ref: SAF/ROM/DMI/MGT/PRD/001 Issue: 2.3 Date: 30 November 2015	ROM SAF CDOP-2 Product Requirements Document	
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GRM-16_v7	Radio Occultation Processing Package	ROPP_v7	PRD_v2.3
Type	Software Product		
Applications and Users	NWP, RO data suppliers, scientific users		
Characteristics and Methods			
Operational Satellite Input Data	See GRM-16		
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	Spatial Resolution	Vertical Resolution	Temporal
N/A	N/A		

Ref: SAF/ROM/DMI/MGT/PRD/001 Issue: 2.3 Date: 30 November 2015	ROM SAF CDOP-2 Product Requirements Document	
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GRM-16_v8	Radio Occultation Processing Package		ROPP_v8	PRD_v2.3
Type	Software Product			
Applications and Users	NWP, RO data suppliers, scientific users			
Characteristics and Methods				
Operational Satellite Input Data	See GRM-16			
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	Spatial Resolution	Vertical Resolution	Temporal	
N/A	N/A			

Ref: SAF/ROM/DMI/MGT/PRD/001 Issue: 2.3 Date: 30 November 2015	ROM SAF CDOP-2 Product Requirements Document	
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GRM-16_v9	Radio Occultation Processing Package	ROPP_v9	PRD_v2.3
Type	Software Product		
Applications and Users	NWP, RO data suppliers, scientific users		
Characteristics and Methods			
Operational Satellite Input Data	See GRM-16		
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	Spatial Resolution	Vertical Resolution	Temporal
N/A	N/A		

GRM-17	Climate Bending Angle	CBGCO1	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Accuracy			
Threshold	Target	Optimal	
25 – 50 km: 0.4 % or 0.8 μ rad*) 8 – 25 km: 0.4 % 0 – 8 km: 4 – 0.4 %	25 – 50 km: 0.2 % or 0.4 μ rad*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0– 0.20 %	25 – 50 km: 0.10 % or 0.2 μ rad*) 8 – 25 km: 0.10 % 0 – 8 km: 1.0 – 0.10 %	
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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-18	Climate Refractivity		CRGCO1	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	180 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.16 % or 0.008 N-units*) 8 – 25 km: 0.16 % 0 – 8 km: 1.6 – 0.16 %	25 – 50 km: 0.08 % or 0.004 N-units*) 8 – 25 km: 0.08 % 0 – 8 km: 0.8 – 0.08 %	25 – 50 km: 0.04 % or /0.002 N-units*) 8 – 25 km: 0.04 % 0 – 8 km: 0.4 – 0.04 %		
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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-19	Climate Temperature	CTGCO1	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Accuracy			
Threshold	Target	Optimal	
25 – 50 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: 2.0 – 0.4 K	25 – 50 km: 0.2 – 2 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K	25 – 50 km: 0.10 – 1.0 K 8 – 25 km: 0.10 K 0 – 8 km: 0.50 – 0.10 K	
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-20	Climate Specific Humidity	CHGCO1	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Accuracy			
Threshold	Target	Optimal	
8 – 12 km: 6.0 % 0 – 8 km: 6.0 %	8 – 12 km: 3.0 % 0 – 8 km: 3.0 %	8 – 12 km: 1.5 % 0 – 8 km: 1.5 %	
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-21	Climate Dry Geopotential Height	CZGCO1	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Accuracy			
Threshold	Target	Optimal	
25 – 50 km: 8 – 80 m 8 – 25 km: 8 m 0 - 8 km: –	25 – 50 km: 4 – 40 m 8 – 25 km: 4 m 0 – 8 km: –	25 – 50 km: 2 – 20 m 8 – 25 km: 2 m 0 – 8 km: –	
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

GRM-22	Climate Dry Temperature	CDGCO1	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Accuracy			
Threshold	Target	Optimal	
25 – 50 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: –	25 – 50 km: 0.2 – 2 K 8 – 25 km: 0.2 K 0 – 8 km: –	25 – 50 km: 0.10 – 1.0 K 8 – 25 km: 0.10 K 0 – 8 km: –	
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

GRM-23	Climate Dry Pressure	CYGC01	PRD_v2.3
Type	Off-line 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	COSMIC Post-processed data		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	180 d	
Accuracy			
Threshold	Target	Optimal	
25 – 50 km: 0.16 – 0.80 % 8 – 25 km: 0.16 % 0 – 8 km –	25 – 50 km: 0.08 – 0.40 % 8 – 25 km: 0.08 % 0 – 8 km: –	25 – 50 km: 0.04 – 0.20 % 8 – 25 km: 0.04 % 0 – 8 km: –	
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-24	Tropopause Height		TPH	PRD_v2.3
Type	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 BUFR	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
2 km	1 km	0.5 km		
Notes				
Verification/Validation Methods	Standard deviation of (TPH product ERA Interim analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal Resolution	
global	RO resolution	Scalar	RO resolution	

GRM-28-L3-B-R1	Reprocessed bending angle grid	RBGMUL	PRD_v2.3
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 from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-002: GRAS L1 R1: 01/ 2007 – 05/2014; WG-DRG Plan CF-016: CHAMP L1 R1: 09/2001 - 09/2008; WG-DRG Plan CF-017: GRACE L1 R1: 01/2005 - 12/2014; WG-DRG Plan CF-018: COSMIC L1 R1: 07/2006 - 12/2014;		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Bending angle			
25 – 50 km: 0.4 % or 0.8 μ rad*) 8 – 25 km: 0.4 % 0 – 8 km: 4 – 0.4 %	25 – 50 km: 0.2 % or 0.4 μ rad*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0–0.20 %	25 – 50 km: 0.10 % or 0.2 μ rad*) 8 – 25 km: 0.10 % 0 – 8 km: 1.0 – 0.10 %	
Refractivity			
25 – 50 km: 0.16 % or 0.008 N-units*) 8 – 25 km: 0.16 % 0 – 8 km: 1.6 – 0.16 %	25 – 50 km: 0.08 % or 0.004 N-units*) 8 – 25 km: 0.08 % 0 – 8 km: 0.8 – 0.08 %	25 – 50 km: 0.04 % or 0.002 N-units*) 8 – 25 km: 0.04 % 0 – 8 km: 0.4 – 0.04 %	
Dry temperature			
25 – 50 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: –	25 – 50 km: 0.2 – 2 K 8 – 25 km: 0.2 K 0 – 8 km: –	25 – 50 km: 0.10 – 1.0 K 8 – 25 km: 0.10 K 0 – 8 km: –	
Dry pressure			
25 – 50 km: 0.16 – 0.80 % 8 – 25 km: 0.16 % 0 – 8 km: –	25 – 50 km: 0.08 – 0.40 % 8 – 25 km: 0.08 % 0 – 8 km: –	25 – 50 km: 0.04 – 0.20 % 8 – 25 km: 0.04 % 0 – 8 km: –	
Dry geopotential height			
25 – 50 km: 8 – 80 m 8 – 25 km: 8 m 0 – 8 km: –	25 – 50 km: 4 – 40 m 8 – 25 km: 4 m 0 – 8 km: –	25 – 50 km: 2 – 20 m 8 – 25 km: 2 m 0 – 8 km: –	

Temperature			
25 – 50 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: 2.0 – 0.4 K	25 – 50 km: 0.2 – 2 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K	25 – 50 km: 0.10 – 1.0 K 8 – 25 km: 0.10 K 0 – 8 km: 0.50 – 0.10 K	
Specific humidity			
8 – 12 km: 6.0 % 0 – 8 km: 6.0 %	8 – 12 km: 3.0 % 0 – 8 km: 3.0 %	8 – 12 km: 1.5 % 0 – 8 km: 1.5 %	
Tropopause Height			
0.2 km	0.1 km	0.05 km	
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate. *) whichever is greater		
Verification/Validation Methods	Statistics of differences relative to ECMWF ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
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	PRD_v2.3
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Hi-res wave optics retrieval		
Operational Satellite Input Data	Reprocessed level 1a Metop from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-002: GRAS L1 R1: 01/ 2007 – 05/2014;		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
35 – 60 km: 4 μ rad 8 – 35 km: 4% 2 – 8 km: 20% - 4%	35 – 60 km: 2 μ rad 8 – 35 km: 2% 2 – 8 km: 10% - 2%	35 – 60 km: 1 μ rad 8 – 35 km: 1% 2 – 8 km: 5% - 1%	
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate BA noise above 60 km is expected to be between 0.5 and 1.5 μ rad;		
Verification/Validation Methods	Standard deviation of (Product – ERA Interim forecasts) Comparison to EUMETSAT reprocessed bending angle		
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	PRD_v2.3
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Hi-res wave optics retrieval		
Operational Satellite Input Data	Reprocessed level 1a Metop from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-002: GRAS L1 R1: 01/ 2007 – 05/2014;		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Refractivity profile			
30 – 50 km: 0.06 N-units 5 – 30 km: 1.2% 0 – 5 km: 4% – 1.2%	30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%	30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%	
Dry temperature profile			
20 – 40 km: 2 K – 20 K 5 – 20 km: 2 K 0 – 5 km: 4 K – 2 K	20 – 40 km: 1 K – 10 K 5 – 20 km: 1 K 0 – 5 km: 2 K – 1 K	20 – 40 km: 0.5 K – 5 K 5 – 20 km: 0.5 K 0 – 5 km: 1 K – 0.5 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 – ERA Interim forecasts)		
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	Reprocessed temperature profile	RTPMET	PRD_v2.3
GRM-29-L2-H-R1	Reprocessed specific humidity profile	RHPMET	
GRM-29-L2-P-R1	Reprocessed pressure profile	RPPMET	
GRM-29-L2-S-R1	Reprocessed surface pressure	RSPMET	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1a Metop from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-002: GRAS L1 R1: 01/ 2007 – 05/2014;		
Other Operational Input Data	ECMWF ERA Interim fields.		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Temperature profile			
30 – 50 km: 3 K – 6 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K	30 – 50 km: 1 K – 2 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	30 – 50 km: 0.5 K – 1 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 K	
Specific humidity profile			
0 – 12 km: 1.8 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 10% *)	0 – 12 km: 0.3 g/kg or 10% *)	
Pressure profile			
0 – 50 km: a) 0.03 hPa 0 – 50 km: b) 0.75% 0 – 50 km: c) 2.4 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) 0.005 hPa 0 – 50 km: b) 0.1% 0 – 50 km: c) 0.7 hPa **)	
Surface pressure			
2.4 hPa	0.8 hPa	0.7 hPa	
Notes	An accuracy 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);		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis)		
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	PRD_v2.3	
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 CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-002: GRAS L1 R1: 01/ 2007 – 05/2014;				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		n/a		
Accuracy						
Threshold		Target		Optimal		
2 km		1 km		0.5 km		
Notes						
Verification/Validation Methods		Standard deviation of (Product - ERA Interim analysis)				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
global		RO resolution		scalar		RO resolution

GRM-29-L3-B-R1	Reprocessed bending angle grid	RBGMET	PRD_v2.3
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 from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-002: GRAS L1 R1: 01/ 2007 – 05/2014;		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Bending angle			
25 – 50 km: 0.6 % or 1.2 μ rad*) 8 – 25 km: 0.6 % 0 – 8 km: 6 – 0.6 %	25 – 50 km: 0.3 % or 0.6 μ rad*) 8 – 25 km: 0.3 % 0 – 8 km: 3 – 0.3 %	25 – 50 km: 0.15 % or 0.3 μ rad*) 8 – 25 km: 0.15 % 0 – 8 km: 1.5 – 0.15 %	
Refractivity			
25 – 50 km: 0.24 % or 0.012 N-units*) 8 – 25 km: 0.24 % 0 – 8 km: 2.4 – 0.24 %	25 – 50 km: 0.12 % or 0.006 N-units*) 8 – 25 km: 0.12 % 0 – 8 km: 1.2 – 0.12 %	25 – 50 km: 0.06 % or 0.003 N-units*) 8 – 25 km: 0.06 % 0 – 8 km: 0.6 – 0.06 %	
Dry temperature			
25 – 50 km: 0.6 – 6 K 8 – 25 km: 0.6 K 0 – 8 km: –	25 – 50 km: 0.3 – 3 K 8 – 25 km: 0.3 K 0 – 8 km: –	25 – 50 km: 0.15 – 1.5 K 8 – 25 km: 0.15 K 0 – 8 km: –	
Dry pressure			
25 – 50 km: 0.24 – 1.20 % 8 – 25 km: 0.24 % 0 – 8 km: –	25 – 50 km: 0.12 – 0.60 % 8 – 25 km: 0.12 % 0 – 8 km: –	25 – 50 km: 0.06 – 0.30 % 8 – 25 km: 0.06 % 0 – 8 km: –	
Dry geopotential height			
25 – 50 km: 12 – 120 m 8 – 25 km: 12 m 0 – 8 km: –	25 – 50 km: 6 – 60 m 8 – 25 km: 6 m 0 – 8 km: –	25 – 50 km: 3 – 30 m 8 – 25 km: 3 m 0 – 8 km: –	
Temperature			
25 – 50 km: 0.6 – 6 K 8 – 25 km: 0.6 K 0 – 8 km: 2.0 – 0.6 K	25 – 50 km: 0.3 – 3 K 8 – 25 km: 0.3 K 0 – 8 km: 1.0 – 0.3 K	25 – 50 km: 0.15 – 1.5 K 8 – 25 km: 0.15 K 0 – 8 km: 0.50 – 0.15 K	

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Specific humidity			
8 – 12 km: 8.0 % 0 – 8 km: 8.0 %	8 – 12 km: 4.0 % 0 – 8 km: 4.0 %	8 – 12 km: 2.0 % 0 – 8 km: 2.0 %	
Tropopause height			
0.4 km	0.2 km	0.1 km	
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate. *) whichever is greater		
Verification/Validation Methods	Statistics of differences relative to ECMWF ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
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	PRD_v2.3	
Type		Reprocessed Data Set				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		Hi-res wave optics retrieval				
Operational Satellite Input Data		Reprocessed level 1a COSMIC from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-018: COSMIC L1 R1: 07/2006 -12/2014				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		n/a		
Accuracy						
Threshold		Target		Optimal		
35 – 60 km: 4 μ rad 8 – 35 km: 4% 2 – 8 km: 20% - 4%		35 – 60 km: 2 μ rad 8 – 35 km: 2% 2 – 8 km: 10% - 2%		35 – 60 km: 1 μ rad 8 – 35 km: 1% 2 – 8 km: 5% - 1%		
Notes		An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate BA noise above 60 km is expected to be between 1 and 2.5 μ rad;				
Verification/Validation Methods		Standard deviation of (Product – ERA Interim forecasts) Comparison to EUMETSAT reprocessed bending angle				
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	PRD_v2.3
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Hi-res wave optics retrieval		
Operational Satellite Input Data	Reprocessed level 1a COSMIC from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-018: COSMIC L1 R1: 07/2006 -12/2014		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Refractivity Profile			
30 – 50 km: 0.06 N-units 5 – 30 km: 1.2% 0 – 5 km: 4% – 1.2%	30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%	30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%	
Dry temperature Profile			
20 – 40 km: 2 K – 20 K 5 – 20 km: 2 K 0 – 5 km: 4 K – 2 K	20 – 40 km: 1 K – 10 K 5 – 20 km: 1 K 0 – 5 km: 2 K – 1 K	20 – 40 km: 0.5 K – 5 K 5 – 20 km: 0.5 K 0 – 5 km: 1 K – 0.5 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 – ERA Interim forecasts)		
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	Reprocessed temperature profile	RTPCO1	PRD_v2.3
GRM-30-L2-H-R1	Reprocessed specific humidity profile	RHPCO1	
GRM-30-L2-P-R1	Reprocessed pressure profile	RPPCO1	
GRM-30-L2-S-R1	Reprocessed surface pressure	RSPCO1	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1a COSMIC from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-018: COSMIC L1 R1: 07/2006 -12/2014		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Temperature Profile			
30 – 50 km: 3 K – 6 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K	30 – 50 km: 1 K – 2 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	30 – 50 km: 0.5 K – 1 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 K	
Specific Humidity Profile			
0 – 12 km: 1.8 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 10% *)	0 – 12 km: 0.3 g/kg or 10% *)	
Pressure Profile			
0 – 50 km: a) 0.03 hPa 0 – 50 km: b) 0.75% 0 – 50 km: c) 2.4 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) 0.005 hPa 0 – 50 km: b) 0.1% 0 – 50 km: c) 0.7 hPa **)	
Surface Pressure			
2.4 hPa	0.8 hPa	0.7 hPa	
Notes	An accuracy 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);		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis)		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal resolution
global	RO resolution	model levels	RO resolution

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GRM-30-L2-C-R1		Reprocessed tropopause height		RCHCO1	PRD_v2.3	
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 EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-018: COSMIC L1 R1: 07/2006 -12/2014				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		n/a		
Accuracy						
Threshold		Target		Optimal		
2 km		1 km		0.5 km		
Notes						
Verification/Validation Methods		Standard deviation of (Product - ERA Interim Analysis)				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
global		RO resolution		scalar		RO resolution

GRM-30-L3-B-R1	Reprocessed bending angle grid	RBGCO1	PRD_v2.3
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 from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-018: COSMIC L1 R1: 07/2006 -12/2014		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Bending angle			
25 – 50 km: 0.4 % or 0.8 μ rad*) 8 – 25 km: 0.4 % 0 – 8 km: 4 – 0.4 %	25 – 50 km: 0.2 % or 0.4 μ rad*) 8 – 25 km: 0.2 % 0 – 8 km: 2.0–0.20 %	25 – 50 km: 0.10 % or 0.2 μ rad*) 8 – 25 km: 0.10 % 0 – 8 km: 1.0 – 0.10 %	
Refractivity			
25 – 50 km: 0.16 % or 0.008 N-units*) 8 – 25 km: 0.16 % 0 – 8 km: 1.6 – 0.16 %	25 – 50 km: 0.08 % or 0.004 N-units*) 8 – 25 km: 0.08 % 0 – 8 km: 0.8 – 0.08 %	25 – 50 km: 0.04 % or /0.002 N-units*) 8 – 25 km: 0.04 % 0 – 8 km: 0.4 – 0.04 %	
Dry temperature			
25 – 50 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: –	25 – 50 km: 0.2 – 2 K 8 – 25 km: 0.2 K 0 – 8 km: –	25 – 50 km: 0.10 – 1.0 K 8 – 25 km: 0.10 K 0 – 8 km: –	
Dry pressure			
25 – 50 km: 0.16 – 0.80 % 8 – 25 km: 0.16 % 0 – 8 km: –	25 – 50 km: 0.08 – 0.40 % 8 – 25 km: 0.08 % 0 – 8 km: –	25 – 50 km: 0.04 – 0.20 % 8 – 25 km: 0.04 % 0 – 8 km: –	
Dry geopotential height			
25 – 50 km: 8 – 80 m 8 – 25 km: 8 m 0 – 8 km: –	25 – 50 km: 4 – 40 m 8 – 25 km: 4 m 0 – 8 km: –	25 – 50 km: 2 – 20 m 8 – 25 km: 2 m 0 – 8 km: –	
Temperature			
25 – 50 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: 2.0 – 0.4 K	25 – 50 km: 0.2 – 2 K 8 – 25 km: 0.2 K 0 – 8 km: 1.0 – 0.2 K	25 – 50 km: 0.10 – 1.0 K 8 – 25 km: 0.10 K 0 – 8 km: 0.50 – 0.10 K	

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Specific humidity			
8 – 12 km: 6.0 % 0 – 8 km: 6.0 %	8 – 12 km: 3.0 % 0 – 8 km: 3.0 %	8 – 12 km: 1.5 % 0 – 8 km: 1.5 %	
Tropopause Height			
0.2 km	0.1 km	0.05 km	
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate. *) whichever is greater		
Verification/Validation Methods	Statistics of differences relative to ECMWF ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
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	PRD_v2.3	
Type		Reprocessed Data Set				
Applications and Users		Climate and atmosphere researchers				
Characteristics and Methods		Hi-res wave optics retrieval				
Operational Satellite Input Data		Reprocessed level 1a CHAMP from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-016: CHAMP L1 R1: 09/2001-09/2008				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		n/a		
Accuracy						
Threshold		Target		Optimal		
35 – 60 km: 4 μ rad 8 – 35 km: 4% 2 – 8 km: 20% - 4%		35 – 60 km: 2 μ rad 8 – 35 km: 2% 2 – 8 km: 10% - 2%		35 – 60 km: 1 μ rad 8 – 35 km: 1% 2 – 8 km: 5% - 1%		
Notes		An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate; BA noise above 60 km is expected to be about 4 μ rad; Product may have reduced information content below 8–10 km due to limitations in the CHAMP closed loop data;				
Verification/Validation Methods		Standard deviation of (Product – ERA Interim forecasts) Comparison to EUMETSAT reprocessed bending angle				
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	PRD_v2.3
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Hi-res wave optics retrieval		
Operational Satellite Input Data	Reprocessed level 1a CHAMP from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-016: CHAMP L1 R1: 09/2001-09/2008		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Refractivity Profile			
30 – 50 km: 0.06 N-units 5 – 30 km: 1.2% 0 – 5 km: 4% – 1.2%	30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%	30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%	
Dry temperature Profile			
20 – 40 km: 2 K – 20 K 5 – 20 km: 2 K 0 – 5 km: 4 K – 2 K	20 – 40 km: 1 K – 10 K 5 – 20 km: 1 K 0 – 5 km: 2 K – 1 K	20 – 40 km: 0.5 K – 5 K 5 – 20 km: 0.5 K 0 – 5 km: 1 K – 0.5 K	
Notes	An accuracy 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 CHAMP closed loop data;		
Verification/Validation Methods	Standard deviation of (Product – ERA Interim forecasts)		
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	Reprocessed temperature	RTPCHA	PRD_v2.3
GRM-32-L2-H-R1	Reprocessed specific humidity	RHPCHA	
GRM-32-L2-P-R1	Reprocessed pressure	RPPCHA	
GRM-32-L2-S-R1	Reprocessed surface pressure	RSPCHA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	1D-Var algorithm on model levels, ERA Interim forecast as background		
Operational Satellite Input Data	Reprocessed level 1a CHAMP from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-016: CHAMP L1 R1: 09/2001-09/2008		
Other Operational Input Data	ECMWF ERA Interim fields		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Temperature Profile			
30 – 50 km: 3 K – 6 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K	30 – 50 km: 1 K – 2 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	30 – 50 km: 0.5 K – 1 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 K	
Specific Humidity Profile			
0 – 12 km: 1.8 g/kg or 30% *)	0 – 12 km: 0.6 g/kg or 10% *)	0 – 12 km: 0.3 g/kg or 10% *)	
Pressure Profile			
0 – 50 km: a) 0.03 hPa 0 – 50 km: b) 0.75% 0 – 50 km: c) 2.4 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) 0.005 hPa 0 – 50 km: b) 0.1% 0 – 50 km: c) 0.7 hPa **)	
Surface Pressure			
2.4 hPa	0.8 hPa	0.7 hPa	
Notes	An accuracy 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 CHAMP closed loop data; *) Whichever is greater **) Whichever is greatest of (a) and (b) but not greater than (c);		
Verification/Validation Methods	Standard deviation of (1D-Var solution – ERA Interim analysis)		
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	PRD_v2.3	
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 EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-016: CHAMP L1 R1: 09/2001-09/2008				
Other Operational Input Data		ECMWF ERA Interim fields				
Dissemination						
Format		Means		Timeliness		
netCDF BUFR		Web		n/a		
Accuracy						
Threshold		Target		Optimal		
2 km		1 km		0.5 km		
Notes						
Verification/Validation Methods		Standard deviation of (Product - ERA Interim Analysis)				
Coverage, Resolution						
Spatial Coverage		Spatial Resolution		Vertical Resolution		Temporal resolution
global		RO resolution		scalar		RO resolution

GRM-32-L3-B-R1	Reprocessed bending angle grid	RBGCHA	PRD_v2.3
GRM-32-L3-R-R1	Reprocessed refractivity grid	RRGCHA	
GRM-32-L3-D-R1	Reprocessed dry temperature grid	RDGCHA	
GRM-32-L3-Y-R1	Reprocessed dry pressure grid	RYGCHA	
GRM-32-L3-Z-R1	Reprocessed dry geopotential height grid	RZGCHA	
GRM-32-L3-T-R1	Reprocessed temperature grid	RTGCHA	
GRM-32-L3-H-R1	Reprocessed humidity grid	RHGCHA	
GRM-32-L3-C-R1	Reprocessed tropopause height grid	RCGCHA	
Type	Reprocessed Data Set		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	Zonal monthly means on 200 m x 5 deg grids		
Operational Satellite Input Data	Reprocessed level 1a CHAMP from EUMETSAT CF, cf. Refs.: CSDP WP230 (EUM/STG/65/14/DOC/18); WG-DRG Plan CF-016: CHAMP L1 R1: 09/2001-09/2008		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	n/a	
Accuracy			
Threshold	Target	Optimal	
Bending angle			
25 – 40 km: 0.8 % or 1.6 μ rad*) 8 – 25 km: 0.8 % 0 – 8 km: –	25 – 40 km: 0.4 % or 0.8 μ rad*) 8 – 25 km: 0.4 % 0 – 8 km: –	25 – 40 km: 0.20 % or 0.4 μ rad*) 8 – 25 km: 0.20 % 0 – 8 km: –	
Refractivity			
25 – 40 km: 0.4 % or 0.016 N-units*) 8 – 25 km: 0.4 % 0 – 8 km: –	25 – 40 km: 0.20 % or 0.008 N-units*) 8 – 25 km: 0.20 % 0 – 8 km: –	25 – 40 km: 0.10 % or 0.004 N-units*) 8 – 25 km: 0.10 % 0 – 8 km: –	
Dry temperature			
25 – 40 km: 0.8 – 8 K 8 – 25 km: 0.8 K 0 – 8 km: –	25 – 40 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: –	25 – 40 km: 0.20 – 2.0 K 8 – 25 km: 0.20 K 0 – 8 km: –	
Dry pressure			
25 – 40 km: 0.4 – 2.0 % 8 – 25 km: 0.4 % 0 – 8 km: –	25 – 40 km: 0.2 – 1.0 % 8 – 25 km: 0.2 % 0 – 8 km: –	25 – 40 km: 0.10 – 0.50 % 8 – 25 km: 0.10 % 0 – 8 km: –	
Dry geopotential height			
25 – 40 km: 16 – 160 m 8 – 25 km: 16 m 0 – 8 km: –	25 – 40 km: 8 – 80 m 8 – 25 km: 8 m 0 – 8 km: –	25 – 40 km: 4– 40 m 8 – 25 km: 4 m 0 – 8 km: –	
Temperature			
25 – 40 km: 0.8 – 8 K 8 – 25 km: 0.8 K 0 – 8 km: –	25 – 40 km: 0.4 – 4 K 8 – 25 km: 0.4 K 0 – 8 km: –	25 – 40 km: 0.20 – 2.0 K 8 – 25 km: 0.20 K 0 – 8 km: –	

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Specific humidity			
8 – 12 km: 12 % 0 – 8 km: –	8 – 12 km: 6.0 % 0 – 8 km: –	8 – 12 km: 3.0 % 0 – 8 km: –	
Tropopause Height			
0.6 km	0.3 km	0.15 km	
Notes	An accuracy 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 CHAMP closed loop data;) whichever is greater		
Verification/Validation Methods	Statistics of differences relative to ECMWF ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

GRM-40	NRT Refractivity Profile		NRPMEB	PRD_v2.3
Type	NRT Product			
Applications and Users	NWP			
Characteristics and Methods	hi-res wave optics sampling; 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		
Accuracy				
Threshold	Target	Optimal		
30 – 50 km: 0.09 N-units 5 – 30 km: 1.8% 0 – 5 km: 6% – 1.8%	30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%	30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%		
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate			
Verification/Validation Methods	NWP, other RO			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	hi-res wave optics sampling; interpolated to 247 fixed levels		

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GRM-41	NRT Temperature Profile		NTPMEB	PRD_v2.3
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		
Accuracy				
Threshold	Target	Optimal		
30 – 50 km: 3 K – 30 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K	30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	30 – 50 km: 0.5 K – 5 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 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 (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	model levels (with interpolation); interpolated to 247 fixed levels		

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GRM-42	NRT Specific Humidity Profile		NHPMEB	PRD_v2.3
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		
Accuracy				
Threshold	Target	Optimal		
1.8 g/kg 30% *	0.6 g/kg 10% *	0.3 g/kg 10% *		
Notes	* whichever is greater; The interval 0 – 12 km is considered			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution	model levels (with interpolation); interpolated to 247 fixed levels		

GRM-43	NRT Pressure Profile		NPPMEB	PRD_v2.3
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		
Accuracy				
Threshold	Target	Optimal		
a) 0.03 hPa b) 0.75% c) 2.4 hPa *	a) 0.01 hPa b) 0.25% c) 0.8 hPa *	a) 0.005 hPa b) 0.1% c) 0.7 hPa *		
Notes	* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered			
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	PRD_v2.3
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		
Accuracy				
Threshold	Target	Optimal		
2.4 hPa	0.8 hPa	0.7 hPa		
Notes				
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)			
Coverage, Resolution				
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal	
global	GRAS resolution			

GRM-46	Offline Bending Angle	OBAMEB	PRD_v2.3
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
Characteristics and Methods	hi-res wave optics retrieval		
Operational Satellite Input Data	Metop-B/GRAS		
Other Operational Input Data	ECMWF FC, AN		
Dissemination			
Format	Means	Timeliness	
netCDF BUFR	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
35 – 60 km: 4 μ rad 8 – 35 km: 4% 2 – 8 km: 20% - 4%	35 – 60 km: 2 μ rad 8 – 35 km: 2% 2 – 8 km: 10% - 2%	35 – 60 km: 1 μ rad 8 – 35 km: 1% 2 – 8 km: 5% - 1%	
Notes	An accuracy interval means a linearly changing quantity between the two values over the given vertical coordinate BA noise above 60 km is expected to be between 0.5 and 1.5 μ rad;		
Verification/Validation Methods	Standard deviation of (Product – ECMWF forecasts)		
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	Offline Refractivity Profile		ORPMEB	PRD_v2.3
Type	Off-line Product			
Applications and Users	Climate and atmosphere researchers			
Characteristics and Methods	hi-res wave optics retrieval			
Operational Satellite Input Data	Metop-B/GRAS			
Other Operational Input Data	ECMWF FC, AN			
Dissemination				
Format	Means	Timeliness		
netCDF BUFR	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
30 – 50 km: 0.06 N-units 5 – 30 km: 1.2% 0 – 5 km: 4% – 1.2%	30 – 50 km: 0.03 N-units 5 – 30 km: 0.6% 0 – 5 km: 2% – 0.6%	30 – 50 km: 0.02 N-units 5 – 30 km: 0.3% 0 – 5 km: 1% – 0.3%		
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	Spatial Resolution	Vertical Resolution	Temporal resolution	
global	RO resolution	hi-res wave optics sampling; interpolated to 247 fixed levels	RO resolution	

GRM-48	OFL Temperature Profile	OTPMEB	PRD_v2.3
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
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	
netCDF BUFR	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
30 – 50 km: 3 K – 30 K 5 – 30 km: 3 K 0 – 5 km: 6 K – 3 K	30 – 50 km: 1 K – 10 K 5 – 30 km: 1 K 0 – 5 km: 2 K – 1 K	30 – 50 km: 0.5 K – 5 K 5 – 30 km: 0.5 K 0 – 5 km: 1 K – 0.5 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 (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-49		OFL Specific Humidity Profile		OHPMEB	PRD_v2.3	
Type		Off-line Product				
Applications and Users		Climate and atmosphere researchers				
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		
netCDF BUFR		Web		30 d		
Accuracy						
Threshold		Target		Optimal		
1.8 g/kg 30% *		0.6 g/kg 10% *		0.3 g/kg 10% *		
Notes		* whichever is greater; The interval 0 – 12 km is considered				
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-50	OFL Pressure Profile	OPPEB	PRD_v2.3
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
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	
netCDF BUFR	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
a) 0.03 hPa b) 0.75% c) 2.4 hPa *	a) 0.01 hPa b) 0.25% c) 0.8 hPa *	a) 0.005 hPa b) 0.1% c) 0.7 hPa *	
Notes	* whichever is greatest of (a) and (b) but not greater than (c); The interval 0 – 50 km is considered		
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-51	OFL Surface Pressure	OSPMEB	PRD_v2.3
Type	Off-line Product		
Applications and Users	Climate and atmosphere researchers		
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	
netCDF BUFR	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
2.4 hPa	0.8 hPa	0.7 hPa	
Notes			
Verification/Validation Methods	Standard deviation of (1D-Var solution – ECMWF analysis)		
Coverage, Resolution			
Spatial Coverage	Spatial Resolution	Vertical Resolution	Temporal
global	GRAS resolution		

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GRM-53	Climate Bending Angle		CBGMEB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.6 % or 1.2 μ rad *) 8 – 25 km: 0.6 % 0 – 8 km: 6 – 0.6 %	25 – 50 km: 0.3 % or 0.6 μ rad*) 8 – 25 km: 0.3 % 0 – 8 km: 3 – 0.3 %	25 – 50 km: 0.15 % or 0.3 μ rad*) 8 – 25 km: 0.15 % 0 – 8 km: 1.5 – 0.15 %		
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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

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GRM-54	Climate Refractivity		CRGMEB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.24 % or 0.012 N-units*) 8 – 25 km: 0.24 % 0 – 8 km: 2.4 – 0.24 %	25 – 50 km: 0.12 % or 0.006 N-units*) 8 – 25 km: 0.12 % 0 – 8 km: 1.2 – 0.12 %	25 – 50 km: 0.06 % or 0.003 N-units*) 8 – 25 km: 0.06 % 0 – 8 km: 0.6 – 0.06 %		
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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-55	Climate Temperature		CTGMEB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.6 – 6 K 8 – 25 km: 0.6 K 0 – 8 km: 2.0 – 0.6 K	25 – 50 km: 0.3 – 3 K 8 – 25 km: 0.3 K 0 – 8 km: 1.0 – 0.3 K	25 – 50 km: 0.15 – 1.5 K 8 – 25 km: 0.15 K 0 – 8 km: 0.50 – 0.15 K		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-56	Climate Specific Humidity		CHGMEB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
8 – 12 km: 8.0 % 0 – 8 km: 8.0 %	8 – 12 km: 4.0 % 0 – 8 km: 4.0 %	8 – 12 km: 2.0 % 0 – 8 km: 2.0 %		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-57	Climate Dry Geopotential Height		CZGMEB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 12 – 120 m 8 – 25 km: 12 m 0 - 8 km: –	25 – 50 km: 6 – 60 m 8 – 25 km: 6 m 0 – 8 km: –	25 – 50 km: 3 – 30 m 8 – 25 km: 3 m 0 – 8 km: –		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-58	Climate Dry Temperature		CDGMEB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.6 – 6 K 8 – 25 km: 0.6 K 0 – 8 km: –	25 – 50 km: 0.3 – 3 K 8 – 25 km: 0.3 K 0 – 8 km: –	25 – 50 km: 0.15 – 1.5 K 8 – 25 km: 0.15 K 0 – 8 km: –		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-59	Climate Dry Pressure	CYGMEMB	PRD_v2.3
Type	Off-line 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	Metop-B/GRAS		
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)		
Dissemination			
Format	Means	Timeliness	
netCDF	Web	30 d	
Accuracy			
Threshold	Target	Optimal	
25 – 50 km: 0.24 – 1.20 % 8 – 25 km: 0.24 % 0 – 8 km –	25 – 50 km: 0.12 – 0.60 % 8 – 25 km: 0.12 % 0 – 8 km: –	25 – 50 km: 0.06 – 0.30 % 8 – 25 km: 0.06 % 0 – 8 km: –	
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.		
Coverage, Resolution			
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution
global	5 deg latitude	200 m	1 month

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GRM-93	Climate Bending Angle		CBGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.6 % or 1.2 μ rad *) 8 – 25 km: 0.6 % 0 – 8 km: 6 – 0.6 %	25 – 50 km: 0.3 % or 0.6 μ rad*) 8 – 25 km: 0.3 % 0 – 8 km: 3 – 0.3 %	25 – 50 km: 0.15 % or 0.3 μ rad*) 8 – 25 km: 0.15 % 0 – 8 km: 1.5 – 0.15 %		
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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-94	Climate Refractivity		CRGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.24 % or 0.012 N-units*) 8 – 25 km: 0.24 % 0 – 8 km: 2.4 – 0.24 %	25 – 50 km: 0.12 % or 0.006 N-units*) 8 – 25 km: 0.12 % 0 – 8 km: 1.2 – 0.12 %	25 – 50 km: 0.06 % or 0.003 N-units*) 8 – 25 km: 0.06 % 0 – 8 km: 0.6 – 0.06 %		
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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-95	Climate Temperature		CTGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.6 – 6 K 8 – 25 km: 0.6 K 0 – 8 km: 2.0 – 0.6 K	25 – 50 km: 0.3 – 3 K 8 – 25 km: 0.3 K 0 – 8 km: 1.0 – 0.3 K	25 – 50 km: 0.15 – 1.5 K 8 – 25 km: 0.15 K 0 – 8 km: 0.50 – 0.15 K		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-96	Climate Specific Humidity		CHGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
8 – 12 km: 8.0 % 0 – 8 km: 8.0 %	8 – 12 km: 4.0 % 0 – 8 km: 4.0 %	8 – 12 km: 2.0 % 0 – 8 km: 2.0 %		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-97	Climate Dry Geopotential Height		CZGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 12 – 120 m 8 – 25 km: 12 m 0 - 8 km: –	25 – 50 km: 6 – 60 m 8 – 25 km: 6 m 0 – 8 km: –	25 – 50 km: 3 – 30 m 8 – 25 km: 3 m 0 – 8 km: –		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-98	Climate Dry Temperature		CDGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.6 – 6 K 8 – 25 km: 0.6 K 0 – 8 km: –	25 – 50 km: 0.3 – 3 K 8 – 25 km: 0.3 K 0 – 8 km: –	25 – 50 km: 0.15 – 1.5 K 8 – 25 km: 0.15 K 0 – 8 km: –		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	

GRM-99	Climate Dry Pressure		CYGMEA	PRD_v2.3
Type	Off-line 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	Metop-A/GRAS			
Other Operational Input Data	ECMWF ERA Interim (validation, sampling error estimation)			
Dissemination				
Format	Means	Timeliness		
netCDF	Web	30 d		
Accuracy				
Threshold	Target	Optimal		
25 – 50 km: 0.24 – 1.20 % 8 – 25 km: 0.24 % 0 – 8 km –	25 – 50 km: 0.12 – 0.60 % 8 – 25 km: 0.12 % 0 – 8 km: –	25 – 50 km: 0.06 – 0.30 % 8 – 25 km: 0.06 % 0 – 8 km: –		
Notes	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 ERA Interim. Resampling statistics: inter-comparison of RO data subsets.			
Coverage, Resolution				
Spatial Coverage	Horizontal Resolution	Vertical Resolution	Temporal Resolution	
global	5 deg latitude	200 m	1 month	