README file for
ENVISAT DORIS Precise Orbit Determination files

Field	Content
Document Title	README file for ENVISAT DORIS Precise Orbit Determination files
Reference	QA4EO-SER-IPF-TSP-4173, issue 1.1, 16/09/2021
Applicability	This README file applies to the latest versions of the ENVISAT DORIS Precise Orbit Determination dataset (DOR_VOR_AX) generated by CNES with GDR standards versions D, E, and F. This README file complements the distribution on ESA side of the ENVISAT DORIS Precise Orbit data.
ESA Reference Documents	[RD.1] ENVISAT-1 PRODUCTS SPECIFICATIONS VOLUME 9: DORIS PRODUCTS SPECIFICATIONS, PO-RS-MDA-GS-2009, Issue 3B, 2008 [RD.2] ENVISAT-1 PRODUCTS SPECIFICATIONS VOLUME 16: AUXILIARY DATA FILES, PO-RS-MDA-GS-2009, issue 3G, 2007 [RD.3] ENVISAT ADF Consolidation Technical Note, V2.6 - XPReSS-SER-TN-0168, 2019 [RD.4] Upgrade from POE-E to POE-F orbit standard for Sentinel-3 mission, SALP-NT-M6-OP-17108-CN, issue 1, 2018.
Filled by	IDEAS/QA4EO service team
Changelog	The table below records history and status of this README file. | Issue	Date	Major Changes
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1.0	24/06/2020	First version
1.1	16/09/2021	Updated for GDR-F	

1   ENVISAT Orbit State Vector Data

Orbit State Vector Data is used to obtain the satellite orbital parameters (latitude, longitude, trajectory, height, and height rate) employing orbit computation routines. The ESA CFI software (http://eop-cfi.esa.int/index.php) is a collection of precompiled C libraries for timing, coordinate conversions, orbit propagation, satellite pointing, and target visibility calculations.

All ENVISAT ground processing makes use of the CFI orbit propagator module and an input state vector to determine the satellite position all along the orbit. Different types of files are available for a precise orbit determination: Orbit State Vectors generated via the ESA Flight Operation Segment (FOS) and Orbit State Vectors derived off-line within the ESA Payload Data Segment (PDS) from Doppler Orbitography and Radio positioning Integrated by Satellite (DORIS) measurements.

Use and selection are driven by rules where the processing software preferentially chose the "best quality" file among the available ones, according to the order summarised in the table below (in descending qualitative order).

	Highest Quality
DORIS Precise	DOR_VOR_AX
DORIS Preliminary	DOR_POR_AX
FOS Restituted	AUX_FRO_AX
FOS Predicted	AUX_FPO_AX
	Lowest Quality

Table 1 – ENVISAT orbit state vectors in descending order of accuracy.

2   DORIS POD data

During ENVISAT operations, the processing of DORIS orbitography measurements enabled to create Precise Orbit Determination (POD) products, which give the accurate location of the satellite in the International Terrestrial Reference Frame (ITRF). The DORIS Preliminary (DOR_POR_AX) and Precise (DOR_VOR_AX) Orbit State Vector files are DORIS Level 2 products and are used as auxiliary data for the ENVISAT precise orbit reconstructions. They have the specific Envisat PDS format (ASCII) with the following structure (details in RD.1)

- UTC of Orbit State Vector
- Delta_UT1 = UT1 - UTC [s]
- Absolute Orbit number
- X position in Earth fixed reference frame [m]
- Y position in Earth fixed reference frame [m]
- Z position in Earth fixed reference frame [m]
- X velocity relative to Earth fixed reference frame [m/s]
- Y velocity relative to Earth fixed reference frame [m/s]
- Z velocity relative to Earth fixed reference frame [m/s]
- POD Quality Flags

The DORIS Precise Orbit file product (DOR_VOR) is the most accurate estimate produced and provides the orbit state vector needed for the processing of all ENVISAT instruments with the highest quality achievable. Usage of DOR_VOR is recommended by ESA for off-line processing and reprocessing campaigns to improve data quality and harmonize among the different ENVISAT instruments.

File naming convention

DORIS Precise Orbit file filenames share the same structure of all ENVISAT auxiliary data files as detailed in RD.2. The filename is 61 characters long with the following fields

DOR_VOR_AXVF-PYYYYMMDD_hhmmss_YYYYMMDD_hhmmss_YYYYMMDD_hhmmss

DOR_VOR_AX	10	Auxiliary data type ID
V	1	Processing Stage flag
F-P	3	Originator ID
YYYYMMDD_hhmmss	15	date and time of creation
_	1	Underscore character
YYYYMMDD_hhmmss	15	date and time of validity start
_	1	Underscore character
YYYYMMDD_hhmmss	15	date and time of validity stop

Temporal coverage

The DORIS Precise Orbit dataset covers ENVISAT orbits from 09 April 2002 (orbit 580) to 09 April 2012 (orbit 52867).

Size

Each DOR_VOR file covers 26 hours + 29 minutes with 1 MDSR (129 bytes) per minute (1589 MDSRs in total) and total file size of 0.2 MB (MPH and SPH have fixed size).

 MPH (1247 bytes) + SPH (378 bytes) + MDS (204981 bytes) = 206606 bytes = 0.2 MB

Data access

Access to the DOR_VOR full mission archive distributed by ESA is provided after registration. See further details for data registration and access here.

POD Quality Flags

The POD orbit quality flag for the DORIS precise orbit implements the following values:
- 3: adjusted precise orbit
- 4: precise orbit estimated during a manoeuvre period
- 5: precise orbit interpolated over a tracking data gap
- 6: precise orbit extrapolated for a duration less than 1 day
- 7: for a preliminary orbit extrapolated for a duration that ranges from 1 day to 2 days
- 8: for a preliminary orbit extrapolated for a duration larger than 2 days, or extrapolated just after a manoeuvre.

3   GUIDE TO VERSIONS

Orbit quality is a determining factor in e.g. global altimetry. After the ENVISAT end of mission, several versions of the Envisat DOR_VOR_AX dataset were generated by CNES with regular reprocessing campaigns adopting different standards, defined for the Geophysical Data Records (GDRs) orbit products, and applied to the DORIS systems. The latest version of the ENVISAT data is GDR-F released in 2021. At present, the last three versions are distributed to users.

Baseline	Year of generation
GDR D	2012
GDR E	2016
GDR F	2020

The last consolidation activity for the ENVISAT DOR_VOR auxiliary data files resulted in a master dataset of 3638 products of nominal quality for the whole ENVISAT mission. The overall data completeness is 99.78% with respect to the planned products [RD.3]. Table 2 reports the number of products available for every year of the mission (GDR-F) for a total data volume of about 0.8 GB.

Details on GDR standards are available from CNES. RD.4 presents the new orbital standard POE-F and the improvements brought to the Sentinel-3 Topography mission.

YEAR	#
2002	253
2003	365
2004	366
2005	365
2006	365
2007	365
2008	366
2009	365
2010	365
2011	365
2012	98
	3638

Table 2: Number of ENVISAT DOR_VOR products in GDR version F.

3.1 **GDR Version F**

This version of the dataset was generated in 2020 and released afterwards. The most significant changes related to the GDR-F standards concern the new ocean tide model (FES2014) and the updated Terrestrial Reference Frame (ITRF2014). The new standards significantly improve all POD metrics. With respect to POE-E, the mean difference and variance of SSH at crossovers is slightly reduced.

Also for the DOR_VOR GDR-F dataset, only the files subject to improvements were re-generated. Therefore, the GDR-F dataset is composed of files newly generated with GDR-F, and files generated in 2012 (150) using GDR-D which were copied to the final dataset. The resulting dataset presents data with two s/w versions:

```
SOFTWARE_VER="orbito/4.2    150
SOFTWARE_VER="orbito/4.7   3488
```

3.2 **GDR Version E**

This version of the dataset was generated by the Centre de Traitement Doris Poseidon (CTDP) and released in 2019. The most significant changes related to the GDR-E standards concern the new ocean tide model (FES2012) and the updated gravity field (a new mean model from CNES/GRGS spanning 12 years of GRACE data including the drifts terms). The new standards significantly improve all POD metrics and, most importantly, the consistency of Envisat Altimeter Sea Surface Height (SSH) with that of Jason-1 and Jason-2 Altimeter missions.

Note that not all the product files of the DOR_VOR GDR-E dataset were re-processed in 2016 (i.e. only the files subject to improvements were re-generated). Therefore, the resulting dataset is composed of files newly generated in 2016 with

GDR-E and files generated in 2012 (156) using GDR-D and copied to the final dataset. The resulting GDR-E dataset presents data with two s/w versions:

SOFTWARE_VER="orbito/4.2   156
SOFTWARE_VER="orbito/4.4   3484

3.3   GDR Version D

GDR version D was released in 2012 and is available to users, as it is still used. The GDR-D dataset presents data with s/w version:

SOFTWARE_VER="orbito/4.2   3640

4   Known Processing Issues

In the DOR_VOR dataset, a single data gap is identified for the year 2002 (between 29 May and 5 June), during the Envisat commissioning phase.

In GDR-F there is one file (i.e., DOR_VOR_AXVF-P20201101_212600_20040615_220328_20040617_002328) with a reduced coverage with respect to nominal value (NUM_DSR=+0000001581 vs NUM_DSR=+0000001589) due to a later start validity time caused by the switch between the DORIS nominal and redundant chain. The file size is thus reduced (205574 bytes instead of 206606). The corresponding product with extra minutes is present in GDR-D but the latest models are not applied.

5   Product format

All POD datasets share the same format: Envisat PDS format (ASCII) detailed in [RD.2].

Acronyms	GDR Geophysical Data Records POD Precise Orbit Determination UTC Universal Time Coordinate