THE GERMAN PAF FOR ERS

ERS D-PAF
Altimeter and Orbit
Global Products Manual

ERS-D-GPM-31200

GeoForschungsZentrum Potsdam, Div.1 (GFZ/D-PAF)
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		chapter 3.6	Product description	Gruber
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		page 6-1	Update of Abbreviation list	Massmann

DISTRIBUTION LIST

Name	Organization	Copies
M. Onnestam	ESRIN/ESA	1
K. Reiniger	DLR/D-PAF	1
Users (CD-ROM)	various	1
Users (D-PAF FTP Server)	various	1

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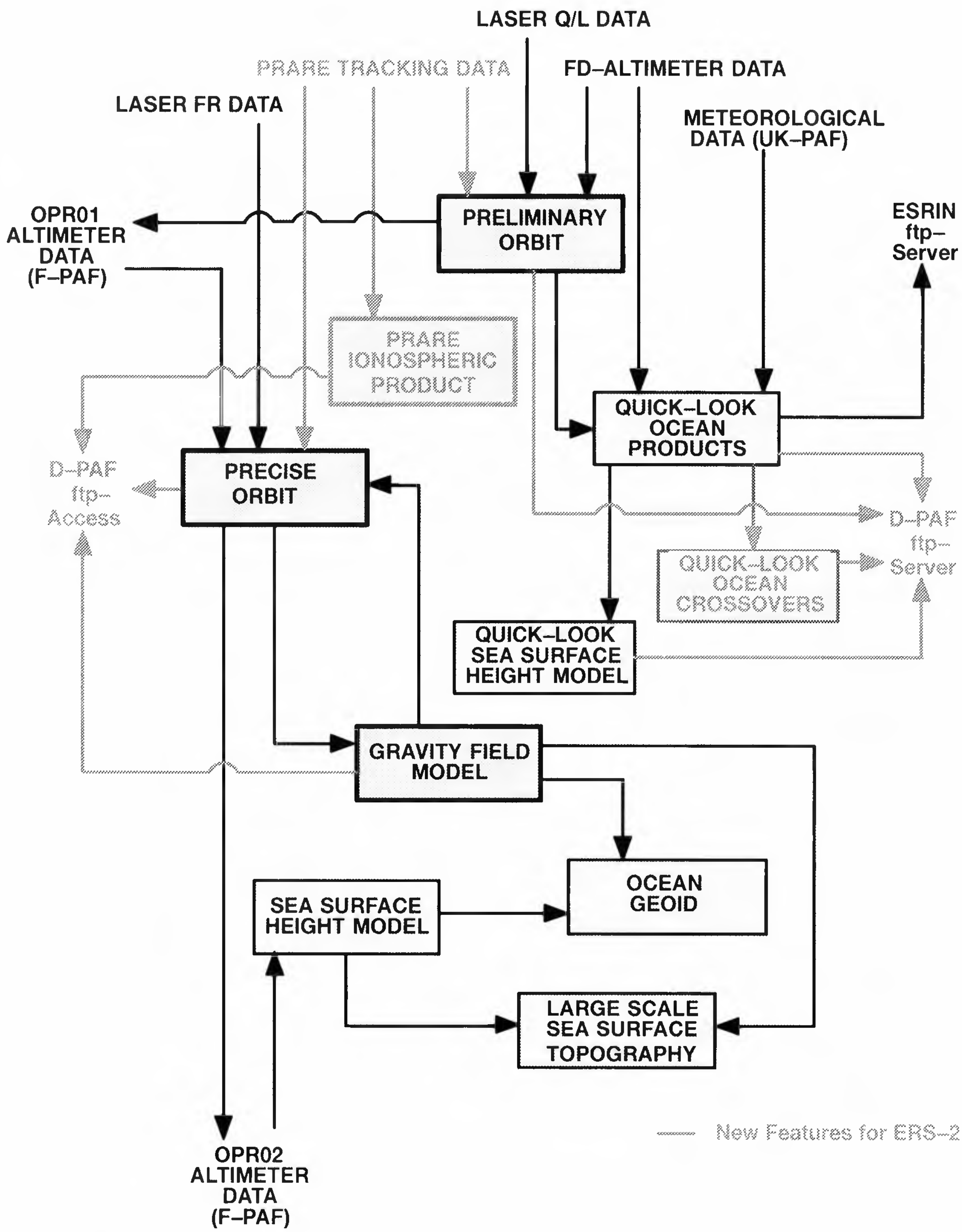

1. Introduction

1.1 The German Processing and Archiving Facility (D-PAF)

D-PAF jointly is operated by the German Remote Sensing Data Center (DFD) of the German Aerospace Research Center (DLR) and the Division on Kinematics and Dynamics of the Earth of the GeoResearchCenter Potsdam (GFZ). D-PAF is located at the DLR research center in Oberpfaffenhofen near Munich. While DFD is responsible for the SAR data processing system, the management and communication system, GFZ/D-PAF is responsible for the processing of altimeter and tracking data. This means:

- Coordination and support of the ERS Laser and PRARE tracking networks
- Archival of all ERS Laser tracking data
- Computation of Preliminary and Precise ERS Orbits and refinement of Earth Gravity Models
- Generation of Geophysical Products from OPR02 and Fast Delivery altimeter data

1.2 Altimeter and Tracking Data Processing at D-PAF

Processing and archiving of the ERS altimeter and tracking data at D-PAF is performed in order to produce a number of ESA ERS standard products. These so-called global products and their relationship are shown in Figure 1 where the box represents the GFZ/D-PAF responsibility.

As indicated by the arrows these products are strongly related to each other. The following short description outlines the impact of the individual products, specifies their interrelationship and indicates their major operational and scientific application.

Preliminary Orbits are generated with the aid of the Quick-Look (Q/L) laser tracking data. The RA-FD data as provided by the Fast Delivery Processing and Dissemination Facilities are used as an additional tracking information. For ERS-2 also PRARE range and doppler measurements will be used. Preliminary orbits with short term availability (1 week) are used for the quick-look altimeter products, and for the off-line processing of other data.

Special quick-look altimeter products based on Radar Altimeter Fast Delivery data are generated. RA-FD data are upgraded by recomputing tropospheric and ionospheric corrections based on actual meteorological data delivered by the UK-PAF. After a cross-over adjustment the **Quick-Look Ocean Products** are generated by extracting daily altimeter data from the upgraded data base. These products contain the corrected sea surface height measurements together with an orbit error estimate from the global cross-over adjustment and an interpolated geoid height. One repeat cycle of these corrected quick-look altimeter data is used to compute a **Quick-Look Sea Surface Height Model** on a weekly basis using a special gridding algorithm. This fast and regular product generation allows a near real-time monitoring of the sea surface and the large scale ocean variability.

The **Precise Orbit** and its accuracy has a strong impact on all follow-on products. Besides the use of other ancillary data its generation is based on the laser tracking and radar altimeter crossover data. For ERS-2 also PRARE range and Doppler measurements are used. The orbit integration is performed with the aid of the most advanced gravity field models. The products are systematically sent to the F-PAF for merging into the OPr products.

Figure 1: Product Overview for Altimeter and Tracking Data

Besides its scientific application the generation of dedicated **ERS Gravity Field Models** must be considered as an essential support to the D-PAF operational activities. Those models using in particular the tracking data of the ERS spacecraft are necessary for an optimal restitution of the precise ERS orbit. In addition they represent the long wavelength components of the geoid, required for the altimetric estimation of the sea surface topography. A general purpose gravity field will be determined including additional surface data in particular the ERS derived oceanic geoid. In addition ERS gravity fields are used as long wavelength a-priori information for the determination of high resolution geoid models.

The generation of the high precision geophysical altimeter products requires the precise orbit information and the altimeter data processed up to level 2. Due to the ESA harmonization scheme for ERS the generation of OPR02 (level 2) RA data and its merging with the precise orbit is performed under French responsibility at F-PAF.

A detailed analysis of the OPR02 altimeter data, in particular a cross-over adjustment allows to construct **Sea Surface Height Models** providing most precise geometrical features of the sea surface on a global scale. The processing is based on monthly or 35 day subsets (depending on the repeat cycle) of OPR02 altimeter data to compute short period solutions or on all available data to update periodically every six months a quasi-stationary sea surface height model.

The **Ocean Geoid** is derived on the basis of this quasi-stationary model, because when subtracting an oceanographic sea surface topography data set, it can be considered as a time independent equipotential surface of the earth gravity field. The geoid model is determined by a combination of the quasi-stationary sea surface height model, additional surface gravity data and the long wavelength features of the ERS gravity field model, which are used as a-priori information. Main applications are gravity field improvements and geophysical interpretations (e.g. correlations with the sea floor topography).

The **Large Scale Sea Surface Topography** is estimated on the basis of the quasi-stationary sea surface height models and the long wavelength representation of the geoid. These deviations between a specific equipotential surface of the earth gravity field and the sea surface are directly correlated with the surface currents and thus provide important informations on the global ocean circulation.

Since July 1997 rapid orbit and ocean products are generated for near real-time applications.

All products mentioned above are specified in detail in the following sections.

1.3 Product Ordering

All the products can be ordered via CUS at ESRIN, Frascati (Italy). Please send your requests to

ESA ERS Order Desk (for ESA ERS Principal Investigators and Pilot Projects)
ESRIN
Frascati, Italy

Phone:	+39 6 94180 336 or 406 or 457
Fax:	+39 6 94180 361
Telex:	610637 esrin i
E-Mail:	ersod@mail.esrin.esa.it

Commercial users should contact Eurimage (Europe, Middle East, North Africa), Radarsat Int. (Canada, USA) or Spot Image (rest of the world).

For any questions there is also a Help Desk available

Phone: +39 6 94180 600 or 656
Fax: +39 6 94180 510
Telex: 610637 esrin i
E-Mail: Helpdesk@ersus.esrinvas.esrin.esa.it

1.4 Product Presentation

In general the products are digital data sets. They are accessible for authorized users via CD-ROM (formerly CCT) and ftp servers.

1.4.1 CD-ROM

The nominal distribution medium is CD-ROM. The file structure in general is as follows:

Directory	Sub-dir	File	Content
CD_INFO		README	CD-Content Description
DPAF		PAF_INFO	D-PAF Overview
ERS1 or	ORB/PRC0ii_r	arc_1	PRC ID ii, rev. r
ERS2		arc_2	
		..	
	ORB/EGM	EGM1	EGM product file
	ALT/OGE/REVr	OGE__yyddd	OGE rev.r, Year yy, day ddd
	ALT/SSH/REVr	SSH__yyddd	SSH rev.r, Year yy, day ddd
	ALT/TOP/REVr	TOP__yyddd	TOP rev.r, Year yy, day ddd
PRS_ION	WKnnyy_r/STATxx	Ixxyyddd.sss	ION week nn, station xx
DOC			Document files
	PROD_MAN		Global Products Manual
	ERS_STD		ERS Standards used at D-PAF
UTILITY		RM_LF	remove line feed for orbit products

1.4.2 FTP Server

The ftp access is forseen for Principle Investigators and Pilot Projects only. It allows a flexible and efficient access to the products.

The following altimeter and orbit products are stored on the D-PAF FTP Server (esaftp.dfd.dlr.de):

Product	Type	Full Name
ALT.ROPR	common	-Altimeter Rapid Ocean Products
ALT.QLOPR	common	-Altimeter Quick-Look Ocean Products
ALT.QLOPC	common	-Altimeter Quick-Look Ocean Products Crossover
ALT.SSHQL	common	-Altimeter Quick-Look Sea Surface Heights
ORB.RPD	common	-Rapid Orbit
ORB.PRL	common	-Preliminary Orbit
ORB.PRC	common	-Precise Orbit
ORB.EGM	common	-Earth Gravity Model
PRS.ION	common	-Prare Ionospheric Total Electron Content

On the ESRIN server (services.esrin.esa.it) mainly the QLOPR data are available.

2. Product Overview

This chapter presents the main characteristics of all D-PAF ERS Altimeter and Orbit Global Products in the short form of tables. More details are provided in the next chapter.

2.1 Orbit and Gravity Field Products

ERS ORBIT PRODUCT OVERVIEW			
Identifier **Name**	**ERS-2.ORB.RPD** **Rapid Orbit**	**ERS-1/2.ORB.PRL** **Preliminary Orbit**	**ERS-1/2.ORB.PRC** **Precise Orbit**
Definition	near real-time preliminary estimate of ERS trajectory	fast preliminary estimate of ERS trajectory	high precision estimate of ERS trajectory
Basic Input	FGNP-Laser, PRARE range and doppler data, RA-FD ranges (downweighted), geometric, dynamic, and measurement model data	FGNP-Laser, RA-FD crossovers, PRARE range and doppler data (ERS-2 only), geometric, dynamic, and measurement model data	FGNP-Laser, OPR01 crossovers, PRARE range and doppler data (ERS-2 only), geometric, dynamic, and measurement model data
Basic Algorithm	numerical integration, variational equations, least squares adjustment	numerical integration, variational equations, least squares adjustment	numerical integration, variational equations, least squares adjustment
Output	position/velocity vectors, time tag, attitude angles	position/velocity vectors, time tag, attitude angles, radial orbit correction	position/velocity vectors, time tag, attitude angles, radial orbit correction
Spatial coverage	global	global	global
Spatial resolution	400km	900km	225km
Time coverage	1 day	7 days	1 month/35d cycle
Time Resolution	60s	120s	30s
Reference system	CTS	CTS & CIS	CTS & CIS
Time System	TDT	TDT	TDT
Constants	ERS Standards	ERS Standards	ERS Standards
Generation	once/day	once/week	monthly
Volume (uncomp.)	0.19 MByte/day	1.3 MByte/week	22.5 MByte/month
Presentation	ftp server	CD-ROM, ftp server	CD-ROM, ftp server

ERS GRAVITY PRODUCT OVERVIEW	
Identifier **Name**	**ERS-1/2.ORB.EGM** **ERS Gravity Model**
Definition	models of the geopotential designed for a) precise orbit restitution b) RA data reduction, geoscientific purposes
Basic Input	non-ERS gravity model, precise orbit input files
Basic Algorithm	numerical integration, variational equations, least squares adjustment
Output	coefficients of spherical harmonic series
Spatial coverage	global
Spatial resolution	approx. 1000km
Time coverage	not applicable
Time Resolution	not applicable
Reference system	CTS
Time System	not applicable
Constants	ERS Standards
Generation	EGM1: once
Volume (uncomp.)	0.28 MByte/model
Presentation	CD-ROM, ftp server

2.2 Altimeter Products

ALTIMETER PRODUCT OVERVIEW (Rapid Products)	
Identifier	**ERS-2.ALT.ROPR**
Name	**Rapid Ocean Product**
Definition	time tagged RA-FD data with updated atmospheric and tidal corrections and rapid orbit incorporated
Basic Input	RA-FD data, rapid orbit, earth/ocean tide model, ionospheric model, monthly models of wet tropospheric correction based on 3 years of ERS-1 radiometer data
Basic Algorithm	merge orbit, update corrections, crossover analysis
Output	corrected range, satellite height, corrections, interpolated geoid
Spatial coverage	global
Spatial resolution	7km
Time coverage	1 day
Time Resolution	980.4ms
Reference system	WGS84
Time System	UTC
Constants	none
Generation	daily
Volume (comp.)	3 MByte/day
Presentation	ftp server
Dissemination	daily

ALTIMETER PRODUCT OVERVIEW (Quick-Look Products)			
Identifier Name	**ERS-1/2.ALT.QLOPR Q-L Ocean Products**	**ERS-1/2.ALT.SSHQL Q-L Sea Surface Heights**	**ERS-2.ALT.QLOPC Q-L Ocean Crossovers**
Definition	time tagged RA-FD data with updated meteorological corrections and preliminary orbit incorporated	digital elevation model of sea surface on an equiangular grid, computed with quick-look ocean products	differences of ascending and descending arcs at crossover locations, computed from quick-look ocean products
Basic Input	RA-FD data, preliminary orbit, earth/ocean tide model, ionosphere model, actual meteorological data, orbit error estimate	RA-FD data, preliminary orbit, earth/ocean tide model, ionosphere model, actual meteorological data, orbit error estimates	RA-FD data, preliminary orbit, earth/ocean tide model, ionosphere model, actual meteorological data
Basic Algorithm	merge orbit, update corrections, crossover analysis	merge orbit, update corrections, crossover analysis, gridding	merge orbit, update corrections, crossover computation
Output	corrected range, satellite height, corrections, orbit error estimate, interpolated geoid	grid with sea surface heights, significant wave heights, wind speed, relative sea height change	crossover location, sea surface height, significant wave height and wind speed crossover differences
Spatial coverage	global	global	global
Spatial resolution	7km	15’	not applicable
Time coverage	1 day	1 repeat cycle	1 day with preceeding 35 days
Time Resolution	980.4ms	not applicable	not applicable
Reference system	WGS84	WGS84	WGS84
Time System	UTC	not applicable	UTC
Constants	none	none	none
Generation	daily	weekly	daily
Volume (comp.)	3 MByte/day	4 MByte/model	0.1 MByte/day
Presentation	ftp server	ftp server	ftp server
Dissemination	daily	weekly	daily

ALTIMETER PRODUCT OVERVIEW (Level 2 Products)			
Identifier Name	**ERS-1/2.ALT.SSH Sea Surface Heights**	**ERS-1/2.ALT.OGE Ocean Geoid**	**ERS-1/2.ALT.TOP Sea Surface Topography**
Definition	digital elevation model of sea surface on an equiangular grid, computed with level 2 ocean products a) short period version b) stationary version	digital elevation model of geoid heights on an equiangular grid	surface spherical harmonic series for deviations between geoid and mean sea surface
Basic Input	level 2 data, precise orbit	stationary sea surface height model, dynamic sea surface topography, ERS gravity field, surface gravity data	stationary sea surface height model, ERS gravity field
Basic Algorithm	crossover analysis, gridding	spherical harmonic analysis, spectral combination	spectral filtering
Output	grid with sea surface heights and standard deviations	grid with geoid heights	coefficients of spherical harmonic series
Spatial coverage	global	global	global
Spatial resolution	a) 15' b) 6'	30'	~2000km
Time coverage	a) 35 days b) as long as possible	as long as possible	as long as possible
Time Resolution	not applicable	not applicable	not applicable
Reference system	WGS84	WGS84	
Time System	not applicable	not applicable	not applicable
Constants	none	none	none
Generation	a) every 35 days b) every 6 months	every 6 months	every 6 months
Volume (uncomp.)	a) 12 MByte/model b) 95 MByte/model	4 MByte/model	0.2 MByte/model
Presentation	CD-ROM	CD-ROM	CD-ROM
Dissemination	irregular	irregular	irregular

2.3 PRARE ION Product

PRARE PRODUCT OVERVIEW	
Identifier **Name**	**ERS2.PRS.ION** **PRARE Ionospheric Product**
Definition	preprocessed PRARE ionospheric refraction data
Basic Input	Observed one-way X-band versus S-band travel time delay, corresponding UTC time tag
Basic Algorithm	Decoding, screening
Output	Total electron content in slant and vertical direction
Spatial coverage	Dependent on station distribution and visibility conditions
Spatial resolution	N/A
Time coverage	Length of an ERS-2 pass
Time resolution	4 sec
Reference system	N/A
Time system	UTC
Constants	ERS standards
Generation	After every data dump at Master Station
Volume (uncomp.)	3.4 MByte / day
Presentation	FTP Server, CD-ROM
Dissemination	weekly

3. Product Specification

3.1 Preliminary Orbit (ERS-1/2.ORB.PRL)

Definition

Preliminary orbits (PRL) are based on fast delivery tracking data (SLR, radar altimeter heights, PRARE range and doppler data). These orbits are an improvement of the initial knowledge of the orbit but don't provide the optimal fit to the real S/C motion. This information is used for the 3d location of the on board sensors. The preliminary orbit product consists of the satellite ephemeris (position and velocity vectors) including time tag, given in the Conventional Inertial Reference Frame (CIS) and the Conventional Terrestrial Reference Frame (CTS) together with the nominal attitude information and a radial orbit correction. The Terrestrial Dynamic Time (TDT) is chosen as the time reference.

Processing Scheme

Input:

- observations: Laser ranges (Q/L or FGNP), partly radar altimeter heights (in case of short pieces between two manoeuvres), radar altimeter crossovers, PRARE range and doppler observations (ERS-2 only)
- Measurement model data: centre of mass correction, tropospheric corrections
- Reference frame model data: Earth rotation parameters, nutation model, station coordinates
- Dynamical model data: Earth gravity model, Earth and ocean tides, drag model, solar activity data, third body attractions

Algorithm:

Numerical integration of satellite's equation of motion and its variational equations, reduction of observations and iterative least squares adjustment.
Processing Parameters

- Orbital elements at initial epoch
- Global scaling factor for direct solar radiation pressure
- Daily or subdaily scaling factor for atmospheric drag
- Once per revolution empirical acceleration
- Station coordinates if appropriate

Constraints: To avoid any discontinuities of subsequent arcs over ocean, all orbits start and end over land except in case of manoeuvres. The subsequent arcs end and start at the same epoch.

Computation of radial orbit corrections via global crossover analysis and merging of these corrections into the product file.

Concatenation of arcs to one monthly product.

Output:

ASCII coded records

- Time system corrections to UTC
- Manoeuvre information
- Leap second information
- Reference frame identifier (CTS, CIS)

- Satellite ID (COSPAR number)
- Type of orbit (here: preliminary)
- Time tag in Julian Days since 2000.01.01 12 hours in TDT time scale
- Position of actual center of mass of ERS spacecraft
- Velocity of actual center of mass of ERS spacecraft
- Roll, pitch and yaw angles
- Flags for first ascending state above the equator and quality indicator (manoeuvre)
- Radial orbit correction
- Quality estimates

Product Specification

Spatial Coverage: global

Spatial Resolution: approximately 900 km

Time Coverage: continuous 7-days data file (Monday through Sunday), only in case of a leap second occurance the file will be split into two pieces

Time Resolution: 120 seconds

Reference System: CTS - Conventional Terrestial Reference System. Z-axis directed towards the **mean pole** as being derived from the BIH pole series (ERP(BIH)87C02) covering the period January 1980 - October 1986. X-axis fixed by allowing no net rotation about the Z-axis with respect to the initial coordinates (SSC(DGFII)91L01). Y-axis complete system to the right-handed.
The offsets to the IERS pole are 45 and 286 mas, i.e.
x_p^{IERS} - 0.045" = x_p^{DPAF} , y_p^{IERS} - 0.286" = y_p^{DPAF}

CIS - Conventional Inertial Reference System. This system is referred to the basic epoch 2000.01.01 12 hours designated J2000.0. The axes of the CIS are chosen in such a way, that at the basic epoch J2000.0 they coincide in optimal approximation with the mean equatorial frame defined by the mean celestial pole (Z-axis) and the mean vernal equinox (X-axis).

Coordinate System: geocentric cartesian coordinates

Time System: Terrestrial Dynamic Time (TDT)

Constants, Models: according to ERS Standards

The main characteristics are

Gravity model	PGM-Model computed by D-PAF
Ocean tides	Schwiderski plus PGM-Model (D-PAF)
Station coordinates	PGM-Model (D-PAF)
Air drag	CIRA 86
Solar flux	preliminary values
Geomagnetic ind.	preliminary values
Surface forces	Macro-Model
Earth rotation	IERS Bulletin A, earlier Bull.B predicted
Nutation	IAU 1980 plus corrections (ERS-D-STD-31101)
Earth radiation	albedo and infrared
Earth tides	modified Wahr (Zhu et.al. 1991)

Times/Rates of Generation: D-PAF computes continuously weekly preliminary orbits once per week. The orbits are immediately transmitted to EECF and the other PAFs, and stored on the D-PAF FTP server.

Product Presentation

Volume: 1.3 MByte per weekly product (uncompressed), 0.5 MByte compressed

Medium: CD-ROM, D-PAF FTP Server

Quality Assessment

The quality of the generated orbits is controlled formally and internally.

The formal quality control comprises procedures to check the correct format and to flag periods where the orbit is degraded by manoeuvres or platform anomalies.

Internal quality checks are performed by

- examining the fits of the measurements to the adjusted orbit
- comparing overlapping arc segments

Each product is complemented by records containing quality information like fit of the observations to the orbit, comparison of overlapping orbit segments, crossover rms (root mean square) before and after consideration of a radial orbit correction.

For the revision 1 orbits the radial accuracy is in the order of 12-15 cm, while the revision 2 provides about 8-10 cm radial accuracy.

PRL History

Date	PRL Period	Rev./Mod	PGM Model	Remarks
01.08.91	Jul.-Oct.91	-/1	GRIM4-S2	observations: SLR Q/L ranges and RA heights
01.11.91	Jul.91-Jun.93	0/2	PGM009	improved gravity model
10.07.93	Jul.93 ff	1/3	PGM035	observations: SLR+RA crossovers (prel. QLOPR) improved Satellite Macro Model introduction of radial orbit correction (ROC) computed from prel. QLOPR Solving also for 1/rev empirical acceleration along-track
24.01.94	Jan.94 ff	1/3	PGM035	ROC flag introduced for no correction due to missing RA data, over land position, above threshold of 60cm
07.02.94	Feb.94	1/3	PGM035	ROC: first + last position over land not flagged "over land" anymore for interpolation reasons (only CIS states)
07.03.94	Mar.94 ff	1/3	PGM035	ROC: first + last position over land not flagged "over land" for CIS + CTS states
21.03.95	-	-	-	Opening of D-PAF FTP Server for product distribution to PIs
01.04.95	-	-	-	Removal of CCT devices, switch to CD-ROM as distribution medium
23.05.95	May.01, 1995 ff	2/4	PGM055	improved gravity model
08.08.95	Jul.24, 1995 ff	2/4	PGM055	Earth rotation parameters from IERS Bulletin A instead of Bull.B
-	ERS-1: Jun.03-Jul.21, 1996	2/4	PGM055	Products based on SLR data only
26.07.96	-	-	-	Product generation terminated for ERS-1
10.01.97	Dec.30, 1995 ff			Operational use of PRARE data (Rev.5)

The different PGM models can be characterized as follows:

Model	Degree	Basic Model	Differences
PGM009	63	GRIM4-S2	+ first preliminary ERS-1 SLR data
PGM035	66	GRIM4-S3	Spot/Doris data replaced + Topex SLR/Doris data (Oct.-Dec.92) + ERS-1 SLR data (Apr.-Jul.92)
PGM055	69	GRIM4-S4	+ ERS-1 SLR/Crossover data (35d, 168d data)

3.2 Precise Orbit (ERS-1/2.ORB.PRC)

Definition

The precise orbits result from a data reduction process in which all available tracking data (SLR, radar altimeter crossovers, PRARE range and doppler data) and most accurate correction, transformation and dynamical models are taken into account and in which high level numerical procedures are applied. These orbits are "optimal" achievable representations of the real orbital motion under the circumstances of tracking situation and the "state of the art" model situation. The precise orbit product for the ERS satellites consists of the satellite ephemeris (position and velocity vectors) including time tag, given in a well defined reference frame, together with the nominal satellite attitude information and a radial orbit correction. The chosen reference systems for the satellite position and velocity representation are the Conventional Inertial System (CIS) and the Conventional Terrestrial System (CTS). The time frame used is the Terrestrial Dynamic Time (TDT). The precise orbit will be used for reduction of the radar altimeter measurements and the determination of geodetic/geophysical products.

Processing Scheme

Input:

- observations: Laser ranges, radar altimeter crossovers, PRARE range and doppler observations (ERS-2 only)
- Measurement model data: centre of mass correction, tropospheric corrections
- Reference frame model data: Earth rotation parameters, nutation model, station coordinates
- Dynamical model data: Earth gravity model, Earth and ocean tides, drag model, solar activity data, third body attractions

Algorithm:

Numerical integration of satellite's equation of motion and its variational equations, reduction of observations and iterative least squares adjustment.
Processing Parameters

- Orbital elements at initial epoch
- Global scaling factor for direct solar radiation pressure
- Daily or subdaily scaling factors for atmospheric drag
- Once per revolution empirical acceleration
- Global time bias (altimeter, PRARE)
- PRARE: station dependent range bias, tropospheric correction per pass

Constraints: To avoid any discontinuities of subsequent arcs over ocean, all orbits start and end over land except in case of manoeuvres.

Reduction of the ephemeris period by one day at beginning and end except in case of manoeuvres. The reduced subsequent subarcs end and start at the same epoch.

Computation of radial orbit corrections via global crossover analysis, merging of these corrections into the product file and concatenation of reduced subarcs to one monthly/35d-cycle product.

ASCII coded records
- Time system corrections to UTC
- Manoeuvre information
- Leap second information
- Reference frame identifier (CTS,CIS)
- Satellite ID (COSPAR number)
- Type of orbit (here: precise)
- Time tag in Julian Days since 2000.01.01 12 hours in TDT time scale
- Position of actual center of mass of ERS spacecraft
- Velocity of actual center of mass of ERS spacecraft
- Roll, pitch and yaw angles
- Flags for first ascending state above the equator and quality indicator (manoeuvre)
- Radial orbit correction
- Quality estimates

Product Specification

Spatial Coverage:	global
Spatial Resolution:	approximately 225 km
Time Coverage:	app. 1 month or 1 35d-cycle, consisting of several continuous 5-7-day files
Time Resolution:	30 seconds
Reference System:	CTS - Conventional Terrestial Reference System. Z-axis directed towards the **mean pole** as being derived from the BIH pole series (ERP(BIH)87C02) covering the period January 1980 - October 1986. X-axis fixed by allowing no net rotation about the Z-axis with respect to the initial coordinates (SSC(DGFII)91L01). Y-axis complete system to the right-handed. The offsets to the IERS pole are 45 and 286 mas, i.e. $x_p^{IERS} - 0.045'' = x_p^{DPAF}$, $y_p^{IERS} - 0.286'' = y_p^{DPAF}$ CIS - Conventional Inertial Reference System. This system is referred to the basic epoch 2000.01.01 12 hours designated J2000.0. The axes of the CIS are chosen in such a way, that at the basic epoch J2000.0 they coincide in optimal approximation with the mean equatorial frame defined by the mean celestial pole (Z-axis) and the mean vernal equinox (X-axis).
Coordinate System:	geocentric cartesian coordinates
Time System:	Terrestial Dynamic Time (TDT)

Constants, Models:	according to ERS Standards	
	The main characteristics are	
	Gravity model	PGM-Model computed by D-PAF
	Ocean tides	Schwiderski plus PGM-Model (D-PAF)
	Station coordinates	PGM-Model (D-PAF)
	Air drag	CIRA 86
	Solar flux	final values
	Geomagnetic ind.	final values
	Surface forces	Macro-Model
	Earth rotation	IERS Bulletin B (final values)
	Nutation	IAU 1980 plus corrections (ERS-D-STD-31101)
	Earth radiation	albedo and infrared
	Earth tides	modified Wahr (Zhu et.al. 1991)
Times/Rates of Generation:	D-PAF computes uninterrupted precise orbital subarcs of about 5 to 7 days worth of tracking data. All subarcs of one month/35d-cycle are compiled into one precise orbit product being available for users after a few months.	

Product Presentation

Volume:	app. 22.5 Mbyte per month/35d-cycle (uncompressed), 8 MByte (compressed)
Medium:	CD-ROM, D-PAF FTP Server

Quality Assessment

The quality of the generated orbits is controlled formally and internally.

The formal quality control comprises procedures to check the correct format and to flag periods where the orbit is degraded by manoeuvres or platform anomalies.

Internal quality checks are performed by
- examining the fits of the laser ranges and the altimeter crossovers to the adjusted orbit
- comparing overlapping arc segments

Each product is complemented by records containing quality information like fit of the observations to the orbit, comparison of overlapping orbit segments, crossover rms (root mean square) before and after consideration of a radial orbit correction.

For the revision 1 orbits the radial accuracy is in the order of 12-15 cm, while the revision 2 provides about 8-10 cm radial accuracy.

PRC History

Date	PRC Period	Rev.	PGM Model	Remarks
01.01.92	Jul.91 - Mar.92	0	PGM009	observations: FR/NP SLR ranges only
20.07.93	Jul.91 - Dec.93	1	PGM035	observations: SLR+RA crossovers (QLOPR) improved Satellite Macro Model introduction of radial orbit correction (ROC) computed from QLOPR
24.01.94	Oct.-Dec.92, Jul.91-Mar.92, Aug.93 ff	1	PGM035	ROC flag introduced for no correction due to missing RA data, over land position, above threshold of 60cm Solving also for 1/rev empirical acceleration along-track
07.02.94	Sep.93, Nov.92	1	PGM035	ROC: first + last position over land not flagged "over land" anymore for interpolation reasons (only CIS states)
07.03.94	Oct.93 ff, Jul.91-Mar.92, Dec.92	1	PGM035	ROC: first + last position over land not flagged "over land" for CIS + CTS states
07.94	Jan.94 ff, Jul.91-Mar.92	1	PGM035	RA crossovers are now based on OPR01 data from F-PAF ROC is also computed from OPR01 data
21.03.95	-	-	-	Opening of D-PAF FTP Server for product distribution to PIs
01.04.95	-	-	-	Removal of CCT devices, switch to CD-ROM as distribution medium
Aug.95	Mar.24, 1995 ff	2	PGM055	improved gravity model, product presentation changed to 35d cycle, 1/rev empirical acceleration per day along-track and cross-track
-	E2: Dec.12, 95 ff	2	PGM055	Operational use of PRARE data (Rev.4)
-	E2: Dec.22, 95 ff	2	PGM055	Routine usage of RA crossover data terminated
-	E1: Jan.19, 96 ff, before April 95	2	PGM055	Crossover time bias solved-for
-	E1: Feb.26, 96ff, before April 95, E2: Dec.01, 95 ff	2	PGM055	Use of improved OPR01 (time bias, SPTR, USO drift)
-	E1: Jun.06-Jul.26, 96	2	PGM055	Products generated from SLR data only

The different PGM models can be characterized as follows:

Model	Degree	Basic Model	Differences
PGM009	63	GRIM4-S2	+ first preliminary ERS-1 SLR data
PGM035	66	GRIM4-S3	Spot/Doris data replaced + Topex SLR/Doris data (Oct.-Dec.92) + ERS-1 SLR data (Apr.-Jul.92)
PGM055	69	GRIM4-S4	+ ERS-1 SLR/Crossover data (35d, 168d data)

3.3 ERS Gravity Field Model (ERS-1/2.ORB.EGM)

Definition

The gravitational geopotential produces the principal acceleration on Earth. A precise orbit restitution applying dynamic methods therefore requires a precise model of the geopotential with a resolution requirement depending on the altitude of the satellite. The gravitational acceleration is the gradient of the gravitational geopotential U, which is conveniently expressed by a spherical harmonic expansion:

$$U(r,\phi,\lambda) = \frac{GM}{r}\left[\bar{C}_{00} + \sum_{n=2}^{N}\sum_{m=0}^{n}\left(\frac{a_e}{r}\right)^n \bar{P}_n^m(\sin\phi)\left(\bar{C}_{nm}\cos m\lambda + \bar{S}_{nm}\sin m\lambda\right)\right]$$

where

GM	gravitational constant times mass of earth and atmosphere
r, ϕ, λ	spherical coordinates for geocentric position in radius, latitude and longitude
a_e	mean equatorial radius of the earth
$\bar{P}_n^m$	fully normalized Legendre polynomials (m=0) and associated Legendre functions (m>0), respectively
$\bar{C}_{nm}, \bar{S}_{nm}$	fully normalized harmonic coefficients (m=0 zonals, m>0 tesserals), where
	$\bar{C}_{20} = \bar{C}_{20}(t) = \bar{C}_{20}(T) + \dot{\bar{C}}_{20} \cdot (t-T)$, t time, T=1986.0 reference epoch
n, m	degree, order of development
N	truncation degree

Selected ocean tide parameters and geocentric coordinates of the satellite tracking stations are estimated simultaneously.

The gravity field models are available in the products: **First Generation Models (ORB.EGM1)** and **Second Generation Models (ORB.EGM2).**
The characteristics of the two models is obvious from the following specifications.

Processing Scheme

Input: ERS-1 First Generation Gravity Field Model:

- non-ERS-1 Earth gravity model (satellite-only, including data from about 30 satellites)
- ERS-1 laser range data of the ERS-1 commissioning phase
- tracking station survey ties
- a-priori degree variance models.

ERS-1 Second Generation Gravity Field Model with improved processing and improved data base:
- updated non-ERS-1 Earth gravity model (satellite-only, including data from about 35 satellites)
- ERS-1 laser range data and (updated version) crossover data
- tracking station survey ties
- a-priori degree variance models.

ERS-2 First Generation Gravity Field Model:
- updated ERS-1 Earth gravity model (satellite-only)
- ERS-2 laser range and crossover data of the ERS-2 commissioning phase
- ERS-2 PRARE range and range rate data of the ERS-2 commissioning phase
- tracking station survey ties
- a-priori degree variance models.

ERS-2 Second Generation Gravity Field Model:
- ERS-2 First Generation Gravity model (satellite-only)
- ERS-2 laser range and crossover data
- ERS-2 PRARE range and range rate data
- tracking station survey ties
- a-priori degree variance models.

Algorithm: Numerical integration of satellite's equations of motion and variational equations followed by a least squares adjustment: reduction, accumulation, combination and solution of normal equations.

Output: Spherical harmonic coefficients $\bar{C}_{nm}$, $\bar{S}_{nm}$ of the expansion of the geopotential U in spherical harmonics, ocean tide parameters and geocentric coordinates of the satellite tracking stations.

Product Specification

Spatial Coverage: global

Spatial Resolution: spherical harmonic expansion of the gravitational geopotential complete to degree n=50 and order m=50 plus higher degree coefficients within order 0 (zonals) and resonant orders 14, 28 and 43.

Reference System: Conventional Terrestrial System (CTS) with (geocentric cartesian) Z-axis directed towards the **mean pole** as being derived from the BIH homogeneous pole series (ERP(BIH)87C02) covering the period 1/1980 to 10/1986, Y-axis fixed by allowing no net rotation about the Z-axis with respect to the initial tracking station coordinates (SSC(DGFII)87L03).

Constants: a_e = 6378136 m (IAG 1987),
GM = 3986004.4 * 10^8 m^3/sec^2 (IAG 1987) (including atmosphere)

Generation Time: irregular; for ERS-1 one EGM1 and two updates of EGM2 have been made available.

Quality Assessment

The quality of a model is described by a vector of characteristic statistical numbers derived from the comparison of various quantities and error propagation:

- computation of orbital fits to tracking observations of various satellites and to crossover differences
- comparison of computed and observed geostationary satellite longitude accelerations, of lumped coefficients (pseudo-observations)
- comparison of model coefficients, mean gravity anomalies and geoid undulations derived from the gravity model's coefficients and those of other models
- computation of the rms of estimated standard deviations derived from rigorous error propagation of the coefficients' variance-covariance matrix to mean gravity anomalies, to mean geoid heights and to radial orbit perturbations.

Product Presentation

Volume: the complete data set of $\bar{C}_{nm}$, $\bar{S}_{nm}$ comprises some 3000 parameters with associated error estimates. This amounts to 0.3 MByte/model.
The data sets of simultaneously estimated ocean tide parameters and station coordinates comprise some additional 1800 parameters and coordinates with associated error estimates. This amounts to 0.2 MByte/model.

Medium: ftp-server, CD-ROM

3.4 Quick-Look Ocean Product Records (ERS-1/2.ALT.QLOPR)

Definition

ESA distributes fast delivery radar altimeter data (ERS-1/2.ALT.URA) from the ground stations of Kiruna, Maspalomas, Gatineau and Prince Albert within three hours after measurement (except for Prince Albert data, which are transmitted to D-PAF with one week delay). At D-PAF this data is received, collected and used for further processing (orbit determination, quick-look sea surfaces). The fast delivery altimeter products consist of time-tagged altimeter range, the footprint location, significant wave height, sigma-naught and corrections for tropospheric and ionospheric influence. These corrections are interpolated from standard tables and the tropospheric correction is not based on actual meteorological data. Satellite height plus Earth and ocean tides are missing. For the generation of quick-look ocean products, fast delivery altimeter data are upgraded by applying the precise time correlation between satellite binary time and UTC by merging the satellite orbital height, by recomputing the altimeter path delay correction terms and by applying the tidal correction terms. Starting with revision 5 products, additional range corrections because of a radar altimeter internal timing error (SPTR correction) and of a drift of the ultra stable oscillator (USO drift) are applied.
For ERS-1 the altimeter bias estimate of -41.6 cm from the external calibration and the center of mass correction of 85.2 cm are taken into consideration.
For ERS-2 the center of mass correction of 83.7 cm is taken into consideration. Until revision 5 the ERS-1 absolute altimeter bias of -41.6 cm from the external calibration and the relative bias estimate of 0 cm between ERS-2 and ERS-1 are applied. Starting with revision 6, the original fast delivery data contain a bias of 40.6 cm to take into account the relative bias between ERS-1 and ERS-2. No additional bias then was applied anymore. With revision 6 additional corrections were applied to the fast delivery data. The Doppler sign, which caused errors of +-1.7 cm in range was rectified, the datation offset of +2.45 msec, an improved internal range calibration and a sigma naught decrease of 0.16 dB were applied. Starting with revision 6 also new ionospheric and tidal models are included to the products.
The upgraded fast delivery data then are separated into daily files and operationally transmitted to the D-PAF ftp-server and to ESRIN (Frascati) for distribution.

Processing Scheme

Input (Rev. 6):
- Fast delivery altimeter data (ice and ocean mode) (ERS-1/2.ALT.URA)
- Precise time correlation files
- SPTR and USO drift correction files
- D-PAF Preliminary orbit (ERS-1/2.ORB.PRL)
- Ocean tide model (FES95.2.1 from Grenoble, Le Provost, 1996)
- Ocean loading model (based on FES95.2.1, Andersen, 1996)
- Earth tide model (Schwidersky, 1980)
- Ionosphere model (IRI95, Bilitz, 1996)
- Meteorological data (surface pressure and temperature, integrated water vapour) from ECMWF via UK-PAF given along the ERS-1 and ERS-2 satellite track with 5 seconds spacing
- Estimated radial orbit correction from global orbit error analysis
- EGM96 (Lemoine, 1996) geoid heights given on an equiangular, global grid with 15' grid spacing

Algorithm:

- Fast delivery data editing (criteria see Quality Assessment)
- Calculation of precise time correlation
- Calculation of Earth and ocean tides
- Satellite height interpolation using preliminary orbit
- Update of tropospheric corrections using actual meteorological data
- Update ionospheric correction
- Global crossover analysis to estimate the radial orbit correction
- Linear interpolation of geoid height to altimeter footprint location

Output:

ASCII coded Quick-Look Ocean Product Records

- Time and location of altimeter measurement
- Satellite height above reference ellipsoid (wgs84)
- Corrected altimeter range and sigma
- Significant wave height and sigma naught
- Ocean, Earth tide corrections
- Wet, Dry troposphere corrections
- Ionospheric Correction
- Orbit error estimate from global analysis
- Interpolated Geoid Height
- Record status flag

Product Specification

Spatial Coverage: global, however, due to the ERS-1/2 inclination the latitude range is limited to about < + 82°, − 82°>.

Spatial Resolution: approximately 7 km

Time Coverage: each file contains for one day altimeter data

Time Resolution: 980.4 ms

Reference System: wgs84 reference ellipsoid

Coordinate System: geographical coordinates

Time System: universal time coordinated

Constants:

semi major axis of ellipsoid	=	6378137 m
flattening of ellipsoid	=	1/298.257223563

Time/Rate of Generation: daily, with 2 weeks delay

Quality Assessment

The quality of ocean product records is given primarily by the standard deviation of the fast delivery altimeter measurements coming from the LRDPF (Low Rate Data Processing Facility). In the second place the quality depends on whether the tropospheric path delay corrections are recomputed using actual meteorological data or not. This is defined in the record status flag at the end of each record. This record flag together with the standard deviation of altimeter range is an indicator for the quality of each record.

Quality also is guaranteed by applying coarse editing criteria to fast delivery altimeter records (URA files). In the following table editing criteria applied for each data field in each record are described in detail. If any value in one data record exceeds the specified minimum or maximum, the complete record is not further processed.

Nr.	Description Data Record	Minimum	Maximum
1	data record number	0	78
2	UTC time middle of source	-	-
3	latitude	-82 degree	+82 degree
4	longitude	0 degree	360 degree
5	average wind speed	0 m/sec	50 m/sec
6	standard deviation wind speed	0 m/sec	50 m/sec
7	average swh	0 m	50 m
8	standard deviation swh	0 m	50 m
9	average altitude (corrected)	700 km	900 km
10	standard deviation altitude	0 km	214.7483647 km
11	number of blocks for averaging	18	20
12	product confidence data	-	-
13	average peakiness	0	327.67
14	average digma naught	0 dB	327.67 dB
15	integrated electrojn density	0	32767
16	calibration status	-	-
17	instrument mode	-	-
18	reserved	-	-
19	altitude correction ionosphere	-1 m	0 m
20	altitude correction wet troposphere	-2 m	0 m
21	altitude correction dry troposphere	-3 m	-1 m
22	altitude correction calibration constant	-2147483.647 m	2147483.647 m
23	smoothed open loop HTL	-2147483.647 m	2147483.647 m
24	smoothed open loop AGC	-2147483.647 dB	2147483.647 dB

Product Presentation

Volume: approximately 3 Mbyte/day compressed

Medium: electronic access to D-PAF and ESRIN data base

3.5 Quick-Look Ocean Crossovers (ERS-2.ALT.QLOPC)

Definition

This product only is available for ERS-2.
ESA distributes fast delivery radar altimeter data (ERS2.ALT.URA) from the ground stations of Kiruna, Maspalomas, Gatineau and Prince Albert within three hours after measurement (except for Prince Albert data, which are transmitted to D-PAF with one week delay). At D-PAF this data is received, collected and used for further processing (orbit determination, quick-look sea surfaces). The fast delivery altimeter products consist of time-tagged altimeter range, the footprint location, significant wave height, sigma-naught and corrections for tropospheric and ionospheric influence. These corrections are interpolated from standard tables and the tropospheric correction is not based on actual meteorological data. Satellite height plus Earth and ocean tides are missing. The quick-look ocean crossovers are based on the quick-look ocean products. For the generation of quick-look ocean products, fast delivery altimeter data are upgraded by applying the precise time correlation between satellite binary time and UTC, by merging the satellite orbital height, by recomputing the altimeter path delay correction terms and by applying the tidal correction terms. Starting with revision 5 products, additional range corrections because of a radar altimeter internal timing error (SPTR correction) and of a drift of the ultra stable oscillator (USO drift) are applied. The centre of mass correction of +83.7 cm is applied for all ranges. Until revision 5 the ERS-1 absolute altimeter bias from the external calibration of -41.6 cm and the estimate of the relative bias between ERS-2 and ERS-1 of 0 cm is applied. Starting with revision 6 the original fast delivery data contain a bias of 40.6 cm to take into account the relative bias between ERS-1 and ERS-2. No additional bias then was applied anymore. With revision 6 additional corrections were applied to the fast delivery data. The Doppler correction sign, which caused errors of +-1.7 cm in range was rectified, the datation offset of +2.45 msec, an improved internal range calibration and a simga naught decrease of 0.16 dB were applied. Starting with revision 6 additionaly new ionospheric and tidal models are included to the products. At crossover locations of ascending and descending tracks, then sea surface height differences, significant wave height differences and wind speed differences are computed. Crossover records then are separated into daily files, where the ascending or descending crossover time is within this day, while the corresponding crossover time of the other track is separated by less than one repeat cycle (35 days). Crossover files then are operationally transmitted to the D-PAF ftp-server and to ESRIN (Frascati) for distribution.

Processing Scheme

Input (Rev. 6):

- Fast delivery altimeter data (ice and ocean mode) (ERS-2.ALT.URA)
- Precise time correlation files
- SPTR and USO drift correction files
- D-PAF Preliminary orbit (ERS-2.ORB.PRL)
- Ocean tide model (FES95.2.1, Le Provost, 1996)
- Tidal loading model (FES95.2.1, Andersen, 1996)
- Earth tide model (Schwiderski, 1980)
- Ionosphere model (IRI95) (Bilitza, 1996)
- Meteorological data (surface pressure and temperature, integrated water vapour) from ECMWF via UK-PAF given along the ERS-2 satellite track with 5 seconds spacing

Algorithm:

- Fast delivery data editing (criteria see Quality Assessment)
- Calculation of precise time correlation
- Calculation of Earth and ocean tides
- Satellite height interpolation using preliminary orbit
- Update of tropospheric corrections using actual meteorological data
- Update ionospheric correction
- Approximation of crossover location
- Precise determination of crossover time and location
- Precise interpolation of sea surface height, swh and wind speed to crossover times and computation of differences.

Output:

ASCII coded Quick-Look Ocean Product Records
- Geographical location of crossover point
- UTC times of ascending and descending arcs at crossover point with respect to 1.1.1990
- Sea surface height of ascending arc at crossover point above reference ellipsoid (wgS84),
- Significant wave height and wind speed of ascending arc at crossover point
- Sea surface height, significant wave height and wind speed differences at crossover point. Differences are defined as ascending arc value minus descending arc value.
- Standard deviations of sea surface height difference, swh difference and wind speed difference, determined by least squares estimation.

Product Specification

Spatial Coverage: global, however, due to the ERS-2 inclination the latitude range is limited to about $< +82^\circ, -82^\circ>$.

Spatial Resolution: not applicable

Time Coverage: each file contains crossover data for one day with preceding 35 days (repeat cycle).

Time Resolution: not applicable

Reference System: wgs84 reference ellipsoid

Coordinate System: geographical coordinates

Time System: universal time coordinated

Constants:

semi major axis of ellipsoid	=	6378137 m
flattening of ellipsoid	=	1/298.257223563

Time/Rate of Generation:

daily, with 2 weeks delay

Quality Assessment

The quality of ocean product crossovers is given primary by the standard deviation of the crossover estimates. In the second place the quality depends on the editing criteria used for the crossovers and the quick-look ocean product records (QLOPR). For the editing criteria applied before the generation of the QLOPR see in the documentation there. Additional editing criteria are applied for the crossover computation. QLOPR records are not used for the crossover computation if:

- Bathymetry is higher than -10 m
- Absolute value of difference of sea surface height to mean sea surface is higher than 3 m
- Standard deviation of range is higher than 0.5 m
- Significant wave height is higher than 12 m
- Wind speed is higher than 15 m/sec

All QLOPR records passing these criteria then are used for crossover computation. Crossovers are not computed if less than 10 measurements within a 20 seconds window around the crossover point are available for one of the two arcs. Finally crossovers exceeding a limit of 1 meter are not written to the QLOPC products.

Product Presentation

Volume: less than 1 Mbyte/day compressed

Medium: electronic access to D-PAF and ESRIN data base

3.6 Quick-Look Sea Surface Height Model (ERS-1/2.ALT.SSHQL)

Definition

The Quick-Look Sea Surface Height Model is a digital data set consisting of a global set of sea surface height point values with respect to a particular reference ellipsoid. Besides the sea surface heights, geographically resampled and averaged significant wave heights and wind speed and an estimated rate of change for the sea surface heights, with respect to a previous model are included in the product. The product is based on one 35 day repeat cycle of upgraded ERS-1/2 fast delivery altimeter data, which are generated for the quick-look ocean products (QLOPR). It is available every week within 2 weeks after reception of fast delivery altimeter. Products are not generated for the 3 day repeat cycle phases. A detailed description of QLOPR can be found in the related chapters of this document.

Processing Scheme

Input:
- Fast delivery altimeter data records: ERS-1/2.ALT.URA
- Precise time correlation files
- Preliminary orbit: ERS-1/2.ORB.PRL
- Ocean tide model
- Earth tide model
- Ionosphere model
- Meteorological data from UK-PAF given along satellite track
- Estimated radial orbit correction from global orbit error analysis
- Pre ERS-1/2 sea surface height models and high resolution geoids

Algorithm:
- Calculation of Earth and ocean tides
- Satellite height interpolation using preliminary orbit
- Update of tropospheric corrections using actual meteorological data
- Update of ionospheric correction using the IRI90 model
- Crossover analysis with global modeling of radial orbit correction for the complete time period of the model
- Application of corrections due to estimated radial orbit correction
- Grid value interpolation of sea surface heights, significant wave heights and wind speed
- Subtraction of long wavelength features of sea surface height differences for sea height change estimation

Output:
- Sea surface heights above reference ellipsoid
- Significant wave heights
- Wind speed
- Sea surface height change with respect to previous repeat cycle

Product Specification

Spatial Coverage:	global, however, due to the ERS-1/2 inclination the latitude range is limited to about < + 82°, − 82°>.
Spatial Resolution:	grid spacing 15', corresponding to a spatial distance of some 28 km at the equator
Time Coverage:	one full repeat cycle (35 days).
Reference System:	sea heights refer to Geodetic Reference System 1980 (GRS80) ellipsoid
Coordinate System:	geographical coordinates
Constants:	semi major axis of ellipsoid = 6378137 m flattening of ellipsoid = 1/298.257222101
Time/Rate of Generation:	weekly, with a delay of 2 to 4 weeks

Quality Assessment

Quality records containing the number of crossovers taken for the orbit error analysis, the a-priori rms of the crossover discrepancies, the rms estimate of the a-posteriori crossover discrepancies, the mean values and rms of differences to external sea surface models, the number of records taken/rejected are included in the product.

Product Presentation

Volume:	For SSHQL's data sets with global coverage (< + 82°, − 82°>) the approximate product volume is 22 MByte. This includes all four data sets as well as associated quality parameters.
Medium:	electronic access to D-PAF data base

Remarks

Different SSHQL's can be uniquely identified by the time coverage and the SSHQL acronym. The product name 'SSHQL_yydoy' indicates a quick-look sea surface height model, which contains 35 days of data till the last day of processing period, defined by day of year 'doy' and year 'yy' (year-1900).

3.7 Sea Surface Height Model (ERS-1/2.ALT.SSH)

Definition

The Sea Surface Height Model is a digital data set consisting of a global set of sea surface height point values with respect to a particular reference ellipsoid on a regular equiangular geographical grid. The product is based on ERS-1/2 OPR02 altimeter data, processed and compiled at F-PAF, and the D-PAF precise orbits. Two different sea surface height model versions are produced. The stationary solution, a most reliable estimate of a long period (mean) sea surface height model and short period solutions, representing the sea surface for a limited time period. Samples for the product are shown below.

Processing Scheme

Input:
- Level 2 altimeter data records: ERS-1/2.ALT.OPR
- Precise orbit: ERS-1/2.ORB.PRC
- Pre ERS-1/2 sea surface height models

Algorithm:
- Preprocessing of ERS-1/2 OPR02 altimeter data records and quality control
- Crossover analysis with global modeling of radial orbit errors for the complete time period of the model
- Apply corrections due to estimated radial orbit correction
- Grid value interpolation of sea surface heights

Output:
- Sea surface heights above reference ellipsoid
- Standard deviations of sea surface heights from least squares approach

Product Specification

Spatial Coverage: global, however, due to the ERS-1/2 inclination the latitude range will be limited to about < + 82°, − 82°>.

Spatial Resolution: depends on product version as well as on repeat cycle. The stationary model has a grid spacing of 6' (corresponding to a spatial distance of some 11 km at the equator). Short period SSH's will have a grid spacing of 15' (corresponding to a spatial distance of some 28 km at the equator), depending on a sufficient input data coverage (repeat cycle).

Time Coverage: depends on product version. The stationary model will cover a time period that is as long as the acquisition period of the level 2 records available at the D-PAF. The time coverage of short period SSH is one cycle of the 35-days repeat orbit or one cycle of the 168-days repeat orbits, but with an increased spatial resolution.

Reference System: Sea surface heights refer to wgs84 ellipsoid

Coordinate System:

geographical coordinates

Constants:

semi major axis of ellipsoid	=	6378137 m
flattening of ellipsoid	=	1/298.257222101

Time/Rate of Generation

The stationary model is generated every 6 months. The first time it is produced when 6 months of level 2 altimeter data for the 35 day repeat cycle are available. The short period solutions are produced every month (for 3 day repeat cycle), or for every new complete repeat cycle.

Revision Overview

REV 0: Orbits based on PGM009 gravity field (Revision 0 orbits)

REV 1: Orbits based on PGM035 gravity field (Revision 1 orbits)

REV 2: Orbits based on PGM055 gravity field (Revision 2 orbits)

REV 3: Orbits based on PGM055 gravity field (Revision 2 orbits). Updated OPR data with additional range and geophysical corrections used for SSH generation.

Quality Assessment

Every sea surface height is supplemented by its individual estimated standard deviation. Quality records containing the number of crossovers taken for the orbit error analysis, the a-priori rms of the crossover discrepancies, the rms estimate of the a-posteriori crossover discrepancies, the mean values and rms of differences to external sea surface models, the number of records taken/rejected are included in the product. Regarding all these quality parameters together, an overall quality parameter between 0 (best) and 9 (worst) is defined and included into the global products table.

Product Presentation

Volume: For the sea surface height products the approximate product volume is 79 MByte for the stationary solution and 12 MByte for the short period models.

Medium: Sea surface height products are provided as digital data sets on CD.

Remarks

Different SSH versions can be uniquely identified by the time coverage and and a letter indicating the model type. The product name 'SSH_Lyydoy' or 'SSH_Syydoy' indicates a stationary (long period) sea surface height model for 'L' or a short period solution for 'S'. The 'yy' and 'doy' acronyms give the year (year-1900) and the day of year of last level 2 altimeter data used for the product.

3.8 Ocean Geoid (ERS-1/2.ALT.OGE)

Definition

The Oceanic Geoid is a digital data set consisting of a global set of point values of geoid heights with respect to a particular reference ellipsoid. The heights are provided for the nodes of a regular equiangular geographically Earth fixed grid. During the ERS-1/2 mission there are different updates of the product. Every time, when a new stationary sea surface height model (ERS-1/2.ALT.SSH) is available a new geoid product, containing all available level 2 altimeter data is generated. A product sample is shown below.

Processing Scheme

Input:

- Stationary version of sea surface height model: ERS-1/2.ALT.SSH
- ERS-1 gravity field model as a-priori information: ERS-1/2.ORB.EGM
- Surface gravity in terms of block mean values
- Global estimates of the dynamic topography

Algorithm:

- Preparation and correction of surface gravity data
- Least squares harmonic analysis of surface gravity data set
- Preparation and correction of stationary sea surface model
- Least squares harmonic analysis of stationary sea surface model
- Spectral combination of a-priori gravity field model, surface gravity data and sea surface model
- Generation of gridded geoid data

Output:

- Geoid heights above reference ellipsoid
- Standard deviations of geoid heights

Product Specification

Spatial Coverage: global

Spatial Resolution: grid spacing 30', corresponding to a spatial distance of some 56 km at the equator

Time Coverage: product will cover a time period that is as long as the acquisition period of level 2 records available at D-PAF

Reference System: The reference ellipsoid and the normal gravity field, the geoid heights refer to, are those of the wgs84

Coordinate System: geographical coordinates

Constants:	semi major axis of ellipsoid	=	$6378137\ m$
	flattening of ellipsoid	=	1/298.257222101
	Earth mass times gravity constant	=	$398600.5\ 10^9 \frac{m^3}{s^2}$
	Earth rotation	=	$0.00007292115\ \frac{rad}{s}$

Time/Rate of Generation: The ocean geoid is generated every six months. The first time it is produced when 6 months of level 2 altimeter data for the 35 day repeat cycle are available.

Revision Overview

REV 0: From revision 0 SSH with orbits based on PGM009 gravity field (Revision 0 orbits)

REV 1: From revision 1 SSH with orbits based on PGM035 gravity field (Revision 1 orbits)

REV 2: From revision 2 SSH with orbits based on PGM055 gravity field (Revision 2 orbits)

REV 3: From revision 3 SSH with orbits based on PGM055 gravity field (Revision 2 orbits) and with updated OPR data with additional range and geophysical corrections used for SSH generation.

Quality Assessment

Every geoid height is supplemented by its rms estimate. Additional quality records are added to the product, which are containing rms-value and mean difference to external geoid models and other quality parameters.

Product Presentation

Volume: The ocean geoid product has a volume of about 3 MByte

Medium: Ocean geoid products are provided as digital data sets on CD.

Remarks

Different geoid models can be uniquely identified by the product acronym. 'OGE___yydoy' indicates that the last data used for the geoid model generation is of day of year 'doy' in year 'yy' (year-1900). Due to the global geoid estimation procedure, which requires data on land and oceans, also geoid heights over land are included to the product.

3.9 Sea Surface Topography (ERS-1/2.ALT.TOP)

Definition

The Sea Surface Topography provides an estimate of the large scale structure of the deviations between the geoid and the mean sea surface in terms of a normalized surface spherical harmonic series of the form

$$h(\lambda,\phi) = \sum_{n=0}^{N_{max}} \sum_{m=0}^{n} \left\{ A_{nm} \cos(m\lambda) + B_{nm} \sin(m\lambda) \right\} P_{nm}(\sin\phi)$$

with λ the longitude and ϕ the geodetic latitude. The maximum degree and order N_{max} will be in the range between 10 and 15. The P_{nm} are normalized according to [Heiskanen/Moritz 1967].

According to its physical meaning, the harmonic series above is the potential function of the vector field that represents the large scale ocean circulation. A product sample is shown below.

Processing Scheme

Input:
- Stationary version of sea surface height model: ERS-1/2.ALT.SSH
- ERS-1/2 gravity field model: ERS-1/2.ORB.EGM

Algorithm:
- Calculation of differences between the stationary sea surface height model and the long wavelength geoidal features from ERS-1/2 gravity field model.
- Least squares spectral filtering

Output:
- Normalized harmonic coefficients A_{nm} and B_{nm} for every degree n and order m up to maximum degree $\leq N_{max}$ (units meter)
- Estimated standard deviations of harmonic coefficients

Product Specification

Spatial Coverage: global, however that values of h determined over land don't have any physical meaning! In addition, the harmonic series should only be used within the latitude range of $< +82°, -82°>$.

Spatial Resolution: Limited by N_{max}. The corresponding half wavelength distance at the Earth's surface is $180°/N_{max}$ or some $20000/N_{max}$ km.

Time Coverage: product will cover a time period that is as long as the acquisition period of level 2 records available at D-PAF

Reference System:	sea surface topography values h don't refer to an absolute reference surface. The relationship to geoid heights n and sea surface heights s is such that $s = n + h$
Coordinate System:	geographical coordinates
Time/Rate of Generation	The sea surface topography is generated every six months. The first time it is produced when 6 months of level 2 altimeter data for the 35 day repeat cycle are available.

Revision Overview

REV 0:	From revision 0 SSH with orbits based on PGM009 gravity field (Revision 0 orbits)
REV 1:	From revision 1 SSH with orbits based on PGM035 gravity field (Revision 1 orbits)
REV 2:	From revision 2 SSH with orbits based on PGM055 gravity field (Revision 2 orbits)
REV 3:	From revision 3 SSH with orbits based on PGM055 gravity field (Revision 2 orbits) and with updated OPR data with additional range and geophysical corrections used for SSH generation.

Quality Assessment

Sea surface topography harmonic coefficients are supplemented by its rms estimate. Additional quality records are added to the product, which are containing rms-value and mean difference to external sea surface topography models.

Product Presentation

Volume:	The sea surface topography product has a volume of about 0.2 MByte.
Medium:	Sea surface topography products are provided as digital data set on CD.

Remarks

Different sea surface topography models can be uniquely identified by the product acronym.

3.10 PRARE Ionospheric Product (ERS2.PRS.ION)

Definition

The PRARE Space Segment on ERS-2 transmittes simultaneously two down-link signals in X- and S-band. The observed travel time difference of both signals $\Delta\tau_{XS}$ is a direct measure of the slant total electron content (TEC_s) of the ionosphere along the transmission path:

$$TEC_s = \frac{c}{40.25}\left[\frac{1}{f_S^2} - \frac{1}{f_X^2}\right]^{-1} \Delta\tau_{SX} \quad [electrons/m^2]$$

The slant TEC is also used to calculate the vertical TEC, the value which corresponds to the ellipsoid normal of the satellite location. This can only be derived using approximation formulas [Jopek, 1990]. The vertical TEC can then be used for a direct correction of the 1-way altimeter ranges or a global mapping of the ionosphere.

Processing Scheme

Input:
- observed S/X travel time delay
- corresponding time tag
- station coordinates
- predicted orbit (PRARE elements)

Algorithm:
- decoding of PRARE raw data dumps
- division into single passes
- decoding of ground station low rate bytes
- screening of X/S travel time delays
- calculation of TEC_s and TEC_v
- concatenation of single passes to a weekly product

Output: ASCII coded PRARE Ionospheric Product Records
- satellite COSPAR id
- time tag
- station COSPAR id
- azimuth and elevation
- 1-way range ground station to satellite
- ground station meteorological data: pressure, temperature and humidity
- X-band versus S-band travel time delay
- total electron content along ray path
- total electron content scaled into vertical direction (ellipsoid normal to satellite location)
- record status flags
- quality estimate

Product Specification

Spatial Coverage:	global, dependent on ground station distribution and visibility conditions
Spatial Resolution:	N/A
Time Coverage:	length of an ERS-2 pass
Time Resolution:	the X- versus S-band travel time delay measurement is performed 1/sec in the ground station and is available in the connected monitor & test computer and in the PRARE Space Segment every 4 seconds as an averaged value.
Reference System:	N/A
Coordinate System:	N/A
Time System:	universal time coordinated
Constants, Models:	semi major axis of ellipsoid = 6378137 m flattening of ellipsoid = 1/298.257222101 velocity of light = 299792458 m/sec PRARE X-band frequency = 8.489 GHz PRARE S-band frequency = 2.248 GHz height of the lower ionosphere boundary = 80000 m
Times/Rates of Generation:	daily after raw data dump at Master Station. Product will be available as a weekly accumulated product.

Quality Assessment

The ionospheric measurement is performed by comparing the demodulated 10 MHz PN-code of the X-Band with the 1 MHz PN-code of the S-Band. The accuracy of that time difference is better than 1.0 nsec which is due to the noise of the used S-band. The quality of the ionospheric product records is therefore given primary by the residuals of a polynomial fit of the observed travel time delays within a pass.

Additionally during the ERS-2 commissioning phase a calibration/validation campaign will take place. The main goal of this campaign will be the determination of a bias parameter using results from GPS and Faraday rotation measurements or the common view technique. This bias will be added to the raw ionospheric measurements and distributed in the weekly PRARE reports.

Product Presentation

Volume: approximately 3.4 Mbyte/day

Medium: FTP-server at D-PAF, CD-ROM

3.11 Rapid Orbit (ERS-2.ORB.RPD)

Definition

Rapid orbits (RPD) are based on fast delivery tracking data (SLR, radar altimeter heights, PRARE range and doppler data). These orbits are an improvement of the initial knowledge of the orbit but don't provide the optimal fit to the real S/C motion. This information is used for the quick (near-real time) 3d location of the on board sensors or the generation of near-real time products (ROPR). The rapid orbit product consists of the satellite ephemeris (position and velocity vectors) including time tag, given in the Conventional Terrestrial Reference Frame (CTS) together with the nominal attitude information. The Terrestrial Dynamic Time (TDT) is chosen as the time reference.

Processing Scheme

Input:

- observations: Laser ranges (Q/L or FGNP), radar altimeter heights (downweighted), PRARE range and doppler observations
- Measurement model data: centre of mass correction, tropospheric corrections
- Reference frame model data: Earth rotation parameters, nutation model, station coordinates
- Dynamical model data: Earth gravity model, Earth and ocean tides, drag model, solar activity data, third body attractions

Algorithm:

Numerical integration of satellite's equation of motion and its variational equations, reduction of observations and iterative least squares adjustment.
Processing Parameters

- Orbital elements at initial epoch
- Daily or subdaily scaling factor for atmospheric drag
- Once per revolution empirical acceleration (cross- and along-track)

Constraints: To avoid any discontinuities of subsequent arcs over ocean, all orbits start and end over land (Antarctica). The subsequent arcs end and start at the same epoch.

Output:

ASCII coded records

- Time system corrections to UTC
- Manoeuvre information
- Leap second information
- Reference frame identifier (CTS)
- Satellite ID (COSPAR number)
- Type of orbit (here: rapid)
- Time tag in Julian Days since 2000.01.01 12 hours in TDT time scale
- Position of actual center of mass of ERS spacecraft
- Velocity of actual center of mass of ERS spacecraft
- Roll, pitch and yaw angles
- Flags for first ascending state above the equator and quality indicator (manoeuvre)
- Quality estimates

Product Specification

Spatial Coverage:	global
Spatial Resolution:	approximately 400 km
Time Coverage:	continuous 1-day data file (appr. 0:00 UTC till shortly after 24:00 UTC).
Time Resolution:	60 seconds
Reference System:	CTS - Conventional Terrestial Reference System. Z-axis directed towards the **mean pole** as being derived from the BIH pole series (ERP(BIH)87C02) covering the period January 1980 - October 1986. X-axis fixed by allowing no net rotation about the Z-axis with respect to the initial coordinates (SSC(DGFII)91L01). Y-axis complete system to the right-handed. The offsets to the IERS pole are 45 and 286 mas, i.e. x_p^{IERS} - 0.045" = x_p^{DPAF} , y_p^{IERS} - 0.286" = y_p^{DPAF}
Coordinate System:	geocentric cartesian coordinates
Time System:	Terrestrial Dynamic Time (TDT)
Constants, Models:	according to ERS Standards

The main characteristics are

Gravity model	PGM-Model computed by D-PAF
Ocean tides	Schwiderski plus PGM-Model (D-PAF)
Station coordinates	PGM-Model (D-PAF)
Air drag	CIRA 86
Solar flux	predicted values
Geomagnetic ind.	predicted values
Surface forces	Macro-Model
Earth rotation	IERS Bulletin A (predicted)
Nutation	IAU 1980 plus corrections (ERS-D-STD-31101)
Earth radiation	albedo and infrared
Earth tides	modified Wahr (Zhu et.al. 1991)

Times/Rates of Generation: D-PAF computes 1-day rapid orbits once per day. The orbits are immediately stored on the D-PAF FTP server.

Product Presentation

Volume: 190 kByte per daily product (uncompressed), 70 kByte compressed

Medium: D-PAF FTP Server

Quality Assessment

The quality of the generated orbits is controlled formally and internally.

The formal quality control comprises procedures to check the correct format and to flag periods where the orbit is degraded by manoeuvres or platform anomalies.

Internal quality checks are performed by
- examining the fits of the measurements to the adjusted orbit with respect to the number of used observations
- comparing overlapping arc segments

Each product is complemented by records containing quality information like fit of the observations to the orbit, comparison of overlapping orbit segments, crossover rms (root mean square).

The radial accuracy is in the order of 10 cm.

RPD History

Date	RPD Period	Rev./Mod	PGM Model	Remarks
01.07.97	-	0/1	PGM073w	

The different PGM models can be characterized as follows:

Model	Degree	Basic Model	Differences
PGM073w	72	GRIM4-S4	+ ERS-1 SLR/Crossover data (35d, 168d data) + ERS-2 PRARE data + GFZ-1 data + terrestrial data

3.12 Rapid Ocean Product Records (ERS-2.ALT.ROPR)

Definition

ESA distributes fast delivery radar altimeter data (ERS-1/2.ALT.URA) from the ground stations of Kiruna, Maspalomas and Gatineau within three hours after measurement. At D-PAF this data is received, collected and used for further processing (orbit determination, quick-look sea surfaces). Prince Albert data are also transmitted to D-PAF, with one week delay however, hence they are not included in the final product. The fast delivery altimeter products consist of time-tagged altimeter range, the footprint location, significant wave height, sigma naught and corrections for tropospheric and ionospheric influence. These corrections are interpolated from standard tables. The dry and wet tropospheric correction are not based on actual meteorological data. Satellite height plus Earth and ocean tides are missing. For the generation of rapid ocean products, fast delivery altimeter data are upgraded by merging the satellite orbital height, by recomputing the altimeter path delay correction terms and by applying the tidal correction terms. For this purpose new ionospheric and tidal models are included to the products.
Some additional corrections to the fast delivery data already were applied at the ground stations. The Doppler sign, which caused errors of +-1.7 cm in range was rectified. The datation offset of +2.45 msec, an improved internal range calibration and a sigma naught decrease of 0.16 dB were applied. For rapid ocean product generation the 87.3 cm distance of the antenna and the centre of gravity is considered. The original fast delivery data already contain a bias value of 40.6 cm which should take into account the relative bias between ERS-1 and ERS-2. Thus no additional bias is applied.
The upgraded fast delivery data then are separated into daily files and operationally transmitted to the D-PAF ftp-server for distribution.

Processing Scheme

Input:

- Fast delivery altimeter data (ice and ocean mode) (ERS-2.ALT.URA)
- D-PAF rapid orbit (ERS-2.ORB.RPD)
- Ocean tide model (FES95.2.1, Le Provost, 1996)
- Ocean loading model (based on FES95.2.1, Andersen, 1996)
- Earth tide model (Schwiderski, 1980)
- Ionosphere model (IRI95, Bilitza, 1996)
- The wet tropospheric correction is retrieved from a wet tropospheric model, which was exclusively implemented for the rapid ocean product record generation. The model is based on ERS-1 radiometer data of a 3-year time period. The model considers day/night and monthly variations of the wet troposphere. Quality tests have shown an accuracy of the wet tropospheric model of better than ± 3 cm.
- EGM96 (Lemoine, 1996) geoid heights given on an equiangular, global grid with 15' grid spacing

Algorithm:	– Fast delivery data editing (criteria see Quality Assessment) – Calculation of Earth and ocean tides – Satellite height interpolation using rapid orbit – Update of wet tropospheric corrections using a wet tropospheric model – Update of ionospheric correction – Bicubic interpolation of the geoid height at the altimeter footprint location
Output:	ASCII coded Rapid Ocean Product Records – Time and location of altimeter measurement – Satellite height above the reference ellipsoid (wgs84) – Corrected altimeter range and sigma – Significant wave height and sigma naught – Ocean tide+tidal loading and Earth tide correction – Wet and dry tropospheric correction – Ionospheric correction – Interpolated geoid height – Record status flag

Product Specification

Spatial Coverage:	global, however, due to the ERS-1/2 inclination the latitude range is limited to about < + 82°, – 82° >.
Spatial Resolution:	approximately 7 km
Time Coverage:	each file contains altimeter data for one day
Time Resolution:	980.4 ms
Reference System:	wgs84 reference ellipsoid
Coordinate System:	geographical coordinates
Time System:	universal time coordinated
Constants:	semi major axis of ellipsoid = 6378137 m flattening of ellipsoid = 1/298.257223563
Time/Rate of Generation:	daily, with one day delay

Quality Assessment

The quality of the rapid ocean product records is given primarily by the standard deviation of the fast delivery altimeter measurements coming from the LRDPF (Low Rate Data Processing Facility). In the second place the quality depends on the orbit accuracy and the accuracy of the models used to compute the altimeter path delay and the tidal corrections. This is defined in the record status flag at the end of each record. This record flag together with the standard deviation of altimeter range is an indicator for the quality of each record.

Quality also is guaranteed by applying coarse editing criteria to fast delivery altimeter records (ERS-2.ALT.URA files). In the following table the editing criteria applied for each data field in each record are described in detail. If any value in one data record exceeds the specified minimum or maximum, the complete record is not further processed.

Nr.	Description Data Record	Minimum	Maximum
1	data record number	0	78
2	UTC time middle of source	-	-
3	latitude	-82 degree	+82 degree
4	longitude	0 degree	360 degree
5	average wind speed	0 m/sec	50 m/sec
6	standard deviation wind speed	0 m/sec	50 m/sec
7	average swh	0 m	50 m
8	standard deviation swh	0 m	50 m
9	average altitude (corrected)	700 km	900 km
10	standard deviation altitude	0 km	214.7483647 km
11	number of blocks for averaging	18	20
12	product confidence data	-	-
13	average peakiness	0	327.67
14	average sigma nought	0 dB	327.67 dB
15	integrated electron density	0	32767
16	calibration status	-	-
17	instrument mode	-	-
18	reserved	-	-
19	altitude correction ionosphere	-1 m	0 m
20	altitude correction wet troposphere	-2 m	0 m
21	altitude correction dry troposphere	-3 m	-1 m
22	altitude correction calibration constant	-2147483.647 m	2147483.647 m
23	smoothed open loop HTL	-2147483.647 m	2147483.647 m
24	smoothed open loop AGC	-2147483.647 dB	2147483.647 dB

Product Presentation

Volume: approximately 3 Mbyte/day compressed

Medium: electronic access to D-PAF and ESRIN data base

4. References

4.1 Applicable Documents

ER-IS-EPO-GE-0102	EARTHNET ERS-1 Central Facility to Processing and Archiving Facility Interface Specifications (Issue 3.2, 15.4.1990)
ER-IS-EPO-GS-0201	ERS-1 Ground Stations Products Specifications (Issue 2.2, 24.9.1991)
ER-IS-EPO-GS-0204	ERS-1 Ground Stations Products Specifications for Users (Issue 2.3, 26.9.1991)
ERS-D-PSD-30000	RAT Product Specification Document (Issue 1.1, 31.5.1990)
ERS-D-STD-31101	ERS-1 Standards used at D-PAF (Issue 1.1, 1991)
C1-EX-MUT-A2-07-CN	Cersat Products General Description (Issue 1.0, 26.12.1992)
C1-EX-MUT-A21-01-CN	Cersat Altimeter Products User Manual (Issue 2.0, 20.8.1992)

4.2 Publications

Andersen O.B., Ray R., *Tidal Loading for FES95.2.1;* personal communication, 1996

Anzenhofer M., Gruber T., Rentsch M., *D-PAF Sea Surface Models Generated from different Data Sources,* in: Proceedings of the Second ERS-1 Symposium - Space at the Service of our Environment, Hamburg 1993; ESA SP-361 (January 1994), Volume 2, 783-788; 1993

Anzenhofer M., Gruber T., *A New Stationary Sea Surface Combining One Year Upgraded ERS-1 Fast Delivery Data and 1987 Geosat Altimeter Data,* Bulletin Geodesique, Vol. 69, 157-163, 1995

Bilitza D., *International Reference Ionosphere 1990,* National Space Science Data Center, NSSDC/WDC-A-R&S 90-20, Greenbelt, Maryland 1990

Bilitza B., *International Reference Ionosphere 1995,* personal communication, 1996

Bosch W., Gruber Th., *Altimetry based Geoid Determination at the German Processing and Archiving Facility within the ERS-1 Project;* IAG Symposium No. 106 - Determination of the Geoid, Present and Future; Springer Verlag; New York; 1991

Gruber Th., Anzenhofer M., Rentsch M., *Quick-Look Ocean Products Generation at D-PAF,* in: Proceedings of the Second ERS-1 Symposium - Space at the Service of our Environment, Hamburg 1993; ESA SP-361 (January 1994), Volume 2, 1191-1196; 1993

Gruber Th., Anzenhofer M., *The GFZ 360 Gravity Field Model;* Proceedings of Session G3 of XVIII General Assembly of European Geophysical Society; Wiesbaden; 1993

Gruber Th., Anzenhofer M., Rentsch M., *The 1995 GFZ High Resolution Gravity Model;* Proceedings of IAG Symposium No. 116, Global Gravity Field and its Temporal Variations; Springer Verlag; 1996

Heiskanen W., Moritz H., *Physical Geodesy;* W.H. Freeman and Company, San Francisco, 1967

Lemoine F., *The EGM96 Gravity Field Model;* Paper pres. at IAG Symposium: Gravity Geoid and Marine Geodesy, Tokyo, 1996

Le Provost C., Lyard F., Moline J.M., Genco M.L., Rabilloud F., *A hydrodynamic ocean tide model improved by assimilating a satellite altimeter derived data set;* Paper submitted to Journal of Geophysical Research, 1996

Levitus S. *Climatological Atlas of the World Ocean* NOAA Professional, paper 13 1982

Massmann F-H., Reigber Ch., Ko@nig R., Raimondo J.C., Rajasenan C., *ERS-1 Orbit Information provided by D-PAF;* in: Proceedings of the Second ERS-1 Symposium - Space at the Service of our Environment, Hamburg 1993; ESA SP-361 (January 1994), Volume 2, 765-770; 1993

Rapp R.H., Wang Y.M., Pavlis N.K., *The Ohio State 1991 Geopotential and Sea Surface Topo- graphy Harmonic Coefficient Models;* Ohio State University, Department of Geodetic Science and Surveying, Report No. 410; Ohio State University; Columbus, Ohio; 1991

Reigber Ch. *Gravity Field Recovery from Satellite Tracking Data,* in: Lecture Notes in Earth Sciences, Volume 25, Theory of Satellite Geodesy and Gravity Field Determination, Springer Verlag, Berlin, Heidelberg, New York, 197-234, 1989

Rummel R., *Principle of Satellite Altimetry and Elimination of Radial Orbit Errors,* Lecture Notes of International Summer School of Theoretical Geodesy, Trieste 1992

Saastamoinen J., *Atmospheric Correction for the Troposphere and Stratosphere in Radio Ranging Satellites;* in: The Use of Artificial Satellites for Geodesy, Geophys.Monogr.Ser.; 15, 247-251; 1972

Schwiderski E.W., *On Charting Global Tides;* Rev. of Geophys. Space Phys.; 18(1); 1980

Schwintzer P., Reigber Ch., Bode A., Kang Z., Zhu S.Y., Massmann F.-H., Raimondo J.C., Biancale R., Balmino G., Lemoine J.M., Moynot B., Marty J.C., Barlier F., Boudon Y., *Improvement of Global Gravity Field Modelling for ERS-1* in: Proceedings of the Second ERS-1 Symposium - Space at the Service of our Environment, Hamburg 1993; ESA SP-361 (January 1994), Volume 2, 771-775; 1993

Tapley B.D., Lundberg J.B., Born G.H., *The Seasat Altimeter Wet Tropospheric Range Correction revisited;* Marine Geodesy; 8, 221-248; 1984

Zhu S.Y., Reigber Ch., Massmann F.-H., *Some Improvements in the Solid Earth Tide Model;* Manuscripta Geodaetica, 16, 215-220, 1991

Zhu S.Y., Reigber Ch., Massmann F.-H., *ERS Standards used at D-PAF;* The German PAF for ERS, Technical Note ERS-D-STD-31101, Sept. 1996

5. ION Format

5.1 Preliminary Orbit (ERS-1/2.ORB.PRL) Format

The preliminary orbit product consists of a chronologically ordered sequence (every 120s) of ASCII coded ephemerides records. Each file is preceded by a data set identification record and a data header record containing overall information about the file. The trajectory records are presented in two blocks: first in the inertial reference frame (CIS) and then in the terrestrial reference frame (CTS). At the end of the product there is a block of records containing quality information. So the product will be composed of the following records

Identifier	Information
DSIDP	Data Set Identification Record
STATE	PRL Data Header Record
STINER	PRL Trajectory Records (Inertial Frame)
STTERR	PRL Trajectory Records (Terrestrial Frame)
QUALCO	Quality Parameter Records

Format Specifications

The following tables present the detailed format description of the PRL product.

PRL Data Set Identification Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'DSIDP '
2	PRODID	6	A15	-	-	'ERS1.ORB.PRL '
3	DATTYP	21	A6	-	-	'POSVEL'
-	-	27	103X	-	-	spare

PRL Data Header Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STATE '
2	START	6	F6.1	days	0.1	Start Date of the Arc in Days since 1.1.2000 12h
3	END	12	F6.1	days	0.1	End Date of the Arc in Days since 1.1.2000 12h
4	OBSTYP	18	A6	-	-	Used Observation Types (3*A2)
5	OBSLEV	24	A6	-	-	Used Level of Individual Observation Types (3*A2)
6	MODID	30	I2	-	-	Model Identifier
7	RELID	32	I2	-	-	Release Identifier
8	RMSFIT	34	I4	mm	1	Rms-Fit of Orbit
9	SIGPOS	38	I4	mm	1	Sigma of Satellite Position
10	SIGVEL	42	I4	$\mu m/s$	1	Sigma of Satellite Velocity
11	QUALIT	46	I1	-	-	Quality Flag 0 = manoeuvre free orbit 1 = by manoeuvre degraded orbit
12	TDTUTC	47	F5.3	s	0.001	Time Difference TDT-UTC
13	CMMNT	52	A78	-	-	Comment

Remarks:

OBSTYP — The following observation types are possible

LA	Laser
PR	Prare (range and doppler)
RA	Altimeter Ranges
XO	Altimeter Crossovers

OBSLEV — This variable may have the following content

QL	Quick-Look or On-Site Normal Points
FR	Full-Rate
NP	Normal Points computed from Full-Rate
FD	Fast Delivery
MX	Mixed Types

MODID

1	very first model (first weeks) (ERS-1)
2	revision 0 (PGM009): July 1991 through June 1993 (ERS-1)
3	revision 1 (PGM035): July 1993 through April 1995 (ERS-1)
4	revision 2 (PGM055): since April 1995 (ERS-1/2)

RELID — increased for a new release of the same product using the same model

RMSFIT, SIGPOS, SIGVEL — see Quality Parameters

PRL Trajectory Record (Inertial Frame) (record is repeated for each state vector)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STINER'
2	SATID	6	I7	-	-	Satellite ID (COSPAR No.)
3	ORBTYP	13	A1	-	-	'V' = preliminary
4	TTAGD	14	F6.1	days	0.1	Julian Days since 1.1.2000 12h in TDT
5	TTAGMS	20	I11	μs	1	Microseconds since 0:00 TDT
6	XSAT	31	I12	mm	1	X-Coordinate of Satellite (CIS)
7	YSAT	43	I12	mm	1	Y-Coordinate of Satellite (CIS)
8	ZSAT	55	I12	mm	1	Z-Coordinate of Satellite (CIS)
9	XDSAT	67	I11	μm/s	1	X-Velocity of Satellite (CIS)
10	YDSAT	78	I11	μm/s	1	Y-Velocity of Satellite (CIS)
11	ZDSAT	89	I11	μm/s	1	Z-Velocity of Satellite (CIS)
12	ROLL	100	F6.3	deg	.001	Roll Angle
13	PITCH	106	F6.3	deg	.001	Pitch Angle
14	YAW	112	F6.3	deg	.001	Yaw Angle
15	ASCARC	118	I2	-	-	Flag 1 = first state vector (ascending arc) at or above the equator 0 = otherwise
16	CHECK	120	I3	-	-	Checksum of Cols 21-120
17	QUALI	123	I1	-	-	Quality Flag 0 = good quality 1 = by manoeuvre degraded state
18	RADCOR	124	I4	cm	1	Radial Orbit Correction
-	-	128	2X	-	-	spare

Remarks:

CHECK
The checksum is computed per record by using the following rules: sum of all single digits in columns 21 through 120 (sign,dot not being considered).

RADCOR
This correction will improve the orbit quality in radial direction and when being applied it has to be **subtracted** from the satellite height. The value is set to 9999, 9998 or 9997 in the following cases:

- there are gaps in the altimeter data so that no correction can be computed (will affect one half-revolution) (value=9999)
- the position is over land (value=9998). This flagging is not performed for the first and last state over land in order to support the interpolation of values.
- the correction exceeds a threshold of 3 times the crossover rms, i.e. a threshold of 60 cm (value=9997)

PRL Trajectory Record (Terrestrial Frame) (record is repeated for each state vector)						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'STTERR'
2	SATID	6	I7	-	-	Satellite ID (COSPAR No.)
3	ORBTYP	13	A1	-	-	'V' = preliminary
4	TTAGD	14	F6.1	days	0.1	Julian Days since 1.1.2000 12h in TDT
5	TTAGMS	20	I11	μs	1	Microseconds since 0:00 TDT
6	XSAT	31	I12	mm	1	X-Coordinate of Satellite (CTS)
7	YSAT	43	I12	mm	1	Y-Coordinate of Satellite (CTS)
8	ZSAT	55	I12	mm	1	Z-Coordinate of Satellite (CTS)
9	XDSAT	67	I11	μm/s	1	X-Velocity of Satellite (CTS)
10	YDSAT	78	I11	μm/s	1	Y-Velocity of Satellite (CTS)
11	ZDSAT	89	I11	μm/s	1	Z-Velocity of Satellite (CTS)
12	ROLL	100	F6.3	deg	.001	Roll Angle
13	PITCH	106	F6.3	deg	.001	Pitch Angle
14	YAW	112	F6.3	deg	.001	Yaw Angle
15	ASCARC	118	I2	-	-	Flag 1 = first state vector (ascending arc) at or above the equator 0 = otherwise
16	CHECK	120	I3	-	-	Checksum of Cols 21-120
17	QUALI	123	I1	-	-	Quality Flag 0 = good quality 1 = by manoeuvre degraded state
18	RADCOR	124	I4	cm	1	Radial Orbit Correction
-	-	128	2X	-	-	spare

Remarks: Same as for the intertial frame data

PRL Quality Parameter Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'QUALCO'
2	QPNAME	7	A24	-	-	Quality Parameter Name
3	-	31	A3	-	-	' = '
4	QPVALUE	34	A10	-	-	Quality Parameter Value
5	QPUNIT	45	A24	-	-	Units of QPVALUE
6	QPREFVAL	69	A10	-	-	Reference Value
-	-	79	51X	-	-	spare

A detailed list of the content of the individual quality parameter records is presented in the following.

Product Quality Parameters

In the following a short description of the product quality parameters as included in the product is given.

Data Header Record Information

RMSFIT
rms (root mean square) of all laser residuals (observed value minus adjusted value) of the arc

SIGPOS
standard deviation for the estimated state vector at the start of the arc

SIGVEL
standard deviation for the estimated state vector at the start of the arc

QUALIT
quality flag indicating whether the orbit is degraded by a manoeuvre (flag = 1) or not (flag = 0); flag set to 1 if manoeuvre information is available within the orbit span

Trajectory Record Information

QUALI
quality flag indicating whether the state vector is degraded by a manoeuvre (flag = 1) or not (flag = 0)

Quality Parameter Record Information

Sigma_Unit_Weight
standard deviation of a fictitious observation with the weight 1; computed from the square root of the sum of the weighted squared observational residuals divided by the degrees of freedom

Sta_Dev_Obs_Laser
standard deviation of laser residuals of the orbit

Mean_Obs_Laser
mean of laser residuals of the orbit

Sta_Dev_Obs_Crossover
standard deviation of altimeter crossover residuals of the orbit

Mean_Obs_Crossover
mean of altimeter crossover residuals of the orbit

Sta_Dev_Obs_Prare_Ran
standard deviation of Prare range residuals of the orbit

Mean_Obs_Prare_Ran
mean of Prare range residuals of the orbit

Sta_Dev_Obs_Prare_Dop
standard deviation of Prare doppler residuals of the orbit

Mean_Obs_Prare_Dop
mean of Prare doppler residuals of the orbit

RMS_Orb_Along_Track_Begi
rms of differences in along-track direction of the actual arc and an arc overlapping the first half of the actual orbit by 3-4 days

RMS_Orb_Cross_Track_Begi
rms of differences in cross-track direction of the actual arc and an arc overlapping the first half of the actual orbit by 3-4 days

RMS_Orb_Radial_Begin
rms of differences in radial direction of the actual arc and an arc overlapping the first half of the actual orbit by 3-4 days

Sta_Dev_Crossover_Corr
standard deviation of altimeter crossover residuals of the orbit after applying the radial orbit correction

Mean_Crossover_Corr
mean of altimeter crossover residuals of the orbit after applying the radial orbit correction

5.2 Precise Orbit (ERS-1/2.ORB.PRC) Format

The precise orbit product consists of a chronologically ordered sequence (every 30s) of ASCII coded ephemerides records. Each file is preceded by a data set identification record and a data header record containing overall information about the file. The trajectory records are presented in two blocks: first in the inertial reference frame (CIS) and then in the terrestrial reference frame (CTS). At the end of the product there is a block of records containing quality information. So the product will be composed of the following records

Identifier	Information
DSIDP	Data Set Identification Record
STATE	PRC Data Header Record
STINER	PRC Trajectory Records (Inertial Frame)
STTERR	PRC Trajectory Records (Terrestrial Frame)
QUALCO	Quality Parameter Records

Format Specifications

The following tables present the detailed format description of the PRC product.

PRC Data Set Identification Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'DSIDP '
2	PRODID	6	A15	-	-	'ERS1.ORB.PRC '
3	DATTYP	21	A6	-	-	'POSVEL'
-	-	27	103X	-	-	spare

PRC Data Header Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STATE '
2	START	6	F6.1	days	0.1	Start Date of the Arc in Days since 1.1.2000 12h
3	END	12	F6.1	days	0.1	End Date of the Arc in Days since 1.1.2000 12h
4	OBSTYP	18	A6	-	-	Used Observation Types (3*A2)
5	OBSLEV	24	A6	-	-	Used Level of Individual Observation Types (3*A2)
6	MODID	30	I2	-	-	Model Identifier
7	RELID	32	I2	-	-	Release Identifier
8	RMSFIT	34	I4	mm	1	Rms-Fit of Orbit
9	SIGPOS	38	I4	mm	1	Sigma of Satellite Position
10	SIGVEL	42	I4	$\mu m/s$	1	Sigma of Satellite Velocity
11	QUALIT	46	I1	-	-	Quality Flag 0 = manoeuvre free orbit 1 = by manoeuvre degraded orbit
12	TDTUTC	47	F5.3	s	0.001	Time Difference TDT-UTC
13	CMMNT	52	A78	-	-	Comment

Remarks:

OBSTYP — The following observation types are possible

LA	Laser
PR	Prare (range and doppler)
RA	Altimeter Ranges
XO	Altimeter Crossovers

OBSLEV — This variable may have the following content

QL	Quick-Look or On-Site Normal Points
FR	Full-Rate
NP	Normal Points computed from Full-Rate
FD	Fast Delivery
O1	OPR01
MX	Mixed Types

MODID

0	revision 0 (PGM009): July 1991 through January 1993 (ERS-1)
1	revision 1 (PGM035): July 1991 through March 1995 (ERS-1)
2	revision 2 (PGM055): since July 1991 (ERS-1)/May 1995 (ERS-2)

RELID — numerically incremented for a new release of the same product using the same model

RMSFIT, SIGPOS, SIGVEL — see Quality Parameters

PRC Trajectory Record (Inertial Frame) (record is repeated for each state vector)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STINER'
2	SATID	6	I7	-	-	Satellite ID (COSPAR No.)
3	ORBTYP	13	A1	-	-	'P' = precise
4	TTAGD	14	F6.1	days	0.1	Julian Days since 1.1.2000 12h in TDT
5	TTAGMS	20	I11	μs	1	Microseconds since 0:00 TDT
6	XSAT	31	I12	mm	1	X-Coordinate of Satellite (CIS)
7	YSAT	43	I12	mm	1	Y-Coordinate of Satellite (CIS)
8	ZSAT	55	I12	mm	1	Z-Coordinate of Satellite (CIS)
9	XDSAT	67	I11	μm/s	1	X-Velocity of Satellite (CIS)
10	YDSAT	78	I11	μm/s	1	Y-Velocity of Satellite (CIS)
11	ZDSAT	89	I11	μm/s	1	Z-Velocity of Satellite (CIS)
12	ROLL	100	F6.3	deg	.001	Roll Angle
13	PITCH	106	F6.3	deg	.001	Pitch Angle
14	YAW	112	F6.3	deg	.001	Yaw Angle
15	ASCARC	118	I2	-	-	Flag 1 = first state vector (ascending arc) at or above the equator 0 = otherwise
16	CHECK	120	I3	-	-	Checksum of Cols 21-120
17	QUALI	123	I1	-	-	Quality Flag 0 = good quality 1 = by manoeuvre degraded state
18	RADCOR	124	I4	cm	1	Radial Orbit Correction
-	-	128	2X	-	-	spare

Remarks:

CHECK — The checksum is computed per record by using the following rules: sum of all single digits in columns 21 through 120 (sign,dot not being considered).

RADCOR — This correction will improve the orbit quality in radial direction and when being applied it has to be **subtracted** from the satellite height. The value is set to 9999, 9998 or 9997 in the following cases:

- there are gaps in the altimeter data so that no correction can be computed (will affect one half-revolution) (value=9999)
- the position is over land (value=9998). This flagging is not performed for the first and last state over land in order to support the interpolation of values.
- the correction exceeds a threshold of 3 times the crossover rms, i.e. a threshold of 60 cm (value=9997)

PRC Trajectory Record (Terrestrial Frame) (record is repeated for each state vector)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STTERR'
2	SATID	6	I7	-	-	Satellite ID (COSPAR No.)
3	ORBTYP	13	A1	-	-	'P' = precise
4	TTAGD	14	F6.1	days	0.1	Julian Days since 1.1.2000 12h in TDT
5	TTAGMS	20	I11	µs	1	Microseconds since 0:00 TDT
6	XSAT	31	I12	mm	1	X-Coordinate of Satellite (CTS)
7	YSAT	43	I12	mm	1	Y-Coordinate of Satellite (CTS)
8	ZSAT	55	I12	mm	1	Z-Coordinate of Satellite (CTS)
9	XDSAT	67	I11	µm/s	1	X-Velocity of Satellite (CTS)
10	YDSAT	78	I11	µm/s	1	Y-Velocity of Satellite (CTS)
11	ZDSAT	89	I11	µm/s	1	Z-Velocity of Satellite (CTS)
12	ROLL	100	F6.3	deg	.001	Roll Angle
13	PITCH	106	F6.3	deg	.001	Pitch Angle
14	YAW	112	F6.3	deg	.001	Yaw Angle
15	ASCARC	118	I2	-	-	Flag 1 = first state vector (ascending arc) at or above the equator 0 = otherwise
16	CHECK	120	I3	-	-	Checksum of Cols 21-120
17	QUALI	123	I1	-	-	Quality Flag 0 = good quality 1 = by manoeuvre degraded state
18	RADCOR	124	I4	cm	1	Radial Orbit Correction
-	-	128	2X	-	-	spare

Remarks: Same as for the inertial frame data

PRC Quality Parameter Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'QUALCO'
2	QPNAME	7	A24	-	-	Quality Parameter Name
3	-	31	A3	-	-	' = '
4	QPVALUE	34	A10	-	-	Quality Parameter Value
5	QPUNIT	45	A24	-	-	Units of QPVALUE
6	QPREFVAL	69	A10	-	-	Reference Value
-	-	79	50X	-	-	spare

A detailed list of the content of the individual quality parameter records is presented in the following.

Product Quality Parameters

In the following a short description of the product quality parameters as included in the product is given.

Data Header Record Information

RMSFIT
rms (root mean square) of all laser residuals (observed value minus adjusted value) of the arc

SIGPOS
standard deviation for the estimated state vector at the start of the arc

SIGVEL
standard deviation for the estimated state vector at the start of the arc

QUALIT
quality flag indicating whether the orbit is degraded by a manoeuvre (flag = 1) or not (flag = 0); flag set to 1 if manoeuvre information is available within the orbit span

Trajectory Record Information

QUALI
quality flag indicating whether the state vector is degraded by a manoeuvre (flag = 1) or not (flag = 0)

Quality Parameter Record Information

Sigma_Unit_Weight
standard deviation of the unit weight; computation by the square root of the sum of the weighted squared observation residuals divided by the degrees of freedom

Sta_Dev_Obs_Laser
standard deviation of laser residuals of the orbit

Mean_Obs_Laser
mean of laser residuals of the orbit

Sta_Dev_Obs_Crossover
standard deviation of altimeter crossover residuals of the orbit

Mean_Obs_Crossover
mean of altimeter crossover residuals of the orbit

Sta_Dev_Obs_Prare_Ran
standard deviation of Prare range residuals of the orbit

Mean_Obs_Prare_Ran
mean of Prare range residuals of the orbit

Sta_Dev_Obs_Prare_Dop
standard deviation of Prare doppler residuals of the orbit

Mean_Obs_Prare_Dop
mean of Prare doppler residuals of the orbit

RMS_Orb_Along_Track_XXXX (XXXX: Begi, Mid or End)
rms of differences in along-track direction of the actual arc and an arc overlapping the begin, mid or end of the actual orbit

RMS_Orb_Cross_Track_XXXX (XXXX: Begi, Mid or End)
rms of differences in cross-track direction of the actual arc and an arc overlapping the begin, mid or end of the actual orbit

RMS_Orb_Radial_XXXX (XXXX: Begin, Mid or End)
rms of differences in radial direction of the actual arc and an arc overlapping the begin, mid or end of the actual orbit

Sta_Dev_Cro_Corr_MProd
standard deviation of altimeter crossover residuals of the orbit after applying the radial orbit correction for the "monthly" product

Mean_Cro_Corr_MProd
mean of altimeter crossover residuals of the orbit after applying the radial orbit correction

5.3 ERS Gravity Field Model (ERS-1/2.ORB.EGM) Format

The EGM product consists of a set of ASCII coded records described and ordered in the following way. It is composed of separated data sets for:

- gravity coefficients
- ocean tide parameters
- station coordinates

Gravity Coefficients Data Set

It is preceded by a data set identification record which is followed by a block of records containing quality parameters. The next record consists of the gravity coefficients header with characteristic parameters of the gravity field model. It is followed by the coefficient records ordered for ascending order and degree of the harmonic coefficients. Consequently the data set is composed of the following records:

Identifier	Information
DSIDP	Data Set Identification Record
QUALCO	Quality Parameter Records
EARTH	Gravity Coefficients Header Record
GRCOEF	Gravity Coefficient Record

Format Specifications

EGM Data Set Designation Record

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'DSIDP '
2	PRODID	6	A16	-	-	product identifier
3	DATTYP	23	A6	-	-	'GRCOEF'

EGM Coefficients Header Record

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'EARTH '
2	MAXD	6	I5	-	-	maximum degree of model
3	MAXO	11	I5	-	-	maximum order of model
4	NORM	17	I2	-	-	parameter for normalization = -1 normalized = +1 unnormalized
5	GM	20	E15.9	m^3s^{-2}	10^5	gravitational parameter (GM)
6	R	36	E15.9	m	10^{-2}	radius of sphere (R)
7	POLEPO	52	F6.1	a	10^{-1}	epoch of mean terrestrial system

EGM Coefficient Record
(record is repeated for each C_{nm}-, S_{nm}-coefficient pair)

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'GRCOEF'
2	N	6	I5	-	-	degree n of coefficients
3	M	11	I5	-	-	order m of coefficients
4	CNM	17	E15.9	-	-	C_{nm}-coefficient
5	SNM	33	E15.9	- (1/d)	-	S_{nm}-coefficient ($\dot{C}_{n0}$, if m=0)
6	STDCNM	49	E10.4	-	-	standard deviation of C_{nm}
7	STDSNM	60	E10.4	- (1/d)	-	standard deviation of S_{nm} ($\dot{C}_{n0}$, resp.)
8	ICSOL	71	I1	-	-	parameter for adjustment = 1 C_{nm} adjusted = 0 C_{nm} not adjusted
9	ISSOL	72	I1	-	-	parameter for adjustment = 1 $S_{nm}(\dot{C}_{n0})$ adjusted = 0 $S_{nm}(\dot{C}_{n0})$ not adjusted
10	CMMNT	75	A8	-	-	comment[1)]

[1)] epoch (J2000) in case of $\dot{C}_{n0}$ values and
e.g. source code, if data has been adopted from external source

EGM Quality Parameter Record
(record is repeated for each individual quality parameter (c.f. Chapter 4.4))

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'QUALCO'
2	QPNAME	7	A24	-	-	quality parameter name
3		31	A3	-	-	' = '
4	QPVALUE	34	A10	-	-	quality parameter value
5	QPUNIT	45	A24	-	-	units of QPVALUE
6	QPREFVA	69	A10	-	-	reference value

A detailed list of the content of the individual quality parameter records is presented on the following pages.

Product Quality Parameters

In the following a short description of all possible product quality parameters is given.

AccelerGeostatSatellites:
weighted rms of differences w.r.t a given set of observed longitude accelerations of geostationary satellites; computation of theoretical longitude accelerations from geopotential model's coefficients (up to degree and order 6) and intercomparison with observed values (weighting of differences according to standard deviations associated with the observed values)

LumpedCoefficientsDirect:
weighted rms of differences w.r.t. a given set of 'observed' lumped coefficients; computation of theoretical lumped coefficients from geopotential model's coefficients (of orders 12 through 16, 29 and 31) and intercomparison with 'observed' values, all values 'normalized' by F_{min} - the lowest degree inclination function - (weighting of differences according to standard deviations associated with the 'observed' values)

LumpedCoefficientsResSol:
weighted rms of differences w.r.t. sets of lumped coefficients computed computed for different inclinations from various resonant coefficient solutions; computation of theoretical lumped coefficients for all inclinations (stepsize 1.5°) from geopotential model's coefficients (of orders 12 through 16) and intercomparison with those derived from resonant coefficient solutions, index $\bar{q}$ = -1,0,+1 considered if even and odd degree coefficients are given, all values 'normalized' by F_{min} - the lowest degree inclination function - (weighting of differences according to standard deviations propagated from those given with the resonant solutions)

GrAnomGeos3-ATS6SST10*10:
std. dev. of differences w.r.t. 10°×10° mean gravity anomalies derived from GEOS-3 - ATS-6 satellite-to-satellite data; computation of 10°×10° mean gravity anomalies from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

GrAnomApollo-ATS6SST-5*5:
std. dev. of differences w.r.t. 5°×5° mean gravity anomalies derived from Apollo - ATS-6 satellite-to-satellite data; computation of 5°×5° mean gravity anomalies from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

GrAnomRapp89Terrestr-5*5:
std. dev. of differences w.r.t. 5°×5° mean gravity anomalies derived from gravimeter measurements including sea gravimetry, compiled and evaluated by Rapp; computation of 5°×5° mean gravity anomalies from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

GrAnomSeasat(Marsh)--5*5:
std. dev. of differences w.r.t. 5°×5° mean gravity anomalies over the oceans derived from SEASAT altimeter data compiled and evaluated by Rapp; computation of 5°×5° mean gravity anomalies from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

UndulaDopplGPSLevelPoint:
std. dev. of differences w.r.t. given sets of geoid undulations (point values) derived from Doppler/GPS satellite tracking and terrestrial levelling; computation of geoid undulations at points of evaluation from geopotential model's coefficients and intercomparison with given point values, least squares adjustment for orientation, position and shape of reference ellipsoid and for one bias parameter per data set (equal weighting of all values, P=I)

UndulaGeos-3(Rapp)---5*5:
std. dev. of differences w.r.t. 5°×5° mean geoid undulations derived from Geos-3 altimeter data by Rapp; computation of 5°×5° mean geoid undulations from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

UndulaSeasat(Marsh)--5*5:
std. dev. of differences w.r.t. 5°×5° mean geoid undulations derived from Seasat altimeter data by Marsh; computation of 5°×5° mean geoid undulations from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

UndulaSeasat(Rapp)---5*5:
std. dev. of differences w.r.t. 5°×5° mean geoid undulations derived from Seasat altimeter data by Rapp; computation of 5°×5° mean geoid undulations from geopotential model's coefficients and intercomparison with given grid values, mean difference subtracted (equal weighting of all values, P=I)

CöffAbcd------DegOrd-ij:
rss of differences w.r.t. the coefficients of the model Abcd model up to degree/order ij (coefficients with indices 0/0, 1/0, 1/1 and 2/1 not considered); direct intercomparison of the Abcd model's coefficients with the coefficients under evaluation, resulting rss value may be given in terms of coefficient values, geoid undulations and/or gravity anomalies depending on the unit given (only those coefficients considered being part of both models)

OrbitSatname--Trtype-ijd:
rms of orbital fit to tracking observations of type Trtype to satellite Satname for arcs of about ij days length; orbit computation and adjustment applying the geopotential model under evaluation for 1 to n arcs, computation of rms of orbital fit over all arcs

CrossoverSatname-----ijd:
rms of altimeter cross-over discrepancies for satellite Satname; orbit computation and adjustment applying the geopotential model under evaluation for 1 to n arcs (arclength ij days) with tracking data from the altimeter satellite Satname, computation of altimeter cross-over differences w.r.t. these arcs, computation of overall rms of differences

ErrPropRmsGravAnomaly5*5:
rms of estimated standard deviations for 5°×5° mean gravity anomalies; rigorous error propagation of coefficient's scaled variance-covariance matrix to 5°×5° mean gravity anomalies (global coverage)

ErrPropRmsGeoidHeight5*5:
rms of estimated standard deviations for 5°×5° mean geoid heights; rigorous error propagation of coefficient's scaled variance-covariance matrix to 5°×5° mean geoid heights (global coverage)

ErrPropRmsErsRadTotAsc-:
rms of estimated total radial orbit error for ERS ascending arcs; rigorous error propagation of coefficient's scaled variance-covariance matrix to ERS radial orbit perturbations

ErrPropRmsErsRadTotDesc:
rms of estimated total radial orbit error for ERS descending arcs; rigorous error propagation of coefficient's scaled variance-covariance matrix to ERS radial orbit perturbations

ErrPropRmsErsRadGeoCorr:
rms of estimated geographically correlated radial orbit error for ERS; rigorous error propagation of coefficient's scaled variance-covariance matrix to ERS radial orbit perturbations

ErrPropRmsErsRadVarMean:
rms of estimated variability about geographically correlated mean of radial orbit error for ERS; rigorous error propagation of coefficient's scaled variance-covariance matrix to ERS radial orbit perturbations

ScalingFactorVarCovarMat:
empirically estimated scaling factor for gravity model's coefficients variance covariance matrix, the square root of this factor is applied to all standard deviations given within this file; intercomparison of estimated and 'observed' statistical values

Ocean Tides Parameter Data Set

It is preceded by a data set identification record. The next record consists of the ocean tides header with characteristic parameters of the ocean tide model. It is followed by the parameter records ordered for ascending Doodson Numbers. Consequently the data set is composed of the following records:

Identifier	Information
DSIDP	Data Set Identification Record
EARTH	Ocean Tides Header Record
TIPARA	Ocean Tide Parameter Record

Format Specifications

EGM Data Set Designation Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'DSIDP '
2	PRODID	6	A16	-	-	product identifier
3	DATTYP	23	A6	-	-	'TIPARA'

EGM Ocean Tides Header Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'EARTH '
2	MAXD	6	I5	-	-	maximum degree of coefficients
3	MAXO	11	I5	-	-	maximum order of coefficients
4	NORM	17	I2	-	-	parameter for normalization = -1 normalized = +1 unnormalized
5	GM	20	E15.9	m^3s^{-2}	10^5	gravitational parameter (GM)
6	R	36	E15.9	m	10^{-2}	radius of sphere (R)

EGM Ocean Tide Parameter Record (record is repeated for each adjusted C_{nm}-, S_{nm}-coefficient pair)						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'TIPARA'
2	FLAGPR	7	A1	-	-	flag (+ prograde, - retrograde)
3	DOODNR	8	F7.3	-	-	DOODSON Number
4	NT	16	I2	-	-	degree n of tidal parameter
5	MT	18	I2	-	-	order m of tidal parameter
6	CNM	20	E15.9	-	-	C_{nm}-coefficient
7	SNM	36	E15.9	-	-	S_{nm}-coefficient
6	STDCNM	52	E10.4	-	-	standard deviation of C_{nm}
8	STDSNM	63	E10.4	-	-	standard deviation of S_{nm}

Station Coordinates Data Set

It is preceded by a data set identification record. The next record consists of the station coordinates header with characteristic parameters of the reference ellipsoid. For any station it is followed by a block of records containing the station coordinates in the geocentric cartesian frame, represented by ellipsoidal coordinates, the coordinate rates and various information on the precision of the coordinates. Consequently the data set is composed of the following records:

Identifier	Information
DSIDP	Data Set Identification Record
SOLID	Station Coordinates Header Record
STAEPO	Station Designation Record
X Y Z	Cartesian Coordinates Record
P L H	Ellipsoidal Coordinates Record
PPLP	Horizontal Rates of Change Record
ERRELL	Error Ellipse Record

Format Specifications

EGM Data Set Designation Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'DSIDP '
2	PRODID	6	A16	-	-	product identifier
3	DATTYP	23	A6	-	-	'COORDS'

EGM Station Coordinates Header Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'SOLID '
2	SOLID	6	A15	-	-	solution identifier
3	SMAELL	25	E15.9	m	10^{-2}	semi-major axis of adopted ellipsoid
4	FLATIN	42	E15.9	-	10^{-6}	inverse flattening of adopted ellipsoid
5	FLAGPT	60	A1	-	-	flag for permanent tide: = Y for reduced = N for not reduced

The following five records are reapeated for each station:

EGM Station Designation Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'STAEPO'
2	SINO	6	I5	-	-	station site number
3	OCCU	11	A6	-	-	system and occupation designation
4	EPOCH	18	F6.1	a	10^{-1}	epoch of given coordinates

EGM Cartesian Coordinates Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'X Y Z '
2	X	6	F12.3	m	10^{-3}	X-coordinate
3	Y	18	F12.3	m	10^{-3}	Y-coordinate
4	Z	30	F12.3	m	10^{-3}	Z-coordinate
5	SX	42	F8.3	m	10^{-3}	std. dev. in X
6	SY	50	F8.3	m	10^{-3}	std. dev. in Y
7	SZ	58	F8.3	m	10^{-3}	std. dev. in Z
8	IXSOL	68	I1	-	-	parameter for adjustment = 1 X-component adjusted = 0 X-component not adjusted
9	IYSOL	69	I1	-	-	parameter for adjustment = 1 Y-component adjusted = 0 Y-component not adjusted
10	IZSOL	70	I1	-	-	parameter for adjustment = 1 Z-component adjusted = 0 Z-component not adjusted
11	CMMNT	75	A6	-	-	comment[1)]

[1)] e.g. source code, if data has been adopted from external data set

EGM Ellipsoidal Coordinates Record

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'P L H '
2	XLATD	6	I3	arcdeg	10^{0}	latitude ϕ
3	XLATM	10	I2	arcmin	10^{0}	
4	XLATS	13	F7.4	arcsec	10^{-4}	
5	XLOND	21	I3	arcdeg	10^{0}	longitude λ
6	XLONM	25	I2	arcmin	10^{0}	
7	XLONS	28	F7.4	arcsec	10^{-4}	
8	H	36	F10.3	m	10^{-3}	ellipsoidal height
9	SLAT	46	F8.4	arcsec	10^{-4}	std. dev. in latitude
10	SLON	54	F8.4	arcsec	10^{-4}	std. dev. in longitude
11	SH	62	F8.3	m	10^{-3}	std. dev. in ell. height
12	CMMNT	75	A6	-	-	comment

EGM Horizontal Rates of Change Record

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'PPLP '
2	XPDOT	13	F7.4	m/a	10^{-3}	$\dot{\phi}$
3	XLDOT	28	F7.4	m/a	10^{-3}	$\dot{\lambda}\cdot\cos\phi$
4	SPDOT	46	F8.4	m/a	10^{-3}	std. dev. in $\dot{\phi}$
5	SLDOT	54	F8.4	m/a	10^{-3}	std. dev. in $\dot{\lambda}\cdot\cos\phi$
6	IPDSOL	68	I1	-	-	parameter for adjustment = 1 $\dot{\phi}$ adjusted = 0 $\dot{\phi}$ not adjusted
7	ILDSOL	69	I1	-	-	parameter for adjustment = 1 $\dot{\lambda}\cdot\cos\phi$ adjusted = 0 $\dot{\lambda}\cdot\cos\phi$ not adjusted
8	CMMNT	75	A6	-	-	comment[1]

[1] e.g. source code ,if data has been adopted from external data set

EGM Error Ellipse Record

No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'ERRELL'
2	XLONG	46	F8.3	m	10^{-3}	semi-major axis
3	XSHORT	54	F8.3	m	10^{-3}	semi-minor axis
4	THETA	62	F6.1	arcdeg	10^{-1}	azimuth of semi-major axis

5.4 Quick-Look Ocean Product Records (ERS-1/2.ALT.QLOPR)

Quick-look Ocean Products consist of a chronologically ordered sequence of ASCII coded altimeter data. Each file is preceded by one header record, containing the date for the data and some additional information, concerning the complete file. The tables below define the record content and record format.

Format Specifications

Quick-Look Ocean Product Header Record					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	DATE	0	A11	-	Date of data in [dd-mon-year]
2	MISS	12	A4	-	Mission acronym (E1FD/E2FD)
3	REV	17	I2	-	Product revision number
4	NL	19	A1	-	newline

Quick-Look Ocean Product Data Record					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	UTC	0	F17.6	sec	time in UTC seconds
2	LAT	18	I10	10^{-6} degree	latitude of footprint
3	LON	28	I10	10^{-6} degree	longitude of footprint
4	HSAT	38	I10	10^{-3} m	satellite height above ellipsoid
5	RANGE	48	I10	10^{-3} m	corrected altimeter range
6	SRANGE	58	I6	10^{-3} m	sigma of altimeter range
7	SWH	64	I6	10^{-3} m	significant wave height
8	NAUGHT	70	I6	10^{-2} db	sigma naught
9	OTID	76	I6	10^{-3} m	ocean tide correction
10	ETID	82	I6	10^{-3} m	solid Earth tide correction
11	WTROPO	88	I6	10^{-3} m	wet troposphere correction
12	DTROPO	94	I6	10^{-3} m	dry troposphere correction
13	IONO	100	I6	10^{-3} m	ionospheric correction
14	ORBERR	106	I6	10^{-3} m	orbit error estimate
15	GEOID	112	I6	10^{-2} m	geoid height
16	FLAG	119	A8	-	record status flag
17	NL	127	A1	-	newline

Undefined values are set to -99999. The records can be read with the following FORTRAN format statement: format(f17.6,4i10,10i6,1x,a8)

Parameter Description

Quick-Look Ocean Product Header Record

1. Date of data in the file in dd-mon-year (e.g. 16-DEC-1992). Each file contains the QLOPR data for one day.
2. Mission acronym of the data file (E1FD = ERS-1 Fast Delivery, E2FD = ERS-2 Fast Delivery).
3. Revision number of the QLOPR product. For any change in software or processing the number will increase by 1.

REV=1:	only ocean mode data processed, preliminary orbit based on PGM035 gravity model, Schwiderski tidal model used for ocean tide.
REV=2:	all fast delivery data processed (ice and ocean mode), preliminary orbit based on PGM035 gravity model, Schwiderski tidal model used for ocean tide, precise time correlation applied, IRI90 ionosphere model used, OSU91A geoid included.
REV=3:	all fast delivery data processed (ice and ocean mode), preliminary orbit based on PGM055 gravity model, FES95.1 tidal model used for ocean tide, precise time correlation applied, IRI90 ionosphere model used, OSU91A geoid included.
REV=4:	for ERS-1: as REV 3 products, but additional SPTR and USO drift range corrections applied. for ERS-2: as REV 3 products, but absolute ERS-1 bias of -41.6 cm and current estimate of relative bias between ERS-2 and ERS-1 of 0 cm is applied to ERS-2.
REV=5:	for ERS-2: as REV 4 products, but additional SPTR and USO drift range corrections applied.
REV=6:	all fast delivery data processed (ice and ocean mode), preliminary orbit based on PGM055 gravity model, FES95.2.1 tidal model used for ocean tide, precise time correlation applied, IRI95 ionosphere model used, EGM96 geoid included. Improved fast delivery data from ESA ground stations, including a bias from new look-up tables (no additional external bias applied).

Quick-Look Ocean Product Data Record

1. Seconds with fractional part since 1.1.1990 0h UTC
2. Geodetic latitude of altimeter footprint with respect to wgs84 ellipsoid
3. Geodetic longitude of altimeter footprint with respect to wgs84 ellipsoid
4. Height of satellite's center of mass above wgs84 reference ellipsoid
5. Altimeter range corrected for Earth and ocean tides, ionospheric path delay, tropospheric path delay, altimeter calibration bias, offset altimeter antenna to satellite's center of mass.
6. Standard deviation of altimeter range
7. Significant wave height estimated from the shape of the altimeter's return echo
8. Sigma naught empirically related to nadir wind speed at the ocean surface

9. Ocean tide correction (see product revision)
10. Earth tide correction derived from Schwidersky model (Schwidersky, 1980)
11. Wet troposphere correction according to Tapley, Lundberg, Born [1984]. In case of absence of actual meteorological data the URA correction is taken.
12. Dry troposphere correction according to Saastamoinen [1972]. In case of absence of actual meteorological data the URA correction is taken.
13. Ionospheric correction (see product revision)
14. Estimate of the radial orbit error using globally distributed cubic polynomials
15. Interpolated geoid value, computed from high resolution geoid model (see product revision)
16. Record status flag indicating the status of the meteorologic corrections (updated or URA), satellite manoevre events (degraded orbit accuracy) and possible double records. The meaning of the record status flag is defined by the following table. The flag is written as 8 byte character string composed of 0/1 digits. The bytes are set to one if the associated criteria is fulfilled.

	Record Status Flag
Byte	**Criteria**
1	wet tropospheric correction not replaced
2	dry tropospheric correction not replaced
3	radial orbit accuracy degraded by manoevre
4	possible double record, separated by less than 979 msec from the previous or the next record (in the original URA data).
5	acquisition in ice mode
6-8	unused

Remarks

From the original fast delivery altimeter data only measurements for which less than 18 single radar pulses are used for averaging are edited. Because sometimes fast delivery records are processed twice on different stations, in all products both of these records are flagged (byte 4). In some cases the range of one of these double records is wrong and and should be eliminated. As editing criterion for example, additional to the flag, the difference (hsat - range) - geoid can be used to identify these corrupted records.

Tidal and meteorological corrections have to be **subtracted** from the corrected altimeter range to get the uncorrected measurement. The orbit error estimate is to be **subtracted** from the satellite height. Inclusion of this parameter helps to improve the initial radial accuracy. Rare gaps in the crossover data base due to gaps in the altimeter data sequence may lead to singularities in the orbit error adjustment process and consequently the orbit error is not given (undefined) for very few half revolution portions of the orbit (usual percentage below 1 %). The same holds for manoevre periods.

5.5 Quick-Look Ocean Crossovers (ERS-2.ALT.QLOPC)

Quick-look Ocean Crossovers consist of a sequence of ASCII coded crossover data. Each file is preceded by one header record, containing the date of the product and some additional information concerning the complete file. Each file contains all crossovers, where ascending or descending crossover time is during the specified day date of product), and the corresponding descending or ascending crossover time is separated by less than 35 days.

The tables below define the record content and record format.

Format Specifications

Quick-Look Ocean Crossover Header Record:					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	DATE	0	A11	-	Date of data in [dd-mon-year]
2	MISS	12	A4	-	Mission acronym (E1FD/E2FD)
3	REV	17	I2	-	Product revision number
4	NL	19	A1	-	newline

Quick-Look Ocean Crossover Record:					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	UTC_A	0	F17.6	sec	ascending crossover time
2	UTC_D	18	F17.6	sec	descending crossover time
3	LAT	36	I10	10^{-6} degree	latitude of crossover
4	LON	46	I10	10^{-6} degree	longitude of crossover
5	SSH_A	56	I6	10^{-2} m	sea surface height asc. arc
6	SWH_A	62	I6	10^{-2} m	swh ascending arc
7	WIND_A	68	I6	10^{-2} m/sec	wind speed asc. arc
8	SSH_X	74	I6	10^{-3} m	ssh crossover difference
9	SSH_S	80	I6	10^{-3} m	std. dev. ssh crossover diff.
10	SWH_X	86	I6	10^{-2} m	swh crossover difference
11	SWH_S	92	I6	10^{-2} m	std. dev. swh crossover diff.
12	WIND_X	98	I6	10^{-2} m/sec	wind crossover difference
13	WIND_S	104	I6	10^{-2} m/sec	std. dev. wind crossover diff.
14	NL	110	A1	-	

Undefined values are set to -99999. The records can be read with the following FORTRAN format statement: format(2(f17.6,x),2i10,9i6)

Parameter Description

Quick-Look Ocean Crossover Header Record

1. Date of data in the file in dd-mon-year (e.g. 16-DEC-1992). Each file contains the QLOPC data for one day with the preceding 35 days.
2. Mission acronym of the data file (e.g ERS2)
3. Revision number of the QLOPC product. For any change in software or processing the number will be increased by 1. Revision number is set equal to revision number of QLOPR product, on which QLOPC is based.

REV=1:	Only ocean mode data processed. Preliminary Orbit based on PEGM035 is used. Schwiderski tidal model used.
REV=2:	All fast delivery data processed (ice and ocean mode). Preliminary Orbit based on PEGM035 used. Schwiderski tidal model used. Precise time correlation applied.
REV=3:	All fast delivery data processed (ice and ocean mode). Preliminary Orbit based on PGM055 gravity model. FES95.1 Grenoble tidal model used. Precise time correlation applied.
REV=4:	for ERS-1: as REV 3 products, but SPTR and USO drift range corrections applied for ERS-2: as REV 3 products, but absolute ERS-1 bias of -41.6 cm and current estimate of relative bias between ERS-2 and ERS-1 of 0 cm is applied to ERS-2.
REV=5:	for ERS-2: as REV 4 products, but SPTR and USO drift range corrections applied
REV=6:	Improved fast delivery data from ESA ground stations (ocean and ice), including a bias from new look-up tables. SPTR and USO drift range corrections applied. FES95.2.1 Grenoble tide model, IRI95 ionospheric correction.

Quick-Look Ocean Crossover Record

1. Seconds of ascending crossover time with fractional part since 1.1.1990 0h UTC
2. Seconds of descending crossover time with fractional part since 1.1.1990 0h UTC
3. Geodetic latitude of crossover point with respect to wgS84 ellipsoid
4. Geodetic longitude of crossover point with respect to wgs84 ellipsoid
5. Sea surface height of ascending arc at crossover location with respect to wgs84 ellipsoid.
6. Significant wave height of ascending arc at crossover location
7. Wind speed of ascending arc at crossover location
8. Sea surface height crossover difference in terms of ascending minus descending sea surface height

9. Standard deviation of sea surface height crossover difference, computed from least squares approach
10. Significant wave height crossover difference in terms of ascending minus descending significant wave heights
11. Standard deviation of significant wave height crossover difference, computed from least squares approach
12. Wind speed crossover difference in terms of ascending minus descending wind speed
13. Standard deviation of wind speed crossover difference, computed from least squares approach

Remarks

Crossover differences are defined as:

crossover difference = ascending arc value - descending arc value

Because ascending arc values at crossover locations are provided in the product, by applying a simple subtraction also the descending arc values at crossover locations can be computed:

descending arc value = ascending arc value - crossover difference

For the parameters provided in the records the descending arc values (marked with "_D") can computed by:

SSH_D = SSH_A - SSH_X SWH_D = SWH_A - SWH_X WIND_D = WIND_A - WIND_X

5.6 Quick-Look Sea Surface Height Model (ERS-1/2.ALT.SSHQL)

The quick-look sea surface height digital data sets are provided in the general D-PAF file structure for gridded data.

Header Section

The header section for gridded data consists of four different types of header records. They identify the product and provide grid system specifications as well as data record formats required to scan through the data. Annotating data is given in additional quality parameter records. All these header records are identified by a leading string and provide further information according to the following table.

Identifier	Information
DSIDP	Data Set Identification Parameter
GGRDS	Global Grid System Specification
GDFRM	Grid Data Record Format
QUALCO	Quality Parameter Record

The first two header records (identified by DSIDP and GGRDS) appear only once. The number of Grid Data Record Format (GDFRM) specifies the number of different data types in the product. The last type of header record (QUALCO) appear as often as there are quality parameters. Header records have fixed format with record length 80 (plus newline). Number and type of parameters are depending on the header identifier. The end of header section is identified by an empty line with record length 80 plus newline. The formats of header records, used for gridded data are specified in the following tables.

Format Specifications

Data Set Identification Header Record (DSIDP)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HRECID	0	A5	-	header record identifier (=DSIDP)
2	DSNAME	6	A15	-	data set name
3	REMARK	25	A55	-	remarks
4	NL	80	A1	-	newline

Global Grid System Header Record (GGRDS)					
No.	Name	Offset	Format	Unit	Description
1	HRECID	0	A5	-	header record identifier (=GGRDS)
2	GLATN	5	F6.2	degree	northern latitude (top)
3	GLATS	11	F6.2	degree	southern latitude (bottom)
4	GLONW	17	F7.2	degree	western longitude (left)
5	GLONE	24	F7.2	degree	eastern longitude (right)
6	NCLAT	31	I5	-	number of cells, latitude direction
7	NCLON	36	I5	-	number of cells, longitude direction
8	CSLAT	41	F5.2	degree	cell size in latitude direction
9	CSLON	46	F5.2	degree	cell size in longitude direction
10	MEANV	51	I1	-	mean- or point-values
11	LFLAG	52	I1	-	latitude type
12	GREFS	53	A7	-	global reference system
13	REMARK	60	A20	-	remarks
14	NL	80	A1	-	newline

Gridded Data Record Format (GDFRM)					
No.	Name	Offset	Format	Unit	Description
1	HRECID	0	A5	-	header record identifier (=GDFRM)
2	IDTYPE	6	I1	-	index for data (sub)type
3	DTYPE	7	A20	-	description of data (sub)type
4	FRM	27	A30	-	format of data (sub)type
5	GAPV	57	F7.2	-	gap value
6	IEXP	64	I3	-	exponent
7	IOFS	67	I3	-	offset (bias)
8	REMARK	70	A10	-	remarks
9	NL	80	A1	-	newline

Quality Parameter Record (QUALCO)					
No.	Name	Offset	Format	Unit	Description
1	RECKEY	0	A6	-	header record identifier (=QUALCO)
2	QPNAME	7	A24	-	quality parameter name
3		31	A3	-	' = '
4	QPVALUE	34	A10	-	quality parameter value
5	QPUNIT	45	A24	-	units of QPVALUE
6	QPREFVA	70	A10	-	reference value
7	NL	80	A1	-	newline

Parameter Description

Data Set Identification Header Record (DSIDP)

1. Data set identification parameter (=DSIDP) acronym, defining the first header record.
2. Data set name, reflecting the ESA product acronym and a field for product version (e.g. SSHQL_93059).

Global Grid System Header Record (GGRDS)

1. Global grid system specification (=GGRDS) acronym, defining the second header record.
2. Northern border of grid in geographical coordinates, given in sdd.mm (eg. +81.30 means 81 degree 30 minutes on northern hemisphere).
3. Southern border of grid in geographical coordinates, given in sdd.mm (eg. -81.30 means 81 degree 30 minutes on southern hemisphere).
4. Western border of grid in geographical coordinates, given in sddd.mm (eg. -030.15 means 30 degree 15 minutes west of Greenwich meridian).
5. Eastern border of grid in geographical coordinates, given in sddd.mm (e.g. +120.45 means 120 degree 45 minutes east of Greenwich meridian).
6. Number of grid cells in latitude direction within the grid.
7. Number of grid cells in longitude direction within the grid.
8. Grid cell size in latitude direction, given in dd.mm (e.g. 1.30 means 2 grid lines are separated by 1 and a half degree in latitude direction).
9. Grid cell size in longitude direction, given in dd.mm (e.g. 3.00 means 2 grid lines are separated by 3 degree in longitude direction).
10. Flag defining if grid data are mean- or point values.
    1 = mean-values
    0 = point values
11. Flag defining if geocentric or geodetic latitudes are used. Geodetic latitudes refer to an ellipsoid, while geocentric latitudes are defined on a sphere.
    1 = geodetic latitudes
    0 = geocentric latitudes
12. Reference ellipsoid to which sea surface refers to. For the product the WGS84 reference ellipsoid is used.

Gridded Data Record Format (GDFRM)

1. Grid data record format (=GDFRM) acronym, defining the header records, containing format specifications for each data type. The number of grid data format records corresponds to the number of data sets in the product.
2. Index number of data type to which the grid data format record belongs to.
3. Description of data (sub)type.
4. Format of data (sub)type records in FORTRAN notation. Data can be read by using this format statement (e.g. 10f8.2 means each complete record contains 10 values written with f8.2 format).
5. Gap value for data (sub)type. Every time when this value appears in the data set, the specific point is not defined.
6. Exponent of data (sub)type (e.g. -2 means each value of data (sub)type has to be multiplied with 10^{-2}).
7. Offset of data (sub)type (e.g. 3.00 means to each value of data (sub)type 3.00 has to be added).

Quality Parameter Record (QUALCO)

1. Quality parameter record (=QUALCO) acronym, defining header records, containing quality parameter values.
2. Quality parameter name
3. sign for quality value attachment
4. Actual quality parameter value for the specific quality parameter.
5. Unit of quality parameter (e.g m = meter).
6. Quality parameter reference value, specifying the optimal value of the specific quality parameter.

Data Section

According to the principle, that gridded data is provided row-by-row the general structure of the data section for gridded data is given by repeating the following sequence of records as often as necessary.

- one record with row specific information; row leader record (ROWLR) with record length 32 plus newline.
- data value records with record length defined by the format described in the GDFRM header (e.g. if format is 10f8.2 the record length is 80 plus newline).

Format Description

The row leader record (ROWLR) provides row specific information and has fixed format according to the following table.

Row Leader Record (ROWLR)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	IDTYPE	0	I1	-	index for data (sub)type
2	GLAT	2	F6.2	degree	latitude of this row
3	CSLAT	9	F5.2	degree	cell size in latitude direction
4	CSLON	15	F5.2	degree	cell size in longitude direction
5	NCLON	21	I5	-	number of cells, longitude direction
6	NADV	27	I5	-	actual number of data values, following
7	NL	32	A1	-	newline

The format of the data value records is the one that was specified in the GDFRM header record (see above). The number of data value records depends on this format and the parameters NCLON and MEANV of the GGRDS header record. For example, if the format is (10f8.2), the data values represent mean-values (MEANV=1) and NCLON was specified to 360 (a $1\times1^{\circ}$grid) then there will be 36 data value records. In case of point-values (MEANV=0) the number of data per row is NCLON + 1. Thus 37 data value records are required to provide the 361 point values with the same (10f8.2) format.

If there are k different data types then

1. there are k GDFRM header records providing the format for all k data types (identified by IDTYPE = 1, 2, ... k) and
2. in the data section the above mentioned sequence of records will be
   - row leader record for first data type (IDTYPE = 1)

- data records for first data type
- row leader record for second data type (IDTYPE = 2)
- data records for second data type.
- ......
- row leader record for k th data type (IDTYPE = k)
- data records for second data type.

Parameter Description

1. Number of data (sub)type for which data are following this record.
2. Latitude of this row, given in sdd.mm (eg. -25.15 means 25 degree 15 minutes on southern hemisphere).
3. Cell size in latitude direction, given in dd.mm (e.g 0.30 means 30 minutes grid spacing in latitude direction).
4. Cell size in longitude direction, given in dd.mm (e.g. 1.20 means 1 degree 20 minutes grid spacing in longitude direction).
5. Number of grid cells in longitude direction within the grid.
6. Number of data values following this row leader record.

Product Quality Parameters

In the following a description of all product quality parameters, which can be included in the product is given.

number_crossovers_taken:
Number of crossover differences used for global orbit error estimation. For a 35 day repeat cycle usually about 35000 crossovers are computed. The number of crossovers indicates the quality of the global orbit error analysis and consequently the quality of the sea surface model.

mean_x_over_diff:
Mean crossover difference before orbit error analysis. This value indicates if there are systematic errors in the preliminary orbit, which is incorporated into the data. The reference value 0 means that no systematic differences between ascending and descending arcs are found. Mean values larger than 10 cm indicate systematic orbit errors in the preliminary orbit for the 35 day period.

min_x_over_diff:
Minimum crossover difference before orbit error analysis. This value indicates the level of crossover editing. A small value (less 1 meter) shows that many crossovers, exceeding a limit were rejected. Usually for the quick-look sea surface height model processing a lower limit of -3 meter for crossover differences is used.

max_x_over_diff:
Maximum crossover difference before orbit error analysis. This value indicates the level of crossover editing. A small value (less 1 meter) shows that many crossovers, exceeding a limit were edited. Usually for the quick-look sea surface height model processing an upper limit of 3 meter for crossover differences is used.

rms_x_over_diff:
Root mean square of crossover differences before orbit error analysis. This value indicates the overall orbit accuracy.

mean_res_x_over_diff:
Mean crossover difference after orbit error analysis. A non zero value shows that there are still remaining systematic orbit errors after crossover analysis.

min_res_x_over_diff:
Minimum crossover difference after orbit error analysis. This value indicates the absolute level of orbit error reduction.

max_res_x_over_diff:
Maximum crossover difference after orbit error analysis. This value indicates the absolute level of orbit error reduction.

rms_res_x_over_diff:
Root mean square of crossover differences after orbit error analysis. This value indicates the overall orbit improvement by the global orbit error analysis. The crossover rms value typically is reduced by the orbit error modeling to about 15 cm. This value can be regarded as the absolute orbit accuracy for the modeling of the sea surface.

mean_diff_to_MSS93A:
Mean difference to the ERS-1 and Geosat mean sea surface computed by D-PAF.

min_diff_to_MSS93A:
Minumum difference to the ERS-1 and Geosat mean sea surface computed by D-PAF. This value shows the absolute negative outlier of sea surface differences.

max_diff_to_MSS93A:
Maximum difference to the ERS-1 and Geosat mean sea surface computed by D-PAF. This value shows the absolute maximum outlier of sea surface differences.

rms_diff_to_MSS93A:
Root mean square of sea surface height differences to the ERS-1 and Geosat mean sea surface computed by D-PAF. This value shows the statistic of global differences to the MSS93A model.

mean_diff_to_RAPP_SSH:
Mean difference to the Ohio State University mean sea surface with Seasat, Geos3 and Geosat data incorporated and a resolution of 7.5 minutes. This value shows the remaining bias between the ERS-1/2 and a non ERS-1/2 sea surface. A value of about 25 cm typically appears, if the ERS-1 altimeter bias of -41.6 cm is applied to fast delivery data.

min_diff_to_RAPP_SSH:
Minumum difference to the Ohio State University mean sea surface. This value shows the absolute negative outlier of sea surface differences.

max_diff_to_RAPP_SSH:
Maximum difference to the Ohio State University mean sea surface. This value shows the absolute maximum outlier of sea surface differences.

rms_diff_to_RAPP_SSH:
Root mean square of sea surface height differences to the Ohio State University mean sea surface. This value shows the statistic of global differences between both models. Because of the high resolution of the Ohio State University model it is a good quality indicator for the high resolution content of the quick-look sea surface height model. Typically a value of about 45 cm appears.

mean_stddev_individ_SSH:
This value gives the mean standard deviation for all points of the sea surface height model. For each point a standard deviation from the least squares approach is computed. This value represents the mean internal accuracy of the estimation procedure and typically is about 5 cm.

max_stddev_individ_SSH:
Maximum standard deviation of estimated sea surface height values from the least squares approach. A value of about 50 cm is typical for the quick-look sea surface height models.

rms_stddev_individ_SSH:
Root mean square of standard deviations for all points of the quick-look sea surface height model. This value indicates the accuracy of the standard deviation estimates coming from the least squares approach. Typically a value of less than 5 cm appears for this parameter.

number_alt_records:
Number of altimeter measurements available within the period of the quick-look sea surface height model (35 days). For each model usually about 1.5 million fast delivery altimeter records are available.

number_edited_alt_record:
Number of not used altimeter measurements for the model because of editing criteria. Usually about 15 percent of the available altimeter records are edited.

exchange_dry_tropo_corr:
Indicator if the dry troposphere correction within the fast delivery records is exchanged by D-PAF or not. Usually the correction term is recomputed by D-PAF using actual meteorological data from UK-PAF. If no meteorological data are available the correction term of the fast delivery data is used.

exchange_wet_tropo_corr:
Indicator if the wet troposphere correction within the fast delivery records is exchanged by D-PAF or not. Usually the correction term is recomputed by D-PAF using actual meteorological data from UK-PAF. If no meteorological data are available the correction term of the fast delivery data is used.

exchange_iono_corr:
Indicator if the ionospheric correction within the fast delivery records is exchanged by D-PAF or not. Usually the correction term is recomputed by D-PAF using the IRI90 model. If the correction term is not recomputed, the URA correction of the fast delivery data is used.

5.7 Sea Surface Height Model (ERS-1/2.ALT.SSH)

The sea surface height digital data sets are provided in the general D-PAF file structure for gridded data.

Header Section

The header section for gridded data consists of four different types of header records. They identify the product and provide grid system specifications as well as data record formats required to scan through the data. Annotating data is given in additional quality parameter records. All these header records are identified by a leading string and provide further information according to the following table.

Identifier	Information
DSIDP	Data Set Identification Parameter
GGRDS	Global Grid System Specification
GDFRM	Grid Data Record Format
QUALCO	Quality Parameter Record

The first two header records (identified by DSIDP and GGRDS) appear only once. The number of Grid Data Record Format (GDFRM) specifies the number of different data types in the product. The last type of header record (QUALCO) appear as often as there are quality parameters. Header records have fixed format with record length 80 (plus newline). Number and type of parameters are depending on the header identifier. The end of header section is identified by an empty line with record length 80 plus newline. The formats of header records, used for gridded data are specified in the following tables.

Format Specifications

Data Set Identification Header Record (DSIDP)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HRECID	0	A5	-	header record identifier (=DSIDP)
2	DSNAME	6	A15	-	data set name
3	REMARK	25	A55	-	remarks
4	NL	80	A1	-	newline

Global Grid System Header Record (GGRDS)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HRECID	0	A5	-	header record identifier (=GGRDS)
2	GLATN	5	F6.2	degree	northern latitude (top)
3	GLATS	11	F6.2	degree	southern latitude (bottom)
4	GLONW	17	F7.2	degree	western longitude (left)
5	GLONE	24	F7.2	degree	eastern longitude (right)
6	NCLAT	31	I5	-	number of cells, latitude direction
7	NCLON	36	I5	-	number of cells, longitude direction
8	CSLAT	41	F5.2	degree	cell size in latitude direction
9	CSLON	46	F5.2	degree	cell size in longitude direction
10	MEANV	51	I1	-	mean- or point-values
11	LFLAG	52	I1	-	latitude type
12	GREFS	53	A7	-	global reference system
13	REMARK	60	A20	-	remarks
14	NL	80	A1	-	newline

Gridded Data Record Format (GDFRM)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HRECID	0	A5	-	header record identifier (=GDFRM)
2	IDTYPE	6	I1	-	index for data (sub)type
3	DTYPE	7	A20	-	description of data (sub)type
4	FRM	27	A30	-	format of data (sub)type
5	GAPV	57	F7.2	-	gap value
6	IEXP	64	I3	-	exponent
7	IOFS	67	I3	-	offset (bias)
8	REMARK	70	A10	-	remarks
9	NL	80	A1	-	newline

Quality Parameter Record (QUALCO)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	RECKEY	0	A6	-	header record identifier (=QUALCO)
2	QPNAME	7	A24	-	quality parameter name
3		31	A3	-	' = '
4	QPVALUE	34	A10	-	quality parameter value
5	QPUNIT	45	A24	-	units of QPVALUE
6	QPREFVA	70	A10	-	reference value
7	NL	80	A1	-	newline

Parameter Description

Data Set Identification Header Record (DSIDP)

1. Data set identification parameter (=DSIDP) acronym, defining the first header record.
2. Data set name, reflecting the ESA product acronym and a field for product version (e.g. SSH__S93059).

Global Grid System Header Record (GGRDS)

1. Global grid system specification (=GGRDS) acronym, defining the second header record.
2. Northern border of grid in geographical coordinates, given in sdd.mm (eg. +81.30 means 81 degree 30 minutes on northern hemisphere).
3. Southern border of grid in geographical coordinates, given in sdd.mm (eg. -81.30 means 81 degree 30 minutes on southern hemisphere).
4. Western border of grid in geographical coordinates, given in sddd.mm (eg. -030.15 means 30 degree 15 minutes west of Greenwich meridian).
5. Eastern border of grid in geographical coordinates, given in sddd.mm (e.g. +120.45 means 120 degree 45 minutes east of Greenwich meridian).
6. Number of grid cells in latitude direction within the grid.
7. Number of grid cells in longitude direction within the grid.
8. Grid cell size in latitude direction, given in dd.mm (e.g. 1.30 means 2 grid lines are separated by 1 and a half degree in latitude direction).
9. Grid cell size in longitude direction, given in dd.mm (e.g. 3.00 means 2 grid lines are separated by 3 degree in longitude direction).
10. Flag defining if grid data are mean- or point values.
    1 = mean-values
    0 = point values
11. Flag defining if geocentric or geodetic latitudes are used. Geodetic latitudes refer to an ellipsoid, while geocentric latitudes are defined on a sphere.
    1 = geodetic latitudes
    0 = geocentric latitudes
12. Reference ellipsoid to which sea surface refers to. For the product the WGS84 reference ellipsoid is used.

Gridded Data Record Format (GDFRM)

1. Grid data record format (=GDFRM) acronym, defining the header records, containing format specifications for each data type. The number of grid data format records corresponds to the number of data sets in the product.
2. Index number of data type to which the grid data format record belongs to.
3. Description of data (sub)type.
4. Format of data (sub)type records in FORTRAN notation. Data can be read by using this format statement (e.g. 10f8.2 means each complete record contains 10 values written with f8.2 format).
5. Gap value for data (sub)type. Every time when this value appears in the data set, the specific point is not defined.
6. Exponent of data (sub)type (e.g. -2 means each value of data (sub)type has to be multiplied with 10^{-2}).
7. Offset of data (sub)type (e.g. 3.00 means to each value of data (sub)type 3.00 has to be added).

Quality Parameter Record (QUALCO)

1. Quality parameter record (=QUALCO) acronym, defining header records, containing quality parameter values.
2. Quality parameter name
3. sign for quality value attachment
4. Actual quality parameter value for the specific quality parameter.
5. Unit of quality parameter (e.g m = meter).
6. Quality parameter reference value, specifying the optimal value of the specific quality parameter.

Data Section

According to the principle, that gridded data is provided row-by-row the general structure of the data section for gridded data is given by repeating the following sequence of records as often as necessary.

- one record with row specific information; row leader record (ROWLR) with record length 32 plus newline.
- data value records with record length defined by the format described in the GDFRM header (e.g. if format is 10f8.2 the record length is 80 plus newline).

Format Description

The row leader record (ROWLR) provides row specific information and has fixed format according to the following table.

Row Leader Record (ROWLR)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	IDTYPE	0	I1	-	index for data (sub)type
2	GLAT	2	F6.2	degree	latitude of this row
3	CSLAT	9	F5.2	degree	cell size in latitude direction
4	CSLON	15	F5.2	degree	cell size in longitude direction
5	NCLON	21	I5	-	number of cells, longitude direction
6	NADV	27	I5	-	actual number of data values, following
7	NL	32	A1	-	newline

The format of the data value records is the one that was specified in the GDFRM header record (see above). The number of data value records depends on this format and the parameters NCLON and MEANV of the GGRDS header record. For example, if the format is (10f8.2), the data values represent mean-values (MEANV=1) and NCLON was specified to 360 (a $1 \times 1^\circ$grid) then there will be 36 data value records. In case of point-values (MEANV=0) the number of data per row is NCLON + 1. Thus 37 data value records are required to provide the 361 point values with the same (10f8.2) format.

If there are k different data types then

1. there are k GDFRM header records providing the format for all k data types (identified by IDTYPE = 1, 2, ... k) and
2. in the data section the above mentioned sequence of records will be
   - row leader record for first data type (IDTYPE = 1)

- data records for first data type
- row leader record for second data type (IDTYPE = 2)
- data records for second data type.
- ......
- row leader record for k th data type (IDTYPE = k)
- data records for second data type.

Parameter Description

1. Number of data (sub)type for which data are following this record.
2. Latitude of this row, given in sdd.mm (eg. -25.15 means 25 degree 15 minutes on southern hemisphere).
3. Cell size in latitude direction, given in dd.mm (e.g 0.30 means 30 minutes grid spacing in latitude direction).
4. Cell size in longitude direction, given in dd.mm (e.g. 1.20 means 1 degree 20 minutes grid spacing in longitude direction).
5. Number of grid cells in longitude direction within the grid.
6. Number of data values following this row leader record.

Product Quality Parameters

In the following a description of all product quality parameters, which can be included in the product is given.

number_crossovers_taken:
Number of crossover differences used for global orbit error estimation. For a 35 day repeat cycle usually about 35000 crossovers are computed. The number of crossovers indicates the quality of the global orbit error analysis and consequently the quality of the sea surface model.

mean_x_over_diff:
Mean crossover difference before orbit error analysis. This value indicates if there are systematic errors in the preliminary orbit, which is incorporated into the data. The reference value 0 means that no systematic differences between ascending and descending arcs are found. Mean values larger than 10 cm indicate systematic orbit errors in the preliminary orbit for the 35 day period.

min_x_over_diff:
Minimum crossover difference before orbit error analysis. This value indicates the level of crossover editing. A small value (less 1 meter) shows that many crossovers, exceeding a limit were rejected. Usually for the quick-look sea surface height model processing a lower limit of -3 meter for crossover differences is used.

max_x_over_diff:
Maximum crossover difference before orbit error analysis. This value indicates the level of crossover editing. A small value (less 1 meter) shows that many crossovers, exceeding a limit were edited. Usually for the quick-look sea surface height model processing an upper limit of 3 meter for crossover differences is used.

rms_x_over_diff:
Root mean square of crossover differences before orbit error analysis. This value indicates the overall orbit accuracy.

mean_res_x_over_diff:
Mean crossover difference after orbit error analysis. A non zero value shows that there are still remaining systematic orbit errors after crossover analysis.

min_res_x_over_diff:
Minimum crossover difference after orbit error analysis. This value indicates the absolute level of orbit error reduction.

max_res_x_over_diff:
Maximum crossover difference after orbit error analysis. This value indicates the absolute level of orbit error reduction.

rms_res_x_over_diff:
Root mean square of crossover differences after orbit error analysis. This value indicates the overall orbit improvement by the globa orbit error analysis. The crossover rms value typically is reduced by the orbit error modeling to about 15 cm. This value can be regarded as the absolute orbit accuracy for the modeling of the sea surface.

mean_diff_to_MSS93A:
Mean difference to the ERS-1 and Geosat mean sea surface computed by D-PAF.

min_diff_to_MSS93A:
Minumum difference to the ERS-1 and Geosat 1987 mean sea surface computed by D-PAF. This value shows the absolute negative outlier of sea surface differences.

max_diff_to_MSS93A:
Maximum difference to the ERS-1 and Geosat 1987 mean sea surface computed by D-PAF. This value shows the absolute maximum outlier of sea surface differences.

rms_diff_to_MSS93A:
Root mean square of sea surface height differences to the ERS-1 and Geosat 1987 mean sea surface computed by D-PAF.

mean_diff_to_RAPP_SSH:
Mean difference to the Ohio State University mean sea surface with Seasat, Geos3 and Geosat data incorporated and a resolution of 7.5 minutes. This value shows the remaining bias between the ERS-1 and a non ERS-1 sea surface. A value of about 65 cm typically appears, if the ERS-1 altimeter bias is not applied in level 2 data.

min_diff_to_RAPP_SSH:
Minumum difference to the Ohio State University mean sea surface. This value shows the absolute negative outlier of sea surface differences.

max_diff_to_RAPP_SSH:
Maximum difference to the Ohio State University mean sea surface. This value shows the absolute maximum outlier of sea surface differences.

rms_diff_to_RAPP_SSH:
Root mean square of sea surface height differences to the Ohio State University mean sea surface. This value shows the statistic of global differences between both models. Because of the high resolution of the Ohio State University model it is a good quality indicator for the high resolution content of the sea surface height model. Typically a value of about 40 cm appears.

mean_stddev_individ_SSH:
This value gives the mean standard deviation for all points of the sea surface height model. For each point a standard deviation from the least squares approach is computed. This value represents the mean internal accuracy of the estimation procedure and typically is about 5 cm.

max_stddev_individ_SSH:
Maximum standard deviation of estimated sea surface height values from the least squares approach. A value of about 50 cm is typical for the sea surface height models.

rms_stddev_individ_SSH:
Root mean square of standard deviations for all points of the sea surface height model. This value indicates the accuracy of the standard deviation estimates coming from the least squares approach. Typically a value of less than 5 cm appears for this parameter.

number_alt_records:
Number of altimeter measurements available within the period of the sea surface height model. For 35 days usually about 1.6 million level 2 altimeter records are available.

number_edited_alt_record:
Number of not used altimeter measurements for the model because of editing criteria. Usually about 15 percent of the available altimeter records are edited.

5.8 Ocean Geoid (ERS-1/2.ALT.OGE)

The oceanic geoid digital data sets are provided in the general D-PAF file structure for gridded data.

Header Section

The header section for gridded data consists of four different types of header records. They identify the product and provide grid system specifications as well as data record formats required to scan through the data. Annotating data is given in additional quality parameter records. All these header records are identified by a leading string and provide further information according to the following table.

Identifier	Information
DSIDP	Data Set Identification Parameter
GGRDS	Global Grid System Specification
GDFRM	Grid Data Record Format
QUALCO	Quality Parameter Record

The first two header records (identified by DSIDP and GGRDS) appear only once. The number of Grid Data Record Format (GDFRM) specifies the number of different data types in the product. The last type of header record (QUALCO) appear as often as there are quality parameters. Header records have fixed format with record length 80 (plus newline). Number and type of parameters are depending on the header identifier. The end of header section is identified by an empty line with record length 80 plus newline. The formats of header records, used for gridded data are specified in the following tables.

Format Specifications

Data Set Identification Header Record (DSIDP)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HRECID	0	A5	-	header record identifier (=DSIDP)
2	DSNAME	6	A15	-	data set name
3	REMARK	25	A55	-	remarks
4	NL	80	A1	-	newline

Global Grid System Header Record (GGRDS)					
No.	Name	Offset	Format	Unit	Description
1	HRECID	0	A5	-	header record identifier (=GGRDS)
2	GLATN	5	F6.2	degree	northern latitude (top)
3	GLATS	11	F6.2	degree	southern latitude (bottom)
4	GLONW	17	F7.2	degree	western longitude (left)
5	GLONE	24	F7.2	degree	eastern longitude (right)
6	NCLAT	31	I5	-	number of cells, latitude direction
7	NCLON	36	I5	-	number of cells, longitude direction
8	CSLAT	41	F5.2	degree	cell size in latitude direction
9	CSLON	46	F5.2	degree	cell size in longitude direction
10	MEANV	51	I1	-	mean- or point-values
11	LFLAG	52	I1	-	latitude type
12	GREFS	53	A7	-	global reference system
13	REMARK	60	A20	-	remarks
14	NL	80	A1	-	newline

Gridded Data Record Format (GDFRM)					
No.	Name	Offset	Format	Unit	Description
1	HRECID	0	A5	-	header record identifier (=GDFRM)
2	IDTYPE	6	I1	-	index for data (sub)type
3	DTYPE	7	A20	-	description of data (sub)type
4	FRM	27	A30	-	format of data (sub)type
5	GAPV	57	F7.2	-	gap value
6	IEXP	64	I3	-	exponent
7	IOFS	67	I3	-	offset (bias)
8	REMARK	70	A10	-	remarks
9	NL	80	A1	-	newline

Quality Parameter Record (QUALCO)					
No.	Name	Offset	Format	Unit	Description
1	RECKEY	0	A6	-	header record identifier (=QUALCO)
2	QPNAME	7	A24	-	quality parameter name
3		31	A3	-	' = '
4	QPVALUE	34	A10	-	quality parameter value
5	QPUNIT	45	A24	-	units of QPVALUE
6	QPREFVA	70	A10	-	reference value
7	NL	80	A1	-	newline

Parameter Description

Data Set Identification Header Record (DSIDP)

1. Data set identification parameter (=DSIDP) acronym, defining the first header record.
2. Data set name, reflecting the ESA product acronym and a field for product version (e.g. OGE___93051).

Global Grid System Header Record (GGRDS)

1. Global grid system specification (=GGRDS) acronym, defining the second header record.
2. Northern border of grid in geographical coordinates, given in sdd.mm (eg. +81.30 means 81 degree 30 minutes on northern hemisphere).
3. Southern border of grid in geographical coordinates, given in sdd.mm (eg. -81.30 means 81 degree 30 minutes on southern hemisphere).
4. Western border of grid in geographical coordinates, given in sddd.mm (eg. -030.15 means 30 degree 15 minutes west of Greenwich meridian).
5. Eastern border of grid in geographical coordinates, given in sddd.mm (e.g. +120.45 means 120 degree 45 minutes east of Greenwich meridian).
6. Number of grid cells in latitude direction within the grid.
7. Number of grid cells in longitude direction within the grid.
8. Grid cell size in latitude direction, given in dd.mm (e.g. 1.30 means 2 grid lines are separated by 1 and a half degree in latitude direction).
9. Grid cell size in longitude direction, given in dd.mm (e.g. 3.00 means 2 grid lines are separated by 3 degree in longitude direction).
10. Flag defining if grid data are mean- or point values.
    1 = mean-values
    0 = point values
11. Flag defining if geocentric or geodetic latitudes are used. Geodetic latitudes refer to an ellipsoid, while geocentric latitudes are defined on a sphere.
    1 = geodetic latitudes
    0 = geocentric latitudes
12. Reference ellipsoid to which sea surface refers to. For the product the WGS84 reference ellipsoid is used.

Gridded Data Record Format (GDFRM)

1. Grid data record format (=GDFRM) acronym, defining the header records, containing format specifications for each data type. The number of grid data format records corresponds to the number of data sets in the product.
2. Index number of data type to which the grid data format record belongs to.
3. Description of data (sub)type.
4. Format of data (sub)type records in FORTRAN notation. Data can be read by using this

format statement (e.g. 10f8.2 means each complete record contains 10 values written with f8.2 format).

5. Gap value for data (sub)type). Every time when this value appears in the data set, the specific point is not defined.
6. Exponent of data (sub)type (e.g. -2 means each value of data (sub)type has to be multiplied with 10^{-2}).
7. Offset of data (sub)type (e.g. 3.00 means to each value of data (sub)type 3.00 has to be added).

Quality Parameter Record (QUALCO)

1. Quality parameter record (=QUALCO) acronym, defining header records, containing quality parameter values.
2. Quality parameter name
3. sign for quality value attachment
4. Actual quality parameter value for the specific quality parameter.
5. Unit of quality parameter (e.g m = meter).
6. Quality parameter reference value, specifying the optimal value of the specific quality parameter.

Data Section

According to the principle, that gridded data is provided row-by-row the general structure of the data section for gridded data is given by repeating the following sequence of records as often as necessary.

- one record with row specific information; row leader record (ROWLR) with record length 32 plus newline.
- data value records with record length defined by the format described in the GDFRM header (e.g. if format is 10f8.2 the record length is 80 plus newline).

Format Description

The row leader record (ROWLR) provides row specific information and has fixed format according to the following table.

Row Leader Record (ROWLR)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	IDTYPE	0	I1	-	index for data (sub)type
2	GLAT	2	F6.2	degree	latitude of this row
3	CSLAT	9	F5.2	degree	cell size in latitude direction
4	CSLON	15	F5.2	degree	cell size in longitude direction
5	NCLON	21	I5	-	number of cells, longitude direction
6	NADV	27	I5	-	actual number of data values, following
7	NL	32	A1	-	newline

The format of the data value records is the one that was specified in the GDFRM header record (see above). The number of data value records depends on this format and the parameters NCLON and MEANV of the GGRDS header record. For example, if the format is (10f8.2), the data values represent mean-values (MEANV=1) and NCLON was specified to 360 (a $1 \times 1^{\circ}$grid) then there will be 36 data value records. In case of point-values (MEANV=0) the number of data per row is NCLON + 1. Thus 37 data value records are required to provide the 361 point values with the same (10f8.2) format.

If there are k different data types then

1. there are k GDFRM header records providing the format for all k data types (identified by IDTYPE = 1, 2, ... k) and
2. in the data section the above mentioned sequence of records will be
   - row leader record for first data type (IDTYPE = 1)
   - data records for first data type
   - row leader record for second data type (IDTYPE = 2)
   - data records for second data type.
   - ......
   - row leader record for k th data type (IDTYPE = k)
   - data records for second data type.

Parameter Description

1. Number of data (sub)type for which data are following this record.
2. Latitude of this row, given in sdd.mm (eg. -25.15 means 25 degree 15 minutes on southern hemisphere).
3. Cell size in latitude direction, given in dd.mm (e.g 0.30 means 30 minutes grid spacing in latitude direction).
4. Cell size in longitude direction, given in dd.mm (e.g. 1.20 means 1 degree 20 minutes grid spacing in longitude direction).
5. Number of grid cells in longitude direction within the grid.
6. Number of data values following this row leader record.

Product Quality Parameters

In the following a description of all product quality parameters, which can be included in the product is given.

a-priori_gravity_model:
Name of gravity model used as a-priori information for geoid determination.

terr_gravity_data:
Name of surface gravity data set used for geoid determination.

sea_surface_height:
Name of sea surface height model used for geoid determination.

oge_sigma0_sqrt:
Unit weight standard deviation determined from least squares harmonic analysis procedure. This value provides an estimate if the weighting of different data sources is consistent. A value of 1 is optimal.

oge_redundancy:
Number of observations minus number of estimated coefficients used for least squares harmonic analysis. For computing the unit weight standard deviation the square sum of residuals is divided by this redundancy value.

mean_diff_terr_dg:
Mean difference of gravity anomalies solved from the product to terrestrial gravity anomalies used for geoid computation. A value near zero should appear for this field.

min_diff_terr_dg:
Minimum difference of gravity anomalies solved from the product to terrestrial gravity anomalies used for geoid computation.

max_diff_terr_dg:
Maximum difference of gravity anomalies solved from the product to terrestrial gravity anomalies used for geoid computation.

rms_diff_terr_dg:
Root mean square for differences of gravity anomalies solved from the product to terrestrial gravity anomalies used for geoid computation.

mean_diff_geoid_height:
Mean difference of geoid heights solved from the product to geoid heights derived from the sea surface height model used for product generation.

max_diff_geoid_height:
Maximum difference of geoid heights solved from the product to geoid heights derived from the sea surface height model used for product generation.

min_diff_geoid_height:
Minimum difference of geoid heights solved from the product to geoid heights derived from the sea surface height model used for product generation.

rms_diff_geoid_height:
Root mean square for differences of geoid heights solved from the product to geoid heights derived from the sea surface height model used for product generation.

mean_diff_osu91a_360:
Mean difference of OGE geoid heights to geoid heights solved from gravity model osu91a to degree and order 360.

max_diff_osu91a_360:
Maximum difference of OGE geoid heights to geoid heights solved from gravity model osu91a to degree and order 360.

min_diff_osu91a_360:
Minimum difference of OGE geoid heights to geoid heights solved from gravity model osu91a to degree and order 360.

rms_diff_osu91a_360:
Root mean square of differences of OGE geoid heights to geoid heights solved from gravity model osu91a to degree and order 360 for short wavelength comparisons.

mean_diff_grim4c4_70:
Mean difference of OGE geoid heights to geoid heights solved from gravity model grim4c4 to degree and order 70.

min_diff_grim4c4_70:
Minimum difference of OGE geoid heights to geoid heights solved from gravity model grim4c4 to degree and order 70.

max_diff_grim4c4_70:
Maximum difference of OGE geoid heights to geoid heights solved from gravity model grim4c4 to degree and order 70.

rms_diff_grim4c4_70:
Root mean square of differences of OGE geoid heights to geoid heights solved from gravity model grim4c4 to degree and order 70.

mean_diff_jgm3_70:
Mean difference of OGE geoid heights to geoid heights solved from gravity model jgm3 to degree and order 70.

max_diff_jgm3_70:
Maximum difference of OGE geoid heights to geoid heights solved from gravity model jgm3 to degree and order 70.

min_diff_jgm3_70:
Minimum difference of OGE geoid heights to geoid heights solved from gravity model jgm3 to degree and order 70.

rms_diff_jgm3_70:
Root mean square of differences of OGE geoid heights to geoid heights solved from gravity model jgm3 to degree and order 70.

n_doppler_stations:
Number of Doppler/GPS stations used for comparisons of geoid heights derived from product with geoid heights determined on stations.

rms_doppler_stations:
Root mean square of differences of geoid heights derived from product with geoid heights, which are independent determined on stations.

5.9 Sea Surface Topography (ERS-1/2.ALT.TOP)

The sea surface topography digital data sets are provided in the general file structure for spherical harmonic series.

Header Section

The header section for spherical harmonic series consists of three different types of header records. They identify the product and provide spherical harmonic series specifications as well as quality parameters. All header records are identified by a leading string and provide further information according to the following table

Identifier	Information
DSIDP	Data Set Identification Parameter
SHSMD	Spherical Harmonic Series Model - Header Record
QUALCO	Quality Parameter Record

The two first header records appear only once in the product. The quality parameter record appears as often as there are quality values in the product. Header records have fixed format with record length 80 (plus newline). The end of header section is identified by an empty line with record length 80 plus newline. The formats of header records that are used for spherical harmonic series are specified in the following tables:

Data Set Identification Header Record (DSIDP)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HRECID	0	A5	-	header record identifier (=DSIDP)
2	DSNAME	6	A15	-	data set name
3	DSTYPE	22	A16	-	data set type
3	REMARK	39	A41	-	remarks
4	NL	80	A1	-	newline

Spherical Harmonic Series Model Description Record (SHSMD)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	HEADID	0	A5	-	header record identifier (=SHSMD)
2	NMAX	6	I5	-	maximum degree n of model
3	MMAX	12	I5	-	maximum order m of model
4	NORM	18	I2	-	parameter for normalization (+-1)
5	LERR	21	I1	-	parameter for presence of errors (0,1)
6	REMARK	23	A57	-	remarks
7	NL	80	A1	-	newline

Quality Parameter Record (QUALCO)					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	RECKEY	0	A6	-	header record identifier (=QUALCO)
2	QPNAME	7	A24	-	quality parameter name
3		31	A3	-	' = '
4	QPVALUE	34	A10	-	quality parameter value
5	QPUNIT	45	A24	-	units of QPVALUE
6	QPREFVA	70	A10	-	reference value
7	NL	80	A1	-	newline

Parameter Description

Data Set Identification Header Record (DSIDP)

1. Data set identification parameter (=DSIDP) acronym, defining the first header record.
2. Data set name, reflecting the ESA product acronym and a field for product version.
3. Data set type specifying the type of spherical harmonic series

Spherical Harmonic Series Model Description Record (SHSMD)

1. Header record identifier acronym (=SHSMD), defining the second header record
2. Maximum degree of spherical harmonic series (n)
3. Maximum order of spherical harmonic series (m)
4. Identifier if coefficients of spherical harmonic series are normalized (-1) or not (+1).
5. Identifier if standard deviations of coefficients are provided (1) or not (0).

Quality Parameter Record (QUALCO)

1. Quality parameter record (=QUALCO) acronym, defining header records, containing quality parameter values.
2. Quality parameter name
3. sign for quality value attachment
4. Actual quality parameter value for the specific quality parameter.
5. Unit of quality parameter (e.g m = meter).
6. Quality parameter reference value, specifying the optimal value of the specific quality parameter.

Data Section

The data section for surface spherical harmonic series consists of records that are formatted according to the following table:

Coefficient Records for SHSMD					
No.	Name	Offset	Format	Unit	Description
1	N	6	I5	-	degree of coefficients
2	M	11	I5	-	order of coefficients
3	ANM	17	E15.9	-	A_{nm}-Coefficient
4	BNM	33	E15.9	-	B_{nm}-Coefficient
5	STDANM	49	E10.4	-	standard deviation of A_{nm}
6	STDBNM	60	E10.4	-	standard deviation of B_{nm}

Parameter Description

1. Degree n of A_{nm} and B_{nm} coefficients in this record.
2. Order m of A_{nm} and B_{nm} coefficients in this record.
3. Coefficient A_{nm} of spherical harmonic series.
4. Coefficient B_{nm} of spherical harmonic series.
5. Standard deviation of coefficient A_{nm} of spherical harmonic series (if LERR = 1).
6. Standard deviation of coefficient B_{nm} of spherical harmonic series (if LERR = 1).

Product Quality Parameters

In the following a description of all product quality parameters, which can be included in the product is given.

geoid_model:
Name of geoid model used for sea surface topography determination.

sea_surface_height:
Name of sea surface height model used for sea surface topography determination.

top_sigma0_sqrt:
Unit weight standard deviation determined from least squares harmonic analysis procedure. This value provides an estimate if the weighting of different data sources is consistent. A value of 1 is optimal.

top_redundancy:
Number of observations minus number of estimated coefficients used for least squares harmonic analysis. For computing the unit weight standard deviation the square sum of residuals is devided by this redundancy value.

mean_diff_levitus:
Mean difference of sea surface topography solved from the product to Levitus oceanographic dynamic topography model [Levitus, 1982].

min_diff_levitus:
Minimum difference of sea surface topography solved from the product to Levitus oceanographic dynamic topography model [Levitus, 1982].

max_diff_levitus:
Maximum difference of sea surface topography solved from the product to Levitus oceanographic dynamic topography model [Levitus, 1982].

rms_diff_levitus:
Root mean square of differences of sea surface topography solved from the product to Levitus oceanographic dynamic topography model [Levitus, 1982].

signal_to_error_degvar:
Degree where error degree variance becomes larger than signal degree variance.

signal_to_geoid_degvar:
Degree where sea surface topography signal degree variance becomes larger than geoid error degree variance, used for product determination.

5.10 PRARE Ionospheric Product (ERS-2.PRS.ION)

The PRARE ionospheric product consists mainly of a chronologically sequence (default every 4 seconds) of ASCII coded records for an individual PRARE ground station. Additionally all records of all ground stations which belong to a specific week of the year are concatenated to one product file.

Format Specifications

PRARE Ionospheric Refraction Data Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A8	-	-	'PRAREION'
2	NSATEL	8	I7	-	-	satellite ID (COSPAR)
3	JAHR	15	I2	y	1	year of century
4	ITAG	17	I3	d	1	day of year
5	SEC	20	F12.7	sec	10^{-7}	second of day
6	IT1	32	I1	-	-	epoch event = 1 : ground station reception time = 2 : satellite transmitting time = 3 : satellite receiving time
7	IT2	33	I1	-	-	epoch time scale = 3 : UTC (USNO) = 5 : UTC (BIH) = 7 : UTC (approximated)
8	NUMSTA	34	I5	-	-	station ID (COSPAR)
9	ICAMP	39	I4	-	-	campaign ID (instrument no. (I2) + occupation no. (I2))
10	IAVER	43	I1	-	-	flag for averaging interval = 1 : 4 sec average
11	AZIM	44	F5.2	degree	0.01	azimuth at ground station
12	ELEV	49	F5.2	degree	0.01	elevation at ground station
13	RANGE1	54	F12.0	psec	1	one-way travel time
14	PRESS	66	F5.1	hpa	0.1	air pressure at ground station
15	TEMP	71	F4.1	Kelvin	0.1	air temperature at ground station
16	WETT	75	F4.1	%	0.1	air humidity at ground station
17	IONO	79	I7	psec	1	X-band versus S-band travel time delay measurement (1-way space to ground)
18	TECSLA	86	E11.5	$1/m^2$	1	total electron content along ray path
19	TEC90	97	E11.5	$1/m^2$	1	total electron content scaled into vertical direction
20	IF1	108	I1	-	-	flag for multipath at S/C = 0 : no multipath = 1 : multipath detected
21	IF2	109	I1	-	-	data edit flag = 0 : data not edited = 1 : data edited
22	IF3	110	A1	-	-	release flag = A,B,C...
23	ISDMES	111	I7	psec	1	precision estimate

Parameter Description

1. Identifier describing the type of a PRARE product (Beside the ionospheric product also range and range rate data are generated at the PRARE Master Station)
2. The satellite identification number provided by COSPAR
3. Year of the observation time tag
4. Day of the year of the observation time tag
5. Seconds of day of the observation time tag
6. Flag describing the epoch of the observation: From measurement principle this flag is always 1 for ionospheric products.
7. Flag describing the time scale of the observation: Usually this flag is set to 3 because of the time transformation of on-board PRARE time to UTC derived from GPS time measurements. If no clock model is available this flag is set to 7.
8. The ground station identification provided by the Master Station in cooperation with COSPAR
9. The serial number of the ground station (1-29) and the incrementing occupation number
10. Flag describing the averaging interval: From measurement principle this flag is always 1 for ionospheric products.
11. Azimuth calculated using PRARE prediction elements
12. Elevation calculated using PRARE prediction elements
13. One way range calculated using PRARE prediction elements
14. Air pressure at ground station
15. Air temperature at ground station
16. Humidity at ground station
17. The (raw) observed averaged X- versus S-band travel time delay
18. The total electron content along ray path
19. The total electron content scaled into vertical (ellipsoid normal at satellite location)
20. Flag describing if a mutipath at satellite has been detected using ESA software SILP
21. Flag describing if the X/S measurement is an outlier
22. Flag describing the release of the product generation
23. Precision estimate derived by polynomial fit of the data

Remarks:

The meteorological data are derived from measurements (nominally once per minute during a pass) at the ground station. If no data are available the corresponding values are set to "Blank".

5.11 Rapid Orbit (ERS-2.ORB.RPD) Format

The rapid orbit product consists of a chronologically ordered sequence (every 60s) of ASCII coded ephemerides records. Each file is preceded by a data set identification record and a data header record containing overall information about the file. The trajectory records are presented in the terrestrial reference frame (CTS). At the end of the product there is a block of records containing quality information. So the product will be composed of the following records

Identifier	Information
DSIDP	Data Set Identification Record
STATE	RPD Data Header Record
STTERR	RPD Trajectory Records (Terrestrial Frame)
QUALCO	Quality Parameter Records

Format Specifications

The following tables present the detailed format description of the RPD product.

RPD Data Set Identification Record						
No.	**Name**	**Offset**	**Format**	**Unit**	**Res.**	**Description**
1	RECKEY	0	A6	-	-	'DSIDP '
2	PRODID	6	A15	-	-	'ERS2.ORB.RPD '
3	DATTYP	21	A6	-	-	'POSVEL'
-	-	27	103X	-	-	spare

RPD Data Header Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STATE '
2	START	6	F6.1	days	0.1	Start Date of the Arc in Days since 1.1.2000 12h
3	END	12	F6.1	days	0.1	End Date of the Arc in Days since 1.1.2000 12h
4	OBSTYP	18	A6	-	-	Used Observation Types (3*A2)
5	OBSLEV	24	A6	-	-	Used Level of Individual Observation Types (3*A2)
6	MODID	30	I2	-	-	Model Identifier
7	RELID	32	I2	-	-	Release Identifier
8	RMSFIT	34	I4	mm	1	Rms-Fit of Orbit
9	SIGPOS	38	I4	mm	1	Sigma of Satellite Position
10	SIGVEL	42	I4	$\mu m/s$	1	Sigma of Satellite Velocity
11	QUALIT	46	I1	-	-	Quality Flag 0 = manoeuvre free orbit 1 = by manoeuvre degraded orbit
12	TDTUTC	47	F5.3	s	0.001	Time Difference TDT-UTC
13	CMMNT	52	A78	-	-	Comment

Remarks:

OBSTYP — The following observation types are possible

LA	Laser
PR	Prare (range and doppler)
RA	Altimeter Ranges

OBSLEV — This variable may have the following content

QL	Quick-Look or On-Site Normal Points
NP	Normal Points computed from Full-Rate
FD	Fast Delivery
MX	Mixed Types

MODID — 1 | revision 0 (PGM73w): since July 1997

RELID — increased for a new release of the same product using the same model

RMSFIT, SIGPOS, SIGVEL — see Quality Parameters

RPD Trajectory Record (Terrestrial Frame) (record is repeated for each state vector)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'STTERR'
2	SATID	6	I7	-	-	Satellite ID (COSPAR No.)
3	ORBTYP	13	A1	-	-	'R' = rapid
4	TTAGD	14	F6.1	days	0.1	Julian Days since 1.1.2000 12h in TDT
5	TTAGMS	20	I11	μs	1	Microseconds since 0:00 TDT
6	XSAT	31	I12	mm	1	X-Coordinate of Satellite (CTS)
7	YSAT	43	I12	mm	1	Y-Coordinate of Satellite (CTS)
8	ZSAT	55	I12	mm	1	Z-Coordinate of Satellite (CTS)
9	XDSAT	67	I11	μm/s	1	X-Velocity of Satellite (CTS)
10	YDSAT	78	I11	μm/s	1	Y-Velocity of Satellite (CTS)
11	ZDSAT	89	I11	μm/s	1	Z-Velocity of Satellite (CTS)
12	ROLL	100	F6.3	deg	.001	Roll Angle
13	PITCH	106	F6.3	deg	.001	Pitch Angle
14	YAW	112	F6.3	deg	.001	Yaw Angle
15	ASCARC	118	I2	-	-	Flag 1 = first state vector (ascending arc) at or above the equator 0 = otherwise
16	CHECK	120	I3	-	-	Checksum of Cols 21-120
17	QUALI	123	I1	-	-	Quality Flag 0 = good quality 1 = by manoeuvre degraded state
18	RADCOR	124	I4	cm	1	always '0'
-	-	128	2X	-	-	spare

Remarks:

CHECK The checksum is computed per record by using the following rules: sum of all single digits in columns 21 through 120 (sign,dot not being considered).

RPD Quality Parameter Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'QUALCO'
2	QPNAME	7	A24	-	-	Quality Parameter Name
3	-	31	A3	-	-	' = '
4	QPVALUE	34	A10	-	-	Quality Parameter Value
5	QPUNIT	45	A24	-	-	Units of QPVALUE
6	QPREFVAL	69	A10	-	-	Reference Value
-	-	79	51X	-	-	spare

A detailed list of the content of the individual quality parameter records is presented in the following.

Product Quality Parameters

In the following a short description of the product quality parameters as included in the product is given.

Data Header Record Information

RMSFIT
rms (root mean square) of all laser residuals (observed value minus adjusted value) of the arc

SIGPOS
standard deviation for the estimated state vector at the start of the arc

SIGVEL
standard deviation for the estimated state vector at the start of the arc

QUALIT
quality flag indicating whether the orbit is degraded by a manoeuvre (flag = 1) or not (flag = 0); flag set to 1 if manoeuvre information is available within the orbit span

Trajectory Record Information

QUALI
quality flag indicating whether the state vector is degraded by a manoeuvre (flag = 1) or not (flag = 0)

Quality Parameter Record Information

Sigma_Unit_Weight
standard deviation of a fictitious observation with the weight 1; computed from the square root of the sum of the weighted squared observational residuals divided by the degrees of freedom

No_Obs_Laser
number of laser observations within the 1-day orbit

Sta_Dev_Obs_Laser
standard deviation of laser residuals of the orbit

Mean_Obs_Laser
mean of laser residuals of the orbit

No_Obs_Prare_Ran
number of PRARE range observations within the 1-day orbit

Sta_Dev_Obs_Prare_Ran
standard deviation of Prare range residuals of the orbit

Mean_Obs_Prare_Ran
mean of Prare range residuals of the orbit

No_Obs_Prare_Dop
number of PRARE doppler observations within the 1-day orbit

Sta_Dev_Obs_Prare_Dop
standard deviation of Prare doppler residuals of the orbit

Mean_Obs_Prare_Dop
mean of Prare doppler residuals of the orbit

No_Obs_Altimeter
number of altimeter range observations within the 1-day orbit

Sta_Dev_Obs_Altimeter
standard deviation of altimeter range residuals of the orbit

Mean_Obs_Altimeter
mean of altimeter range residuals of the orbit

No_Obs_Crossover
number of altimeter crossover observations within the 1-day orbit

Sta_Dev_Crossover
standard deviation of altimeter crossover residuals of the orbit (not used within the orbit determination process)

Mean_Crossover
mean of altimeter crossover residuals of the orbit (not used within the orbit determination process)

5.12 Rapid Ocean Product Records (ERS-2.ALT.ROPR)

Rapid Ocean Products consist of a chronologically ordered sequence of ASCII coded altimeter data. Each file is preceded by one header record, containing the date for the data and some additional information, concerning the complete file. The tables below define the record content and record format.

Format Specifications

Rapid Ocean Product Header Record					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	DATE	0	A11	-	Date of data in [dd-mon-year]
2	MISS	12	A4	-	Mission acronym (E2RP)
3	REV	17	I2	-	Product revision number
4	NL	19	A1	-	newline

Rapid Ocean Product Data Record					
No.	**Name**	**Offset**	**Format**	**Unit**	**Description**
1	UTC	0	F17.6	sec	time in UTC seconds
2	LAT	18	I10	10^{-6} deg	latitude of footprint
3	LON	28	I10	10^{-6} deg	longitude of footprint
4	HSAT	38	I10	10^{-3} m	satellite height above ellipsoid
5	RANGE	48	I10	10^{-3} m	corrected altimeter range
6	SRANGE	58	I6	10^{-3} m	sigma of altimeter range
7	SWH	64	I6	10^{-3} m	significant wave height
8	NAUGHT	70	I6	10^{-2} db	sigma naught
9	OTID	76	I6	10^{-3} m	ocean tide + tidal loading correction
10	ETID	82	I6	10^{-3} m	solid Earth tide correction
11	WTROPO	88	I6	10^{-3} m	wet troposphere correction
12	DTROPO	94	I6	10^{-3} m	dry troposphere correction
13	IONO	100	I6	10^{-3} m	ionospheric correction
14	-	106	I6	-	undefined
15	GEOID	112	I6	10^{-2} m	geoid height
16	FLAG	119	A8	-	record status flag
17	NL	127	A1	-	newline

Undefined values are set to -99999. The records can be read with the following FORTRAN format statement: format(f17.6,4i10,10i6,1x,a8)

Parameter Description

Rapid Ocean Product Header Record

1. Date of the data in DD-MON-YEAR (e.g. 26-JUN-1997). Each file contains the ROPR data for one day.
2. Mission acronym of the data file (E2RP = ERS-2 Rapid Product).
3. Revision number of the ROPR product. For any change in software or processing the number will increase by 1.

REV=1: All fast delivery data processed (ice and ocean mode), rapid orbit based on pgm073w gravity model, FES95.2.1 tidal model used for ocean tide and tidal loading, IRI95 ionosphere model used, EGM96 geoid included. Improved fast delivery data from ESA ground stations, including a bias from new look-up tables (no additional external bias applied).

Rapid Ocean Product Data Record

1. Seconds with fractional part since 1.1.1990 0h UTC
2. Geodetic latitude of altimeter footprint with respect to wgs84 ellipsoid
3. Geodetic longitude of altimeter footprint with respect to wgs84 ellipsoid
4. Height of the satellite's centre of gravity above wgs84 reference ellipsoid
5. Altimeter range corrected for Earth and ocean tides, tidal loading, ionospheric path delay, tropospheric path delay, distance antenna / centre of gravity.
6. Standard deviation of altimeter range
7. Significant wave height estimated from the slope of the leading edge of the return waveform
8. Sigma naught empirically related to nadir wind speed at the ocean surface
9. Correction for ocean tide and tidal loading (see product revision)
10. Earth tide correction derived from Schwiderski model (Schwiderski, 1980)
11. Wet troposphere correction retrieved from a wet tropospheric model, which was exclusively implemented for the rapid ocean product record generation. The model is based on ERS-1 radiometer data of a 3-year time period. The model considers day/night and monthly variations of the wet troposphere. Quality tests have shown an accuracy of the wet tropospheric model of better than ± 3 cm. In case of absence of the model correction the URA correction is taken.
12. Dry troposphere correction according to the original URA correction.
13. Ionospheric correction (see product revision)
14. not used
15. Interpolated geoid value, computed from a high resolution geoid model (see product revision)
16. Record status flag indicating the status of the wet tropospheric correction (updated or URA), satellite manoevre events (degraded orbit accuracy) and possible double records. The meaning of the record status flag is defined by the following table. The flag is written as 8 byte character string composed of 0/1 digits. The bytes are set to one if the associated criteria is fulfilled.

Byte	Record Status Flag Criteria
1	wet tropospheric correction not replaced
2	dry tropospheric correction not replaced
3	radial orbit accuracy degraded by manoevre
4	possible double record, separated by less than 979 msec from the previous or the next record (in the original URA data).
5	acquisition in ice mode
6-8	unused

Remarks

Tidal and meteorological corrections have to be **subtracted** from the corrected altimeter range to get the uncorrected measurement.

From the original fast delivery altimeter data only measurements for which less than 18 single radar pulses are used for averaging are edited. Because sometimes fast delivery records are processed twice on different stations, in all products both of these records are flagged (byte 4). In some cases the range of one of these double records is wrong and should be eliminated. As editing criterion for example, additional to the flag, the difference (hsat - range) - geoid can be used to identify these corrupted records.

6. List of Acronyms

ADP	Altimeter Data Processing System
CD-ROM	Compact Disk/Read Only Memory
CUS	Central User Service EECF
DFD	Deutsches Fernerkundungsdatenzentrum der DLR
DLR	Deutsche Forschungsanstalt fuer Luft- und Raumfahrt
D-PAF	German Processing and Archiving Facility for ERS
EECF	Earthnet ERS Central Facility
EGM	Earth Gravity Field Model
EPOS	Earth Parameter and Orbit System
ERS	ESA Remote Sensing Satellite
ESA	European Space Agency
ESRIN	European Space Research Institute of ESA
FGNP	Field Generated Normal Points
F-PAF	French Processing and Archiving Facility for ERS
FTP	File Transfer Protocol
GFZ	GeoForschungsZentrum Potsdam
IAG	International Association of Geodesy
IERS	International Earth Rotation Service
ION	PRARE Ionospheric Product
OGE	Ocean Geoid
OPR	Ocean Product
PRARE	Precise Range and Range Rate Equipment
PRC	Precise Orbit
PRL	Preliminary Orbit
Q/L	Quick Look
QLOPC	Q/L Ocean Product Crossovers
QLOPR	Q/L OPR
RA	Radar Altimeter
RA-FD	Radar Altimeter Fast Delivery Products
ROPR	Rapid Ocean Product
RPD	Rapid Orbit
SLR	Satellite Laser Ranging
SSH	Sea Surface Height
SSHQL	Q/L SSH
TDT	Terrestrial Dynamical Time
TOP	Sea Surface Topography
UK-PAF	UK Processing and Archiving Facility for ERS