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PO.DAAC

MERGED GDR (TOPEX/POSEIDON)

Generation B

MGDR-B

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Author: J. Robert Benada

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TABLE OF CONTENTS

1. INTRODUCTION TO MGDR-B — 1

1.1 Handbook Purpose — 1

1.2 Handbook Overview — 1

1.3 New Features in the MGDR-B — 2

1.4 Conventions — 3
- 1.4.1 Vocabulary — 3
- 1.4.2 Orbits, Revs and Passes — 3
- 1.4.3 Reference Ellipsoid — 3
- 1.4.4 Correction Conventions — 4
- 1.4.5 Time Convention — 4
- 1.4.6 Unit Convention — 4
- 1.4.7 Flagging and Editing — 4
- 1.4.8 Default Values — 5

2. TOPEX/POSEIDON MISSION OVERVIEW — 7

2.1 TOPEX/POSEIDON Mission — 7

2.2 TOPEX/POSEIDON Requirements — 7
- 2.2.1 Accuracy of Sea-level Measurement — 8
- 2.2.2 Sampling Strategy — 8
- 2.2.3 Tidal Aliases — 8
- 2.2.4 Duration and coverage — 8
- 2.2.5 Data Reduction and Distribution — 8

2.3 Satellite Description — 8
- 2.3.1 Sensors — 9
- 2.3.2 Orbit — 10
- 2.3.3 The TOPEX Project Phases — 15
- 2.3.4 The Antenna Sharing Plan — 15

2.4 Data Processing and Distribution — 16

3. HOW TO USE THE MGDR DATA — 17

3.1 Altimeter Range — 17
- 3.1.1 Range Compression — 18
- 3.1.2 Timetags for Ten per Frame Ranges — 18
- 3.1.3 Records with Time Regressions — 18
- 3.1.4 Retracked Ranges in POSEIDON Data after Cycle 138 — 18

3.2 Sea Surface Height — 19

3.3 Residual Sea Surface — 19
- 3.3.1 Geophysical Surface - Mean Sea Surface or Geoid — 19
- 3.3.2 Tide Effects — 20

3.4 Flagging/Editing Data — 20

3.5 Correcting the Mean Sea Surface — 21

3.6 Mean Sea Surface and Adjustment of the Cross Track Gradient — 21

3.7 Smoothing TOPEX Ionosphere Correction — 23

3.8 Total Electron Content from Ionosphere Correction 23
3.9 Early Pointing Angle Problems 24
4. ALTIMETRIC DATA 25
4.1 Orbits 25
4.2 Altimeter Range and Calibration Biases 25
4.3 Geoid 26
4.4 Mean Sea Surface 27
4.5 Geophysical Corrections 29
4.5.1 Troposphere (dry and wet) 29
4.5.2 Ionosphere 29
4.5.3 Ocean Waves (electromagnetic bias) 30
4.5.3.1 Ku band coefficients 31
4.5.3.2 C band coefficients 31
4.5.3.3 POSEIDON Tracker Bias 31
4.6 Rain Flag 32
4.7 Tides 32
4.7.1 Elastic Ocean Tide 33
4.7.1.1 CSR3.0 33
4.7.1.2 FES95.2.1 33
4.7.2 Solid Earth Tide 35
4.7.3 Pole tide 35
4.8 Inverse Barometer Effect 36
4.9 Sigma O 36
4.9.1 Corrections to Sigma0 36
4.9.2 Further Adjustments to C band Sigma0 36
4.10 Wind Speed 37
4.11 Fine Height Flags (in Iono_Bad) 37
4.12 Bathymetery Information 37
5. MERGED TOPEX/POSEIDON PRODUCTS 39
5.1 Overview 39
5.2 File Structure 39
5.3 CD ROM Header File 40
5.3.1 Labeling 40
5.3.2 Content Overview 40
5.3.3 Format 40
5.4 MGDR Cycle Header File 42
5.4.1 Labeling 42
5.4.2 Content overview 42
5.4.3 Format 42
5.5 MGDR pass-files 44
5.5.1 Labeling 44
5.5.2 Content overview 44
5.5.3 Format 45

5.6 Crossover Point File 49
5.6.1 Labeling 49
5.6.2 Content overview 49
5.6.3 Format 50
5.6.4 *Crossover* **Point File Contents** 51

6. HEADERS ELEMENTS *55*

6.1 Header Element Description Format 5s

6.2 Header Elements (in alphabetical order) 55

7. *MGDR ELEMENTS* *71*

7.1 MGDR Element Format 71

7.2 MGDR Elements (in alphabetical order) 71

8. *CROSSOVER POINTS ELEMENTS* *101*

8.1 Crossover Point Elements Definition Forma 101

8.2 Crossover Point Elements (in alphabetical order) 101

9. *ADDITIONAL INFORMATION* *115*

9.1 ACRONYMS 115

9.2 REFERENCES 117

9.4 INSTRUMENT ANOMALY RECORD 121

9.5 Crossover Point Time Differences 123

9.6 123

9.6 VAX/VMS Format 124

9.7 POINT OF CONTACT 125

Section **7 is a detailed description of each field of the MGDR files on the CD-ROM. REFERENCE**

Section 8 is a detailed description of each field of the crossover files on the CD-ROM. REFERENCE

Appendix A contains acronyms. REFERENCE

Appendix B contains references. REFERENCE

Appendix C contains a list of Instrument Anomalies, REFERENCE

Appendix D contains a description of the VAX/VMS format. READ! **if you are <u>not</u> familiar with the difference between VAX/VMS byte order and other byte orders** such as UNIX, otherwise REFERENCE

Appendix E tells how to order information or data from PO.DAAC and lists related Web sites. REFERENCE

1.3 New *Features in the MGDR-B*

1. New Orbits - Both NASA and CNES orbit ephemerides have been substantially improved. (See 4)

2. Tide Models - Two new elastic ocean tide models are used in the MGDR-B (See 4) They are the University of Texas Center for Space Research model CSR 3.0.1 and the Grenoble Ocean Modelling Group model FES95.2.1. The loading tide is from the CSR 3.0.1 model. The flag assignments in Geo_Bad_2 have been changed (See 7).

3. The Precision Orbif Determination Team (POD) discovered a discrepancy in the pole tide on the TOPEX values which is corrected in the MGDR-B (See 4)

4. New Electro-Magnetic Bias Algorithm - (See 4)

5. Range - The altimeter range as found on the MGDR-B now has bias corrections included (See 3). The range has been corrected for the oscillator drift error (detected Summer '96).

6. Sigma-O - the TOPEX sigma-O for cycles 1-132 have been corrected for instrumental drift with the table from Wallops dated October 8, 1996.

7. Sigma0_C - NOTE: anyone using the TOPEX C band sigma0 must read Section 4.9 for a discussion of how to correct the MGDR value for atmospheric attenuation!

8. MSS & Geoid - New values of the Mean Sea Surface and the Geoid have been calculated by R. Rapp's group at Ohio State University. (Sees 4.3, 4.4)

9. Windspeed - The windspeed value on the MGDR-B is calculated for 10m whereas the MGDR-A value was calculated for 19.5 m. The windspeed algorithm has not changed. (See 4. 10)

10. Geo_Bad_2 - Bit O is still the rain flag, but it now indicates a liquid water estimate greater than 600 microns rather than the previous limit of 1000 microns (See 4.7).

11. SWH_K and C are now given in centimeters rather than 0.1 meters and is now stored as a 2 byte unsigned integer rather than a byte integer.

12. Ind_Rtk - A new flag field indicating that the POSEIDON range is based on retracing. (See 7)

13. H_Ocs - The H_Ocs (ocean depth in meters) found in the MGDR-B corrects errors found in the values on the MGDR-A. Not very many values are affected.

1. INTRODUCTION TO MGDR-B

This new TOPEX/POSEIDON product provides the full mission data set in a new format with many data quality improvements brought about by the work of many scientists during the mission. It is a revised form of the MGDR-A CD-ROM set which covered data from the beginning of the mission, September 22, 1992 to April 23, 1996. All data from the begining of the mission will be released in MGDR-B. It incorporates the improved orbits, new tide models and some improved algorithms which have been developed during the mission. Section 1.3 contains a list of the significant changes.

1.1 Handbook Purpose

The purpose of this document is to provide a comprehensive description of contents and formats for users of the Physical Oceanography Distributed Active Archive Center (PO.DAAC)' new Generation B Merged TOPEX/POSEIDON Geophysical Data Record (MGDR-B). This document also provides an overview of the TOP EX/POSEI DON mission and an introduction to measurements, corrections and errors. More information on data algorithms and sensors can be found in the POSEIDON and TOPEX project documents (see Appendix B).

PO. DAAC, which distributes TOPEX/POSEIDON data, is one element of the Earth Observing System Data and Information System (EOSDIS). The goal of the PO.DAAC is to serve the needs of the oceanographic, geophysical and interdisciplinary science communities which require physical information about the oceans. This goal is primarily accomplished through the acquisition, processing, archiving, and distribution of data obtained through remote sensing or conventional instruments.

TOPEX/POSEIDON data is also distributed by Archivage, Validation et Interpretation des donnes des Satellites Ocanographiques (AVISO). The French AVISO is a multi-satellite databank dedicated to space oceanography. AVISO is being developed in stages by the French space agency, Centre National d'Etudes Spatiales (CNES). They are developing a product similar to the MGDR distributed by PO. DAAC. The geographical arrangement for distributing the TOPEX/POSEIDON data products to the international scientific community are covered by a CNES-NASA agreement. Both centers will disseminate all **MGDR data.**

1.2 Handbook Overview

This is a combination of a guide to data use and a reference handbook, so not all of it will be needed by all readers. The list of the sections are marked with READ! or REFERENCE based on how critical it is for the reader to learn the contents. All users should read the sections marked **READ!,** even those familiar with TOPEX GDR and the AVISO produced Merged IGDR.

Section 1 provides background information about the MGDR and this document. It also contains a summary of significant changes in the new MGDR-B. READ!

Section 2 gives an overview of the TOPEX/POSEIDON mission. READ! **If you are not familiar with** the project, otherwise REFERENCE.

Section 3 introduces the reader to how to use the data. READ!

Section 4 is an introduction to altimeter algorithms and accuracy. READ!

Section 5 gives a description of TOPEX/POSEIDON MGDR contents in the PO.DAAC CD-ROM. It gives the content and format of all files. REFERENCE

Section 6 is a detailed description of each field of the header files on the CD-ROM. REFERENCE

14. Shorter MGDR-B record - spare fields have been removed (See 5).

15. Three cycles/CD - Three cycles now fit on a CD thanks to the reduced MGDR-B record size. (See 5)

16. Orbif files eliminated - The Precision Orbif Files on the MGDR-A have not been included on MGDR-B. If you need orbit ephemerides other that those found in the MGDR-B record, contact PO.DAAC (See Appendix E).

17. The Cross-over Point to be published on separate CD's. The Cross-over Point files have been removed from the MGDR-B CD-ROMs to facilitate rapid production. They will be available via ftp and on separate CD's. However, the section describing the format remains in this document.

18. Paperless distribution - Coverage maps are on the CD in GIF and PostScript format. Documentation is also on the CD in ASCII text, HTML, Microsoft Word or Postscript format as appropriate. However, a hardcopy of this handbook will be sent with the first CD shipment to a user.

19. Web Browser - the documentation on the CDs is now accessible by using your web browser.

1.4 Conventions

1.4.1 Vocabulary

In order to reduce confusion in discussing altimeter measurements and corrections, the following terms are used in this document as defined below.

DISTANCE or LENGTH are generic terms with no special meaning in this document.

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

ALTITUDE is the distance of a satellite or altimeter above a reference point. The reference point will usually be either the reference ellipsoid (as in the MGDR) or the center of the Earth. This distance is computed from the satellite ephemeris data.

HEIGHT is the distance of the sea surface above the reference ellipsoid. The sea surface height is the difference of altimeter range and satellite attitude above the reference ellipsoid.

1.4.2 Orbits, Revs and Passes

An ORBIT is one circuit of the earth by the satellite as measured from one ascending node crossing to the next. An ascending node occurs when the subsatellite point crosses the earth's equator going from south to north. A REVOLUTION or REV is synonymous with orbit.

The merged GDR data is organized into pass files in order to avoid having data boundaries in the middle of the oceans, as would happen if the data were organized by orbit. A PASS is half a revolution of the earth by the satellite from extreme latitude to the opposite extreme latitude. Thus an ASCENDING PASS begins at -66.04° and ends at +66.04°. A DESCENDING PASS is the opposite. The passes are numbered from 1 to 254 representing a full repeat cycle of TOPEX/POSEIDON data. Ascending passes are odd numbered and descending passes are even numbered.

See also Section 2.3.2.

1.4.3 Reference Ellipsoid

The “reference ellipsoid” is the first-order definition of the **non-spherical** shape of the Earth as an ellipsoid of revolution with equatorial radius of 6378.1363 kilometers and a flattening coefficient of 1/298.257.

1.4.4 Correction Conventions

All environmental and instrument corrections ***are*** computed so that they should **be** added to the quantity which they correct. That is, a correction is applied to a measured value by

Corrected Quantity = Measured Value + Correction

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

Examples:

Corrected Range . Measured Range + Range Correction

Therefore,

Corrected Sea Surface Height = Measured Orbit - **Corrected Range**

1.4.5 Time Convention

Times are UTC and referenced to January 1, 195800:00:00.00, sometimes abbreviated **UTC58**.

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** (In fact, these values will never be encountered on the MGDR because the input data has a gap of a few minutes around each leap second.)

In Section 5, reference will be made to UTC1 and UTC2. These are ASCII expressions of UTC times expressed using the following format:

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

  YYYY-DDDTHH:MM:SS

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

  YYYY-DDDTHH:MM:SS.XXXXXX

with:

YYYY	= year
DDD	= day of 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)
XXX)(XX	= microseconds

1.4.6 Unit Convention

All distances and distance corrections are reported in millimeters.

1.4.7 Flagging and Editing

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

Instrument flags specify which instruments are on or which frequency is used.

Telemetry flags are first based on altimeter modes and checking of telemetry data quality. Only severely corrupted data are not processed. 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 limits and excessive changes.

1.4.8 Default Values

Data elements are recorded as integers in a limited number of bytes. Default values are defined as the maximum possible value for the storage type (e.g. signed 2 byte integer). They are given when the parameter value is unavailable (missing data, flagged data).

Default values are also given when the field has no meaning for the altimeter which is currently on. For example, all fields dealing with C-band data (e.g. Sigma0_C) contain default values when the POSEIDON Solid State Altimeter is on because it uses Ku-band only.

The following are the default values used for the different storage types and sizes:

signed integer	1 byte 127
unsigned integer	1 byte 255
bit field	1 byte 255
signed integer	2 bytes 32767
unsigned integer	2 bytes 65535
bit field	2 bytes 65535
signed integer	4 bytes 2147483647
unsigned integer	4 bytes not used

2. TOPEX/POSEIDON MISSION OVERVIEW

TOPEX/POSEIDON is jointly conducted by the United States' National Aeronautics and Space Administration (NASA) and the French Space Agency, Centre National d'Etudes Spatiales (CNES), for studying the global circulation from space [Ref. 2 and 3]. The mission uses the technique of satellite altimetry to make precise and accurate observations of sea level for several years. TOPEX/POSEIDON was launched August 10, 1992.

An overview of the mission and spacecraft are also provided on the TOPEX/POSEIDON Informational CD-ROM (See Appendix E)

2.1 TOPEX/POSEIDON Mission

Knowing that accurate measurements of sea level contain information about surface currents, tides, and waves and knowing that sea level can be measured by satellites, the TOPEX and POSEIDON projects have worked together to design and operate a specific altimetric satellite mission that will increase substantially our understanding of global ocean dynamics by making precise and accurate observations of sea level. This began four years ago and may continue beyond year 2000. These observations are used by Principal Investigators (PIs) (selected by NASA and CNES) and by the wider oceanographic community working closely with large international programs for observing the Earth on studies leading to an improved understanding of global ocean dynamics and the interaction of the ocean with other global processes influencing life on Earth.

The TOPEX/POSEIDON mission has been coordinated with a number of international oceanographic and meteorological programs including the World Ocean Circulation Experiment (WOCE) and the Tropical Ocean and Global Atmosphere program (TOGA), both of which are sponsored by the World Climate Research Program (WCRP).

The specific goals of the TOPEX/POSEIDON mission are:

1) Measure sea level in a way that allows the study of ocean dynamics, including the calculation of the mean and variable surface geostrophic currents and the tides of the world's oceans.
2) Process, verify and distribute the data in a timely manner, with other geophysical data, to science investigators.
3) Lay the foundation for a continuing program to provide long-term observations of the oceanic circulation and its variability.

2.2 TOPEX/POSEIDON Requirements

The major elements of the mission include a satellite carrying an altimetric system for measuring the height of the satellite above the sea surface; a precision orbit determination system for referring the altimetric measurements to geodetic coordinates; a data analysis and distribution system for processing the satellite data, verifying their accuracy, and making them available to the scientific community; and a Principal Investigator program for scientific studies based on the satellite observations.

To ensure that science and mission goals are accomplished by the TOPEX/POSEIDON Mission, the following requirements were established.

2.2.1 Accuracy of Sea-level Measurements

Each measurement of sea level shall have a precision of ±2.4 cm and an accuracy of ±14 cm (1 standard deviation) for typical oceanic conditions, with small geographically correlated errors. In this context, precision is the ability to determine changes in sea level over distances of 20 km, and accuracy is the uncertainty of each measurement of sea level when expressed in geocentric coordinates,

2.2.2 Sampling Strategy

Sea level shall be measured along a fixed grid of subsatellite tracks such that it will be possible to investigate and minimize the spatial and temporal aliases of surface geostrophic currents and to minimize the influence of the geoid on measurements of the time-varying topography.

2.2.3 Tidal Aliases

Sea level shall be measured such that tidal signals will not be aliased into semiannual, annual, or zero frequencies (which influences the calculation of the permanent circulation) or frequencies close to these.

2.2.4 Duration and coverage

Sea level shall be measured for a minimum of three years, with the potential to extend this period for an additional two years.

The grid of subsatellite tracks shall extend in latitude at least as far south as the southern limit of the Drake Passage (62°) and the subsatellite tracks that comprise the grid will cross at sufficiently large angles that the two orthogonal components of surface slope can be determined with comparable accuracy.

2.2.5 Data Reduction and Distribution

A system to process and distribute data to the Principal Investigators shall be tested, documented, and in operation at the time of launch. More than 80% of the oceanic data that could be acquired by the spacecraft shall be acquired with no systematic gaps, processed and made available for scientific investigations. The intent is to collect and process all data continuously. Small amounts of data could be lost during adjustments of the satellite's orbit, during tests of the altimeter's performance, and during various other such events.

2.3 Satellite Description

The 2400 kg satellite consists of the Multimission Modular Spacecraft (MMS) bus and the Instrument Module (IM) which houses the sensors. The MMS provides all housekeeping functions including propulsion, electrical power, command and data handling, attitude control.

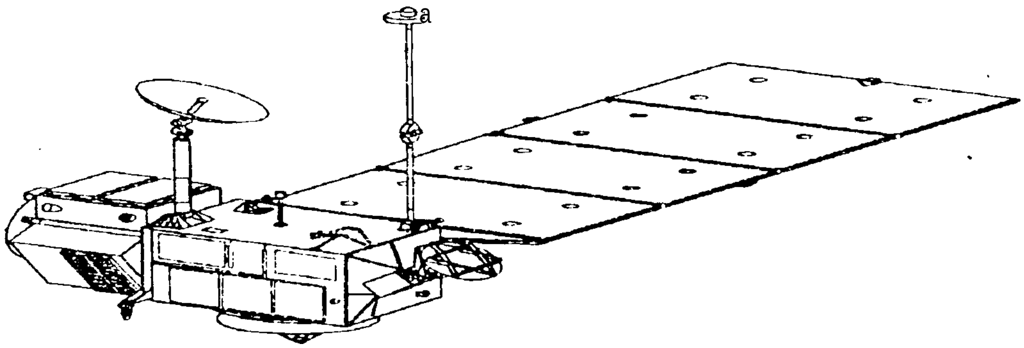

Figure 1 TOPEX/POSEIDON SATELLITE

2.3.1 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) 4 operational sensors

(1) Dual-frequency Ku/C band 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, 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 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 in 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.

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

The LRA reflects signals from network of 10 to 15 satellite laser tracking stations to calibrate NRA bias and to provide the baseline tracking data for NASA precise orbit determination.

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

The DORIS system uses a two-channels receiver (1401 .25 MHz and 2036.25 MHz) on the satellite to observe the Doppler signals from a network of 40 to 50 ground transmitting stations. It provides all-weather global tracking of the satellite for CNES precise orbit determination and an accurate correction for the influence of the ionosphere on both the Doppler signal and altimeter signals.

(B) 2 experimental sensors

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), will validate the technology of a low-power, light-weight 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, since this sensor uses a single frequency, an external correction for the ionosphere must be supplied.

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

The GPSDR, operating at 1227.6 MHz **and 1575.4** MHz, uses a new technique of GPS differential ranging for precise orbit determination.

2.3.2 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, and it is high enough to ease the precision of the orbit determination process in minimizing the atmospheric drag. Orbital characteristics and the equator crossing longitudes are given below. Figure 2 is a plot of the ground track on a world map.

(A) Mean classical orbit elements

- Semi-major axis	7714.43 km
- Eccentricity	0.000095
- Inclination	66.04°
- Argument of periapsis	90.0°

	- Inertial longitude of the ascending node	116.56°
	- Mean anomaly	253.13°
(B)	Auxiliary data	
	- Reference (Equatorial) attitude	1336 km
	- Nodal period	6745.72 sec
	- Repeat period (1 O-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°
	- Longitude of Equator crossing of pass	99.947°
	- Inertial nodal rate	-2.08°/day
	- Orbital speed	7.2 km/s
	- Ground track speed	5.8 km/s

TOPEX/POSEIDON ORBIT CHARACTERISTICS

This orbit overflies two verifications sites: A NASA site near Pt. Conception, California (239°19' E, 34°28' N) (ascending pass 43) and a CNES site at Lampedusa Island (12°57' E, 35°52' N) (descending pass 222)

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

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

EQUATOR CROSSING LONGITUDES (IN ORDER OF PASS NUMBER)

Pass	Long.								
		51	111.2637	102	288.4290	153	105.5943	204	282.7598
1	99.9249	52	277.0905	103	94.2556	154	271.4211	205	88.5862
2	65.7517	53	82.9167	104	260.0823	155	77.2471	206	254.4130
3	71.5776	54	248.7435	105	65.9083	156	243.0739	207	60.2389
4	237.4044	55	54.5694	106	231.7351	157	48.8999	208	226.0657
5	43.2305	56	220.3962	107	37.5614	158	214.7267	209	31.8922
6	209.0573	57	26.2229	108	203.3881	159	20.5536	210	197.7189
7	14.8844	58	192.0497	109	9.2154	160	186.3804	211	3.5463
8	180.7112	59	357.8771	110	175.0422	161	352.2079	212	169.3731
9	346.5387	60	163.7039	111	340.8697	162	158.0346	213	335.2005
10	152.3655	61	329.5313	112	146.6964	163	323.8620	214	141.0273
11	318.1928	62	135.3580	113	312.5237	164	129,6887	215	306.8545
12	124.0196	63	301.1851	114	118.3505	165	295.5157	216	112.6813
13	289.8463	64	107.0119	115	284.1770	166	101.3425	217	278.5075
14	95.6731	65	272.8379	116	90.0038	167	267.1683	218	84.3343
15	261.4989	66	78.6647	117	255.8295	168	72.9951	219	250.1600
16	67.3256	67	244.4904	118	61.6562	169	238.8209	220	55.9867
17	233.1515	68	50.3172	119	227.4823	170	44.6477	221	221.8129
18	38.9783	69	216.1435	120	33.3090	171	210.4741	222	27.6397
19	204.8049	70	21.9702	121	199.1358	172	16.3009	223	193.4666
20	10.6317	71	187.7974	122	4.9626	173	182.1282	224	359.2934
21	176.4592	72	353.6242	123	170.7903	174	347.9550	225	165.1212
22	342.2860	73	159.4520	124	336.6170	175	153.7829	226	330.9479
23	148.1139	74	325.2788	125	142.4448	176	319.6096	227	136.7755
24	313.9406	75	131.1062	126	308.2716	177	125.4369	228	302.6023
25	119.7676	76	296.9330	127	114.0984	178	291.2636	229	108.4290
26	285.5944	77	102.7596	128	279.9252	179	97.0902	230	274.2558
27	91.4209	78	268.5864	129	85.7515	180	262.9170	231	80.0819
28	257.2477	79	74.4124	130	251.5783	181	68.7430	232	245.9087
29	63.0736	80	240.2392	131	57.4042	182	234.5697	233	51.7347
30	228.9004	81	46.0652	132	223.2310	183	40.3959	234	217.5614
31	34.7268	82	211.8920	133	29.0576	184	206.2227	235	23.3883
32	200.5535	83	17.7190	134	194.8843	185	12.0499	236	189.2150
33	6.3809	84	183.5458	135	0.7117	186	177.8767	237	355.0425
34	172.2076	85	349.3733	136	166.5385	187	343.7042	238	160.8693
35	338.0351	86	155.2000	137	332.3659	188	149.5309	239	326.6966
36	143.8619	87	321.0274	138	138.1927	189	315.3582	240	132.5234
37	309.6891	88	126.8541	139	304.0198	190	121.1850	241	298.3504
38	115.5159	89	292.6810	140	109.8466	191	287.0117	242	104.1772
39	281.3423	90	98.5078	141	275.6727	192	92.8384	243	270.0031
40	87.1690	91	264.3336	142	81.4995	193	258.6642	244	75.8299
41	252.9947	92	70.1603	143	247.3252	194	64.4909	245	241.6556
42	58.8215	93	235.9862	144	53.1520	195	230.3169	246	47.4824
43	224.6476	94	41.8130	145	218.9782	196	36.1437	247	213.3088
44	30.4744	95	207.6395	146	24.8050	197	201.9704	248	19.1355
45	196.3012	96	13.4663	147	190.6320	198	7.7971	249	184.9628
46	2.1280	97	179.2937	148	356.4588	199	173.6248	250	350.7896
47	167.9557	98	345.1205	149	162.2866	200	339.4515	251	156.6174
48	333.7825	99	150.9484	150	328.1133	201	145.2793	252	322.4442
49	139.6102	100	316.7751	151	133.9409	202	311.1061	253	128.2715
50	305.4370	101	122.6022	152	299.7676	203	116.9330	254	294.0983

EQUATOR CROSSING LONGITUDES (IN ORDER OF LONGITUDE)

Pass	Long.
135	0.7117
46	2.1280
211	3.5463
122	4.9626
33	6.3809
198	7.7971
109	9.2154
20	10.6317
185	12.0499
96	13.4663
7	14.8844
172	16.3009
83	17.7190
248	19.1355
159	20.5536
70	21.9702
235	23.3883
146	24.8050
57	26.2229
222	27.6397
133	29.0576
44	30.4744
209	31.8922
120	33.3090
31	34.7268
196	36.1437
107	37.5614
18	38.9783
183	40.3959
94	41.8130
5	43.2305
170	44.6477
81	46.0652
246	47.4824
157	48.8999
68	50.3172
233	51.7347
144	53.1520
55	54.5694
220	55.9867
131	57.4042
42	58.8215
207	60.2389
118	61.6562
29	63.0736
194	64.4909
105	65.9083
16	67.3256
181	68.7430
92	70.1603
3	71.5776
168	72.9951
79	74.4124
244	75.8299
155	77.2471
66	78.6647
231	80.0819
142	81.4995
53	82.9167
218	84.3343
129	85.7515
40	87.1690
205	88.5862
116	90.0038
27	91.4209
192	92.8384
103	94.2556
14	95.6731
179	97.0902
90	98.5078
1	99.9249
166	101.3425
77	102.7596
242	104.1772
153	105.5943
64	107.0119
229	108.4290
140	109.8466
51	1.11.2637
216	112.6813
127	114.0984
38	115.5159
203	116.9330
114	118.3505
25	119.7676
190	121.1850
01	122.6022
12	124.0196
177	125.4369
88	126.8541
253	128.2715
164	129.6887
75	131.1062
240	132.5234
151	133.9409
62	135.3580
227	136.7755
138	138.1927
49	139.6102
214	141.0273
125	142.4448
36	143.8619
201	145.2793
112	146.6964
23	148.1139
188	149.5309
99	150.9484
10	152.3655
175	153.7829
86	155.2000
251	156.6174
162	158.0346
73	159.4520
238	160.8693
149	162.2866
60	163.7039
225	165.1212
136	166.5385
47	167.9557
212	169.3731
123	170.7903
34	172.2076
199	173.6248
110	175.0422
21	176.4592
186	177.8767
97	179.2937
8	180.7112
173	182.1282
84	183.5458
249	184.9628
160	186.3804
71	187.7974
236	189.2150
147	190.8320
58	192.0497
223	193.4666
134	194.8843
45	196.3012
210	197.7189
121	199.1358
32	200.5535
197	201.9704
108	203.3881
19	204.8049
184	206.2227
95	207.6395
6	209.0573
171	210.4741
82	211.8920
247	213.3088
158	214.7267
69	216.1435
234	217.5614
145	218.9782
56	220.3962
221	221.8129
132	223.2310
43	224.6476
208	226.0657
119	227.4823
30	228.9004
195	230.3169
106	231.7351
17	233.1515
182	234.5697
93	235.9862
4	237.4044
169	238.8209
80	240.2392
245	241.6556
156	243.0739
67	244.4904
232	245.9087
143	247.3252
54	248.7435
219	250.1600
130	251.5783
41	252.9947
206	254.4130
117	255.8295
28	257.2477
193	258.6642
104	260.0823
15	261.4989
180	262.9170
91	264.3336
2	265.7517
167	267.1683
78	268.5864
243	270.0031
154	271.4211
65	272.8379
230	274.2558 “
141	275.6727
52	277.0905
217	278.5075
128	279.9252
39	281.3423
204	282.7598
115	284.1770
26	285.5944
191	287.0117
102	288.4290
13	289.8463
178	291.2636
89	292.6810
254	294.0983
165	295.5157
76	296.9330
241	298.3504
152	299.7676
63	301.1851
228	302.6023
139	304.0198
50	305.4370
215	306.8545
126	308.2716
37	309.6891
202	311.1061
113	312.5237
24	313.9406
189	315.3582
100	316.7751
11	318.1928
176	319.6096
87	321.0274
252	322.4442
163	323.8620
74	325.2788
239	326.6966
150	328.1133
61	329.5313
226	330.9479
137	332.3659
48	333.7825
213	335.2005
124	336.6170
35	338.0351
200	339.4515
111	340.8697
22	342.2860
187	343.7042
98	345.1205
9	346.5387
174	347.9550
85	349.3733
250	350.7896
161	352.2079
72	353.6242
237	355.0425
148	356.4588
59	357.8771
224	359.2934

Figure 2 TOPEX/POSEIDON Ground Tracks

2.3.3 The TOPEX Project Phases

The satellite mission has two phases:

(1) The first phase, the verification phase, began when the satellite reached the operational orbit and the satellite and-sensor systems functioned normally. This phase continued until the data being received from the sensors had been satisfactorily calibrated and verified. The phase began 22 September 1992 and lasted nominally six months ending with a calibration/validation workshop 22-24 February 1993. Each agency conducted its own evaluation and calibration to verify performance obtained on-orbit by its sensors.

During this phase, the French and Ameriian ground segments produced IGDR-type altimeter data computed using logistic edits (about 1 m rms accuracy) and invalidated algorithms.

(2) Following the calibration/validation workshop, the algorithms were reworked and the second phase, the observational phase, began. It continued for three years after launch, which was the nominal mission, and has been extended for an additional 4 years. As of publication, the spacecraft and instruments are expected to operate through August of 2000.

During this phase, the French and American ground segments produce GDR-type altimeter data computed using precise orbits (about 10 cm rms accuracy) and verified algorithms.

Though not a formal mission phase, the project entered a new period in June 1995 when a SWT meeting at JPL reviewed advances in orbit determination, tides, EM bias calculations and other areas and recommended all GDR data be released with this new information. AVISO and PO.DAAC were given this task. The changes are summarized in Sec 1 and described in Sees 3 and 4. The old MGDR version, MGDR-A was produced for cycles 1-132. Starting in srping of 1997, the new MGDR-B CD-ROMS will be distributed for cycles 133 and up. Also during that time, all data from cycles 1-132 will be reprocessed as MGDR-B's so users have a consistent set of data for the whole mission.

PO.DAAC expects there will be another reprocessing of the data at the end of mission to take advantages of further advances in altimeter, orbit and tidal science.

2.3.4 The Antenna Sharing Plan

Because the NASA and CNES altimeters share one antenna, an antenna sharing plan has been developed for the verification phase and the initial portion of the observational phase. In general, the SSALT will be on about 100/' of the time and NRA, 90%. Through cycle 16, the two altimeters shared each cycle; that is, SSALT was on for about one day total and the NRA, for the remainder of the cycle. Starting with the observation phase, the antenna sharing plan now has only one altimeter on for a full cycle. As of publication, the SSALT cycles are 20, 31, 41, 55, 65, 79, 91, 97,103, 114, 126, 138, and 150 with planned SSALT cycles of 162,174,180,186,197,209 and 216. The NRA was on for all other cycles beyond 16 although the there can be one pass of SSALT data present when the adjacent cycle is a SSALT cycle.

This sharing plan is subject to change at the direction of the Science Working Team.

2.4 *Data Processing and Distribution*

NASA and CNES entities process data from their respective instruments and exchange processed data. Processing centers, called respectively TGS and CCDP, include functions such as 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).

Geophysical data records are sent as they become available to PO.DAAC and AVISO for processing, archiving and distribution to PIs and the wider scientific community. PIs will further process the TOPEX/POSEIDON data and will conduct oceanographic or geophysical investigations based on these data.

During the verification phase of the mission, unverified and uncalibrated interim geophysical data (IGDR-P, IGDR-T) were available daily within five days of data acquisition. They are computed using logistic orbits.

During the observational phase, verified and calibrated geophysical data (GDR-P, GDR-T) are available per cycle within about one month of data acquisition. They are computed using precise orbits.

3. HOW TO USE THE MGDR DATA

This section will give the reader a guide to the use of this TOPEX/POSEIDON MGDR data Generation B. Remember that this is research data. While this handbook tries to be correct and complete, nothing can replace the information to be gained at conferences and other meetings of those using these data. The reader must proceed with taution and at his or her own risk. Please direct questions and comments to the contacts given on the last page of this handbook.

In this Section, references are made to specific MGDR parameters by name. For example, Geo_Bad_l is a flag parameter indicating, among other things, whether or not the data point is over land. All parameters are described in alphabetical order in Section 7.2.

WARNING: Default values are given to data when valid numbers are not available (See Section 1.4.8) so you must screen parameters to avoid using those with default values. Also you must check flag values. The related flags are given with the parameter in Section 7 although some discussion of flags appears in this section.

3.1 *Altimeter Range*

The main data of the MGDR are the altimeter ranges. The one/frame value of range (H_Alt) is calculated at midframe time. (A frame is one full cycle of the instrument, about 0.98 seconds long, and corresponds to one data record) This is derived from the 10 per frame range differences from the one per frame range (H_Alt_Hi_Rate(i)). The reported range is already corrected for instrument effects. This correction is separately reported (Net_ Instr R Corr_K and Net_Instr_R_Corr_C). See Section 4.2 for a description of new corrections applied to H_Alt and Net_Instr_R_Corr_Ku/C.

The range must be corrected for the atmosphere through which the radar pulse passes and the nature of the reflecting sea surface. Recall all range corrections are defined so they should be ADDED to the range. The corrected range is given by

Corrected Range = range + wet troposphere correction
+ dry troposphere correction
+ ionosphere correction
+ electromagnetic bias

Wet **troposphere correction -** choice of 1) TMR correction (Wet_H_Rad) and 2) ECMWF correction (Wet_Corr). Normally, use Wet_H_Rad. When this is not usable (land, ice or flag TMR_Bad), use Wet_Corr.

Dry troposphere correction - Use ECMWF correction (Dry_Corr).

Ionosphere correction - Choice of 1) TOPEX two frequency ionosphere correction (Iono_Corr), 2) DORIS model correction (Iono_Dor) and 3) Bent model correction (Iono_Ben). Iono_Corr is best for

TOPEX data but not available for POSEIDON data (IMPORTANT: See Section 3.8 "Smoothing the Ionosphere Correction"). Iono_Dor is available for all data and is preferred over Iono_Ben.

Electromagnetic bias (EM bias) - NEW Use the Gaspar formula, calculated for all data as described in Section 4.3 (EMB_Gaspar). The EMB_Walsh, which is what was used with TOPEX data prior to 1996, is included for consistency. This is an active area of research and no current algorithm is considered the final answer.

3.1.1 Range Compression

The method for computing one per frame range (H_Alt) from 10 per frame ranges is slightly different for TOPEX and for POSEIDON data. The related values of number of points averaged (Nval_H_Alt), the fit RMS (RMS_H_Alt) and the flag word (Rang_SME) are also slightly different. This difference will not be important to most users. Anyone trying to use the altimeter data over ice or land should redo the compression according to their own algorithm.

When POSEIDON is on, Rang_SME flag bit are set for values which exceed the word capacity and Nval_H_Alt will equal the number of unflagged 10 per frame values. The unflagged points are fitted with a least absolute deviation line fit and the RMS is given as RMS_H_Alt. The range value evaluated at the frame timetag is given as H_Aft.

Also, when TOPEX is on, Rang_SME flag bits are set for values which exceed the word capacity. However, the value of H_Alt is determined by a straight line fit if there are at least 8 good 10 per frame ranges, otherwise, it is simply the median of good 10 per frame ranges. Also, if any 10 per frame range differs from the fit or median, it is excluded and the calculation redone. Thus, Nval_H_Alt is the number of 10 per frame ranges actually used in the calculation of H_Alt (and is thus less than or equal to the number of unflagged points shown in Rang_SM E). The value of RMS_H_Alt is the RMS of the fit or around the median using only the 10 per frame ranges actually used in the calculation of H_Alt).

3.1.2 Timetags for Ten per Frame Ranges

The time spacing between each ten per frame range (Dtim_Pac) is slightly different for TOPEX and POSEIDON data. The POSEIDON 10 per frame ranges are equally spaced within the frame. The TOPEX 10 per frame ranges are not equally spaced. The precise times depend on the range which normally changes slightly during a frame. The average spacing is reported in Dtim_Pac and it is this spacing which used to when interpolating the MGDR 10 per frame satellite attitudes. The exact time calculation are described in Ref. 6. Timetags for Ten per Frame Ranges

3.1.3 Records with Time Regressions

TOPEX data occasionally contains a few records which duplicate of earlier records. The original data is present in the file in the right time sequence but the duplicate records, appearing later in the file, look like time regressions. When this happens, the latitude, longitude and altitude of the duplicate records are set to default values but the timetags are not changed. With these default values, the data should be removed in editing and never appear in any analysis.

3.1.4 Retracked Ranges in POSEIDON Data after Cycle 138

POSEIDON has aftered their processing begining with cycle 138. The ranges from that cycle forward are now based on ground-processing retracing the twenty per second waveforms rather than the POSEIDON altimeters on-board range determination. There are no plans at present to reprocess the earlier POSEIDON data with retracing. For further information, contact Patrick Vincent at AVISO (Patrick. Vincent@cst.cnes.fr).

3.2 *Sea Surface Height*

Sea surface height (SSH) is the height of the sea surface above the reference ellipsoid. It is calculated by subtracting the corrected range (see above) from the Attitude:

SSH = Attitude - Corrected Range

Corrected Range is defined above.

Altitude - Choice of 1) NASA orbit (Sat_Alt) and 2) CNES orbit (HP_Sat). The two orbits have comparable precision. Both are given regardless of which altimeter is operating.

3.3 *Residual Sea Surface*

The residual sea surface is defined here as the sea surface height minus the mean sea surface or the geoid and minus known effects, namely tides and inverse barometer. It is given by:

Residual Height = Sea Surface Height - Geophysical Surface - Tide Effects - Inverse Barometer

Sea Surface Height is defined above

Geophysical Surface - Mean sea surface (H_MSS) or Geoid (H_Geo) See discussion below in this section and in Section 4.

Tide Effects - See discussion below in this section and Section 4.

inverse Barometer Use (INV_BAR) but see Section 4.

This quantity contains information about

(1) real changes in ocean topography related to ocean currents
(2) non-static inverse barometer effects
(3) differences between tides and the tide models
(4) differences between the mean surface and the true surface at the TOPEX/POSEIDON location
(5) unmodeled or mismodeled measurement effects (skewness, EM bias, altimeter errors, tropospheric corrections, etc.)
(6) orbit errors.

Of course, there is also random measurement noise. Understanding the first four items as a function of space and time is the purpose of TOPEX/POSEIDON.

3.3.1 Geophysical Surface - Mean Sea Surface or Geoid

The geophysical fields Geoid (H-Gee) (actually geoid undulation, but called simply geoid) and Mean Sea Surface (H_MSS) are distances above the reference ellipsoid, as is the SSH. These values are for the location indicated by latitude (Lat_Tra) and longitude (Len Tra). They are updated when the IGDR is converted to the GDR to reflect the location from the precision orbit. If the values of these fields are needed at a different location within the current frame, along-track interpolation may be done using the high rate (1 O/second) range and attitude values.

The H_MSS is set to the H_Geo value over inland seas and lakes where the actual mean sea surface is not well determined.

As the geoid is derived from the mean sea surface, the latter is the more precise quantity. The Residual Surface using mean sea surface is sometimes called the "dynamic topography" of the ocean surface.

See also discussions of mean sea surface and geoid in Section 4.

3.3.2 Tide Effects

The total tide effect on the sea surface height is the sum of three values from the MGDR:

Tide Effect = Ocean Tide+ Solid Earth Tide+ Pole Tide .

(See also Section 4.7 and subsections)

Ocean Tide - NEW The elastic ocean tide which includes the loading tide - choice of 1) UT_CSR model elastic ocean tide (H_ EOT_CSR) and 2) Grenoble model elastic ocean tide (H_EOT_FES). This also includes the long period, equilibrium tide.

Solid Earth Tide - Use H_Set

Pole Tide - use H_Pol

The tide values all have the same sign/sense in that positive numbers indicate that the surface is farther from the center of the Earth. The ocean tides are the elastic ocean tide so that the effects of ocean loading (H_LT_CSR) are included:

ocean tide (on MGDR) = ocean tide model + tidal loading .

CORRECTION See Section 4.7.3 for a description of a correction made in the pole tide which appeared on the MGDR-A.

3.4 *Flagging/Editing Data*

There Is no consensus on data editing for TOPEX/POSEIDON data. One may develop as a result of on-going research but for now the user must give careful attention to which data records to include or exclude.

The following are given as guide lines for flag usage. Users may wish to exclude data based on other conditions such as:

(1) the RMS of various quantities

(2) the number of points averaged into a compressed SSH, AGC, Sigma0, or SWH

(3) values being outside of "normal" limits where processing flag limits were set rather wide (For example, sigma0 is flagged only > 40 dB, but values above approximately 16 to 20 dB indicate anomalous ocean returns.).

TOPEX altimeter on

Nval_H_Att26	sufficient 10/second measurements
Alt_Bad_1 = O	no altimeter problems
SWH_K ≤ 1500	SWH in reasonable range
Geo_Bad_1, bit 1 = O	not land
Geo_Bad_1, bit 3 = O	not ice
Geo_Bad_1, bit 2 = O	TMR overwater
Geo_Bad_2, bit O = O	TMR not excess liquid water

TMR_Bad ≤ 1	TMR measurement quality "good" or "fair" (=0 for "good" only)
Geo_Bad_2, bits 1,2 ≤ 3 (CSR) or bits 3,4 ≤ 3 (FES)	Tide Model quality good
Iono_Corr ≠ Default Value	dual frequency iono correction exists
Sat_Alt ≠ Default Value	orbit height exists
EMB_Gaspar ≠ Default Value	EM Bias correction exists
Dry_Corr ≠ Default Value	dry correction exists
H_Set ≠ Default Value	Solid Earth Tide exists
H_Pol ≠ Default Value	Pole Tide exists

POSEIDON altimeter on

Nval_H_Alt ≥ 15	sufficient 1 O/second measurements
RMS_H_Alt ≤ 175	1 sec ave not noisy
SWH_K ≤ 1500	SWH in reasonable range
Current_Mode_2 = 3	altimeter tracking
Geo_Bad_1, brt 1 = O	not land
Geo_Bad_1, bit 3 = O	not ice
Geo_Bad_1, bit 2 = O	TMR over water
Geo_Bad_2, bit O = O	TMR not excess liquid water
TMR_Bad ≤ 1	TMR measurement quality "good" or "fair" (=0 for "good" only)
Geo_Bad_2, bits 1,2<3 (CSR) or bits 3,4 ≤ 3 (FES)	Tide Model quality good
Iono_Dor_Bad ≤ 3	Doris iono exists and is good
Sat_Alt ≠ Default Value	orbit height exists
EMB_Gaspar ≠ Default Value	EM Bias correction exists
Dry_Corr ≠ Default Value	dry correction exists
H_Set ≠ Default Value	Solid Earth Tide exists
H_Pol ≠ Default Value	Pole Tide exists

To restrict study to deep water, either require Geo_Bad_1, bit O = O which is set for all points with water depth of 10OOm or greater, or apply a limit using the H_Ocs parameter (ocean depth in meters).

The above editing criteria applied to a complete TOPEX cycle (total of about 774,000 data records), passes about 489,000 records (including shallow water) or about 458,000 records (deep water only, ≥1000m). Most of the reduction comes from eliminating points over land. POSEIDON data yields similar deep and shallow water numbers but the total points value is less because land points are rarely included in the data.

If analysis is to be done near land, it maybe necessary to ignore not only Geo_Bad_1 bit 0 (deep water), but also bit 2 (TMR land) and Geo_Bad_2 either bits 1,2 or 3,4- ocean tide. depending on which tide model is used. Unless the user has a precise land map against which to check the locations, Geo_Bad_1 bit 1 (altimeter land) should be checked as other flags may not change immediately for some water to land transitions.

3.5 Correcting the Mean Sea Surface

NEW: The MSS on the MGDR-B does not require correction. The MSS on the MGDR-A contained a radius difference and a center shift which had to be corrected before use with the altimeter data.

3.6 Mean Sea Surface and Adjustment of the Cross Track Gradient

To study sea level changes between two dates, it is necessary to difference sea surface heights from different cycles at the exact same latitude-longitude, so that the full unknown geoid automatically cancels out. However, the MGDR samples are not given at the same latitude-longitude on different cycles. They are given approximately every 1 sec along the pass (about 6 km, the time difference and distance vary slightly with satellite height above the surface), and the satellite ground track is allowed to drift by +/-1 km (see section 3-1 O). This introduces a problem: on different cycles the satellite will sample a different geoid profile. This effect is the so-called cross-track geoid gradient, and Brenner and Koblinsky (Ref 42) estimated it at about 2 cm/km over most of the ocean, larger over continental slopes, reaching 20 cm/km at trenches. Even if the passes repeated exactly, one would have to interpolate along the pass (say, to a fixed set of latitudes) because a 3 km mismatch in along pass position wwld cause approximately a 6 cm difference in the geoid, that would mistakenly be interpreted as a change in oceanographic conditions.

Both problems are simultaneously solved if the quantity one interpolates along a given pass is the difference

residual_height - mean_sea_surface

Then the real geoid changes across the track are automatically accounted for (to the extent the MSS model is close to the true geoid) because the MSS is spatially interpolated to the actual satellite lat-lon in the MGDR. The residual_height term above must include all the tidal, atmospheric and ionospheric corrections, etc. Otherwise, those need to be interpolated separately.

Each quantity must be interpolated along track to a set of common points, a “reference” track. The reference could be

(1) an actual pass with maximum data and/or minimum gaps or

(2) a specially constructed fixed track (see below).

The procedure is

(1) For each common point, find neighboring points in the pass of interest (POI).

(2) In the POI, interpolate along track to the common point, using longitude as the independent variable, for each quantity of interest - sea surface height (see above), mean sea surface, geoid, tides, etc.

(3) As stated above, the quantity to compare at each common point is

dSSH = interpolated POI SSH - interpolated POI MSS .

(4) Other geophysical corrections must be applied to dSSH, depending on the type of investigation

The geoid model in the MGDR could be substituted for MSS model, but its use will result in reduced accuracy in the interpolation because the resolution of the geoid undulation is lower than that of the MSS (limited by the 360x 360 geoid model).

Desirable features of a fixed reference track include

(1) equal spacing of points (good for FFT)

(2) independent variable = (point longitude - pass equator crossing longitude)

(3) equator is a point (simplifies calculation of item 2)

(4) point density similar to original data density.

With these specifications, it is possible to make only two fixed tracks, one ascending and one descending, which will serve for all passes. The template pass is then shifted by the equator crossing longitude found in the header (Equator_Longitude) of each pass. Recall that Equator_Longitude is from a predicted orbit (not updated during GDR processing). Improved accuracy can be obtained by interpolating in the latitude, longitude values. When one interpolates to the reference track, it is good **practice to** check that the interpolated latitude from the data records used is close to the latitude on the reference track.

3.7 Smoothing TOPEX Ionosphere Correction

Results from the Verification meeting (February 1993) and further analysis during the development of the TOPEX processing software led to the conclusion that there was a bias in the TOPEX dual frequency ionospheric correction. A bias of +1 O cm is being added to the C band range before the ionospheric correction is computed. This makes the ionospheric correction on the MGDR (Iono_Cor) more negative by 17.9 mm. As noted above, changes to the EM Bias correction and the Pointing Angle/Sea State correction will also cause changes in the reported ionospheric value. Subsequent ('94 -'96) analysis shows that there is a bias of ~1 cm between the dual frequency ionosphere correction and that of DORIS. That, plus comparisons with GPS suggests that there is a bias of ~0.5cm in the current dual frequency ionospheric correcion. It is suggested that this bias be ignored unless one is merging the data with another dual frequency altimeter.

The ionospheric (range) correction is expected to be negative, but positive values are allowed up to +40 mm to accommodate instrument noise effects. However, averaging over 100 km or more, as recommended at the Verification meeting (See Imel Rev 43), will almost always result in negative numbers. Review of a large amount of data indicates that the noise on the l/frame Iono_Corr is only about 6 mm 1-sigma, as predicted by the range noise of approximately 20 mm.

Ionospheric averaging is not being done to the MGDR in order to provide a reversible correction which the users may smooth as desired. In order to use a smoothed ionospheric correction, do the following:

(1) Smooth Iono_Corr as desired. Care should be taken regarding flagged data and in the case of data (land) gaps. Typical/maximum smoothing scales are 100-150 km (20-25 frames) for local times between 06 and 24 hours and 150-200 km (25-35 frames) for local times between 00 and 06 hours. The shorter (longer) smoothing time is also more appropriate during times of high (low) solar activity.

(2) Apply the smoothed ionospheric correction to sea surface height as shown in 3.2

It is <u>not</u> recommended that this approach be applied to Iono_Dor (or Iono_Ben) which is smoothed as a result of the model used.

3.8 Total Electron Content from Ionosphere Correction

To calculate Ionospheric Total Electron Content, TEC, use the following formula:

Ionoshperic Total Electron Content= (dR*f^2)/-403

where

Ionospheric Total Electron Content is in TECU (1 TECU = 10^{16} electrons/m^2)

dR = ionospheric range correction from the MGDR in mm (Iono_Cor or Iono_Dor)

f = frequency in GHz(for the Ku beam this is 13.6 GHz)

3.9 Early Pointing Angle Problems

The off nadir pointing angle (Att_Wvf) is determined from waveform data. K band waveforms (if available, otherwise C band) are used for the angle. If the value is flagged or the retrieved angle exceeds the limit value of 0.45°, the value defaults to the maximum for the field (255).

From cycle 1 through cycle 8 pass 189 (September 23 through December 8, 1992, day of year, DOY, 343), the satellite attitude control system was not properly calibrated. This resulted in pointing the altimeter relatively far from nadir (typically 0.3°, but up to 0.6°) with a sinusoidal signature over each pass much of the time. Since the pointing angle/sea state corrections are less accurate for angles larger than about 0.3° and the geometric pointing correction cannot be done, these data will be less accurate than later data. The pointing calibration was improved on 1992 DOY 353 and 357 and 1993 DOY 046, but these changes were minor compared to the initial calibration on 1992 DOY 343.

The user may want to begin analysis on data begining with cycle 11.

4. ALTIMETRIC DATA

This section presents a short discussion of the main quantities on the MGDR.

A very good and fairly complete paper on the theoretical background for radar altimetry is in the WOCE paper authored by Dudley Chelton [Ref 44]. Copies can be obtained from PO.DAAC [see contact points at the end of this document].

4.1 Orbits

The TOPEX/POSEIDON mission includes two precision orbit determination programs, one from CNES and one from NASA [see HP_Sat and Sat_Att parameters]. Both systems used laser ranging and DORIS tracking data and the JGM3 gravity model (JGM2 was used in the orbits for the MGDR-A). For both orbit fields, the vertical component of the ephemeris is known with an accuracy of ± 3cm. While the CNES and NASA orbits have comparable accuracies, geographically correlated errors may still exist.

4.2 *Altimeter Range and Calibration Biases*

An altimeter operates by sending out a short pulse of radiation and measuring the time required for the pulse to return from the sea surface. This measurement, called the altimeter range, gives 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.

The range reported in the MGDR [see H_Alt parameter] has been corrected for calibration errors, pointing angle/sea state errors, satellite center of gravity motion and other terms related to the altimeter acceleration, Doppler shift, and oscillator drift. All corrections also appear in the MGDR [See Net_Instr_R_Corr_K (and C) parameters].

After a misprinting problem which happened during the first 8 cycles of the mission, the satellite attitude is less that 0.1 degree (starling with cycle 9). Noise of both altimeters is within specification, i.e. at a 2 cm RMS level for a one second average and a 2 meter significant wave height.

The TOPEX and POSEIDON altimeter ranges on the MGDR-B have been corrected for the following instrument errors:

1. TOPEX Oscillator drift error - The MGDR-B range for TOPEX date has been corrected for the oscillator drift error discovered in July 1996. This does not aff act POSEIDON data. This error created an exaggerated (over 1 inch) apparent sea level rise between 3/94 and 3/96 as well as an offset of approximately 13 cm between the measurements of the TOPEX and POSEIDON altimeters. The values (l/cycle) used can be found at the Wallops Flight Facility (WFF) web site http://osb3.wff.nasa.gov/TOPEX/.

2. TOPEX range drift - The TOPEX range has been corrected for the range drift as estimated by Wallops Flight Facility and is available on their web page.

3. The TOPEX and POSEIDON ranges have been corrected for "absolute" bias based on platform measurements of sea level at Lampedusa Island and Harvest Platform. The best estimates of the respective absolute biases use the new orbits and other corrections are:

TOPEX	1.5 cm
POSEIDON	0.0 cm.

These values are supported by crosstrack analyses. The bias values used are given in the MGDR science data file header (see Sec 5,6). Until recently, the TOPEX bias was estimated at 14 to 15 cm. The user will see figures of this order in the literature. Almost all of this was due to the oscillator drift error mentioned above.

4. The POSEIDON range has been corrected for the POSEIDON tracker bias (see EM Bias - this section).

In summary:

TOPEX DATA

H_Aft (update)= H_Alt (MGDR-A)

+ oscillator drift correction

+ altimeter bias (15 mm)

range drift

POSEIDON DATA

H_Alt (update) = H_Alt (MGDR-A)

+ attimeter bias (O mm)

+ POSEIDON tracker bias

The instrument correction parameters, Net_Instr_R_Corr_K and C are adjusted with the same formula.

4.3 *Geoid*

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 hi-axial ellipsoid of revolution. 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 [see H_Geo parameter Sec 7].

The geoid undulation, over the entire Earth, has a root mean square value of 30.6m with extreme values of approximately 63m and -106m. 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 (OSU91 A, Rapp, Wang, Pavlis, Ref. 24) that was used for the computation of the undulations in the initial MGDR-A. Tests (Tapley et al., Ref. 32, Rapp et al, Ref. 26) with the newer geopotential models (e.g. JGM2 and JGM3) demonstrate that the JGM3 potential coefficient model, described in Tapley et al., Ref. 33, gives long wavelength geoid undulation information superior to earlier models. In order to provide high frequency geoid undulation information the JGM3 model, that is complete to degree 70, can be merged with the OSU91 A potential coefficient model from degree 71 to 360.

The JGM3/0SU91A 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+09 m^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 (Rapp Ref. 27) to be 63781 35.59m. This estimate is dependent on the bias estimate adopted at the time (-14.5 cm) for the TOPEX altimeter bias.

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, ±24cm. 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 JGM3/OSU91 A model is approximately ± 26cm. Improvements continue to be sought in the estimation of the gravitational potential of the Earth. Developments now (April 1996) underway will lead to substantial improvements in our knowledge of the geoid at all wavelengths.

4.4 *Mean* Sea *Surface*

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 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 aftimeter missions can be reduced, etc. (See H_MSS Sec 7)

NOTE: This OSU95 Mean Sea Surface was computed using TOPEX cycles 17 to 53, as well as 6 months of ERS-1 altimetry. When removed from TOPEX/POSEIDON sea surface heights, the residual's standard deviation is smaller for cyces 17 to 53 (around 9 cm rms excluding shallow water) than for other cycles (11.5 cm rms) because of this.

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, 0SUMSS92, used for the initial TOPEX/POSEIDON GDRs was that developed by Basic and Rapp (Ref. 13). The was givenona0.125 x 0.125 degree grid calculated from Geos-3, Seasat, and Geosat ERM aftimeter 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, Ref. 25). 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) described the data and procedures being used for MSS determination. This discussion led to the identification of a number of issues (Rapp and Nerem, Ref. 28) 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 repeat). 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 OSU MSS 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 repeat), 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 JGM3/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 30m 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 (Ref. 26) and Anzenofer et al.(Ref. 29), 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 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 *Guff* Stream region (42N TO 32N, 290E TO 300 E). 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: ± 23.0cm (OSUMSS95) to 24.8 cm(NEW MSS).

Along track gradient comparisons showed little change (e.g. ± 0.60 to 0.62 cm/km for the TOPEX data). Cross track gradient changes have not been computed. .

As the MSS was calculated assuming a 14.7 cm TOPEX bias, that amount has been subtracted from the model value in calculating H_MSS.

The MSS being incorporated on the MGDR-B is a significant improvement over the previously used MSS grii (OSUMSS92). 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. '

4.5 Geophysical Corrections

The atmosphere and ionosphere slow the velocity of radio pulses at a rate proportional to the total mass of the atmosphere, the mass of water vapor in the atmosphere, and the number of free electrons in the ionosphere. In addition, radio pulses do not reflect from the mean sea level but from a level that depends on wave height and windspeed. While not large, the errors due to these processes cannot be ignored and must be removed. Discussions of these effects are given in Chelton (Ref. 44) and Zlotnicki (Ref 45).

4.5.1 Troposphere (dry and wet)

The propagation velocity of a radio pulse is slowed by the "dry" gasses and the quantity of water vapor in the Earths troposphere. The "dry" gas contribution is nearly constant and produces height errors of approximately -2.3m. The water vapor in the troposphere is quite variable and unpredictable and produces a height calculation error of -6cm to -40cm. However, these effects can be measured or modeled as discussed below.

The gases in the troposphere contribute to the index of refraction. 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. (See Refs 44 and 45) The dry meteorological tropospheric range correction is equal to the surface pressure multiplied by -2.27mm/m [see Dry_Corr, Dryl_Corr and Dry2_Corr parameters]. There is no straight forward way of measuring the nadir surface pressure from a satellite, so it is determined from model assimilated weather data from the European Center for Medium Range Weather Forecasting (ECMWF). The uncertainty on the dry tropospheric correction is about 0.7cm.

The amount of water vapor present along the path length contributes to the index of refraction of the Earth's atmosphere. Its contribution can be estimated by measuring the atmospheric brightness near the water vapor line at 22.2356 GHz and providing suitable removal of the background. The TOPEX Microwave Radiometer (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 removes the surface emission (wind speed influence), and the 37 GHz removes other atmospheric contributions (cloud cover influence). Measurements are combined to obtain the error in the satellite range measurement due to water vapor effect, The uncertainty is ±1.2 cm. [see Wet_H_Rad parameter]

Elsewhere, the meteorological model calculates also a value of the wet tropospheric delay which is placed on the MGDR 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.

4.5.2 Ionosphere

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. The retardation of velocity is inversely proportional to frequency squared. For instance, it causes the altimeter to slightly over-estimate the range to the sea surface by typically 0.2 to 20 cm at 13.6 GHz. The amount varies from day to night (very few free electrons at night), from summer to winter (fewer during the summer), and as a function of the solar cycle (fewer during solar minimum). (For treatments of this correction, see Refs 43, 44, 45 and 46) (Also, see Sec 3.7 on smoothing the ionosphere correction).

Because this effect is dispersive, measurement of the range at two frequencies allows it to be estimated. Thus if is computed from the TOPEX data with an expected accuracy of 0.5cm [see Iono_Corr parameter] and from DORIS measurements with an accuracy of 2 cm [see Iono_Dor parameter]. The first term is only valid for TOPEX data and the second term for TOPEX and POSEIDON data. The average of TOPEX versus DORIS difference is nearly 1 cm with an rms of 2cm (depending on the local time of the cycle). As a backup, the Bent model correction is also placed on the MGDR [see Iono_Ben parameter].

While this 2cm rms difference is small viewed globally, there are large differences in some regions. The main areas are the western Pacific due to lack of DORIS coverage and the equatorial Atlantic due to insufficient geomagnetic modelling. The subsolar point is another area of discrepancy due to the peak of the electron content.

4.5.3 Ocean Waves (electromagnetic bias)

Over the large footprint of these radar measurements, the 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, termed the electromagnetic bias (EMB) [see EMB_Gaspar and EMB_Walsh parameters Sec 7], causes the altimeter to overestimate the range. In reality, there are three distinct effects at play. The electromagnetic bias as just described (See Rodriguez et al., Ref 47); a skewness bias, due to the assumption in the onboard algorithms that the probability density function of heights is symmetric, while in reality if is skewed, and a 'tracker bias', a purely instrumental effect. The sum of EM bias and skewness bias is called 'sea state bias'. For TOPEX/POSEIDON, because of the closeness between the pre-launch and after-launch estimates of the TOPEX EM bias (which presumably is independent of the instrument, except for the wavelength of the radar pulse), no tracker bias is applied. The difference between the empirical estimates of sea state bias for TOPEX and POSEIDON (about 39'. of SWH) has been defined to be the Poseidon tracker bias (see below).

A theoretical understanding of the EMB remains limited and continues to be a topic of research. The current most accurate estimates are obtained using empirical models derived from analyses of the altimeter data. Based on the results of Gaspar et al. (Refs. 18,19) and others, the EMB is calculated as a second -order power series in significant wave height and wind speed (at 10 m).

$$EMB = - SWH [a + b*SWH + c*U + d*U^2]$$

where

EMB	electromagnetic bias (m)
SWH	significant wave height (m)
u	windspeed (m/s)

NOTE: The windspeed algorithm on this MGDR is implemented slightly differently from that on the AVISO product. This results in different windspeed values and consequently, different EMB values on the different products. The differences between PO.DAAC and AVISO windspeeds are small (about 0.1 m/s) except below 0.7 m/s and above 21 m/s.

•

The coefficients 'a' through 'd' are given in the following subsections,

4.5.3.1 Ku band coefficients

EMB_Gaspar (Recommended for use with all Ku data)

a = +0.0203

b = -0.00265

C = +0.00369

d = -0.000149

EMB_Walsh (Provided **for continuity with MGDR-A). (This correction is copied from the** TOPEX GDR **and the coefficients are provided here for user reference)**

TOPEX DATA 0NL%

a = +0.0029

b = +0.0

C = +0.0038

d = -0.00015

4.5.3.2 C band coefficients

Walsh method - This was in the MGDR-A as EM_Bias_Corr_C but is not included in the MGDR-B science record. The user may calculate if desired.

a = +0.0039

b = +0.0

c = +0.00403

d = -0.000146

4.5.3.3 POSEIDON Tracker Bias

The difference between the POSEIDON and TOPEX Ku band EMB_Gaspar above is defined to be the POSEIDON tracker bias. This value is included in both the POSEIDON range (H_Alt) values and the corresponding instrument correction (Net_ Instr_R_Corr_K).

The value of this bias is calculated using the same formula as the EMB with the following coefficients:

a = +0.03360

b = +0.0082

c = -0.00144

d = **+0.000052**

4.6 Rain Flag

Liquid water along the pulse's path reduces the energy returned to the altimeter, mainly at Ku band. In heavy rain, there are competing effects from attenuation and surface changes. The small scale nature of rain cells tends to produce rapid changes in the strength of the echo as the aftimeter crosses rain cells. Both effects degrade the performance of the altimeter. Data contaminated by rain should be rare and are consequently tagged and ignored [see Geo_Bad_2 parameter].

NOTE: This flag is set when the liquid water, Lz, reaches or exceeds 600 microns. It was set in the original TOPEX GDR and the TOPEX/POSEIDON MGDR at 1000 microns. The isues of the appropriate algorithm for computing Lz and the cutoff value are still being debated.

In the event that the user wishes to use a different threshhold, the algorithm used in the MGDR-B is given below. The theoretical basis for this algorithm is Ref 6 and the threshold change is Ref 49.

To estimate atmospheric liquid water in microns:

LZ = L600 + Lcor

where

	L600	=LZA0 + LZA1 ● Tb18 + LZA2*Tb21 + LZA3*Tb37
	Lcor	= O if L600 < Lhigh
else		= Lc1*(L600 - 600) + Lc2*(L600 - 600)'2

IF Lz .GE. LZLimitT THEN Set rain flag.

Input values to the above equations are:

Tb18 = the TMR 18 GHz from the MGDR converted from 0.01°K to 'K
Tb21 = the TMR 21 GHz from the MGDR converted from 0.01°K to "K
Tb37 = the TMR 37 GHz from the MGDR converted from 0.01 "K to "K

LZA0	= -2280.360
LZA1	= -12.241
LZA2	= -5.128
LZA3	· 28.964
LZLimit	· 600.0
Lcl	· 0.43
Lc2	· 0.0003
Lhigh	· 600.0

Also, set the rain flag if any of the brightness temperatures are outside the following limits:

100< Tb18 < 208°K.
105< Tb21 < 238°K.
130< Tb37 < 258°K.

4.7 Tides

Tides are obviously a significant contributor to the observed sea surface height. While they are of interest in themselves, they have more energy than all other time-varying ocean signals. Since they are highly predictable, they are removed from the data in order to study ocean circulation. The TOPEX/POSEIDON orbit was specifically selected (inclination and altitude) so that diurnal and semidiurnal tides would not be aliased to low frequencies. 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 pure ocean tide (equilibrium and non-equilibrium tides) and the loading tide. The pole tide is due to variations in the earth's rotation and are unrelated to luni-solar forcing.

4.7.1 Elastic Ocean Tide

The TOPEX/POSEIDON Science Working Team (SWT) has deriied numerous new' tide models. After much evaluation the two selected for inclusion in the MGDR-B are a model from the University of Texas (UT CSR 3.0.1) and one from the Institut de Mechanique de Grenoble (FES95.2.1). Early versions of the UT model were based on aftimeter data, while early versions of the Grenoble modle were purely hydrodynamic, The current versions of both models area blen of a hydrodynamic model with assimilated aftimeter data. The last decimal of the FES designation indicates a change which was made after the October 1995 SWT to correct some small inconsistencies in the model. The UT model includes a loading tide computation. These models have been used to calculate the tide values on the MGDR-B (See H_ EOT_CSR, H_EOT_FES, H_LT_CSR, Geo_Bad_2 Sec 7)

These and other tide models are available on CD-ROM orderable through the PO.DAAC web page.

4.7.1.1 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. The model is based upon 89 cycles (2.4 years) of T/P altimetry. First diurnal orthoweights were fit to the Q1, 01, P1 and K1 constituents of the Grenoble hydrodynamical model FES94.1 [Le Provost et al., Ref. 20], and semidiurnal orthoweights were fit to the N2, M2, S2 and K2 constituents of Andersen's "Adjusted Grenoble Model". Tides in the Mediterranean from Canceil et al. (Ref. 15) 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 aftimetry was used to solve for corrections to these orthoweights in 3 X 3 degree spatial bins. The orthoweight corrections so obtained were then smoothed by convolution with a 2-d Gaussian filter 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 JGM3 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 coasts. Ocean tide flagging for CSR3.0 should not be used as a land/sea flag. Instead use Geo_Bad_1bit 1 (= 1 if land, O if sea).

4.7.1.2 FES95.2. 1

The FES95.2.1 model is an improved version of the earlier pure hydrodynamic solution FES94.1, produced on the basis of the finite element model developed by the Grenoble Ocean Modeling Group (Le Provost & Vincent, Ref. 37; Lyard & Genco, Ref. 38). FES94.1 was produced with the aim of offering the satellite **altimetry community** a prediction of the **tidal** contribution to sea surface height variations that is independent of **altimetric** measurements (Le Provost et al, Ref. **32).** 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, 01, **Q1**. Five secondary constituents have been deduced by admittance from these 8 major ones (following Le Provost et al., Ref. 39): these waves are Mu2, Nu2, L2, T2, PI. the resolution of the numerical model is spatially varying with a finite element grid refined over shelves and along the coasts, down to 10 km. This high resolution concentrated over the major topographic features of the world oceans allows the FES95.2. 1 to model the local characteristics of the tidal components unresolved in the classical coarser hydrodynamical ocean tide models.

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, Ref. 40). Although the accuracy of this new hydrodynamic solution is clearly improved by reference to the previous solutions available in the literature, comparison of **FES94.1** to the **TOPEX/POSEIDON** solutions of Scrama and Ray (1994) revealed that the former contained large scale errors, up to 6 cm in amplitude for M2 and a few centimeters for the other major constituents.

The FES95.2 is an improved version of **FES94.1** derived by assimilating the earlier empirical T/P **CSR2.0** tidal solution using a represented method as developed by Egbert et al. (Ref. 16). 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 JGM3 orbits. The data set used in the assimilation consisted of a sampling of **CSR2.0** on a 5 degree **grid** for ocean depths greater than 1000 m. The assimilation was performed over five basins: **North** Atlantic, South Atlantic, Indian Ocean, North Pacific Ocean and South Pacific Ocean. The solutions were then completed by adding the Mediterranean Sea (from **Canceil** et al. Ref. 15), the Arctic Ocean from Lyard (Ref. 22) and Hudson Bay, English Channel, North Sea and Irish Sea from FES94.1. Two versions of the assimilation solutions have been produced.

The standard release of these new solutions, **FES95.2,** is a 0.5 degree gridded version of the full resolution solutions computed on the finite element grid. The associated tidal prediction includes 27 constituents. Among them, **only the 8 major constituents are from the hydrodynamic model: 3 diurnal** (KI, 01, QI) and 5 semi-diurnal (M2, S2, N2, K2, **2N2).** These components are corrected by assimilation, except K2 and 2N2. The other 19 constituents are derived by admittance from the 8 major ones. Among these secondary waves are MI, **J1,** 001, epsilon2, **lambda2,** eta2 and so on.

The quality of these solutions has been evaluated by Le Provost et al (Ref. 21) by reference to the standard sea truth data set including 95 stations. It shows that the rms differences between these solutions and in situ data are significantly reduced after the assimilation process is applied, compared to the similar rms differences of both the a priori hydrodynamic solutions and the T/P solutions used as a priori data for assimilations. The rms evaluated over the 8 major constituents is reduced form 3.8 cm for **FES94.1** to 2.8 cm for FES95.2. The evaluation of the performance of the prediction model is done in two ways in Le Provost et al (1996). Test 1 compares tide predictions with observations at 59 pelagic or island sites distributed over the world ocean. Test 2 looks at the level of variance of the sea surface variability observed by T/P attimeter at its crossover track points which is explained by the tidal predictions.

The two kinds of evaluation lead to the same conclusion: this new prediction model performs much better than FES94.1. Test 1 estimates the overall rms in ocean tide predictions at the level of 3.86 cm (the same test for **CSR3.0** gives 3.48 cm).

A more complete intercomparison within the T/P SWT is given in **Shum** et al (Ref. 31).

Note that

1. FES95.2 model calculates only non-equilibrium tides so load and equilibrium tides must be added to give the elastic ocean tide. The MGDR-B value H_EOT_FES has the load and equilibrium tides added in.

2. FES95.2 model is deriied from the hydrodynamic FES94.1 solutions, which are of particular interest because of their resolution over the continental shelves. However, the assimilation has led to some local spurious resonances over a few regions.

4.7.2 Solid Earth Tide

The solid Earth responds to external gravitational forces similarly to the oceans. The response of the Earth is fast enough that it can 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 two proportionality constants are the so-called Love numbers. It should be noted that the Love numbers are largely frequency independent, an exception occurs near a frequency corresponding to the KI tide constituents due to a resonance in the liquid core [Refs. 10 and 48].

Such a tide is computed as described by Cartwright and Tayler [Ref. 11] and Cartwright and Edden (Ref. 12) [see H_Set parameter].

4.7.3 Pole tide

The pole tide is a tide-like motion of the ocean surface that has nothing to do with the luni-olar forcing. It is forced by small perturbations of the Earth's rotation, with periods primarily annual and around 428 days (called the Chandler wobble, with about 0.1 arc-sac amplitude) and the different response to this forcing between the land and ocean areas. To model it, one needs a time series of perturbations to the Earth rotation, a quantity now measured almost routinely with space techniques. The period is long enough that it can be considered to be in equilibrium for both the ocean and the solid Earth.

If we know the location of the pole – this information is supplied with the edit ephemeris – the pole tide is easily computed as described in Wahr [Ref. 10] [see H_Pol parameter]

The TOPEX Precision Orboit Determination team discovered a discrepancy in the pole tide on the TOPEX GDR cycles 1- 132 and the pole tide on the MGDR-B has been corrected for all these cycles. The problem is that average value of the pole position for the TOPEX/POSEIDON epoch must be subtracted from the current values obtained from the NASA precision orbit. The resulting error is up to 13 mm. 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))

where

amp = -11. E6 • as2rad • (1 + k2) = -69.435 mm

as2rad converts arc seconds to radians

k2 = 0.302 is the second degree gravitational Love number

x_pole_avg = 0.042 arc seconds and

y_pole_avg = 0.293 arc seconds.

4.8 Inverse Barometer Effect

As atmospheric pressure increases and decreases, the sea surface tends to respond hydrostatically, falling or rising respectively. Generally, 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 from the MGDR (parameter Dry_Corr in mm)

P_atm = Dry_Corr/(-2.277 *(1 + (0.0026' cos (2x1 0^-6*Lat_Tra*pi/180 .0)))).

The inverse barometer correction [see INV_BAR parameter] is

INV_BAR = -9.948 •(P_atm - 1013.3)

To apply this correction, it should be added to altimeter range and/or subtracted from sea surface height.

The scale factor 9.948 is based on the theoretical value of the static inverted barometer at mid latitudes. Other values are used by some researchers. Also, the 1013.3 is the nominal value of mid latitude average atmospheric pressure. One would do better by using an average pressure for each cycle.

NOTE: The parameter INV_BAR changes by 4 to 5 mm steps as the Dry_Corr change by 1 mm. This will give rise to an apparent quantization in INV_BAR. Since Dry_Corr accuracy is not better than 1 mm, the resulting INV_BAR is a accurate as the data allows.

4.9 *Sigma O*

4.9.1 Corrections to Sigma0

Two adjustments have been made to the sigma0's on the MGDR:

1. A 0.16 dB bias was identified between the distributions of TOPEX and POSEIDON sigma0's and has been applied to the Sigma0_K for POSEIDON data only.

2. A drift in the TOPEX Ku and C band sigmaO's has been detected and a correction applied to SigmaO_K and Sigma0_C for TOPEX data only. (See WFF web site given in Section 4.2)

Further, when the Sigma0_K is used to calculate wind speed, an offset of -0.63 dB is added to match the GEOSAT sigma0 distribution which was used in the formulation of the Chelton-Wentz wind speed model. This is done for TOPEX and POSEIDON data

4.9.2 Further Adjustments to C band Sigma0

The value of C band sigma0 (Sigma0_C) has been copied from the TOPEX GDR and adjusted as shown in the previous section. The sigma0 (Ku and C) values reported on the MGDR are corrected for atmospheric attenuation using Atm_Att_Sig0_Cor (see Sec 7). This atmospheric attenuation is calculated for Ku band and when applied to Sigma0_C overcorrects in areas of high atmospheric moisture. For any use of the Sigma0_C the following correction should be made:

Sigma0_C(Corrected) . Sigma_C(MGDR) - Atm_Att_SigO_Cor(MGDR) + Atm_Att_C

where

$Atm\_Att\_C = 10*log_{10}e*(0.00987 + 2.17E-5\ P_v + 0.05187\ L_z)$

P_v= vapor induced path delay in cm (Wet_Cor/1O.)

L_z = integrated liquid water content in cm (see Sec 4.6 where L_z is calculated in microns)

For completeness, here is the formula for calculating the Ku band correction(i.e. Atm_Att_Sig0_Cor):

$Atm\_Att\_C = 10*log_{10}e*(0.01362 + 5.5\ E\text{-}4\ P_v + 0.32896\ L_z$

4.10 *Wind Speed*

The model functions developed to date for altimeter wind speed have all been purely empirical. The model function tries to establish a relation between the sea surface backscatter coefficient (σ_o) and the windspeed.

The wind speed algorithm selected is the model defined by Witter and Chelton (Ref. 35), the Modified Chelton and Wentz. A tabular form is used for the MGDR-B windspeed calculation.

The windspeed algorithm on this MGDR is implemented slightly differently from that on the AVISO product. This results in different windspeed values (and consequently, different EMB values) on the different products. The differences between PO.DAAC and AVISO windspeeds are small (about 0.1 reds) except below 0.7 m/s and above 21 m/s. The largest difference at low winds is 0.7 m/s and at high winds is about 5 m/s.

The windspeed model function is evaluated for 10m (above the sea surface) for all cycles. NOTE: The MGDR-A calculated winds at 19.5 m. Note also that ERS-1/2 and NSCAT scatterometer winds are reported at 19.5 m.

4.11 *Fine Height Flags (in Iono_Bad)*

For TOPEX data, flag bits have been added to Iono_Bad to indicate which part of the digital filter bank (DFB) the signal is in based on the original range values have been added to the SDR processing. This is important because leakages in the waveform appear to be fixed in the DFB and thus contribute differently to the measured range as the actual signal is shifted based on the operation of the hardware. The effect of the leakages also varies with gate index. The fine height flags will allow users to apply a correction to the sea surface height based on the position of the signal in the DFB and the gate index. The correction is <--1 cm for gates 1-3 (SWH <6 m). The correction algorithm will be supplied by WFF. The WFF web site in Section 4.2 should be checked for this correction, The fine height flags are stored in Iono_Bad bits 13, 14 (K, C band) on the GDR.

4.12 *Bathymetery Information*

The bathymetric information on the MGDR is given in the parameter H_Ocs which is the ocean depth in meters based on the land-ocean model ETOPO5. This is given so users may make their own "cut for shallow water if they don't wish to use the Geo_Bad_1 bit O which is set to 1 for depths less than 1000 m. Typically, of the 480,000 data records per cycle which pass the editing criteria described in Sec 3, some 30,000 or 6°/'0 have H_Ocs shallower than 1000m.

NOTE: This MGDR-B has H_Ocs values generated from ETOP05 using a different interpolator from that used by AVISO. The agreement is good except in the few areas where there are very high bathymetric gradients. In these special areas, trenches, sea-mounts, etc., one or two data records will have quite different values depending on which interpolator is used.

The following information on ETOP05 is taken from the U.S. National Geophysical Data Center's Web page (search on ETOPO5):

ETOP05 was generated from a digital data base of land and sea- floor elevations on a 5-minute latitude/longitude grid. The resolution of the gridded data varies from true 5-minute for the ocean floors, the U. S. A., Europe, Japan, and Australia to 1 degree in data-deficient parts of Asia, South America, northern Canada, and Africa. Data sources are as follows: Ocean Areas: U.S. Naval Oceanographic Ofice; U. S. A., W. Europe, Japan/Korea: U.S. Defense Mapping Agency; Australia: Bureau of Mineral Resources, Australia; New Zealand: Department of Industrial and Scientific Research, New Zealand; balance of world land masses: U.S. Navy Fleet Numerical Oceanographic Center. These various data bases were originally assembled in 1988 into the worldwide 5-minute grid by Margo Edwards, then at Washington University, St. Louis, MO.

The ETOP05 data may be credited in publications by reference to "Data Announcement 88-MGG-02, Digits/ relief of the Surface of the Earth. NOAA, National Geophysical Data Center, Boulder, Colorado, 1988." The version of the data making up ETOPO5 is from May, 1988, with the exception of a small area in Canada (120-130 W, 65-70 N), which was regridded in 1990.

5. MERGED TOPEX/POSEIDON PRODUCTS

5.1 Overview

PO.DAAC processes, archives and distributes on CD ROM, TOPEX/POSEIDON merged products, i.e., the MGDRs [Ref. 1]. The **crossover point files are described In this document but will be** distributed **separately.**

MGDR products are generated from TOPEX and POSEIDON measurements. They have been designed to reinforce unity of the TOPEX/POSEIDON mission.

TOPEX data are available over both land and oceans, whereas POSEIDON altimeter data are available only over oceans. Products consist of ten-day repeat cycles of data. They are designed scientifically to be as homogeneous as possible so that they can be used for ocean and geophysical studies. To reach that objective, special attention has been paid on various elements of the original TOPEX and POSEIDON GDR's (GDR-T and GDR-P respectively). Generally speaking, no information is lost when going from these GDR's to the MGDR. Computations of some other elements are possible because they do not depend at all on sensor measurements. Basically, MGDR includes the measurement locations based on orbit ephemeris, altimeter height measurements and associated corrections. When TOPEX and POSEIDON altimeters do not provide any measurements, no record is included in the MGDR.

MGDR data are organized in one cycle header file and a maximum of 254 pass-files. A pass-file contains altimeter data from a satellite pass (half a revolution). Elementary records of a pass-file are at a one per second rate.

Crossover point products contain TOPEX and POSEIDON information at each crossover point (geophysical information). This means that both ascending arc information and descending arc information are present. This information is deduced from the merged GDR product and consists of a ten-day cycle of data.

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

5.2 File Structure

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 should be used to ensure that the correct/ latest version is being used if file reissue is necessary.

Note **that TOPEX/POSEIDON merged products lead to four types of headers: one for the** CD ROM **header file, one for the** MGDR cycle **header file, one for** MGDR **pass-files and one for the crossover points file.**

5.3 CD ROM Header File

5.3.1 Labeling

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

MGxvol_v.HDR

where

M	for the PO.DAAC Merged product
G	for GDR data type
x	the generation letter (A to Z) (at publication X="B")
Vol	the volume number (001 to 999)
v	the CD ROM version number (O to 9)
HDR	for a header file

Note that the data type, the generation letter and the version number are also reported inside the file.

5.3.2 Content Overview

This file is only a header. It provides organization and data product identification, i.e., identification of the entity in charge of the CD ROM and about the CD ROM content.

All products of a ten-day repeat cycle are recorded in a specific directory whose name is reported in this header [see "Directory_Cycle"] element. For more convenience, the cycle header and crossover file name are also reported in this header [see "Header_Cycle" and "Crossover_Cycle" elements].

5.3.3 Format

FILE NAME	MGxvol_v.HDR
FORMAT	Unformatted
ACCESS	Sequential direct
TYPE	ASCII (CCSDS format)
RECORD LENGTH (FIXED)	80 Bytes
SIZE	2.8 Kbytes

File content is given below. See chapter 6 for more details on each element.

MGxvol_v.HDR Record Number	KEYWORD FORMAT	cONTENT	VALUE . FORMAT
1	char*20	CCSD3ZF0000100000001	....

2	char*20	CCSD3KSOOO06CDROMHDR	
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	CCSD3RFOOO0300000001	....
22	char*15	Directory_Cycle	char*7
23	char*15	Header_Cycle	char*12
24	char*12	Crossover_Cycle	char*12
25	char*15	Directory_Cycle	char*7
26	char*15	Header_Cycle	char*12
27	char*12	Crossover_Cycle	char*12
28	char*15	Directory_Cycle	char*7
29	char*15	Header_Cycle	char*12
30	char*12	Crossover_Cycle	char*12

5.4 MGDR Cycle Header File

5.4.1 Labeling

The MGDR cycle header file conforms to the following naming convention:

MGxccc.HDR

where

M	for the PO.DAAC Merged product
G	for GDR data type
x	the generation letter (A to Z)
ccc	cycle number
HDR	for a header file

Note that:

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

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

5.4.2 Content Overview

This file is only a header. It provides organization and data product identification, i.e., identification of the entity in charge of the production and about the data product of the ten-day repeat cycle this file is referring to.

Pass-file names are listed in the cycle header file in the “Reference” elements [see § 6.2].

5.4.3 Format

FILE NAME	MGxccc.HDR
FORMAT	Unformatted
ACCESS	Sequential direct
TYPE	ASCII (CCSDS format)
RECORD LENGTH (FIXED)	80 Bytes
SIZE	2216 Kbytes

File content is given below. See chapter 6 for more details on each element.

MGxvoLv.HDR			
Record Number	KEYWORD		VALUE
	FORMAT	CONTENT	FORMAT
1	char*20	CCSD3ZF0000100000001	....
2	char*20	CCSD3KSOOO06CYCLEHDR	....
3	char*20	Producer_Agency_Name	char*4
4	char*25	Producer_Institution_Name	char*5
5	char*11	Swrce_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
1 5	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	CCSD3RFOOO0300000001	....
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	char*12
"			
"			
23 + 254 max	char*9	Reference	char*12

5.5 *MGDR pass-files*

5.5.1 Labeling

Each MGDR passfile conforms to the following naming convention:

MGxccc.ppp

where

M	for the PO.DAAC merged product
G	for GDR data type
x	the generation letter (A to Z)
ccc	cycle number
PPP	the pass-file number (001 to 254)

Note that:

The data type, 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 t ype is also recorded inside the file (header part).

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

5.5.2 Content Overview

MGDR passfile is a pass-file of geophysical data (GDR) produced using precise orbit ephemeris and validated algorithms. Each pass file contains a header part and a data part.

The header part provides organization and data product identification, i.e., identification of the entity in charge of the production and identification about the data, calibration results, orbit quality as well as processing history and typical pass characteristics.

The data part is a time record. Each record maybe split into 12 groups of elements concerning:

(1) TIME

(2) LOCATION

(3) ALTITUDE

(4) ATTITUDE

(5) ALTIMETER RANGES

(6) ENVIRONMENTAL CORRECTIONS

(7) SIGNIFICANT WAVE HEIGHT

(8) BACKSCATTER COEFFICIENTS AND AGC

(9) GEOPHYSICAL QUANTITIES

(10) BRIGHTNESS TEMPERATURES

(11) FLAGS

Geophysical data records consist primarily of satellite measurements of sea level (altimeter ranges), including all corrections applied to the data (instrument effects), plus the precise ephemeris of the satellite. All measurements are appended with the latitude, longitude and time of the observation. The records also include the altimeter measurements of wave height, wind speed, and ionospheric electron content, and the microwave radiometer observations of brightness temperatures, plus the deriied value of tropospheric water vapor and the best available values for the height of the tides and geoid. Finally, records include flags which reflect the numerous conditions of the sensors and of the values of the data during processing. Three types of flags are:

1. Instrument flags,

2. Telemetry flags,

3. Quality flags.

This MGDR definition describes a second generation product, that is Generation B. It is anticipated that a third generation MGDR will be produced after the end of mission. The previous generation, MGDR-A contined about 100 spare bytes primarily to provide room for a third orbit. As this is not needed, those spares have been dropped in order to reduce data volume sufficient to fit three cycles on a CD. Later generations of this product may take advantage of improvements in CD-ROM capacity to fit more cycles on a single CD. New documents will be provided with any new generation product.

The definition of each data element is given in chapters 6 and 7. For more information on the original GDR-T, GDR-P or CORIOTROP related elements, refer to documents 5,6, 7,8 and 9.

Most fields are copies or simple calculation from the original GDR's. A few, such a winds speed and EM bias are more implicated and are shown in section 5.5.4.

5.5.3 Format

A pass-file contains a header and N scientific data records ($N \leq 3360$). Whereas the header is recorded in ASCII type, data part is recorded in a VAX binary integer type. A scientific data record contains 118 fields, each stored as one, two or four bytes.

<u>Pass-file content</u>

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

FILE NAME	MGxccc.ppp
FORMAT	Unformatted

ACCESS	Sequential direct
TYPE	Header: ASCII (CCSDS format) Date: Binary integers
RECORD LENGTH (FIXED)	228 Bytes Header: 33x228 Bytes Data: Nx228 Bytes (N≤3,360
SIZE	774 Kbytes maximum

MGxccc.ppp/ HEADER RECORDS			
Record Number	KEYWORD		VALUE
	FORMAT	CONTENT	FORMAT
1	char*20	CCSD3ZF0000100000001	....
2	char*20	CCSD3KSOOO06PASSFILE	....
3	char*20	Producer_Agency_Name	char*4
4	char*25	Producer_Institution_N ame	char*5
5	char*11	Source_Name	char*14
6	char'11	Sensor_Name	char*14
7	char*23	Data_Handbook_Reference	char*21
3	char*25	Product_Create_Start_Time	char*17
3	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*19	POSEIDON_Range_Bias	char*8
14	char*19	TOPEX_Range_Bias	char*8
15	char*17	T/P_SigmaO_Off set	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_I D	char*38
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	NJPL31FOO04700000001	....

In the following table, the parameters are logically grouped. The class of each is given at the beginning of the group. This is the order in which they appear in the MGDR record.

MGxccc.ppp / SCIENTIFIC DATA RECORD n					
Field No.	Size	Type	Param Name	Content	Units
TIME GROUP					
1	2	I	Tim_Moy_l	Time, days past epoch	Days
2	4	I	Tim_Moy_2	Time, millisec in day	10%
3	2	I	Tim_Moy_3	Time, microsec	1 0's
4	4	SI	Dtim_Mil	Time shift midframe	10%
5	4	SI	Dtim_Bias	Net timetag correction	10%
6	4	SI	Dtim_Pac	10 per sac timing	104s
LOCATION GROUP					
7	4	SI	Lat_Tra	Latitude	10^{-6}deg
B	4	SI	Lon_Tra	Longitude	10^{-6}deg
ALTITUDE GROUP					
9	4	SI	Sat_Alt	Altitude above ref ellipsoid (NASA)	104m
10	4	SI	HP_Sat	Altitude above ref ellipsoid (CNES)	104m
11-20	10X2	SI	Sat_Alt_Hi_Rate	Difference of 10/see sat alt from Sat_Alt	10"'m
21-30	10x2	SI	HP_Sat_Hi_Rate	Difference of 10/see sat alt from HP_Sat	104m
ATTITUDE GROUP					
31	1	I	Att_Wvf	Waveform attitude	10^{-2}deg
32	1	I	Att_Ptf	Platform attitude	10^{-2}deg
ALTIMETER RANGE GROUP					
33	4	SI	H_Alt	One per second altimeter range	10"3m
34-43	1 0X2	SI	H_Alt_SM E(i)	Difference of altimeter range from H_Alt	10"'m
44	1	SI	Nval_H_Alt	Number of valid points for 1 second attitude	/
45	2	SI	RMS_H_Alt	RMS range	10^{-3}m
46	2	SI	Net_lnstr_R_Corr_K	Net instrument correction to range (Ku)	104m
47	2	SI	Net_lnstr_R_Corr_C	Net instrument correction to range (C)	10^{-3}m
46	1	SI	CG_Range_Corr	Center of gravity movement correction to range	10^{-3}m
49	2	SI	Range_Deriv	Range derivative	1 O"'m/s
50	2	SI	RMS_Range_Deriv	RMS of high rate values of Range_Deriv	10"'rrds
ENVIRONMENTAL CORRECTION GROUP					
51	2	SI	Dry_Corr	Dry tropo corr. - met fields interpol. to measurement time	10"sm
52	2	SI	Dry1_Corr	Dry tropo correction - early met field	10"3m
53	2	SI	Dry2_Corr	Dry tropo correction - late met field	10"3m
54	2	SI	INV_BAR	Inverse barometer correct ion at measurement time	10'3m
55	2	SI	Wet_Corr	Wet tropo corr. - met fields interpol. to measurement time	10^{-3}m
56	2	SI	Wet 1 _Corr	Wet tropo correcting - early met field	1 O"m
57	2	SI	Wet2_Corr	Wet tropo correction - late met field	10"'m
56	2	SI	Wet_H_Rad	Radiometer wet tropo correction	10"3m
59	2	SI	Iono_Corr	TOPEX dual-frequency ionospheric correction	10"3m
60	2	SI	Iono_Dor	Ionospheric correction from DORIS	10"3m
61	2	SI	Iono_Ben	Ionospheric correction from Bent model	10"3m
SIGNIFICANT WAVE HEIGHT AND BACKSCATTER COEFFICIENT GROUP					
62	2	1	SWH_K	Significant Wave Height (Ku)	1 O"zm
63	2	I	SWH C	Significant Wave Height (C)	10"2m

64	1	I	SWH_RMS_K	RMS of SWH (Ku)	10“2m
65	1	I	SWH_RMS_C	RMS of SWH (C)	1 0“2m
66	1	SI	SWH_Pts_Avg	Number of valid points *used* to compute SWH	/
67	1	SI	Net_Instr_SWH_Corr_K	Net instrument correction to SWH (Ku)	10^{-1}m
68	1	SI	Net_Instr_SWH_Corr_C	Net instrument correction to SWH (C)	10^{-1}m
69	2	SI	DR_SWH_Att_K	Attitude correction (Ku)	10"'m
70	2	SI	DR_SWH_Att_C	Attitude correction (C)	1 0“m
71	2	SI	EMB_Gaspar	Electromagnetic bias correction (Ku) (Gaspar)	10“m
72	2	SI	EMB_Walsh	Electromagnetic bias correction (Ku) (Walsh)	10“m
73	2	I	Sigma0_K	BackScatter coefficient (Ku)	10“2dB
74	2	I	Sigma0_C	Backscatter coefficient (C)	10^{-2}dB
75	2	I	AGC_K	Automatic gain control (Ku)	102dB
76	2	I	AGC_C	Automatic gain control (C)	10^{-2}dB
77	2	SI	AGC_RMS_K	RMS of Automatic gain control (Ku)	10“2dB
78	1	I	AGC_RMS_C	RMS of Automatic gain control (C)	10“2dB
79	1	I	Atm_Att_SigO_Corr	Atmospheric attenuation correction to sigma0	10“2dB
80	2	SI	Net_Instr_.SigO_Corr	Net instrument correction to sigma0	10^{-2}dB
81	2	SI	Net_Instr_AGC_Corr_K	Net instrument correction to AGC (Ku)	10“2dB
82	2	SI	Net_Instr_AGC_Corr_C	Net instrument correction to AGC (C)	10“2dB
83	1	SI	AGC_Pts_Avg	Number of valid points used to compute AGC	/
GEOPHYSICAL QUANTITY GROUP					
84	4	SI	H_MSS	Mean sea surface height	10’3m
B5	4	SI	H_Geo	Geoid height	10"'m
B6	2	SI	H_EOT_CSR	Elastic ocean tide (CSR 3.0)	10^{-3}m
B7	2	SI	H_EOT_FES	Elastic ocean tide (FES 95.2)	1 0’3m
88	2	SI	H_LT	Loading tide effect (CSR 3.0)	103m
89	2	SI	H_Set	Solid earth tide	10^{-3}m
90	1	SI	H_Pol	Geocentric pole tide	1 0“m
91	1	I	Wind_Sp	Wind speed (from altimeter sigma0 data)	10^{-1}m/s
92	2	SI	H_Ocs	Ocean depth	m
TMR BRIGHTNESS TEMPERATURE GROUP					
93	2	SI	Tb_18	TMR brightness temperature 18 GHz	10^{-2}°K
94	2	SI	Tb_21	TMR brightness temperature 21 GHz	10^{-2}°K
95	2	SI	Tb_37	TMR brightness temperature 37 GHz	10^{-2}°K
FLAGS GROUP					
96	1	SI	ALTON	Altimeter flag (0= POSEIDON, 1 =TOPEX)	/
97	1	B F	Instr_State_TOPEX	State of TOPEX altimeter	I
98	1	B F	Instr_State_TMR	State of TMR	I
99	1	SI	Instr_State_DORIS	State of DORIS instrument	/
100	1	St	IMANV	Maneuver indicator	I
101	1	SI	Lat_Err	Quality index of the latitude	I
102	1	St	Lon_Err	Quality index of the longitude	/
103	1	SI	Val_Att_Ptf	Platform attitude validity	I
104	1	B F	Current_Mode_1	Aftimeter current mode (TOPEX first frame)	/
105	1	B F	Current_Mode_2	Altimeter current mode (POSEIDON or TOPEX second frame)	/
106	**1**	**B F**	**Gate_Index**	TOPEX gate index	I
107	1	SI	Ind_Pha	POSEIDON indicator on tracker processing	/
108	2	I	Rang_SME(i)	State of 10 per second values	/
109	1	B F	Alt_Bad_1	TOPEX and POSEIDON measurement conditions #1	/
110	1	B F	Alt_Bad_2	TOPEX and POSEIDON measurement conditions #2	/
111	1	SI	Fl Aft	Attitude flag	/

112	1	SI	Dry_Err	Quality flag on Dry_Corr	I
113	1	St	Dry1_Err	Quality flag on Dry1_Corr	/
114	1	SI	Dry2_Err	Quality flag on Dry2_Corr	I
115	1	SI	Wet_Flag	Interpolation flag on Wet_Corr, Wet1_Corr, Wet2_Corr	/
116	1	SI	Wet_H_Err	Quality flag on Wet_Corr, Wet1_Corr, Wet2_Corr	/
117	2	I	Iono_Bad	Quality flag on Iono_Cor	/
118.	1	SI	Iono_Dor_Bad	Quality flag on Iono_Dor	/
119	1	BF	Geo_Bad_1	Ocean/land/ice flag	/
120	1	BF	Geo_Bad_2	Rain/tide flag	/
121	1	BF	TM R_Bad	Brightness temperature flags	I
122	1	BF	Ind_RTK	POSEIDON ground retracing indicator	

5.6 *Crossover Point File*

The **crossover files are distributed separately from the MGDRB** CD-ROMs but are described here for convenience.

5.6.1 Labeling

The crossover point file conforms to the following naming convention:

MGxccc.XNG

where

M for the PO.DAAC Merged product

G for GDR data type

x the generation letter (A to Z)

ccc cycle number

XNG for the crossover file

Note that:

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)

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

5.6.2 Content overview

The crossover point file is produced by AVISO and is included by PO.DAAC on this CD-ROM.

A crossover point file is computed from a cycle of MGDR data. Each crossover file contains a header part and a data part. The header part provides organization and data product identification.

The data part contains the main MGDR 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 not 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

RMS_H_Alt <200 mm for POSEIDON data type

Nval_H_Alt > 5 for TOPEX data type and

Nval_H_Alt > 15 for POSEIDON data

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, otherwise a default value is reported.

For the flags, the maximum values are reported as that is the worst state.

5.6.3 Format

A crossover file contains a header and N data records (N ≤ 7000). Whereas the header is recorded in ASCII type, data part is recorded in a VAX binary integer type. A data record contains 99 fields, each stored as one, two or four bytes.

Crossover file content

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

FILE NAME	MGxccc.XNG
FORMAT	Unformatted
ACCESS	Sequential direct
TYPE	Header: ASCII (CCSDS format)
	Date: Binary integers
RECORD LENGTH (FIXED)	228 Bytes

SIZE	Header: 33x228 Bytes Data: Nx228 Bytes (N≤7,000 1600 Kbytes maximum

5.6.4 **Crossover Point File Contents**

MGxccc.XNG / HEADER RECORD			
Record Number	KEYWORD FORMAT	CONTENT	VALUE FORMAT
	char*20	CCSD3ZF0000100000001	....
	char*20	CCSD3KSOOO06XINGFILE	....
	char*20	Producer_Agency_Name	char*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	char21
12	char*9	Data_Type	char*6
13	char*23	GDRM_Cycle_Header_Name	char*12
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	CCSD3RFOOO0300000001	....

MGxccc.XNG / SCIENTIFIC DATA RECORD					
Field #	Size	Type	Mnemonic	Contents	Units
1	1	SI	Typ_Cro	Crossover points type	/
2	4	SI	Lat_Cro	Latitude	10^{-6} deg
3	4	SI	Lon_Cro	Longitude	106 deg
4	4	SI	H_MSS_Cro	Mean sea surface height	10^{-3} m
5	2	SI	H_Ocs_Cro	Ocean depth	m
6	1	-	Spare		/
				ASCENDING ARC PARAMETERS	
7	1	I	Num_Pass_Asc	Ascending arc number	/
8	2	SI	Tim_Moy_Asc_1	Time, day part	day
9	4	SI	Tim_Moy_Asc_2	Time, millisecond part	103s
10	2	SI	Tim_Moy_Asc_3	Time, microsecond part	104s
11	4	SI	Sat_Alt_Asc	Altitude above reference ellipsoid (NASA)	10^{-3} m

12	4	SI	HP_Att_Asc	Altitude above reference ellipsoid (CNES)	103m
13	1	I	Att_Ptf_Asc	Platform attitude	,0.2 deg
14	1	I	Att_Wvf_Asc	Waveform attitude	10'2 deg
15	4	SI	H_Alt_Asc	One per second altimeter range	10^{-3} m
16	1	SI	Spline_RMS_Asc	RMS of 8 points compared to the spline	10^{-3} m
17	2	SI	Net_Instr_R_Corr_K_Asc	Net instrument correction to range (Ku)	10^{-3} m
18	2	SI	Net_Instr_R_Corr_C_Asc	Net instrument correction to range (C)	10^{-3} m
19	2	SI	Range_Deriv_Asc	Range derivative	,0.2 m/s
20	2	SI	RMS_H_Alt_Asc	RMS of range	10^{-3} m
21	2	SI	Dry_Corr_Asc	Dry tropospheric correction at crossing point	10am
22	2	SI	Dry1_Corr_Asc	Dry tropospheric correction - early met field	10^{-3} m
23	2	SI	Dry2_Corr_Asc	Dry tropospheric correction - late met field	10^{-3} m
24	2	SI	INV_BAR_Asc	Inverse barometer correction at crossing point	10^{-3} m
25	2	SI	Wet_Corr_Asc	Wet tropospheric correction at crossing point	10^{-3} m
26	2	SI	Wet 1_Corr_Asc	Wet tropospheric correction - early met field	103m
27	2	SI	Wet2_Corr_Asc	Wet tropospheric correction - late met field	10^{-3} m
28	2	SI	Wet_H_Rad_Asc	TMR - Radiometer wet tropospheric correction	10^{-3} m
29	2	SI	Iono_Cor_Asc	TOPEX dual-frequency ionospheric correction	10^{-3} m
30	2	SI	Iono_Dor_Asc	Ionospheric correction from DORIS	10^{-3} m
31	2	SI	Iono_Ben_Asc	Ionospheric correction from Bent model	10^{-3} m
32	2	I	SWH_K_Asc	Significant wave height (Ku)	10^{-2} m
33	2	I	SWH_C_Asc	Significant wave height (C)	10“2 m
34	2	SI	EMB_Corr_K1_Asc	Electromagnetic bias correction (Ku)(Gaspar)	103m
35	2	SI	DR_SWH_Att_K_Asc	Attitude correction (Ku)	10^{-3} m
36	2	SI	DR_SWH_Att_C_Asc	Attitude correction (C)	10“3 m
37	2	I	Sigma0_K_Asc	BackScatter coefficient (Ku)	10^{-2} dB
38	2	1	Sigma0_C_Asc	BackScatter coefficient (C)	10“2 dB
39	2	SI	H_EOT_CSR_Asc	Elastic ocean tide (CSR 3.0)	103m
40	2	St	H_EOT_FES_Asc	Elastic ocean tide(FES 95.2)	10^{-3} m
41	2	SI	H_LT_CSR_Asc	Tidal loading effect (CSR 3.0)	10-3 m
42	2	SI	H_Set_Asc	Solid earth tide	10^{-3} m
43	1	SI	H_Pol_Asc	Geocentric pole tide	10^{-3} m
44	1	I	Wind_Sp_Asc	Wind speed (from attimeter sigma0)	' 0^{-1} M/s
45	1	BF	Geo_Bad_1_Asc	Ocean/land/ice indicator	/
46	1	BF	Geo_Bad_2_Asc	Rain/tide conditions	/
47	1	SI	Dry_Err_Asc	Quality index on Dry_Corr_Asc	/
48	1	SI	Dry1_Err_Asc	Quality index on Dry1_Corr_Asc	I
49	1	SI	Dry2_Err_Asc	Quality index on Dry2_Corr_Asc	/
50	1	St	Wet_H_Err_Asc	Quality index on Wet_Corr_Asc, Wet 1_Corr_Asc and Wet2_Corr_Asc	/
51	1	SI	Iono_Dor_Bad_Asc	Quality index on Iono_Dor Asc	I
52	1	BF	Ind_RTK_Asc	POSEIDON ground retracing indicator	/
				DESCENDING ARC PARAMETERS	
53	1	I	Num_Pass_Des	Descending arc number	/
54	2	SI	Tim_Moy_Des_1	Time, day part	day
55	4	St	Tim_Moy_Des_2	Time, millisecond part	10'3 s
56	2	SI	Tim_Moy_Des_1	Time, microsecond part	10' s
57	4	SI	Sat_Alt_Des	Attitude above reference ellipsoid (NASA)	10^{-3} m
58	4	SI	HP_Alt_Des	Altitude above reference ellipsoid (CNES)	103m

59	1	I	Att_Ptf_Des	Platform attitude	,0.2 deg
60	1	I	Att_Wvf_Des	Waveform attitude	,0.2 deg
61	4	SI	H_Alt_Des	One per second altimeter range	10^{-3} m
62	1	SI	Spline_RMS_Des	RMS of 8 points compared to the spline	10^{-3} m
63	2	SI	Net_Instr_R_Corr_K_Des	Net instrument correction to range (Ku)	10^{-3} m
64	2	SI	Net_Instr_R_Corr_C_Des	Net instrument correction to range (C)	10"m
65	2	SI	Range_Deriv_Des	Range derivative	,0.2 m/s
66	2	SI	RMS_H_Alt_Des	RMS of range	10^{-3} m
67	2	SI	Dry_Corr_Des	Dry tropospheric correction at crossing point	10^{-3} m
68	2	SI	Dry1_Corr_Des	Dry tropospheric correction - early met field	10^{-3} m
69	2	SI	Dry2_Corr_Des	Dry tropospheric correction - late me! field	10^{-3} m
70	2	SI	INV_BAR_Des	Inverse barometer correction at crossing point	10^{-3} m
71	2	SI	Wet_Corr_Des	Wet tropospheric correction at crossing point	10^{-3} m
72	2	SI	Wet 1_Corr_Des	Wet tropospheric correction - early met field	10"m
73	2	SI	Wet2_Corr_Des	Wet tropospheric correction - late met field	10^{-3} m
74	2	SI	Wet_H_Rad_Des	TMR - Radiometer wet tropospheric correct ion	10"3 m
75	2	SI	Iono_Cor_Des	TOPEX dual-frequency ionospheric correct ion	10"m
76	2	SI	Iono_Dor_Des	Ionospheric correction from DORIS	10^{-3} m
77	2	SI	Iono_Ben_Des	Ionospheric correction from Bent model	10^{-3} m
78	2	I	SWH_K_Des	Significant wave height (Ku)	10"2 m
79	2	I	SWH_C_Des	Significant wave height (C)	10"2 m
80	2	SI	EM B_Corr_Kl_Des	Electromagnetic bias correction (Ku)(Gaspar)	10"3 m
81	2	SI	DR_SWH_Att_K_Des	Attitude correction (Ku)	10'3 m
82	2	SI	DR_SWH_Att_C_Des	Attitude correction (C)	10^{-3} m
83	2	I	SigmaO_K_Des	BackScatter coefficient (Ku)	10^{-2} dB
84	2	I	SigmaO_C_Des	BackScatter coefficient (C)	10^{-2} dB
85	2	SI	H_EOT_CSR_Des	Elastic ocean tide (CSR 3.0)	10^{-3} m
86	2	SI	H_EOT_FES_Des	Elastic ocean tide(FES 95.2)	10"3 m
87	2	SI	H_LT_CSR_Des	Tidal loading effect (CSR 3.0)	103m
88	2	SI	H_Set_Des	Solid earth tide	10^{-3} m
89	1	SI	H_Pol_Des	Geocentric pole tide	10"3 m
90	1	I	Wind_Sp_Des	Wind speed (from altimeter sigma0)	'0^{-1} m/s
91	1	BF	Geo_Bad_1_Des	Ocean/land/ice indicator	/
92	1	BF	Geo_Bad_2_Des	Rain/tide conditions	I
93	1	SI	Dry_Err_Des	Quality index on Dry_Corr_Des	/
94	1	SI	Dry1_Err_Des	Quality index on Dry1_Corr_Des	I
95	1	SI	Dry2_Err_Des	Quality index on Dry2_Corr_Des	I
96	1	SI	Wet_H_Err_Des	Quality index on Wet_Corr_Des, Wet1_Corr_Des and Wet2_Corr_Des	I
97	1	SI	Iono_Dor_Bad_Des	Quality index on Iono_Dor_Des	/
98	1	BF	Ind_RTK_Des	POSEIDON ground retracking indicator	
99	40		Spares		

6. HEADERS ELEMENTS

6.1 *Header Element Description Format*

Elements of headers are generally characterized by the following items:

Definition	Eiement 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, UTC1, UTC2 or none (/)
Minimum value	Typical or approximate minimum eiement value.
Maximum value	Typical or approximate maximum element value.
Nominal value	Typical or approximate nominai element value.
Default value	Eiement value when the measurement is not available or the eiement is not computable ("flag value").
Comment	Other comment.

6.2 *Header Elements (in alphabetical order)*

There are four headers found in the Merged GDR CD-ROM. Many of the parameters are unique to a particular header and are therefore given unique names. There are many parameters with the same format and meaning which are common to more than one header and therefore are given a common name. An exampie of the latter is Build_ID which gives the identification of the software version used to generate the fiie to which the header refers. The value will be different for each header as the generating software is different, but the format is the same.

For clarity, the headers where each parameter is found is given in parentheses after the parameter name. For exampie, Build_ID (CD, Cycle, Pass, XNG) where

CD=	CD-ROM header
Cycle =	Cycle header
Pass =	Pass file header (first 33 records of the Pass file)
XNG =	Crossing Point fiie header (first 18 records of the crossing point file)

Build_Id (CD, Cycle, Pass, XNG)

Definition	Reference of the document describing the software used to produce this file.
Eiement type	string
Storage type	Character
Size	21
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	JPL D-III 14 mm/dd/yy
Default value	N/A

Comment	This element provides the identifier of the release description document used to create this product. The format for this element is "PGS MGDR x.y" where:
x	Major software release version number
Y	Minor software release subversion number

Calib_R_Corr_C_TOPEX (Pass)

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	**NIA**
Default value	
Comment	This element appears only when the file contains TOPEX data. When not computable, ASCII spaces (blanks) are used.

Calib_R_Corr_K_TOPEX (Pass)

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	-99999
Maximum value	99 999
Nominal value	N/A
Default value	
Comment	This element appears only when the file contains TOPEX data. When not computable, ASCII spaces (blanks) are used.

CCSD... (CD, Cycle, Pass, XNG)

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	CCSD...
Default value	N/A
Comment	A SFDU label is coded as two lines. Therefore 2 elements are present per label, one element per line. 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 " CCSDS header, the first element starts with the letters "CCSD$$MARKER" and the second element with "CCSD3RF" (class R label).

CNES_Orbit_Filename (Pass)

Definition	Name of the CNES orbit file used in producing this data product.
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	EPHTE1...
Default value	
Comment	This element provides information on the source, date, version, etc... of the CNES orbit file used in producing this data product followed by the UTC1 format date the orbit file was produced. ASCII spaces '(blanks) are used when this file is not available.

This element specifies ASCII file name. The format for this element is "EPHTE1ttjjjjjkkx;vv yyyy-dddThh:mm:ss" and where:

tt	being T1 or T2 depending on which DORIS instrument is on
jjjjj	the Julian date (referred to January 1, 1950, OOh OOmn 00.0s)
kk	being 00, 01 or 10 00= file starts at midnight' and ends at midnight' 01 = file starts during the day (after midnight) and ends at midnight' 10= file starts at midnight' and ends during the day (before midnight)
x	orbit quality [see the Orbit_Qual_CNES element]
w	file version number

yyyy-dddThh:mm:ss UTC1 format date for the generation of the orbit file named.

CORIOTROP_File_ld (Pass)

Definition	Name of the COR1OTROP file used in producing this data product.
Element type	String
Storage type	Character
Size	38
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	CTIOG1TP...
Default value	
Comment	**This** element provides information on the source, date, version, etc... of the CORIOTROP file used in producing this data product followed by the UTC1 format date the CORIOTROP file was produced. ASCII spaces (blanks) are used when this file is not available.

This element specifies ASCII file name. The format for this element is: "CT10G1TPjjjjj000; w yyyy-dddThh:mm:ss1" and where:

jjjjj	the Julian date (referred to January 1, 1950, 00h 00mn 00.0s)
w	the version number (coded as 1 or 2 characters)

yyyy-dddThh:mm:ss. UTC1 format date for the generation of the orbit file named.

Crossover_Count (XNG)

Definition	Number of crossover points identified in the current crossover points file.
Element type	Integer
Storage type	Character

' Start at midnight means 140 seconds before midnight,

[2] End at midnight means 1400 seconds after midnight.

Size	5
Unit	I
Minimum value	O
Maximum value	9,000
Nominal value	N/A
Default value	N/A
Comment	This number should not exceed 9,000.

Crossover_Cycle (CD)

Definition	**Name** of the crossover points files recorded on this CD ROM.
Element type	String
Storage type	Character
Size	12
Unit	I
Minimum value	N/A
Maximum value	N/A
Nominal value	MGxccc.XNG
Default value	N/A
Comment	Two ten-day repeat cycle products are recorded on the CD ROM.
This element specifies ASCII file name.	The format for this element is "MGxccc.XNG" and where:
x	Generation letter
ccc	the cycle number

Cycle_Count (CD)

Definition	Number of cycles recorded on this CD ROM.
Element type	Integer
Storage type	Character
Size	1
Unit	I
Minimum value	1
Maximum value	**2**
Nominal value	N/A
Default value	N/A
Comment	Nominally, two ten-day repeat cycle products are recorded. If one cycle of a pair is missing, only one cycle will be present on the CD ROM.

Cycle_Number (Cycle, Pass, XNG)

Definition	Cycle number.
Element type	Integer
Storage type	Character
Size	3
Unit	I
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 (CD, Cycle, Pass, XNG)

Definition	**Name of the reference handbook.**
Element type	**string**
Storage type	**Character**

Size	21
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	JPL D-11007 mm/dd/yy
Default value	N/A
Comment	This element provides the document of the software interface specification that describes this file. The format for this **element is "JPL D-nnnn dd/mm/yy"** where nnnn is the JPL "D" number which can be ordered from JPL Vellum Files (818) 354-6222. The mm/dd/yy is the date of issue of the document version current when the header was generated. Documents will be different for different data types.

Data_Type (Pass)

Definition	Product type.
Element type	String ˙"
Storage type	Character
Size	6
Unit	/
Minimum value	N/A
Maximum value	NJA
Nominal value	MGDR
Default value	N/A
Comment	This element specifies the type of data that constitutes this product. Valid type is "MGDR" during the operational phase.

Director)_Cycle (CD)

Definition	Directory name.
Element type	String
Storage type	Character
Size	7
Unit	I
Minimum value	N/A
Maximum value	N/A
Nominal value	MGx_ccc
Default value	N/A
Comment	As many directories as the recorded number of cycle (see Cycle_Count element) may appear on a CD ROM. Therefore one or two or three of this element are present. A directory contains all products of one ten-day repeat cycle. This element specifies ASCII directory name. The format for this element is "MGx_ccc" where:
x	the generation letter (1 character) [see Generation_Letter element]
ccc	the cycle number (3 characters) [see Cycle_Number element]

End_Cycle_Number (CD)

Definition	Cycle 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 **Nominally, two** tenday repeat cycle products are recorded on the CD ROM.

End_Pass_.Number (Cycle)

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	I
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 tenday 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 (Pass)

Definition	East longitude at which this pass crosses the Equator.
Element type	Real
Storage type	Character
Size	10
Unit	degree
Minimum value	0.000000
Maximum value	359.999999
Nominal value	**N/A**
Default value	**N/A**
Comment	**This** element is characteristic of the satellite orbit.

Equator_Time (Pass)

Definition	UTC date and time at which this pass crosses the Equator.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1992-001 TOO: OO:OO[.OOOOOO]
Maximum value	9999 -366T23:59:60[.999999]
Nominal value	NIA
Default value	N/A
Comment	This element is characteristic of the satellite **orbit**.

GDR_M_Cycle_Header-N ame **(XNG)**

Definition	Name of the merged GDR header file used in producing this crossover points product.
Element **type**	**String**
Storage type	Character
Size	12
Unit	**/**
Minimum value	**N/A**
Maximum value	**N/A**
Nominal value	**MGxccc.HDR**
Default value	**N/A**

Comment	**This element provides information** on the source, date, version, etc... of the merged GDR header file used in producing this data product. This element specifies ASCII file name. The format for this element is "MGxccc.HDR" and where:
x	Generation letter
ccc	the cycle number

Generation_Letter (CD)

Definition	Generation letter.
Element type	String
Storage type	Character
Size	1
Unit	/
Minimum value	A
Maximum value	Z
Nominal value	N/A
Default value	N/A
Comment	This element is "B" for MGDR second generation products.

Generating_Software_Name (Cycle, Pass, XNG)

Definition	Name of the software generating this product file.
Element type	String
Storage type	Character
Size	50
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	GDRM
Default value	N/A
Comment	The field is padded with blanks to make 50 characters

Header_Cycle (2) (CD)

Definition	Name of the MGDR cycle header files recorded on this CD ROM.
Element type	String
Storage type	Character
Size	12
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	MGxccc.HDR
Default value	N/A
Comment	Nominally, two ten-day repeat cycle products are recorded. Therefore one or two of this element are present. This element specifies ASCII file name. The format for this element is "MGxccc.HDR" and where: x Generation letter ccc the cycle number

NASA_Orbit_Filename (Pass)

Definition	**Name** of the NASA **orbit** file used in producing this data product.
Element type	**String**
Storage type	**Character**
Size	**38**
Unit	**/**

Minimum value	**N/A**
Maximum value	**N/A**
Nominal value	**NASAPOE...**
Default value	
Comment	**This eiement provides information** on the source, data, version, etc... of the NASA orbit fiie used in producing this data product followed by the UTC1 format date the orbit file was produced. ASCII spaces (blanks) are used when this file is not available.

There is normally only one NASA POE file per cycle and it is named as shown in case 1 below. Maneuvers are nominally performed at the ends of cycles so there is no need to produce two separate files describing orbit before and after the maneuver.

However, when a maneuver occurs within a cycle, two NASA POE files are needed and are named as shown in case 2 below.

This element specifies ASCII file. There are two formats possible for this field:

Case 1) "NASAPOECCC.HDR;W yyyy-dddThh:mm:ss"

Case 2) "NASAPOEccc_xx.HDR;vv yyyy-dddThh:mm:ss"

ccc	the cycle number
w	the version number (coded as 1 or 2 characters)
xx	sequence number of POE file 01 = from beginning of cycle to maneuver 02= from maneuver to end of cycle
yyyy-dddThh:mm :ss	is the UTC1 format date for the generation of the file named.

Orbit_Qual_CNES (Pass)

Definition	indicator about CNES orbit quality.
Element type	String
Storage type	Character
Size	1
Unit	I
Minimum value	A
Maximum value	G
Nominal value	C
Default value	
Comment	This element comes from the CNES orbit file used in producing this data. 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_Qual_NASA (Pass)

Definition	Indicator about NASA orbit quality.
Element type	String
Storage type	Character
Size	11
Unit	/
Minimum value	*o*
Maximum value	N/A
Nominal value	N/A
Default value	

Comment	**This element comes from the NASA orbit header file** used in producing **this** data otherwise. ASCII spaces (blanks) are used when this **file** is **not** available. The value can be one of three forms "PASS **n.nnn** " **"MARG n.nnn** " "FAIL **n.nnn** " where **n.nnn** is floating point type representation of orbit quality. Current defining limits are: Pass >1.7 Marginal **1.4 to 1.7** Fail <1.4

Package_Data_End_Time (CD, Cycle)

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	**1992-001T00:00:00.000000**
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 (CD, Cycle)

Definition	**ITC** 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	1992-001**T00: 00:00.000000**
Maximum value	**9999 -366T23:59:60 .999999**
Nominal value	**NJA**
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 (Cycle)

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	1
Maximum value	254
Nominal value	**N/A**
Default value	NJA
Comment	A pass is half a revolution, from minimum/maximum to maximurrdminimum 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 (Pass)

Definition	Number of altimeter records identified in the current pass file.
Element type	integer
Storage type	Character
Size	4
Unit	/
Minimum value	1
Maximum value	3400
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_Fiie_Data_Type (CD, Cycle, Pass)

Definition	Product type.
Element type	String
Storage type	Character
Size	6
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	MGDR
Default value	N/A
Comment	This element specifies the type of data that constitutes this product. Valid type is "MGDR" for the operational phase.

Pass_File_Deiimiter (Cycle)

Definition	Fiie delimiter of the pass-fries.
Eiement 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 the method by which the pass files are delimited.

Pass_File_Protocol (Cycle)

Definition	File protocol of the pass-files.
Element type	String
Storage type	Character
Size	4
Unit	I
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 (Pass)

Definition	Pass number.

Element type Integer
Storage type Character
Size 3
Unit I
Minimum value 1
Maximum value 254
Nominal value N/A
Default value
Comment A pass is half a revolution, from minimum/maximum to maximurrVminimum 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 (see the Rev_Number element). 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 (Pass)

Definition Name of the GDR-P pass-file used in producing this data product.
Element type String
Storage type Character
Size 38
Unit I
Minimum value N/A
Maximum value NJA
Nominal value GDR0G2TP...
Default value
Comment This element provides information on the source, date, version, etc... of the GDR-P pass-file used in producing this data product followed by the UTC1 format date the pass file was produced. ASCII spaces (blanks) are used when this file is not available.

This element specifies ASCII file name. The format for this element is "GDR0G2TPjjjjjppp.;vv yyyy-dddThh:mm:ss" where:

jjjjj the Julian date (referred to January 1, 1950, 00h 00mn 00.0s)
PPP the pass number
w the version number (coded as 1 or 2 characters)
yyyy-dddThh:mm:ss is the UTC1 format date for the generation of the file named.

POSEIDON_Range_Bias (Pass)

Definition Value of the POSEIDON range bias.
Element type String
Storage type Character
Size 8
Unit cm
Minimum value N/A
Maximum value N/A
Nominal value *0*
Default value N/A
Comment This element provides the external calibration range bias of the POSEIDON altimeter.

Producer_Agency_Name (CD, Cycle, Pass, XNG)

Definition Producer agency name.
Element type String
Storage type Character
Size 4

Unit I
Minimum value N/A
Maximum value N/A
Nominal value NASA
Default value N/A
Comment This element provides the name of the government agency producing this product file.

Producer_Institution_Name (CD, Cycle, Pass, XNG)

Definition	Producer institution name.
Element type	String
Storage type	Character
Size	5
Unit	/
Minimum value	NJA
Maximum value	N/A
Nominal value	JPL
Default value	N/A
Comment	This element provides the name of the institution associated with the production of this product file. The nominal value is "JPL "t that is, the characters JPL followed by two blanks.

Product_Create_End_Time (CD, Cycle, Pass, XNG)

Definition	UTC date and time at which this product file ended to be generated.
Element type	String
Storage type	Character
Size	17
Unit	UTC1
Minimum value	1992-001 T00:00:00
Maximum value	9999 -366T23:59:60
Nominal value	N/A
Default value	N/A
Comment	This element specifies the local time of the end of the activity which generated this product file.

Product_Create_Start_Time (CD, Cycle, Pass, XNG)

Definition	UTC date and time at which this product file started to be generated.
Element type	String
Storage type	Character
Size	17
Unit	UTC1
Minimum value	1992-O01TOO:OO:O0
Maximum value	9999-366T23 :59:60
Nominal value	N/A
Default value	N/A
Comment	This element specifies the local time of the beginning of the activity which generated this product file.

Reference (1 to 254) (Cycle)

Definition	Name of the pass-files associated to the cycle from which this file refers to.
Element type	String
Storage type	Character
Size	12
Unit	I

Element type	Integer
Storage type	Character
Size	3
Unit	/
Minimum value	1
Maximum value	999
Nominal value	N/A
Default value	N/A
Comment	Nominally, two tenday repeat cycle products are recorded.

Start_Pass_Number (Cycle)

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	I
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 [see the Rev_Number element]. 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 (Pass, XNG)

Definition	UTC reference date and time.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	N/A
Maximum value	N/A
Nominal value	1956-OO1 TOO: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 micro- second, Preferred zero point is January 1, 1958 (OOh 00m 00.0s).

Time_First_Pt (Pass)

Definition	UTC date and time of the first data point in the current pass.
Element type	string
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1992-001 TOO:OO:OO.OOOOOO
Maximum value	9!399-366T23:59:60 .999999
Nominal value	N/A
Default value	NJA
Comment	

Time_Last_Pt (Pass)

Definition	UTC date and time of the last data point in the current pass.
Element type	String
Storage type	Character
Size	24
Unit	UTC2
Minimum value	1992-001TOO:OO: O0.000000
Maximum value	9999-366T23:59:60 .999999
Nominal value	N/A
Default value	N/A
Comment	

TOPEX_Pass_File_id (Pass)

Definition	Name of the GDR-T pass-file used in producing this data product.
Element type	String
Storage type	Character
Size	15
Unit	I
Minimum **value**	N/A
Maximum **value**	N/A
Nominal value	C . . .
Default value	
Comment	**This element provides information on the source, date, version, etc... of the GDR-T pass-file** used in producing this data product. ASCII spaces (blanks) are used when this file is not available.

This element specifies ASCII file name. The format for this element is "CcccPppp.dat;vv" and where:

ccc	the cycle number
PPP	the pass number
w	the version number (coded as 1 or 2 characters)

T/P_SigmaO_Offset (Pass)

Definition	Value of Ku band Sigma0 offset for between POSEiDON and TOPEX.
Eiement 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 to the backscattering coefficient to make TOPEX and POSEIDON values consistent.

TOPEX_Range_Bias (Pass)

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 of the TOPEX altimeter.**

Type (Cycle)

Definition	Data type.
Element type	String
Storage type	Character
Size	50
Unit	/
Minimum value	N/A
Maximum value	N/A
Nominal value	MGDR
Default value	N/A
Comment	This element specifies the type of data that constitutes this product.. Valid type is "GDR" for MGDR during the operational phase.

Version_Number (CD)

Definition	Version number.
Element type	Integer
Storage type	Character
Size	1
Unit	/
Minimum value	1
Maximum value	9
Nominal value	N/A
Default value	N/A
Comment	This element starts from one. It is incremented if data products are reissued.

Volume_Id (CD)

Definition	CD ROM volume identifier.
Element type	**String**
Storage type	**Character**
Size	**11**
Unit	**/**
Minimum value	**N/A**
Maximum value	**N/A**
Nominal value	**POM...**
Default value	**N/A**
Comment	**This element specifies ASCII** file name. The format for this element is: POMGx_Vol_v and where:
x	the generation letter [see the Generation_Letter element]
vol	the CD ROM volume number
v	the version number [see the Version_Number element]

NOTE: the AVISO product uses the same volume label except the "PO" is replaced by "AV"

7. MGDR ELEMENTS

7.1 *MGDR Element Format*

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

Definition	Eiement definition
Element type	An eiement 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, UTC1, UTC2 or none (/)
Minimum value	Typical or approximate minimum eiement value.
Maximum value	Typical or approximate maximum eiement value.
Nominal value	Typical or approximate nominal element value.
Default value	Eiement 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 (/).

7.2 MGDR Elements (in alphabetical order)

AGC_C

Definition	C band, Automatic Gain Control (AGC), 1 per frame fit.
Eiement type	integer
Storage type	Unsigned
Size	2
Unit	0.01 decebei
Minimum value	O
Maximum value	6400
Default value	65535
Comment	This eiement exist oniy 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.
Eiement type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	O
Maximum value	6400
Default value	65535

Comment	**This element exists for TOPEX and POSEIDON data. Note that this value depends on the altimeter. A default value is** given when the AGC cannot be computed (no valid high-rate points).
Quality flags	(TOPEX only) AGC_Pts_Avg,Alt_Bad_2(bit # 6)

AGC_Pts_Avg (Quality flag)

Definition	Number of points used to compute the one per frame Automatic Gain Control (AGC) average.
Element type	Integer
Storage type	Signed
Size	1
Unit	l
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.

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 2 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	32767
Comment	This element exists for TOPEX and POSEIDON data. Non rejected high-rate values are only used to compute this element and a minimum of 2 good points is required.
Quality flags	(TOPEX only) AGC_Pts_Avg

Alt_Bad_1 (Quality flag)

Definition	Set of flags n_1 on TOPEX and POSEIDON measurement conditions.
Element type	Bit field
Storage type	Bit

Size 1
Unit /
Minimum value O
Maximum value 255
Default value 255
Comment This set of flags exists and is different for TOPEX and POSEIDON data. When TOPEX is on, it indicates if problems were detected with the altimeter sensor corrections, dual frequency ionospheric correction or in compressing high-rate measurements. Bits are defined as follows:

Bits	Definition
0	Compression used (O= fit, 1 = Median)
1	Valid points from fit (O= OK, 1 = Too many invalid)
2	High-rate waveforms (O= OK, 1 = Too many out of limit)
3	"TFLAG" (Fine track, EML, AGC Gate) (o= OK, 1 = not in fine, EML tracking)
4	Slope of fit (O= OK, 1 = Too steep)
5	One per second altimeter range quality (O= OK, 1 = RMS >15 cm)
6	Dual frequency ionospheric correction (O= OK, 1 = Iono_Bad indicates too many errors
7	Total altimeter range correction O -Ku and C values OK 1- Problem detected in Ku or (and) C value(s).

NOTE: For all TOPEX data during cycles 1-9, Alt_Bad_1 bit 7 was always set =1

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	Definition
O-1	Altimeter range (O= OK, 1 = Possible error, 2 = Bad data)
2-3	Significant Wave Height (O= OK, 1 = Possible error, 2 = Bad data)
4-5	Backscatter coefficient (O= 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 Bit field
Storage type Bit
Size 1
Unit I
Minimum value o
Maximum value 255
Default value 255
Comment This set of flags exists and is different for TOPEX and POSEIDON data. When TOPEX is on, if indicates if any of the pointing/sea-state conditions were invalid or sigma0 was out of limits. Bits are defined as follows:

Bits	Definition
0	Spare (0)
1	Ku range correction (O= Done, 1 = Not done)

2	C range correction (O= Done, 1 = Not done)
3	C SWH correction (O= Done, 1 = Not done)
4	Ku SWH correction (O= Done, 1 = Not done)
5	C band - AGC correction or sigma0 0- Good values 1- AGC correction not done or sigma0 out of range
6	Ku band - AGC correction or sigma0 O - Good values 1- AGC correction not done or sigma0 out of range

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:

Bits	Definition
O-1	Altimeter range correction (O= OK, 1 = Possible error, 2 = Bad data)
2-3	Significant Wave Height correction (O= OK, 1 = Possible error, 2 = Bad data)
4-5	Backscatter coefficient correction (O= 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	I
Minimum value	O
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:

w	Definition
0	POSEIDON on
1	TOPEX on

Atm_Att_SigO_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	o
Maximum value	170
Default value	255
Comment	This element exists 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	o
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**

Att_Wvf

Definition	Off-nadir angle estimated from the measured waveform. The off-nadir angle is the mne angle between altimeter electrical axis and nadir, nadir being defined as the normal to the reflecting surface. NOTE: due to early pointing problems (cycles 1-8 see section 3.8) if is very important to check for this parameter being within the maximum value.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.01 degree
Minimum value	o
Maximum value	45
Default value	255
Comment	This element exists 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 **altimeter** tracker range for center of mass movement caused by solar array motion and satellite roll and pitch. If this value is used, it must be added to the range to get **corrected** range (or subtracted from sea surface height). The correction should be on the order of one or two centimeters.
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeters
Minimum value	-128
Maximum value	**N/A**
Default value	127
Comment	This element exists for TOPEX and POSEIDON data.
Quality flags	**N/A**

Current_Mode_1 (Telemetry flag)

Definition	**Altimeter current mode n_1(TOPEX' first frame).**
Element type	**Bit field**

storage type Bit
Size 1
Unit /
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. When TOPEX is on, if indicates the altimeter current mode for the first half frame. Bits are defined
as follows:

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

Current_Mode_2 (Telemetry flag)

Definition Attimeter current mode n_2 (POSEIDON TOPEX' second frame).
Element type Bitfield
Storage type Bit
Size 1
Unit I
Minimum value O
Maximum value 255
Default value N/A
Comment This element exists 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 to altimeter tracker range for Significant Wave Height (SWH) and attitude effects at C band. This is already incorporated in Net_Instr_R_Corr_C.
Element type Integer
Storage type Signed
Size 2
Unit millimeter
Minimum value -400

Maximum value	*400*
Default value	*32767*
Comment	This element exists only for TOPEX measurements. A **default** value is given when POSEIDON is on. Its value is added to instrument range to get correct range.
Quality flags	**ALT_Bad_2** (bit # 2)

DR_SWH_Att_K

Definition	Correction to altimeter tracker range for Significant Wave Height **(SWH)** and attitude effects at Ku band. This is already incorporated in **Net_Instr_R_Corr_K**.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	***-400***
Maximum value	***400***
Default value	***32767***
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Its value is added to instrument range to get correct range.
Quality flags	**ALT_Bad_2 (bit** # 2)

Dry_Corr

Definition	Dry meteorological tropospheric correction interpolated to the altimeter measurement time.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	***-3000***
Maximum value	-2000
Default value	32767
Comment	This element is reported for TOPEX and POSEIDON data. It corresponds a time interpolation between the dry tropospheric correction computation using the 2 meteorological fields surrounding the **altimeter** measurement epoch **(Dry1_Corr** and **Dry2_Corr** - see below). The interpolation is done between the times of the meteorological fields to the altimeter measurement time. 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	**Dry_Err**

Dry1_Corr

Definition	**Dry** meteorological tropospheric correction from the **first** (early) **CORIOTROP** field.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	***-3000***
Maximum value	***-2000***
Default value	32767
Comment	This element is reported for TOPEX and POSEIDON data. ECMWF fields are generally generated for O, 6, 12 and 18 hours UTC. The **CORIOTROP**

file contains a dry correction estimate based on the two ECMWF fields nearest in time to the **timetag**. It is the dry tropospheric correction as calculated for this latitude/longitude from the early field in the **CORIOTROP** file. 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. Normally, one should use **Dry_Corr** for this **correction**.

Quality flags — Dry I_Err

Dry2_Corr

Definition	Dry meteorological tropospheric correction from the second **(late) CORIOTROP** field.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3000
Maximum value	-2000
Default value	32767
Comment	See **Dry1_Corr**
Qualify flags	**Dry2_Err**

Dry_Err (Quality flag)

Definition	Quality index on **Dry_Corr**
Element type	Integer
Storage type	Signed
Size	1
Unit	I
Minimum value	0
Maximum value	9
Default value	127
Comment	This element is **reported** for TOPEX and POSEIDON data. A **default** value is given when the **CORIOTROP** file is not available or when both **Dry1_Err** and **Dry2_Err** are default values. Its value ranges from O to 9 with lower ranges when this element is valuable and higher ranges when if is not valuable. The value is the larger of the two values describing the two meteorological fields.

Dry I_ 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 reported for TOPEX and POSEIDON data. A **default** value is **given** when the field (i.e., **CORIOTROP)** is not available. Its value ranges from O to 9 with lower ranges when this element is valuable and higher ranges when if 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	See **Dry1_Err**.

Dtim_Bias

Definition	Net time tag correction,
Element type	Integer
Storage type	Signed
Size	4
Unit	microsecond
Minimum value	-5000
Maximum value	-4000
Default value	32767
Comment	This element exists for TOPEX and POSEIDON data. It represents the internal delay (-50 microseconds) plus height delay (pulse travel time) (-4.45 milliseconds). The attimeter internal delay is the difference between the altimeter frame time tag and the average one per frame time (see Tim_Moy_l, Tim_Moy_2, **Tim_Moy_3)**.

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	475494
Maximum value	560000
Default value	N/A
Comment	This element exists for TOPEX and POSEIDON data. Its value is added to the corrected altimeter science frame time tag to produce the average one per frame time of the measurement (see **Tim_Moy_1, Tim_Moy_2, Tim_Moy_3)**.

Dtim_Pac

Definition	Elapsed time between the 10 per second ranges.
Element type	Integer
Storage type	Signed
Size	4
Unit	microsecond
Minimum value	50052
Maximum value	50052
Default value	NIA
Comment	This element exists for TOPEX and POSEIDON data. The complete ten per second elapsed time can be obtained with respect to unit systems as follows:

10/s Elapsed Time (j) = 10’* (1/2 Elapsed Time* - **Dtim_Mil** + 2 (j-l) **Dtim_Pac** + 0.5 **Dtim_Pac)**
.cf, Tim_Moy_l, **Tim_Moy_2, Tim_Moy_3** to compute the **l/s** Elapsed Time.

EMB_Gaspar

Definition	Ku band, one per frame range correction for electromagnetic bias *(EMB)* computed using Gaspar algorithm.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1200
Maximum value	0
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. The algorithm used to produce it, is described in Sec 4.5.3. The electromagnetic bias value (negative) has to be added to instrument range to get correct range.
Quality flags	I

EMB_Walsh

Definition	Ku band, one per frame range correction for electromagnetic bias (EMB) computed using the Walsh algorithm.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1200
Maximum value	0
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. The algorithm used to produce it, The algorithm used to produce it, is described in Sec 4.5.3. The electromagnetic bias value (negative) has to be added to instrument range to get correct range.
Quality flags	Fl_EMB_K2

FL_Att (Quality flag)

Definition	Flag indicating which attitude (Att_Wvf or Att_Ptf) is used for altimeter tracking correction.
Element type	Integer
Storage type	Signed
Size	1
Unit	I
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 (always used when TOPEX is on)

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 seoondary altimeter channels.**
Element type	Bit field
Storage type	Bit
Size	1
Unit	I

Minimum value	11 (hexadecimal)
Maximum value	55(hexadecimal)
Default value	255
Comment	This element exists only for TOPEX measurements. A default value is given when POSEIDON is on. Bits O-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	Bit field
Storage type	Bit
Size	1
Unit	I
Minimum value	0
Maximum value	255
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. Bits are defined as follows:

Bits	Definition
0	Deep water flag O - Deep water 1- Shallow water
1	Land/water flag for the altimeter O - Water 1- Land
2	Land/water flag for the TMR O - Water 1- Land
3	Ice surface as detected by the TMR O- Noice 1- Ice
4-7	Spares (0)

Geo_Bad_2 (Quality flag)

Definition	Set of flags indicating the rain and tide conditions.
Element type	Bit field
Storage type	Bit
Size	1
Unit	/
Minimum value	0
Maximum value	255
Default value	NJA
Comment	This element is computed for TOPEX and POSEIDON data. Bits are defined as follows:

Bits	Definition
0	Rain/Excess liquid O - Normal 1 - Rain/Excess liquid detected
1,2	CSR 3.0 ocean tide 00- 4 points Valid 01- 3 points Valid 10- 2 points Valid 11- less than 2 points Valid
3,4	FES 95.2

	00- 4 points Valid
	01- 3 points Valid
	10- 2 points Valid
	11- less than 2 points Valid
5-7	Spares (0)

H_Alt

Definition One per second altimeter range. **Attimeter ranges** are corrected for instrumental effects only.
Element type Integer
Storage type Signed
Size 4
Unit millimeter
Minimum value 1,200,000,000
Maximum value 1,400,000,000
Default value 2147483647
Comment This element is computed for TOPEX and POSEIDON data.
Quality flags
For TOPEX data: Nval_Hsat
Rang_SME (bits #O to 9)
Geo_Bad_1 (Bit #1)
Alt_Bad_1 (bits #O to 4, and bit #7)
For POSEIDON data: Nval_Hsat
Rang_SME (bits #0 to 9)
Geo_Bad_1 (bit #1)
Alt-Bad_1 (bits #O and 1)
Alt-Bad_2 (bits #0 and 1)

H_Alt_SME(i)

Definition Difference for high-rate (ten per second) altimeter range from one per second altimeter range (H_Alt). Altimeter ranges are corrected for instrumental effects **only.**
Element type Integer
Storage type Signed
Size 2X1O
Unit **millimeter**
Minimum value **-32768**
Maximum value **32767**
Default value **32767**
Comment **This element is computed for TOPEX and POSEIDON data.**
Quality flags
For TOPEX data: Nval_Hsat
Rang_SME (bits #O to 9)
Geo_Bad_1 (Bit #1)
Alt_Bad_1 (bits #1,2 and 7)
For POSEIDON data: Nval_Hsat
Rang_SME (bits #O to 9)
Geo_Bad_1 (bit #1)

H_EOT_CSR

Definition Height of the elastic ocean tide at the measurement point computed from the University of Texas Center for Space Research model (CSR 3.0). It is the sum of the ocean tide and the loading tide.
Element type Integer
Storage type Signed

Size	2
Unit	millimeter
Minimum value	-15000
Maximum value	15000
Default value	32767
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.
Quality flags	Geo_Bad_2 (bits 1,2)

H_EOT_FES

Definition	Height of the elastic ocean tide at the measurement point computed from "Grenoble" model (FES 95.2) developed by LeProvost. It is the sum of the ocean tide and the loading tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15000
Maximum value	15000
Default value	32767
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.
Quality flags	Geo_Bad_2 (bits 3,4)

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	-300000
Maximum value	300000
Default value	2147483647
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. See Sec 4.3.
Quality flags	I

H_LT_CSR

Definition	Ocean loading effect on the tide at the measurement point computed from the University of Texas, Center for Space Research model (CSR 3.0).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-500
Maximum value	500
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. It is included in the ocean tide height, i.e. H_EOT_CSR and H_EOT_FES].
Quality flags	Geo_Bad_2 (bits 1,2)

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	-300000
Maximum value	300000
Default value	2147483647
Comment	This element is computed for TOPEX and POSEIDON data. This element is deduced from Rapp et al mean sea surface height fields computed using Geos3, Sea sat, Geosat and TOPEX/POSEIDON altimeter data. See Sec 4.4.

H_Ocs

Definition	Ocean depth at the measurement point.
Element type	Integer
Storage type	Signed
Size	2
Unit	meter
Minimum value	-15000
Maximum value	0
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data from ETOP05 database (NOAA, Boulder, Colorado)
Quality flags	/

H_Pol

Definition	Geocentric pole tide height at the measurement point.
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.
Quality flags	/

HP_Sat

Definition	One per second CNES attitude of satellite center of mass above the reference ellipsoid.
Element type	Integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1200000000
Maximum value	1400000000
Default value	2147483647
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when the CNES orbit is not available.

HP_Sat_Hi_Rate

Definition	Difference for high-rate (ten per second) CNES satellite attitude from one **per** second CNES satellite attitude **(HP_Sat)**.
Element type	Integer
Storage type	Signed
Size'	2X1O
Unit	millimeter
Minimum value	-32768
Maximum value	32767
Default value	32767
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.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	1000
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. It is calculated using **Cartwright** tables and consists of the second and third degree constituents. The permanent tide (zero frequency) is not included.
Quality flags	/

IMANV (Instrument flag)

Definition	Maneuver indicator.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	0
Maximum value	8
Default value	127
Comment	This element exists only for POSEIDON measurements. A **default** value is given when TOPEX is on. The logistic **orbit** is not normally used in MGDR records, only the precise **orbit**. Therefore, values of O, 1 and 2 are not expected to be encountered.

Value	Definition
0	A maneuver is **occrring** (logistic orbit)
1	Adjusted when no maneuver (logistic **orbit)**
2	Extrapolated when no maneuver (logistic edit)
3	Accuracy better than 2 cm rms (precise orbit)
4	Accuracy below 7.5 cm rms (precise orbit)
5	Accuracy below 13 cm rms (precise orbit)
6	Accuracy below 20 cm rms (precise **orbit)**
7	Accuracy worse than 20 cm rms (precise **orbit)**
8	No Dons data available (precise orbit)

Ind_Pha (Telemetry flag)

Definition	POSEIDON retracker 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 (Telemetry flag)

Definition	POSEIDON ground retracker indicator
Element type	Integer
Storage type	Signed
Size	1
Unit	I
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	Retracing done
1	Retracing not done

Instr_State_DORIS (Quality flag)

Definition	Flag indicating DORIS instrument state, i.e., if an ionospheric correction has been computed.
Element type	Integer
Storage type	Unsigned
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	Bit field
Storage type	Bit
Size	1
Unit	I
Minimum value	O
Maximum value	127
Default value	N/A

Comment	**This element exists for TOPEX and POSEIDON data. Bits are** defined as follows:
Bits	Definition
o-4	Spares (0)
5	TMR21 A status (O= On, 1 = Off)
6	TMR21 B Status (O= Off, 1 = On)
7	Spare (0)

lnstr_State_TOPEX (Instrument flag)

Definition	Flag indicating variis states of TOPEX altimeter
Element type	Bit field
Storage type	Bit
Size	1
Unit	/
Minimum value	o
Maximum value	127
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 (O= On, 1 = Off)
1	C bandwidth (O= 320 MHz, 1 = 100 MHz)
2	Ku band status (O= On, 1 = Off)
3	Altimeter operating (0 = A, 1 = B)
4-7	Spares (0)

INV_BAR

Definition	Inverse barometric effect correction
Element type	Integer
Storage type	Signed
Size	2
Unit	mm
Minimum value	-1300
Maximum value	3105
Default value	32767
Comment	This element is calculated for TOPEX and POSEIDON measurements. The default value is given when Dry_Corr = default value. INV_BAR has to be added to instrument range or added to sea surface height to correct for the static inverse barometric effect. Note: this correction is not always valid - see 4.8.
Quality Flags	Dry_Err

lono_Bad (Quality flag)

Definition	Quality index on lono_Cor
Element **type**	Bit field
Storage type	Bit
Size	2
Unit	I
Minimum value	o

Maximum value	8187
Default value	65535
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. It also has information on what part of the digital fitter bank the signal was found (bits 13,14). Bits are defined as follows:

<u>Bits</u>	<u>Definition</u>
o-9	Flags corresponding to the ten per second range values (O= OK, 1 = Bad data)
10	Spare (0)
11	Altimeter engineering preliminary flags set
12	Altimeter science preliminary flags set
13	Ku band fine height flag 0- signal in lower part of digital filter bank 1- signal in upper part of digital filter bank
14	C band fine height flag O - signal in lower part of digital filter bank 1- signal in upper part of digital filter bank
15	Spare (0)

Note that bits #11 and 12 are telemetry flags (e.g., check sum exception, reset detected...), and are used in production of the TOPEX GDRs.

NOTE: This parameter is an exception. The order of bytes that make up this flag is backwards from the usual sense in this product. To read on a UNIX system, do NOT swap the bytes and on a VAX/VMS, system, DO swap the bytes.

Iono_Ben

Definition	One per frame ionospheric correction computed from BENT model.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	O
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. An ionospheric correction has to be added (negative value) to instrument range to get correct range.
Quality flags	**Instr_State_DORIS**

Iono_Corr

Definition	**TOPEX dual-frequency one per frame ionospheric correction.**
Element type	**Integer**
Storage type	**Signed**
Size	**2**
Unit	**millimeter**
Minimum value	**-1000**
Maximum value	**40**
Default value	**32767**
Comment	**This** element exists for TOPEX measurements only. A default value is given when POSEIDON **is on.** An ionospheric correction has to be added to instrument range to correct the range.
Quality **flags**	Alt_Bad_1(bit 6), IonO_Bad (bits O to 9)

Iono_Dor

Definition	One per frame ionospheric correction computed from DORIS data,
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when CORIOTROP data are not available. An ionospheric correction has to be added to instrument range to correct the range.
Quality flags	Instr_State_DORIS, Iono_Dor_Bad

Iono_Dor_Bad

Definition	Quality index on Iono_Dor.
Element type	Integer
Storage type	Signed
Size	1
Unit	I
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 O to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.
Quality flags	/

Lat-Err (Quality flag)

Definition	Quality index between CNES and NASA latitude locations.
Element type	Integer
Storage type	Signed
Size	1
Unit	I
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	-90000000
Maximum value	90000000
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**, the **latitude** is computed from NASA orbif data. A quality flag between CNES and NASA latitudes is reported in the MGDR product (see **Lon_Err**). Positive latitude is north **latitude**.
Quality flags	**Lat_Err**

Len-Err (Quality flag)

Definition	Quality index between CNES and NASA longitude locations.
Element type	integer
Storage type	Signed
Size	1
Unit	l
Minimum value	o
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	o
Maximum value	359999999
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, the longitude is computed from NASA orbit data. A quality fiag between CNES and NASA longitudes is reported in the MGDR product (see **Lon_Err**). The longitude corresponds to the East **longitude** relative to Greenwich meriiian.
Quality flags	**Lon_Err**

Net_Instr_AGC_Corr_C

Definition	C band, net instrument correction to Automatic Gain Control **(AGC)**
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 decibel .
Minimum value	-32766
Maximum value	32767
Default value	32767
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	Ku band, net instrument correction to Automatic Gain Control **(AGC)**
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 decibel
Minimum value	-32768
Maximum value	32767
Default value	32767
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	C **band, net** (summed) instrument correction to range.
Element type	integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	1000
Maximum value	**12000**
Default value	**32767**
Comment	This element exists only for TOPEX measurements. A **default** value is given when POSEIDON is on. This correction is added to instrument range to get correct range.
Quality flags	**Alt_Bad_1** (bit #7)

Net_Instr_R_Corr_K

Definition	Ku band, net (summed) instrument correction to range.
Element type	**Integer**
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	1000
Maximum value	**12000**
Default value	**N/A**
Comment	This element exists for TOPEX and POSEIDON data. This correction is added to instrument range to get correct range. 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** #O and 1)

Net_Instr_.SigO_Corr

Definition	Ku band, net instrument correction to the **backscatter** coefficient **(Sigma0_K)**.
Element type	Integer
Storage type	Signed
Size	2
Unit	**0.01 decibel**
Minimum value	**-200**
Maximum value	**O**
Default value	**32767**

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	C **band, net** (summed) instrument correction to Significant Wave Height **(SWH)**.
Element type	Integer
Storage type	Signed
Size	1
Unit	0.1 meter
Minimum value	-128
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	Ku band, net (summed) instrument correction to Significant Wave Height **(SWH)**.
Element type	Integer
Storage type	Signed
Size	1
Unit	0.1 meter
Minimum value	-128
Maximum value	127
Default value	127
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_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	I
Minimum value	o
Maximum value	10
Default value	**N/A**
Comment	This element exists for TOPEX and POSEIDON data. [See **Rang_SME** for more details].

Rang_SME (Quality flag)

Definition	Set of flags to indicate if high-rate ranges (ten per frame) are believed to be valid or not. For TOPEX data only, it also includes electromagnetic bias flags which are set to zero for good data.
Element type	Bit field
Storage type	Bit
Size ‘	2

Unit	**/**
Minimum value	**/**
Maximum value	**/**
Default value	**N/A**
Comment	**This element exists and is different for TOPEX and POSEIDON data.**

When TOPEX is on, bits are defined as follows:

Bits	Definition
o-9	**Flags corresponding to the ten per second ranges (O= OK, 1 = Bad data)**
10	**Spare (0)**
11	**EMB out of range and consequently** limited
12	EMB calculation from SWH only
13-15	Spares (0)

When POSEIDON is on, **bits** are defined as follows:

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

Range_Deriv

Definition	One per second range derivative.
Element type	Integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	**-3500**
Maximum value	**3500**
Default value	**32767**
Comment	This element exists only for POSEIDON measurements. A default value is given when TOPEX is on.
Quality flags	**Alt_Bad_1** (bits #O and **1**), **Alt_Bad_2** (**bits #0** and **1**)

RMS_H_Alt

Definition	Root Mean Square **(RMS)** of **H_Alt_SME(i)** 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	-32768
Maximum value	32767
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. Non rejected high-rate values are only used to compute this element and a minimum of 3 good points is required.
Quality flags	**Nval_Hsat, Rang_SME (bits** #O to 9)

RMS_Range_Deriv

Definition	Root Mean Square **(RMS)** of the high-rate (ten per second) range derivatives about the fit or average used to obtain the one per frame **value (Vit_Moy)**.
Element type	Integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	**0**

Maximum value	1000
Default value	**32767**
Comment	**This eiemenf** exists only for POSEIDON measurements. A default value is given when TOPEX is on.
Quality flags	**Alt_Bad_1 (bits #0** and 1), **Alt_Bad_2 (bits #0 and 1)**

Sat_Alt

Definition	One per second NASA altitude of satellite center of mass above the reference ellipsoid.
Eiement type	integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1200000000
Maximum value	1400000000
Default value	2147483647
Comment	This element is computed for TOPEX and POSEIDON data. A default value is given when **the NASA orbit is not available.**

Sat_Alt_Hi_Rate

Definition	Difference for high-rate (ten per second) NASA satellite altitude from one per second NASA satellite altitude (Sat_Alt).
Eiement type	Integer
Storage type	Signed
Size	2X1O
Unit	millimeter
Minimum value	-32766
Maximum value	32767
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. These values are needed to perform orbif replacement without having the **original orbit** and software. A default value is given when the NASA orbit is not **available.**

Sigma0_C

Definition	C band, backscatter coefficient computed from AGC_C.
Eiement type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	o
Maximum value	32767
Default value	65535
Comment	This element exists oniy for TOPEX measurements. A default value is given when POSEIDON is on.
Quality flags	**Alt_Bad_2 (bit** #5)

SigmaO_K

Definition	**Ku band,** backscatter **coefficient computed from** AGC_K.
Eiement type	**integer**
Storage type	**Unsigned**
Size	**2**
Unit	**0.01 decibel**
Minimum value	**o**
Maximum value	**4500**

Default value	**65535**
Comment	**This** element exists for TOPEX and POSEIDON data.
Quality flags	
For TOPEX:	**Alt_Bad_2 (bit** #6)
For POSEIDON:	**Alt_Bad_1** (bits #4 and 5)
	Alt_Bad_2 (bits #4 and 5)

SWH_C

Definition	C band, one per frame Significant Wave Height (SWH).
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 meter (NOTE: **MGDR-A** unit was **0.1meter)**
Minimum value	0
Maximum value	65534
Default value	65535 (NOTE: Due to a processing error, this parameter's default value is given as 2550 for cycles 1-132.
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	0.01 meter (NOTE: MGDR-A unit was **0.1meter)**
Minimum value	0
Maximum value	65534
Default value	65535
Comment	This element exists for TOPEX and POSEIDON data. **Its** computation depends on the instrument.
Quality flags	
For TOPEX:	**SWH_Pts_Avg,**
	Alt_Bad_2 (bit #4)
For POSEIDON:	**Alt**_Bad_ I **(bits** #2 and 3)
	Alt_Bad_2 (bits #2 and 3)

SWH_Pts_Avg (Quality flag)

Definition	Number of points used to compute the one per frame SWH average.
Element type	Integer
Storage type	Signed
Size	1
Unit	I
Minimum value	O
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).**

SWH_RMS_C

Definition	Root Mean Square (RMS) of high-rate (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	o
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 2 good points is required.
Quality flags	SWH_Pts_Avg

SWH_RMS_K

Definition	Root Mean Square (RMS) of high-rate (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	o
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 2 good points is required.
Quality flags	SWH_Pts_Avg

Tb_l 8

Definition	Corrected brightness temperature at 18 GHz.
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 degree Kelvin
Minimum value	12000
Maximum value	*29000*
Default value	*32767*
Comment	This element is computed for TOPEX and POSEIDON data.
Quality flags	Geo_Bad_1 (bits #2 and 3), TM R_Bad

Tb_21

Definition	Corrected brightness temperature at 21 GHz.
Element type	Integer
Storage type	Signed
Size	2
Unit	0.01 degree Kelvin
Minimum value	o
Maximum value	29000
Default value	32767
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 degree Kelvin
Minimum value	15000
Maximum value	29000
Default value	32767
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 epochl and the one per frame time of the measurement, day part.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	day
Minimum value	/
Maximum value	I
Default value	NJA
Comment	This element is **computed** for TOPEX and POSEIDON data. The complete one per second elapsed time (days, milliseconds and microseconds) can be obtained as UTC seconds since epoch as follows:

UTC Elapsed Time= Tim_Moy_I '86400+ **Tim_Moy_2/1**,000 + **Tim_Moy_3/1,000,000**

This assumes all values are treated like floating point numbers
TAI Elapsed time= UTC Elapsed Time+ Leap Seconds
where **Leap** Seconds is the number of "UTC **leap** second" since Januarv 1, 1958.

FROM	TO	TOTAL' LEAP SECONDS "
Mission start	June 30, **1993**	27
July 1,1993	June 30, 1994	28
July 1, 1994	Dec 31, 1995	29
Jan 1, 1996	June 30, **1997**	3 0
July 1, 1997	----	31

and so on. In the future, the reader can find out the times and signs (they can be negative) of additional leap seconds by contacting the U.S. National Earth Orientation Service operated by the U.S. Naval Observatory. **(NEOS** Home page is **http://maia.usno. navy.mil)**

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	Unsigned
Size	4
Unit	millisecond
Minimum value	I
Maximum value	/
Default value	**N/A**
Comment	This element is computed for TOPEX and POSEIDON data. See **Tim_Moy_1**.

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	Unsigned
Size	2
Unit	microsecond
Minimum value	/
Maximum value	/
Default value	N/A
Comment	This element is computed for TOPEX and POSEIDON data. See **Tim_Moy_1**.

TMR_Bad (Quality flag)

Definition	Set of flags for brightness temperatures.
Element type	Bit field
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 follows:

<u>Bits</u>	<u>Definition</u>
0-1	00- All channels in "interpolation" mode - Quality = GOOD 01- One or more channels in “proximity” mode - Quality = FAIR 10- One or more channels in “least square” mode - Quality= POOR 11- One or more channels with interpolation failure - Quality= 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	-128
Maximum value	126
Default value	127
Comment	This element is given for POSEIDON data only. A defautt value is **used when** TOPEX is on.

Wet_Corr

Definition	Wet meteorological tropospheric correction interpolated to the **altimeter** measurement time.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
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 defautt 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

Wetl_Corr

Definition	Wet meteorological tropospheric correction from the <u>first</u> (early) field on the CORIOTROP file.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
Comment	This element is computed for TOPEX and POSEIDON data. ECMWF fields are generally generated for O, 6, 12 and 18 hours UTC. The CORIOTROP file contains a dry correction estimate based on the two ECMWF fields nearest in time to the timetag. It corresponds to the wet troposphere 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 defauft value is given when the meteorological fields (i.e., CORIOTROP) are not available or is flagged. 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 from the <u>second</u> (late) field on the CORIOTROP file.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	*0*
Default value	32767
Comment	See Wet1_Corr
Quality flags	Wet_Flag, Wet_H_Err

Wet_Flag (Quality flag)

Definition	Interpolation indicator for Wet_Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	I
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:
<u>Value</u>	<u>Definition</u>
0	No point over land
1	One point at least over land

Wet_H_Err (Quality flag)

Definition	Quality index on **Wet_Corr**.
Element type	Integer
Storage type	Signed
Size	1
Unit	I
Minimum value	o
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 O to 9 with **lower** ranges when this element is valuable and higher ranges when it is not valuable.

Wet_H_Rad

Definition	Radiometer wet tropospheric correction.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	*0*
Default value	32767
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_l (bits #2 and 3), **TMR_Bad**

Wind_Sp

Definition	Wind speed intensity
Element type	Integer
Storage type	Unsigned
Size	1
Unft	0.1 meter per second
Minimum value	7
Maximum value	214
Default value	255
Comment	This element is computed for TOPEX and POSEIDON data. The algorithm used to produce it, is the Modified **Chelton-Wentz** model.
Quality flags	I

8. CROSSOVER POINTS ELEMENTS

The Crossover Points files are distributed separately from the MGDRB but are described here for convenience.

8.1 *Crossover Point Elements Definition Forma*

Elements of the Crossover Files 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.

8.2 Crossover Point Elements (in alphabetical order)

Due to the repetitive nature of the elements in this file, the separate ascending and descending parameters are given a single entry. For example, Dry_Corr_Asc and Dry_Corr_Des are both described in the entry below labeled "Dry_Corr_A/D". There are 6 parameters, all ending in "_Cro" which describe only the crossing point and hence, only occur once per record.

Att_Ptf_A/D

Definition	Ptf-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	O
Maximum value	150
Default value	255
Comment	See Att_Ptf MGDR parameter for details

Att_Wvf_A/D

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.
Eiement type	integer
Storage type	Unsigned
Size	1

Unit	**0.01** degree
Minimum value	o
Maximum value	150
Default value	255
Comment	See **Att_Ptf** MGDR parameter for details

DR_SWH_Att_C_A/D

Definition	Correction 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	32767
Comment	

DR_SWH_Att_K_A/D

Definition	Correction 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	32767
Comment	

Dry_Corr_A/D

Definition	Dry tropospheric correction interpolated at the altimeter measurement . time
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3000
Maximum value	-2000
Default value	32767
Comment	This element **corresponds** to the dry tropospheric correction computation using **respectively** one of the 2 meteorological fields surrounding the **altimeter** measurement epoch (nearest value) and interpolating to measurement time. [See the **Dry_Corr** MGDR parameter for more **details.]**

Dry1_Corr_A/D

Definition	**Dry** tropospheric correction before altimeter measurement .
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-3000
Maximum value	-2000
Default value	**32767**

Comment	This element corresponds to the dry tropospheric correction computation using the first of the 2 meteorological fields surrounding the altimeter measurement epoch (nearest value). [See the **Dry1_Corr** MGDR parameter for more details.]

Dry2_Corr_A/D

Definition	Dry tropospheric correction after **altimeter** measurement file).
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum **value**	-3000
Maximum value	-2000
Default **value**	32767
Comment	This element corresponds to the dry tropospheric correction computation using the second of the 2 meteorological fields surrounding the **altimeter** measurement epoch (nearest value). [See the **Dry2_Corr** MGDR parameter for more details.]

Dry_Err_A/D

Definition	Quality index on **Dry_Corr**
Eiement type	Integer
Storage type	Signed
Size	1
Unit	I
Minimum value	0
Maximum value	9
Default value	127
Comment	Its value ranges from O to 9 with **lower** ranges when this element is valuable and higher ranges when it is not valuable. The value is the larger of the two values describing the two meteorological **fields**.

Dry1_Err_A/D

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	Its value ranges from O to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Dry2_Err_A/D

Definition	Quality index on **Dry2_Corr**
Element type	Integer
Storage type	Signed
Size	1
Unit	I
Minimum value	0
Maximum value	9
Default value	127

Comment	Its value ranges from O to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

EM_Bias_Corr_K1_A/D

Definition	CNES, Ku band range correction for electromagnetic bias (EMB)
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1200
Maximum value	0
Default value	32767
Comment	This element is computed by linear interpolation from MGDR EMB values (EM_Bias_Corr_K1).

EM_Bias_Corr_K2_A/D

Definition	NASA, Ku band range correction for electromagnetic bias (EMB)
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1200
Maximum value	0
Default value	32767
Comment	This element is computed by linear interpolation from MGDR EMB values (EM_Bias_Corr_K2).

Geo_Bad_1_A/D

Definition	Set of flags indicating ocean/land/ice states.
Element type	Bit field
Storage type	Bit
Size	1
Unit	I
Minimum value	o
Maximum value	255
Default value	N/A
Comment	

Geo_Bad_2_A/D

Definition	Set of flags indicating the rain and tide conditions.
Element type	Bit field
Storage type	Bit
Size	1
Unit	/
Minimum value	o
Maximum value	255
Default value	N/A
Comment	

H_Alt_A/D

Definition	Altimeter range.
Element type	Integer
Storage type	Signed
Size	4

Unit	millimeter
Minimum value	120000000
Maximum value	*140000000*
Default value	*2147483647*
Comment	This element is computed by spline interpolation from MGDR altimeter range values (H_Alt). Altimeter ranges are corrected for instrumental effects only.

H_EOT_C_A/D

Definition	Height of the elastic ocean tide
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15000
Maximum value	15000
Default value	32767
Comment	This element is computed by linear interpolation from Cartwright and Ray model MGDR elastic ocean tide values (H_EOT_C).

H_EOT_SCH_A/D

Definition	Height of the elastic ocean tide
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-15000
Maximum value	15000
Default value	32767
Comment	This element is computed by linear interpolation from modified, Enhanced Schwiderski model MGDR elastic ocean tide values (H_EOT_SCH).

H_LT_C_A/D

Definition	Ocean loading effect on tide
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1500
Maximum value	1500
Default value	32767
Comment	This element is computed by linear interpolation from Cartwright and Ray model MGDR ocean loading effect values on tide (H_LT_C).

H_LT_SCH_A/D

Definition	Ocean loading effect on tide
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1500
Maximum value	1500
Default value	32767
Comment	This element is computed by linear interpolation from modified, Enhanced Schwiderski model MGDR ocean loading effect values on tide (H_LT_SCH).

H_MSS_Cro

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	-300000
Maximum value	300000
Default value	2147463647
Comment	This element is deduced from **Rapp** et al. mean sea surface height fields computed using **Geos3,** Seasat and **Geosat** altimeter data [Ref. 22].

H_Ocs_Cro

Definition	Ocean depth at the measurement point.
Element type	Integer
Storage type	Signed
Size	2
Unit	meter
Minimum value	-15000
Maximum value	0
Default value	32767
Comment	This element is computed from ETOP05 database (NOAA, Boulder, Colorado)

H_ Pol_A/D

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

H_Set_A/D

Definition	Height of the solid Earth tide.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	1000
Default value	32767
Comment	This element is computed by linear interpolation from MGDR solid Earth tide height values **(H_Set).**

HP_Alt_A/D

Definition	CNES altitude of satellite center of mass above the reference ellipsoid .
Element type	Integer
Storage type	Signed
Size	4

Unit	millimeter
Minimum value	1200000000
Maximum value	1400000000
Default value	2147483647
Comment	This element is computed by linear interpolation from MGDR CNES attitude values **(HP_Sat)**.

INV_BAR_A/D

Definition	Inverse barometric effect correction
Element **type**	Integer
Storage type	Signed
Size	2
Unit	mm
Minimum **value**	-1300
Maximum **value**	3105
Default **value**	32767
Comment	**INV_BAR** has to be added to instrument range to correct for the static inverse barometric **effect**. Note: this **correction** is not always valid - see 4.6.

Iono_Ben_A/D

Definition	Ionospheric correction issued from Bent model .
Element **type**	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum **value**	-1000
Maximum value	0
Default **value**	32767
Comment	This element is **computed** by linear interpolation from MGDR Bent ionospheric correction values **(Iono_Ben)**.

Iono_Cor_A/D

Definition	TOPEX dual-frequency ionospheric correction .
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	*-500*
Maximum value	40
Default value	32767
Comment	This element is computed by linear interpolation from MGDR TOPEX **dual**-frequency ionospheric correction values **(Iono_Cor)**.

Iono_Dor_A/D

Definition	DORIS ionospheric correction .
Element **type**	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum **value**	**-1000**
Maximum **value**	**0**
Default value	32767
Comment	This element is computed by linear interpolation from MGDR DORIS ionospheric correction values **(Iono_Dor)**.

Iono_Dor_Bad_A/D

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	Its value ranges from O to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Lat_Cro

Definition	Geodetic latitude of the crossover points.
Element type	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	-90000000
Maximum value	90000000
Default value	N/A
Comment	This element is computed by linear interpolation from MGDR geodetic latitude values **(Lat_Tra)**.

Lon_Cro

Definition	Geodetic latitude of the crossover points.
Element **type**	Integer
Storage type	Signed
Size	4
Unit	microdegree
Minimum value	**0**
Maximum value	**360000000**
Default value	N/A
Comment	This element is computed by linear interpolation from MGDR geodetic longitude values **(Lon_Tra)**.

Net_Instr_R_Corr_C_A/D

Definition	C band, net (summed) instrument correction to range.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	*-5000*
Maximum value	*2000*
Default value	*32767*
Comment	See **Net_Instr_R_Corr_C** for more details.

Net_Instr_R_Corr_K_A/D

Definition	Ku band, net (summed) instrument correction to range.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	*-5000*

Maximum value	o
Default value	N/A
Comment	See Net_Instr_R_Corr_K for more details.

Num_Pas_A/D

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

Range_Deriv_A/D

Definition	One per second range derivative.
Eiement type	integer
Storage type	Signed
Size	2
Unit	centimeter per second
Minimum value	-3500
Maximum value	3500
Default value	32767
Comment	See Range_Deriv MGDR for more details

RMS_H_Alt

Definition	Root Mean Square (RMS) of H_Alt_SME(i) 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	o
Maximum value	10000
Default value	32767
Comment	I

Sat_Alt_A/D

Definition	NASA altitude of satellite center of mass above the reference ellipsoid .
Eiement type	integer
Storage type	Signed
Size	4
Unit	millimeter
Minimum value	1200000000
Maximum value	1400000000
Default value	2147483647
Comment	This element is computed by linear interpolation from MGDR NASA altitude values (Sat_Alt).

Sigma0_C_A/D

Definition	C band, backscatter coefficient computed from AGC_C.
Eiement type	integer

Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	o
Maximum value	32767
Default value	65535
Comment	/

Sigma0_K_A/D

Definition	Ku band, backscatter coefficient computed from AGC_K.
Element type	Integer
Storage type	Unsigned
Size	2
Unit	0.01 decibel
Minimum value	o
Maximum value	3000
Default value	65535
Comment	/

Spares_Cro

Definition	Spares for additional crossing point information
Element type	Integer
Storage type	Byte
Size	8
Unit	/
Minimum value	N/A
Maximum value	N/S
Default value	o
Comment	Some or all of these bytes this may be used for parameters in future versions of this product

Spares_A/D

Definition	Spares for additional crossing point information
Element type	Integer
Storage type	Byte
Size	45
Unit	/
Minimum value	N/A
Maximum value	N/S
Default value	o
Comment	Some or all of these bytes this may be used for parameters in future versions of this product. There are separate "spare" fields, each 45 bytes, for ascending and descending data.

Spline_RMS_A/D

Definition	Root Mean Square (RMS) of the 8 distances between the satellite and the sea surface about the spline used to get H_Alt_A/D through interpolation.
Element type	Integer
Storage type	Signed
Size	1
Unit	millimeter
Minimum value	o
Maximum value	80
Default value	127

Comment	I

SWH_C_A/D

Definition	Significant Wave Height (SWH), C band.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.1 meter
Minimum value	o
Maximum value	200
Default value	255
Comment	This element is computed by linear interpolation from MGDR Significant Wave Height values (SWH_C).

SWH_K_A/D

Definition	Significant Wave Height (SWH), Ku band.
Element type	Integer
Storage type	Unsigned
Size	1
Unit	0.1 meter
Minimum value	o
Maximum value	200
Default value	255
Comment	This element is computed by linear interpolation from MGDR Significant Wave Height values (SWH_K).

Tim_Moy_A/D_1

Definition	Time elapsed between the reference epoch' and the ascending crossover point, day part
Element type	Integer
Storage type	Signed
Size	2
Unit	day
Minimum value	I
Maximum value	I
Default value	N/A
Comment	This element is computed by spline interpolation from MGDR elapsed time values (Tim_Moy_1, Tim_Moy_2, Tim_Moy_3). The complete elapsed time (days, milliseconds and micro- seconds) which corresponds to the time when the satellite passes ascending over the crossover point location, can be obtained, with respect to unit systems, as follows: Elapsed Time = Tim_Moy_A/D_1 + Tim_Moy_A/D_2 + Tim_Moy_A/D_3

Tim_Moy_A/D_2

Definition	Number of milliseconds in the day for the complete elapsed time (see Tim_Moy_A/D_1 and Tim_Moy_A/D_3).
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 MGDR elapsed time values (Tim_Moy_l, Tim_Moy_2, Tim_Moy_3). It includes "UTC leap second".

Tim_Moy_A/D_3

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

Typ_Cro

Definition	Type of the crossover points
Element type	Integer
Storage type	Signed
Size	1
Unit	N/A
Minimum value	o
Maximum value	3
Default value	none
Comment	Values are:

O for TOPEX/TOPEX crossovers type (T/T),
1 for POSEIDON/POSEIDON crossovers type (P/P),
2 for TOPEX/POSEIDON crossovers type (TIP),
3 for POSEIDON/TOPEX crossovers type (P/T).

Wet_Corr_A/D

Definition	Wet tropospheric correction interpolated at the altimeter measurement time.
Element type	Integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
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 and interpolating at the measurement time. [See the Wet_Corr MGDR parameter for more details].

Wet_H_Err_A/D

Definition	Quality index on Wet_Corr.
Element type	Integer
Storage type	Signed
Size	1
Unit	/
Minimum value	o
Maximum value	9
Default value	127

Comment its value ranges from O to 9 with lower ranges when this element is valuable and higher ranges when it is not valuable.

Wet_H_Rad_A/D

Definition	Radiometer wet tropospheric.
Element type	integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
Comment	This element is computed by linear interpolation from MGDR radiometer wet tropospheric correction values (Wet_H_Rad).

Wet 1_Corr_A/D

Definition	Wet tropospheric correction before altimeter measurement .
Eiement type	integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
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 MGDR parameter for more details].

Wet2_Corr_A/D

Definition	Wet tropospheric correction after altimeter measurement .
Eiement type	integer
Storage type	Signed
Size	2
Unit	millimeter
Minimum value	-1000
Maximum value	0
Default value	32767
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 MGDR parameter for more details].

Wind_Sp_A/D

Definition	Wind intensity.
Element type	integer
Storage type	Unsigned
Size	1
Unit	0.1 meter per second
Minimum value	o
Maximum value	250
Default value	255
Comment	This eiement is computed by linear interpolation from MGDR wind speed values (Wind_Sp).

9. ADDITIONAL INFORMATION

9.1 *ACRONYMS*

AGC	Automatic Gain Control
ASCII	American Standard Code for Information interchange
AVISO	Archivage, Validation et Interprtation des donnes des Satellites Oceanographiques
CCDP	Centre de Contrle Doris/POSEIDON
CCSD	Consultative Committee on Space Data
CCSDS	Consultative Committee on Space Data System
CD	Compact Disk Read Only Memory
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 Onosphriques françaises
CTRS	Conventional Terrestrial Reference System
DFB	Digital Filter Bank
DORIS	Determination d'Orbite et Radiopositionnement Intégrés par satellite
DOY	Day of year
ECMWF	European Center for Medium range Weather Forecasting
EM	Electromagnetic
EMB	Electromagnetic Bias
EOF	End of file
EOSDIS	Earth Observing System - Data Information System
FFT	Fast Fourier Transform
GDR	Geophysical Data Record
MGDR	Merged Geophysical Data Record
GDR-P	GDR - POSEIDON
GDR-T	GDR - TOPEX
GPS	Global Positioning System
GPSDR	Global Positioning System Demonstration Receiver
GRGS	Groupe de Recherche en Géodésie Spatiale
JPL	Jet Propulsion Laboratory
IGDR	Interim Geophysical Data Record
IGDR - P	IGDR - POSEIDON
IGDR - T	IGDR - TOPEX
I/GDR	IGDR or GDR
IM	Instrument Module
LRA	Laser Retroreflector Array
MMS	Multimission Modular Spacecraft
NASA	National Aeronautics and Space Administration (US space agency)
N/A	Not Applicable
NOAA	National Oceanic and Atmospheric Administration
NRA	NASA Radar Altimeter
OMM	Orbital Maintenance Maneuver
Pi(s)	Principal Investigator(s)
POD	Precision Orbit Determination
PO.DAAC	Physical Oceanography Distributed Active Archive Center
POE	Precision Orbit Ephemerides

RMS	Root Mean Square
SFDU	Standard Formatted Data Units
SIS	Software Interface Specification
SSALT	Solid State ALTimeter
SSH	Sea surface height
SWH	Significant Wave Height
SWT	Science Working Team (TOPEX/POSEIDON)
TGS	TOPEX Ground System
TOGA	Tropical Ocean and Global Atmosphere
TMR	TOPEX Microwave Radiometer
TOPEX	Ocean Topography Experiment
UMR 39	Unité Mixte de Recherche 39 du CNRS
UTC	Universal Time Coordinated
VMS	Vax virtual Memory operating System
WCRP	World Climate Research Program
WOCE	World Ocean Circulation Experiment
XNG	Crossing Point File

9.2 REFERENCES

For an on-line list of TOPEX/POSEIDON journal references, see the Texas A&M Oceanography Departments web page: **http://volcans.tamu.edu/publications/post-nov.html**

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9.3

9.4 *INSTRUMENT ANOMALY RECORD*

1-July-1 997

UTC DATE yyyy-doyThh:mm	CYC	PASS	PROBLEM	SENSOR AFFECTED	DATA LOSS dd hh mm
1992-240T18:13			ADCS Safehold	NALT	0030 37
1992-242T05:40			TMON group #22	NALT	0012 38
1992-247T17:05			Scrambled memory	NALT	0010 52
1992-268T00:06	001	022	ADCS Safehold	NALT	0028 57
1992-354T01:35	009	195	ALT SEU	NALT	0017 00
1993-058T09:31	016	219	Command Error	SSALT	0024 00
1993-089T12:40	019	254	TMON group #22	SSALT	0005 38
1993-203T18:25	031	132	Bad patch or SEU	SSALT	0401 40
1993-218T23:03	033	014	ADCS Safehold	NALT	0015 25
1993-230T21:13	034	065	ALT SEU	NALT	0002 17
1993-264T02:44	037	154	ALT SEU	NALT	0014 26
1993-266T09:47	037	213	ALT SEU	NALT	0007 30
1993-307T16:17	041	254	ALT SEU	NALT	0002 15
1993-330T09:25	044	074	ALT SEU	NALT	0008 16
1994-001T09:14	047	234	ALT SEU	NALT	0003 42
1994-017T20:12	049	148	TR-C Playback	All Sensors	0001 01
1994-075T19:31	055	109	SSALT SEU	SSALT	0123 30
1994-112T04:14	059	024	ALT SEU	NALT	0001 05
1994-256T03:34	073	156	ALT SEU	NALT	0004 21
1994-271T15:30	075	045	ALT SEU	NALT	0000 05
1994-288T00:59	076	211	ALT SEU	NALT	0002 31
1994-294T01:14	077	111	ALT SEU	NALT	0001 13
1994-315T10:43	079	151	SSALT SEU	SSALT	0107 54
1994-324T17:39	080	135	ALT SEU	NALT	0003 03
1995-013T22:05	085	253	ALT SEU	NALT	0000 40
1995-083T20:53	093	013	ALT SEU	NALT	0001 35
1995-132T22:37	097	254	ALT SEU	NALT	0000 14
1995-157T20:37	100	130	ALT SEU	NALT	0008 22
1995-251T06:30	109	237	ALT SEU	NALT	0003 53
1995-306T12:24	115	128	ALT SEU	NALT	0003 25
1995-325T07:58	117	102	ALT SEU	NALT	0001 50
1995-327T10:31	117	156	ALT SEU	NALT	0003 32
1995-330T08:28	117	231	Sat Safehold	All Sensors	0916 22
1995-361T00:17	120	254	ALT SEU	NALT	0003 20
1996-006T16:32	122	020	ALT SEU	NALT	0000 01
1996-020T03:41	123	110	Sat Safehold	All Sensors	0219 43
1996-019T21:10	123	104	ALT SEU	NALT	0002 00
1996-041T14:38	125	152	ALT SEU	NALT	0003 05
1996-057T19:18	127	059	ALT SEU	NALT	0002 13
1996-058T03:09	127	067	TMON Group #22	NALT	0005 18
1996-077T08:44	129	052	ALT SEU	NALT	0001 36
1996-083T07:31	129	204	TR-A Playback	All sensors	0000 29
1996-150T04:15	136	139	TR-A Halt Cmd	All sensors	0001 37

1996-162T20:29	137	210	ALT Mem Reload	NALT	0000 49
1996-178T07:34	139	098	TR-A Playback	All sensors	0000 26
1996-187T22:32	140	090	ALT Mem Reload	NALT	0000 41
1996-197T17:12	141	087	ALT SEU	NALT	0001 05
1996-217T11:19	143	085	ALT SEU	NALT	000249
1996-21 8T23:48	143	124	ALT SEU	NALT	0000 05
1996-226T21:08	144	072	ALT SEU	NALT	0004 54
1996-258T1 7:22	147	126	ALT SEU	NALT	0000 01
1996-263T10:27	147	246	SADE-A incident	NALT	0018.57
1996-289T20:20	150	161	SSALT SEU	SSALT	0013 50
1996-362T12:55	157	1245	ALT SEU(C band)	NALT	0004 50
1996-21 8T23:48	143	124	ALT SEU	NALT	0000 05
1996-226T21:08	144	072	ALT SEU	NALT	0004 54
1996-258T17:22	147	126	ALT SEU	NALT	0000 01
1996-263T1 0:27	147	246	SADE-A incident	NALT	0018 57
1996-289T20:20	150	161	SSALT SEU	SSALT	0013 50
1996-362T12:55	157	245	ALT SEU - C Band	NALT	0004 50
1997-048T1 0:07	163	050	ALT SEU	NALT	0000 09
1997-084T1 5:03	166	216	ALT DFB Calib	NALT	0000 37
1997-099T1 0:26	168	087	ALT DFB SEU	NALT	0001 02
1997-1 58T01:38	174	065	SSALT SEU	SSALT	0106 55

(NALT = NASA Altimeter, SSALT = CNES Solid State Altimeter)

9.5 Crossover Point Time Differences

The following table gives the time difference between TOPEX/POSEIDON crossovers at a given latitude. The time difference is given as fractions of a day between the ascending pass and the descending pass. The time differences are the same for negative latitudes. This table was taken from Shamma and Ray [Ref 41].

66.12	-3.9823
66.08.	-1.0157
66.03	1.9509
65.97'	4.9175
65.89	-2.0315
65.80	0.9351
65.70	3.9017
65.58	-3.0473
65.44	-0.0807
65.29	2.8859
65.12	-4.0631
64.93	-1.0965
64.73	1.8701
64.50	4.8367
64.26	-2.1123
64.01	0.8542
63.73	3.8208
63.42	-3.1283
63.10	-0.1617
62.75	2.8048
62.38	-4.1442
61.98	-1.1777
61.56	1.7888
61.10	4.7553
60.62	-2.1938
60.10	0.7727
59.55	3.7391
58.96	-3.2100
58.33	-0.2435
57.65	2.7228
56.94	-4.2263
56.17	-1.2599
55.34	1.7064
54.46	4.6727
53.52	-2.2766
52.51	0.6897
51.43	3.6560
50.26	-3.2934
49.01	-0.3272
47.67	2.6389
46.22	-4.3106
44.66	-1.3446
42.98	1.6214
41.14	4.5874
39.21	-2.3624
37.10	0.6034
34.82	3.5692
32.37	-3.3808
29.72	-0.4152
26.89	2.5503
23.85	-4.3999
20.61	-1.4346
17.18	1.5306
13.57	4.4958
9.81	-2.4547
5.94	0.5103
1.99	3.4753

9.6 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 lone exception to this is Iono_Bad, see *Section* 7.2. 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, O 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 O 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 O through bit 7. The value of the unsigned integer is in the range O through 255.

Word: Word is two contiguous bytes starting on an arbitrary byte boundary. The 16 bits are numbered from right to left, O 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 O 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 O through bit 15. The value of the unsigned integer is in the range O through 65S35.

Longword: A longword is four contiguous bytes starting on an arbitrary byte boundary. The 32 bits are numbered from right to left, O 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 O 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 O through bit 31. The value of the unsigned integer is in the range O through 4294967295.

9.7 POINT OF CONTACT

For more information on TOPEX/POSEIDON products, to order a catalogue of data at PO.DAAC or to order data please contact:

PODAAC@PODAAC.JPL. NASA.GOV on INTERNET

User Services Office
Physical Oceanography Archive Center (PO. DAAC)
Jet Propulsion Laboratory
M/S 300-320
4800 Oak Grove Drive
Pasadena, CA 91109, U.S.A.
Phone: (818) 354-9890
FAX: (818) 393-2718 (Attention: PO.DAAC User Services Office)

WEB PAGE http://podaac.jpl. nasa.gov

From this web site you can view and order the TOPEX Informational CD.

There are additional links to the TOPEX home page and many other sites related to ocean data.

As one element of the Earth Observing System Data and Information System (EOSDIS), the mission of PO. DAAC is to archive and distribute data relevant to the physical state of the oceans. The goals of PO.DAAC are to serve the needs of the oceanographic and geophysical sciences research communities and to provide data in support of interdisciplinary research. The primary means of achieving these goals are through: acquiring, compiling, processing, and distributing data obtained from spaceborne and conventional instruments; producing and distributing higher level data products; and providing an increasing range of data services to the broad research community.

10.