

GRACE 327-732

(GR-GFZ-FD-001)

Gravity Recovery and Climate Experiment

GRACE Gravity Field Solution Data Formats

(Rev. 1.1, November 27, 2003)

Frank Flechtner
GeoForschungszentrum Potsdam
Department 1: Geodesy and Remote Sensing

John Ries
University of Texas Center for Space Research



Prepared by:

Frank Flechtner, GFZ
GRACE Deputy Science Operations Manager

Contact Information:

GeoForschungsZentrum Potsdam
Department 1: Geodesy and Remote Sensing
c/o DLR Oberpfaffenhofen
D-82234 Wessling, Germany
Email: flechtne@gfz-potsdam.de

John Ries, UTCSR
UTCSR Research Scientist

Contact Information:

Center for Space Research
The University of Texas at Austin
3925 W. Braker Lane, Suite 200
Austin, Texas 78759-5321, USA
Email: grace@csr.utexas.edu

Reviewed by: Peter Schwintzer, GFZ

Approved by:

Byron D. Tapley, UTCSR
GRACE Principal Investigator

Christoph Reigber, GFZ
GRACE Co-Principal Investigator

Document Change Record

Issue	Date	Pages	Change Description
1.0	07.11.2003	all	Initial Version 1.0
1.1	26.11.2003	all	Layout updated
		5	Chapter 2: 'FIRST' record updated
		12	Chapter 6.1: Product Identifier updated

Table of Contents

1	<i>General Format Information</i>	5
2	<i>SHM-Format (Earth Gravity Spherical Harmonic Model Format)</i>	5
3	<i>CORREGM-format (Correlation Matrix Format, Earth Gravity Field Model)</i>	9
4	<i>OTI-Format (Ocean/Atmosphere Tide Format)</i>	10
5	<i>CORROTI-Format (Correlation Matrix Format, Ocean Tides)</i>	12
6	<i>Orbit and Gravity Field Low Level Data Formats</i>	13
6.1	Product Identifier (42 characters)	13
6.2	Gravity Parameter Identifier	13
6.3	Tidal Parameter Identifier	14

1 GENERAL FORMAT INFORMATION

The GRACE gravity format description is based on the document "CHAMP Gravity Field Solution Data Formats (CH-GFZ-FD-003)". New GRACE specific records are marked with bold "RECKEY descriptions". The format for the CMMNT record is the same for all products and is defined in Section 2. Blanks in the descriptions are represented by underscores (_).

2 SHM-FORMAT (EARTH GRAVITY SPHERICAL HARMONIC MODEL FORMAT)

The GRACE gravity field product has mandatory and optional records as follows:

- FIRST** (mandatory, must be first record in file, must appear only once)
- EARTH (mandatory)
- CMMNT (optional, can appear anywhere except before **FIRST**)
- SHM (mandatory)
- SHM* (optional)
- GRCOEF/**GRCOF2**/GRDOTA (optional)

Data Set Designation Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	' FIRST _'
2	PRODIG	6	A42	-	-	y-product_id (c.f. Chapter 6.1.)
3	BLANK	48	A1	-	-	'_'
4	FORMID	44	A7	-	-	'SHM____'
5	BLANK	56	A1	-	-	'_'
6	GENINST	57	A12	-	-	generating institute (e.g. 'GFZ_POTSDAM_')
7	BLANK	69	A1	-	-	'_'
8	GENDATE	70	A8	d	1	yyyymmdd, solution generation date
9	TEXT	78	A42	-	-	arbitrary text

Note: must be first line of file

EGM Defining Constants Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'EARTH_'
2	GM	6	E16.10	m ³ s ⁻²	10 ⁵	gravitational constant times mass of Earth
3	BLANK	22	A1	-	-	'_'
4	R	23	E16.10	m	10 ⁻³	mean equator radius

EGM Comment Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'CMMNT_'
2	TEXT	6	A114	-	-	arbitrary text

Note: record may be inserted anywhere after first record; not obligatory

EGM Coefficient Header Record 1						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'SHM___'
2	MAXD	6	I5	-	-	maximum degree of model
3	MAXO	11	I5	-	-	maximum order of model
4	SCALE	16	F5.2	-	10 ⁻²	scale factor applied to given std. dev. (if SCALE=0 or '___', no std. dev. given) ¹⁾
5	BLANK	21	A1	-	-	'___'
6	NORM	22	A16	-	-	'fully normalized' or 'unnormalized_____'
7	BLANK	38	A1	-	-	'___'
8	PTIDE	39	A24	-	-	'inclusive permanent tide' or 'exclusive permanent tide' or 'not applicable_____' ²⁾

¹⁾ scale factor has already been applied to reported std. dev.
²⁾ inclusive is equivalent to zero-tide; exclusive is equivalent to tide-free

EGM Coefficient Header Record 2						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'SHM*___'
2	BLANK	6	A1	-	-	'___'
3	MAXDO(I)	7	10(I4,'_',I4,',')-	-	-	10*maximum degree (I4) per order (I4) starting with order 0 up to MAXO

Note: records must be given in this sequence, SHM* record is repeated until MAXO is reached

EGM Coefficient Record 1 (one record per degree/order)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'GRCOEF'
2	L	6	I5	-	-	degree l
3	M	11	I5	-	-	order m
4	BLANK	16	A1	-	-	'___'
5	CLM	17	E18.12	-	-	C _{lm} -coefficient
6	BLANK	35	A1	-	-	'___'
7	SLM	36	E18.12	-	-	S _{lm} -coefficient
8	BLANK	54	A1	-	-	'___'
9	STDC	55	E10.4	-	-	std. dev. of C _{lm}
10	BLANK	65	A1	-	-	'___'
11	STDS	66	E10.4	-	-	std. dev. of S _{lm}
12	BLANK	76	A1	-	-	'___'
13	EPOCH	77	A8	d	1	yyyymmdd, epoch of C, S -coefficients ³⁾
14	BLANK	85	A1	-	-	'___'
15	CSOL	86	A1	-	-	C _{lm} adjusted: =y: yes, =n: no
16	SSOL	87	A1	-	-	S _{lm} adjusted: =y: yes, =n: no
17	CINF	88	A1	-	-	stoch. a priori inf. for C _{lm} : =y: yes, =n: no
18	SINF	89	A1	-	-	stoch. a priori inf. for S _{lm} : =y: yes, =n: no
19	CMMNT	90	A30	-	-	arbitrary text

³⁾ epoch represents mid-point of time span of data used to determine the C_{lm}, S_{lm} pair of coefficients

EGM Coefficient Record 2 (one record per degree/order)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'GRCOF2'
2	BLANK	6	A1	-	-	' '
3	L	7	I4	-	-	degree l
4	BLANK	11	A1	-	-	' '
5	M	12	I4	-	-	order m
6	BLANK	16	A1	-	-	' '
7	CLM	17	E18.12	-	-	C_{lm} -coefficient
8	BLANK	35	A1	-	-	' '
9	SLM	36	E18.12	-	-	S_{lm} -coefficient
10	BLANK	54	A1	-	-	' '
11	STDC	55	E10.4	-	-	std. dev. of C_{lm}
12	BLANK	65	A1	-	-	' '
13	STDS	66	E10.4	-	-	std. dev. of S_{lm}
14	BLANK	76	A1	-	-	' '
15	EPOBEG	77	A13	d	1	'yyyymmdd.hhmm', epoch begin ⁴⁾
16	BLANK	90	A1	-	-	' '
17	EPOEND	91	A13	d	1	'yyyymmdd.hhmm', epoch end ⁴⁾
18	BLANK	104	A1	-	-	' '
19	CSOL	105	A1	-	-	C_{lm} adjusted: =y: yes, =n: no
20	SSOL	106	A1	-	-	S_{lm} adjusted: =y: yes, =n: no
21	CINF	107	A1	-	-	stochastic a priori inf. for C_{lm} : =y: yes, =n: no
22	SINF	108	A1	-	-	stochastic a priori inf. for S_{lm} : =y: yes, =n: no
23	CMMNT	109	A23	-	-	arbitrary text

⁴⁾ epochs represent time span of data used to determine this C_{lm} , S_{lm} pair of coefficients

EGM Coefficient Rate Record						
(one record per degree/order)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'GRDOTA'
2	BLANK	6	A1	-	-	'_'
3	L	7	I4	-	-	degree l
4	BLANK	11	A1	-	-	'_'
5	M	12	I4	-	-	order m
6	BLANK	16	A1	-	-	'_'
7	CLMDOT	17	E18.12	1/a	-	C_{lm} rate per year
8	BLANK	35	A1	-	-	'_'
9	SLMDOT	36	E18.12	1/a	-	S_{lm} rate per year
10	BLANK	54	A1	-	-	'_'
11	SCDOT	55	E10.4	1/a	-	std. dev. of C_{lm} -dot
12	BLANK	65	A1	-	-	'_'
13	SSDOT	66	E10.4	1/a	-	std. dev. of S_{lm} -dot
14	BLANK	76	A1	-	-	'_'
15	EPOCH	77	A8	d	1	yyyymmdd, epoch of C_{lm} , S_{lm} coefficients ⁵⁾
16	BLANK	85	A1	-	-	'_'
17	CSOL	86	A1	-	-	C_{lm} rate adjusted: =y: yes, =n: no
18	SSOL	87	A1	-	-	S_{lm} rate adjusted: =y: yes, =n: no
19	CINF	88	A1	-	-	stochastic a priori inf. for C_{lm} rate: =y: yes, =n: no
20	SINF	89	A1	-	-	stochastic a priori inf. for S_{lm} rate: =y: yes, =n: no
21	CMMNT	90	A30	-	-	arbitrary text

⁵⁾ epoch is time to which coefficients with rates are mapped.

3 CORREGM-FORMAT (CORRELATION MATRIX FORMAT, EARTH GRAVITY FIELD MODEL)

Data Set Designation Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'FIRST_'
2	PRODID	6	A36	-	-	y-product_id (c.f. Chapter 6.1.)
3	BLANK	42	A1	-	-	'_'
4	FORMID	43	A7	-	-	'CORREGM'
5	BLANK	50	A1	-	-	'_'
6	GENINST	51	A12	-	-	generating institute (e.g. 'GFZ_POTSDAM_')
7	BLANK	63	A1	-	-	'_'
8	GENDATE	64	A8	d	1	yyyymmdd, solution generation date

Note: must be first line of file; used for 36 character product id; must not be used if DSIDP is used

EGM Coefficient Correlations Header Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'ORDER_'
2	IORD	6	I6	-	-	order of correlation matrix

EGM Coefficient Names Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	CSID(I)	0	7A17	-	-	y-gravity-parameter *7 (c.f. Chapter 6.2.)

Note: record is repeated to take in the full vector of IORD parameter names

EGM Correlation Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RIJ(I)	0	20F6.2	-	10 ⁻²	correlations r _{ij} *20

Note: record is repeated to take in the left lower triangle of the correlation matrix; each line starts with a new record

4 OTI-FORMAT (OCEAN/ATMOSPHERE TIDE FORMAT)

Data Set Designation Record ¹⁾						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'FIRST_'
2	PRODID	6	A36	-	-	y-product_id (c.f. Chapter 6.1.)
3	BLANK	42	A1	-	-	'_'
4	FORMID	43	A7	-	-	'OT____'
5	BLANK	50	A1	-	-	'_'
6	GENINST	51	A12	-	-	generating institute (e.g. 'GFZ_POTSDAM_')
7	BLANK	63	A1	-	-	'_'
8	GENDATE	64	A8	d	1	yyyymmdd, solution generation date

Note: must be first line of file

OTI Defining Constants Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'EARTH_'
2	GM	6	E16.10	m ³ s ⁻²	10 ⁵	gravitational constant times mass of Earth
3	BLANK	22	A1	-	-	'_'
4	R	23	E16.10	m	10 ⁻³	mean equator radius
5	BLANK	39	A1	-	-	'_'
4	DENSW	40	E12.6	kg/m ³	10 ⁻²	sea water density

OTI Parameter Header Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'TIPAR_'
2	MAXD	6	I5	-	-	maximum degree of model
3	MAXO	11	I5	-	-	maximum order of model
4	SCALE	16	F5.2	-	10 ⁻²	scale factor applied to given std. dev. (if SCALE=0 or _, no std. dev. given)
5	BLANK	21	A1	-	-	'_'
6	NORM	22	A16	-	-	'fully_normalized' or 'unnormalized____'

Ocean Loading Love Numbers Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	OLDLVE
2	LOVNR(I)	6	10F10.4	-	10 ⁻⁴	load Love numbers from degree 1 to degree MAXD

Note: OLDLVE record is repeated until MAXD is reached

Ocean Loading Tide Coefficient Record						
(one record per degree/order of prograde/retrograde partial wave)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'OTICS_' for ocean tides 'ATICS_' for atmosphere tides 'CTICS_' for cumulative ocean/atmosph. tides
2	BLANK	6	A1	-	-	' '
3	FLAGPR	7	A1	-	-	flag (+ prograde, - retrograde)
4	DOODNR	8	F7.3	-	-	DOODSON number
5	BLANK	15	A1	-	-	' '
6	LT	16	I3	-	-	degree l of coefficient
7	MT	19	I3	-	-	order m of coefficient
8	BLANK	22	A1	-	-	' '
9	CLM	23	E15.9	-	-	C_{lm} -coefficient
10	BLANK	38	A1	-	-	' '
11	SLM	39	E15.9	-	-	S_{lm} -coefficient
12	BLANK	54	A1	-	-	' '
13	STDC	55	F10.4	-	-	std. dev. of C_{lm}
14	BLANK	56	A1	-	-	' '
15	STDS	66	F10.4	-	-	std. dev. of S_{lm}
16	BLANK	76	A1	-	-	' '
17	CSOL	77	A1	-	-	C_{lm} adjusted:=y: yes, =n: no
18	SSOL	78	A1	-	-	S_{lm} adjusted:=y: yes, =n: no
19	CINF	79	A1	-	-	stoch. a priori inf. for C_{lm} =y: yes, =n: no
20	SINF	80	A1	-	-	stoch. a priori inf. for S_{lm} =y: yes, =n: no
21	CMMT	81	A39	-	-	arbitrary text

Ocean/Atmosphere Constituent Record						
(one record per degree/order of prograde/retrograde wave)						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'OTIAP_' for ocean tides 'ATIAP_' for atmosph. tides 'CTIAP_' for cumulative ocean/atmosph. tides
2	BLANK	6	A1	-	-	' '
3	FLAGPR	7	A1	-	-	flag (+ prograde, - retrograde)
4	DOODNR	8	F7.3	-	-	DOODSON number
5	BLANK	15	A1	-	-	' '
6	LT	16	I3	-	-	degree l of constituent
7	MT	19	I3	-	-	order m of constituent
8	BLANK	22	A1	-	-	' '
9	ALM	23	E15.9	cm	-	A_{lm} : Amplitude
10	BLANK	38	A1	-	-	' '
11	PLM	39	E15.9	deg	-	P_{lm} : Phase
12	BLANK	54	A1	-	-	' '
13	STDA	55	E10.4	cm	-	std. dev. of A_{lm}
14	BLANK	65	A1	-	-	' '
15	STDP	66	E10.4	deg	-	std. dev. of P_{lm}
16	BLANK	76	A1	-	-	' '
17	CSOL	77	A1	-	-	A_{lm} adjusted:=y: yes, =n: no
18	SSOL	78	A1	-	-	P_{lm} adjusted:=y: yes, =n: no
19	CINF	79	A1	-	-	stoch. a priori inf. for A_{lm} =y: yes, =n: no
20	SINF	80	A1	-	-	stoch. a priori inf. for P_{lm} =y: yes, =n: no
21	CMMT	81	A39	-	-	arbitrary text

5 CORROTI-FORMAT (CORRELATION MATRIX FORMAT, OCEAN TIDES)

OTI Data Set Designation Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'FIRST_'
2	PRODID	6	A36	-	-	y-product_id (c.f. Chapter 6.2.)
3	BLANK	42	A1	-	-	' '
4	DATTYP	43	A7	-	-	'CORROTI'

Note: must be first line of file

OTI Parameter Correlations Header Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RECKEY	0	A6	-	-	'ORDER'
2	IORD	6	I6	-	-	order of correlation matrix

OTI Parameter Names Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	TIPAR(I)	0	7A17	-	-	y-tidal-parameter *7 (c.f. Chapter 6.3.)

Note: record is repeated to take in the full vector of IORD parameter names

OTI Parameter Correlation Record						
No.	Name	Offset	Format	Unit	Res.	Description
1	RIJ(I)	0	20F6.2	-	10^{-2}	correlations r_{ij} *20

Note: record is repeated to take in the left lower triangle of the correlation matrix; each line starts with a new record

6 ORBIT AND GRAVITY FIELD LOW LEVEL DATA FORMATS

6.1 Product Identifier (42 characters)

y-product_id						
No.	Name	Offset	Format	Unit	Res.	Description
1	PROD1	0	A1	-	-	'G' for geopotential coefficients 'C' for covariance matrix
2	PROD2	1	A1	-	-	'S' estimate made from satellite data only 'C' combination of satellite and surface data 'E' background model specified as a time series 'T' background model specified in functional form 'A' average of background model over a time period
3	PROD3	2	A1	-	-	'M' static field (includes epochs and rates) 'U' update relative to background model 'T' total background model 'A' non-tidal atmosphere 'B' non-tidal oceans 'C' non-tidal atmosphere and oceans 'S' solid earth tide 'P' pole tide 'O' ocean tide 'E' any empirical variation
4	LEVEL	3	A2	-	-	'-2' indicates Level-2 product
5	FILL	5	A1	-	-	'_' 'underscore' (not blank)
6	DAYS	6	I4	d	1	number of processed days within observation period
7	FILL	10	A1	-	-	'_' 'underscore' (not blank)
8	START	11	A7	d	1	yyydyoy, start of GRACE observation period
9	FILL	18	A1	-	-	'-' 'dash'
10	END	19	A7	d	1	yyydyoy, end of GRACE observation period
11	FILL	26	A1	-	-	'_' 'underscore' (not blank)
12	GENINST	27	A5	-	-	'sssss' institution specific string
13	FILL	32	A1	-	-	'_' 'underscore' (not blank)
14	MIS1	33	A1	-	-	'G' GRACE data used (else '-' 'dash')
15	MIS2	34	A1	-	-	'C' CHAMP data used (else '-' 'dash')
16	MIS3	35	A1	-	-	'O' Other satellite data used (else '-' 'dash')
17	MIS4	36	A1	-	-	'-' 'dash' (spare e.g. for GOCE)
18	FILL	37	A1	-	-	'_' 'underscore' (not blank)
19	RELEASE	38	I4	-	-	release number

6.2 Gravity Parameter Identifier

y-gravity-parameter						
No.	Name	Offset	Format	Unit	Res.	Description
1	CS	0	A2	-	-	'C_', 'S_' resp. and 'CD', 'SD' resp. in case of C-dot, S-dot values
2	IDEG	2	I3	-	-	degree l of coefficient
3	IORD	5	I3	-	-	order m of coefficient
4	BLANK	8	A1	-	-	'_'
5	EPOCH	9	A8	d	1	yyyymmdd, epoch of coefficient

6.3 Tidal Parameter Identifier

y-tidal-parameter						
No.	Name	Offset	Format	Unit	Res.	Description
1	PARTYPE	0	A1	-	-	'C' and 'S', resp. for C_{lm} , S_{lm} -coeff. 'A' and 'P', resp. for ampl., phase
2	PAROGI	1	A1	-	-	'O', 'A', 'C' for ocean, atmosph. and ocean + atm., resp.
3	FLAGPR	2	A1	-	-	flag (+ prograde, - retrograde)
4	DOODNR	3	F7.3	-	-	DOODSON number
5	LT	10	I3	-	-	degree l of parameter
6	MT	13	I3	-	-	order m of parameter
7	BLANK	16	A1	-	-	' '