The ICGEM-format

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The ICGEM-format is a Linux /Unix ASCII-format for the representation of
- Earth Gravity Field models in terms of spherical harmonic coefficients and
- Ocean and Atmosphere Tides

The ICGEM data file format has been developed in the context of the IAG service ICGEM (International Centre for Global Earth Models, http://icgem.gfz-potsdam.de).

The ICGEM-format has been established over the years since 2004. In the beginning, it was intended to keep the format definition simple in such a way that format versions could be avoided. However, as the models developed over the years have become more sophisticated, a more complex ICGEM-format emerged. Therefore, it made sense to define different format versions (see below).

Data files given in the ICGEM-format are indicated by the filename extension ".gfc" which stands for "gravity field coefficients". The names of ICGEM-formatted files must not contain spaces.

Each individual data file consists of three sections:
1. The **comment-section** which starts at the beginning of a respective file and ends with the keyword "begin_of_head" (as a separator between the comment section and the header). This keyword is optional (to stay compatible with earlier versions). That means, without this keyword no explicit comment section is defined (nevertheless, comments are also possible inside the header).
2. The **header** contains general parameters which do not depend on degree l and order m. The end of the header is marked by the keyword "end_of_head" (as a separator between the header and the data section). Without any keyword "begin of head" the header starts at the beginning of the respective file.
3. The **data section** contains the list of degree- and order-dependent parameters.

The records in the header and the data section have the following basic structure:
- The record lines are unformatted, i.e., separators are blanks and/or tabs.
- Each record consists of one keyword followed by one or more parameters (numbers or characters, according to the meaning of the keyword), which are separated by one or an arbitrary number of blanks and/or tabs.
- The number of parameters in a particular record line depends on the meaning of the corresponding keyword as defined in the tables below.
- There are mandatory and optional records.
- All lines beginning with non-defined keywords are comments. But it's recommended to avoid mixture of comments with header or data records and to use the keyword "begin_of_head" for a separate comment section at the beginning of a respective file.

- In any line, additional characters and/or numbers beyond the last parameter are allowed as comments.
- Leading and trailing blanks are ignored, but they should be avoided in the data section.
- Floating-point values should be represented using the e-notation.
- In case of occurrence of gfct parameters, the respective time variabilities are defined according to the formulae in the headers of the two examples below
- The format parameter with the keyword “format” with the value “icgem2.0” has been introduced to indicate time-limited validity periods of the time-varying coefficients (see the tables below). A mixture of icgem1.0 and icgem2.0 formatted gfct coefficients is not allowed.

Earth Gravity Field Models

Header section:

mandatory keywords	number of parameters	meaning of parameters
product_type	1	"gravity_field"
modelname	1	name of the model (usually the respective filename without the extension “.gfc”)
earth_gravity_constant	1	gravitational constant times mass of the earth $[m^3s^{-2}]$
radius	1	reference radius of the spherical harmonic development [m]
max_degree	1	maximum degree of the spherical harmonic development
errors	1	either "no", "calibrated", “formal” or both "calibrated_and_formal" errors are included
end_of_head	0	The position of this keyword defines the end of the header

Case dependent keywords	number of parameters	meaning of parameters
format	1	“icgem1.0” or “icgem2.0” This parameter with the value “icgem2.0” is mandatory in case the time variable coefficients gfct and the associated parameters trnd, asin respective acos are given piecewise for dedicated periods. Otherwise, this parameter is optional and may be given with the value “icgem1.0”

optional keywords	number of parameters	meaning of parameters
begin_of_head	0	The position of this keyword indicates the begin of the header section. All preceding lines are comments.
tide_system	1	either "zero_tide", "tide_free", “mean_tide” or "unknown" (default)
norm	1	either "fully_normalized" (=default) or "unnormalized"

Data section (format version icgem1.0):

optional keyword	number of parameters	meaning of the parameters
Static spherical harmonic coefficients		
gfc	6(*)	degree, order, Clm, Slm, sigmaC sigmaS
gfc	8(**)	degree, order, Clm, Slm, sigmaC_cal, sigmaS_cal, sigmaC_formal, sigmaS_formal
gfc	4(***)	degree, order, Clm, Slm
Time variable spherical harmonic coefficients, according to the respective formulas in the examples below		
gfct	7(*)	degree, order, Clm, Slm, sigmaC, sigmaS, time (yyyymmdd)
gfct	9(**)	degree, order, Clm, Slm, sigmaC_cal, sigmaS_cal, sigmaC_formal, sigmaS_formal, time (yyyymmdd)
gfct	5(***)	degree, order, Clm, Slm, time (yyyymmdd)
trnd	6(*)	degree, order, trend_C, trend_S, sigma_trend_C, sigma_trend_S
trnd	8(**)	degree, order, trend_C, trend_S, sigma_trend_C_cal, sigma_trend_S_cal, sigma_trend_C_formal, sigma_trend_S_formal,
trnd	4(***)	degree, order, trend_C, trend_S
dot	The same as the above cases for "trnd"	This keyword is the old version of "trnd" and was used in the past before introduction the "asin" and "acos" records. It's still allowed due to backward compatibility in older models where are "asin" and "acos" records are not given. "dot" must not be used together with the "asin" and "acos" records.
asin	7(*)	degree, order, sine_amplitude_C, sine_amplitude_S, sigma_sine_amplitude_C, sigma_sine_amplitude_S, period [year]
asin	9(**)	degree, order, sine_amplitude_C, sine_amplitude_S, sigma_sine_amplitude_C_cal, sigma_sine_amplitude_S_cal , sigma_sine_amplitude_C_formal, sigma_sine_amplitude_S_formal , period [year]
asin	5(***)	degree, order, sine_amplitude_C, sine_amplitude_S, period
acos	7(*)	degree, order, cosine_amplitude_C, cosine_amplitude_S, sigma_cosine_amplitude_C, sigma_cosine_amplitude_S, period [year]
acos	9(**)	degree, order, cosine_amplitude_C, cosine_amplitude_S, sigma_sine_amplitude_C_cal, sigma_sine_amplitude_S_cal, sigma_sine_amplitude_C_formal, sigma_sine_amplitude_S_formal, period [year]
acos	5(***)	degree, order, cosine_amplitude_C, cosine_amplitude_S, period [year]

(*) – in the case of errors = "calibrated" or "formal" in the header
(**) – in the case of errors = "calibrated_and_formal" in the header
(***) – in the case of errors = "no" in the header

The keywords "trnd", "asin" and "acos" require a corresponding keyword "gfct".

Data section (format version icgem2.0):

optional keyword	number of parameters	meaning of the parameters
Static spherical harmonic coefficients		
gfc	6(*)	degree, order, Clm, Slm, sigmaC sigmaS
gfc	8(**)	degree, order, Clm, Slm, sigmaC_cal, sigmaS_cal, sigmaC_formal, sigmaS_formal
gfc	4(***)	degree, order, Clm, Slm
Time variable spherical harmonic coefficients, according to the respective formulas in the examples below		
gfct	8*)	degree, order, Clm, Slm, sigmaC, sigmaS, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm)
gfct	10**)	degree, order, Clm, Slm, sigmaC_cal, sigmaS_cal, sigmaC_formal, sigmaS_formal, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm)
gfct	6(***)	degree, order, Clm, Slm, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm)
trnd	8(*)	degree, order, trend_C, trend_S, sigma_trend_C, sigma_trend_S, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm)
trnd	10(**)	degree, order, trend_C, trend_S, sigma_trend_C_cal, sigma_trend_S_cal, sigma_trend_C_formal, sigma_trend_S_formal, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm)
trnd	6(***)	degree, order, trend_C, trend_S, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm)
asin	9(*)	degree, order, sine_amplitude_C, sine_amplitude_S, sigma_sine_amplitude_C, sigma_sine_amplitude_S, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm), period [year]
asin	11(**)	degree, order, sine_amplitude_C, sine_amplitude_S, sigma_sine_amplitude_C_cal, sigma_sine_amplitude_S_cal , sigma_sine_amplitude_C_formal, sigma_sine_amplitude_S_formal , t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm), period [year]
asin	7(***)	degree, order, sine_amplitude_C, sine_amplitude_S, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm), period [year]
acos	9(*)	degree, order, cosine_amplitude_C, cosine_amplitude_S, sigma_cosine_amplitude_C, sigma_cosine_amplitude_S, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm), period [year]
acos	11(**)	degree, order, cosine_amplitude_C, cosine_amplitude_S, sigma_sine_amplitude_C_cal, sigma_sine_amplitude_S_cal, sigma_sine_amplitude_C_formal, sigma_sine_amplitude_S_formal, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm), period [year]
acos	7(***)	degree, order, cosine_amplitude_C, cosine_amplitude_S, t0(yyyymmdd.hhmm), t1(yyyymmdd.hhmm), period [year]

(*) – in the case of errors = "calibrated" or "formal" in the header
(**) – in the case of errors = “calibrated_and_formal” in the header
(***) – in the case of errors = "no" in the header

The keywords “trnd”, “asin” and “acos” require a corresponding keyword "gfct".

Example for Earth Gravity Field Models (format version icgem1.0):

```
This is an example.
Here could be some comment, e.g. references and/or description of
the calculation method of the model

For each gravity parameter G of degree l and order m
(i.e. for each spherical harmonic coefficient Clm or Slm)
until degree l=50 six mean parameters has been estimated:

             coefficient at reference time t=t0:  G(t0)
                                   linear trend:   trnd
amplitude for   sine oscillation with period p1:  asin1
amplitude for cosine oscillation with period p1:  acos1
amplitude for   sine oscillation with period p2:  asin2
amplitude for cosine oscillation with period p2:  acos2

                    p1 is the annual period: p1 = 1.0 y
                 p2 is the semiannual period: p2 = 0.5 y


The final, cumulated equation, contains six parameters for each coefficient
until degree 50: G(t0), trnd, asin1, acos1, asin2, acos2);
and one parameter per coefficient from degree 51 to 370.
All parameters are solved-for in one run.

To calculate a gravity field functional from this model, the coefficients G=G(t)
up to degree 50 have to be calculated for the corresponding time point t
by the formula:

G(t)=G(t0) + trnd*(t-t0) + asin1*sin(2pi/p1 * (t-t0)) + acos1*cos(2pi/p1 * (t-t0))
                         + asin2*sin(2pi/p2 * (t-t0)) + acos2*cos(2pi/p2 * (t-t0))

The reference time t0 is: t0 = 2005.0 y

begin_of_head ==================================================

          product_type     gravity_field
             modelname     EXAMPLE_MODEL
earth_gravity_constant      0.3986004415E+15
                radius      0.6378136460E+07
            max_degree        370
                errors     formal


key    L    M         C                   S           sigma C    sigma S   t0[yyyymmdd]
                                                                            period[y]
end_of_head ===================================================================================
gfc    0    0  1.00000000000e+00 0.000000000000e+00 0.0000e+00 0.0000e+00
gfc    1    0  0.00000000000e+00 0.000000000000e+00 0.0000e+00 0.0000e+00
gfct   2    0 -4.84165299806e-04 0.000000000000e+00 1.9482e-13 0.0000e+00 20050101
trnd   2    0 -1.26060242677e-11 0.000000000000e+00 3.2284e-14 0.0000e+00
acos   2    0  4.10012162817e-11 0.000000000000e+00 1.8915e-13 0.0000e+00 1.0
asin   2    0  5.32328946063e-11 0.000000000000e+00 1.9618e-13 0.0000e+00 1.0
acos   2    0  3.33917546745e-11 0.000000000000e+00 1.8829e-13 0.0000e+00 0.5
asin   2    0 -2.44339926664e-11 0.000000000000e+00 1.9158e-13 0.0000e+00 0.5
gfct   3    0  9.57211211877e-07 0.000000000000e+00 1.6575e-13 0.0000e+00 20050101
trnd   3    0 -8.37409795344e-12 0.000000000000e+00 5.0047e-14 0.0000e+00
acos   3    0 -1.76060539636e-11 0.000000000000e+00 2.2776e-13 0.0000e+00 1.0
asin   3    0  9.47586646659e-11 0.000000000000e+00 2.2725e-13 0.0000e+00 1.0
acos   3    0  1.06250666438e-11 0.000000000000e+00 1.8607e-13 0.0000e+00 0.5
asin   3    0 -9.12652655373e-12 0.000000000000e+00 1.8757e-13 0.0000e+00 0.5
gfct   4    0  5.39990171043e-07 0.000000000000e+00 6.2820e-14 0.0000e+00 20050101
trnd   4    0  1.24828057445e-12 0.000000000000e+00 2.8139e-14 0.0000e+00
acos   4    0 -7.55236874480e-12 0.000000000000e+00 7.4141e-14 0.0000e+00 1.0
asin   4    0 -3.50320360424e-12 0.000000000000e+00 7.2096e-14 0.0000e+00 1.0
acos   4    0  8.17774288320e-12 0.000000000000e+00 7.4031e-14 0.0000e+00 0.5
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asin   4    0 -1.53703748172e-11 0.000000000000e+00 7.3160e-14 0.0000e+00 0.5
gfct   5    0  6.86846086922e-08 0.000000000000e+00 4.4587e-14 0.0000e+00 20050101
trnd   5    0 -5.03351696812e-12 0.000000000000e+00 2.0154e-14 0.0000e+00
acos   5    0  5.08662560512e-12 0.000000000000e+00 5.2391e-14 0.0000e+00 1.0
asin   5    0 -1.05985537206e-10 0.000000000000e+00 5.1024e-14 0.0000e+00 1.0
acos   5    0  2.22624185397e-12 0.000000000000e+00 5.2349e-14 0.0000e+00 0.5
asin   5    0  8.82192224350e-13 0.000000000000e+00 5.1716e-14 0.0000e+00 0.5.
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gfct  27   27  8.06120329239e-09  1.06608226493e-09 2.2844e-13 2.2826e-13 20050101
trnd  27   27  3.67098016238e-13  2.27158968548e-13 7.3838e-14 7.3724e-14
acos  27   27  8.91937468847e-14  7.77803575847e-13 1.7863e-13 1.7852e-13 1.0
asin  27   27 -8.51683023418e-13  4.34767822873e-13 1.7514e-13 1.7498e-13 1.0
acos  27   27  5.06913063717e-13 -2.32657020141e-13 1.7766e-13 1.7742e-13 0.5
asin  27   27  1.89774541915e-13 -1.45928916924e-13 1.7583e-13 1.7582e-13 0.5
gfct  28   27 -8.03143232828e-09  1.20703195531e-09 2.7913e-13 2.7915e-13 20050101
trnd  28   27 -2.00166443528e-13 -3.93373011285e-13 1.0621e-13 1.0623e-13
acos  28   27  7.34123111437e-13 -6.81259850564e-13 2.5327e-13 2.5322e-13 1.0
asin  28   27  4.90821907582e-13 -1.59350550219e-13 2.4966e-13 2.4972e-13 1.0
acos  28   27  1.08483587687e-12 -1.72429171568e-13 2.5241e-13 2.5231e-13 0.5
asin  28   27 -7.06527907663e-13  1.53301500544e-12 2.5024e-13 2.5035e-13 0.5
gfct  29   27 -7.73381038494e-09 -7.12599251556e-10 2.2397e-13 2.2400e-13 20050101
trnd  29   27  7.45731672960e-14 -1.88010301771e-13 7.8838e-14 7.8851e-14
acos  29   27  1.26344942042e-14 -1.71165107390e-14 1.8983e-13 1.8991e-13 1.0
asin  29   27 -7.34314665050e-13 -4.01985361372e-13 1.8657e-13 1.8667e-13 1.0
acos  29   27  2.49158864776e-16  1.10238884087e-13 1.8895e-13 1.8908e-13 0.5
asin  29   27 -1.02102111285e-12 -5.40708657982e-13 1.8721e-13 1.8726e-13 0.5
gfct  30   27 -7.72874025980e-09  1.25541295052e-08 1.8714e-13 1.8715e-13 20050101
trnd  30   27 -1.87538029519e-13  1.82696340981e-13 7.2002e-14 7.2011e-14
acos  30   27  7.59741523741e-13 -8.97191941982e-14 1.7319e-13 1.7315e-13 1.0
asin  30   27  6.03260716490e-13  3.53437864527e-13 1.7051e-13 1.7057e-13 1.0
acos  30   27  1.03533466862e-12  2.86879182500e-13 1.7253e-13 1.7248e-13 0.5
asin  30   27  7.07570156865e-14  3.97615584293e-13 1.7097e-13 1.7105e-13 0.5
gfct  31   27 -1.13744297023e-09  1.10316027212e-08 2.3031e-13 2.3047e-13 20050101
trnd  31   27  7.40871533735e-14  1.21037257769e-13 6.8705e-14 6.8737e-14
acos  31   27  5.71415899456e-13  4.20057832732e-14 1.6117e-13 1.6128e-13 1.0
asin  31   27  4.58757750487e-13 -5.00999874499e-14 1.5886e-13 1.5903e-13 1.0
acos  31   27 -6.77760455270e-14 -2.62483376992e-13 1.6062e-13 1.6071e-13 0.5
asin  31   27 -1.60638948013e-13 -4.30190569712e-13 1.5925e-13 1.5941e-13 0.5
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gfc   80   53 -6.98612520806e-10 -8.15476908997e-10 1.2825e-12 1.2831e-12
gfc   81   53  1.92170808521e-09 -3.28956589348e-09 1.2497e-12 1.2506e-12
gfc   82   53  9.31735484272e-10  9.51657560255e-10 1.3631e-12 1.3640e-12
gfc   83   53 -4.49512933539e-10  2.35684623894e-09 1.3869e-12 1.3880e-12
gfc   84   53  5.08987212551e-10 -4.97988534071e-11 1.4527e-12 1.4538e-12
gfc   85   53  4.17659273146e-11 -1.13197887747e-09 1.5374e-12 1.5387e-12
gfc   86   53 -2.70028498118e-10  4.50284895284e-10 1.5580e-12 1.5595e-12
gfc   87   53 -1.41103157756e-10  1.64767302491e-10 1.6992e-12 1.7006e-12
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gfc  370  366 -1.55480023415e-11  1.93505587305e-11 7.2077e-11 7.2076e-11
gfc  367  367 -2.89431310483e-11  2.37374959911e-11 7.3543e-11 7.3542e-11
gfc  368  367  9.03717109323e-13  6.91852047933e-13 7.3142e-11 7.3143e-11
gfc  369  367 -1.14492738762e-11  2.63952107639e-11 7.2747e-11 7.2748e-11
gfc  370  367 -3.64375144637e-12  1.15893956997e-11 7.2335e-11 7.2337e-11
gfc  368  368 -2.54244519773e-11 -1.55400024226e-11 7.3386e-11 7.3385e-11
gfc  369  368  8.26779522399e-13  1.90002206374e-11 7.2987e-11 7.2987e-11
gfc  370  368 -6.27441636505e-12  2.23015857612e-11 7.2593e-11 7.2593e-11
gfc  369  369  1.07090530321e-11  3.17611923497e-11 7.3230e-11 7.3232e-11
gfc  370  369  2.44645105996e-11 -1.24447844022e-11 7.2832e-11 7.2833e-11
gfc  370  370 -2.53164796379e-11 -1.72931830167e-11 7.3077e-11 7.3076e-11
```

Example for Earth Gravity Field Models (format version icgem2.0):

```
This is an example.

To calculate a gravity field functional from this model at a dedicated epoch t, the coefficients G=G(t)
have to be calculated for the corresponding time period t0 < t < t1 by the formula:

G(t)=G(t0) + trnd*(t-t0) + asin1*sin(2pi/p1 * (t-t0)) + acos1*cos(2pi/p1 * (t-t0))
                         + asin2*sin(2pi/p2 * (t-t0)) + acos2*cos(2pi/p2 * (t-t0))

begin_of_head ======================================
format                     icgem2.0
product_type               gravity_field
modelname                  EXAMPLE_MODEL_2
earth_gravity_constant     0.3986004415E+15
radius                     0.6378136460E+07
max_degree                 300
errors                     calibrated (sigma calibration factor = 2.00)
norm                       fully_normalized
tide_system                tide_free

key    L    M          C          S    sigma C    sigma S   t0[yyyymmdd.xxxx]  t1[yyyymmdd.xxxx] period[y]
end_of_head ========================================================================================
gfc    0    0  1.00000000000E+00  0.00000000000E+00 0.0000E+00 0.0000E+00
gfct   1    0  7.01776593302E-11  0.00000000000E+00 1.3180E-13 0.0000E+00 19500101.0000 20020815.0817
trnd   1    0  0.00000000000E+00  0.00000000000E+00 0.0000E+00 0.0000E+00 19500101.0000 20020815.0817
acos   1    0  7.81500675516E-11  0.00000000000E+00 3.5640E-14 0.0000E+00 19500101.0000 20020815.0817 1.0
asin   1    0 -2.91423806169E-12  0.00000000000E+00 3.6200E-14 0.0000E+00 19500101.0000 20020815.0817 1.0
acos   1    0 -3.34601799827E-11  0.00000000000E+00 3.4480E-14 0.0000E+00 19500101.0000 20020815.0817 0.5
asin   1    0 -2.09359348050E-11  0.00000000000E+00 3.3920E-14 0.0000E+00 19500101.0000 20020815.0817 0.5
gfct   1    0  7.01776593302E-11  0.00000000000E+00 1.3180E-13 0.0000E+00 20020815.0817 20030101.0000
trnd   1    0 -3.77603884451E-12  0.00000000000E+00 2.4210E-13 0.0000E+00 20020815.0817 20030101.0000
acos   1    0  7.82954716489E-11  0.00000000000E+00 1.5400E-13 0.0000E+00 20020815.0817 20030101.0000 1.0
asin   1    0 -2.73582797094E-12  0.00000000000E+00 1.0520E-13 0.0000E+00 20020815.0817 20030101.0000 1.0
acos   1    0 -3.36579162445E-11  0.00000000000E+00 1.3510E-13 0.0000E+00 20020815.0817 20030101.0000 0.5
asin   1    0 -2.06958680138E-11  0.00000000000E+00 1.5250E-13 0.0000E+00 20020815.0817 20030101.0000 0.5
gfct   1    0  6.87432297897E-11  0.00000000000E+00 1.1030E-13 0.0000E+00 20030101.0000 20040101.0000
trnd   1    0 -4.96847579522E-12  0.00000000000E+00 2.1030E-13 0.0000E+00 20030101.0000 20040101.0000
acos   1    0  7.82241505823E-11  0.00000000000E+00 5.3280E-14 0.0000E+00 20030101.0000 20040101.0000 1.0
asin   1    0 -3.41050412917E-12  0.00000000000E+00 8.1540E-14 0.0000E+00 20030101.0000 20040101.0000 1.0
acos   1    0 -3.35798492155E-11  0.00000000000E+00 5.1700E-14 0.0000E+00 20030101.0000 20040101.0000 0.5
asin   1    0 -2.07233495045E-11  0.00000000000E+00 6.4780E-14 0.0000E+00 20030101.0000 20040101.0000 0.5
.
trnd   2    0  0.00000000000E+00  0.00000000000E+00 0.0000E+00 0.0000E+00 19500101.0000 19850109.1751
gfct   2    0 -4.84165442874E-04  0.00000000000E+00 1.3920E-11 0.0000E+00 19850109.1751 19860101.0000
trnd   2    0  1.24657017393E-11  0.00000000000E+00 2.2600E-11 0.0000E+00 19850109.1751 19860101.0000
gfct   2    0 -4.84165430707E-04  0.00000000000E+00 8.6720E-12 0.0000E+00 19860101.0000 19870101.0000
trnd   2    0  2.24347107494E-11  0.00000000000E+00 1.8180E-11 0.0000E+00 19860101.0000 19870101.0000
gfct   2    0 -4.84165408273E-04  0.00000000000E+00 9.5070E-12 0.0000E+00 19870101.0000 19880101.0000
trnd   2    0  1.28987611358E-10  0.00000000000E+00 1.7360E-11 0.0000E+00 19870101.0000 19880101.0000
gfct   2    0 -4.84165279285E-04  0.00000000000E+00 7.8510E-12 0.0000E+00 19880101.0000 19890101.0000
trnd   2    0 -8.33020306695E-11  0.00000000000E+00 1.4760E-11 0.0000E+00 19880101.0000 19890101.0000
gfct   2    0 -4.84165362587E-04  0.00000000000E+00 6.9040E-12 0.0000E+00 19890101.0000 19900101.0000
trnd   2    0  6.49257734499E-12  0.00000000000E+00 1.4200E-11 0.0000E+00 19890101.0000 19900101.0000
gfct   2    0 -4.84165356094E-04  0.00000000000E+00 7.2950E-12 0.0000E+00 19900101.0000 19910101.0000
trnd   2    0  1.62048658823E-11  0.00000000000E+00 1.4490E-11 0.0000E+00 19900101.0000 19910101.0000
.
gfct   2    0 -4.84165275354E-04  0.00000000000E+00 4.6580E-12 0.0000E+00 20020101.0000 20030101.0000
trnd   2    0  2.61477983048E-11  0.00000000000E+00 9.4530E-12 0.0000E+00 20020101.0000 20030101.0000
acos   2    0  3.87007395388E-11  0.00000000000E+00 1.1170E-12 0.0000E+00 19500101.0000 20030101.0000 1.0
asin   2    0  5.91814852349E-11  0.00000000000E+00 1.1010E-12 0.0000E+00 19500101.0000 20030101.0000 1.0
acos   2    0  3.93538776211E-11  0.00000000000E+00 1.1070E-12 0.0000E+00 19500101.0000 20030101.0000 0.5
asin   2    0 -2.19462790927E-11  0.00000000000E+00 1.1040E-12 0.0000E+00 19500101.0000 20030101.0000 0.5
gfct   2    0 -4.84165227624E-04  0.00000000000E+00 2.3300E-11 0.0000E+00 20030101.0000 20040101.0000
trnd   2    0 -4.92366971847E-11  0.00000000000E+00 3.8060E-11 0.0000E+00 20030101.0000 20040101.0000
acos   2    0  3.84911295545E-11  0.00000000000E+00 1.0960E-11 0.0000E+00 20030101.0000 20040101.0000 1.0
asin   2    0  7.22385315628E-11  0.00000000000E+00 1.3540E-11 0.0000E+00 20030101.0000 20040101.0000 1.0
acos   2    0  7.66906872209E-12  0.00000000000E+00 8.9060E-12 0.0000E+00 20030101.0000 20040101.0000 0.5
asin   2    0 -3.13633906172E-11  0.00000000000E+00 1.5220E-11 0.0000E+00 20030101.0000 20040101.0000 0.5
.
gfc  297  295  2.29523141302E-11  6.86811783437E-12 4.1592E-11 4.1592E-11
gfc  298  295  3.11451761449E-11 -1.12040550160E-11 4.1450E-11 4.1450E-11
gfc  299  295  3.58362974130E-11 -4.78094005662E-11 4.1287E-11 4.1287E-11
gfc  300  295  1.81858778688E-11  4.25479256891E-11 4.1120E-11 4.1120E-11
gfc  296  296  2.09280222039E-11 -6.95265699531E-13 4.1557E-11 4.1557E-11
gfc  297  296 -7.21965378531E-11  6.67927856973E-11 4.1602E-11 4.1602E-11
gfc  298  296  3.65699895399E-11 -3.25077564694E-11 4.1426E-11 4.1426E-11
gfc  299  296 -1.73625517783E-11  1.55832187380E-11 4.1279E-11 4.1279E-11
gfc  300  296  4.11115342628E-12 -7.93710768974E-12 4.1114E-11 4.1114E-11
gfc  297  297  1.98319581062E-11  1.35621234370E-11 4.1402E-11 4.1402E-11
gfc  298  297 -4.63739382940E-12 -2.33275489478E-11 4.1434E-11 4.1434E-11
gfc  299  297  3.46570935392E-11  1.02831045999E-11 4.1256E-11 4.1256E-11
gfc  300  297  2.46286339082E-11  1.34883288401E-11 4.1106E-11 4.1106E-11
gfc  298  298 -2.13616224563E-11  1.41143439473E-11 4.1246E-11 4.1246E-11
gfc  299  298 -5.14714984205E-11 -1.87041933606E-11 4.1263E-11 4.1263E-11
gfc  300  298  2.49195806602E-12 -2.85237041020E-11 4.1085E-11 4.1085E-11
gfc  299  299 -4.66647625803E-12 -1.95871938119E-11 4.1085E-11 4.1085E-11
gfc  300  299 -4.61943815481E-11 -1.16876632959E-12 4.1090E-11 4.1090E-11
gfc  300  300 -1.25298319912E-11 -1.00609822622E-11 4.0923E-11 4.0923E-11
```

Ocean/Atmosphere Tides

Header section:

mandatory keywords	number of parameters	meaning of parameters
product_type	1	"ocean_tides"
modelname	1	name of the model
earth_gravity_constant	1	gravitational constant times mass of the earth
radius	1	reference radius of the spherical harmonic development
max_degree	1	maximum degree of the spherical harmonic development
errors	1	either "no", "calibrated" or "formal" errors given
end_of_head	0	position of keyword defines the end of the header

optional keywords	number of parameters	meaning of parameters
begin_of_head	0	position of keyword defines the begin of the header (all previous lines are comments; such comments are safer than comments within the keyword-section which simply do not start with a keyword sequence)
norm	1	either "fully_normalized" (=default) or "unnormalized"
water_density	1	density of sea water [kg/m3] (default = 1025.0)

Data section:

optional keywords	number of parameters	meaning of parameters
lovnr	2	degree, load love number
ocs	8(*)	degree, order, "pro" or "retro", Doodson number, Clm-coefficient, Slm-coefficient, sigmaC, sigmaS
ocs	6(**)	degree, order, "pro" or "retro", Doodson number, Clm-coefficient, Slm-coefficient
acs	8(*) / 6(**)	(dto. for atmosphere tide coefficients)
ccs	8(*) / 6(**)	(dto. for combined ocean/atmosphere tide coefficients)
oap	8(*)	degree, order, "pro" or "retro", Doodson number, Alm (amplitude), Plm (phase), sigmaA, sigmaP
oap	6(**)	degree, order, "pro" or "retro", Doodson number, Alm (amplitude), Plm (phase)
aap	8(*) / 6(**)	(dto. for atmosphere tide amplitude/phase)
cap	8(*) / 6(**)	(dto. for combined ocean/atmosphere tide amplitude/phase)

(*) – in the case of errors = "calibrated" or "formal" in the header

(**) – in the case of errors = "no" in the header

Example for Ocean/Atmosphere Tides:

```
product_type                ocean_tides
modelname                   EXAMPLE-MODEL
earth_gravity_constant      0.3986030000E+15
radius                      0.6378160000E+07
water_density               1025.0
max_degree                  6
errors                      formal
norm                        fully_normalized

end_of_head
=======================================
lovnr 0    0.0000
lovnr 1   -0.3075
lovnr 2   -0.1950
lovnr 3   -0.1320
lovnr 4   -0.1032
lovnr 5   -0.0892
lovnr 6   -0.0820
ocs   2   1 pro   +135.655  -.699279379E+00  0.616931102E+00 0.1048E+00 0.1035E+00
oap   2   1 pro   +135.655   .933000000E+00  0.311400000E+03 0.0210E+00 0.1200E+01
.
.
.
.
.
ocs   6   2 pro   +275.555  -.102235651E+00  0.489852820E-02 0.3575E-02 0.3308E-02
oap   6   2 pro   +275.5552  .102240000E+00  0.272700000E+03 0.1000E-03 0.4000E+00
```