Description of the SHC format for storing spherical harmonic models of the internal magnetic field

Note: This is the format in which the Swarm Level-2 internal field models will be provided.

The Gauss coefficients g and h of spherical harmonic models are given as snapshots at different time instants. A static field (i.e. the high-degree lithospheric field) is given as a snapshot; the core field is provided as a series of snapshot models.

Each file contains one or more blocks. Each of these blocks describes a certain range of Gauss coefficients with the same description of time dependence (i.e. either static, linear time dependent, cubic splines, or order-6 splines, or …).

Each block contains a header part and a coefficient part of length $K = N\_max*(N\_max+2) - (N\_min-1)*(N\_min+1)$ lines with the Gauss coefficients stored row-wise in natural order $(g_1^0, g_1^1, h_1^1, g_2^0 \, g_2^1 \, h_2^1, \ldots)$. The first column of this coefficient part contains spherical harmonic degree n, the second contains spherical harmonic order m. Non-negative values of the order refer to the Gauss coefficients g_n^m while negative orders indicate the Gauss coefficients h_n^m. Rows 3 to `N_times+2` of this coefficient part contains the Gauss coefficients of the `N_times` snapshot models, provided at the time instants `t` (given in decimal years).

Such a series of snapshot models is sufficient to completely describe a model if its time dependence is defined to be static, a Taylor expansion in time, or a piecewise linear varying spline (order 2 spline).

In the case of a time dependence described by splines of order larger than 2 (e.g. cubic splines, i.e. spline of order 4), additional information is needed to reconstruct the time dependence from the `N_times` snapshot models.

`spline_order` snapshot models are provided for each knot interval (i.e. an "oversampling" of the model), indicated by the value `N_step` (which is equal to `spline_order-1` in this case). This is explained in Table 1.

It is possible to read the whole block using space-delimited free format read instructions.

Comment lines may be added before and after a block; each comment line start with the character #.

# Comment line part. An arbitrary number of comment lines, each starting with '#',						
# may be added before or after each block						
N_min	N_max	N_times	spline_order	N_step =spline_order -1		
		t(1)	t(2)	t(3)	...	t(N_times)
N_min	0	g(1)	g(2)			g(N_times)
N_min	1	g(1)	g(2)			g(N_times)
N_min	-1	h(1)	h(2)			h(N_times)
n	m	g(1)	g(2)			g(N_times)
n	-m	h(1)	h(2)			h(N_times)
N_max	N_max	g(1)	g(2)			g(N_times)
N_max	-N_max	h(1)	h(2)			h(N_times)

Table 1 Format of field model: every N_step value of time t (in decimal years) are the spline knots, and therefore N_step=spline_order - 1.