AVISO
USER HANDBOOK

MERGED TOPEX/POSEIDON PRODUCTS

(GDR-Ms)

AVI-NT-02-101-CN
Edition 3.0, July 1996

1. INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

This document provides a comprehensive description of contents and formats of the altimeter products on AVISO/Altimetry CD ROMs containing merged TOPEX/POSEIDON Geophysical Data Records **(GDR-Ms, version C).** The document includes 11 chapters and 2 appendices:

Chapter 1	(this chapter) introduces the document.
Chapter 2	provides an overview of the AVISO/Altimetry program and the TOPEX/POSEIDON mission.
Chapter 3	describes the TOPEX/POSEIDON merged products as recorded on the AVISO CD ROMs. It details content, file structure and format.
Chapter 4	introduces how to use POSEIDON and TOPEX altimeter data to science application.
Chapters 5 to 11	comment on respectively each header field, each GDR-M field, each crossover field and each orbit field.
Acronyms	
References	
Appendix A	description of VAX/VMS binary data storage format.
Appendix B	description of CCSDS format conventions.

A description on how to read the CD ROM is available in the:AVISO CD ROM User Manual for Merged TOPEX/POSEIDON products (AVI-NT-02-100-CN).

For more information, please contact :

AVISO PROJECT	AVISO user services
Patrick Vincent, CNES (DSO/ED/AL/MA)	**CLS**
BPi 2002 18, avenue Edouard Belin 31401 Toulouse Cedex 4 France	8-10 rue Hermes Parc Technologique du Canal 31526 Ramonville Cedex France
Tel : (+33) (0) 561 274 469 Fax : (+33) (0) 561 282 595 Email:Patrick.Vincent@cnes.fr	Tel : (+33) (0) 561 394 780 Fax : (+33) (0) 561 751 014 E-mail:aviso@cls.fr

AVISO/Altimetry is also on the World Wide Web, "http://www-aviso.cls.cnes.fr", providing information on the TOPEX/POSEIDON altimetry mission, products available and quality, and a point of contact between users, experts and providers.

1.2 DOCUMENT REFERENCE AND CONTRIBUTORS

When refering to this document the following form should be used:

AVISO/Altimetry 1996, "AVISO User Handbook for Merged TOPEX/POSEIDON products", AVI-NT-02-101, Edition 3.0.

Contributors are:

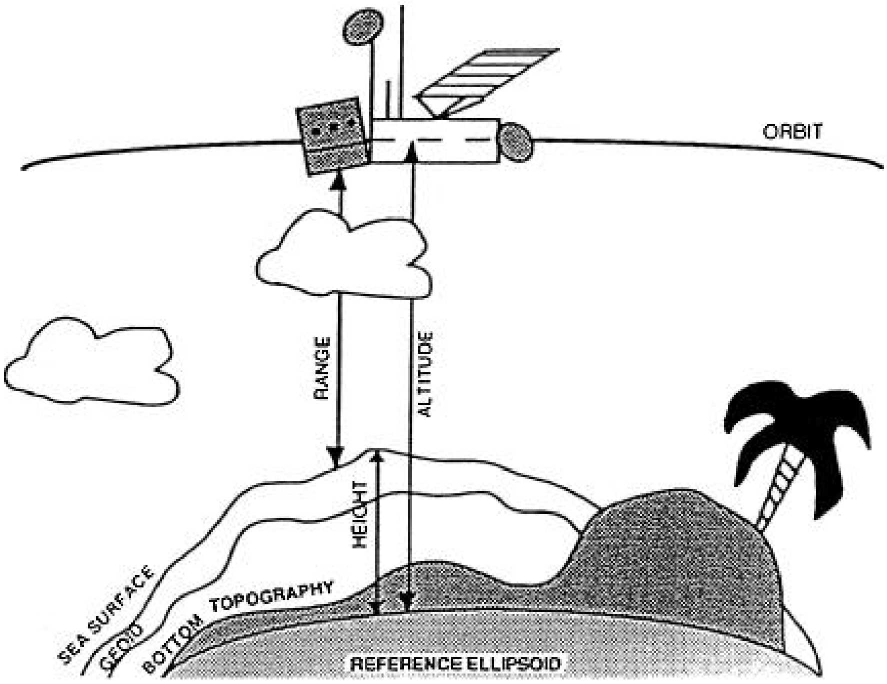
Frédérique Blanc(*), Monique Borra, Pierrette Boudou, Sylvie d'Alessio, Philippe Gaspar, Nigel Greenwood, Christian Le Provost, Michèle Marseille, Richard Rapp, Catherine Schgounn(*), C. K. Shum, Patrick Vincent.

(*) *Main authors*

1.3 CONVENTIONS

1.3.1 Vocabulary

In order to reduce confusion in discussing altimeter measurements and corrections, it is desirable that the following terms be used consistently. It is understood that the usage required is somewhat different from past unconstrained usage.



- DISTANCE or LENGTH are generic terms with no special reference point or meaning.

- RANGE is the distance from the center of mass of the satellite to the surface of the Earth, as measured by the altimeters. Thus, the altimeter measurement are referred as "range" or "altimeter range", not height.

- ALTITUDE refers to the distance of the center of mass of the satellite above a reference point. The reference point will usually be either on the reference ellipsoid or the center of the Earth. This distance is computed from the satellite ephemeris data.

- HEIGHT refers to the distance of the sea surface above the reference ellipsoid. The sea surface height is computed from altimeter range and satellite altitude above the reference ellipsoid.

- A REVOLUTION is one circuit of the earth by the satellite.

- A satellite PASS is half a revolution. Pass numbers increase with time. Passes with odd numbers correspond to ascending orbits, from minimum to maximum latitude. Passes with even numbers correspond to descending orbits, from maximum to minimum latitude.

- REPEAT CYCLE is the time period for the satellite overfly again the same location.

- The REFERENCE ELLIPSOID is the first-order definition of the non-spherical shape of the Earth with **equatorial radius of 6378.1363 kilometers and a flattening coefficient of 1/298.257.** It is specific to the TOPEX/POSEIDON mission

1.3.2 Correction conventions

The main data of the GDR-M are the altimeter ranges. The one per frame value of range (H_Alt) is calculated at midframe time. This is derived for the 10 per frame (10 Hz) range differences from the one per frame (1 Hz) range. The reported range is already corrected for instrument effects (Net_Inst_R_Corr_K). Corrections to be applied are errors due to the atmosphere through which the radar pulse travels and the nature of the reflecting surface [See chapter 4 for more details.].

All corrections are computed so that they have to be added to the quantity which they correct to revise the value to(ward) truth. That is, an error is removed from a measurement by

Corrected Quantity = Measured Value + Correction.

This means that a correction to the altimeter range for an effect which lengthens the apparent signal path will be computed as a negative number. Adding this negative number to the uncorrected (measured) range will reduce it from its original value to the correct value.

Examples :

Corrected Range	=	Altimeter Range + Corrections
Corrected Sea Surface Height	=	Orbit - Altimeter Range - Corrections

1.3.3 Time Convention

Times are UTC and referred to January 1, 1958 (0h 0mn 0.0s).

Nota: A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day. Thus, the UTC values (minutes:seconds) appear as: 59:58; 59:59; 59:60 ; 00:00 ; 00:01. On July 1 1992, the gap between UTC and IAT is 27 seconds; on July 1, 1993, 28 seconds; on July 1, 1994, 29 seconds; on January 1, 1996, 30 seconds.

1.3.4 Units

All distances and geophysical corrections are reported in millimeters.

1.3.5 Flagging and editing

In general, flagging consist of three parts : instrument flags (on/off), telemetry flags (preliminary flagging and editing) and data quality flags (geophysical processing flags).

Instrument flags	tell which instrument/s is/are on and, or which frequencies are used.
Telemetry flags	are first based on altimeter modes and checking of telemetry data quality. Only severely corrupted data are not processed. The flag setting is designed to get a maximum amount of data into the Sensor Data Records. Science data are processed only when the altimeter is in a tracking mode.
Quality flags	involve residuals from smoothing or fits through the data themselves. Flag setting checks for gaps, exceeding limit and excessive changes. Among those flags, some have a global meaning, describing the measurement environment.

More information on data editing can be found in chapter 4.

1.3.6 Default values

Data elements are recorded as integers in a limited number of bytes. Default values are defined as the maximum value to be recorded for the data element. They are given when the field is unavailable (missing data, flagged data,...).

2. AVISO/ALTIMETRY

2.1 OBJECTIVES, ROLES AND RESPONSABILITIES

The AVISO/Altimetry center, in Toulouse, France, is the French Active Archive Data Center for multi-satellite altimeter missions. It first task is to serve the U.S./French TOPEX/POSEIDON mission.

AVISO/Altimetry processes, validates and archives above level-2 altimeter data (full GDRs) from the TOPEX/POSEIDON mission, and distributes them to its broad user community. It also post-processes data at higher levels from all altimeter missions.

AVISO/Altimetry is being developed by CNES, the French Space Agency with assistance from its subsidiary CLS and science teams involved in altimetry. It is run by CLS.

2.2 THE TOPEX/POSEIDON MISSION

♦ Mission objectives

Launched on August 10, 1992 with an expected 5-year lifetime (extended mission), the TOPEX/POSEIDON satellite measures the precise height of the sea surface using two state-of-the-art radar altimetry systems for studying the dynamics of the circulation of the world's ocean. It is laying the foundation for long-term ocean monitoring from space to an extent that will ultimately lead to improved understanding of the ocean's role in global climate change. Other applications include the ocean tides, geodesy and geodynamics, ocean wave height, and wind speed.

To be useful for studying ocean circulation, especially at the gyre and basin scales, numerous improvements have been made in TOPEX/POSEIDON relative to previous altimeter systems including:
- a dedicated satellite design, sensor suite, satellite tracking systems, and orbit configuration,
- an optimal gravity model for precision orbit determination,
- dedicated ground systems for mission operations.

♦ Data processing and distribution

The TOPEX/POSEIDON mission is jointly conducted by the United States' National Aeronautics and Space Administration (NASA) and the French Space Agency (CNES). TOPEX/POSEIDON data are distributed to the international science community via the U.S. PO.DAAC and French AVISO/Altimetry centers.

The NASA and CNES entities process data from their instruments (from raw level to geophysical level) and exchange processed data. Processing centers or ground segments, called TGS and

CTDP respectively, include functions such as monitoring the instruments, pre-processing, science data processing, data verification and precision orbit determination.

Processed data are placed in National archives for further distribution to the scientific community. There are three levels of processed data:

1. Telemetry data (raw data),
2. Sensor Data Records (engineering units),
3. Geophysical Data Records (geophysical units).

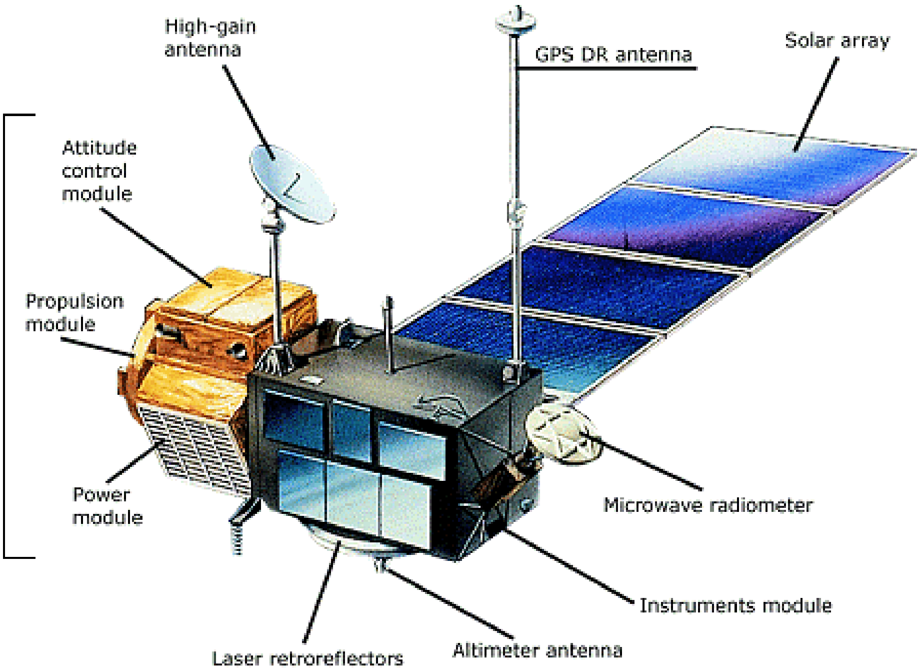
Verified and calibrated geophysical data (GDR-P, GDR-T) are available per cycle within one month of data acquisition. They are computed using precise orbits. During the same phase, small amounts of interim geophysical data are available every day and within five days from data acquisition to help plan oceanographic experiments. These IGDRs differ from GDRs by lacking only accurate ephemeris.

As geophysical data become available, they are sent to the American and French active archive data center (PO.DAAC and AVISO respectively) for further processing (generating merged products). Systematic extended quality control and analysis are performed before archiving and distribution to users.

The geophysical arrangements for distributing TOPEX/POSEIDON data products to the international scientific community via PO.DAAC and AVISO are covered by a CNES-NASA agreement. Both centers disseminate all TOPEX/POSEIDON data.

♦ **The satellite**

The TOPEX/POSEIDON satellite is an adaptation by Fairchild Space of the existing Multimission Modular Spacecraft (MMS) which successfully has carried the payload of the Solar Maximum Mission, Landsat 4 and Landsat 5. The MMS design was modified to achieve the mission goals: a 2400 kg mass carrying four operational and two experimental science instruments. It also provides all house-keeping functions including propulsion, electrical power command and data handling.



TOPEX/POSEIDON SATELLITE

Sensor name	Sensor type	Origin	Frequency	Measurements
NRA (TOPEX)	NASA radar altimeter (*)	NASA operational	13.6 Ghz 5.3 Ghz	Altimeter range Significant wave height Wind speed magnitude Backscatter coefficient Ionospheric correction
SSALT (POSEIDON)	Solid state radar altimeter (*)	CNES experimental	13.65 Ghz	Altimeter range Significant wave height Wind speed magnitude Backscatter coefficient
TMR	TOPEX microwave radiometer	NASA operational	18 Ghz 21 Ghz 37 Ghz	Brightness temperature Water vapour content Liquid water content
LRA	Laser retroreflector array	NASA operational		Precise orbit ephemeris (**)
DORIS	Doppler tracking system receiver	CNES operational	401.25 Mhz 2036.25 Mhz	Precise orbit ephemeris (**) Ground beacon precise positioning Ionospheric correction
GPSDR	Global positioning system demonstration receiver	NASA experimental	1227.6 Mhz 1574.4 Mhz	Precise orbit ephemeris

(*) The two altimeters share the same antenna; thus only one altimeter operates at any given time.

(**) Altimetric measurements are referred to geodetic coordinates by means of a precise orbit determination system. The mission relies on two precise orbit determination teams which both use the combination of LRA and DORIS tracking data: one is operated by CNES and one is by NASA.

♦ The sensors

The science and mission goals are carried out with a satellite carrying six science instruments, four from NASA and two from CNES. They are divided into operational and experimental sensors as follows :

(A) <u>4 operational sensors</u>

(1) Dual-frequency Ku/C band NASA Radar Altimeter (NRA) (NASA)

The NRA, operating at 13.6 GHz (Ku band) and 5.3 GHz (C band) simultaneously, is the primary sensor for the TOPEX/POSEIDON mission. The measurements made at the two frequencies are combined to obtain altimeter height of the satellite above the sea (satellite range), the wind speed, the wave height and the ionospheric correction. This instrument is the first spaceborne altimeter that uses two-channel measurements to compute the effect of ionospheric free electrons in the satellite range measurements. It is redundant except for the microwave transmission unit and the antenna.

(2) Three-frequency TOPEX Microwave Radiometer (TMR) (NASA)

The TMR measures the sea surface microwave emissivity (brightness temperatures) at three frequencies (18 GHz, 21 GHz and 37 GHz) to provide the total water-vapor content in the troposphere along the altimeter beam. The 21 GHz channel is the primary channel for water-vapor measurement. It is redundant (21A and 21B). The 18 GHz and 37 GHz channels are used to remove the effects of wind speed and cloud cover respectively on the water-vapor measurement. TMR data are sent to CNES for processing along with their altimeter data. The measurements are combined to obtain the error in the satellite range measurements caused by pulse delay due to the water vapor and to obtain the sigma naught correction for liquid water absorption.

(3) Laser Retroreflector Array (LRA) (NASA)

The LRA is used with a network of 10 to 15 Satellite Laser Ranging stations to calibrate the altimeter bias and to provide the baseline tracking data for precise orbit determination.

(4) Dual-frequency Doppler tracking system receiver (DORIS) (CNES)

The DORIS system uses a two-channels receiver (401.25 MHz and 2036.25 MHz) on the satellite to observe the Doppler signals from a network of about 50 ground transmitting stations. It provides all-weather global tracking of the satellite for precise orbit determination and an accurate correction for the influence of the ionosphere on both the Doppler signal and altimeter signals.

(B) <u>2 experimental sensors</u>

The two experimental instruments are intended to demonstrate new technology.

(1) Single frequency Ku band Solid State ALTimeter (SSALT) (CNES)

The SSALT, operating at a single frequency of 13.65 GHz (Ku band) validates the new technology of a low-power (49W), light-weight (23Kg) altimeter for future Earth-observing missions. It shares the antenna used by the NRA; thus only one altimeter operates at any given time. Measurements give the same geophysical information as NRA's. However and since this sensor uses a single frequency, an external correction for the ionosphere must be supplied (see DORIS instrument).

(2) Global Positioning System Demonstration Receiver (GPSDR) (NASA)

The GPSDR, operating at 1227.6 MHz and 1575.4 MHz, receives signals from the GPS constellation of up to 6 satellites with a combination of the GPSDR data and a number of GPS receivers on the Earth's surface (3 minimum, 6 planned). The GPS antenna is mounted on a long boom to reduce multipath effects which can severely corrupt the measurements. Precise tracking of the satellite is made possible by using the technique of Kalman fittering and a new GPS differential ranging technique for precise orbit determination.

♦ **The orbit**

The orbit chosen for the TOPEX/POSEIDON mission is a compromise among a number of conflicting requirements. It provides broad coverage of the ice-free oceans as frequently as possible without aliasing the tides to unacceptable frequencies. It is high enough to minimize atmospheric drag and make orbit determination more precise. The orbit is prograde and not sun synchronous.

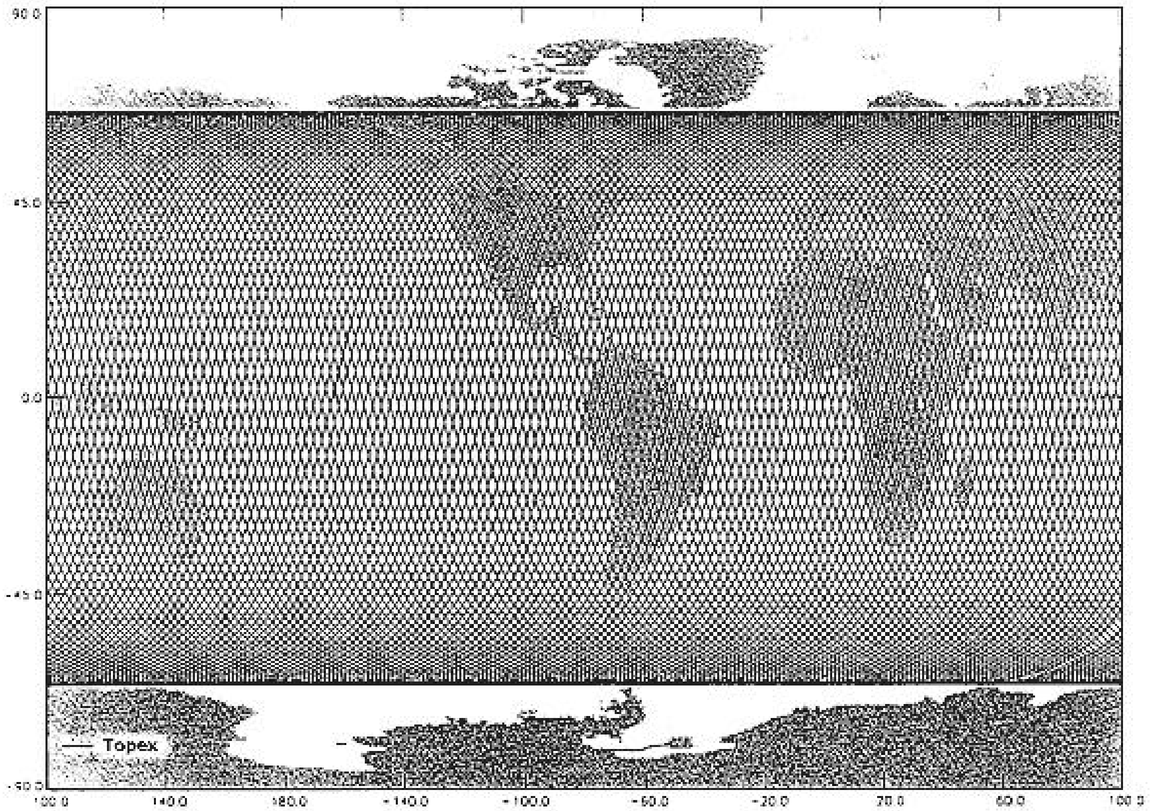
The orbit overflies two calibration sites: a NASA site near Pt Conception California (Harvest platform, 239°19' E, 34°28'N, revolution number 22, ascending pass 43) and a CNES site at Lampedusa Island, Italy (12°57'E, 35°52'N, revolution number 111, descending pass 222).

Mean classical orbit elements	
Semi-major axis	7 714.4278 km
Eccentricity	0.000095
Inclination (not sun-synchronous)	66.039 degrees
Argument of periapsis	90.0 degrees
Inertial longitude of the ascending node	116.5574 degrees
Mean anomaly	253.13 degrees
Auxiliary data	
Reference (Equatorial) altitude	1 336 km
Nodal period	6 745.72 seconds (112' 42'' or 1H52')
Repeat period (10-day cycle)	9.9156 days
Number of revolutions within a cycle	127
Equatorial cross-track separation	315 km
Ground track control band	+ / - 1 km
Acute angle at Equator crossings	39.5 degrees
Longitude of Equator crossing of pass 1	99.9242 degrees
Inertial nodal rate	-2.0791 degrees / day
Orbital speed	7.2 km / second
Ground track speed	5.8 km / second

TOPEX/POSEIDON ORBIT CHARACTERISTICS

A satellite orbit slowly decays due to air drag, and has long-period variability due to the inhomogeneous gravity field of Earth, solar radiation pressure, and smaller forces. Periodic maneuvers are required to keep the satellite on its orbit. The frequency of maneuvers depends primarily on the solar flux as it affects the Earth's atmosphere, and it is expected to be one maneuver (or series of maneuvers) every 40 to 200 days.

The process is expected to take from 20 to 60 minutes. Maneuvers will be performed at the end of a 10-day cycle and prefered to occur when the satellite overflies land in order not to disrupt precise orbit determination. Science data is not taken when orbit maintenance maneuvers are performed.



TOPEX/POSEIDON GROUND TRACKS

Pass n°	Rev n°	Longitude	Pass n°	Rev n°	Longitude	Pass n°	Rev n°	Longitude
1	1	99.92	**87**	44	321.03	**173**	87	182.13
3	2	71.58	**89**	45	292.68	**175**	88	153.78
5	3	43.23	**91**	46	264.33	**177**	89	125.44
7	4	14.88	**93**	47	235.99	**179**	90	97.09
9	5	346.54	**95**	48	207.64	**181**	91	68.74
11	6	318.19	**97**	49	179.29	**183**	92	40.40
13	7	289.85	**99**	50	150.95	**185**	93	12.05
15	8	261.50	**101**	51	122.60	**187**	94	343.70
17	9	233.15	**103**	52	94.26	**189**	95	315.36
19	10	204.80	**105**	53	65.91	**191**	96	287.01
21	11	176.46	**107**	54	37.56	**193**	97	258.66
23	12	148.11	**109**	55	9.21	**195**	98	230.32
25	13	119.77	**111**	56	340.87	**197**	99	201.97
27	14	91.42	**113**	57	312.52	**199**	100	173.62
29	15	63.07	**115**	58	284.18	**201**	101	145.28
31	16	34.73	**117**	59	255.83	**203**	102	116.93
33	17	6.38	**119**	60	227.48	**205**	103	88.59
35	18	338.03	**121**	61	199.13	**207**	104	60.24
37	19	309.69	**123**	62	170.79	**209**	105	31.89
39	20	281.34	**125**	63	142.44	**211**	106	3.55
41	21	252.99	**127**	64	114.10	**213**	107	335.20
43	22	224.65	**129**	65	85.75	**215**	108	306.85
45	23	196.30	**131**	66	57.40	**217**	109	278.51
47	24	167.96	**133**	67	29.06	**219**	110	250.16
49	25	139.61	**135**	68	0.71	**221**	111	221.81
51	26	111.26	**137**	69	332.36	**223**	112	193.47
53	27	82.92	**139**	70	304.02	**225**	113	165.12
55	28	54.57	**141**	71	275.67	**227**	114	136.77
57	29	26.22	**143**	72	247.32	**229**	115	108.43
59	30	357.88	**145**	73	218.98	**231**	116	80.08
61	31	329.53	**147**	74	190.63	**233**	117	51.73
63	32	301.18	**149**	75	162.29	**235**	118	23.39
65	33	272.84	**151**	76	133.94	**237**	119	355.04
67	34	244.49	**153**	77	105.59	**239**	120	326.70
69	35	216.14	**155**	78	77.25	**241**	121	298.35
71	36	187.80	**157**	79	48.90	**243**	122	270.00
73	37	159.45	**159**	80	20.55	**245**	123	241.65
75	38	131.11	**161**	81	352.21	**247**	124	213.31
77	39	102.76	**163**	82	323.86	**249**	125	184.96
79	40	74.41	**165**	83	295.51	**251**	126	156.62
81	41	46.06	**167**	84	267.17	**253**	127	128.27
83	42	17.72	**169**	85	238.82			
85	43	349.37	**171**	86	210.47			

REFERENCE GRID
BETWEEN ASCENDING EQUATORIAL CROSSING LONGITUDE
AND PASS NUMBER (ODD)

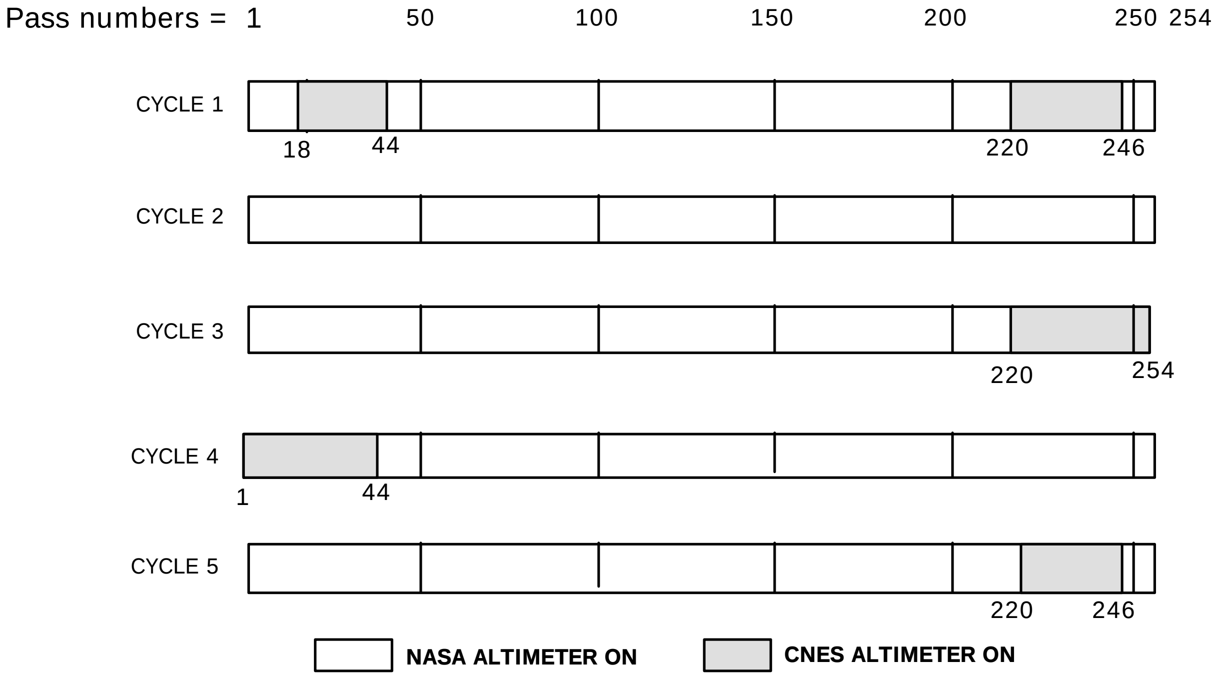
Pass n°	Rev n°	Longitude	Pass n°	Rev n°	Longitude	Pass n°	Rev n°	Longitude
2	1	265.75	**88**	44	126.86	**174**	87	347.96
4	2	237.40	**90**	45	98.51	**176**	88	319.61
6	3	209.06	**92**	46	70.16	**178**	89	291.26
8	4	180.71	**94**	47	41.81	**180**	90	262.92
10	5	152.37	**96**	48	13.47	**182**	91	234.57
12	6	124.02	**98**	49	345.12	**184**	92	206.22
14	7	95.67	**100**	50	316.78	**186**	93	177.88
16	8	67.33	**102**	51	288.43	**188**	94	149.53
18	9	38.98	**104**	52	260.08	**190**	95	121.19
20	10	10.63	**106**	53	231.74	**192**	96	92.84
22	11	342.29	**108**	54	203.39	**194**	97	64.49
24	12	313.94	**110**	55	175.04	**196**	98	36.14
26	13	285.60	**112**	56	146.70	**198**	99	7.80
28	14	257.25	**114**	57	118.35	**200**	100	339.45
30	15	228.90	**116**	58	90.00	**202**	101	311.11
32	16	200.56	**118**	59	61.66	**204**	102	282.76
34	17	172.21	**120**	60	33.31	**206**	103	254.41
36	18	143.86	**122**	61	4.96	**208**	104	226.07
38	19	115.52	**124**	62	336.62	**210**	105	197.72
40	20	87.17	**126**	63	308.27	**212**	106	169.37
42	21	58.82	**128**	64	279.93	**214**	107	141.03
44	22	30.48	**130**	65	251.58	**216**	108	112.68
46	23	2.13	**132**	66	223.23	**218**	109	84.33
48	24	333.78	**134**	67	194.89	**220**	110	55.99
50	25	305.44	**136**	68	166.54	**222**	111	27.64
52	26	277.09	**138**	69	138.19	**224**	112	359.30
54	27	248.74	**140**	70	109.85	**226**	113	330.95
56	28	220.40	**142**	71	81.50	**228**	114	302.60
58	29	192.05	**144**	72	53.15	**230**	115	274.26
60	30	163.71	**146**	73	24.81	**232**	116	245.91
62	31	135.36	**148**	74	356.46	**234**	117	217.56
64	32	107.01	**150**	75	328.11	**236**	118	189.22
66	33	78.66	**152**	76	299.77	**238**	119	160.87
68	34	50.32	**154**	77	271.42	**240**	120	132.53
70	35	21.97	**156**	78	243.07	**242**	121	104.18
72	36	353.63	**158**	79	214.73	**244**	122	75.83
74	37	325.28	**160**	80	186.38	**246**	123	47.48
76	38	296.93	**162**	81	158.03	**248**	124	19.14
78	39	268.59	**164**	82	129.69	**250**	125	350.79
80	40	240.24	**166**	83	101.34	**253**	126	322.45
82	41	211.89	**168**	84	73.00	**254**	127	294.10
84	42	183.55	**170**	85	44.65			
86	43	155.20	**172**	86	16.30			

REFERENCE GRID
BETWEEN DESCENDING EQUATORIAL CROSSING LONGITUDE
AND PASS NUMBER (EVEN)

♦ The antenna sharing plan

Because the NASA and CNES altimeters use the one antenna, an antenna sharing plan has been developed: the CNES altimeter will be on about 10% of the time and the NASA altimeter 90%.

- Through cycle 16, during the verification phase, the two altimeters shared each cycle, the antenna sharing plan being based on a repeated pattern consisting of a set of five 10-day cycles :



**THE ANTENNA SHARING PLAN FOR THE VERIFICATION PHASE :
THE FIVE-CYCLE REPEAT PATTERN**

The pattern begins once the satellite is on the repeat orbit. For the first ten-day repeat cycle, the CNES altimeter will be on for approximately two days, the first day (passes 18 through 44) and roughly the last day (passes 220 through 246). On the second ten-day repeat cycle, the NASA altimeter will be on continuously. Near the end of the third ten-day repeat cycle, the CNES altimeter will begin a three-day sub-cycle, starting with pass 220. The sub-cycle ends early in the fourth ten-day repeat cycle with pass 44. On the fifth ten-day repeat cycle, the CNES altimeter will be on for approximately one day (passes 220 through 246). After completion of this cycle, the five-cycle pattern will repeat from cycle 1 to cycle 16. With this plan, the CNES altimeter will be on 12% of the time.

- Starting with the observation phase, the antenna sharing plan now has only one altimeter on for a full cycle. Thus POSEIDON cycles are about every ten cycles: until end of 96, full POSEIDON cycles (CNES altimeter on) are cycles 20, 31, 41, 55, 65, 79, 91, 97, 103, 114, 126, 138, 150.

3. AVISO MERGED TOPEX/POSEIDON PRODUCTS

3.1 OVERVIEW

Each CD ROM volume includes products for three consecutive ten-day repeat cycles: a volume i includes cycles (3i-2), (3i-1) and (3i), all products associated to the same cycle recorded in a dedicated directory. Each file is a fixed-length unformatted record and contains a header. Data are recorded in VAX binary integer data format, headers in ASCII following the CCSDS format convention. Headers provide identification, processing history and content information.

The products per cycle are the Merged Geophysical Data Records (GDR-Ms), crossover points and CNES and NASA orbit ephemeris files:

GDR-Ms are generated from TOPEX and POSEIDON measurements to reinforce unity of the TOPEX/POSEIDON mission i.e. they are designed scientifically to be as homogeneous as possible to use in ocean and geophysical studies. To achieve this, special attention was paid on various elements of the original GDRs. Generally speaking, no information is lost when going from GDR-Ts and GDR-Ps to GDR-Ms. Computations of some other elements are possible because they do not depend on sensor measurements. Basically, GDR-M includes the measurement locations based on orbit ephemeris, altimeter height measurements and associated corrections. When TOPEX and POSEIDON altimeters do not provide any measurements, the GDR-M does not include any records.

A GDR-M consists of ten-day repeat cycles of data. It is organized as a cycle header file and a maximum of 254 pass-files (about 200 Mb per cycle). A pass-file contains altimeter data from a satellite pass (half a revolution). Elementary records of a pass-file are one per second, but may be discontinuous if measurements are not available.

Crossovers the crossover point file includes both ascending arc and descending arc information for each crossover point of a cycle.

There are four different crossover points: TOPEX/TOPEX (T/T), POSEIDON/POSEIDON (P/P), TOPEX/POSEIDON (T/P) and POSEIDON/TOPEX (P/T).

Orbit ephemeris an orbit file contains precise orbit data covering a ten-day repeat cycle. Elementary records are one per minute, but may be discontinuous if measurements are not available.

The TOPEX/POSEIDON mission includes two precision orbit determination programs which use LRA and DORIS tracking data, one from CNES and one from NASA. Therefore there are two orbit files.

3.2 CD ROM HEADER FILE

3.2.1 Labeling and brief description

The CD ROM header file conforms to the following naming convention :

MGxvol_v.HDR

where

M	for the AVISO Merged product.
G	for GDR data type(1).
x	the generation letter (A to Z) (1). [At the date of edition 3, x = C.]
vol	the volume number (001 to 999).
v	the CD ROM version number (0 to 9)(1).
HDR	for a header file.

(1) The data type, the generation letter and the version number are also reported inside the file.

This file is only a header. It provides processing history, content information and data product identification.

3.2.2 Format

FILE NAME	**MGxvol v.HDR**
FORMAT	Unformatted
ACCESS	Sequential or direct
TYPE	ASCII (CCSDS format)
RECORD LENGTH (fixed)	80 Bytes
SIZE	2.2 bytes

3.2.3 Content

File content is given below. See chapter 5 for more details on each field.

CD ROM HEADER FILE : CONTENT

Record number	**Format**	**KEYWORD Content**		**VALUE Format**
1	char*20	CCSD3ZF0000100000001		-------
2	char*20	CCSD3KS00006CDROMHDR		-------
3	char*20	Producer_Agency_Name		char*4
4	char*25	Producer Institution_Name		char*5
5	char*11	Source_Name		char*14
6	char*11	Sensor_Name		char*14
7	char*23	Data_Handbook_Reference		char*21
8	char*25	Product_Create_Start_Time		char*17
9	char*23	Product_Create_End_Time		char*17
10	char*8	Build_Id		char*21
11	char*19	Pass_File_Data_Type		char*6
12	char*17	Generation_letter		char*1
13	char*9	Volume_Id		char*11
14	char*14	Version_Number		char*1
15	char*23	Package_Data_Start_Time		char*24
16	char*21	Package_Data_End_Time		char*24
17	char*18	Start_Cycle_Number		char*3
18	char*16	End_Cycle_Number		char*3
19	char*11	Cycle_Count		char*1
20	char*20	CCSD$$MARKERCDROMHDR		-------
21	char*20	CCSD3RF0000300000001		-------
22	char*15	Directory_Cycle		char*7
23	char*12	Header_Cycle	(GDR-M Cycle Header File)	char*10
24	char*15	Crossover_Cycle		char*10
25	char*19	CNES_Ephem_Filename		char*10
26	char*19	NASA_Ephem_Filename		char*10
27	char*15	Directory_Cycle		char*7
28	char*12	Header_Cycle	(GDR-M Cycle Header File)	char*10
29	char*15	Crossover_Cycle		char*10
30	char*19	CNES_Ephem_Filename		char*10
31	char*19	NASA_Ephem_Filename		char*10
32	char*15	Directory_Cycle		char*7
33	char*12	Header_Cycle	(GDR-M Cycle Header File)	char*10
34	char*15	Crossover_Cycle		char*10
35	char*19	CNES_Ephem_Filename		char*10
36	char*19	NASA_Ephem_Filename		char*10

3.3 GDR-M CYCLE HEADER FILE

3.3.1 Labeling and brief description

The GDR-M cycle header file conforms to the following naming convention :

MGxccc.HDR

where

M	for the AVISO Merged product.
G	for GDR data type(1).
x	the generation letter (A to Z) (1). [At the date of edition 3, x = C.]
ccc	cycle number(2).
HDR	for a header file.

(1) The data type and the generation letter are reported inside the file, and known through the name of the directory in which this file is recorded.

(2) The cycle number associated with the ten-day repeat period in which this data were acquired is recorded inside the file and accessible also through the directory name.

This file is only a header. It provides processing history and identification of the data product of the ten-day repeat cycle this file refers to.

3.3.2 Format

FILE NAME	**MGxccc.HDR**
FORMAT	Unformatted
ACCESS	Sequential or direct
TYPE	ASCII (CCSDS format)
RECORD LENGTH (fixed)	80 Bytes
SIZE	22.2 Kbytes

3.3.3 Content

File content is given below. See chapter 5 for more details on each field.

CYCLE HEADER FILE: CONTENT

Record number	Format	KEYWORD Content		VALUE Format
1	char*20	CCSD3ZF0000100000001		-------
2	char*20	CCSD3KS00006CYCLEHDR		-------
3	char*20	Producer_Agency_Name		char*4
4	char*25	Producer Institution_Name		char*5
5	char*11	Source_Name		char*14
6	char*11	Sensor_Name		char*14
7	char*23	Data_Handbook_Reference		char*21
8	char*25	Product_Create_Start_Time		char*17
9	char*23	Product_Create_End_Time		char*17
10	char*24	Generating_Software_Name		char*50
11	char*8	Build_Id		char*21
12	char*19	Pass_File_Data_Type		char*6
13	char*12	Cycle_Number		char*3
14	char*23	Package_Data_Start_Time		char*24
15	char*21	Package_Data_End_Time		char*24
16	char*17	Start_Pass_Number		char*3
17	char*15	End_Pass_Number		char*3
18	char*10	Pass_Count		char*3
19	char*20	CCSD$$MARKERCYCLEHDR		-------
20	char*20	CCSD3RF0000300000001		-------
21	char*18	Pass_File_Protocol		char*4
22	char*19	Pass_File_Delimiter		char*3
23	char*4	Type		char*50
23 + 1	char*9	Reference	(Pass file name)	char*10
«	«	«		«
«	«	«		«
23+254 max	char*9	Reference	(Pass file name)	char*10

3.4 GDR-M PASS-FILES

3.4.1 Labeling and brief description

Each GDR-M passfile conforms to the following naming convention :

MGxccc.ppp

where

M	for the AVISO merged product.
G	for GDR data type(1).
x	the generation letter (A to Z)(1). [At the date of edition 3, x = C.]
ccc	cycle number(2).
ppp	the pass-file number (001 to 254).

(1) The data type and the generation letter and the version number are known through the associated cycle header file and through the name of the directory in which this file is recorded. The data type is also recorded inside the file (header part).

(2) The cycle number associated with the ten-day repeat period in which this data were acquired is recorded inside the file (header part) and also accessible through the cycle header file and through the directory name.

A GDR-M passfile is a pass-file of geophysical data records (GDR) produced using precise orbit ephemeris and validated algorithms. Each pass file contains a header part and a science data part.
The header part provides product identification, processing history and information about the data, calibration results, orbit quality as well as typical characteristics of the pass.
The science data part is a time record. Each record may be split into 11 groups of elements concerning :

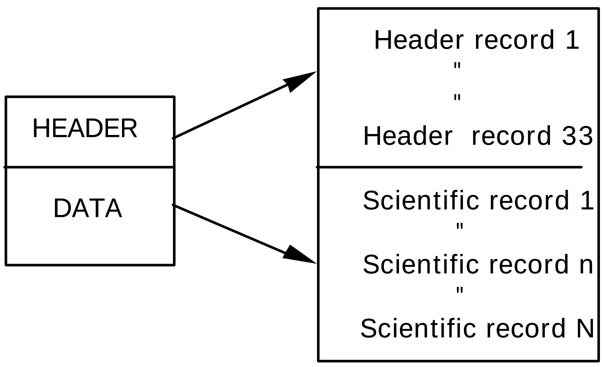
(1) TIME
(2) LOCATION
(3) ALTITUDE
(4) ATTITUDE
(5) ALTIMETER RANGE
(6) ENVIRONMENTAL CORRECTION
(7) SIGNIFICANT WAVE HEIGHT AND EMB
(8) BACKSCATTER COEFFICIENT AND AGC
(9) GEOPHYSICAL QUANTITY
(10) BRIGHTNESS TEMPERATURES
(11) FLAGS
(12) SPARES

3.4.2 Format

FILE NAME	**MGxccc.ppp**
FORMAT	Unformatted
ACCESS	Sequential or direct
TYPE	Header : ASCII (CCSDS format)
	Data : binary
RECORD LENGTH (fixed)	228 Bytes
	Header : 33 x 228 Bytes
	Data : N x 228 Bytes (N ≤ 3360)
SIZE	774.0 Kbytes maximum

3.4.3 Content

A pass-file contains a header and 3360 scientific data records maximum. Whereas the header is recorded in ASCII type, the data part is recorded in a VAX binary integer type. A scientific data record contains 123 fields, each stored as one, two or four bytes, or spare (1 byte).



File content is given below. See chapters 5 and 6 for more details on each field.

PASS-FILE : HEADER RECORDS

Record number	Format	KEYWORD Content	VALUE Format
1	char*20	CCSD3ZF0000100000001	-------
2	char*20	CCSD3KS00006PASSFILE	-------
3	char*20	Producer_Agency_Name	char*4
4	char*25	Producer Institution_Name	char*5
5	char*11	Source_Name	char*14
6	char*11	Sensor_Name	char*14
7	char*23	Data_Handbook_Reference	char*21
8	char*25	Product_Create_Start_Time	char*17
9	char*23	Product_Create_End_Time	char*17
10	har*24	Generating_Software_Name	char*50
11	char*8	Build_Id	char*21
12	char*19	Pass_File_Data_Type	char*6
13	char*19	POSEIDON_Range_Bias	char*8
14	char*16	TOPEX_Range_Bias	char*8
15	char*17	T/P_Sigma0_Offset	char*8
16	char*19	NASA_Orbit_Filename	char*38
17	char*15	Orbit_Qual_NASA	char*11
18	char*19	CNES_Orbit_Filename	char*38
19	char*15	Orbit_Qual_CNES	char*1
20	char*18	Topex_Pass_File_Id	char*33
21	char*21	Poseidon_Pass_File_Id	char*38
22	char*17	CORIOTROP_File_Id	char*38
23	char*12	Cycle_Number	char*3
24	char*11	Pass_Number	char*3
25	char*15	Pass_Data_Count	char*4
26	char*10	Rev_Number	char*5
27	char*17	Equator_Longitude	char*10
28	char*12	Equator_Time	char*24
29	char*13	Time_First_Pt	char*24
30	char*12	Time_Last_Pt	char*24
31	char*10	Time_Epoch	char*24
32	char*20	CCSD$$MARKERPASSFILE	-------
33	char*20	CCSD3RF0000300000001	-------

PASSFILE : SCIENTIFIC DATA RECORD n

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
		TIME GROUP				
1	**1**	Tim_Moy_1	Time, day part*1	SI	2	Day
2	**3**	Tim_Moy_2	Time, millisecond part	SI	4	10^{-3}s
3	**7**	Tim_Moy_3	Time, microsecond part	SI	2	10^{-6}s
4	**9**	Dtim_Mil	Time shift midframe	SI	4	10^{-6}s
5	**13**	Dtim_Bias	Net time tag correction	SI	4	10^{-6}s
6	**17**	Dtim_Pac	10 per second timing	SI	4	10^{-6}s
		LOCATION GROUP				
7	**21**	Lat_Tra	Latitude	SI	4	10^{-6}deg
8	**25**	Lon_Tra	Longitude	SI	4	10^{-6}deg
		ALTITUDE GROUP				
9	**29**	Sat_Alt	Altitude above the reference ellipsoid (NASA)	SI	4	10^{-3}m
10	**33**	HP_Sat	Altitude above the reference ellipsoid (CNES)	SI	4	10^{-3}m
11 to 20	**37**	Sat_Alt_Hi_Rate(i), i=1 to 10	Differences of satellite altitude from Sat_Alt	SI	10x2	10^{-3}m
21 to 30	**57**	HP_Sat(i), i = 1 to 10	Differences of satellite altitude from HP_Sat	SI	10x2	10^{-3}m
		ATTITUDE GROUP				
31	**77**	Att_Wvf	Waveform attitude	I	1	10^{-2}deg
32	**78**	Att_Ptf	Platform attitude	I	1	10^{-2}deg
		ALTIMETER RANGE GROUP				
33	**79**	H_Alt	One per second altimeter range	SI	4	10^{-3}m
34 to 43	**83**	H_Alt_SME(i), i= 1 to 10	Difference of altimeter range from H_Alt	SI	10x2	10^{-3}m
44	**103**	Nval_H_Alt	Number of valid points for 1 second altitude	SI	1	-
45	**104**	RMS_H_Alt	Root mean square of range	SI	2	10^{-3}m
46	**106**	Net_Instr_R_Corr_K	Net instrument correction to range (Ku)	SI	2	10^{-3}m
47	**108**	Net_Instr_R_Corr_C	Net instrument correction to range (C)	SI	2	10^{-3}m
48	**110**	CG_Range_Corr	Center of gravity movement correction to range	SI	1	10^{-3}m
59	**111**	Range_Deriv	Range derivative	SI	2	10^{-2}m/s
50	**113**	RMS_Range_Deriv	RMS of high-rate values of Range_Deriv	SI	2	10^{-2}m/s
		ENVIRONMENTAL CORRECTION GROUP				
51	**115**	Dry_Corr	Dry tropospheric correction at measurement time	SI	2	10^{-3}m
52	**117**	Dry1_Corr	Dry tropospheric correction before measurement	SI	2	10^{-3}m
53	**119**	Dry2_Corr	Dry tropospheric correction after measurement	SI	2	10^{-3}m
54	**121**	Inv_Bar	Inverse barometer correction at measurement time	SI	2	10^{-3}m
55	**123**	Wet_Corr	Wet tropospheric correction at measurement time	SI	2	10^{-3}m
56	**125**	Wet1_Corr	Wet tropospheric correction before measurement	SI	2	10^{-3}m
57	**127**	Wet2_Corr	Wet tropospheric correction after measurement	SI	2	10^{-3}m
58	**129**	Wet_H_Rad	Radiometer wet tropospheric correction	SI	2	10^{-3}m
59	**131**	Iono_Cor	Topex dual-frequency ionospheric correction	SI	2	10^{-3}m
60	**133**	Iono_Dor	Ionospheric correction from DORIS	SI	2	10^{-3}m
61	**135**	Iono_Ben	Ionospheric correction from Bent model	SI	2	10^{-3}m

* SI : Signed integer ; I : Unsigned integer ; BF : Bitfield

PASSFILE : SCIENTIFIC DATA RECORD n (continued)

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
		SIGNIFICANT WAVE HEIGHT AND EMB GROUP				
62	**137**	SWH_K	Significant wave height (Ku)	I	2	10^{-2}m
63	**139**	SWH_C	Significant wave height (C)	I	2	10^{-2}m
64	**141**	SWH_RMS_K	RMS of significant wave height (Ku)	I	1	10^{-2}m
65	**142**	SWH_RMS_C	RMS of significant wave height (C)	I	1	10^{-2}m
66	**143**	SWH_Pts_Avg	Number of valid points used to compute SWH	SI	1	
67	**144**	Net_Instr_SWH_Corr_K	Net instrument correction to SWH (Ku)	SI	1	10^{-1}m
68	**145**	Net_Instr_SWH_Corr_C	Net instrument correction to SWH (C)	SI	1	10^{-1}m
69	**146**	DR(SWH/att)_K	SWH/Attitude correction (Ku)	SI	2	10^{-3}m
70	**148**	DR(SWH/att)_C	SWH/Attitude correction (C)	SI	2	10^{-3}m
71	**150**	SSB_Corr_Kl	Sea State Bias correction (Ku) (BM4)	SI	2	10^{-3}m
72	**152**	SSB_Corr_K2	Sea State Bias correction (Ku) (TGS)	SI	2	10^{-3}m
		BACKSCATTER COEFFICIENT AND AGC GROUP				
73	**154**	Sigma0_K	Backscatter coefficient (Ku)	I	2	10^{-2}dB
74	**156**	Sigma0_C	Backscatter coefficient (C)	I	2	10^{-2}dB
75	**158**	AGC_K	Automatic gain control (Ku)	I	2	10^{-2}dB
76	**160**	AGC_C	Automatic gain control (C)	I	2	10^{-2}dB
77	**162**	AGC_RMS_K	RMS of automatic gain control (Ku)	SI	2	10^{-2}dB
78	**164**	AGC_RMS_C	RMS of automatic gain control (C)	I	1	10^{-2}dB
79	**165**	Atm_Att_Sig0_Corr	Atmospheric attenuation correction to sigma0	I	1	10^{-2}dB
80	**166**	Net_Instr_Sig0_Corr	Net instrument correction to sigma0	SI	2	10^{-2}dB
81	**168**	Net_Instr_AGC_Corr_K	Net instrument correction to AGC (Ku)	SI	2	10^{-2}dB
82	**170**	Net_Instr_AGC_Corr_C	Net instrument correction to AGC (C)	SI	2	10^{-2}dB
83	**172**	AGC_Pts_Avg	Number of valid points used to compute AGC	SI	1	
		GEOPHYSICAL QUANTITY GROUP				
84	**173**	H_MSS	Mean sea surface height	SI	4	10^{-3}m
85	**177**	H_Geo	Geoid height	SI	4	10^{-3}m
86	**181**	H_Eot_CSR	Elastic ocean tide (CSR 3.0)	SI	2	10^{-3}m
87	**183**	H_Eot_FES	Elastic ocean tide (FES95.2)	SI	2	10^{-3}m
88	**185**	H_Lt_CSR	Tidal loading effect (CSR3.0	SI	2	10^{-3}m
89	**187**	H_Set	Solid earth tide	SI	2	10^{-3}m
90	**189**	H_Pol	Geocentric pole tide	SI	1	10^{-3}m
91	**190**	Wind_Sp	Wind intensity (from altimeter data)	I	1	10^{-1}m/s
92	**191**	H_Ocs	Ocean depth	SI	2	m
		BRIGHTNESS TEMPERATURES GROUP				
93	**193**	Tb_18	Brightness temperature 18 GHz	SI	2	10^{-2}K
94	**195**	Tb_21	Brightness temperature 21 GHz	SI	2	10^{-2}K
95	**197**	Tb_37	Brightness temperature 37 GHz	S	2	10^{-2}K

PASSFILE : SCIENTIFIC DATA RECORD n (continued)

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
		FLAGS GROUP				
96	**199**	ALTON	Altimeter indicator	SI	1	-
97	**200**	Instr_State_TOPEX	States of Topex altimeter	BF	1	-
98	**201**	Instr_State_TMR	States of the TMR	BF	1	-
99	**202**	Instr_State_DORIS	States of Doris instrument	SI	1	-
100	**203**	IMANV	Maneuver indicator	SI	1	-
101	**204**	Lat_Err	Quality index of the latitude	SI	1	-
102	**205**	Lon_Err	Quality index of the longitude	SI	1	-
103	**206**	Val_Att_Ptf	Platform attitude validity	SI	1	-
104	**207**	Current_Mode_1	Altimeter current mode (Topex' first frame)	BF	1	-
105	**208**	Current_Mode_2	Altimeter current mode (Topex or Poseidon' second frame)	BF	1	-
106	**209**	Gate_Index	Topex gate index	BF	1	-
107	**210**	Ind_Pha	Poseidon indicator on tracker processing	SI	1	-
108	**211**	Rang_SME	State of 1/10 second values	I	2	-
109	**213**	Alt_Bad_1	Topex and Poseidon measurement conditions n°1	BF	1	-
110	**214**	Alt_Bad_2	Topex and Poseidon measurement conditions n°2	BF	1	-
111	**215**	Fl_Att	Attitude indicator	SI	1	-
112	**216**	Dry_Err	Quality index on Dry_Corr	SI	1	-
113	**217**	Dry1_Err	Quality index on Dry1_Corr	SI	1	-
114	**218**	Dry2_Err	Quality index on Dry2_Corr	SI	1	-
115	**219**	Wet_Flag	Interpolation indicator on Wet_Corr, Wet1_Corr and Wet2_Corr	SI	1	-
116	**220**	Wet_H_Err	Quality index on Wet_Corr, Wet1_Corr and Wet2_Corr	SI	1	-
117	**221**	Iono_Bad	Quality index on Iono_Cor	I	2	-
118	**223**	Iono_Dor_Bad	Quality index on Iono_Dor	SI	1	-
119	**224**	Geo_Bad_1	Ocean/land/ice indicator	BF	1	-
120	**225**	Geo_Bad_2	Rain/tide conditions	BF	1	-
121	**226**	TMR_Bad	Flags for brightness temperatures	BF	1	-
122	**227**	Ind_RTK	POSEIDON ground retracking indicator	BF	1	-
		SPARES GROUP				
123	**228**	spare	---	-	1	-

[*] SI : Signed integer ; I : Unsigned integer ; BF : Bitfield

3.5 CROSSOVER POINT FILE

3.5.1 Labeling and brief description

The crossover point file conforms to the following naming convention :

MGxccc.XNG

where

M	for the AVISO Merged product.
G	for GDR data type(1).
x	the generation letter (A to Z)(1). [At the date of edition 3, x = C.]
ccc	cycle number(2).
XNG	for the crossover point file.

(1) The data type, the generation letter and the version number are known through the cycle header file and through the name of the directory in which this file is recorded. The data type is also recorded inside the file (header part).

(2) The cycle number associated with the ten-day repeat period in which this data were acquired is recorded inside the file (header part) and also accessible through the cycle header file and through the directory name.

A crossover point file is computed from a cycle of GDR-M data. Each crossover file contains a header part and a science data part.
The header part provides processing history. The science data part contains the main GDR-M parameters for the ascending and descending tracks, interpolated at the crossover positions :

- ♦ **Altimeter range is interpolated using cubic splines from the 4 points before and the 4 points after the crossover point. However, if these points are too discontinuous in time or they do no respect some validity tests, no crossover point is recorded. The validity tests are :**
  - **| H_Alt - HP_Sat | ≤ 200 m,**
  - **RMS_H_Alt < 100 mm for Topex data type and < 200 mm for Poseidon data type,**
  - **Nval_H_Alt > 5 for Topex data type and > 15 for Poseidon data type,**
  - **0 ≤ Att_Wvf ≤ 0.4°,**
  - **0 ≤ SWH_K ≤ 15 m,**
  - **5 ≤ Sigma0_K ≤ 25 dB,**
  - **Data over land and over ice are also rejected.**

- ♦ **The other geophysical parameters (orbit, tides, etc) are linearly interpolated using the point before and the point after the crossover point. No gap is permitted between these two points, elsewhere a default value is reported.**

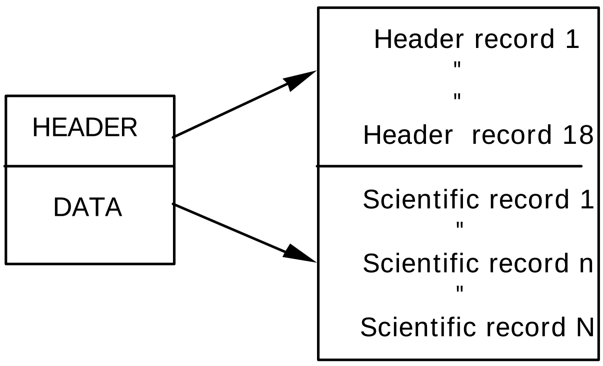
- ♦ **For the flags, the maximum values are reported, that is the worst state.**

3.5.2 Format

FILE NAME	**MGxccc.XNG**
FORMAT	Unformatted
ACCESS	Sequential or direct
TYPE	Header : ASCII (CCSDS format)
	Data : binary
RECORD LENGTH (fixed)	228 Bytes
	Header : 18 x 228 Bytes
	Data : N x 228 Bytes (N ≤ 7000)
SIZE	1600.0 Kbytes maximum

3.5.3 Content

A crossover point file contains a header and 7 000 scientific data records maximum. Whereas the header is recorded in ASCII type, the data part is recorded in a VAX binary integer type. A scientific data record contains 99 fields, each stored as one, two, four bytes or spares (1 + 40 bytes).



File content is given below. See chapters 5 and 7 for more details on each field.

CROSSOVER POINT FILE : HEADER RECORDS

Record number	*Format*	*KEYWORD Content*	*VALUE Format*
1	char*20	CCSD3ZF0000100000001	-------
2	char*20	CCSD3KS00006XINGFILE	-------
3	char*20	Producer_Agency_Name	char*4
4	char*25	Producer Institution_Name	char*5
5	char*11	Source_Name	char*14
6	char*11	Sensor_Name	char*14
7	char*23	Data_Handbook_Reference	char*21
8	char*25	Product_Create_Start_Time	char*17
9	char*23	Product_Create_End_Time	char*17
10	char*24	Generating_Software_Name	char*50
11	char*8	Build_Id	char*21
12	char*9	Data_Type	char*6
13	char*23	GDR-M_Cycle_Header_Name	char*10
14	char*12	Cycle_Number	char*3
15	char*15	Crossover_count	char*5
16	char*10	Time_Epoch	char*24
17	char*20	CCSD$$MARKERXINGFILE	-------
18	char*20	CCSD3RF0000100000001	-------

CROSSOVER POINT FILE : SCIENTIFIC DATA RECORD n

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
1	**1**	Typ_Cro	Crossover point type	SI	1	-
2	**2**	Lat_Cro	Latitude	SI	4	10^{-6}deg
3	**6**	Lon_Cro	Longitude	SI	4	10^{-6}deg
4	**10**	H_MSS_Cro	Mean sea surface height	SI	4	10^{-3}m
5	**14**	H_OCS_Cro	Ocean depth	SI	2	m
6	**16**	Spare	--------------------------------------	-	1	-

SI : Signed integer ; I : Unsigned integer ; BF : Bitfield

CROSSOVER POINT FILE : SCIENTIFIC DATA RECORD n (continued)

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
		ASCENDING ARC PARAMETERS				
7	**17**	Num_Pass_Asc	Ascending arc number	I	1	-
8	**18**	Tim_Moy_Asc_1	Time, day part	SI	2	day
9	**20**	Tim_Moy_Asc_2	Time, millisecond part	SI	4	10^{-3}s
10	**24**	Tim_Moy_Asc_3	Time, microsecond part	SI	2	10^{-6}s
11	**26**	Sat_Alt_Asc	Altitude above the reference ellipsoid (NASA)	SI	4	10^{-3}m
12	**30**	HP_Sat_Asc	Altitude above the reference ellipsoid (CNES)	SI	4	10^{-3}m
13	**34**	Att_Ptf_Asc	Platform attitude	I	1	10^{-2}deg
14	**35**	Att_Wvf_Asc	Waveform attitude	I	1	10^{-2}deg
15	**36**	H_Alt_Asc	One per second altimeter range	SI	4	10^{-3}m
16	**40**	Spline_RMS_Asc	RMS of 8 points compared to the spline	SI	1	10^{-3}m
17	**41**	Net_Instr_R_Corr_K_Asc	Net instrument correction to range (Ku)	SI	2	10^{-3}m
18	**43**	Net_Instr_R_Corr_C_Asc	Net instrument correction to range (C)	SI	2	10^{-3}m
19	**45**	Range_Deriv_Asc	Range derivative	SI	2	10^{-2}m/s
20	**47**	RMS_H_Alt_Asc	Root mean square of range	SI	2	10^{-3}m
21	**49**	Dry_Corr_Asc	Dry tropospheric correction at measurement time	SI	2	10^{-3}m
22	**51**	Dry1_Corr_Asc	Dry tropospheric correction before measurement	SI	2	10^{-3}m
23	**53**	Dry2_Corr_Asc	Dry tropospheric correction after measurement	SI	2	10^{-3}m
24	**55**	Inv_Bar_Asc	Inverse barometer correction at measurement time	SI	2	10^{-3}m
25	**57**	Wet_Corr_Asc	Wet tropospheric correction at measurement time	SI	2	10^{-3}m
26	**59**	Wet1_Corr_Asc	Wet tropospheric correction before measurement	SI	2	10^{-3}m
27	**61**	Wet2_Corr_Asc	Wet tropospheric correction after measurement	SI	2	10^{-3}m
28	**63**	Wet_H_Rad_Asc	Radiometer wet tropospheric correction	SI	2	10^{-3}m
29	**65**	Iono_Cor_Asc	TOPEX dual-frequency ionospheric correction	SI	2	10^{-3}m
30	**67**	Iono_Dor_Asc	Ionospheric correction from DORIS	SI	2	10^{-3}m
31	**69**	Iono_Ben_Asc	Ionospheric correction from Bent model	SI	2	10^{-3}m
32	**71**	SWH_K_Asc	Significant wave height (Ku)	I	2	10^{-2}m
33	**73**	SWH_C_Asc	Significant wave height (C)	I	2	10^{-2}m
34	**75**	SSB_Corr_K1_Asc	Sea State Bias correction (Ku) (BM4)	SI	2	10^{-3}m
35	**77**	DR(SWH/att)_K_Asc	Attitude correction (Ku)	SI	2	10^{-3}m
36	**79**	DR(SWH/att)_C_Asc	Attitude correction(C)	SI	2	10^{-3}m
37	**81**	Sigma0_K_Asc	Backscatter coefficient (Ku)	I	2	10^{-2}dB
38	**83**	Sigma0_C_Asc	Backscatter coefficient (C)	I	2	10^{-2}dB
39	**85**	H_Eot_CSR_Asc	Elastic ocean tide (CSR3.0)	SI	2	10^{-3}m
40	**87**	H_Eot_FES_Asc	Elastic ocean tide (FES95.2)	SI	2	10^{-3}m
41	**89**	H_Lt_CSR_Asc	Tidal loading effect (CSR3.0)	SI	2	10^{-3}m
42	**91**	H_Set_Asc	Solid earth tide	SI	2	10^{-3}m
43	**93**	H_Pol_Asc	Geocentric pole tide	SI	1	10^{-3}m
44	**94**	Wind_Sp_Asc	Wind intensity (from altimeter data)	I	1	10^{-1}m/s
45	**95**	Geo_Bad_1_Asc	Ocean/land/ice indicator	BF	1	-
46	**96**	Geo_Bad_2_Asc	Rain/tide conditions	BF	1	-
47	**97**	Dry_Err_Asc	Quality index on Dry_Corr_Asc	SI	1	-
48	**98**	Dry1_Err_Asc	Quality index on Dry1_Corr_Asc	SI	1	-
49	**99**	Dry2_Err_Asc	Quality index on Dry2_Corr_Asc	SI	1	-
50	**100**	Wet_H_Err_Asc	Quality index on Wet_Corr_Asc, Wet1_Corr_Asc and Wet2_Corr_Asc	SI	1	-
51	**101**	Iono_Dor_Bad_Asc	Quality index on Iono_Dor_Asc	SI	1	-
52	**102**	Ind_RTK_Asc	POSEIDON ground retracking indicator	BF	1	-

SI : Signed integer ; I : Unsigned integer ; BF : Bitfield.

CROSSOVER POINT FILE : SCIENTIFIC DATA RECORD n (continued)

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
		DESCENDING ARC PARAMETERS				
53	**103**	Num_Pass_Des	Descending arc number	I	1	-
54	**104**	Tim_Moy_Des_1*	Time, day part	SI	2	day
55	**106**	Tim_Moy_Des_2	Time, millisecond part	SI	4	10^{-3}s
56	**110**	Tim_Moy_Des_3	Time, microsecond part	SI	2	10^{-6}s
57	**112**	Sat_Alt_Des	Altitude above the reference ellipsoid (NASA)	SI	4	10^{-3}m
58	**116**	HP_Sat_Des	Altitude above the reference ellipsoid (CNES)	SI	4	10^{-3}m
59	**120**	Att_Ptf_Des	Platform attitude	I	1	10^{-2}deg
60	**121**	Att_Wvf_Des	Waveform attitude	I	1	10^{-2}deg
61	**122**	H_Alt_Des	One per second altimeter range	SI	4	10^{-3}m
62	**126**	Spline_RMS_Des	RMS of 8 points compared to the spline	SI	1	10^{-3}m
63	**127**	Net_Instr_R_Corr_K_Des	Net instrumentcorrection to range (Ku)	SI	2	10^{-3}m
64	**129**	Net_Instr_R_Corr_C_Des	Net instrument correction to range (C)	SI	2	10^{-3}m
65	**131**	Range_Deriv_Des	Range derivative	SI	2	10^{-2}m/s
66	**133**	RMS_H_Alt_Des	Root mean square of range	SI	2	10^{-3}m
67	**135**	Dry_Corr_Des	Dry tropospheric correction at measurement time	SI	2	10^{-3}m
68	**137**	Dry1_Corr_Des	Dry tropospheric correction before measurement	SI	2	10^{-3}m
69	**139**	Dry2_Corr_Des	Dry tropospheric correction after measurement	SI	2	10^{-3}m
70	**141**	Inv_Bar_Des	Inverse barometer correction at measurement time	SI	2	10^{-3}m
71	**143**	Wet_Corr_Des	Wet tropospheric correction at measurement time	SI	2	10^{-3}m
72	**145**	Wet1_Corr_Des	Wet tropospheric correction before measurement	SI	2	10^{-3}m
73	**147**	Wet2_Corr_Des	Wet tropospheric correction after measurement	SI	2	10^{-3}m
74	**149**	Wet_H_Rad_Des	Radiometer wet tropospheric correction	SI	2	10^{-3}m
75	**151**	Iono_Cor_Des	TOPEX dual-frequency ionospheric correction	SI	2	10^{-3}m
76	**153**	Iono_Dor_Des	Ionospheric correction from DORIS	SI	2	10^{-3}m
77	**155**	Iono_Ben_Des	Ionospheric correction from Bent model	SI	2	10^{-3}m
78	**157**	SWH_K_Des	Significant wave height (Ku)	I	2	10^{-2}m
79	**159**	SWH_C_Des	Significant wave height (C)	I	2	10^{-2}m
80	**161**	SSB_Corr_K1_Des	Sea State Bias correction (Ku) (BM4)	SI	2	10^{-3}m
81	**163**	DR(SWH/att)_K_Des	Attitude correction (Ku)	SI	2	10^{-3}m
82	**165**	DR(SWH/att)_C_Des	Attitude correction (C)	SI	2	10^{-3}m
83	**167**	Sigma0_K_Des	Backscatter coefficient (Ku)	I	2	10^{-2}dB
84	**169**	Sigma0_C_Des	Backscatter coefficient (C)	I	2	10^{-2}dB
85	**171**	H_Eot_CSR_Des	Elastic ocean tide (CSR3.0)	SI	2	10^{-3}m
86	**173**	H_Eot_FES_Des	Elastic ocean tide (FES95.2)	SI	2	10^{-3}m
87	**175**	H_Lt_CSR_Des	Tidal loading effect (CSR3.0)	SI	2	10^{-3}m
88	**177**	H_Set_Des	Solid earth tide	SI	2	10^{-3}m
89	**179**	H_Pol_Des	Geocentric pole tide	SI	1	10^{-3}m
90	**180**	Wind_Sp_Des	Wind intensity (from altimter data)	I	1	10^{-1}m/s
91	**181**	Geo_Bad_1_Des	Ocean/land/ice indicator	BF	1	-
92	**182**	Geo_Bad_2_Des	Rain/tide conditions	BF	1	-
93	**183**	Dry_Err_Des	Quality index on Dry_Corr_Des	SI	1	-
94	**184**	Dry1_Err_Des	Quality index on Dry1_Corr_Des	SI	1	-
95	**185**	Dry2_Err_Des	Quality index on Dry2_Corr_Des	SI	1	-
96	**186**	Wet_H_Err_Des	Quality index on Wet_Corr_Des, Wet1_Corr_Des and Wet2_Corr_Des	SI	1	-
97	**187**	Iono_Dor_Bad_Des	Quality index on Iono_Dor_Des	SI	1	-
98	**188**	Ind_RTK_Des	POSEIDON ground retracking indicator	BF	1	-
99	**189**	Spares	--	-	40	-

SI : Signed integer ; I : Unsigned integer ; BF : Bitfield.

3.6 ORBIT FILES

3.6.1 Labeling and brief description

The orbit file conforms to the following naming convention :

MGxccc.eee

where

M	for the AVISO Merged product.
G	for GDR data type(1).
x	the generation letter (A to Z)(1). [At the date of edition 3, x = C.]
ccc	cycle number(2).
eee	orbit origin (EPC for the CNES ephemeris or EPN for the NASA ephemeris).

(1) The data type and the generation letter are known through the cycle header file and through the name of the directory in which this file is recorded. The data type is also recorded inside the file (header part).

(2) The cycle number associated with the ten-day repeat period in which this data were acquired is recorded inside the file (header part) and also accessible through the cycle header file and through the directory name.

An orbit file contains precise orbit data covering a ten-day repeat cycle. Two orbit files are available, one computed by CNES (EPC type) and one computed by NASA (EPN type).

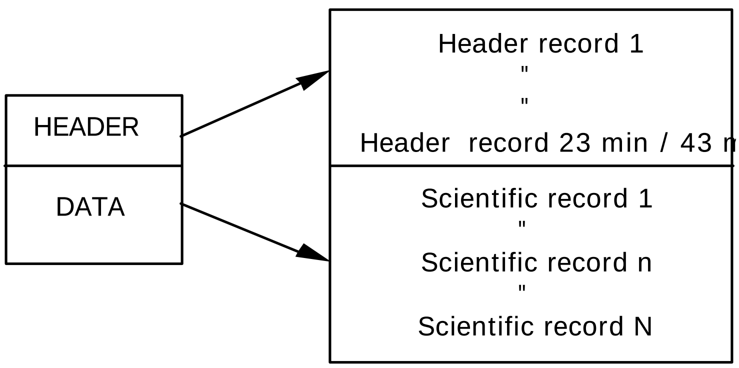
Each orbit file contains a header part and a science data part. The header part provides processing history. The science data part contains the orbit data sampled every minute.

3.6.2 Format

FILENAME	**MGxccc.eee**
FORMAT	Unformatted
ACCESS	Sequential or direct
TYPE	Header : ASCII (CCSDS format)
	Data : binary
RECORD LENGTH (fixed)	56 Bytes
	Header : 23/43 min/maximum x 56 Bytes
	Data : N x 56 Bytes (N ≤ 14 424)
SIZE	810.2 Kbytes maximum

3.6.3 Content

An orbit file contains a header and 14 424 scientific data records maximum (one per minute on ten days). Whereas the header is recorded in ASCII type, the data part is recorded in a VAX binary integer type. A scientific data record contains 13 fields, each stored as one, two or four bytes or spares (18 bytes).



File content is given below. See chapters 5 and 8 for more details on each field.

ORBITS-FILE : HEADER RECORDS

Record number	Format	KEYWORD Content	VALUE Format
1	char*20	CCSD3ZF0000100000001	-------
2	char*20	CCSD3KS00006ORBIFILE	-------
3	char*20	Producer_Agency_Name	char*4
4	char*25	Producer Institution_Name	char*5
5	char*11	Source_Name	char*14
6	char*11	Sensor_Name	char*14
7	char*23	Data_Handbook_Reference	char*21
8	char*25	Product_Create_Start_Time	char*17
9	char*23	Product_Create_End_Time	char*17
10	char*24	Generating_Software_Name	char*50
11	char*8	Build_Id	char*21
12	char*12	Cycle_Number	char*3
13	char*13	Time_First_Pt	char*24
14	char*12	Time_Last_Pt	char*24
15	char*10	Time_Epoch	char*24
16	char*13	Sampling_Rate	char*2
17	char*17	Equatorial_Radius	char*9
18	char*28	Inverse_Flatness_Coefficient	char*12
19	char*23	Input_Orbit_File_Number	char*2
20	char*8	Orbit_Id	char*38
21	char*13	Orbit_Quality	char*11
(22)	char*8	Orbit_Id[*]	char*38
(23)	char*13	Orbit_Quality*	char*11
(24)	char*8	Orbit_Id*	char*38
(25)	char*13	Orbit_Quality*	char*11
(26)	char*8	Orbit_Id*	char*38
(27)	char*13	Orbit_Quality*	char*11
(28)	char*8	Orbit_Id*	char*38
(29)	char*13	Orbit_Quality*	char*11
(30)	char*8	Orbit_Id*	char*38
(31)	char*13	Orbit_Quality*	char*11
(32)	char*8	Orbit_Id*	char*38
(33)	char*13	Orbit_Quality*	char*11
(34)	char*8	Orbit_Id*	char*38
(35)	char*13	Orbit_Quality*	char*11
(36)	char*8	Orbit_Id*	char*38
(37)	char*13	Orbit_Quality*	char*11
(38)	char*8	Orbit_Id*	char*38
(39)	char*13	Orbit_Quality*	char*11
(40)	char*8	Orbit_Id*	char*38
(41)	char*13	Orbit_Quality*	char*11
22 (to 42)	char*20	CCSD$$MARKERORBIFILE	-------
23 (to 43)	char*20	CCSD3RF0000300000001	-------

[*] The NASA orbit file used to compute the orbit file on CD ROM is unique if there is no maneuver during the cycle. If there is a maneuver, there are two orbit files, one before the maneuver time, one after the maneuver time. The CNES orbit files used to compute the orbit file on CD ROM are per day. There may be 10 to 11 files to cover a cycle.

ORBIT-FILE : SCIENTIFIC DATA RECORD n

Field Number	*Record Location*	*Mnemonic*	*Content*	*Type*	*Size*	*Units*
1	**1**	Tim_Moy_1	Time, day part	SI	2	day
2	**3**	Tim_Moy_2	Time, millisecond part	SI	4	10^{-3}sec
3	**7**	Tim_Moy_3	Time, microsecond part	SI	2	10^{-6}sec
4	**9**	Lat	Latitude	SI	4	10^{-6}deg
5	**13**	Lon	Longitude	SI	4	10^{-6}deg
6	**17**	Orb	Radial orbital height	SI	4	10^{-3}m
7	**21**	X_CTRS_1	X, satellite position (CTRS), millimeter part	SI	2	10^{-3}m
8	**23**	X_CTRS_2	X, satellite position (CTRS), meter part	SI	4	m
9	**27**	Y_CTRS_1	Y, satellite position (CTRS), millimeter part	SI	2	10^{-3}m
10	**29**	Y_CTRS_2	Y, satellite position (CTRS), meter part	SI	4	m
11	**33**	Z_CTRS_1	Z, satellite position (CTRS), millimeter part	SI	2	10^{-3}m
12	**35**	Z_CTRS_2	Z, satellite position (CTRS), meter part	SI	4	m
13	**39**	Spares	--	-	18	-

4. USING GDR-M ALTIMETER DATA

The scope of this chapter is to introduce the reader on how he may use POSEIDON and TOPEX altimeter measurements for science applications. The information that will be given concern :

1. orbit fields,
2. altimeter range and calibration biases,
3. geophysical corrections,
4. ocean wave influence (sea state bias),
5. inverse barometer effect,
6. geoid and mean sea surface,
7. tidal models,
8. Sigma naughts,
9. algorithm used for computing the wind speed,
10. data editing criteria,

4.1 ORBIT FIELDS

Two orbit fields are available with the GRD-Ms. Both are computed with the JGM3 gravity model and using DORIS and Laser measurements. The NASA orbit is a classical dynamic orbit whereas the CNES orbit is a reduced dynamic orbit (called ELFE, a French acronyms for estimation by empirical smoothing and filtering).

Why use both the CNES reduced and the NASA dynamic orbit in the GDRs ? Experience shows that the space-time error spectrum was comparable when CNES and NASA both produced dynamic orbits with JGM2. The change to JGM3 was deservedly successful [Relative to JGM2, JGM3 corrects some of the orbit errors geographically correlated in certain areas. This can be seen by comparing, point by point, dynamic orbits calculated with JGM2 and JGM3], but two over-similar products would have added nothing. ELFE is a way of reshaping the error spectra while staying within a comparable accuracy range (2 to 3 cm).

4.2 ALTIMETER RANGE AND CALIBRATION BIASES

An altimeter operates by sending out a short radar pulse and measuring the time required for the pulse echoe to return from the sea surface. This measurement called the altimeter range gives an estimate of the height of the instrument above the sea surface, provided that the velocity of the propagation of the pulse and the precise arrival time are known.

After a mispointing problem which happened during the first phase of the mission (cycles 1 to 8), the satellite attitude is often much less than 0.1°. Noise of both altimeters is far within specification, i.e. at a 2 cm rms level for one second average and a typical 2 m significant waveheight.

The TOPEX and POSEIDON altimeter ranges reported in the GDR-M science data record have been corrected for all instrumental errors - *they are not corrected for the center of gravity movement caused by solar array motion* - and are displayed as fully homogeneous - *absolute and relative range biases, as well as any altimeter drift are taken into account* -.

- Note that POSEIDON range measurements automatically account for internal calibration data, so that there is nothing comparable to TOPEX to perform. Internal calibration constants have been applied to TOPEX range measurements on the basis of figures provided by WFF on a cycle by cycle rythm.

- An updated platform oscillator drift correction to the TOPEX range measurements has been accounted for, after an error was lately -July 1996- discovered about the corresponding algorithm. (Note that POSEIDON data were not corrupted by the error because POSEIDON time reference is given by the DORIS instrument and not the platform oscillator).

- POSEIDON range measurement have been corrected for the difference in sea state instrumental bias between TOPEX and POSEIDON (see § 4.4 for details).

- Altimeter range calibration biases have been applied to provide homogeneity between TOPEX and POSEIDON, so that a user has no longer to distinguish one altimeter from the other in his own data processing. Taking into account the right correction for oscillator drift effect, computation of TOPEX - POSEIDON relative range measurement comes down to 1.5 cm.

Absolute range biases are thus assumed as:

- **Range Bias applied on POSEIDON data = 0 cm**
- **Range Bias applied on TOPEX data = 1.5 cm (TOPEX measuring too short)**

These figures of absolute biases are compatible with figures derived from the two project calibration campaigns that were held in Lampedusa (Mediterranean Sea) and near Point Conception (Harvest platform, California) by CNES and NASA.

Indeed, figures published by Ménard et al. (1994) and Christensen et al. (1994) should be updated by taking into account the platform oscillator drift effect correctly in the TOPEX measurements, and after analysis of longer time series (more than 3 years instead of roughly 6 months in the above mentioned publications) of calibration data. By doing so, the 0 cm bias for POSEIDON and 1.5 cm for TOPEX are within the errors bars of the estimates resulting from ground calibration analysis.

The AVISO/CALVAL group also used a repeat-track technique to derive an estimate of the relative range bias between both altimeters (see Le Traon et al., 1994, Minster et al., 1994). Along-track differences between data from a full POSEIDON cycle n and the full neighbouring TOPEX cycles, i.e. cycles n-1 and n+1, were computed for each half revolution track. The mean relative bias found is -1.5 cm, the negative sign meaning that the NRA is measuring shorter than the SSALT: such a figure has been calculated when using the CSR3.0 tide model and the BM4 sea state bias correction (see § 4.7 and 4.4 respectively).

- Altimetric measurements have many other sources of error. For instance, they need to be corrected for environment perturbations like the geophysical corrections (wet troposphere, dry troposphere, ionosphere), the ocean wave infiuence (sea state or electromagnetic bias). Also, the tide influence (ocean tide, earth tide and pole tide) and inverse barometer effect have to be accounted for. To compute the correct value of sea surface height, the following operation need to be done : « Orbit - Altimeter Range - Geophysical Corrections » (see § 1.3.2). If now we subtract the geoid height, we obtain the sea surface dynamic topography signal, i.e. the oceanic topography caused by permanent surface geostrophic currents.

  Rain influence attenuates also the altimeter pulse, and heavy rain greatly reduces the echo from the sea surface. Light rain tends to produce rapid changes in the strength of the echo as the altimeter crosses rain cells. Both effects degrade the performance of the altimeter. Data contaminated by rain are evidenced by the inverse of RMS_H_Alt or the decrease in Sigma0_K and are consequently tagged and ignored [see also Geo_Bad_2 parameter].

4.3 GEOPHYSICAL CORRECTIONS

The atmosphere and ionosphere slow the velocity of radio pulses at a rate proportional to the total mass of the atmosphere (dry troposphere influence), the mass of water vapor in the atmosphere (wet troposphere influence), and the number of free electrons in the ionosphere (ionosphere influence). In addition, radio pulses do not reflect from the mean sea level but from a level that depends on wave height.

4.3.1 Troposphere influence (dry and wet)

The propagation velocity of a radio pulse is slowed by the gases and the quantity of water vapor in the Earth's troposphere. The former is quite predictable and produces height errors of approximately -2.3 m. But water vapor in the troposphere is more variable and difficult to access, it produces a height error of 6-30 cm.

- The gases in the troposphere contribute to the index of refraction of the Earth's atmosphere. Its contribution depends on density and temperature. When hydrostatic equilibrium and the ideal gas law are assumed, the vertically integrated range delay is a function only of the surface pressure. The dry meteorological tropospheric range correction is equal to the surface pressure value multiplied by -2.27 mm/mb [see Dry_Corr, Dry1_Corr and Dry2_Corr parameters]. There is no straightforward way of measuring the nadir surface pressure from a satellite, so it will be determined from numerical model outputs received every six hours from the European Center for Medium Range Weather Forecasting (ECMWF). The uncertainty on the dry tropospheric correction is about 0.7 cm on a 1000 - 3000 km scale.

- The amount of water vapor along the path length contributes also to the index of refraction of the Earth's atmosphere. Its contribution can be estimated by measuring the natural radiation emerging at the top of the atmosphere at frequencies located around the water vapor line at 22.2356 GHz.

  TMR measures the brightness temperatures in the nadir path at 18, 21 and 37 GHz : the water vapor signal is sensed by the 21 GHz channel, while the 18 GHz is used to remove the surface emission (wind speed influence), and the 37 GHz to remove other atmospheric contributions (cloud cover influence). Measurements are combined to obtain the error in the satellite range measurements due to the water vapor effect [see Wet_H_Rad parameter]. The uncertainty is about 1.2 cm for 100 - 2000 km scalse.

Elsewhere, the meteorological model calculates also a value of the wet tropospheric delay which is placed on the GDR-M as a backup to the TMR. This backup will prove useful when sun glint, land contamination, or anomalous sensor behavior makes the TMR data unusable [see Wet_Corr, Wet1_Corr and Wet2_Corr parameters].

4.3.2 Ionosphere influence

At the frequencies used by the TOPEX/POSEIDON altimeters, the propagation velocity of a radio pulse is slowed by an amount proportional to the number of free electrons of the Earth’s ionosphere and inversely proportional to the square of the altimeter frequency. For instance, it causes the altimeter to slightly over-estimate the range to the sea surface by typically 0.2-20 cm at 13.6 Ghz. The amount varies from day to night (very few free electons at night), from summer to winter (fewer during the summer), and as a function of the solar cycle (fewer during solar minimum).

Because this effect is dispersive, it can be estimated from measurements at two frequencies of any field. Thus it is computed from the TOPEX altimeter measurements [see Iono_Cor parameter] and from the DORIS measurements [see Iono_Dor parameter]. The former estimate is only valid for TOPEX data, the latter for TOPEX and POSEIDON data. As a backup, the BENT model correction is also provided in the GDR-M [see Iono_Ben parameter].

Note that the TOPEX ionospheric correction is expected to be negative, but positive values are allowed up to +40mm to accomodate instrument noise effects. However averaging over 100 km or more, as recommended during the 1993 Verification meeting, will almost always result in negative numbers. The TOPEX ionspheric GDR-M parameter is not averaged to allow the user to smooth the data as desired.

The comparison between the DORIS correction and the TOPEX dual frequency correction leads to a mean difference of the order of 1 cm together with a global rms figure of 1.5 cm (depending on the local time of the cycle). The remarkably small mean difference is quite stable from cycle to cycle and could be attributed to the accuracy of the C-band height calibration. Regionally speaking, two areas display the major discrepancies. Due to a lack of DORIS data, the western Pacific area is first concerned, the situation being gradually improved with the installation of new beacons in this area ; the equatorial Atlantic is also concerned due to an unsufficient modelling of the geomagnetic field that has been much improved since cycle 41.

Typical figures of accuracy are 0.5 cm over 150 - 2000 km scales for the TOPEX bi-frequency estimate.

4.4 OCEAN WAVE INFLUENCE (sea state bias)

Due to the large footprint radar measurements, the sea surface scattering elements do not contribute equally to the radar return : troughs of waves tend to reflect altimeter pulses better than do crests. Thus the centroid of the mean reflecting surface is shifted away from mean sea level towards the troughs of the waves. The shift causes the altimeter to over-estimate the height of the satellite above the sea surface The Sea State Bias (SSB) is the difference between the apparent sea level as measured by an altimeter and the true mean sea level [see SSB_Bias_Corr_Ki parameters].

The nature of the sea state bias has been investigated using airborne radars and lasers capable of determining for various sea states the strength of the vertically reflected signal as a function of the displacement of the reflecting area from mean sea level. It is given as a function of wind speed and the skewness and kurtosis of the probability distribution of sea surface elevation due to the waves on the sea surface. The SSB is made of two components : the electromagnetic bias (EMB) and the instrumental bias (INB):

- The EMB is the difference between the mean height of the sea surface specular facets and the mean sea level, it is a purely physical effect linked to the electromagnetic properties of the sea surface: The sea surface radar cross section per unit area varies with displacement from the mean water level. It is smaller towards the crests and larger towards the troughs (Yaplee, 1971). In other words, the wave troughs are better reflectors than the crests. As a result, the mean height of the sea surface specular facets is below the mean sea level. The difference between the mean height of the specular facets and the mean sea level is the EMB. It is a function of the significant wave height and other sea-state related parameters. It varies with the radar frequency.

Since TOPEX and POSEIDON operate at the same frequency, they have the same EMB.

- The INB is the error in tracking the mean height of the specular facets; it depends on the radar design and the algorithms used for tracking: Altimeter trackers tend to provide a slightly biased estimate of the mean height of the sea surface specular facets. This instrumental bias is generally proportional to the significant wave height. Formally, the instrumental bias can be expressed as the sum of a so-called skewness bias and a tracker bias but this distinction is not used here.

  TOPEX and POSEIDON INB can be different, thereby causing different SSBs

a) Theoretical understanding of the SSB, and in particular of the EMB, remains limited. Therefore, the most accurate SSB estimates are still obtained using empirical models derived from analyses of altimeter data itself. Based on the results of Gaspar et al. (1994) and Chelton (1994), the so-called BM4 model is used to estimate the SSB of both TOPEX and POSEIDON, **Ku band** [SSB_Corr_Ki parameter]. This model takes the form :

$$SSB_{[Ku]} = SWH_{[Ku]} \ [a1 + a^2 * U + a3 * U^2 + a4 * SWH_{[Ku]}]$$

where	SSB	is the sea state bias, in meters	(Ku band)
	U	is the wind intensity, in m/s	(Ku band)
	SWH	is the Significant Wave Height, in meters	(Ku band)

The latest estimates of the "ai" parameters, reported by Gaspar et al. (1996) are given in the table below :

	a1	**a2**	**a3**	**a4**
TOPEX (Ku)	**-0.0203**	**-0.00369**	**0.000149**	**0.00265**
POSEIDON	**-0.0539**	**-0.00225**	**0.000097**	**0.00183**

Thus, the new M-GDRs displays a first SSB_Corr_K1 correction corresponding to the above BM4 [TOPEX] model, and that must be applied homogeneously to both TOPEX and POSEIDON range measurements. **To make this possible, an arbitrary correction : dSSB= BM4(POSEIDON) - BM4(TOPEX) has been added to the POSEIDON range. Notice that, since TOPEX and POSEIDON have the same EMB, this correction simply corresponds to the difference in instrumental bias between TOPEX and POSEIDON : dSSB = INB(POSEIDON)-INB(TOPEX).**

b) Besides the SSB estimate that was computed using TOPEX/POSEIDON data themselves the NASA TOPEX project team has chosen to report a second estimate of the Ku and C-band sea-state biases as computed using a general second-order power series showing dependance upon various possible altimeter observables:

$$SSB_{[Ku]} = -SWH_{[Ku]} * [a_{Ku} + b_{Ku} * SWH_{[Ku]} + c_{Ku} * U_{[Ku]} + d_{Ku} * (rU_{[Ku]}{}^2 / SWH_{[Ku]})^{0.5} + e_{Ku} * SWH_{[Ku]}{}^2 + f_{Ku} * U_{[Ku]}{}^2]$$

$$SSB_{[C]} = -SWH_{[C]} * [a_C + b_C * SWH_{[C]} + c_C * U_{[C]} + d_C * (rU_{[C]}{}^2/SWH_{[C]})^{0.5} + e_C * SWH_{[C]}{}^2 + f_C * U_{[C]}{}^2]$$

where

- SSB is the sea state bias, in meters (for Ku or C band)
- SWH is the significant wave height, in meters (for Ku or C band)
- U is the wind speed, in m/s for Ku or C band (for Ku or C band)
- r is a proportionality constant: r = 0.026
  rU^2 represents the SWH that the wind speed is capable of generating (see Mognard et al., 1982), $(rU^2/SWH)^{0.5}$ is approximately proportional to the reciprocal of the 'wave age'. It deals with wind speed and wave height together. It characterizes the wave heights as being all swell (=0), a combination of sea and swell (<1), fully developed (=1), or developing sea (>1).

- a_{Ku}, b_{Ku}, c_{Ku}, d_{Ku}, e_{Ku}, f_{Ku} are calibration constants of Ku band:
- a_C, b_C, c_C, d_C, e_C, f_C are calibration constants of C band:

	a	b	c	d	e	f
TOPEX (Ku)	**0.0029**	**0.0**	**0.0038**	**0.0**	**0.0**	**- 0.00015**
TOPEX (C)	**0.0038**	**0.0**	**0.0038**	**0.0**	**0.0**	**- 0.00013**

(Note that the Ku_Band Sea State Bias is reported in the SSB_Corr_K_2 GDR-M parameter and C_Band Sea State Bias is not inclucled in the science records. A user can get the C_Band value from the above coefficients, if necessary).

4.5 THE INVERSE BAROMETER EFFECT

As atmospheric pressure increases and decreases, the sea surface tends to respond hydrostatically. The ocean rises and falls, that is, a 1 mbar increase in atmospheric pressure depresses the sea surface by about 1 cm.

The instantaneous correction is computed using as input the surface atmospheric pressure (P_atm, in mbar) which is available indirectly via the dry tropospheric correction obtained from meteorology (Dry_Corr, in mm) :

$$\text{P\_atm} = \text{Dry\_Corr} / \{(-2.277) * (1 + (0.0026 * \cos(2 * \text{Lat\_Tra} * 1.\ 10^{-6} * \pi / 180.0)))\}.$$

The inverse barometer correction (Inv_Bar, in mm) is then :

$$\text{Inv\_Bar} = -9.948 * (\text{P\_atm} - 1013.3)$$

This mode of calculation of the inverse barometric effect could be questionned when considering time scales of sea-level response versus time scales of barometric forcing. Response of sea-level to atmospheric pressure forcing being a subject of science investigation, the estimate that is provided in the GDR-M is thus to be used with caution depending in the type of applications which is intended.

4.6 GEOID AND MEAN SEA SURFACE

4.6.1 Geoid (JGM-3/OSU91A)

The geoid is an equipotential surface of the Earth's gravity field that is closely associated with the location of the mean sea surface. The reference ellipsoid is a bi-axial ellipsoid of revolution whose surface is equipotential. The center of the ellipsoid is ideally at the center of mass of the Earth although the center is usually placed at the origin of the reference frame in which a satellite orbit is calculated and tracking station positions given. The separation between the geoid and the reference ellipsoid is the geoid undulation.

The geoid undulation, over the entire Earth, has a root mean square value of 30.6 meters with extreme values of approximately 83 meters and -106 meters. Although the geoid undulations are primarily a long wavelength phenomena, high frequency changes in the geoid undulation are seen over seamounts, trenches, ridges, etc., in the oceans. The calculation of a high resolution geoid requires high resolution surface gravity data in the region of interest as well as a potential coefficient model that can be used to define the long and medium wavelengths of the Earth's gravitational field. If no surface gravity data is used the highest degree expansion of the Earth's gravitational potential is desired. Currently such expansions can be done to degree 360 and in some cases higher.

For ocean circulation studies, it is important that the long wavelength part of the geoid be accurately determined. Improved geopotential models have become available that are a substantial improvement over the model (OSU91A, Rapp, Wang, Pavlis, 1991) that was used for the computation of the undulations placed on the initial TOPEX/POSEIDON GDRs. Tests (Tapley et al., 1994a; Rapp et al., 1995) with the newer geopotential models (e.g. JGM-2 and JGM-3) demonstrate that the JGM-3 potential coefficient model, described in Tapley et al., 1994b, gives long wavelength geoid undulation information superior to earlier models. In order to provide high frequency geoid undulation information the JGM-3 model, that is complete to degree 70, can be merged with the OSU91A potential coefficient model from degree 71 to 360.

The JGM-3/OSU91A model has been used to calculate a 0.25 x 0.25 degree grid of geoid undulations. The undulations were computed in the mean tide system which is consistent with the system in which the sea surface heights are given. The values of the geoid undulations, in the mean tide system, are interpolated to the position of the sea surface height. The geoid undulations were calculated with the following constants : a = 6378136.3m ; GM = 398600.4415E+09m^3/s^2 and f (the flattening)= 1/298.257. Conceptually the geoid undulations refer to an ellipsoid whose origin is at the center of mass of the Earth and whose size is that of the ideal ellipsoid. The equatorial radius of this ellipsoid was estimated by Rapp (1995b) to be 6378135.59 meters. This estimate is dependent on the bias estimate adopted (-14.5 centimeters) for the TOPEX altimeter bias (before correction for the oscillator drift).

Since the geoid undulations have been computed from an expansion to degree 360, the resolution of the undulations will be on the order of 50 km. In addition the estimation of the high frequency part of the potential coefficient model (OSU91A) was primarily based, in the ocean areas on Geosat ERM data so that high frequency signal between the Geosat tracks may not be represented in the geoid undulation.

One should also note that the effect of neglected information above degree 360, is approximately, +/-24 cm. which may be larger in ocean areas of high frequency signal and lower in benign areas. The approximate standard deviation, in the ocean areas of the geoid undulation computed from the JGM-3/OSU91A model is approximately +/-26 cm.

Improvements continue to be sought in the estimation of the gravitational potential of the Earth. Underway developments now (April 1996) will lead to substantial improvements in our knowledge of the geoid at all wavelengths.

4.6.2 Mean Sea Surface (OSUMSS95)

A mean sea surface (MSS) represents the position of the ocean surface averaged over an appropriate time period to remove annual, semi-annual, seasonal, and spurious sea surface height signals. A MSS is given as a grid with the grid spacing consistent with the altimeter and other data used in the generation of the grid values. The MSS grid can be useful for data editing purposes ; for the calculation of along-track and cross-track geoid gradients ; for the definition of a surface from which sea surface topography can be removed to yield an estimate of the geoid in ocean areas ; for the calculation of gridded gravity anomalies using FFT procedures, for geophysical studies ; for a reference surface to which sea surface height data from different altimeter missions can be reduced, etc.

Numerous MSS grids have been developed in the past by various groups using sea surface height data from a number of altimeter satellites. The mean sea surface used for the initial TOPEX/POSEIDON GDRs was that developed by Basic and Rapp (1992). The OSUMSS92 was given on a 0.125 x 0.125 degree grid calculated from Geos-3, Seasat, and Geosat ERM altimeter data with high frequency signal estimated with the aid of a high resolution bathymetric data set. This MSS was placed in the reference frame defined by the Geosat data set. Comparisons between OSUMSS92 and TOPEX data indicated a root mean square difference of approximately +/-17 cm (over one cycle) after translation and bias effects were taken into account (Rapp, Yi, Wang, 1994).

With the availability of the TOPEX/POSEIDON, ERS-1 35-day repeat cycle, and ERS-1 168-day repeat cycle, as well as Geosat data, various groups embarked on the creation of an improved sea surface. At the May 1995 meeting of the TOPEX/POSEIDON SWT a discussion took place where several groups (University of Texas at Austin, CNES/GRGS, Ohio State University) described the data and procedures being used for MSS determination.

This discussion led to the identification of a number of issues (Rapp and Nerem, 1995) related to MSS definition and generation that were to be resolved through additional computation and revised MSS grids. Within one month after the SWT meeting four new grids (from UT/CSR, OSU, CNES/GRGS, GFZ/D-PAF) were available for testing and validation. Actually UT/CSR and OSU produced two grids : one in which an inverted barometer (IB) effect had been removed and another where no such correction was made.

Tests were carried out by comparing the sea surface height and along track gradients found from the MSS grids with actual data from TOPEX, Geosat, and ERS-1 35-day. Mean sea surface height tracks and individual cycles were examined. Statistics on the differences were computed at UT/CSR, OSU, JPL, GSFC, and GFZ/D-PAF with the results being distributed by e-mail during June and July 1995. In addition contour plots and color images were made available to the designated evaluation group. Based on criteria (goodness of fit with sea surface heights and slopes to TOPEX/POSEIDON data (primarily) and Geosat and ERS-1 (secondarily) and geographic grid coverage (third)) described in an e-mail message of July 21, 1995, Nerem and Zlotnicki recommended that the IB corrected OSUMSS be adopted for the processing of the new GDRs. The message notes that the « UT/CSR and OSU models were practically indistinguishable in terms of their performance » and that all MSS grids represented « spectacular improvement in mean sea surfaces ».

The OSUMSS95 is based on a one year mean TOPEX sea surface height track, a one year ERS-1 35-day, a one year Geosat ERM track and the first cycle of the 168-day repeat track of ERS-1. The values are given on a 1/16 degree grid with an IB correction made in the processing of the sea surface height data. The values are given in the mean tide system and refer to an ellipsoid whose parameters are : a=6378136.3m and f=1/298.257. The center and axis alignment of this ellipsoid corresponds to the TOPEX/POSEIDON reference frame. The MSS grid extends from 82N to 80S. The scale of the MSS values is defined by the TOPEX altimeter measurements with no bias correction made. The grid values in several land regions are given as geoid undulation values computed from the merged JGM-3/OSU91A potential coefficient model. These regions were : 60N to 40N, 60E to 100E ; and 60N to 40N, 240E to 260E. In addition a separate MSS calculation was made in the Caspian Sea region (60N to 35N, 45E to 60E) recognizing the level of the Caspian Sea is about 30 m below the geoid.

The details on the development of the OSUMSS95 are given in Yi (1995) where numerous comparisons and evaluations can be found. For example, the standard deviation of the difference between TOPEX (cycle 25) sea surface heights and along-track gradients is 9.3 cm and +/-0.62 cm/km. Both values represent a significant improvement over the use of the OSUMSS92.

As noted in the initial tests and as pointed out by Yi (1995) and Anzenhofer et al. (1996), the OSUMSS95 exhibits, in a few regions, track signature in images created from the gridded data. The patterns are primarily seen in areas of significant ocean variability (e.g. western boundary currents) where averaging of the 168-day ERS-1 data was not possible. In addition this could cause residual radial orbit error on other altimeter data through the crossover procedure used. The track pattern signature has the potential for causing cross track gradient errors.

To assess the magnitude of the possible error a cross-track gradient correction was calculated with the OSUMSS95 and the CSRMSS95 (that showed little track signature), using cycle 25 of TOPEX data in the Gulf Stream region. Cycle 25 was chosen because it is almost 1 km from the the nominal track. The standard deviation of the difference between the cross-track gradient corrections implied by the 2 MSS grids was only 0.5 cm in this extreme situation.

Improved procedures have been developed at OSU that eliminate the track signature problem and retain the high frequency content of the data. The improved MSS and the OSUMSS95 were compared to sea surface height data in the Gulf Stream region (42N to 32N, 290E to 300E). The standard deviation between the sea surface height data and that predicted from the two sea surface grids was hardly changed: (for TOPEX cycle 25: +/- 21.7 cm (OSUMSS95) to 21.7 cm (NEW MSS) ; for ERS-1, cycle 11: +/- 19.1 cm (OSUMSS95) to 18.6 cm (NEW MSS) ; for GEOSAT (ERM), cycle 5: +- 23.0 cm (OSUMSS95) to 24.8 cm (NEW MSS)). Along-track gradient comparisons showed little change (e.g. +/-.60 to 0.62 cm/km for the TOPEX data). Cross-track gradient changes have not been computed.

OSUMSS95 has been computed using TOPEX range measurements not corrected for the oscillator drift error that was evidenced lately in June 1996.

The H_MSS parameter being incorporated on the new GDRs is a significant improvement over the previously used MSS grid (OSUMSS92), it corresponds to OSUMSS95 with a 14.5 cm bias so as to refer it to the same level than TOPEX/POSEIDON altimeter data.

Improved MSS grids can be obtained in the future using longer time spans of data and with improved techniques for handling data for which averaging does not eliminate variability effects. Care must be given to the retention of high frequency signal and the reduction of high frequency noise.

4.7 TIDAL MODELS

Tides are obviously a significant contributor to the observed sea surface height. While they are of interest in themselves, these predictable ocean signals must be removed from the sea level observed by altimeters as a « correction » in order to see other oceanic signals. There are several contributions to the tidal effect : the elastic ocean tide, the solid earth tide and the pole tide. The elastic ocean tide is the sum of the Ocean tide (equilibrium and non-equilibrium tides) and the loading tide.

Note that the TOPEX/POSEIDON orbit was specifically selected (inclination and altitude) so that diurnal and semidiurnal tides would not be aliased to low frequencies.

4.7.1 Elastic Ocean tide

Although predictable, models of the tides continue to improve computers and more data (altimetry and tide gauges) become available. The TOPEX/POSEIDON Tides Committee co-chaired by Phil Woodworth, C.K. Shum and C. Le Provost has conducted studies comparing some of the most recently available ocean tide models. These models include semi-empirical assimilation models and empirical models. There are significant interdisciplinary contributions from accurate ocean tide models to studies in areas related to global climate change. While TOPEX/POSEIDON successfully mapped the deep-ocean tides, interpretation of the tides and their geophysical consequences is still progressing. Furthermore, the tides near coastal regions and on continental shelves remain somewhat problematic.

Tide models evolving through a number of versions, cautions need to be taken to note version number when using them. Also a word or warning when using modeled tide data : the models incorporate a variety of terms. Differences to be aware of include ‘geocentric’ vs. ‘bottom-referenced’ tides, 'equilibrium’ vs. non-equilibrium tides, ‘orthoweights’ vs. ‘harmonic’ coefficients, and global vs. regional.

The recommendation from the Tides Committee includes the adoption of two global tide models, the CSR3.0 (empirical model from University of Texas, USA) and the FES95.2 (assimilation model from University of Grenoble, France), for the two available GDR-M slots [see H_Eot_CSR and H_Eot_FES parameters.].

♦ **CSR3.0**

This model, developed by Richard Eanes and colleagues at the University of Texas, is basically a long wavelength adjustment to the Grenoble FES94.1 hydrodynamic model. Thereby, a tide model product is produced which preserves the long wavelength accuracy of T/P with the detailed spatial resolution of the Grenoble model. It is available via anonymous ftp (ftp://ftp.csr.utexas.edu/pub/tide, about 13 Mb).

The model is based upon 89 cycles (2.4 years) of T/P altimetry. First diurnal orthoweights were fit to the Q1, O1, P1 and K1 constituents of the Grenoble hydrodynamical model FES94.1 [Le Provost et al., 1994], and semidiurnal orthoweights were fit to the N2, M2, S2 and K2 constituents of Andersen’s « Adjusted Grenoble Model » [Andersen et al., 1995]. Elsewhere its ocean tide predictions include the classical equilibrium model for long period tides.

Tides in the Mediterranean from the reduced resolution Canceil model (0.1 to 0.5°grid) (Canceil et al., 1995) were used in both tidal bands as they appeared in the Andersen Adjusted Grenoble model as well as in FES94.1 itself. Radial ocean loading tides from the previous CSR2.0 model were added to the Grenoble ocean tides to convert them to geocentric tides.

Then T/P altimetry was used to solve for corrections to these orthoweights in 3 degrees by 3 degrees spatial bins (long wavelength adjustments). The orthoweight corrections so obtained were then smoothed by convolution with a 2-d gaussian for which the full-width-half-maximum (FWHM) was 7.0 degrees. The smoothed orthoweight corrections were output on the 0.5x0.5 degree grid of the Grenoble model and then added to the Grenoble values to obtain the new model with a global domain.

The T/P orbit used for this tide model development was computed at Texas and used the JGM-3 gravity field and a dynamical ocean tide model based upon an even earlier Texas solution (CSR1.6).

The model authors have intentionally eroded the coastline in the CSR3.0 model to provide improved interpolation near the real coasts. Ocean tide flagging for CSR3.0 should then not be used as a land/sea flag. Rather, it should be used in conjunction with a land/sea mask whose resolution is chosen for compatibility with the altimeter footprint.

♦ **FES95.2**

The FES95.2 model is an improved version of the earlier pure hydrodynamic solution FES94.1, produced on the basis of the finite element model developped by the Grenoble Ocean Modelling Group (Le Provost & Vincent, 1986 ; Lyard & Genco, 1994). FES94.1 was produced with the aim of offering the scientific community using satellite altimetric data a prediction of the tidal contribution to sea surface height variations under the tracks of the satellites that is totally independent of altimetric measurements (Le Provost et al, 1994). The geographic coverage of this model is global, from the Arctic to Antarctica, including the under-ice shelf areas of the Weddell Sea and Ross Sea, and most of the shallow seas.

Then, eight constituents have been simulated : M2, S2, N2, K2, 2N2, K1, O1, Q1. Five secondary constituents have been deduced by admittance from these 8 major ones (following Le Provost et al.,1991) : these waves are Mu2, Nu2, L2, T2 and P1. The resolution of the numerical model is spatially varying with a finite element grid refined over shelves and along the coasts, up to 10 km (see figure 1 of Le Provost et al, 1994). This high resolution concentrated over the major topographic features of the world ocean allows the FES model to catch the local characteristics of the tidal waves unresolved in the classical coarser hydrodynamical ocean tide models : see as illustrations Le Provost & Lyard (1991), for the Kerguelen Plateau, and Genco et al (1994), for the Weddel Sea and Falklands.

All these solutions have been projected on a 0.5 x 0.5 degree grid, for convenience for archiving on a CD ROM and distribution from an anonymous ftp site (meolipc.img.fr -#IP 130.190.38.36 -, cd pub/CDROM).

The accuracy of FES94.1 has been estimated by reference to a standard ground truth data set, and compared to the first new solutions derived from the first year of TOPEX/POSEIDON (see Le Provost et al, 1995). Although the accuracy of this new hydrodynamic solutions are clearly improved by reference to the previous solutions available in the litterature, comparison of FES94.1 to the T/P solutions of Schrama and Ray (1994) revealed that the former contained large scale errors, of the order of up to 6 cm in amplitude for M2 (see Figure 3 of Le Provost et al., 1995), and a few centimeters for the other major constituents.

FES95.2 is an improved version of FES94.1 derived by assimilating the earlier empirical T/P CSR2.0 tidal solution into the hydrodynamical model using a representer method as developed by Egbert et al.(1994). The CSR2.0 solutions were computed at the end of 1994 by the University of Texas from two years of T/P data and with JGM-3 orbits. The assimilated data set used in the assimilation is a sample of CSR2.0 on a 5 degree x 5 degree grid for ocean depths greater than 1000 m. The assimilation has been performed over the Atlantic Ocean, Indian Ocean, and Pacific Ocean. The solutions have been completed by adding the Mediterranean Sea (from Canceil et al., 1995), the Arctic Ocean from Lyard (1995) and Hudson Bay, English Channel, North Sea and Irish Sea from FES94.1. (see Le Provost et al, 1996)

The standard release of these new solutions, under the code FES95.2, is again a 0.5° x 0.5° gridded version of the full resolution solutions computed on the finite element grid. The associated tidal prediction model which allows to predict tides everywhere over the world ocean includes 27 constituents. Among them, only the 8 major constituents are issued from the hydrodynamic model : 3 diurnals (K1, O1, Q1) and 5 semi-diurnals (M2, S2, N2, K2, 2N2). These components are corrected by assimilation, except K2 and 2N2. The other 19 constituents are derived by admittance from these 8 major components. Among these secondary waves are M1, J1, OO1, epsilon2, lambda2, eta2..

The quality of these solutions has been evaluated by Le Provost et al (1996) by reference to a standard sea truth data set including 95 stations. It shows that the root mean square (RMS) differences between these solutions and in situ data are significantly reduced after the assimilation process is applied, compared the similar RMS differences of both the apriori hydrodynamic solutions and the T/P solutions used as a priori data for assimilation. The root sum square of the RMS evaluated over the 8 major constituents is reduced from 3.8 cm for FES94.1 to 2.8 cm for FES95.2, i.e. a gain of 1 cm. The evaluation of the performances of the prediction model is done in two ways in Le Provost et al, 1996. Test 1 is by comparing tidal predictions with observations at 59 pelagic or island sites distributed over the word ocean. Test 2 is by looking at the level of variance of the sea surface variability observed by T/P altimeter at its cross-over track points which is explained by the tidal predictions.

These two kinds of evaluation lead to the same conclusion : this new prediction model is performing much better than the one based on FES94.1, due to the correction of the major constituents by the assimilation procedure and to the increase of the number of constituents from 13 to 26. Test 1 estimates the overall RMS residual in ocean tide predictions at the level of 3.86 cm (the same test for CSR3.0 leads to 3.48 cm).

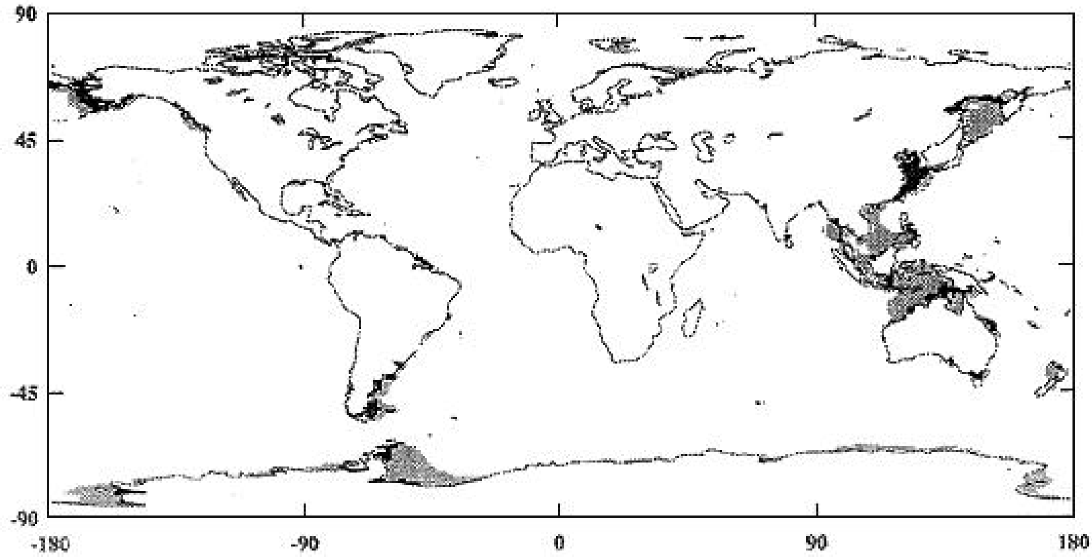
A more complete intercomparison carried within the SWT of T/P is available in Shum et al. (1996).

It must be recalled that:

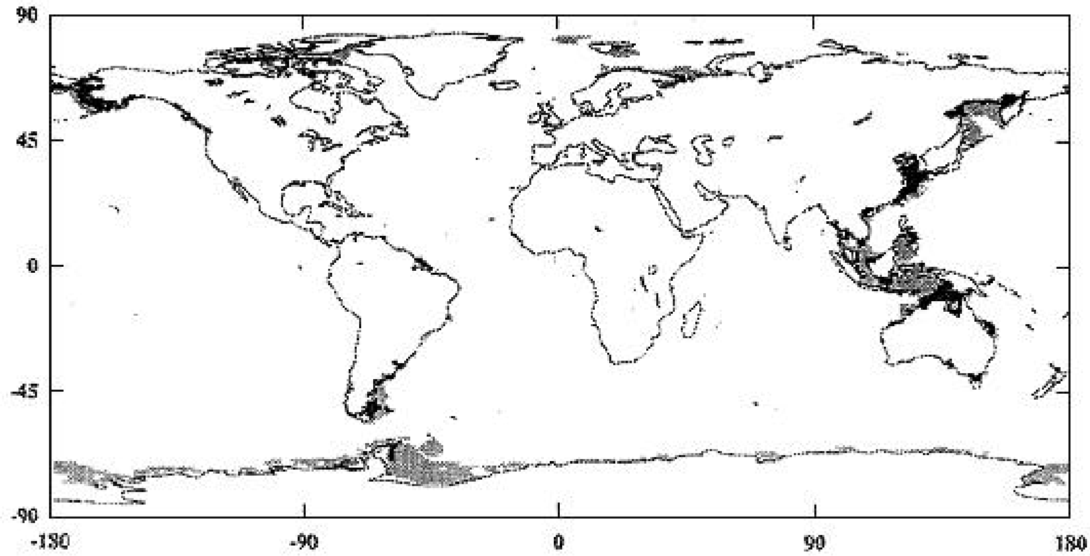
- FES95.2 is for non-equilibrium ocean tides only (not including earth tides, neither loading effects). Classical equilibrium model for long period tides is added to the ocean tide prediction as well as the CSR3.0 loading effect.

- FES95.2 is derived from the hydrodynamic FES94.1 solutions, which are of particular interest because of their resolution over the continental shelves. However, the assimilation has led in the FES95.2 solutions to some local spurious resonnances over a few areas : these areas are shaded on the top figure on next page, where the maximum difference between FES94.1 and FES95.2 cumulated over M2+S2+N2 are shown (the scale is in cm). The users must be aware of the possible degraded accuracy of FES95.2 over these areas.

- The same kind of cross-comparison has been applied to detect the areas where the largest difference between FES95.2 and CSR3.0 are (cumulated over M2+S2+N2+K1+O1). These areas are shaded on the bottom figure on next page,(the scale is in cm).



FES94.1 - FES95.2 (cumulated M2 + S2 + N2 differences in cm)



CSR3.0 - FES95.2 (cumulated M2 + S2 + N2 + K1 + O1 differences in cm)

4.7.2 Solid Earth Tide

The solid Earth responds to external gravitational forces similarly to the oceans. The Earth responds fast enough for it to be considered to be in equilibrium with the tide generating forces. Then, the surface is parallel with the equipotential surface, and the tide height is proportional to the potential. The proportionality is the so-called Love number. It should be noted that, although the Love number is largely frequency independant, an exception occurs near a frequency corresponding to the K1 tide constituents due to a resonance in the liquid core (Wahr 1985)

Such a tide is computed as described by Cartwright and Tayler (1971) and Cartwright and Edden (1973) [see H_Set parameter].

4.7.3 Pole tide

The Earth's rotational axis oscillates around its nominal direction with apparent periods of 12 and 14 months. This result in an additional centrifugal force which displaces the surface. The effect is thus indistinguishable from tides, and it is called the pole tide The period is long enough to be considered in equilibrium for both the ocean and the solid Earth.

If we know the location of the pole - this information is supplied with the orbit ephemeris -, the pole tide is easily computed as described in Wahr (1985) [see H_Pol parameter].

The complete pole tide expression is

$$pole\_tide\_height = amp * \sin *(2*lat) * ((x\_pole - x\_pole\_avg)*\cos(lon) - (y\_pole - y\_pole\_avg)*\sin(lon))$$

$$amp = - 11.\ E6 *as2rad * (1 + k2) = -69.435$$

Where

- as2rad function converts "arc sec" to radians,
- k2 (0.302) is the second degree gravitational Love number,
- x_pole_avg = 0.042 and y_pole_avg = 0.293 arc sec are average values of the pole position for the TOPEX/POSEIDON epoch.
- x axis is the direction of the IERS reference meridian
- y axis is in the direction 90° west longitude

The pole tide computation follows the 1995 IERS annual report conventions.

4.8 SIGMA NAUGHTS

TOPEX and POSEIDON Ku band sigma-naughts have been made fully homogeneous.
A 0.16 dB bias was identified between statistical distributions of TOPEX and POSEIDON Ku band sigma-naughts and has been applied on POSEIDON data.

4.9 ALGORITHM USED FOR COMPUTING THE WIND SPEED

The model functions developped to date for altimeter wind speed are all purely empirical. The roots of algorithms rely on establishing the relation(s) between the mean square sea surface slope and the wind speed. The relation differs generally with wind speed values.

The wind speed model function selected is the wind speed model defined by Witter and Chelton (1991). The model function is obtained by a least-squares fit of a fifth order polynomial to the Modified Chelton and Wentz wind speed tabular model :

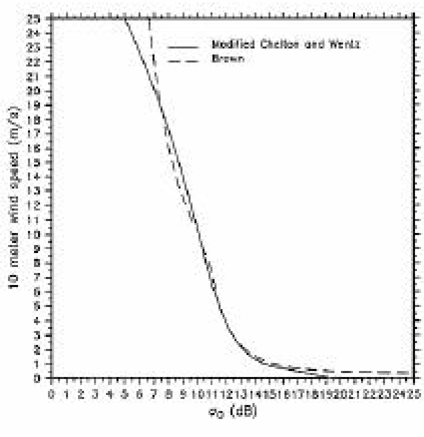
$$U = \sum_{n=0}^{4} a_n \left(\sigma_{ob}\right)^n$$

where

- U is the wind speed, in meters per second (10 m exposure wind speed)
- σ_{ob} is the biased backscatter coefficient : $\sigma_{ob} = \sigma_o + d\sigma$.(in decibels)
  σ_o is the backscatter coefficient and $d\sigma$ is a bias which is added to the backscatter coefficient to fit Geosat data. The bias value is the same for TOPEX and POSEIDON altimeters.

- $d\sigma = -0.63$ dB
- a_0, a_1, a_2, a_3, a_4 are polynomial coefficients defined as follows :

U limits	σ_{ob} limits	a_0	a_1	a_2	a_3	a_4
U > 7.30	$\sigma_{ob} < 10.8$	51.045307042	-10.982804379	1.895708416	-0.174827728	0.005438225
$0.01 \le U \le 7.30$	$10.8 \le \sigma_{ob} \le 19.6$	317.474299469	-73.507895088	6.411978035	-0.248668296	0.003607894
U = 0.0	$19.6 < \sigma_{ob}$	0.0	0.0	0.0	0.0	0.0



WIND SPEED MODEL FUNCTIONS
relating σ_o to wind speed
for the Modifed Chelton and Wentz algorithm (heavy solid line)
and the Brown algorithm (dashed line).

4.10 DATA EDITING CRITERIA

The Alt_Bad1 and Alt_Bad2 flags were built to make easy data editing together with the Geo_Bad_1 and Geo_Bad_2 flags. Concerning Poseidon, these two flags have been subject to large improvements since the begining of the mission thanks to the growing number of data which were acquired. Nevertheless, it seems better to perform editing operations by considering the following tests described below rather than using the Alt_Bad flags :

- First, check ocean/land conditions as the radiometer observes (bit number 2 of Geo_Bad_1 flag) and ice distribution (bit number 3 of Geo_Bad_1 flag) to retain only ocean data.

- Then, apply the following tests :

POSEIDON ALTIMETER DATA (SSALT)	**TOPEX ALTIMETER DATA (NRA)**
Nval_H_Alt ≥ 10 to 15 (20 Hz heights)	Nval_H_Alt ≥ 5 (10 Hz heights)
depending on wanted sensibility RMS_H_Alt ≤ 175 to 200 mm (20 Hz heights)	RMS_H_Alt ≤ 100 mm (10 Hz heights)
- 130 000 mm ≤ (HP_Sat - H_Alt) ≤ 100 000 mm - 2 500 mm ≤ dry tropospheric correction (Dry_Cor) ≤ - 1 900 mm - 500 mm ≤ wet tropospheric correction (Wet_Corr , Wet_H_Rad) ≤ - 1 mm - 400 mm ≤ Doris ionospheric correction (Iono_Dor) ≤ 0 mm - 400 mm ≤ Topex ionospheric correction (Iono_Cor) ≤ 40 mm - 5 000 mm ≤ ocean tide (H_Eot_CSR , H_Eot_FES) ≤ 5 000 mm - 500 mm ≤ loading tide (H_Lt_CSR) ≤ 500 mm - 1 000 mm ≤ solid earth tide (H_Set) ≤ 1 000 mm - 15 000 mm ≤ pole tide (H_Pol) ≤ 15 000 mm - 500 mm ≤ sea state bias correction (EM_Bias_Corr_K1, EM_Bias_Corr_K2) ≤ 0 mm 0 mm ≤ significant waveheight (SWH_K) ≤ 11 000 mm 7 dB ≤ Ku band sigma naught (Sigma0_K) ≤ 30 dB (or 25 dB for POSEIDON data) 0 deg ≤ waveform attitude (Att_Wvf) ≤ 0.4 deg (or 0.3 deg for POSEIDON data	

Warning: default values are given to data when valid numbers are not available.

5. HEADER ELEMENTS (alphabetical order)

Elements of headers are generally characterized by the following items :

Definition	Element definition
Element type	An element type can be bitfield, integer, real or a string.
Storage type	A storage type can be signed (signed integer), unsigned (unsigned integer), bit (contiguous sequence of bits) or character (contiguous sequence of ASCII characters).
Size	Size of elements in 8-bit bytes.
Unit	Unit of measure including scale factor, UTC1[1] , UTC2[1] or none (/)
Minimum value	Typical or approximate minimum element value.
Maximum value	Typical or approximate maximum element value.
Nominal value	Typical or approximate nominal element value.
Default value	Element value when the measurement is not available or the element is not computable ("flag value").
Comment	Other comment.

When an item can not be filled, there is N/A which stands for not applicable.

1 Note here, that any time variable recorded in CCDS headers has two formats :

* UTC1 format gives time in seconds and is recorded with 17 characters. The format is:

YYYY-DDDTHH:MM:SS

* UTC2 format gives time in microseconds and is recorded with 24 characters.The format is:

YYYY-DDDTHH:MM:SS.XXXXXX

with :

YYYY	=	year
DDD	=	day of the year (001 to 366)
HH	=	hours (00 to 23)
MM	=	minutes (00 to 59)
SS	=	seconds (00 to 59 or 60 for UTC leap second[2])
XXXXXX	=	microseconds

2 A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day.
Thus, the UTC values (minutes:seconds) appear as : 59:58 ; 59:59 ; 59:60 ; 00:00 ; 00:01

Build_Id

Definition	Reference of the document describing the software used to produce this file.
Element type	String
Storage type	Character
Size	21
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	The format for this element is "AVI_XX_XXXXX_XXXX_XXX" which is a AVISO project document reference.

Calib_R_Corr_C_TOPEX

Definition	Altimeter bias C band correction from TOPEX calibration correction to range algorithm (internal calibration).
Element type	Integer
Storage type	Character
Size	6
Unit	millimeter
Minimum value	-99 999
Maximum value	99 999
Nominal value	N/A
Default value	
Comment	This element appears only when the file contains TOPEX data. It is valid for all TOPEX data points in the pass. When not computable, ASCII spaces (blanks) are used.

Calib_R_Corr_K_TOPEX

Definition	Altimeter bias Ku band correction from TOPEX calibration correction to range algorithm (internal calibration).
Element type	Integer
Storage type	Character
Size	6
Unit	millimeter
Minimum value	-99 999
Maximum value	99 999
Nominal value	N/A
Default value	
Comment	This element appears only when the file contains TOPEX data. It is valid for all TOPEX data points in the pass. When not computable, ASCII spaces (blanks) are used.

CCSD...

Definition	SFDU label indicating the beginning or the end of the CCSDS header.
Element type	String
Storage type	Character
Size	20
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	A SFDU label is coded as two lines or on two elements. Each element is coded as a 20-character string. For a label at the beginning of the CCSDS header, the first element starts with the letters "CCSD3Z" (class Z label) and the second element with "CCSD3K" (class K label). For a label at the end of the CCSDS header, the first element starts with the letters "CCSD$$MARKER" and the second element with "CCSD3RF" (class R label).

CNES_Ephem_Filename (1,2)

Definition	Name of the CNES orbit file(s) recorded on the CD ROM.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

This element specifies ASCII file name in accordance with VAX/VMS. ASCII spaces (blancks) are used when this file is not available. The format for this element is "MXxccc.EPC" and where:

X being the data type (G for GDR products).

x being the generation letter. (coded as 1 character) [see the Generation_Letter element]

ccc being the cycle number to which the data refer to. (coded as 3 characters)

CNES_Orbit_Filename

Definition	Information on the CNES orbit data used to produce the passfile.
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element provides information on the name, version number and creation date of the CNES orbit file. ASCII spaces (blanks) are used when this file is not available. The format for this element is "EPHTE1ssjjjjjhhx;vv YYYYDDTHH:MM:SS" and where :

EPHTE1ssjjjjjhhx;vv	being the orbit file name in accordance with the VAX/VMS convention. This file covers a day period.
tt	being T1 or T2 depending on which DORIS instrument is on. (coded as 2 characters)
jjjjj	being the Julian date of the file. (refered to January 1, 1950, 0h 0mn 0.0s) (coded as 5 characters)
hh	being 00, 01 or 10. (coded as 2 characters) 00 = file starts at midnight[1] and ends at midnight[2] 01 = file starts during the day (after midnight) and ends at midnight[2] 10 = file starts at midnight[1] and ends during the day (before midnight)
x	orbit quality. (coded as 1 character) [see the Orbit_Qual_CNES element]
vv	being the version number. (coded as 1 or 2 characters)
YYYY-DDDTHH:MM:SS	being the orbit file creation date recorded in UTC1 format.

1 Start at midnight means 140 seconds before midnight.
2 End at midnight means 1 400 seconds after midnight.

CORIOTROP_File_Id

Definition	Information on the CORIOTROP data used to produce this passfile.
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element provides ASCII information on the name, version number and creation date of the CORIOTROP file. ASCII spaces (blanks) are used when this file is not available.

The format for this element is : "CTI0G1TPjjjjj000.;vv YYYY-DDDTHH:MM:SS" and where:

CTI0G1TPjjjjj000.;vv	being the CORIOTROP file name in accordance with the VAX/VMS convention. This file covers a day period.
jjjjj	being the Julian date of the file. (refered to January 1, 1950, 0h 0mn 0.0s) (coded as 5 characters)
vv	being the version number. (coded as 1 or 2 characters)
YYYY-DDDTHH:MM:SS	being the CORIOTROP file creation date recorded in UTC1 format.

Crossover_Count

Definition	Number of crossover points identified in the current crossover points file.
Element type	Integer
Storage type	Character
Size	5
Unit	/
Minimum value	0
Maximum value	7 000
Nominal value	N/A
Default value	N/A
Comment	

Crossover_Cycle (1,2)

Definition	Name of the crossover points file(s) recorded on the CD ROM.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

This element specifies ASCII file name in accordance with VAX/VMS. The format for this element is "MXxccc.XNG" and where:

X being the data type (G for GDR products).

x being the generation letter. (coded as 1 character) [see the Generation_Letter element).

Ccc being the cycle number to which the data refer to. (coded as 3 characters)

Cycle_Count

Definition	Number of cycles recorded on the CD ROM.
Element type	Integer
Storage type	Character
Size	1
Unit	/
Minimum value	1
Maximum value	3
Nominal value	N/A
Default value	N/A
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

Cycle_Number

Definition	Cycle number.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	999
Nominal value	N/A
Default value	N/A
Comment	This element corresponds to the ten-day repeat cycle number associated to this file.

Data_Handbook_Reference

Definition	Reference of the AVISO CD ROM User Manual : Merged TOPEX/POSEIDON Products
Element type	String
Storage type	Character
Size	21
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	AVI-NT-02-100-CN
Default value	N/A
Comment	The format for this element is"AVI_XX_XXXXX_XXXX_XXX" which is a AVISO project document reference.

Data_Type

Definition	Type of data used to produce the crossover points.
Element type	String
Storage type	Character
Size	6
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	GDR-M
Default value	N/A
Comment	Valid types are "GDR-M" for GDR-M products (cf. the operational phase).

Directory_Cycle (1,2,3)

Definition	CD ROM directory name(s).
Element type	String
Storage type	Character
Size	7
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

This element specifies ASCII file name in accordance with VAX/VMS. The format for this element is "MXx_ccc" and where :

X being the data type (G for GDR products).

x being the generation letter. (coded as 1 character) [see the Generation_Letter element]

ccc being the cycle number. (coded as 3 characters) [see the Cycle_Number element]

End_Cycle_Number

Definition	Number of the last cycle recorded on the CD ROM.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	999
Nominal value	N/A
Default value	N/A
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

End_Pass_Number

Definition	Pass number of the last non empty pass-file within the current ten-day repeat cycle.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	254
Nominal value	254
Default value	N/A
Comment	A pass is half a revolution, from minimum/maximum to maximum/minimum latitude to which is assigned a unique number. The numbers run from one to twice the number of revolutions in a ten-day repeat cycle. These numbers are used to facilitate the sorting of data for science applications. 254 passes nominally occur within a ten-day repeat cycle.

Equator_Longitude

Definition	East longitude at which the pass crosses the Equator.
Element type	Real
Storage type	Character
Size	10
Unit	degree
Minimum value	000.000000
Maximum value	359.999999
Nominal value	N/A
Default value	N/A
Comment	This element is characteristic of the satellite orbit and of pass (see tables pages 15 and 17).

Equatorial_Radius

Definition	Value of the semi-major axis of the TOPEX reference ellipsoid.
Element type	Real
Storage type	Character
Size	9
Unit	meter
Minimum value	N/A
Maximum value	N/A
Nominal value	6378136.3
Default value	N/A
Comment	[See § 1.3.1].

Equator_Time

Definition	UTC date and time at which this pass crosses the Equator.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1991-001T00:00:00.000000
Maximum value	9999-366T23:59:60.999999
Nominal value	N/A
Default value	N/A
Comment	

GDR_M_Cycle_Header_Name

Definition	Name of the merged GDR header file used to produce this crossover point file.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	This element provides information on the source, date, version, etc. of the merged GDR header file.

This element specifies ASCII file name in accordance with VAX/VMS. The format for this element is "MXxccc.HDR" and where :

X being the data type (G for GDR products).

x being the generation letter. (coded as 1 character)
[see the Generation_Letter element]

ccc being the cycle number to which the data refer to.
(coded as 3 characters)

Generation_Letter

Definition	Generation letter.
Element type	String
Storage type	Character
Size	1
Unit	/
Minimum value	A
Maximum value	Z
Nominal value	C
Default value	N/A
Comment	This element was "A" for IGDR-M products of the verification phase. It was "B" for the first GDR-M. It is C for the second generation GDR-M product, computed after accounted from the May and October 95 SWT recommendations on algorithms.

Generating_Software_Name

Definition	Name of the software generating the file.
Element type	String
Storage type	Character
Size	50 for the cycle header file, the passfiles and the crossover point file. 26 for the orbit files.
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	TS_GDM_PROD_PRINCIPAL
Default value	N/A
Comment	The format for this element is "TS_XXX_PROD_PRINCIPAL" where XXX being a 3-character ASCII string identifies the generating product. "XXX" = "GDM" for GDR-M files (cycle header file and passfiles), "XXX" = "CRO" for the crossover point file, "XXX" = "EPH" for the orbit files.

Header_Cycle (1,2,3)

Definition	Name of the GDR-M cycle header file(s) recorded on the CD ROM.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

This element specifies ASCII file name in accordance with VAX/VMS. The format for this element is "MXxccc.HDR" and where :

X being the data type (G for GDR data products).

x being the generation letter. (coded as 1 character) [see the Generation_Letter element].

ccc being the cycle number to which the data refer to. (coded as 3 characters)

ICP_Poseidon

Definition	Information about POSEIDON Internal Calibration.
Element type	String
Storage type	Character
Size	43
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element appears only when the file contains POSEIDON data. It is valid for all POSEIDON data points in the pass. When not computable, ASCII spaces (blancks) are used.

Input_Orbit_File_Number

Definition	Number of input orbit files used to build the orbit file which cover a ten-day repeat period (a cycle).
Element type	Integer
Storage type	Character
Size	2
Unit	/
Minimum value	1
Maximum value	11
Nominal value	1 for the NASA orbit 10 for the CNES orbit
Default value	N/A
Comment	To cover a 10-day repeat-cycle, the input NASA orbit file is unique if there is no maneuver. There are two in case of a maneuver. An input CNES orbit file covers a day period. So, there are 10 to 11 files to cover a cycle.

Inverse_Flatness_Coefficient

Definition	Value of the inverse flatness coefficient of the TOPEX reference ellipsoid.
Element type	Real
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	298.257
Default value	N/A
Comment	[see § 1.3.1]

NASA_Ephem_Filename (1,2,3)

Definition	Name of the NASA orbit file(s) recorded on the CD ROM.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	Version C GDR-M are recorded by packages of 3 ten-day repeat cycles.

This element specifies ASCII file name in accordance with VAX/VMS. ASCII spaces (blanks) are used when this file is not available. The format for this element is "MXxccc.EPN" and where:

X being the data type (G for GDR products).

x being the generation letter. (coded as 1 character)
[see the Generation_Letter element]

ccc being the cycle number to which the data refer to. (coded as 3 characters).

NASA_Orbit_Filename

Definition	Information on the NASA orbit data used to produce the passfile.
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element provides ACSII information on the name, version number and creation date of the NASA orbit file used. ASCII spaces (blanks) are used when this file is not available.

The format for this element is "NASAPOEccc.HDR;vv YYYY-DDDTHH:MM:SS" and where:

NASAPOEccc.HDR;vv	being the orbit file name in accordance with VAX/VMS convention. This name is correct if there is no maneuver. Elsewhere, it is NASAPOEcccc_0i.HDR;vv with i = 1 fo a period before the maneuver and i = 2 for a period following the maneuver.
ccc	being the cycle number. (coded as 3 characters)
vv	being the version number. (coded as 1 or 2 characters)
YYYY-DDDTHH:MM:SS	being the orbit file creation date recorded in UTC 1 format.

Orbit_Id (1...11)

Definition	Information on the orbit data used to produce the file.
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	For a CNES orbit file, see the CNES_Orbit_Filename element definition, for a NASA orbit file, see the NASA_Orbit_Filename element definition. The total number of Orbit_Id elements is equal to the Input_Orbit_File_Number element value.

Orbit_Qual_CNES

Definition	Indicator about CNES orbit quality.
Element type	String
Storage type	Character
Size	1
Unit	/
Minimum value	A
Maximum value	G
Nominal value	C
Default value	
Comment	This element comes from the CNES orbit file used to produce the passfile. ASCII spaces (blanks) are used when this file is not available. Valid values are:

A for logistic and adjusted
B for intermediate and adjusted
C for precise and adjusted
D for logistic and extrapolated
G for operational and adjusted

Orbit_Quality (1...11)

Definition	Indicator about CNES orbit quality for the orbit file referenced on above line (see the Orbit_Id element).
Element type	String
Storage type	Character
Size	11
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	For a CNES orbit file, see the Orbit_Qual_CNES element definition. For a NASA orbit file, see the Orbit_Qual_NASA element definition. The total number of Orbit_Qual elements is equal to the Input_Orbit_File_Number element value.

Orbit_Qual_NASA

Definition	Indicator about NASA orbit quality.
Element type	String
Storage type	Character
Size	11
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element comes from the NASA orbit header file used to produce the passfile. ASCII spaces (blanks) are used when this file is not available.

Package_Data_End_Time

Definition	UTC date and time of the last data record from which this file refers to.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1991-001T00:00:00.000000
Maximum value	9999-366T23:59:60.999999
Nominal value	N/A
Default value	N/A
Comment	This element comes from the last data point in the last pass-file within the (last) ten-day repeat cycle.

Package_Data_Start_Time

Definition	UTC date and time of the first data record from which this file refers to.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1991-001T00:00:00.000000
Maximum value	9999-366T23:59:60.999999
Nominal value	N/A
Default value	N/A
Comment	This element comes from the first data point in the first pass-file within the (first) ten-day repeat cycle.

Pass_Count

Definition	Total number of non empty pass-files in the current ten-day repeat cycle.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	0
Maximum value	254
Nominal value	N/A
Default value	N/A
Comment	A pass is half a revolution, from minimum/maximum to maximum/minimum latitude to which is assigned a unique number. The numbers run from one to twice the number of revolutions in a ten-day repeat cycle. These numbers are used to facilitate the sorting of data for science applications. 254 passes nominally occur within a ten-day repeat cycle.

Pass_Data_Count

Definition	Total number of altimeter records identified in the current pass file.
Element type	Integer
Storage type	Character
Size	4
Unit	/
Minimum value	0
Maximum value	3360
Nominal value	N/A
Default value	N/A
Comment	A pass is half a revolution, from minimum/maximum to maximum/minimum latitude. Measurement frequency is about 1 Hz, a revolution period about 6746 seconds. This number should not exceed 3360.

Pass_File_Data_Type

Definition	Type of data used to produce the file.
Element type	String
Storage type	Character
Size	6
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	GDR-M
Default value	N/A
Comment	Valid types are "IGDR-M" during the verification phase, " GDR-M" during the operational phase.

Pass_File_Delimiter

Definition	File delimeter of the pass-files.
Element type	String
Storage type	Character
Size	3
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	EOF
Default value	N/A
Comment	This element describes how the passfiles are delimited.

Pass_File_Protocol

Definition	File protocol of the pass-files.
Element type	String
Storage type	Character
Size	4
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	NONE
Default value	N/A
Comment	This element specifies the format of the data object. The value NONE indicates a non CCSDS protocol.

Pass_Number

Definition	Pass number.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	254
Nominal value	N/A
Default value	N/A
Comment	A pass is half a revolution, from minimum/maximum to maximum/minimum latitude to which is assigned a unique number. The numbers run from one to twice the number of revolutions in a ten-day repeat cycle. These numbers are used to facilitate the sorting of data for science applications. 254 passes nominally occur within a ten-day repeat cycle.

Poseidon_Pass_File_Id

Definition	Information on the I/GDR-P pass-file used to produce the I/GDR-M pass-file
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element provides ASCII information on the name, version, number and creation date the GDR-P pass-file used. ASCII spaces (blanks) are used when this file is not available. The format for this element is "XXXXG2TPjjjjjppp.;vv YYYY-DDDTHH:MM:SS" and where :

XXXXG2TPjjjjjppp.;vv	being the Poseidon passfile name in accordance with VAX/VMS convention.
jjjjj	being the Julian date of the first data point of the pass. (refered to January 1, 1950, 0h 0mn 0.0s) (coded as 5 characters)
ppp	being the pass number. (coded as 3 characters)
vv	being the version number. (coded as 1 or 2 characters)
YYYY-DDDTHH:MM:SS	being the Poseidon pass-file creation date recorded in UTC1 format.

POSEIDON_Range_Bias

Definition	Value of the POSEIDON range bias.
Element type	String
Storage type	Character
Size	8
Unit	cm
Minimum value	0.0
Maximum value	N/A
Nominal value	0.0
Default value	N/A
Comment	This element provides the external calibration range bias of the POSEIDON altimeter.

Producer_Agency_Name

Definition	Producer agency name.
Element type	String
Storage type	Character
Size	4
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	CNES
Default value	N/A
Comment	This element provides the name of the government agency in charge of this product.

Producer_Institution_Name

Definition	Producer institution name.
Element type	String
Storage type	Character
Size	5
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	AVISO
Default value	N/A
Comment	This element provides the name of the institution producing the file.

Product_Create_End_Time

Definition	Local time ot the end of the production of the file.
Element type	String
Storage type	Character
Size	17
Unit	UTC1
Minimum value	1991-001T00:00:00
Maximum value	9999-366T23:59:60
Nominal value	N/A
Default value	N/A
Comment	

Product_Create_Start_Time

Definition	Local time when the file started to be produced
Element type	String
Storage type	Character
Size	17
Unit	UTC1
Minimum value	1991-001T00:00:00
Maximum value	9999-366T23:59:60
Nominal value	N/A
Default value	N/A
Comment	

Reference (254)

Definition	Pass-files names of the cycle from which this file refers to.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	A pass is half a revolution, from minimum/maximum to maximum/minimum latitude to which is assigned a unique number. The numbers run from one to twice the number of revolutions in a ten-day repeat cycle. 254 passes nominally occur within a ten-day repeat cycle. The total number of pass-files is equal to the Pass_Count element value.

This element specifies ASCII file name in accordance with VAX/VMS. The format for this element is "MXccc.ppp" and where :

X being the data type (G for GDR products).

x being the generation letter. (coded as 1 character)
[see the Generation_Letter element]

ccc being the cycle number to which the data refer to.
(coded as 3 characters)

ppp being the pass number. (coded as 3 characters).

Rev_Number

Definition	Revolution (orbit) number.
Element type	Integer
Storage type	Character
Size	5
Unit	/
Minimum value	0
Maximum value	99 999
Nominal value	N/A
Default value	N/A
Comment	The revolution number is counted from launch, incremented at the ascending node.

Sampling_Rate

Definition	Sampling interval of the orbit data.
Element type	Integer
Storage type	Character
Size	2
Unit	Second
Minimum value	1
Maximum value	60
Nominal value	60
Default value	N/A
Comment	File records are at a one per Sampling_Rate element value rate. However, records may be discontinuous because of a lack of data.

Sensor_Name

Definition	Main sensors used to acquire the data.
Element type	String
Storage type	Character
Size	14 for the CD ROM header file, the cycle header file, the pass- files and the crossover point file.
Unit	1 for the orbit files
Minimum value	N/A
Maximum value	N/A
Nominal value	"Altimeters-T/P" or " "
Default value	N/A
Comment	

Source_Name

Definition	Name of the project.
Element type	String
Storage type	Character
Size	14
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	TOPEX/POSEIDON
Default value	N/A
Comment	This element refers, in terms of project, to the spacecraft which contains the sensors.

Start_Cycle_Number

Definition	Number of the first cycle recorded on the CD ROM.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	999
Nominal value	N/A
Default value	N/A
Comment	Version C GDR-M are recorded by packages of three ten-day repeat cycles.

Start_Pass_Number

Definition	Pass number of the first non empty pass-file within the current ten-day repeat cycle.
Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	254
Nominal value	1
Default value	N/A
Comment	A pass is half a revolution, from minimum/maximum to maximum/minimum latitude to which is assigned a unique number. The numbers run from one to twice the number of revolutions in a ten-day repeat cycle. These numbers are used to facilitate the sorting of data for science applications. 254 passes nominally occur within a ten-day repeat cycle.

Time_Epoch

Definition	Reference date.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	N/A
Maximum value	N/A
Nominal value	1958-001T00:00:00.000000
Default value	N/A
Comment	This element is the zero point of time from which data times are recorded, it is given in UTC2 format to the nearest microsecond. Preferred zero point is January 1, 1958 (0h 0mn 0.0s).

Time_First_Pt

Definition	Date of the first data point in the current file.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1991-001T00:00:00.000000
Maximum value	9999-366T23:59:60.999999
Nominal value	N/A
Default value	N/A
Comment	

Time_Last_Pt

Definition	Date the last data point in the current file.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1991-001T00:00:00.000000
Maximum value	9999-366T23:59:60.999999
Nominal value	N/A
Default value	N/A
Comment	

TOPEX_Pass_File_Id

Definition	Information on the GDR-T pass-file used to produce the GDR-M pass-file.
Element type	String
Storage type	Character
Size	33
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	
Comment	This element provides ASCII information on the name, version number and creation date of the GDR-T pass-file. ASCII spaces (blanks) are used when this file is not available.

The format for this element is "CcccPppp.dat;vv YYYY-DDDTHH:MM:SS" and where :

CcccPppp.dat;vv	being the TOPEX pass file name in accordance with VAX/VMS convention.
ccc	being the cycle number. (coded as 3 characters)
ppp	being the pass number. (coded as 3 characters)
vv	being the version number. (coded as 1 or 2 characters)
YYYY-DDDTHH:MM:SS	being the TOPEX pass-file creation date recorded in UTC1 format.

T/P_Sigma0_Offset

Definition	Value of the Ku band Sigma0 offset between POSEIDON and TOPEX
Element type	String
Storage type	Character
Size	8
Unit	dB
Minimum value	0.0
Maximum value	N/A
Nominal value	0.16 dB
Default value	N/A
Comment	This element provides the offset applied on the backscattering coefficient to unify TOPEX and POSEIDON data.

TOPEX_Range_Bias

Definition	Value of the TOPEX range bias.
Element type	String
Storage type	Character
Size	8
Unit	cm
Minimum value	0.0
Maximum value	N/A
Nominal value	1.5
Default value	N/A
Comment	This element provides the external calibration range bias applied on the TOPEX altimeter range.

Type

Definition	Type of data used to generate the merged products.
Element type	String
Storage type	Character
Size	50
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	GDR
Default value	N/A
Comment	Valid types are "IGDR" for IGDR-M products (cf. the verification phase), or "GDR" for GDR-M products (cf. the operational and extended phase).

Version_Number

Definition	CD ROM version number.
Element type	Integer
Storage type	Character
Size	1
Unit	/
Minimum value	1
Maximum value	9
Nominal value	/
Default value	N/A
Comment	This element starts from one. It is incremented if data products are reissued or generating softwares being updated (new version).

Volume_Id

Definition	CD ROM volume identifier.
Element type	String
Storage type	Character
Size	11
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	N/A
Default value	N/A
Comment	This element specifies ASCII file name in accordance with VAX/VMS. The format for this element is "AVMXx_vol_v" and where :

X	being the data type (G for GDR products)
x	being the generation letter. (coded as 1 character) [see the Generation_Letter element]
vol	being the CD ROM volume number. (coded as 3 characters)
v	being the version number. (coded as 1 character) [see the Version_Number element]

6. GDR-M ELEMENTS (alphabetical order)

Elements of the GDR-M product are generally characterized by the following items :

Definition	Element definition.
Element type	An element type can be bitfield or integer.
Storage type	A storage type can be signed (signed integer), unsigned (unsigned integer), bit (contiguous sequence of bits) or character (contiguous sequence of ASCII characters).
Size	Size of elements in 8-bit bytes.
Unit	Unit of measure including scale factor, or none (/).
Minimum value	Typical or approximate minimum element value.
Maximum value	Typical or approximate maximum element value.
Nominal value	Typical or approximate nominal element value.
Default value	Element value when the measurement is not available or the element is not computable ("flag value").
Comment	Other comment.
Quality flags	Flags indicating the quality of this element, or none (/). This item exists if the element is not a flag itself.

When an item cannot be filled, there is N/A which stands for not applicable.

AGC_C

Definition	C band, Automatic Gain Control (AGC), 1 per frame fit.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	6 400
Default value	65 535
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on or when it is not computable (no valid high-rate points).
Quality flags	AGC_Pts_Avg, Alt_Bad_2 (bit # 5)

AGC_K

Definition	Ku band, Automatic Gain Control (AGC) , 1 per frame fit.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	6 400
Default value	65 535
Comment	This element exists for TOPEX and POSEIDON data. Note that this value depends on the altimeter. A default value is given when it can't be computed (no valid high-rate points).
Quality flags	AGC_Pts_Avg, Alt_Bad_2 (bit # 6)

AGC_Pts_Avg (Quality flag)

Definition	Number of points (20 per frame) used to compute the one per frame Automatic Gain Control (AGC) average.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	20
Default value	127
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. A good value is 16.

AGC_RMS_C

Definition	Root Mean Square (RMS) of high-rate Automatic Gain Control (AGC) data, C band, about the fit or average used to obtain the one per frame value (AGC_C).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 decibel
Minimum value	0
Maximum value	255
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Non rejected high-rate values are only used to compute this element and a minimum of two good points is required.
Quality flags	AGC_Pts_Avg

AGC_RMS_K

Definition	Root Mean Square (RMS) of high-rate Automatic Gain Control (AGC) data, Ku band, about the fit or average used to obtain the one per frame value (AGC_K).
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	500
Default value	32 767
Comment	This element exists only for TOPEX and POSEIDON data. Non rejected high-rate values are only used to compute this element and a minimum of two good points is required.
Quality flags	AGC_Pts_Avg

Alt_Bad_1 (Quality flag)

Definition	Set of flags n° 1 on TOPEX and POSEIDON measurement conditions
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This set of flags exists and is different for TOPEX and POSEIDON data.

When TOPEX is on, it indicates if problem were detected with the altimeter sensor corrections, dual frequency ionospheric correction or in compressing high-rate measurements. Bits are defined as follows :

Bits	Indicator on
0	Compression used (0 = Fit, 1 = Median)
1	Valid points from fit (0 = OK, 1 = Too many invalid)
2	High-rate waveforms (0 = OK, 1 = Too many flagged)
3	TFLAG (fine tracks, EML, AGC gate)
4	Slope of fit (0 = OK, 1 = Too steep)
5	One per second altimeter range quality (0 = OK, 1 = RMS >15cm)
6	Dual frequency ionospheric correction (0 = OK, 1 = Too many errors reported [see Iono_Bad for more details]
7	Total altimeter range correction 0 - Ku and C values OK 1 - Problem detected in Ku or (and) C value(s).

When POSEIDON is on, it indicates if the one per second ranges, significant wave heights or backscatter coefficients are believed to be valid or not. Bits are defined as follows :

Bits	Indicator on
0-1	Altimeter range (0 = OK, 1 = Possible error, 2 = Bad data)
2-3	Significant Wave Height (0 = OK, 1 = Possible error, 2 = Bad data)
4-5	Backscatter coefficient (0 = OK, 1 = Possible error, 2 = Bad data)
6-7	Spares (0)

Alt_Bad_2 (Quality flag)

Definition	Set of flags n°2 on TOPEX and POSEIDON measurement conditions.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This set of flags exists and is different for TOPEX and POSEIDON data.

When TOPEX is on, it indicates if any of the pointing/sea-state conditions were invalid or sigma0 was out of limits. Bits are defined as follows :

<u>Bits</u>	<u>Indicator on</u>
0	Spare (0)
1	Ku range correction (0 = Done , 1 = Not done)
2	C range correction (0 = Done , 1 = Not done)
3	C SWH correction (0 = Done , 1 = Not done)
4	Ku SWH correction (0 = Done , 1 = Not done)
5	C band - AGC correction or sigma0 - Good values 1 - AGC correction not done or sigma0 out of limit
6	Ku band - AGC correction or sigma0 0 - Good values 1 - AGC correction not done or sigma0 out of limit
7	Spare (0)

When POSEIDON is on, it indicates if the net (summed) instrument correction to ranges, significant wave heights or backscatter coefficients are believed to be valid or not. Bits are defined as follows :

<u>Bits</u>	<u>Indicator on</u>
0-1	Altimeter range (0 = OK , 1 = Possible error, 2 = Bad data)
2-3	Significant Wave Height (0 = OK , 1 = Possible error, 2 = Bad data)
4-5	Backscatter coefficient (0 = OK , 1 = Possible error, 2 = Bad data)
6-7	Spares (0)

ALTON (Instrument flag)

Definition	Altimeter indicator.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. It indicates which altimeter is on at the time of the measurement and defined as follows :

Value	Definition
0	POSEIDON on
1	TOPEX on

Atm_Att_Sig0_Corr

Definition	Atmospheric attenuation correction to the Ku band backscatter coefficient (Sigma0_K).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 decibel
Minimum value	0
Maximum value	170
Default value	255
Comment	This element is computed for TOPEX and POSEIDON data. This value is added to the backscatter coefficient derived from the Automatic Gain Control data (AGC_K) to produce Sigma0_K.
Quality flags	/

Att_Ptf

Definition	Off-nadir angle estimated from platform elements. The off-nadir angle is the cone angle between altimeter electrical axis and nadir, nadir being defined as the normal to the reflecting surface.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	0
Maximum value	150
Default value	255
Comment	This element exists only for the POSEIDON measurements. A default value is given when TOPEX is on. If available, it is used to compute POSEIDON altimeter corrections involving attitude (see Fl_Att).
Quality flags	Fl_Att, Val_Att_Ptf

Att_Wvf

Definition	Off-nadir angle estimated from the measured waveform. The off-nadir angle is the cone angle between altimeter electrical axis and nadir, nadir being defined as the normal to the reflecting surface.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	0
Maximum value	150
Default value	255
Comment	This element is computed for TOPEX and POSEIDON data. Note that this value depends on the altimeter on. It is used to compute TOPEX altimeter corrections involving attitude. It is used for POSEIDON altimeter data only if Att_Ptf is not used (see Fl_Att).
Quality flags	Fl_Att

CG_Range_Corr

Definition	Correction to the altimeter tracker range for center of gravity movement caused by solar array motion and satellite roll and pitch.
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimum value	-128
Maximum value	127
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. It is not included in the net summed instrumental correction.
Quality flags	Val_Att_Ptf

Current_Mode_1 (Telemetry flag)

Definition	Altimeter current mode n° 1 (Topex' first frame).
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. It indicates the altimeter current mode for the first half frame. Bits are defined as follows :

Bits	Indicator on
0-3	Mode 0011 - Standby 0110 - Cal I 1100 - Cal II 1001 - Coarse acquisition 1010 - Coarse track 0101 - Fine acquisition 1111 - Fine track
4	Track (0 - EML, 1 - Threshold)
5	Gate (0 - AGC gate, 1 - Primary Max / 3)
6	High variability (0 = low, 1 = high)
7	High/Low rate waveform channel assignment (0 = Ku / C, 1 = C / Ku)

Current_Mode_2 (Telemetry flag)

Definition	Altimeter current mode n° 2 (TOPEX and POSEIDON' second frame).
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element exists and is different for TOPEX and POSEIDON data. When TOPEX is on, it indicates the altimeter current mode for the second half frame [see Current_Mode_1 for bits definition]. When POSEIDON is on, it is defined as follows :

Value	Definition
1	Acquisition mode
2	Low-rate tracking
3	High-rate tracking

DR(SWH/att)_C

Definition	Correction applied to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at C band.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-400
Maximum value	400
Default value	32 767
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	ALT_Bad_2 (bit # 2)

DR(SWH/att)_K

Definition	Correction applied to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at Ku band.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-400
Maximum value	400
Default value	32 767
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	ALT_Bad_2 (bit # 2)

Dry_Corr

Definition	Dry meteorological tropospheric correction before altimeter measurement [see § 4.3].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It is interpolated from Dry1_Corr and Dry2_Corr elements at altimeter measurement epoch. A default value is given when the two meteorological fieds are not available. A dry tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Dry_Err

Dry1_Corr

Definition	Dry meteorological tropospheric correction before altimeter measurement.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It corresponds to the dry tropospheric correction computation using respectively one of the two meteorological fields surrounding the altimeter measurement epoch (nearest value) and which are included in the CORIOTROP data. A default value is given when the meteorological fields (i.e. CORIOTROP) are not available. A dry tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Dry1_Err

Dry2_Corr

Definition	Dry meteorological tropospheric correction after altimeter measurement.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It corresponds to the dry tropospheric correction computation using respectively one of the 2 meteorological fields surrounding the altimeter measurement epoch (nearest value) and which are included in the CORIOTROP data. A default value is given when the meteorological fields (i.e. CORIOTROP) are not available. A dry tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Dry2_Err

Dry_Err (Quality flag)

Definition	Quality index on Dry_Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when the field (i.e. CORIOTROP) is not available. Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Dry1_Err (Quality flag)

Definition	Quality index on Dry1_Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	This element is compued for TOPEX and POSEIDON data. A default value is given when the field (i.e. CORIOTROP) is not available. Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Dry2_Err (Quality flag)

Definition	Quality index on Dry2-Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when the field (i.e. CORIOTROP) is not available. Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Dtim_Bias

Definition	Net time tag correction.
Element type	Integer
Storage type	Signed
Size	4
Unit	microsecond
Minimum value	-50 000
Maximum value	+50 000
Default value	N/A
Comment	This element exists and is different for TOPEX and POSEIDON data. Nominal value is -4 570 microseconds for TOPEX data and -49 975 microseconds for Poseidon data.

Dtim_Mil

Definition	Frame time shift from the first height in a science data frame to the middle of the frame.
Element type	Integer
Storage type	Signed
Size	4
Unit	microsecond
Minimum value	400 000
Maximum value	600 000
Default value	N/A
Comment	This element exists and is different for TOPEX and POSEIDON data. Nominal value is 515 641 microseconds for TOPEX data and 475 494 microseconds for Poseidon data.

Dtim_Pac

Definition	Elapsed time between the 20 per second ranges.
Element type	Integer
Storage type	Signed
Size	4
Unit	microsecond
Minimum value	40 000
Maximum value	60 000
Default value	N/A
Comment	This element exists and is different for TOPEX and POSEIDON data. Nominal value is 54 278 microseconds for TOPEX data and 50 052 microseconds for POSEIDON data.

Fl_Att (Quality flag)

Definition	Flag indicating which attitude (Att_Wvf or Att_Ptf) is used for altimeter tracker correction.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. Its value is defined as follows :

Value	Definition
0	Att_Ptf used
1	Att_Wvf used

Note that for TOPEX data, the waveform estimate is always used to compute altimeter corrections involving attitude.

Gate_Index (Telemetry flag)

Definition	TOPEX flag indicating the gate index for both primary and secondary altimeter channels.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Bits 0-3 are a binary representation of the gate index for the primary channel, whereas bits 4-7 represent the gate index for the secondary channel. The value for each gate index ranges from 1 to 5.

Geo_Bad_1 (Quality flag)

Definition	Set of flags indicating ocean/land/ice states.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. Bits are defined as follows :

Bits	Indicator on
0	Deep water state (/ 1000 m) 0 - Deep water 1 - Shallow water
1	Water/land distribution 0 - Water 1 - Land
2	Sea surface state as observed by the radiometer 0 - Water 1 - Land
3	Ice distribution 0 - No ice 1 - Ice
4-7	Spares (0)

Geo_Bad_2 (Quality flag)

Definition	Set of flags indicating the rain and tide conditions.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. Bits are defined as follows :

Bits	Indicator on
0	Rain / Excess liquid 0 - Normal 1 - Rain / Excess liquid detected
1-2	CSR 3.0 ocean tide 0 - 4 valid points 1 - 3 valid points 2 - 2 valid points 3 - 1 less than 2 valid points
3-4	FES 95.2 ocean tide 0 - 4 valid points 1 - 3 valid points 2 - 2 valid points 3 - 1 less than 2 valid points
5-7	Spares (0)

H_Alt

Definition	One per second altimeter range [see section 4]. Altimeter ranges are corrected for instrumental effects only (see Net_Instr_R_Corr_K).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	120 000 000
Maximum value	140 000 000
Default value	2 147 483 647
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	

For TOPEX data :	Nval_H_Alt (10 per second values) Rang_SME Alt_Bad_1 (bits # 0 to 4, and bit # 7)
For POSEIDON data :	Nval_H_Alt (20 per second values) Rang_SME Alt_Bad_1 (bits # 0 and 1) Alt_Bad_2 (bits # 0 and 1)

H_Alt_SME(i)

Definition	Difference for ten per second altimeter ranges from one per second altimeter range (H_Alt). Altimeter ranges are corrected for instrumental effects only (see Net_Instr_R_Corr_K).
Element type	Integer
Storage type	Signed
Size	2 x 10
Unit	millimeter
Minimum value	-32 767
Maximum value	32 767
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	

For TOPEX data :	Nval_H_Alt Rang_SME Alt_Bad_1 (bits # 1, 2 and 7)
For POSEIDON data :	Nval_Hsat Rang_SME

H_Eot_CSR

Definition	Height of the elastic ocean tide at the measurement point computed from CSR 3.0 model [see section 4]. It is the sum of the ocean tide (equilibrium long period tides and non-equilibrium tides) and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15 000
Maximum value	15 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It includes equilibrium value for long period constituents and dynamical model solutions for short periods. The permanent tide (zero frequency) is not included in this parameter whereas it is included in the geoid (see H_Geo).
Quality flags	Geo_Bad_2 (bit # 1 and 2).

H_Eot_FES

Definition	Height of the elastic ocean tide at the measurement point computed from FES 95.2 model [see section 4]. It is the sum of the ocean tide tide (equilibrium long period tides and non-equilibrium tides) and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15 000
Maximum value	15 000
Default value	32 767
Comment	This element is copied for TOPEX and POSEIDON data. It includes equilibrium value for long period constituents and dynamical model solutions for short periods. The permanent tide (zero frequency) is not included in this parameter whereas it is included in the geoid [see H_Geo].
Quality flags	Geo_Bad_2 (bit # 3 and 4).

H_Geo

Definition	Geoid height (equipotential surface) above the reference ellipsoid at the measurement point.
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	-300 000
Maximum value	300 000
Default value	2 147 483 647
Comment	This element is computed for TOPEX and POSEIDON data. It is deduced from JGM3/OSU95A model with a correction to refer the value to the mean tide system i.e. includes the permanent tide (zero frequency). [See section 4 for more details].
Quality flags	/

H_Lt_CSR

Definition	Ocean loading effect on tide at the measurement point computed from CSR 3.0 model.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	500
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. Its value is included in the ocean tide height, i.e. the element H_Eot_CSR et H_Eot_FES.
Quality flags	Geo_Bad_2 (bit # 1 and 2).

H_MSS

Definition	Mean sea surface height above the reference ellipsoid at the measurement point.
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	-300 000
Maximum value	300 000
Default value	2 147 483 647
Comment	This element is computed for TOPEX and POSEIDON data. This element is deduced from Rapp et al. mean sea surface height fields computed. [See section 4 for more details].
Quality flags	/

H_Ocs

Definition	Ocean depth at the measurement point.
Element type	Integer
Storage type	Signed
Size	2
Unit	meter
Minimum value	-15 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data from ETOPO5 database (NOAA, Boulder, Colorado).
Quality flags	/

H_Pol

Definition	Geocentric pole tide height at the measurement point. [See section 4].
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimum value	-100
Maximum value	100
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. It was not available during the verification phase.
Quality flags	/

HP_Sat

Definition	One per second CNES altitude of satellite center of mass above the reference ellipsoid. [See section 4].
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	2 147 483 647
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when the CNES orbit is not available.

HP_Sat(i)

Definition	Difference for ten per second CNES satellite altitudes from one per second CNES satellite altitude (HP_Sat).
Element type	Integer
Storage type	Signed
Size	2 x 10
Unit	millimeter
Minimum value	-32 767
Maximum value	32 767
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. These values are needed to perform orbit replacement without having the original orbit and software. A default value is given when the CNES orbit is not available.

H_Set

Definition	Height of the solid earth tide at the measurement point. [See section 4].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	1 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It is calculated using Cartwright and Tayler tables and consists of the second and third degree constituents. The permanent tide (zero frequency) is not included.
Quality flags	/

Inv_Bar

Definition	Inverse barometer correction at altimeter measurement. [See section 4].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	+500
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. [See § 4.6 for more details].
Quality flags	/

IMANV (Quality flag)

Definition	Quality indicator on precise CNES orbit ephemeris or maneuver indicator for logistic CNES orbit ephemeris.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element exists only for POSEIDON measurements. A default value is given when TOPEX is on.

Value	Definition	
0	A maneuver is occuring	logistic orbit
1	Adjusted when no maneuver	
2	Extrapolated when no maneuver	
3	Accuracy better than 2 cm rms	precise
4	Accuracy below 7.5 cm rms	
5	Accuracy below 13 cm rms	
6	Accuracy below 20 cm rmsorbit	
7	Accuracy worst than 20 cm rms	
8	No Doris data available	

Ind_Pha (Telemetry flag)

Definition	POSEIDON indicator on tracker processing.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	3
Default value	127
Comment	This element exists only for POSEIDON measurements. A default value is given when TOPEX is on.

Value	Definition
0	OK
1	Tracking lost
2	Computation time too long

Ind_RTK

Definition	POSEIDON ground retracking indicator
Element type	Bitfield
Storage type	Unsigned
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element exists only for POSEIDON measurements. A default value is given when TOPEX is on.

Instr_State_DORIS (Instrument flag)

Definition	Flag indicating DORIS instrument state, i.e. if a ionospheric correction has been computed.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	2
Default value	127
Comment	This element exists for TOPEX and POSEIDON data. A default value is given when the field (i.e. CORIOTROP) is not available. Its value is defined as follows :

Value	Definition
0	No ionospheric correction available (DORIS or BENT)
1	BENT correction available
2	BENT and DORIS correction available

Instr_State_TMR (Instrument flag)

Definition	Flag indicating various states of the TMR.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element exists for TOPEX and POSEIDON data. Bits are defined as follows :

Bits	Definition
0-4	Spares (0)
5	TMR 21A status (0 = On , 1 = Off)
6	TMR 21B status (0 = Off , 1 = On)
7	Spare (0)

Instr_State_TOPEX (Instrument flag)

Definition	Flag indicating various states of TOPEX altimeter.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Bits are defined as follows :

Bits	Definition	
0	C band status	(0 = On , 1 = Off)
1	C bandwidth	(0 = 320 MHz , 1 = 100 MHz)
2	Ku band status	(0 = On , 1 = Off)
3	Altimeter operating	(0 = A , 1 = B)
4-7	Spares (0)	

Iono_Bad (Quality flag)

Definition	Quality index on Iono_Cor
Element type	Integer
Storage type	Bit
Size	2
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	65 535
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. It represents a set of flags which indicates that the computed dual-frequency ionospheric correction is out of range or not computed because only one band was operating. Bits are defined as follows:

Bits	Definition
0-9	Flags corresponding to the ten per second range values (0 = OK , 1 = Bad data)
10	Spare (0)
11	Altimeter engineering preliminary flags set
12	Altimeter science preliminary flags set
13	SDR Flag_Fine_Ht_K (Ku band)
14	SDR Flag_Fine_Ht_C (C band)
15	Spare (0)

Note that bits # 11 and 12 are telemetry flags (e.g. check sum exception, reset detected...), they are used to produce the GDRs.

Iono_Ben

Definition	One per frame ionospheric correction computed from BENT model. [See § 4.3].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. A ionospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Instr_State_DORIS

Iono_Cor

Definition	TOPEX dual-frequency one per frame ionospheric correction. [See § 4.3].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	40
Default value	32 767
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. A ionospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Alt_bad_1 (bit # 6), Iono_Bad (bits # 0 to 9)

Iono_Dor

Definition	One per frame ionospheric correction computed from DORIS data. [See § 4.3].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. A ionospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Instr_State_DORIS, Iono_Dor_Bad

Iono_Dor_Bad (Quality flag)

Definition	Quality index on Iono_Dor.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Lat_Err (Quality flag)

Definition	Quality index between CNES and NASA latitude locations.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when one of the two latitudes is not available. Its definition is as follows :

Value	Definition
0	Difference below ten microdegrees
1	Difference over ten microdegrees

Lat_Tra

Definition	Geodetic latitude of the one per frame averaged measure.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	- 90 000 000
Maximum value	90 000 000
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. A latitude is always reported. It is nominally computed from CNES orbit data. When CNES orbit data are not available and TOPEX altimeter is on, the latitude corresponds to the GDR-T latitude which has been computed from NASA orbit data. Anyhow, a quality flag between CNES and NASA latitudes is reported in the GDR-M product (see Lat_Err). Positive latitude is North latitude, whereas negative latitude is South latitude.
Quality flags	Lat_Err

Lon_Err (Quality flag)

Definition	Quality index between CNES and NASA longitude locations.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when one of the two longitudes is not available. Its definition is as follows :

Value	Definition
0	Difference below ten microdegrees
1	Difference over ten microdegrees

Lon_Tra

Definition	Geodetic longitude of the one per frame averaged measure.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	0
Maximum value	360 000 000
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. A longitude is always reported. It is nominally computed from CNES orbit data. When CNES orbit data are not available and TOPEX altimeter is on, the longitude corresponds to the GDR-T longitude which has been computed from NASA orbit data. Anyhow, a quality flag between CNES and NASA longitudes is reported in the GDR-M product (see Lon_Err). The longitude corresponds to the East longitude relative to Greenwich meridian.
Quality flags	Lon_Err

Net_Instr_AGC_Corr_C

Definition	Net (summed) instrument correction at C band applied to Automatic Gain Control (AGC_C).
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 decibel
Minimum value	-32 767
Maximum value	32 767
Default value	32 767
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. This correction also applies directly to the backscatter coefficient (Sigma0_C).
Quality flags	Alt_Bad_2 (bit # 5).

Net_Instr_AGC_Corr_K

Definition	Net (summed) instrument correction at Ku band applied to Automatic Gain Control (AGC_K) .
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 decibel
Minimum value	-32 767
Maximum value	32 767
Default value	32 767
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. This correction also applies directly to the backscatter coefficient (Sigma0_K).
Quality flags	Alt_Bad_2 (bit # 6).

Net_Instr_R_Corr_C

Definition	Net (summed) instrument correction at C band applied to TOPEX altimeter tracker range.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-32 768
Maximum value	32 767
Default value	32 767
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	Alt_Bad_1 (bit # 7).

Net_Instr_R_Corr_K

Definition	Net (summed) instrument correction at Ku band applied to altimeter tracker range (H_Alt).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-32 768
Maximum value	32 767
Default value	N/A
Comment	This element exists for TOPEX and POSEIDON data. Note that this value depends on the altimeter on.
Quality flags	

For TOPEX data:	Alt_Bad_1 (bit # 7)
For POSEIDON data:	Alt_Bad_2 (bits # 0 and 1)

Net_Instr_Sig0_Corr

Definition	Net (summed) instrument correction at Ku band applied to backscatter coefficient (Sigma0_K).
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 decibel
Minimum value	-200
Maximum value	0
Default value	32 767
Comment	This element exists only for POSEIDON measurements. A default value is given when TOPEX is on.
Quality flags	Alt_Bad_2 (bits # 4 and 5)

Net_Instr_SWH_Corr_C

Definition	Net (summed) instrument correction at C band applied to Significant Wave Height (SWH_C).
Element type	Integer
Storage type	Signed
Size	1
Unit	0.1 meter
Minimum value	-127
Maximum value	127
Default value	127
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	Alt_Bad_2 (bit # 3).

Net_Instr_SWH_Corr_K

Definition	Net (summed) instrument correction at Ku band applied to Significant Wave Height (SWH_K).
Element type	Integer
Storage type	Signed
Size	1
Unit	0.1 meter
Minimum value	-127
Maximum value	127
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. Note that this value depends on the altimeter on.
Quality flags	

For TOPEX data:	Alt_Bad_2 (bit # 4)
For POSEIDON data:	Alt_Bad_2 (bits # 2 and 3)

Nval_H_Alt (Quality flag)

Definition	Number of high-rate ranges used (unflagged) to compute the one per frame range average (H_Alt).
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	10 for TOPEX data 20 for Poseidon data
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. High-rate ranges are the ten per second values for TOPEX data and the twenty per second values for POSEIDON data.

Range_Deriv

Definition	One per second range derivative.
Element type	Integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	-3 500
Maximum value	3 500
Default value	32 767
Comment	This element exists only for POSEIDON measurements. A default is given when TOPEX is on.
Quality flags	Alt_Bad_1 (bits # 0 and 1), Alt_Bad_2 (bits # 0 and 1)

Rang_SME (Quality flag)

Definition	Set of flags to indicate if the ten per second ranges are believed to be valid or not.
Element type	Integer
Storage type	Bit
Size	2
Unit	N/A
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. Bits are defined as follows :

<u>Bits</u>	<u>Definition</u>
0-9	Flags corresponding to the ten per second ranges (0 = OK , 1 = Bad data)
10-15	Spares (0)

RMS_H_Alt

Definition	Root Mean Square (RMS) of the high-rate ranges about the fit or average used to obtain the one per frame value (H_Alt).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	0
Maximum value	10 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. High-rate ranges are ten per second values for TOPEX and twenty per second values for POSEIDON. Non rejected high-rate values are only used to compute this element and a minimum of three good points is required.
Quality flags	Nval_H_Alt, Rang_SME.

RMS_Range_Deriv

Definition	Root Mean Square (RMS) of the high-rate range derivatives about the fit or average used to obtain the one per frame value (Range_Deriv).
Element type	Integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	0
Maximum value	1 000
Default value	32 767
Comment	This element exists for TOPEX and POSEIDON data. A default value is given when TOPEX is on.
Quality flags	Alt_Bad_1 (bit # 0 and 1), Alt_Bad_2 (bit # 0 and 1)

Sat_Alt

Definition	One per second NASA altitude of satellite center of mass above the reference ellipsoid. [See section 4].
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	2 147 483 647
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when the NASA orbit is not available. This happens particularly for POSEIDON data in IGDR-M products.

Sat_Alt_Hi_Rate(i)

Definition	Difference for the ten per second NASA satellite altitudes from one per second NASA satellite altitude (Sat_Alt).
Element type	Integer
Storage type	Signed
Size	2 x 10
Unit	millimeter
Minimum value	-32 767
Maximum value	32 767
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. These values are needed to perform orbit replacement without having the original orbit and software. A default value is given when the NASA orbit is not available. This happens particularly for POSEIDON data in IGDR-M products.

Sigma0_C

Definition	C band, backscatter coefficient computed from AGC_C, corrected.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	32 767
Default value	65 535
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	Alt_Bad_2 (bits # 5)

Sigma0_K

Definition	Ku band, backscatter coefficient computed from AGC_K, corrected.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	3 000
Default value	65 535
Comment	This element exists for TOPEX and POSEIDON data.
Quality flags	For TOPEX data : Alt_Bad_2 (bit # 6) For POSEIDON data : Alt_Bad_1 (bits # 4 and 5) Alt_Bad_2 (bits # 4 and 5)

Spare(s)

Definition	Spare(s)
Element type	Integer
Storage type	Character
Size	Variable
Unit	/
Minimum value	0
Maximum value	0
Default value	0
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	/

SSB _Corr_K1

Definition	Ku band, one per frame range correction for sea state bias (SSB).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 200
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. The sea state bias value (negative) has to be added to instrument range to get correct range. It is computed using the BM4 formulation [see section 4]. This element should not be used over land.
Quality flags	/

SSB_Corr_K2

Definition	Ku band, one per frame, range correction for sea state bias (SSB) computed using a polynomial formula.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 200
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX data, a default value is given for POSEIDON [see § 4.4]. The sea state bias value (negative) has to be added to instrument range to get correct range [see section 4].. It is computed using theNASA project team formulation. This element should not be used over land.
Quality flags	/

SWH_C

Definition	C band, one per frame Significant Wave Height (SWH).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	centimeter
Minimum value	0
Maximum value	65 534
Default value	65 535
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	SWH_Pts_Avg, Alt_Bad_2 (bit # 3)

SWH_K

Definition	Ku band, one per frame Significant Wave Height (SWH).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	centimeter
Minimum value	0
Maximum value	65 534
Default value	65 535
Comment	This element is computed for TOPEX and POSEIDON data. Its computation depends on the instrument.
Quality flags	

For TOPEX data :	SWH_Pts_Avg, Alt_Bad_2 (bit # 4)
For POSEIDON data :	SWH_Pts_Avg, Alt_Bad_1 (bits # 2 and 3) Alt_Bad_2 (bits # 2 and 3)

SWH_Pts_Avg (Quality flag)

Definition	Number of points (10 per frame) used to compute the one per frame Significant Wave Height (SWH) average.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	10
Default value	127
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. This element concerns the primary channel (see Instr_State_Topex). A good value is 8.

SWH_RMS_C

Definition	Root Mean Square (RMS) of the ten per second C band Significant Wave Height (SWH) data about the fit or averaged used to obtain the one per frame value (SWH_C).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	centimeter
Minimum value	0
Maximum value	254
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Non rejected high-rate values are only used to compute this element and a minimum of two good points is required.
Quality flags	SWH_Pts_Avg

SWH_RMS_K

Definition	Root Mean Square (RMS) of the ten per second Ku band Significant Wave Height (SWH) data about the fit or averaged used to obtain the one per frame value (SWH_K).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	centimeter
Minimum value	0
Maximum value	254
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Non rejected high-rate values are only used to compute this element and a minimum of two good points is required.
Quality flags	SWH_Pts_Avg

Tb_18

Definition	Corrected brightness temperature at 18 GHz.
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 Kelvin
Minimum value	0
Maximum value	22 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	Geo_Bad_1 (bits # 2 and 3), TMR_Bad

Tb_21

Definition	Corrected brightness temperature at 21 GHz.
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 Kelvin
Minimum value	0
Maximum value	25 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	Geo_Bad_1 (bits # 2 and 3), TMR_Bad

Tb_37

Definition	Corrected brightness temperature at 37 GHz.
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 Kelvin
Minimum value	0
Maximum value	27 000
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	Geo_Bad_1 (bits # 2 and 3), TMR_Bad

Tim_Moy_1

Definition	Time elapsed between the reference epoch[1] and the one per frame time of the measurement, day part.
Element type	Integer
Storage type	Signed
Size	2
Unit	day
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. The complete one per second elapsed time (in seconds) can be obtained, with respect to unit systems, and "UTC leap second"[2] as follows : 1/s Elapsed Time = 86400 x Tim_Moy_1 + 10^{-3} x Tim_Moy_2 + 10^{-6} x Tim_Moy_3

Tim_Moy_2

Definition	Number of milliseconds in the day for the complete elapsed time (see Tim_Moy_1 and Tim_Moy_3).
Element type	Integer
Storage type	Signed
Size	4
Unit	millisecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. It includes "UTC leap second"[2] .

1 The reference epoch is the zero point of time from which data times are measured. It is reported in the Time_Epoch variable (see chapter 5). Prefered zero point is January 1, 1958 (0h 0mn 0.0 s).

2 A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day.
Thus, the UTC values (minutes:seconds) appear as: 59:58 ; 59:59 ; <u>59:60</u> ; 00:00 ; 00:01

Tim_Moy_3

Definition	Number of microseconds in the millisecond for the complete elapsed time (see Tim_Moy_1 and Tim_Moy_2).
Element type	Integer
Storage type	Signed
Size	2
Unit	microsecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data.

TMR_Bad (Quality flag)

Definition	Set of flags for brightness temperatures.
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This set of flags exists for TOPEX and POSEIDON data. Bits are defined as folows :

Bits	Definition
0-1	00 - All channels good 01 - One or more channels fair 10 - One or more channels poor 11 - One or more channels with interpolation failure (bad)
2-6	Spares (0)

Val_Att_Ptf (Quality flag)

Definition	Platform attitude validity.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	2
Default value	127
Comment	This flag exists only for POSEIDON measurements. A default value is given when TOPEX is on. It indicates if the platform attitude is believed to be valid or not, and defined as follows

Value	Definition
0	OK
1	Possible error
2	Bad data

Wet_Corr

Definition	Wet meteorological tropospheric correction interpolated at altimeter measurement. [See section 4].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It is interpolated from Wet1_Corr and Wet2_Corr elements at altimeter measurement epoch. A default value is given when the two meteorological fields are not available. A wet tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Wet_Flag, Wet_H_Err

Wet1_Corr

Definition	Wet meteorological tropospheric correction before altimeter measurement.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It corresponds to the wet tropospheric correction computation obtained from models of water vapor from the French Meteorological Office via the surface meteorological data file and which is included in the CORIOTROP data. A default value is given when the meteorological fields (i.e. CORIOTROP) are not available. A wet tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Wet_Flag, Wet_H_Err

Wet2_Corr

Definition	Wet meteorological tropospheric correction after altimeter measurement.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. It corresponds to the wet tropospheric correction computation obtained from models of water vapor from the French Meteorological Office via the surface meteorological data file and which is included in the CORIOTROP data. A default value is given when the meteorological fields (i.e. CORIOTROP) are not available. A wet tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Wet_Flag, Wet_H_Err

Wet_Flag (Quality flag)

Definition	Interpolation indicator on Wet1_Corr and Wet2_Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. It is defined as follows :

Value	Definition
0	No point over land
1	One point at least over land

Wet_H_Err (Quality flag)

Definition	Quality index on Wet_Corr, Wet1_Corr and Wet2_Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranghes when it is not valuable.

Wet_H_Rad

Definition	Radiometer wet tropospheric correction. [See section.4].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	1 000
Maximum value	0
Default value	32 767
Comment	This element is computed for TOPEX and POSEIDON data. A wet tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Geo_Bad_1 (bits # 2 and 3), TMR_Bad

Wind_Sp

Definition	Wind intensity (Ku band).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.1 meter per second
Minimum value	0
Maximum value	250
Default value	255
Comment	This element is computed for TOPEX and POSEIDON data. [see § 4.9]. This element should not be used over land.
Quality flags	/

7. CROSSOVER POINT ELEMENTS (ALPHABETICAL ORDER)

Elements of the crossover file product are generally characterized by the following items :

Definition	Element definition.
Element type	An element type can be bitfield or integer.
Storage type	A storage type can be signed (signed integer), unsigned (unsigned integer), bit (contiguous sequence of bits) or character (contiguous sequence of ASCII characters).
Size	Size of elements in 8-bit bytes.
Unit	Unit of measure including scale factor, or none (/).
Minimum value	Typical or approximate minimum element value.
Maximum value	Typical or approximate maximum element value.
Default value	Element value when the measurement is not available or the element is not computable ("flag value").
Comment	Other comment.
Quality flags	Flags indicating the quality of this element, or none (/). This item exists if the element is not a flag itself.

When an Item can not be filled, there is N/A which stands for not applicable.

Att_Ptf_Asc

Definition	Off-nadir angle estimated from platform elements (ascending pass-file).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	0
Maximum value	150
Default value	255
Comment	This element is computed by linear interpolation from GDR-M off-nadir angle values (Att_Ptf).
Quality flags	/

Att_Ptf_Des

Definition	Off-nadir angle estimated from platform elements (descending pass-file).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	0
Maximum value	150
Default value	255
Comment	This element is computed by linear interpolation from GDR-M off-nadir angle values (Att_Ptf).
Quality flags	/

Att_Wvf_Asc

Definition	Off-nadir angle estimated from the measured waveform (ascending pass-file).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	0
Maximum value	150
Default value	255
Comment	This element is computed by linear interpolation from GDR-M off-nadir angle values (Att_Wvf).
Quality flags	/

Att_Wvf_Des

Definition	Off-nadir angle estimated from the measured waveform (descending pass-file).
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	0
Maximum value	150
Default value	255
Comment	This element is computed by linear interpolation from GDR-M off-nadir angle values (Att_Wvf).
Quality flags	/

DR(SWH/att)_C_Asc

Definition	Correction applied to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at C band (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-400
Maximum value	400
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M SWH and attitude correction values (DR(SWH/att)_C).
Quality flags	/

DR(SWH/att)_C_Des

Definition	Correction applied to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at C band (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-400
Maximum value	400
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M SWH and attitude correction values (DR(SWH/att)_C).
Quality flags	/

DR(SWH/att)_K_Asc

Definition	Correction applied to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at Ku band (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-400
Maximum value	400
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M SWH and attitude correction values (DR(SWH/att)_K)
Quality flags	/

DR(SWH)/att)_K_Des

Definition	Correction applied to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at Ku band (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-400
Maximum value	400
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M SWH and attitude correction values (DR(SWH/att)_K)
Quality flags	/

Dry_Corr_Asc

Definition	Dry meteorological tropospheric correction interpolated at altimeter measurement (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M dry tropospheric correction values (Dry_Corr). A dry tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Dry_Err_Asc

Dry_Corr_Des

Definition	Dry meteorological tropospheric correction interpolated at altimeter measurement (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M dry tropospheric correction values (Dry_Corr). A dry tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Dry_Err_Des

Dry1_Corr_Asc

Definition	Dry tropospheric correction before altimeter measurement (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element corresponds to the dry tropospheric correction computation using respectively one of the two meteorological fields surrounding the altimeter measurement epoch (nearest value). [See the Dry1_Corr GDR-M parameter for more details.]
Quality flags	Dry1_Err_Des

Dry1_Corr_Des

Definition	Dry tropospheric correction before altimeter measurement (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element corresponds to the dry tropospheric correction computation using respectively one of the two meteorological fields surrounding the altimeter measurement epoch (nearest value). [See the Dry1_Corr GDR-M parameter more details.]
Quality flags	Dry1_Err_Des

Dry2_Corr_Asc

Definition	Dry tropospheric correction after altimeter measurement (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element corresponds to the dry tropospheric correction computation using respectively one of the two meteorological fields surrounding the altimeter measurement epoch (nearest value). [See the Dry2_Corr GDR-M parameter for more details.]
Quality flags	Dry2_Err_Des

Dry2_Corr_Des

Definition	Dry tropospheric correction after altimeter measurement (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3 000
Maximum value	-2 000
Default value	32 767
Comment	This element corresponds to the dry tropospheric correction computation using respectively one of the two meteorological fields surrounding the altimeter measurement epoch (nearest value). [See the Dry2_Corr GDR-M parameter for more details.]
Quality flags	Dry2_Err_Des

Dry_Err_Asc (Quality flag)

Definition	Quality index on Dry_Corr_Asc.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Dry_Err GDR-M parameter for more details.]

Dry_Err_Des (Quality flag)

Definition	Quality index on Dry_Corr_Des.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Dry_Err GDR-M parameter for more details.]

Dry1_Err_Asc (Quality flag)

Definition	Quality index on Dry1_Corr_Asc.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Dry1_Err GDR-M parameter for more details.]

Dry1_Err_Des (Quality flag)

Definition	Quality index on Dry1_Corr_Des.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Dry1_Err GDR-M parameter for more details.]

Dry2_Err_Asc (Quality flag)

Definition	Quality index on Dry2_Corr_Asc.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Dry2_Err GDR-M parameter for more details.]

Dry2_Err_Des (Quality flag)

Definition	Quality index on Dry2_Corr_Des.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Dry2_Err GDR-M parameter for more details.]

Geo_Bad_1_Asc (Quality flag)

Definition	Set of flags indicating ocean/land/ice states (ascending pass-file).
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is defined as follows :

Bits	Indicator on
0	Deep water state 0 / 1 - Deep / Shallow water (/1000 m)
1	Water/land distribution 0 / 1 - Water / Land
2	Sea surface state as observed by the radiometer 0 / 1 - Water / Land
3	Ice distribution 0 / 1 - No ice / Ice
4-7	Spares (0)

Geo_Bad_1_Des (Quality flag)

Definition	Set of flags indicating ocean/land/ice states (descending pass-file).
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is defined as follows :

Bits	Indicator on
0	Deep water state 0 / 1 - Deep / Shallow water (/1000 m)
1	Water/land distribution 0 / 1 - Water / Land
2	Sea surface state as observed by the radiometer 0 / 1 - Water / Land
3	Ice distribution 0 / 1 - No ice / Ice
4-7	Spares (0)

Geo_Bad_2_Asc (Quality flag)

Definition	Set of flags indicating the rain and tide conditions (ascending pass-file).
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is defined as follows :

Bits	Indicator on	
0	Rain / Excess liquid	
	0 / 1 - Normal / Rain or Excess liquid detected	
1	"CSR3.0 ocean tide	
	0	4 points
	1	3 points
	2	2 points
	3	less than 2 points valid
2	"FES95.2 tide	
	0	4 points
	1	3 points
	2	2 points
	3	less than 2 points valid
3-7	Spares (0)	

Geo_Bad_2_Des (Quality flag)

Definition	Set of flags indicating the rain and tide conditions (descending pass-file).
Element type	Bitfield
Storage type	Bit
Size	1
Unit	/
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	This element is defined as follows :

Bits	Indicator on	
0	Rain / Excess liquid	
	0 / 1 - Normal / Rain or Excess liquid detected	
1	"CSR3.0 ocean tide	
	0	4 points
	1	3 points
	2	2 points
	3	less than 2 points valid
2	"FES95.2 tide	
	0	4 points
	1	3 points
	2	2 points
	3	less than 2 points valid
3-7	Spares (0)	

H_Alt_Asc

Definition	Altimeter range (ascending pass-file). Altimeter ranges are corrected for instrumental effects only (see Net_Instr_R_Corr_K_Asc).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	120 000 000
Maximum value	140 000 000
Default value	2 147 483 647
Comment	This element is computed by spline interpolation from GDR-M altimeter range values (H_Alt).
Quality flags	RMS_H_Alt_Asc, Spline_RMS_Asc

H_Alt_Des

Definition	Altimeter range (descending pass-file). Altimeter ranges are corrected for instrumental effects only (see Net_Instr_R_Corr_K_Des).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	120 000 000
Maximum value	140 000 000
Default value	2 147 483 647
Comment	This element is computed by spline interpolation from GDR-M altimeter range values (H_Alt).
Quality flags	RMS_H_Alt_Des, Spline_RMS_Des

H_Eot_CSR_Asc

Definition	Height of the elastic ocean tide (ascending pass-file) computed from CSR 3.0 model It is the sum of the ocean tide and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15 000
Maximum value	15 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M elastic ocean tide values (H_Eot_CSR).
Quality flags	Geo_Bad_2 (bit # 1 and 2).

H_Eot_CSR_Des

Definition	Height of the elastic ocean tide (descending pass-file) computed from CSR 3.0 model. It is the sum of the ocean tide and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15 000
Maximum value	15 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M elastic ocean tide values (H_Eot_CSR).
Quality flags	Geo_Bad_2 (bit # 1 and 2).

H_Eot_FES_Asc

Definition	Height of the elastic ocean tide (ascending pass-file) computed from FES 95.2 model. It is the sum of the ocean tide and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15 000
Maximum value	15 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M elastic ocean tide values (H_Eot_FES).
Quality flags	Geo_Bad_2 (bit # 3 and 4).

H_Eot_FES_Des

Definition	Height of the elastic ocean tide (descending pass-file) computed from FES 95.2 model. It is the sum of the ocean tide and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15 000
Maximum value	15 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M elastic ocean tide values (H_Eot_FES).
Quality flags	Geo_Bad_2 (bit # 3 and 4).

H_Lt_CSR_Asc

Definition	Ocean tide loading effect computed from CSR 3.0 model (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	500
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M ocean loading tide values (H_Lt_CSR).
Quality flags	Geo_Bad_2 (bit # 1 and 2).

H_Lt_CSR_Des

Definition	Ocean tide loading effect computed from CSR 3.0 model (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	500
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M ocean loading tide values (H_Lt_CSR).
Quality flags	Geo_Bad_2 (bit # 1 and 2).

H_MSS_Cro

Definition	Mean sea surface height above the reference ellipsoid at the crossover point.
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	-300 000
Maximum value	300 000
Default value	2 147 483 647
Comment	This element is computed by linear interpolation from GDR-M mean sea surface height values (H_MSS).
Quality flags	/

H_Ocs_Cro

Definition	Ocean depth at the crossover point.
Element type	Integer
Storage type	Signed
Size	2
Unit	meter
Minimum value	-15 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M ocean depth values (H_Ocs).
Quality flags	/

H_Pol_Asc

Definition	Geocentric pole tide height (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimum value	-100
Maximum value	100
Default value	127
Comment	This element is computed by linear interpolation from GDR-M geocentric pole tide height values (H_Pol).

H_Pol_Des

Definition	Geocentric pole tide height (descending pass-file).
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimum value	-100
Maximum value	100
Default value	127
Comment	This element is computed by linear interpolation from GDR-M geocentric pole tide height values (H_Pol).

HP_Sat_Asc

Definition	CNES altitude of satellite center of mass above the reference ellipsoid (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	2 147 483 647
Comment	This element is computed by linear interpolation from GDR-M CNES altitude values (HP_Sat).

HP_Sat_Des

Definition	CNES altitude of satellite center of mass above the reference ellipsoid (descending pass-file).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	2 147 483 647
Comment	This element is computed by linear interpolation from GDR-M CNES altitude values (HP_Sat).

H_Set_Asc

Definition	Height of the solid Earth tide (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	1 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M solid Earth tide height values (H_Set).

H_Set_Des

Definition	Height of the solid Earth tide (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	1 000
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M solid Earth tide height values (H_Set).

Ind_RTK_Asc

Definition	POSEIDON ground retracking indicator (ascending pass-file).
Element type	Bit field
Storage type	Bit
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element exists only for POSEIDON data, a default value is given when TOPEX is on.
Quality flags	/

Ind_RTK_Des

Definition	POSEIDON ground retracking indicator (descending pass-file).
Element type	Bit field
Storage type	Bit
Size	1
Unit	/
Minimum value	0
Maximum value	1
Default value	127
Comment	This element exists only for POSEIDON data, a default value is given when TOPEX is on.
Quality flags	/

Inv_Bar_Asc

Definition	Inverse barometer correction (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	+500
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M inverse barometer correction values (Inv_Bar).
Quality flags	/

Inv_Bar_Des

Definition	Inverse barometer correction (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	+500
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M inverse barometer values (Inv_Bar).
Quality flags	/

Iono_Ben_Asc

Definition	Ionospheric correction issued from Bent model (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M Bent ionospheric correction values (Iono_Ben).
Quality flags	/

Iono_Ben_Des

Definition	Ionospheric correction issued from Bent model (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M Bent ionospheric correction values (Iono_Ben).
Quality flags	/

Iono_Cor_Asc

Definition	TOPEX dual-frequency ionospheric correction (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M TOPEX dual-frequency ionospheric correction values (Iono_Cor).
Quality flags	/

Iono_Cor_Des

Definition	TOPEX dual-frequency ionospheric correction (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M TOPEX dual-frequency ionospheric correction values (Iono_Cor).
Quality flags	/

Iono_Dor_Asc

Definition	DORIS ionospheric correction (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M DORIS ionospheric correction values (Iono_Dor).
Quality flags	Iono_Dor_Bad_Asc

Iono_Dor_Des

Definition	DORIS ionospheric correction (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M DORIS ionospheric correction values (Iono_Dor).
Quality flags	Iono_Dor_Bad_Des

Iono_Dor_Bad_Asc (Quality flag)

Definition	Quality index on Iono_Dor_Asc.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 wiht lower ranges when this element is valuable and higher ranges when it is no valuable. [See the Iono_Dor_Bad GDR-M parameter for more details].

Iono_Dor_Bad_Des (Quality flag)

Definition	Quality index on Iono_Dor_Des.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	It value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is no valuable. [See the Iono_Dor_Bad GDR-M parameter for more details].

Lat_Cro

Definition	Geodetic latitude of the crossover points.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	- 90 000 000
Maximum value	90 000 000
Default value	N/A
Comment	This element is computed by linear interpolation from GDR-M geodetic latitude values (Lat_Tra).
Quality flags	/

Lon_Cro

Definition	Geodetic latitude of the crossover points.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	0
Maximum value	360 000 000
Default value	N/A
Comment	This element is computed by linear interpolation from GDR-M geodetic longitude values (Lon_Tra).
Quality flags	/

Net_Instr_R_Corr_C_Asc

Definition	Net (summed) instrument correction at C band applied to altimeter tracker range (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-32 768
Maximum value	32 767
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M net instrument correction values (Net_Instr_R_Corr_C).
Quality flags	/

Net_Instr_R_Corr_C_Des

Definition	Net (summed) instrument correction at C band applied to altimeter tracker range (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-32 768
Maximum value	32 767
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M net instrument correction values (Net_Instr_R_Corr_C).
Quality flags	/

Net_Instr_R_Corr_K_Asc

Definition	Net (summed) instrument correction at Ku band applied to altimeter tracker range (H_Alt_Asc) (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-32 768
Maximum value	32 767
Default value	N/A
Comment	This element is computed by linear interpolation from GDR-M net instrument correction values (Net_Instr_R_Corr_K).
Quality flags	/

Net_Instr_R_Corr_K_Des

Definition	Net (summed) instrument correction at Ku band applied to altimeter tracker range (H_Alt_Des) (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-32 768
Maximum value	32 767
Default value	N/A
Comment	This element is computed by linear interpolation from GDR-M net instrument correction values (Net_Instr_R_Corr_K).
Quality flags	/

Num_Pass_Asc

Definition	Pass-file number of the ascending pass-file from which the ascending crossover point is issued.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	counts
Minimum value	1
Maximum value	254
Default value	N/A
Comment	/
Quality flags	/

Num_Pass_Des

Definition	Pass-file number of the descending pass-file from which the ascending crossover point is issued.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	counts
Minimum value	1
Maximum value	254
Default value	N/A
Comment	/
Quality flags	/

Range_Deriv_Asc

Definition	One per second range derivative (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	-3 500
Maximum value	3 500
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M range derivative values (Range_Deriv)
Quality flags	/

Range_Deriv_Des

Definition	One per second range derivative (descenfing pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	-3 500
Maximum value	3 500
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M range derivative values (Range_Deriv)
Quality flags	/

RMS_H_Alt_Asc

Definition	Root Mean Square (RMS) of high-rate altimeter ranges about the fit or average used to obtain the one per frame value (ascending pass-file)
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	0
Maximum value	10 000
Default value	32 767
Comment	This element is the maximum value of RMS_H_Alt for each H_Alt element used to compute H_Alt_Asc.
Quality flags	/

RMS_H_Alt_Des

Definition	Root Mean Square (RMS) of high-rate altimeter ranges about the fit or average used to obtain the one per frame value (descending pass-file)
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	0
Maximum value	10 000
Default value	32 767
Comment	This element is the maximum value of RMS_H_Alt for each H_Alt element used to compute H_Alt_Des.
Quality flags	/

Sat_Alt_Asc

Definition	NASA altitude of satellite center of mass above the reference ellipsoid (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	2 147 483 647
Comment	This element is computed by linear interpolation from GDR-M NASA altitude values (Sat_Alt).
Quality flags	/

Sat_Alt_Des

Definition	NASA altitude of satellite center of mass above the reference ellipsoid (descending pass-file).
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	2 147 483 647
Comment	This element is computed by linear interpolation from GDR-M NASA altitude values (Sat_Alt).
Quality flags	/

Sigma0_C_Asc

Definition	C band, backscatter coefficient computed from AGC_C (ascending pass-file), corrected.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	32 767
Default value	65 535
Comment	This element is computed by linear interpolation from GDR-M backscatter coefficient values (Sigma0_C).
Quality flags	/

Sigma0_C_Des

Definition	C band, backscatter coefficient computed from AGC_C (descending pass-file), corrected.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	32 767
Default value	65 535
Comment	This element is computed by linear interpolation from GDR-M NASA altitude values (Sigma0_C).
Quality flags	/

Sigma0_K_Asc

Definition	Ku band, backscatter coefficient computed from AGC_K (ascending pass-file), corrected.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	3 000
Default value	65 535
Comment	This element is computed by linear interpolation from GDR-M backscatter coefficient values (Sigma0_K).
Quality flags	/

Sigma0_K_Des

Definition	Ku band, backscatter coefficient computed from AGC_K (descending pass-file), corrected.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	0
Maximum value	3 000
Default value	65 535
Comment	This element is computed by linear interpolation from GDR-M backscatter coefficient values (Sigma0_K).
Quality flags	/

Spare(s)

Definition	Spare(s).
Element type	Integer
Storage type	Character
Size	Variable
Unit	/
Minimum value	0
Maximum value	0
Default value	0
Comment	/
Quality flags	/

Spline_RMS_Asc

Definition	Root Mean Square (RMS) of the 8 distances between the satellite and the sea surface about the spline used to get H_Alt_Asc through interpolation (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimun value	0
Maximum value	80
Default value	127
Comment	/
Quality flags	/

Spline_RMS_Des

Definition	Root Mean Square (RMS) of the 8 distances between the satellite and the sea surface about the spline used to get H_Alt_Des through interpolation (descending pass-file).
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimun value	0
Maximum value	80
Default value	127
Comment	/
Quality flags	/

SSB_Bias_Corr_K1_Asc

Definition	Ku band range correction for sea state bias (SSB) (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 200
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M SSB values (SSB_Bias_Corr_K1).
Quality flags	/

SSB_Bias_Corr_K1_Des

Definition	Ku band range correction for sea state bias (SSB) (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 200
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M SSB values (SSB_Bias_Corr_K1).
Quality flags	/

SWH_C_Asc

Definition	Significant Wave Height (SWH), C band (ascending pass-file).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	centimeter
Minimum value	0
Maximum value	32767
Default value	65535
Comment	This element is computed by linear interpolation from GDR-M Significant Wave Height values (SWH_C).
Quality flags	/

SWH_C_Des

Definition	Significant Wave Height (SWH), C band (descending pass-file).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	centimeter
Minimum value	0
Maximum value	32767
Default value	65535
Comment	This element is computed by linear interpolation from GDR-M Significant Wave Height values (SWH_C).
Quality flags	/

SWH_K_Asc

Definition	Significant Wave Height (SWH), Ku band (ascending pass-file).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	centimeter
Minimum value	0
Maximum value	32767
Default value	65535
Comment	This element is computed by linear interpolation from GDR-M Significant Wave Height values (SWH_K)
Quality flags	/

SWH_K_Des

Definition	Significant Wave Height (SWH), Ku band (descending pass-file).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	centimeter
Minimum value	0
Maximum value	32767
Default value	65535
Comment	This element is computed by linear interpolation from GDR-M Significant Wave Height values (SWH_K).

Tim_Moy_Asc_1

Definition	Time elapsed between the reference epoch[1] and the ascending crossover point, day part. (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	day
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed by spline interpolation from GDR-M elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3). The complete elapsed time (in seconds) which corresponds to the time when the satellites passes ascendingly over the crossover point location, can be obtained,with respect to unit systems, as follows : Elapsed Time = 86400 x Tim_Moy_1 + 10^{-3} x Tim_Moy_2 + 10^{-6} x Tim_Moy_3

Tim_Moy_Asc_2

Definition	Number of milliseconds in the day for the complete elapsed time (ascending pass-file)
Element type	Integer
Storage type	Signed
Size	4
Unit	millisecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed by spline interpolation from GDR-M elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3). It includes "UTC leap second"[2] .

---

1 The reference epoch is defined in the parameter Time_Epoch (see chapter 5).

2 A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day.
Thus, the UTC values (minutes:seconds) appear as: 59:58 ; 59:59 ; <u>59:60</u> ; 00:00 ; 00:01

Tim_Moy_Asc_3

Definition	Number of microseconds in the milliseconds for the complete elapsed time (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	microsecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed by spline interpolation from GDR-M elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3)

Tim_Moy_Des_1

Definition	Time elapsed between the reference epoch[1] and the descending crossover point, day part (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	day
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed by spline interpolation from GDR-M elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3). The complete elapsed time (in seconds) which corresponds to the time when the satellites passes descendingly over the crossover point location, can be obtained,with respect to unit systems, as follows : Elapsed Time = 86400 x Tim_Moy_1 + 10^{-3} x Tim_Moy_2 + 10^{-6} x Tim_Moy_3

1 The reference epoch is defined in the parameter Time_Epoch (see chapter 5).

Tim_Moy_Des_2

Definition	Number of milliseconds in the day for the complete elapsed time (descending pass-file)
Element type	Integer
Storage type	Signed
Size	4
Unit	millisecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed by linear interpolation from GDR-M elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3). It includes "UTC leap second"[2].

Tim_Moy_Des_3

Definition	Number of microseconds in the milliseconds for the complete elapsed time (descending pass-file)
Element type	Integer
Storage type	Signed
Size	2
Unit	microsecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed by spline interpolation from GDR-M elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3)

[2] A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day.
Thus, the UTC values (minutes:seconds) appear as: 59:58 ; 59:59 ; 59:60 ; 00:00 ; 00:01

Typ_Cro

Definition	Type of the crossover point.
Element type	Integer
Storage type	Signed
Size	1
Unit	N/A
Minimum value	0
Maximum value	3
Default value	none
Comment	Values are : 0 for TOPEX/TOPEX crossover type (T/T), 1 for POSEIDON/POSEIDON crossover type (P/P), 2 for TOPEX/POSEIDON crossover type (T/P), 3 for POSEIDON/TOPEX crossover type (P/T).
Quality flags	/

Wet_Corr_Asc

Definition	Wet meteorological tropospheric correction interpolated at altimeter measurement (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M wet tropospheric correction values (Wet_Corr). A wet tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Wet_H_Err_Asc

Wet_Corr_Des

Definition	Wet meteorological tropospheric correction interpolated at altimeter measurement (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M wet tropospheric correction values (Wet_Corr). A wet tropospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	Wet_H_Err_De

Wet1_Corr_Asc

Definition	Wet tropospheric correction before altimeter measurement (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element corresponds to the wet tropospheric correction computation obtained from models of water vapor from the French Meteorological Office via the surface meteorological data file. [See the Wet1_Corr GDR-M parameter for more details].
Quality flags	Wet_H_Err_Asc

Wet1_Corr_Des

Definition	Wet tropospheric correction before altimeter measurement (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element corresponds to the wet tropospheric correction computation obtained from models of water vapor from the French Meteorological Office via the surface meteorological data file. [See the Wet1_Corr GDR-M parameter for more details].
Quality flags	Wet_H_Err_Des

Wet2_Corr_Asc

Definition	Wet tropospheric correction after altimeter measurement (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element corresponds to the wet tropospheric correction computation obtained from models of water vapor from the French Meteorological Office via the surface meteorological data file. [See the Wet2_Corr GDR-M parameter for more details].
Quality flags	Wet_H_Err_Asc

Wet2_Corr_Des

Definition	Wet tropospheric correction before altimeter measurement (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element corresponds to the wet tropospheric correction computation obtained from models of water vapor from the French Meteorological Office via the surface meteorological data file. [See the Wet2_Corr GDR-M parameter for more details].
Quality flags	Wet_H_Err_Des

Wet_H_Err_Asc (Quality flag)

Definition	Quality index on Wet_Corr_Asc, Wet1_Corr_Asc and Wet2_Corr_Asc.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Wet_H_Err GDR-M parameter for more details].

Wet_H_Err_Des (Quality flag)

Definition	Quality index on Wet_Corr_Des, Wet1_Corr_Des and Wet2_Corr_Des.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from 0 to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable. [See the Wet_H_Err GDR-M parameter for more details].

Wet_H_Rad_Asc

Definition	Radiometer wet tropospheric correction (ascending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M radiometer wet tropospheric correction values (Wet_H_Rad).
Quality flags	/

Wet_H_Rad_Des

Definition	Radiometer wet tropospheric correction (descending pass-file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1 000
Maximum value	0
Default value	32 767
Comment	This element is computed by linear interpolation from GDR-M radiometer wet tropospheric correction values (Wet_H_Rad).
Quality flags	/

Wind_Sp_Asc

Definition	Wind intensity (ascending pass-file). (Ku band)
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.1 meter per second
Minimum value	0
Maximum value	250
Default value	255
Comment	This element is computed by linear interpolation from GDR-M wind speed values (Wind_Sp).
Quality flags	/

Wind_Sp_Des

Definition	Wind intensity (descending pass-file). (Ku band)
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.1 meter per second
Minimum value	0
Maximum value	250
Default value	255
Comment	This element is computed by linear interpolation from GDR-M wind speed values (Wind_Sp).
Quality flags	/

8. ORBIT ELEMENTS (ALPHABETICAL ORDER)

Elements of the orbit product are generally characterized by the following items :

Definition	Element definition.
Element type	An element type can be bitfield or integer.
Storage type	A storage type can be signed (signed integer), unsigned (unsigned integer), bit (contiguous sequence of bits) or character (contiguous sequence of ASCII characters).
Size	Size of elements in 8-bit bytes.
Unit	Unit of measure including scale factor, or none (/).
Minimum value	Typical or approximate minimum element value.
Maximum value	Typical or approximate maximum element value.
Default value	Element value when the measurement is not available or the element is not computable ("flag value").
Comment	Other comment.

When an Item can not be filled, there is N/A which stands for not applicable.

Lat

Definition	Geodetic latitude at the date of the orbital height evaluation.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	-90 000 000
Maximum value	90 000 000
Default value	N/A
Comment	Positive latitude is North latitude, whereas negative latitude is South latitude.

Lon

Definition	Geodetic longitude at the date of the orbital height evaluation.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	0
Maximum value	360 000 000
Default value	N/A
Comment	The longitude corresponds to the East longitude relative to Greenwich meridian.

Orb

Definition	Height of the satellite center of mass above the reference ellipsoid.
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1 200 000 000
Maximum value	1 400 000 000
Default value	N/A
Comment	

Spare(s)

Definition	Spare(s)
Element type	Integer
Storage type	Character
Size	variable
Unit	/
Minimum value	0
Maximum value	0
Default value	0
Comment	

Tim_Moy_1

Definition	Time elapsed between the reference epoch[1] and the orbit evaluation, day part.
Element type	Integer
Storage type	Signed
Size	2
Unit	day
Minimum value	/
Maximum value	/
Default value	N/A
Comment	The complete elapsed time (in seconds) can be obtained, with respect to unit systems, ans "UTC leap second"[2]

$$\text{Elapsed Time} = 86400 \times \text{Tim\_Moy\_1} + 10^{-3} \times \text{Tim\_Moy\_2} + 10^{-6} \times \text{Tim\_Moy\_3}$$

Tim_Moy_2

Definition	Number of milliseconds in the day for the complete elapsed time of the orbit evaluation (see Tim_Moy_1 and Tim_Moy_3)
Element type	Integer
Storage type	Signed
Size	4
Unit	millisecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	It includes "UTC leap second"[2].

1 The reference epoch is the zero point of time from which data times are measured. It is reported in the Time_Epoch variable (see chapter 5). Prefered zero point if January 1, 1958 (0h 0mn 0.0s).

2 A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day.
Thus, the UTC values (minutes:seconds) appear as: 59:58 ; 59:59 ; 59:60 ; 00:00 ; 00:01

Tim_Moy_3

Definition	Number of microseconds in the milliseconds for the complete elapsed time of the orbit evaluation (see Tim_Moy_1 and Tim_Moy_2)
Element type	Integer
Storage type	Signed
Size	2
Unit	microsecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	

X_CTRS_1

Definition	X component of the position vector, millimeter part, in the CTRS reference frame. [See X_CTRS_2 for the meter part].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	The complete X component (in mm) can be obtained as follows: X_CTRS = (X_CTRS_2 x 1000) + sign (X_CTRS_2) * X_CTRS_1

X_CTRS_2

Definition	X component of the position vector, or meter part, in the CTRS reference frame. [See X_CTRS_1 for the millimeter part].
Element type	Integer
Storage type	Signed
Size	4
Unit	meter
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	The complete X component (in mm) can be obtained as follows: X_CTRS = (X_CTRS_2 x 1000) + sign (X_CTRS_2) * X_CTRS_1

Y_CTRS_1

Definition	Y component of the position vector, millimeter part, in the CTRS reference frame. [See Y_CTRS_2 for the meter part].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	The complete Y component (in mm) can be obtained as follows: $Y\_CTRS = (Y\_CTRS\_2 \times 1000) + \text{sign}(Y\_CTRS\_2) * Y\_CTRS\_1$

Y_CTRS_2

Definition	Y component of the position vector, or meter part, in the CTRS reference frame. [See Y_CTRS_1 for the millimeter part].
Element type	Integer
Storage type	Signed
Size	4
Unit	meter
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	The complete Y (in mm) component can be obtained as follows: $Y\_CTRS = (Y\_CTRS\_2 \times 1000) + \text{sign}(Y\_CTRS\_2) * Y\_CTRS\_1$

Z_CTRS_1

Definition	Z component of the position vector, millimeter part, in the CTRS reference frame. [See Z_CTRS_2 for the meter part].
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	The complete Z component (in mm) can be obtained as follows: $Z\_CTRS = (Z\_CTRS\_2 \times 1000) + \text{sign}(Z\_CTRS\_2) * Z\_CTRS\_1$

Z_CTRS_2

Definition	Z component of the position vector, or meter part, in the CTRS reference frame. [See Z_CTRS_1 for the millimeter part].
Element type	Integer
Storage type	Signed
Size	4
Unit	meter
Minimum value	N/A
Maximum value	N/A
Default value	N/A
Comment	The complete Z (in mm) component can be obtained as follows: Z_CTRS = (Z_CTRS_2 x 1000) + sign (Z_CTRS_2) * Z_CTRS_1

9. ACRONYMS

AGC	Automatic Gain Control
ASCII	American Standard Code for Information Interchange
AVISO	Archivage,Validation et Interprétation des données des Satellites Océanographiques (Archiving, Validation and Interpretation of Satellites Oceanographic data)
CCDP	Centre de Contrôle Doris/Poseidon
CCSDS	Consultative Committee on Space Data System
CD ROM	Compact Disk Read Only Memory
CLS	Collecte Localisation Satellites
CNES	Centre National d'Etudes Spatiales (French space agency)
CNRS	Centre National de la Recherche Scientifique
CORIOTROP	CORrections IOnosphériques et TROPosphériques françaises (French ionospheric and tropospheric corrections)
CR	Carriage Return
CTO	Centre de Topographie des Océans
CTRS	Conventional Terrestrial Reference System
DORIS	Détermination d'Orbite et Radiopositionnement Intégrés par satellite (Doppler Orbitography and Radiopositioning Integrated by Satellite)
ECMWF	European Center for Medium range Weather Forecasting
EMB	ElectroMagnetic Bias
FNOC	Fleet Numerical Oceanographic Center
GDR	Geophysical Data Record
GDR - M	GDR Mixtes (Merged GDR)
GDR - P	GDR - Poseidon
GDR - T	GDR - Topex
GPS	Global Positionning System
GPSDR	Global Positioning System Demonstration Receiver
GRGS	Groupe de Recherche en Géodésie Spatiale
IAT	International Atomic Time
IGDR	Interim Geophysical Data Record
IGDR - M	IGDR Mixtes (Merged IGDR)
IGDR - P	IGDR - Poseidon
IGDR - T	IGDR - Topex
I/GDR	IGDR or GDR
IM	Instrument Module

ACRONYMS (continued)

LF	Line Feed
LRA	Laser Retroreflector Array
MMS	Multimission Modular Spacecraft
NASA	National Aeronautics and Space Administration
N/A	Not Applicable
NRA	NASA Radar Altimeter
PI(s)	Principal Investigator(s)
PODAAC	Physical Oceanography Distributed Active Archive Center
RMS	Root Mean Square
SFDU	Standard Formatted Data Units
SLR	Satellite Laser Ranging
SSALT	Solid State ALTimeter
SWH	Significant Wave Height
SWT	Science Working Team
TBC	To Be Confirmed
TGS	Topex Ground System
TOGA	Tropical Ocean and Global Atmosphere
TMR	Topex Microwave Radiometer
TOPEX	Ocean TOPography EXperiment
T/P	TOPEX/POSEIDON
UMR 5566	Unité Mixte de Recherche 5566 CNRS/CNES/UNIVERSITE
UTC	Universal Time Coordinated
VMS	Vax virtual Memory operating System
WCRP	World Climate Research Program
WOCE	World Ocean Circulation Experiment

10. REFERENCES

AVISO, "AVISO CD ROM User Manual : Merged TOPEX/POSEIDON Products",AVI-NT-02-100-CN, 1996.

Basic, T. , R. H. Rapp, "Ocean wide prediction of gravity anomalies and sea surface heights using Geos-3, Seasat and Geosat altimeter data, and ETOPO5U bathymetric data", Report n° 416, Dept. of Geodetic Science and Surveying, the Ohio State University, Columbus, Ohio 43210-1247, 1992.

Branger, H., *A. Ramamonjarisoa, L. Bliven, , "A Ku-Band laboratory experiment on the electromagnetic bias", IEEE, Transactions on Geoscience and Remote Sensing, in press, 1993.*

Brown, G. S., H. R. Stanley, N. A. Roy, , "The wind speed measurement capability of spaceborne radar altimetry" IEEE J. Oceanic Eng., OE6, 59-63, 1981.

Canceil , P., R. Angelou and P. Vincent, Barotropic tides in the Mediterranean Sea from a finite element numerical model, J. Geophys. Res., 1996.

Cartwright, D. E. , R. J. Tayler, "New computations of the tide-generating potential",Geophys. J. R. Astr. Soc., 23, 45-74, 1971.

Cartwright, D. E., A. C. Edden, "Corrected tables of tidal harmonics", Geophys. J. R. Astr. Soc., 33, 253-264, 1973.

Cartwright, D. E.,, R. J. Tayler, 1971 "New computations of the tide-generating potential", Geophys. J. R. Astr. Soc., 23, 45-74.

Cartwright, D. E., R. D. Ray,"Oceanic tides from Geosat altimetry", J. of Geophys. Res. (Oceans), 95, 3069-3090, 1990.

Cartwright, D.E. and R.D. Ray, Energetics of global ocean tides from Geosat altimetry. J. Geophys. Res., 96, (C9), 16897-16912, 1991.

Chelton, D.B., 1994 : The sea state bias in altimeter estimates of sea level from collinear analysis of TOPEX data. J. Geophys. Res., 99, 24995-25008.

Christensen E.J. et al, Calibration of Topex/Poseidon at platform Harvest, JGR, Vol. 99, C12, pp. 24465-24485., 1994.

Egbert, G.D., A.F. Bennett and M.G. Foreman, TOPEX / POSEIDON tides estimated using a global inverse model, J. Geophys. Res., Vol 99, C12, 24821-24852, 1994.

Fu, L.L., R. Glazman, "The effect of wave age on the sea state bias in radar altimetry measurements", J. of Geophys. Res. (Oceans), 96, 8829-8834, 1991.

Gaspar, P., F. Ogor, P.Y. Le Traon and O.Z. Zanife, Estimating the sea state bias of the TOPEX and POSEIDON altimeters from crossover differences. J. Geophys. Res., 99, 24981-24994, 1994.

Gaspar,P., F. Ogor and C. Escoubes, Nouvelles calibration et analyse du biais d'état de mer des altimètres TOPEX et POSEIDON. Technical note 96/018 of CNES Contract 95/1523, 1996.

Genco M.L., F. Lyard and C. Le Provost, The oceanic tides in the South Atlantic Ocean, Ann. Geophysicae, 12, 868-886, 1994.

Le Provost C. and P.Vincent, Extensive tests of precision for a finite element model of Ocean Tides,Journal of Computational Physics , 65, 273-291, 1986.

Le Provost, C, F. Lyard, "Global ocean tides, maps and atlas of five semi-diurnal tides -- $2N_2$,MU_2,NU_2,L_2,T_2", Institut de Mécanique de Grenoble, Internal Report, MEOL 90/03, 1990.

Le Provost, C., F. Lyard and J.M. Molines, Improving ocean tide predictions by using additional semi-diurnal constituents from spline interpolation in the frequency domain, Geophys. Res. Let., 18, 845-848, 1991.

Le Provost, C. and F. Lyard, Towards a detailed knowledge of the world ocean tides : the example of the Kerguelen Plateau, Geophys. Res. Let., 20, (14), 1519-1522, 1993.

Le Provost, C., M.L. Genco, F. Lyard, P. Vincent and P. Canceil, Tidal spectroscopy of the world ocean tides from a finite element hydrodynamic model, J. Geophys. Res., Vol 99, C12, 24777-24798, 1994.

Le Provost, C., A.F. Bennett, and D.E. Cartwright, Ocean tides for and from TOPEX/POSEIDON, Science, Vol. 267, 639-642, 1995.

Le Provost, C., F. Lyard, J.M. Molines, M.L. Genco and F. Rabilloud, A Hydrodynamic Ocean Tide Model Improved by assimilating a satellite altimeter derived dataset. submitted to J. Geophys. Res., 1996.

Lyard F. and M.L. Genco, Optimization Methods for Bathymetry and Open Boundary Conditions in a Finite Element Model of Ocean Tides, J. Comput. Phys., 114, 234-256, 1994.

Lyard F., The Arctic Ocean Tides, J. Geophys. Res., in press, 1996.

Lyard F. and C. Le Provost, Data assimilation in a variationnal ocean tide model,, Applied Math. Modelling, submitted, 1996.

Marsh, J. G., A. C. Brenner, B. D. Beckeley, T. V. Martin, "Global mean sea surface based upon the Seasat altimeter data", J. of Geophys. Res. (Oceans), 91, 3501-3506, 1986.

Ménard Y., E. Jeansou and P. Vincent, , Calibration of the Topex/Poseidon altimeters over Lampedusa. Additional results over Harvest, JGR, Vol. 99, C12, pp. 24487-24504, 1994

Mognard, N. M., W. J. Campbell, R. E. Cheney, J. G. Marsh, D. B.Ross, "Southern ocean waves and winds derived from Seasat altimeter measurements, in waves dynamics and radio probing of the ocean surface", Plenum Press, New York, 479-489, 1982.

Rapp, R. H., Y. Wang, N. K. Pavlis, "The Ohio state 1991 geopotential and sea surface topography harmonic coefficient models", Report n. 410, Dept of Geodetic Science and Surveying, the Ohio State University, Colombus, Ohio 43210-1247, 1991.

Rapp, RH, YM Wang, NK Pavlis, The Ohio State 1991 Geopotential and Sea Surface Topography Harmonic Coefficient Models, Rpt. 410, Dept. Of Geodetic Science and Surveying, The Ohio State University, Columbus, 1991

Rapp, RH, Y, Yi, and YM Wang, Mean Sea Surface and Geoid Gradient Comparisons with TOPEX Altimeter Data, J. Geophys. Res., 99(C12), 24,667, 1994.

Rapp, RH, C Zhang, and Y Yi, Analysis of Dynamic Topography Using Topex Data and Orthonormal Functions, submitted Journal of Geophysical Research, 1995a.

Rapp, RH. Equatorial Radius Estimates from Topex Altimeter Data, Festschrift Erwin Groten, Inst. of Geodesy and Navigation, University FAF Munich, Neubiberg, p90-97, 1995b.

Rapp, RH and RS Nerem, Geoid Undulation and Mean Sea Surface Recommendation, in Minutes of TOPEX/POSEIDON Science Working Team Meeting of May 1995, Jet Propulsion Laboratory, JPL D-12817, August 15, 1995.

Rapp, RH, YM Wang, NK Pavlis, The Ohio State 1991 Geopotential and Sea Surface Anzenhofer, M T Gruber and M Rentsch, Global High Resolution Mean Sea Surface Based on ERS-1 35- and 168- Day Cycles and Topex Data, In : Rapp, Cazenave, Nerem(ed.), Global Gravity Field and Its Temporal Variations, IAG Symp. 116, Springer Berlin , 1996.

Ray, R. D., B. V. Sanchez, "Radial deformation of the Earth by oceanic tidal loading", NASA Technical Memorandum 100743, 1989.

Saastamoinen, J., "Atmospheric correction for the troposphere and stratosphere in radioranging for satellite", Geophys. Monogr., 15, AGU, Wasington D.C, 1972.

Schwiderski, E. N., "On charting global ocean tides",Rev. of Geophy. and Space Phy., 18, 243-268, 1980.

Schrama E. J. O. and R.D. Ray. A preliminary tidal analysis of TOPEX/POSEIDON altimetry, J. Geophys. Res., Vol 99, C12, 24799-24808,1994.

Shum, C.K., P.L. Woodworth, O.B. Andersen, G. Egbert, O. Francis, C. King, S. Klosko, C. Le provost, X. Li, J.M. Molines, M. Parke, R. Ray, M. Schlax, D. Stammer, C. Thierney, P. Vincent, C. Wunsch, accuracy assessement of recent ocean tide models J. Geophys. Res., in press, 1996.

Stewart, R., L. L. Fu, M. Lefebvre, , "Science Opportunities from the Topex/Poseidon mission", TP-RP-03-128-JPL, 1986.

Tapley, BD et al., The JGM-3 Gravity Model, Annales Geophysical, Vol. 13 Suppl. 1, p C192, 1994a

Tapley, BD et al., Accuracy Assessment of the Large Scale Dynamic Ocean Topography from TOPEX/POSEIDON Altimetry, J. Geophys. Res., 99(C12), 24,605-24,618, 1994b

TOPEX/POSEIDON Project, "Mission", TP-RP-0-5001-JPL , 1991.

TOPEX/POSEIDON Project, "Interface Control Document between Physical Oceanography Distributed Active Archive Center (PO-DAAC) and Centre National d'Etudes Spatiales, Archivage Validation et Interprétation des données des Satellites Océanographiques (AVISO)", AVI-IF-02-150-CN, 1992.

TOPEX/POSEIDON Project,"GDR -T USER'S HANDBOOK",TP-OP-0522-5408- JPL, 1992.

TOPEX/POSEIDON Project,"TOPEX Ground System, Science Algorith "Specification"TP-SP-43-2738-JPL, 1991.

TOPEX/POSEIDON Project, "Manuel des interfaces CCDP-RADALT" TP-MI-613-278-CLS, 1992.

TOPEX/POSEIDON Project, "Poseidon geophysical algorithm specification" TP-ST-613-220-CLS., 1991.

TOPEX/POSEIDON Project, "Spécification des algorithmes de traitement ionosphérique du niveau 1.5 au niveau 2.0" CM-ST-6136-395-CLS, 1992.

Walsh, E. J., F. C. Jackson, D. E. Hines, C. Piazza, L. Hevizi, D. Mc Laughlin, R. McIntosh, R. N. Swift, J. F. Scott, J. Yungel, E. Frederick, "Frequency dependence of electromagnetic bias in sea surface range measurements", submitted to IGARSS symposiun digest, 695-698, 1990.

Wahr, J. W., "Deformation of the Earth induced by polar motion", J. of Geophys. Res. (Solid Earth), 90, 9363-9368, 1985.

Witter, D. L., D. B. Chelton, 1991, "A Geosat altimeter wind speed algorithm development", J. of Geophys. Res. (oceans), 96, 8853-8860, 1991.

Yaplee, B.S., A. Shapiro, D.L. Hammond., B.D. Au and E.A. Uliana,: Nanosecond radar observation of the ocean surface from a stable platform, IEEE Trans. Geosci. Electron., GE-9, 170-174, 1971

Yi, Y, Determination of Gridded Mean Sea Surface from TOPEX, ERS-1 and GEOSAT Altimeter Data, Rpt. 434, Dept. of Geodetic Science and Surveying, The Ohio State University, Columbus, 9363-9368, 1995.

APPENDIX A

VAX/VMS FORMAT

All files are generated on Digital Equipment Corporation (DEC) VAX/VMS computers, and hence contain data organized according to the VAX data formats. The basic VAX addressable unit is the 8-bit byte. Multi-byte quantities are addressed by the least significant byte, and hence bytes are stored in order of increasing significance. Vax data types are byte, word and longword:

- *Byte :* A byte is eight contiguous bits starting on an addressable byte boundary. The 8 bits are numbered from right to left, 0 through 7.

```
7                          0
+--------------------------+
!                          !
!                          !
+--------------------------+
```

When interpreted as a signed integer, a byte is a two's complement integer with bits of increasing significance ranging from bit 0 through bit 6, with bit 7 being the sign bit. The value of the integer is in the range -128 through +127. For the purpose of addition, subtraction, and comparison, VAX instructions also provide direct support for the interpretation of a byte as an unsigned integer with bits of increasing significance ranging from bit 0 through bit 7. The value of the unsigned integer is in the range 0 through 255.

- *Word :* A word is two contiguous bytes starting on an arbitrary byte boundary. The 16 bits are numbered from right to left, 0 through 16.

```
15                         0
+---------------------------+
!                          !
!                          !
+---------------------------+
```

When interpreted as a signed integer, a word is a two's complement integer with bits of increasing significance ranging from bit 0 through bit 14, with bit 15 being the sign bit. The value of the integer is in the range -32768 through +32767. For the purpose of addition, subtraction, and comparison, VAX instructions also provide direct support for the interpretation of a word as an unsigned integer with bits of increasing significance ranging from bit 0 through bit 15. The value of the unsigned integer is in the range 0 through 65535.

- *Longword :* A longword is four contiguous bytes starting on an arbitrary byte boundary. The 32 bits are numbered from right to left, 0 through 31.

```
31                         0
+--------------------------+
!                          !
!                          !
+--------------------------+
```

When interpreted as a signed integer, a longword is a two's complement integer with bits of increasing significance ranging from bit 0 through bit 30, with bit 31 being the sign bit. The value of the integer is in the range -2147483648 through +2147483647. For the purpose of addition, subtraction, and comparison, VAX instructions also provide direct support for the interpretation of a word as an unsigned integer with bits of increasing significance ranging from bit 0 through bit 31. The value of the unsigned integer is in the range 0 through 4294967295.

APPENDIX B

CCSDS FORMAT CONVENTION

CCSDS FORMAT CONVENTION

Each file is a fixed-length unformatted record and contains a header. All file headers are ASCII and follow the CCSDS format convention. Headers provide identification, processing history and content information. Processing history includes software version and processing time. Content information provides data start and end times and a number of files or records. Processing time and build/version would be used to insure that correct/latest version is being used if files reissue is necessary.

A header includes Standard Formatted Data Unit (SFDU) identifiers. The SFDU label is coded as two lines. Each line contains a 20-character keyword padded with ASCII spaces to maintain a fixed length equal to the record length of the file. The first four letters of a SFDU label are CCSD. All other header entries follow a "KEYWORD=VALUE" syntax as shown below:

KEYWORD Assignment_symbol VALUE Stmt_Terminator

wher :

- KEYWORD is the leftmost component term and is made up with a character string that describes the keyword. It is of variable length.
- Assignment symbol is the ASCII equal sign character :" = ". It is coded as three characters.
- VALUE is the rightmost component term and is made up of a character string containing the value of the data object described by the keyword. It is of variable length.
- Stmt_Terminator is the ASCII semicolon character : ";". It is coded as one character.

Each line is then padded with ASCII spaces (blanks) to the record length specified for the file in which the "KEYWORD=VALUE" pair is located, and ends with a Carriage Return - Line Feed pair (<CR><LF>).

CCSDS TIME FORMATS

Time has two formats in CCSDS headers:

- UTC1 format gives time in seconds and is recorded with 17 characters. The format is:

  YYYY-DDDTHH:MM:SS

- UTC2 format gives time in microseconds and is recorded with 24 characters. The format is:

  YYYY-DDDTHH:MM:SS.XXXXXX

with

YYYY	=year
DDD	=day of the year (001 to 366)
HH	=hours (00 to 23)
MM	=minutes (00 to 59)
SS	=seconds (00 to 59 or 60 for UTC leap second[*]
XXXXXX	=microseconds

[*] A UTC leap second can occur on June 30 or December 31 of any year. The leap second is a sixty-first second introduced in the last minute of the day. Thus, the UTC values (minutes:seconds) appear as : 59:58 ; 59:59 ; 59:60 ; 00:00 ; 00:01