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AMSS3: Software system for Aeromagnetic data processing, Grid data manipulation, and Reduction and quantitative interpretation of magnetic anomaly data (3)

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Content

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1. Introduction

This report is a fully-revised and expanded version for the previous GSJ Open-File Report no. 519 "Software system for Aeromagnetic data processing, Grid data manipulation, and Reduction and quantitative interpretation of magnetic anomaly data (2)" [Nakatsuka, 2009f], with adding newly developed programs (ANAMX) of higher sophisticated analysis methods such as 3D imaging interpretation and Generalized crossover analysis of aeromagnetic data. Also, this report includes an update of Library Software (GSJ Open-File Report no. 518 [Nakatsuka, 2009e]).

We have been engaged in the research on aeromagnetic survey, and developed various kinds of programs for data processing, analysis and interpretation. The outlines of them have already been reported on the scientific journals and at the scientific meetings [Nakatsuka and Okuma, 2005b, 2005c, 2006a, 2006e, 2009a, 2011, 2014; Nakatsuka *et al.*, 2009c; and others : see 'References' section]. Their source codes are open to public through the GSJ Open-file Reports.

In this report, We deal with six groups of programs for the aeromagnetic survey, as follows.
(1) **DPAM:** programs for aeromagnetic survey observation data processing,
(2) **GDMP:** programs for grid data manipulation,
(3) **ANAM:** programs for analysis of magnetic anomaly data,
(4) **ANAMX:** programs for 3D imaging and generalized crossover analysis of aeromagnetic data,
(5) **libgm:** library subprograms for geophysical analysis and graphic presentation,
(6) **utils:** miscellaneous utility programs.
This software system is in a style of program libraries, consisting of many individual programs of rather simple functions. Then the actual process to some target/objective would require a series of program executions. The data formats used in this system are customized for our own original style. However, as for its design, all data are handled in the form of ASCII text, so that the user can easily convert data to/from another style of formats.

Among six program groups, (1) **DPAM**, (2) **GDMP**, and (3) **ANAM** are the succession from the GSJ Open-file Report no.449, while (4) **ANAMX** are the lately developed programs for higher sophisticated analysis methods. (5) **libgm**, and (6) **utils** are the newest updated version for the GSJ Open-file Report no.400 "Library Software for Geophysical Data Processing and Representation", but be aware that there exist some major changes of specification.

2. Outline of each group of programs

2.1 Program group DPAM

DPAM group consists of programs for aeromagnetic survey data processing as follows.

alog2asc	**xldam**	**despike**	**ggrid**	**pframe**	**pchkmag**
daq2asc	**xldpn**	**dvcorr**	**ggrids**	**pltrk**	**pchkres**
bdaq2asc	**xldhg**	**ecomp**	**xslin**	**pchkdv**	**pchkcomp**
dmaq2asc	**filtadasc**	**fcomp**	**xslina**		

Programs **alog2asc**, **daq2asc**, **bdaq2asc**, and **dmaq2asc** converts aeromagnetic raw acquisition data (specialized for our survey system) into common ASCII file format. **alog2asc** / **daq2asc** correspond to the stinger type survey system of (old) AIRLOGS / (newer) AMDAQ, **bdaq2asc** for bird type survey, and **dmaq2asc** for newly developed multicopter (drone) or some other mobile surveys.

Programs **xldam** and **xldpn** generate line data (DPAM line data) file from aeromagnetic ASCII raw data, making use of Real-time GPS and PostNav processed DGPS position data, respectively, and the program **xldhg** generates similar line data (HGAM line data) file from helicopter-borne gradiometer aeromagnetic data acquired. In addition, **xldam**, **xldpn** and **xldhg** also calculate the IGRF residuals. The program **filtadasc** was newly added to suppress high frequency noise caused by helicopter, when such situation occasionally took place.

The program **despike** eliminates spike noises in magnetic field values (total magnetic field and IGRF residual) of DPAM line data, the program **dvcorr** performs the diurnal correction of magnetic field data making use of Ground-Station magnetic field data, and the programs **ecomp** and **fcomp** execute the compensation of aircraft's magnetic effect for compensation flight DPAM line data and for survey flight DPAM line data, respectively, using the method described by Nakatsuka and Okuma [2005c].

The programs **ggrid** and **ggrids** generate grid data from random points data (i.e., DPAM line data or equivalent) by using the method of "continuous curvature splines in tension" as developed by Smith and Wessel [1990]. Only the magnetic field (IGRF residual) data are converted into grid by **ggrid**, while **ggrids** applies the method also on the altitude data. The programs **xslin** and **xslina** extract simple standard line (StdLIN) data from random point data. Various formats of random point (line) data are supported by **xslin** as input data, while **xslina** deals with only DPAM line data but with the function of averaged re-sampling.

The program **pframe** draws an illustration of coordinates framework of survey area for easier setting of grid location parameters, program **pltrk** plots trackline paths from DPAM line data, and program **pchkdv** plots the ground station magnetic data to reveal the diurnal magnetic variation.
The programs **pchkmag**, **pchkres** and **pchkcomp** are used to plot magnetic field data in order to inspect the data quality. Total magnetic field data is plotted in black by **pchkmag**, and IGRF residual data is plotted in blue by **pchkres**, while **pchkcomp** plots IGRF residual magnetic data both before and after the compensation of aircraft's magnetic noise in red and blue colors.

2.2 Program group GDMP

GDMP group consists of programs for grid data manipulation as follows.

sel	**adjlv**	**govlay**	**altchg**	**plmap**	**plmapg**	**xplmap**
seldb	**gadd**	**gojoin**	**gtrf**	**plmapc**	**plmaps**	**xplmapc**
seldb2	**gsub**	**gmerge**	**altx**	**plmapl**	**plmapcs**	**xplmapcs**
gtopo	**gtrim**	**txproj**	**rearx**	**plmapcl**	**shade**	

The programs **sel**, **seldb** and **seldb2** generate new grid data from an existing grid data with re-gridding. For **sel** program, the existing grid data should be assigned as the input filename parameter, while grid data from

"Aeromagnetic Database of Japan" [Geological Survey of Japan, 2005a] * (AMDB) is selected by the code-name input for **seldb**, and data from "The compilation of magnetic anomalies at a smooth surface of 1,500m above terrain by using the Aeromagnetic Database of Japan" [Nakatsuka and Okuma, 2009b] ** (AMDB2) for **seldb2**. Program **gtopo** generates grid data of topographic elevation from "DEM40" data *** (Digital Elevation Model 40m).

* AMDB grid data must be stored under the directory /pub/AMDB/DATA/ defined by AMDBDIR parameter in the seldb.f90 source (survey area data within subdirectory **grd**, and district data within subdirectory **reg**), and filenames must be "*code*.gd", where *code* is small letter filename of original.

** AMDB2 grid data must be stored in the directory (/pub/AMDB2/DATA/) defined by AMDB2DIR parameter in the seldb2.f90 source, and filenames must be "*MMNN*.mgc", where *MMNN* is the primary mesh code of the correponding area.

*** DEM40 is a group of topographic elevation data files, reconstructed from Digital Maps (50m mesh elevation, Japan-I, Japan-II and Japan-III) by the Geographical Survey Institute (GSI). Refer to "How to generate DEM40 data files" genDEM40mE.html. Data files must be stored under the directory (/home/SHARE/data/DEM/dem40/) defined by DEMDIR parameter in the gtopo.f90 source, and divided into subdirectories 'Z*??*' corresponding to its UTM zone number *??*. [If older version DEM data (wm40) is prepared already, see the description at the bottom of Section 4.]

The program **adjlv** adds a constant value to all grid data in order to adjust DC level, the program **gadd** adds 2 sets of grid data, and the program **gsub** subtracts the 2nd file grid data values from the 1st set grids, to generate a new grid data. The program **gtrim** replaces values of input grid data with NULL (undefined) data value for the range where the values of reference (2nd) grid data are NULL data value, to generate a new grid data.

The program **govlay** overlays multiple grid data sequentially with placing slit zone, the program **gojoin** joins multiple grid data sequentially with placing transient zone surrounding the overlaid data, and the program **gmerge** merges multiple grid data sequentially with placing transient zone along overlapping zone, to create a new grid data. The program **txproj** translates grid data into another map projection with re-gridding.

The standard format magnetic anomaly grid data file also include the information of the observation surface altitude, in the form of second set of grid or as a constant elevation value in the header part of magnetic anomaly data. The program **altchg** changes the altitude information of magnetic anomaly data, by replacing only altitude information. The program **gtrf** translates IGRF residual grid data into another reference IGRF model. The program **altx** extracts the altitude information into a standard grid data form, and **rearx** extracts the selected set of grid data from multiple sets grid data file.

The programs **plmap**, **plmapc**, **plmapg**, **plmaps**, **plmapcs** and **shade** produce illustrations of 3D surface given as altitude distribution of grid data, by line contour map (**plmap**), color-graded contour map (**plmapc**), gray-scale grading map (**plmapg**), shaded-relief contour map (**plmaps**), shaded-relief color-grading map (**plmapcs**) and shaded-relief map (**shade**), all on an A4 sheet. The program **plmapl** generates line contour map with drawing trackline paths, and the program **plmapcl** generates color-graded contour map with trackline paths, both on an A4 sheet.

The programs **xplmap** / **xplmapc** / **xplmapcs** create line contour map / color-graded contour map/ shaded-relief color-grading map of grid data, respectively, with adding various supplementary items on a selectable size of sheet up to B0.

2.3 Program group ANAM

ANAM group consists of programs for the altitude reduction and quantitative interpretation of magnetic anomaly data as follows.

emag	**emagf**	**tmcorr**	**emeq**	**emeqs**	**edeq**	**edeqs**
amag	**amagc**	**tmcfix**	**ameq**	**ameqs**	**adeq**	**adeqs**
cmag	**cmagf**	**lcecorr**	**ameqc**	**ameqsc**	**adeqc**	**adeqsc**
plamag		**aaptdp**	**cmeq**	**cmeqs**	**cdeq**	**cdeqs**
plamagc	**calmas**	**galtf**	**galts**	**rpmeqs**		**rpdeqs**

The programs **emag**, **emagf**, **amag**, **amagc**, **cmag** and **cmagf** are used for the magnetization intensity mapping [Okuma *et al.*, 1994a; Nakatsuka, 1995]. First, **emag** / **emagf** calculates the contribution coefficients matrix COEF, then **amag** / **amagc** executes inversion process of magnetization intensity mapping by the method of conjugate gradients (CG), and **cmag** / **cmagf** may be used to calculate the synthetic magnetic anomalies on a desired altitude surface by using the result of **amag** / **amagc**. The source model is approximated into rectangular blocks in **emag** / **cmag**, while the surface undulation is considered in **emagf** / **cmagf**. The iteration of CG method is controlled by the number of loop count (**amag**) or by convergency tolerance (**amagc**). The programs **plamag** / **plamagc** plot the result of the magnetization intensity mapping in the form of line contour map / color-graded contour map, respectively, with masking the surrounding source region.

The program **tmcorr** executes the correction of topographic effect on the magnetic anomaly grid data, assuming a uniform terrain magnetization, while the program **tmcfix** executes the correction of topographic effect with the assigned value of terrain magnetization. The program **lcecorr** estimates the railway loop-current effect in the observed magnetic anomaly grid data, and correct for it. The program **aaptdp** is for the semi-automatic modeling by point-dipole sources for observed magnetic anomaly grid data. These processes were used in the data interpretation of aeromagnetic data in the Kobe-Kyoto area [Nakatsuka *et al.*, 2004b].

The program **galtf** interpolates observation altitudes of StdLIN data into grid data (for the purpose of illustrating observation altitudes), and the program **galts** generates grid data of smoothed observation altitude from StdLIN data (for the purpose of using as the reference in altitude reduction).

The programs **emeq**, **ameq**, **ameqc** and **cmeq** are for the altitude reduction from grid data, and the programs **edeq**, **adeq**, **adeqc** and **cdeq** are for the altitude reduction from random point data, by equivalent anomaly method [Nakatsuka and Okuma, 2005b, 2006a]. First, **emeq** or **edeq** calculates the contribution coefficients matrix CMUP or CFUP, and **ameq** / **ameqc** or **adeq** / **adeqc** executes inversion process of equivalent anomaly derivation by CG method. The iteration of CG method is controlled by the number of loop count in **ameq** / **adeq**, or by convergency tolerance in **ameqc** / **adeqc**. Then the reduction calculation is performed by **cmeq** or **cdeq** program.

The programs **emeqs**, **ameqs**, **ameqsc**, **cmeqs** and **rpmeqs** are for the altitude reduction from grid data, and the programs **edeqs**, **adeqs**, **adeqsc**, **cdeqs** and **rpdeqs** are for the altitude reduction from random point data, by equivalent source magnetization method [Nakatsuka and Okuma, 2005b, 2006a]. First, **emeqs** or **edeqs** calculates the contribution coefficients matrix CMUPS or CFUPS, and **ameqs** / **ameqsc** or **adeqs** / **adeqsc** executes inversion process of deriving equivalent source magnetization by CG method. The iteration of CG method is controlled by the number of loop count in **ameqs** / **adeqs**, or by convergency tolerance in **ameqsc** / **adeqsc**. Then the reduction calculation is performed by **cmeqs** or **cdeqs** program, and the reduction-to-pole anomaly on that surface is calculated by **rpmeqs** or **rpdeqs** program.

The program **calmas** calculates theoretical magnetic anomaly distribution on the specified observation surface, caused by a simple source model.

2.4 Program group ANAMX

ANAMX group consists of programs for the 3D imaging analysis of magnetic anomalies and generalized crossover analysis in aeromagnetic survey, as follows.

eimgd	**aimgn**	**nimgn**	**cimgn**	**plsim**	**plimv**	**exdeq1**	**axdeq**
eimga	**aimgnc**	**nimgnc**	**cimgnc**	**plsimc**	**plimvc**	**exdeq2**	**axdeqc**
fimgs	**aimgs**	**nimgs**	**cimgs**	**plxim**		**exdeq3**	**cxdeq**
fimgsc	**aimgsc**	**nimgsc**	**cimgsc**	**plximc**	**plmvarc**	**exdeq4**	**genroff**

The programs **eimgd**, **eimga**, **aimgn**, **aimgnc**, **aimgs**, **aimgsc**, **nimgn**, **nimgnc**, **nimgs**, **nimgsc**, **cimgn**, **cimgnc**, **cimgs**, **cimgsc**, **fimgs**, **fimgsc** are used for 3D magnetization imaging analysis [Nakatsuka and Okuma, 2011, 2014a]. First, **eimgd** or **eimga** calculates the sensitivity coefficients matrix CFIM and scaling coefficients matrix FSCL, then one of the other 14 programs is used to perform 3D imaging analysis of each regularizing condition preferred.

When CG method is applied to 3D imaging of quite many unknown parameters to be solved, the least squares fitting solution tends in general toward minimum norm solution, which leads the solution to a shallow structure of magnetization distribution. To avoid this disadvantage, parameter scaling is required. Program **eimgd** uses a parameter scaling concerned with the source depth, and **eimga** adopts an automatic parameter scaling with taking account of CFIM matrix character.

Now 3 types of 3D imaging analysis programs are available, depending on the selected regularization. **aimgn**, **aimgnc**, **aimgs**, **aimgsc** perform simple inversion with no regularization, and **nimgn**, **nimgnc**, **nimgs**, **nimgsc** perform minimum norm inversion, while **cimgn**, **cimgnc**, **cimgs**, **cimgsc** perform a inversion with minimum effective source volume (compact) constraint. Here, 4 programs in each type analysis correspond whether source elements thickness is considered at scaling (-s, -sc) or not (-n, -nc), and two method of iteration control [by loop count (-n, -s) or by convergency tolerance (-nc, -sc)]. In addition, **fimgs** and **fimgsc** are further modified version for **cimgs** and **cimgsc**, where magnetization values are forced to be within predefined range throughout iterative optimization.

Programs **plsim**, **plsimc**, **plxim**, and **plximc** visualize a vertical cros-section view of 3D imaging result. **plsim** / **plsimc** is for NS or EW section along the grid, and **plxim** / **plximc** is for arbitrary line segment section in any desired direction, each with line contours / with color-graded contour map, respectively. Program **plimv** / **plimvc** show the whole 3D imaging result in a bird's-eye view, with line contours / with color-graded contour map, respectively.

Programs **exdeq1**, **exdeq2**, **exdeq3**, **exdeq4**, **axdeq**, **axdeqc**, **cxdeq**, **genroff**, and **plmvarc** are used for the processing of generalized crossover analysis in aeromagnetic survey [Nakatsuka and Okuma, 2006e; Nakatsuka *et al.*, 2009c]. The principle of the method is an extension of **edeq** "Altitude reduction from survey line data" introducing additional unknown parameters describing mis-tie adjustment. That is, the inversion to equivalent source anomaly and mis-tie adjustment is combined into simultaneous equation, and solved with CG method.
First, **exdeq1**, **exdeq2**, **exdeq3**, or **exdeq4** calculates the contribution coefficient matrix CXFUP. Program **exdeq1** deals with constant level shift each survey line, **exdeq2** accepts linear variation for each line, and **exdeq3** permits variations at all cross-over point (linear between the points). Program **exdeq4** is used for the analysis of magnetic anomaly change between two time-epochs survey lines crossing each other, similar to **exdeq3** case but only one epoch's parameter is variable.
Next, **axdeq** / **axdeqc** executes inversion process of CG method to obtain optimum model of level shift. Then, **cxdeq** calculates the altitude reduction result including cross-over adjustment.

For the case of **exdeq4**, program **genroff** converts the level shift (control point) data from **axdeq** / **axdeqc** into a random point distribution data (StdLIN form) of magnetic anomaly change. This random point data can be transformed to a grid data of distribution (e.g. using **ggrid**), and then program **plmvarc** is used to plot the magnetic anomaly change map (color-graded contour map) with illustrating control point distribution.

2.5 Subprogram library 'libgm'

Library **libgm** is composed of subprograms listed in the table below.

Name	Function	Entry-name (for Fortran)
psplot	LINE graphics postscript output	psopn, plots, plote, pscls, epsbox plot, scisor, factor, where newpen, penatr wrect, wpolyg, wcirc
pspaint	SURFACE graphics postscript output	dftone, dfrgbt, dfcols, dfc40s dframe, dframo, paintm, paintw, dresol dfpcol, paintc, paintr, paintp
ptext	Draw Font Text and Centered Symbol	ptext, lstyle, pcstr pmark
cont	Draw line contour map	conts, contso, contx, contr
wshore	Draw coastlines, etc.	wshore, rshore, pshore
igrf	IGRF calculation	gigrf, igrfc, igrfm, sigrf, spgrf, sdgrf
xyconv	Convert map projection	xyconv, nxycnv, utm, ikconv, nikcnv, utmik cvinit, cviken, cvenik, cvdinit, cvdiken, cvdenik

sml	Regression analysis	sm1opn, sm1ex, sm1cls, sm1rv sm2opn, sm2ex, sm2cls, sm2rv sm3opn, sm3ex, sm3cls, sm3rv
randD	Generate random number	rand1, randg
xw84t	Geodetic translation (WGS84 <=> Tokyo datum)	xw84t, xtw84, xw84td, xtw84d
hgeoid	Get geoid height	sgeoid, hgeoid, jhgeoid/td>
calma	Calculate synthetic magnetic anomaly	magafd, mpoint, mvline, mhrect, mprism, calma
lwkdir **opnpin** **getargs**	Message output, Progress display, setting up Working directory, and Process parameters, etc.	prompt, premsg, dpcini, dpcent, strdtm, lrtrim abend, abendm, opnpin, clspin, lwkdir parmin, gparma, gparmi, gparmf, gparmd gparmif, gparmid, gparmi2, gparmf2, gparmd2> getargs

Descriptions of function and usage of each subprogram in the Library **libgm** are available through the page "**libgm**: Library Subprograms".

2.6 Miscellaneous utilities 'utils'

Following miscellaneous utility programs are available.

cats	**crlf**	**cview**	**qpencode**	**cxtw84**	**utmcal**	**job**
cat4	**onlycr**	**cviewe**	**qpdecode**	**cxw84t**	**xycal**	**job1**
cat8	**onlylf**	**uncview**	**b64encode**	**igrfcal**	**cxiken**	
	hdump	**hdumpe**	**b64decode**	**hgeoidcal**	**cxenik**	

Programs **cats**, **cat4**, **cat8**, **crlf**, **onlycr**, **onlylf**, **cview**, **cviewe**, **uncview**, **hdump**, **hdump**, **qpencode**, **qpdecode**, **b64encode**, **b64decode** are simple programs to assist user's operation under the common environment of UNIX system. Programs **cxtw84**, **cxw84t**, **igracal**, **hgeoidcal**, **utmcal**, **xycal**, **cxiken**, **cxenik** support the usage of Library **libgm** subprograms, in such a way that the function of each individual subprogram is utilized interactively with dialog on a terminal.

Programs **job**, **job1** are used to realize our own style of "Batch process" of sequential execution of various programs with assigning parameter data. This is intending an easy Job control language (JCL) as was utilized in the legacy "mainframe computer". Our system "AMSS3" of aeromagnetic data handling, reduction, analysis and interpretation is designed to match with this "Batch process", and if the source data and the job control file (plus preferably log file record of actually executed process) are saved, the completely same processing can be repeated easily.

3. Common characteristic feature

We have developed these programs on a Linux system, on which the GNU Compiler Collection [http://www.gnu.org/software/gcc/] and one component 'gfortran' included in it are installed, and almost all programs are coded in Fortran90 language, except that those in **libgm** and **utils** groups and a limited number of programs/subprograms are coded in C language. The programs were developed step by step during the years of research activities on aeromagnetic survey at the Geological Survey of Japan, AIST and they were verified to function well by some practical data. Some programs, however, have been revised further for the improvement on reasonable data handling or easier operation. So there is a little possibility that some unaware bugs are left. But, we convince the user will easily correct bugs, as the source codes are presented.

In these programs, the subroutine library 'libgm' starting at Nakatsuka [2003] is utilized quite frequently. So, on this time update of software, the subroutine library 'libgm' (also updated a little) has been included in this report.

Most programs use some array variables, and the necessary size (dimension) of the array is dependent on the actual data to be dealt with. (Although too large size definition does not harm the correct result, the memory resource may be wasted, or program may not work because of memory shortage.) The definitions of such dimensions had been often given by using 'parameter' statement in source codes, to enable easier adjustment. Actually the definitions of such parameters was inconsistent among programs even in the same group. On this time software revision, rather new function of Fortran programing, dynamic allocation of array area was utilized. Then, even in case of requiring giant array, new programs can work without recompilation. Also, in this time revision, we used some other newer functions, such as free format coding, structured programming excluding statement number, C-like comparison operator, etc. As a result, some of the source programs cannot be compiled with old Fortran77 compilers.

When executing these programs, a few to several or more parameters have to be specified, along with selecting working directory path. In these programs, the LWKDIR (assist to set-up working dir. and process parameters, etc.) function with 'opnpin' mechanism of the subroutine library 'libgm' is implemented. The use of this function provides us two merits.

1. One is that the parameter input is prompted with informative message or valid choice, which is very useful to learn how to operate the program.
2. The other is that the same program is used to the non-interactive process for predetermined parameters with the help of 'opnpin' mechanism.

The latter style of program execution is realized by creating 'Job Control File' and submitting **job / job1** command (in the '**utils**' Utility programs). Refer to the section of "Job Control File" in [**utils**: Utility Programs], with respect to the detail of executing a series of job steps with the help of 'opnpin' mechanism.

4. Important points of full revision

This report contains various points of renewal and augmentation againt the previous version software. The most important point of augmentation is the newly added group programs **ANAMX** performing the 3D imaging and generalized crossover analysis of aeromagnetic data. Actually, there are some programs (4 **DPAM**, 4 **GDMP**, and 5 **utils** programs) newly added, but they are not so important but rather simple tools useful.

Besides, a lot of existing programs were improved or revised during the process of re-coding into Fortran90 style, but the basic functions of them are unchanged even if the way of use or the function is a little changed. And we didn't list up the minor change of specifications. Such minor changes of specifications are reflected on the documentation HTMLs of program groups.

This software system had a historical limitation of specification. At this time full revision of software system, we made effort of mitigating the effect of out-of-date specification, in two main points as follows.

[New Standard GRID data file Format v2018 and New Coordinate Number]

In order to define 2-dimensional distribution of physical quantity, grid data are frequently utilized. In our "Standard GRID data file Format", the spatial position is identified by the combination of the coordinate number indicating reference geodetic system and map projection type, and the coordinates in that map projection. In the 20th century in Japan, Japanese original TOKYO datum based on the Bessel ellipsoid had been used, and later we moved to "Japanese Geodetic Datum 2000" (JGD2000) [= World Geodetic System (WGS84)] after April, 2002. In that occasion, we assigned coordinate numbers 200-399 for WGS system, with continued coordinate numbers 0-199 for existing TOKYO datum. Nowadays, however, it is common and reasonable to use WGS basically. So, at this time full revision of the software, we decided to move to the new definition of coordinate number: 0-199 is used for WGS, 800-999 for (old) TOKYO datum, and define new "Standard GRID data file Format v2018" to enable converting old coordinate number into new one automatically.

[Globalization in Filename naming convention of service data files]

From the older version of this software, we prepared useful data of Japanese Islands, such as location data of coastlines, rivers and lakes, prefecture boundaries, and altitudes data of DEM and geoid. But, the directory and filenames convention is specialized to the North-Eastern Semi-hemisphere because of the location of Japan, and there was a limitation that the data of Western hemisphere or Southern hemisphere cannot be handled. At this time full revision of the software, we updated the program and directory/filename convention to enable worldwide processing.

"Standard GRID data file Format v2018", described in the Documentation for GDMP programs, seems there is little revision. To be focused, however, are
 (1) "4x,i4" in 1st Header format was "i4,4x" in old version, and
 (2) the description on earth ellipsoid is transposed and new coordinate numbers
   are 0-199 for WGS, and 800-999 for old TOKYO datum.
 There is redundant 4-column space in "1st Header Format", and it was used to distinguish old and new coordinate number. Also, as GRID data format other than the part of 1st Header is common between new and old format description, users can convert old GRID data into new format v2018 quite easily.
 All programs included in this report are equipped with the automatic distinction of old and new format, and old coordinate number is converted to new coordinate number. Accordingly, users can use old Format GRID data files as it is, only by giving new "coordinate number" parameter correctly, if it is required.

The program revision for the globalization is so as to enable successful program execution even in case of Southern Latitudes or Western Longitudes, and the main point was re-definition of directory-filename convention. If any parameter of latitude or longitude is to be read in, South Latitude and West Longitude should be given as minus values. (If it is specified with degrees and minutes, both should be minus. Usually program will only regard [deg.Value + min.Value/60.] be the resultant deg.Value.)
 As for directory/filename convention, DEM data read by **gtopo** program and the shore data handled by **wshore** subprogram are the files of [1 deg.Lat. × 1 deg.Long.] range each, and filenames are related to the SW corner of the range (e.g., **N33E135**, **S20E046**, **N19W090**, etc.), and files are stored under subdirectories indicating its UTM zone number, in order to avoid too many files in a directory. Next table shows the concrete examples of old and new filenames contrast.

[Examples]	*Old Filename*	*New Filename*
DEM data	`wm40/33135.alt`	`dem40/Z53/N33E135.alt`
coastlines, etc. (WGS84)	`SW33/cst135.jpn`	`Z53/N33E135.coast`
	`SW33/riv135.jpn`	`Z53/N33E135.river`
	`SW33/prf135.jpn`	`Z53/N33E135.prefb`
coastlines, etc. (Old Tokyo datum)	`SH33/cst135.jpn`	`t53/N33E135.coast`
	`SH33/riv135.jpn`	`t53/N33E135.river`
	`SH33/prf135.jpn`	`t53/N33E135.prefb`

In order to change the path names as above for the old version data, script files **renewal_script** are placed in corresponding directories in this report, for reference. (This is only for renaming, and the DEM data are in old version Standard GRID data file Format v2005.)

5. Files contained in this report

Source programs coded in Fortran90 language have the filenames with **.f90** (specifier) extensions, and those in C language with **.c** (specifier) extensions. To compile these programs under UNIX environment, **@mkall** script in each directory can be used, provided that the subroutine library 'libgm' is at first installed as the archive file **libgm.a** under the directory of **/home/SHARE/lib**, and the command names '**fort**' and '**gcc**' is aliased to (or the name of) the desired Fortran and C compilers. The executable program after compilation is stored in the directory **/home/SHARE/bin** with the name same as the source filename without the extension. It is recommended the users set their own environment variable **PATH** to contain the path **/home/SHARE/bin**, for comfortable environment of execution.

There are also HTML documentations for each of six program groups, **DPAM**, **GDMP**, **ANAM**, **ANAMX**, **libgm**, and **utils**. The explanation of the function of individual program is given briefly, and the parameters required to execute the program are described.

In the CD-ROM appended to this report, HTML files, Fortran90 and C source files, templates of Job Control files for non-interactive (Batch Job) execution, and TGZ archive files are stored, in the tree structure below.

===(Service data of Japanese DEM and coastlines etc. not included)===
  [Data of Japanese DEM] DEM40 is a group of files of terrain elevation data in Japan, extracted from Digital Maps (50m mesh elevation, Japan-I, Japan-II and Japan-III) by the Geographical Survey Institute, Japan (GSI) [Publication discontinued]. The source data are subject to GSI's copyright. The procedure how

to generate DEM40 files from GSI's Digital Maps is presented in genDEM40mE.html. Data contents are not included in this report, because it requires a procedure of getting approval from the Authority (GSI). Data contents are not modified in this time software revision, but only the file path names are changed because of the globalization update. If old style data are existing, a script file data/DEM/renewal_script is useful to change file paths.

[Data of Japanese Coastlines etc.] The data of coastlines, lakes and rivers, and prefecture boundaries of Japan are subject to be changed the file path name because of the globalization update of library subprogram "wshore", although the data contents are not modified. If old style data is existing, a script file data/shore/renewal_script is useful to change file paths. But data contents are not included in this report, because it is considered a procedure of getting approval from the Authority (GSI) is necessary. Refer to the former report no. 442 [Nakatsuka, 2006c], if necessary.

```
        <<< Tree structure of files included in this report >>>
        (Large size files are colored (> 5 MB) with rough size, or else (> 1 MB).

openfile0648.html   Cover page HTML
no0648/             (Directory containing all contents except Cover page HTML)
 |
 +-- indexE.html      Overview of this report (This document)
 +-- dpamE.html       Documentation for DPAM programs
 +-- gdmpE.html       Documentation for GDMP programs
 +-- anamE.html       Documentation for ANAM programs
 +-- anamxE.html      Documentation for ANAMX programs
 +-- libgmE.html      Documentation for Library 'libgm'
 +-- utilsE.html      Documentation for 'utils' programs
 +-- genDEM40mE.html  How to generate DEM40 files
 |
 +-- index.html       Overview of this report (in Japanese)
 +-- dpam.html        Documentation for DPAM programs (in Japanese)
 +-- gdmp.html        Documentation for GDMP programs (in Japanese)
 +-- anam.html        Documentation for ANAM programs (in Japanese)
 +-- anamx.html       Documentation for ANAMX programs (in Japanese)
 +-- libgm.html       Documentation for Library 'libgm' (in Japanese)
 +-- utils.html       Documentation for 'utils' programs (in Japanese)
 +-- genDEM40m.html   How to generate DEM40 files (in Japanese)
 |
 +-- html.tgz         TGZ archive of 16 HTML files above
 +-- libgm.tgz        TGZ archive of directory 'libgm'
 +-- lib.tgz          TGZ archive of directory 'lib'
 +-- utils.tgz        TGZ archive of directory 'utils'
 +-- dpam.tgz         TGZ archive of directory 'dpam'
 +-- gdmp.tgz         TGZ archive of directory 'gdmp'
 +-- anam.tgz         TGZ archive of directory 'anam'
 +-- anamx.tgz        TGZ archive of directory 'anamx'
 +-- Tplate.tgz       TGZ archive of directory 'Tplate'
 +-- data.tgz(10MB)   TGZ archive of directory 'data' with NGA geoid contents
 |
 +-- libgm/            (Directory containing 'libgm' documentation)
 |    |
 |    +-- libcE.html, psplotE.html, pspaintE.html, ptextE.html, contE.html,
 |    |    wshoreE.html, igrfE.html, xyconvE.html, smlE.html, randE.html,
 |    |     xw84tE.html, hgeoidE.html, calmaE.html, lwkdirE.html    (in English)
 |    +-- libc.html, psplot.html, pspaint.html, ptext.html, cont.html,
 |    |    wshore.html, igrf.html, xyconv.html, sml.html, rand.html,
 |    |     xw84t.html, hgeoid.html, calma.html, lwkdir.html       (in Japanese)
 |    |
 |    +-- figs/        (Directory containing figures for document)
 |         |
 |         +-- cont.png, pmark.png, pspaint.png, ptext.png, ptext2.png,
 |              test.png, wshore.png, cont.ps, pmark.ps, pspaint.ps,
 |               ptext.ps, ptext2.ps, wshore.ps, samples.f90
 |
 +-- lib/              (Directory containing 'libgm' subprogram sources)
 |    |
 |    +-- @mkall       Script to compile all subprograms
 |    +-- psplot.c, pspaint.c, ptext.c, cont.c, wshore.c,
 |         igrf.c, xyconv.c, sml.c, rand.c, xw84t.c,
 |          hgeoid.c, calma.c, lwkdir.c, opnpin.c, getargs.f90
 |
 +-- utils/            (Directory containing 'utils' source programs)
```

```
|    |
|    +-- @mkall       Script to compile all 'utils' programs
|    +-- cats.c, cat4.c, cat8.c, crlf.c, onlycr.c, onlylf.c,
|         cview.c, cviewe.c, uncview.c, hdump.c, hdumpe.c,
|          qpencode.c, qpdecode.c, b64encode.c, b64decode.c,
|           cxtw84.c, cxw84t.c, igrfcal.c, hgeoidcal.c, utmcal.c,
|            xycal.c, cxiken.c, cxenik.c, job.c, job1.c
|
+-- dpam/             (Directory containing 'dpam' source programs)
|    |
|    +-- @mkall       Script to compile all 'dpam' programs
|    +---- sml5.c, gsurf.c     (common subprograms)
|    +-- alog2asc.c, daq2asc.c, bdaq2asc.c, dmaq2asc.c,
|         xldam.f90, xldpn.f90, xldhg.f90, filtadasc.f90,
|          despike.f90, dvcorr.f90, ecomp.f90, fcomp.f90,
|           ggrid.f90,  ggrids.f90, pframe.f90, pltrk.f90,
|            pchkdv.f90, pchkmag.f90, pchkres.f90, pchkcomp.f90,
|             xslin.f90, xslina.f90
|
+-- gdmp/             (Directory containing 'gdmp' source programs)
|    |
|    +-- @mkall       Script to compile all 'gdmp' programs
|    +---- xplgobj.c     (common subprogram)
|    +-- sel.f90, seldb.f90, seldb2.f90, gtopo.f90,
|         adjlv.f90, gadd.f90, gsub.f90, gtrim.f90,
|          govlay.f90, gojoin.f90, gmerge.f90, txproj.f90,
|           altchg.f90, gtrf.f90, altx.f90, rearx.f90,
|            plmap.f90, plmapc.f90, plmapl.f90, plmapcl.f90,
|             plmapg.f90, plmaps.f90, plmapcs.f90, shade.f90,
|              xplmap.f90, xplmapc.f90, xplmapcs.f90
|
+-- anam/             (Directory containing 'anam' source programs)
|    |
|    +-- @mkall       Script to compile all 'anam' programs
|    +-- emag.f90, emagf.f90, amag.f90, amagc.f90, cmag.f90,
|         cmagf.f90, plamag.f90, plamagc.f90, tmcorr.f90,
|          tmcfix.f90, lcecorr.f90, aaptdp.f90, galtf.f90,
|           galts.f90, emeq.f90, ameq.f90, ameqc.f90,
|            cmeq.f90, emeqs.f90, ameqs.f90, ameqsc.f90,
|             cmeqs.f90, rpmeqs.f90, edeq.f90, adeq.f90,
|              adeqc.f90, cdeq.f90, edeqs.f90, adeqs.f90,
|               adeqsc.f90, cdeqs.f90, rpdeqs.f90, calmas.f90
|
+-- anamx/            (Directory containing 'anamx' source programs)
|    |
|    +-- @mkall       Script to compile all 'anamx' programs
|    +-- eimgd.f90, eimga.f90, aimgn.f90, aimgnc.f90, aimgs.f90,
|         aimgsc.f90, nimgn.f90, nimgnc.f90, nimgs.f90, nimgsc.f90,
|          cimgn.f90, cimgnc.f90, cimgs.f90, cimgsc.f90,
|           fimgs.f90, fimgsc.f90, plsim.f90, plsimc.f90,
|            plxim.f90, plximc.f90, plimv.f90, plimvc.f90,
|             exdeq1.f90, exdeq2.f90, exdeq3.f90, exdeq4.f90,
|              axdeq.f90, axdeqc.f90, cxdeq.f90, genroff.f90,
|               plmvarc.f90
|
+-- Tplate/
|    |
|    +-- dpam_tp/         (Directory containing templates for 'dpan' programs)
|    |    |
|    |    +-- alog2asc.tp, daq2asc.tp, bdaq2asc.tp, dmaq2asc.tp,
|    |         xldam.tp, xldpn.tp, xldhg.tp, filtadasc.tp,
|    |          despike.tp, dvcorr.tp, ecomp.tp, fcomp.tp,
|    |           ggrid.tp, ggrids.tp, pframe.tp, pltrk.tp,
|    |            pchkdv.tp, pchkmag.tp, pchkres.tp, pchkcomp.tp,
|    |             xslin.tp, xslina.tp
|    |
|    +-- gdmp_tp/         (Directory containing templates for 'gdmp' programs)
|    |    |
|    |    +-- sel.tp, seldb.tp, seldb2.tp, gtopo.tp,
|    |         adjlv.tp, gadd.tp, gsub.tp, gtrim.tp,
|    |          govlay.tp, gojoin.tp, gmerge.tp, txproj.tp,
|    |           altchg.tp, gtrf.tp, altx.tp, rearx.tp,
|    |            plmap.tp, plmapc.tp, plmapl.tp, plmapcl.tp,
```

```
|       |              plmapg.tp, plmaps.tp, plmapcs.tp, shade.tp,
|       |               xplmap.tp, xplmapc.tp, xplmapcs.tp
|       |
|       +-- anam_tp/          (Directory containing templates for 'anam' programs)
|       |     |
|       |     +-- emag.tp, emagf.tp, amag.tp, amagc.tp, cmag.tp,
|       |          cmagf.tp, plamag.tp, plamagc.tp, tmcorr.tp,
|       |           tmcfix.tp, lcecorr.tp, aaptdp.tp, galtf.tp,
|       |            galts.tp, emeq.tp, ameq.tp, ameqc.tp,
|       |             cmeq.tp, emeqs.tp, ameqs.tp, ameqsc.tp,
|       |              cmeqs.tp, rpmeqs.tp, edeq.tp, adeq.tp,
|       |               adeqc.tp, cdeq.tp, edeqs.tp, adeqs.tp,
|       |                adeqsc.tp, cdeqs.tp, rpdeqs.tp, calmas.tp
|       |
|       +-- anamx_tp/         (Directory containing templates for 'anamx' programs)
|             |
|             +-- eimgd.tp, eimga.tp, aimgn.tp, aimgnc.tp, aimgs.tp,
|                  aimgsc.tp, nimgn.tp, nimgnc.tp, nimgs.tp, nimgsc.tp,
|                   cimgn.tp, cimgnc.tp, cimgs.tp, cimgsc.tp,
|                    fimgs.tp, fimgsc.tp, plsim.tp, plsimc.tp,
|                     plxim.tp, plximc.tp, plimv.tp, plimvc.tp,
|                      exdeq1.tp, exdeq2.tp, exdeq3.tp, exdeq4.tp,
|                       axdeq.tp, axdeqc.tp, cxdeq.tp, genroff.tp,
|                        plmvarc.tp
|
+-- data/                     (Directory containing Service data)
|       |
|       +-- DEM/
|       |     |
|       |     +-- renewal_script      Script to update filename path of DEM40 data
|       |     |
|       |     +-- dem40/
|       |           |                    (Directory for DEM40 data)
|       |           +-- Z51/, Z52/, Z53/, Z54/, Z55/, Z56/
|       |
|       +-- IGRFCOEF/
|       |     |                          (IGRF coefficients files)
|       |     +-- igrf01.coef, igrf02.coef, igrf03.coef, igrf04.coef,
|       |          igrf05.coef, igrf06.coef, igrf07.coef, igrf08.coef,
|       |           igrf09.coef, igrf10.coef, igrf11.coef, igrf12.coef
|       |
|       +-- geoid/
|       |     |
|       |     +-- world.hgeoid(12MB)   World geoid height data (Low resol.)  [NGA]
|       |     |
|       |     +-- NGA/
|       |           |          (Directory for NGA geoid height data)
|       |           +-- Z51/, Z52/, Z53/, Z54/, Z55/, Z56/
|       |                   Contents data to be stored in these directories
|       |                    are contained in the TGZ archive "data.tgz".
|       +-- shore/
|             |
|             +-- wcoast.jpn, wriver.jpn     Small scale map data
|             +-- world.cst                  World map data
|             |
|             +-- renewal_script      Script to update filename path of shore data
|             |
|             +-- Z51/, Z52/, Z53/, Z54/, Z55/, Z56/,
|                  t51/, t52/, t53/, t54/, t55/, t56/
|                                        (Directory for [shore, etc.])
+-- PDFs/
|       |
|       +-- openfile0648.pdf      PDF version of this report (Cover page)
|       +-- English.pdf           PDF version of this report (English portion)
|       +-- Japanese.pdf          PDF version of this report (Japanese portion)
|
+-- TESTs/
        |
        +-- Tdpam.tgz(35MB), Tgdmp.tgz, Tanam1.tgz, Tanam2.tgz(7MB), Tanam3.tgz,
             Tanamx1.tgz, Tanamx2.tgz, Tanamx3.tgz, Tanamx4.tgz, Tanamx5.tgz
                          [TGZ archives of Test data and results]
                           They are records of Test Batch execution of programs,
                            and the same test can be repeated easily.
```

```
See the files "@Memo.txt", "@scrlog*.txt", "cntl*",
 and "cntl*.log", if interested.
(Not for the purpose of showing good looking result.)
```

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DPAM: Programs for Aeromagnetic Survey Observation Data Processing

Japanese

alog2asc	xldam	ecomp	pchkdv	xslin	line information Format
daq2asc	xldpn	fcomp	pchkmag	xslina	Various line data Format
bdaq2asc	xldhg	ggrid	pchkres	AM raw data Format	StdLIN data Format
dmaq2asc	despike	ggrids	pchkcomp	Common ASCII Format	DPAM line data Format
filtadasc	dvcorr	pframe	pltrk	GSmag data Format	HGAM data Format

Program Name	Function
alog2asc	Convert AIRLOGS airborne binary raw data into Common ASCII obs.data Format, with correcting PC's Time data by GPS and converting GPS-time (UTC) into Localtime. Parameters: log filename input binary data filename output ASCII data filename Localtime zone ([+/-]HHMM)
daq2asc	Convert AMDAQ raw data into Common ASCII obs.data Format, with correcting PC's Time data by GPS and converting GPS-time (UTC) into Localtime. Parameters: log filename input AMDAQ obs.data filename output ASCII data filename Localtime zone ([+/-]HHMM)
bdaq2asc	Convert AMBDAQ raw data into Common ASCII obs.data Format, with correcting PC's Time data by GPS and converting GPS-time (UTC) into Localtime. Parameters: log filename input AMBDAQ obs.data filename output ASCII data filename Localtime zone ([+/-]HHMM)
dmaq2asc	Convert G858+GPS downloaded raw data into Common ASCII obs.data Format, with correcting G858 Time data by GPS and converting GPS-time (UTC) into Localtime. Parameters: log filename input G858+GPS obs.data filename output ASCII data filename Localtime zone ([+/-]HHMM)
filtadasc	Filter out high-frequency noise component from the ADC 8ch data in Common ASCII obs.data, with a boxcar averaging of [2n+1] data. Parameters: log filename input Common ASCII obs.data filename output Common ASCII obs.data filename half-width of filter window (n)
xldam	Generate DPAM line data file from airborne Common ASCII obs.data making use of Real-time GPS position data included, with calculation of IGRF residuals. Also, the correction of Mag.Sensor offset from GPS can be done. Parameters: log filename filename of survey line information data output DPAM line data filename survey year IGRF generation number

	thin-out ratio N (crop 1 out of N data) Mag.Sensor offset [forward, starboard, downward] (m) or a blank line (In case all 3 values equal 0. or a blank line, no correction shall be done.) Filename of input Common ASCII obs.data is specified in the survey line information data.
xldpn	Generate DPAM line data file from airborne Common ASCII obs.data and PostNav GPS position data, with calculation of IGRF residuals. Also, the correction of Mag.Sensor offset from GPS can be done. Parameters: log filename filename of survey line information data Time spec of Pos. data (Localtime(0) or UTC(1)) [if UTC(1)] Localtime Time-zone string output DPAM line data filename survey year IGRF generation number thin-out ratio N (crop 1 out of N data) Mag.Sensor offset [forward, starboard, downward] (m) or a blank line (In case all 3 values equal 0. or a blank line, no correction shall be done.) Filenames of input Common ASCII obs.data and PostNav GPS position data are specified in the survey line information data.
xldhg	Generate HGAM line data file (similar to DPAM line data) from helicopter-borne gradiometer AM (HGAM) data, making use of HGAM bird-mag data and Real-time or PostNav GPS position data, with diurnal correction by GSmag data and calculation of IGRF residuals. Parameters: log filename filename of survey line information data Pos. data spec.: 0(PNAV-DGPS) or 1(Real-time) Time spec of Pos. data (UTC(1) or Localtime(0)) [if UTC(1)] Localtime Time-zone string input GSmag data filename output DPAM line data filename survey year IGRF generation number magnetic sensors vertical separation (m) thin-out ratio N (crop 1 out of N data) Filenames of input HGAM bird-mag data and Real-time/PostNav GPS position data are specified in the survey line information data.
despike	Eliminate magnetic field spike noise in DPAM line data. Parameters: log filename input DPAM line data filename output DPAM line data filename
dvcorr	Correct for magnetic field diurnal variation in DPAM line data, making use of GSmag data. Parameters: log filename input DPAM line data filename input GSmag data filename output DPAM line data filename
ecomp	Execute compensation of aircraft magnetic effect for CompBox DPAM line data, using line data of CompBox flight itself. (Test purpose) Parameters: log filename filename of DPAM CompBox data

	output DPAM line data filename
fcomp	Execute compensation of aircraft magnetic effect for Survey DPAM line data, using DPAM line data of CompBox flight. Parameters: log filename filename of DPAM CompBox data filename of input DPAM survey line data filename of output DPAM survey line data
ggrid	Generate magnetic field grid data from DPAM line data or equivalent, by the method developed by Smith and Wessel [1990]. Parameters: log filename input AM line data file-type (*1) input AM line data filename Geodetic system of input data [WGS(1) or TYO(2)] [if random file] data formatting parameter (*2) effecting radius (km) areaname label map projection coordinate number grid location parameters (*3) output grid filename
ggrids	Generate grid data of magnetic field and observation altitude from DPAM line data or equivalent, by the method developed by Smith and Wessel [1990]. Parameters: log filename input AM line data file-type (*1) input AM line data filename Geodetic system of input data [WGS(1) or TYO(2)] [if WGS(1)] Altitude Reference [GRS(1) or Geoid(2)] (*4) [if Geoid(2)] Geoid model [0:NGA or Model name] (*4) [if random file] data formatting parameter (*2) effecting radius (km) areaname label map projection coordinate number (NC) [if NC < 200] Alt.Reference of output [GRS(1) or Geoid(2)] (*4) [if Geoid(2)] Geoid model [0:NGA or Model name] (*4) grid location parameters (*3) output grid filename
pframe	Draw map of coordinates framework of survey area. (For easier setting of grid location parameters.) Parameters: log filename output PS filename areaname map projection coordinate number Latitude/Longitude range drawing parameter
pltrk	Draw trackline paths from DPAM line data or equivalent. Parameters: log filename input AM line data file-type (*1) input AM line data filename Geodetic system of input data [WGS(1) or TYO(2)] [if random file] data formatting parameter (*2) output PS filename areaname map projection coordinate number location parameters

	drawing parameters
pchkdv	Plot Ground station magnetic field data. Parameters: log filename input GSmag data filename output PS filename
pchkmag	Plot magnetic total field data of DPAM line data, HGAM line data, HGAM bird mag. data or Common ASCII obs. data (in black). Parameters: log filename data type (1:DPAM, 1/2:HGAM(1st/2nd), 3/4: HeliBird(1st/2nd) or 0:CommonASCIIobs.) input filename (DPAM/HGAM line / HGAM bird mag. or Common ASCII obs. data) output PS filename
pchkres	Plot IGRF residual (or difference) magnetic field data of DPAM line data or HGAM line data (in blue). Parameters: log filename data type (1:DPAM, or 1/2/3:HGAM(1st/2nd/diff)) input DPAM/HGAM line data filename output PS filename
pchkcomp	Plot IGRF residual magnetic field data before and after the compensation of aircraft magnetic effect, for the output DPAM file from the process **ecomp/fcomp**. Parameters: log filename input DPAM line data filename output PS filename
xslin	Convert various format line data into StdLIN standard line data. Parameters: log filename input AM line data file-type (*1) input AM line data filename Geodetic system of input data [WGS(1) or TYO(2)] [if WGS(1)] Altitude Reference [GRS(1) or Geoid(2)] (*4) [if Geoid(2)] Geoid model [0:NGA or Model name] (*4) [if generic random file] data formatting parameter (*2) output StdLIN data filename Geodetic system of output data [WGS(1) or TYO(2)] [if WGS(1)] Altitude Reference [GRS(1) or Geoid(2)] (*4) [if Geoid(2)] Geoid model [0:NGA or Model name] (*4)
xslina	Extract StdLIN line data with averaged re-sampling from DPAM line data. Parameters: log filename input DPAM line data filename Geodetic system of input data [WGS(1) or TYO(2)] [if WGS(1)] Altitude Reference [GRS(1) or Geoid(2)] (*4) [if Geoid(2)] Geoid model [0:NGA or Model name] (*4) time interval of averaged re-sampling (sec.) output StdLIN data filename Geodetic system of output data [WGS(1) or TYO(2)] [if WGS(1)] Altitude Reference [GRS(1) or Geoid(2)] (*4) [if Geoid(2)] Geoid model [0:NGA or Model name] (*4)

(*1) There are variations of file types of AM line data as follows: 1: DPAM survey line data, 2: AMDB-GSJ located line data, 3: AMDB-NEDO integrated located data, 4: StdLIN standard line data, 0: generic random point data.
The detail of generic random point data file is specified by the data formatting parameter (*2).

(*2) Data formatting parameter includes the unit [minute(1), degree(2) or Deg:Min(3)] of latitudes/longitudes, and the sequence numbers for latitude, longitude, altitude (in m) and magnetic field (in nT) data in the free-format data string (when ':' delimiter has been replaced with space).

(*3) "grid location parameters" include Northing and Easting of Southwest corner, mesh interval and number of mesh to the North, and to the East.

(*4) If Geodetic system is TYO(2) [Tokyo-Datum], altutude reference must be Geoid, while it may be selectable from ITRF-GRS(1) and Geoid(2) if Geoditic system is WGS(1), and the Geoid model is selectable from 0:NGA and another name (if geoid data is prepared) when Geoid(2) is selected. Here the altitude in Tokyo-Datum is assumed to be equal to the elevation from Geiod. When the altitude reference is different between input and output data, conversion of ellipsoidal heights to/from elevations from Geoid (or height translation between different Geoid models) is performed, using 'libgm' function "hgeoid/sgeoid".

AM raw obs.data file Format

- **AIRLOGS binary data**

  - After the 232 bytes Header, data blocks are placed.
  - Header (232 bytes) consists of 29 8-byte real binary values, i.e., Version#, Date(Windows style), Julian day, Year, Month, Day, Hour, Minute, Second, Sub-second, Sensor-typw(0/1), Flight#, Cycle intv.(sec.), and 16 coeff values of ADC 8ch calibration.
  - The length of data block is 68 bytes or 98 byte depending on the condition that the 4th byte of the block is 0 (: 68 bytes) or else.
  - The contents of 5th to 68th byte are 4 8-byte real values (Fiducial#, System time, t200 value, Mag. intensity [nT]) and 8 4-byte real values (8ch ADC data corresponding to Fluxgate data [3 components], Radio Alt., Baro-alt., and Auxiliary analog input [3 components]). "t200" value seems a kind of fiducial number only unknown.
  - The contents of 69th to 98th byte are 3 8-byte real values of UTC [hhmmss.sss], Latitude[dddmmss.ss], Longitude[dddmmss.ssss] and 1 4-byte real value of Altitude, 2 1-byte integer values of Pos. method code and Number of Sats used.

- **AMDAQ acqisition raw data (Stinger type AM survey)**

```
/AMDAQ     ver.2014-09-19  by  T.Nakatsuka (GSJ)
/DateTime:  2014-11-26 14:53:44  (Logging start)
/CyclingInterval:  100 mSec  (60 mSec Gate-time)
/GyromagneticRatioUsed:  3.498577 Hz/nT (Scintrex)
M 53624.35 00027.11 45451.232 -3.657+2.026+1.548+0.010+4.243+0.010+0.005+0.005
M 53624.45 00027.21 45451.061 -3.652+2.036+1.548+0.000+4.238+0.010+0.005+0.005
M 53624.55 00027.31 45451.150 -3.652+2.031+1.548+0.005+4.248-0.005+0.005+0.005
M 53624.65 00027.41 45450.871 -3.657+2.026+1.548+0.000+4.248+0.005+0.005+0.005
S 53624.59 00027.35$GPGGA,055345.00,3515.0110,N,13655.3893,E,1,16,0.8,15.38,M,37.80,M,,*55^M
M 53624.74 00027.51 45451.003 -3.652+2.036+1.543+0.010+4.248+0.010+0.005+0.005
M 53624.85 00027.61 45450.811 -3.657+2.031+1.543+0.005+4.258+0.005+0.005+0.005
M 53624.95 00027.71 45451.083 -3.657+2.031+1.548+0.005+4.238+0.010+0.005+0.005
M 53625.05 00027.81 45451.211 -3.657+2.031+1.543-0.005+4.243-0.005+0.005+0.005
          :
          :
Preceding 4 lines are Header Comments.
M record consists of 'M', ReceiveTime(sec.), Fiducial number, Mag.Intensity, and 8 values of ADC.
S record consists of 'S', ReceiveTime(sec.), Fiducial number, and $GPGGA record from GPS.
($GPGGA record includes: '$GPGGA', UTC time[hhmmss.ss], Latitude[ddmm.mmmm], 'N', Longitude
 [dddmm.mmmm], 'E', Pos. method code, Number of Sats used, Hor. accuracy index (HDOP),
 Antenna height, 'M', Geoid height, 'M', , '*' check-sum '^M'.)
```

- **AMBDAQ acqisition raw data (Bird type AM or other mobile survey)**

```
/AMBDAQ     by  T.Nakatsuka (GSJ)  ver.2007NOV22
/DateTime:  2007-11-23 09:12:04  (Logging start)
           :
           :
36411.16,0,  46741.827,     0.000,10:06:52.45,11/23/07,  0
36411.26,0,  46743.765,     0.000,10:06:52.55,11/23/07,  0
36411.36,0,  46745.239,     0.000,10:06:52.65,11/23/07,  0
36411.46,0,  46746.836,     0.000,10:06:52.75,11/23/07,  0
36411.56,0,  46748.750,     0.000,10:06:52.85,11/23/07,  0
36411.66,0,  46750.397,     0.000,10:06:52.95,11/23/07,  0,36411.54,$GPGGA,010653.00,3526.0033,N,13850.1248,E,1,08,1.2,1206.08,M,
36411.76,0,  46751.727,     0.000,10:06:53.05,11/23/07,  0
36411.86,0,  46753.094,     0.000,10:06:53.15,11/23/07,  0
36411.96,0,  46754.179,     0.000,10:06:53.25,11/23/07,  0
36412.06,0,  46755.981,     0.000,10:06:53.35,11/23/07,  0
36412.16,0,  46757.653,     0.000,10:06:53.45,11/23/07,  0
           :
           :
Preceding 2 lines are Header Comments.
Each of the rest records consists of 7 items separated by comma
(ReceiveTime(sec.), 0, Mag.Intensity-1, Mag.Intensity-2, Time(hh:mm:ss.tt),
 Date(MM/DD/YY), and 0), and a set of ReceiveTime(sec.) and GPS $GPGGA record
might follow if received at that timing. (See the "AMDAQ acqisition raw data"
above for the contents of $GPGGA record.)
```

- **G858+GPS acqisition raw data (Small multicopter magnetic survey)**

```
6         0.000        0.000 14:50:47.500 11/30/16       7599           1           1   5          0
0   46214.218      0.000 14:50:47.500 11/30/16   0
21 $GPGGA,055047.00,3533.4110,N,14023.9125,E,1,15,0.7,3.28,M,33.30,M,,*6F 14:50:47.400 11/30/16  65 0
0   46214.335      0.000 14:50:47.400 11/30/16   0
0   46214.455      0.000 14:50:47.300 11/30/16   0
0   46214.646      0.000 14:50:47.200 11/30/16   0
0   46214.663      0.000 14:50:47.100 11/30/16   0
0   46214.932      0.000 14:50:47.00 11/30/16   0
0   46215.002      0.000 14:50:46.900 11/30/16   0
0   46215.400      0.000 14:50:46.800 11/30/16   0
0   46215.644      0.000 14:50:46.700 11/30/16   0
0   46215.778      0.000 14:50:46.600 11/30/16   0
0   46216.190      0.000 14:50:46.500 11/30/16   0
21 $GPGGA,055046.00,3533.4110,N,14023.9126,E,1,15,0.7,3.40,M,33.30,M,,*63 14:50:46.400 11/30/16  66 0
0   46216.671      0.000 14:50:46.400 11/30/16   0
0   46217.048      0.000 14:50:46.300 11/30/16   0
0   46217.265      0.000 14:50:46.200 11/30/16   0
          :
          :
0   45980.890      0.000 14:20:37.800 11/30/16   0
0   45980.962      0.000 14:20:37.700 11/30/16   0
0   45980.293      0.000 14:20:37.600 11/30/16   0
```

```
0   45979.364      0.000 14:20:37.500 11/30/16   0
21 $GPGGA,052037.00,3533.4097,N,14023.9110,E,1,13,0.8,7.46,M,33.30,M,,*62 14:20:37.500 11/30/16 208 0
0   45978.507      0.000 14:20:37.400 11/30/16   0
0   45977.638      0.000 14:20:37.300 11/30/16   0
0   45974.065      0.000 14:20:37.200 11/30/16   0
6        0.000        0.000 14:20:36.900 11/30/16          0           0           0  36          0
```

Common ASCII obs.data Format (Example of "daq2asc" output)

```
//daq2asc v.2017-10-16 by T. Nakatsuka
//InputDataFilename: /home/nktk/data/Tfield/20150622_085808.daq
//PC-Time data were Shifted by  +0.47 sec.
/AMDAQ     ver.2014-09-19  by  T.Nakatsuka (GSJ)
/DateTime: 20150622 08:58:08 (Logging start)
/CyclingInterval:  100 mSec  (60 mSec Gate-time)
/GyromagneticRatioUsed:  3.498577 Hz/nT (Scintrex)
/   FID     SYSTIME      t200       MAG     FGx     FGy     FGz    Ralt    Balt     AD6     AD7     AD8    LTsec         LAT
        :
        :
  134.9 08:59:40.85   134.910 44022.322  -3.965  -0.605   2.588   0.010   0.233   0.024   0.005   0.000   *          *             *
  135.0 08:59:40.94   135.010 44021.805  -3.901  -0.630   2.559   0.005   0.238   0.000   0.010   0.005   *          *             *
  135.1 08:59:41.05   135.110 44024.093  -3.901  -0.601   2.549   0.005   0.238  -0.005   0.005   0.005 32381.00  34.5741050  135.8166
  135.2 08:59:41.14   135.210 44020.111  -3.887  -0.645   2.520   0.005   0.238   0.020   0.005   0.005   *          *             *
  135.3 08:59:41.25   135.310 44018.997  -3.955  -0.605   2.573   0.000   0.233  -0.015   0.005   0.005   *          *             *
  135.4 08:59:41.35   135.410 44022.616  -3.970  -0.654   2.578   0.010   0.243  -0.015   0.005   0.005   *          *             *
  135.5 08:59:41.44   135.510 44025.231  -3.960  -0.615   2.593   0.010   0.233  -0.015   0.005   0.005   *          *             *
  135.6 08:59:41.55   135.610 44018.321  -3.950  -0.571   2.603  -0.005   0.238   0.015   0.005   0.000 32381.50  34.5741050  135.8166
  135.7 08:59:41.64   135.710 44020.228  -3.950  -0.576   2.520   0.000   0.233  -0.010   0.005   0.005   *          *             *
  135.8 08:59:41.75   135.810 44019.916  -3.950  -0.649   2.515   0.000   0.233  -0.010   0.005   0.000   *          *             *
        :
        :
  153.5 08:59:59.44   153.510 44394.005  -3.975  -0.591   2.588   0.000   0.224   0.010   0.005   0.005   *          *             *
  153.6 08:59:59.55   153.610 44933.933  -3.960  -0.645   2.510   0.005   0.243  -0.005   0.005   0.000 32399.50  34.5741050  135.8166
  153.7 08:59:59.64   153.710 45287.924  -3.940  -0.625   2.559   0.000   0.194  -0.010   0.010   0.005   *          *             *
  153.8 08:59:59.75   153.810 44750.706  -3.970  -0.610   2.603   0.005   0.258   0.005   0.005   0.000   *          *             *
  153.9 08:59:59.85   153.910 44848.155  -3.901  -0.605   2.515   0.005   0.263  -0.010   0.005   0.005   *          *             *
  154.0 08:59:59.94   154.010 44516.191  -3.916  -0.635   2.529   0.005   0.248   0.024   0.005   0.005   *          *             *
  154.1 09:00:00.05   154.110 44512.921  -3.970  -0.625   2.607   0.000   0.248  -0.010   0.005   0.005 32400.00  34.5741050  135.8166
  154.2 09:00:00.14   154.210 44779.757  -3.901  -0.552   2.612   0.005   0.175   0.034   0.005   0.005   *          *             *
        :
        :
  156.5 09:00:02.44   156.510 43976.703  -3.882  -0.566   2.529   0.005   0.277  -0.015   0.005   0.005   *          *             *
  156.6 09:00:02.55   156.610 43987.158  -3.887  -0.615   2.515   0.010   0.121   0.034   0.005   0.005 32402.50  34.5741017  135.8166
  156.7 09:00:02.64   156.710 43995.208  -3.906  -0.649   2.622   0.000   0.302   0.020   0.005   0.005   *          *             *
  156.8 09:00:02.75   156.810 44004.666  -3.979  -0.562   2.627  -0.005   0.297  -0.010   0.005   0.000   *          *             *
  156.9 09:00:02.85   156.910 44007.559  -3.950  -0.571   2.593   0.000   0.346   0.015   0.005   0.005   *          *             *
```

```
  157.0 09:00:02.94   157.010 43997.328  -3.892  -0.664   2.515   0.005   0.341   0.005   0.005   0.005   *          *            *
  157.1 09:00:03.05   157.110 44007.911  -3.916  -0.654   2.578   0.000   0.414   0.010   0.005   0.005 32403.00  34.5741017  135.8166
  157.2 09:00:03.14   157.210 44012.890  -3.945  -0.654   2.520   0.000   0.331   0.010   0.005   0.005   *          *            *
        :
        :
```

Ground station magnetic field data (example)

```
/Base:  46490           <-- Baseline value (nighttime value of quiet day) (*)
/Date: 20030215         <-- Date (8 columns of "yyyymmdd") (*)
130008 464795
130023   46480
130038  464795
130053 4648030          <-- Acquired data from ground station magnetometer
130108 46480.5          <-- 6 cols Time "HHMMSS", 1 col (or more) space,
130123 46480.71         <--  and magnetic field (in 1nT, 0.1nT or 0.01nT unit)
130138 464806.1
130153 4648052.
   .......

        (*) If Baseline value and/or Date is specified in the midst of file,
            it is effective rearward.
```

PostNav DGPS / Real-time GPS position data (example)

```
   12:51:11.000 35.0960951 137.6353737 983.83
   12:51:12.000 35.0963192 137.6353688 985.57
   12:51:13.000 35.0965443 137.6353639 987.19
        .......
  14:14:46.00  36.4404884  138.5358380  1408.51
  14:14:47.00  36.4404885  138.5358380  1408.50
  14:14:48.00  36.4404886  138.5358380  1408.47
        .......

     All lines are GPS position data in free format consisting of Localtime,
       latitude (in degrees), longitude (in degrees) and altitude (in m).
       Time data must be in the form of "HH:MM:SS.tt".
```

Survey line information data (example)

```
=030217f1.asc  030217f1.pnav
220      095250 100100    0
210      100330 101000  180
```

```
200      101210 101950    0
     .......
140      111210 112050    0
130      112340 113120  180
=030217f2.asc  030217f2.pnav
120      121300 122010    0
110      122235 122840  180
100      123105 123850    0
     .......
```

Lines starting with '=' on the 1st column specify data files, giving filenames of Common ASCII obs.data and GPS position data.
(Prog. **xldam** does not require filename of GPS position data.)

All other lines are individual survey line information, i.e., Line name, Start time, End time, and Flying direction (azimuth in degrees) separated by space.
(The time format is "hhmmss.tt", where ".tt" can be omitted.)
Flying direction data may be omitted if the correction of Mag.Sensor offset is not executed.

Various Line data File Format

There is variations of AM line data file formats, as follows.

1) DPAM line data file
2) AMDB-GSJ located line data file
3) AMDB-NEDO integrated located data file
4) StdLIN standard line data file
0) Generic random point data file

In the file format of 2 and 3, latitude and longitude values are referred to WGS (World Geodetic System), and altitude values are elevation from the Geoid. However, there is no such rule in other types of format, and the user has to specify the sort of geodetic system, etc.

The format type 0 is one for manipulating general versatile data, and the unit of latitude and longitude values and the sequence of each data are to be specified. In this case, the data line must consist of mumeric data only, with an exception that ":" is treated as a data seperator sama as a space.

Commonly, individual point data consists 1 line data, the 1st column of which is a blank or the 1st digit of a value. To indicate the start of new line with any attribute information, there is a header line starting with "&", "#" or "%" at the 1st column. Also, there may exist some comment lines starting with "#".
(Accordingly, the omission of lines starting with "&", "%" and "#" gives the series of valid point data.)

StdLIN line data format (example)

```
# Areaname: Kobe-Kyoto
# Survey Date: 1995.12.07-12.27
&A-01
  2079.02221N  8116.27649E   277.87m   -45.15nT
  2079.04052N  8116.31640E   278.58m   -44.66nT
  2079.05883N  8116.35641E   279.19m   -44.47nT
        .......
  2087.39584N  8134.25592E   275.40m   -48.38nT
  2087.41585N  8134.29643E   275.41m   -53.69nT
&    C-2r
  2088.27126N  8134.37994E   279.12m   -44.90nT
  2088.25637N  8134.33845E   279.33m   -40.81nT
  2088.24078N  8134.29646E   279.64m   -40.12nT
        .......
```

```
     Lines starting with '#' are comment information, usually placed only at
       the head of the file.  (Never be placed among series of line data.)
     Lines starting with '&' or '%' indicate the start of line data.
       Line name (number) is described in 2nd-9th columns, and the form of
       the rest is not restricted.  (Starting time and number of data points
       included are commonly described.)
       In some cases, a line with no data points is defined for explicit
       declaration of the end of file.
     All other lines are data of individual points, consisting of Latitude
       (in minutes), Longitude (in minutes), Altitude (in m), and Residual
       magnetic anomaly (in nT) data, with the format (47 columns) of
          format(1x, f11.5, 1hN,1x, f11.5, 1hE,1x, f8.2, 1hm,1x, f8.2, 2hnT)
       while number of columns of each data may be different for input data.
```

DPAM line data format (example)

```
# Areaname: Ootoge
# Survey Date: 2003.02.17
&220        20030217 95250.00 100100.00
  418860 20030217  95250.02  3  35.0885765  137.7122326 1033.28 46445.27   -50.13  -3.535   2.783   1.099  35570.02
  418870 20030217  95250.09  3  35.0885932  137.7122356 1033.31 46445.02   -50.39  -3.525   2.783   1.108  35570.09
  418880 20030217  95250.17  3  35.0886091  137.7122389 1033.34 46445.90   -49.51  -3.545   2.781   1.084  35570.17
        .......
  494660 20030217 100059.89  3  35.2059824  137.7122510 1258.37 46440.41  -115.48  -3.560   2.891   0.713  36059.89
  494670 20030217 100059.95  3  35.2059986  137.7122531 1258.30 46439.93  -115.95  -3.555   2.874   0.708  36059.95
&210       20030217 100330.00 101000.00
  517780 20030217 100330.09  3  35.2047662  137.7067634 1247.53 46418.68  -138.34  -3.281  -3.225  -0.249  36210.09
  517790 20030217 100330.19  3  35.2047375  137.7067660 1247.46 46418.48  -138.52  -3.296  -3.230  -0.273  36210.19
```

```
517800 20030217 100330.29  3  35.2047093  137.7067705 1247.39 46418.52  -138.47  -3.286  -3.210  -0.288  36210.29
      .......
```

```
Lines starting with '#' are comment information, usually placed only at
  the head of the file.  (Never be placed among series of line data.)
Lines starting with '&' or '%' indicate the start of line data,
  describing Line name (number), Date "yyyymmdd" and Start/End time.
  Time data is double precision value in the form of "HHMMSS.tt".
All other lines are data of individual points (115 columns + LF).
        format(i8, 1x,i8, 1x,f9.2, 1x,i2, 1x,f11.7, 1x,f12.7, 1x,f7.2,
       *       2(1x,f8.2), 3(1x,f7.3), 1x,f9.2)
      1) Fiducial number, 2) Date (yyyymmdd), 3) Time (HHMMSS.tt),
      4) Data spec.(*), 5) Latitude (Deg.), 6) Longitude (Deg.),
      7) Altitude (m), 8) Magnetic field (nT), 9) IGRF residual (nT),
      10-12) Fluxgate 3 components values (V),
      13) Localtime seconds (number of seconds from 00:00)
  In case of output from ecomp/fcomp, following data related to the
  aircraft magnetic field compensation are added with format (4(1x,f8.2)).
      14) residual before compensation (tres),
      15) correction for aircraft magnetic field (corr),
      16) random variation component (rand),
      17) linear trend component (trend),
      [tres = corr + rand + trend]
  (*) Meaning of Data spec.(k) :
     k = 4,5,6,7 :   5) Lat., 6) Long., 7) Alt. are from Real-time GPS
     k = 0,1,2,3 :   5) Lat., 6) Long., 7) Alt. are from PostNav DGPS
     k = 2,3,6,7 :   8) Mag.F, 9) IGRFres. are not diurnal corrected yet
     k = 0,1,4,5 :   8) Mag.F, 9) IGRFres. are diurnal corrected already
     k = 1,3,5,7 :   8) Mag.F, 9) IGRFres. are not AMF compensated yet
     k = 0,2,4,6 :   8) Mag.F, 9) IGRFres. are AMF compensated already
```

Bird-mag data and Line data in Helicopter-borne gradiometer AM (HGAM)

[*HGAM bird-mag data format*] (example)

```
       .......
20051012 09:14:51.10  99999.99  46949.90
20051012 09:14:51.20  99999.99  46949.89
20051012 09:14:51.30  99999.99  46949.85
20051012 09:14:51.40  46781.33  46949.85
20051012 09:14:51.50  99999.99  46949.79
20051012 09:14:51.60  99999.99  46949.77
20051012 09:14:51.70  46795.16  46949.70
20051012 09:14:51.80  46850.40  46949.78
20051012 09:14:51.90  46851.73  46949.73
20051012 09:14:52.00  46851.76  46949.70
```

```
.......

Each data consists of  Date (yyyymmdd), Time (HH:MM:SS.tt),
  Total force magnetic field at 1st sensor (nT), and
  Total force magnetic field at 2nd sensor (nT),
  with the form (41 columns + LF) as follows.
     format(1x, i8, 1x, i2,1h:,i2,1h:,f5.2, 1x, f9.2, 1x, f9.2)
```

[*HGAM line data format*] (example)

```
&F13       20051012 142618.00 152530.00
 1893030 20051012 142618.00 80  36.4324162  138.4260987 2285.58 46934.03   -58.27 46936.09   -56.09    -2.06
 1893040 20051012 142618.10 80  36.4323834  138.4261012 2285.41 46934.69   -57.58 46936.12   -56.03    -1.43
 1893050 20051012 142618.20 80  36.4323596  138.4261236 2285.44 46935.28   -56.97 46936.75   -55.38    -1.47
       .......
 2248210 20051012 152529.80 80  36.4200127  138.5840531 2700.97 47043.23   112.45 47048.76   118.09    -5.53
 2248220 20051012 152529.90 80  36.4200489  138.5840760 2700.40 47043.27   112.47 47048.77   118.09    -5.50
 2248230 20051012 152530.00 80  36.4200661  138.5840904 2699.93 47042.84   112.02 47048.52   117.81    -5.67
&F23a      20051013 125215.00 130130.00
 1388080 20051013 125215.00 80  36.4079470  138.5286123 2771.76 47531.58   593.48 47536.52   598.54    -4.94
 1388090 20051013 125215.10 80  36.4079393  138.5285881 2772.09 47531.73   593.64 47536.70   598.73    -4.98
 1388100 20051013 125215.20 80  36.4079166  138.5285668 2772.32 47531.83   593.75 47536.73   598.77    -4.90
 1388110 20051013 125215.30 80  36.4079055  138.5285373 2772.65 47531.95   593.87 47536.86   598.90    -4.91
       .......

Lines starting with '&' indicate the start of line data,
  describing Line name (number), Date "yyyymmdd" and Start/End time.
  Time data is double precision value in the form of "HHMMSS.tt".
All other lines are data of individual points (108 columns + LF).
        format(i8, 1x,i8, 1x,f9.2, 1x,i2, 1x,f11.7, 1x,f12.7, 1x,f7.2,
       *       5(1x,f8.2))
       1) Fiducial number, 2) Date (yyyymmdd), 3) Time (HHMMSS.tt),
       4) Data spec.(*), 5) Latitude (Deg.), 6) Longitude (Deg.),
       7) Altitude (m), 8) MagneticField-1(nT), 9) IGRFresidual-1 (nT),
       10) MagneticField-2 (nT), 11) IGRFresidual-2 (nT),
       12) Magnetic field difference (nT),
   (*) Data spec.(k) :
      k = 80  if position data is recovered by PostNav DGPS
      k = 84  if position data is recovered by Real-time GPS
      (Both, diurnal already corrected, no need of AMF compensation.)
This data has the form of a variation of DPAM line data.
  It can be processed much the same as DPAM line, as far as dealing
  with MagneticField-1 value.
  When dealing with MagneticField-2 value, the file shall be processed
  as a generic random point data file.
```

AMDB-GSJ line data format

Located line data file from GSJ digital data processing consists of 1 row of areaname header and a repetition of line data blocks, and the line data block is composed of 1 row line header and repeated point data. The format of each data row is as follows.

name	offset	cols	format	Contents
(Areaname Header)				
-	0	2	A2	fixed string '`##`'
-	2	2	2X	(space)
`area`	4	8	A8	Area name
`year`	12	8	F8.2	Year of survey (as used for DGRF calculation)
`high`	20	6	F6.0	Altitude in ft
-	26	2	A2	fixed string '`ft`'
(Line Header)				
-	0	2	A2	fixed string '`# `'
`lnam`	2	8	A8	Line name (aligned left)
`npt`	10	6	I6	Number of point data included
(Point data)				(repeat `npt` times)
`isec`	0	8	I8	Time in seconds (converted from DDHHMMSS string)
`alat`	8	9	F9.3	Latitude in minutes (ITRF)
`alon`	17	9	F9.3	Longitude in minutes (ITRF)
`tres`	26	8	F8.1	DGRF residual magnetic value in nT after all corrections

AMDB-NEDO line data format

Integrated located data file of NEDO survey consists of 1 row of areaname header and a repetition of line data blocks, and the line data block is composed of 1 row line header and repeated point data. The format of each data row is as follows.

name	offset	cols	format	Contents
(Areaname Header)				

-	0	2	A2	fixed string '##'
-	2	8	A8	fixed string ' NEDO '
area	10	8	A8	Area name (kyushu / tohoku / hokkaido / chubu / kanto / chugoku)
(Line Header)				
-	0	2	A2	fixed string '# '
lnam	2	8	A8	Line name (aligned right)
npt	10	6	I6	Number of point data included
(Point data)				(repeat npt times)
ifid	0	8	I8	Fiducial number
isec	8	6	I6	Time of a day in seconds
alat	14	9	F9.3	Latitude in minutes (ITRF)
alon	23	9	F9.3	Longitude in minutes (ITRF)
tair	32	8	F8.1	Magnetic field in the air in nT
tmdv	40	8	F8.1	Magnetic diurnal variation in nT
tcor	48	8	F8.1	Magnetic field in nT after diurnal correction and level adjustment
tres	56	8	F8.1	DGRF residual in nT after correction and adjustment
irad	64	5	I5	Radio altimeter value in ft
ibar	69	5	I5	Barometric altimeter value in ft

GDMP: Programs for Grid Data Manipulation

Japanese

sel	adjlv	govlay	plmap	plmaps/shade	Standard GRID data file Format
seldb	gadd	gojoin	plmapc	plmapcs	How to use "xplmap/xplmapc"
seldb2	gsub	gmerge	plmapg	xplmap	Parameters
altchg	gtrim	txproj	plmapl	xplmapc	OverlayObject Descriptor
altx/rearx	gtopo	gtrf	plmapcl	xplmapcs	Caption Specifier / Example

Program Name	Function
sel	Generate new GRID data from an existing GRID data, with re-gridding. Parameters: log filename input GRID data filename (new) areaname label location parameters (*1) output filename
seldb	Generate new GRID data from AMDB GRID data, with re-gridding. (To perform this process, it is required that AMDB grid data are stored in a specific directory, the name of which is specified by a parameter AMDBDIR in the source program "seldb.f90".) Parameters: log filename input data class (SurveyDB / Composite) codename of source data (new) areaname label location parameters (*1) output filename
seldb2	Generate new GRID data with re-gridding from AMDB2 GRID data (GSJ Open-file Report no.516). (To perform this process, it is required that AMDB2 grid data are stored in a specific directory the name of which is specified by a parameter AMDB2DIR in the source program "seldb2.f90".) Parameters: log filename (new) areaname label coordinate number (*2) location parameters (*1) output data filename
altchg	Generate new GRID data from an existing GRID data, with replacing the Altitude information. New altitude data may be (0)Const. value, (1) Simple GRID data file, or (2) any GRID data with 2nd set altitudes. Parameters: log filename input data filename How to specify altitude (0 / 1 / 2) [*if (0)Const.value*] altitude value (m) [*if (1)/(2) File input*] Filename of GRID data file (new) areaname label output data filename
altx	Extract altitude GRID data from a Standard Format magnetic anomaly GRID data (i.e., from 2nd set data or from header information). Parameters: log filename input data filename (new) areaname label output data filename

rearx	Extract single selected set GRID data from multiple sets data file. Parameters: log filename input data filename seq.no. of the set to extract output data filename
adjlv	Add a constant value to GRID data to adjust DC level. Parameters: log filename input data filename constant value to be added (new) areaname label output data filename
gadd	Add 2 GRID data, generating a new GRID data. Altitude values are copied from the 1st data. Parameters: log filename input data1 filename input data2 filename (new) areaname label output data filename
gsub	Subtract 2nd GRID data from the 1st one, generating a new GRID data. Altitude values are copied from the 1st data. Parameters: log filename input data 1 filename input data 2 filename (new) areaname label output data filename
gtrim	Trim-off data of undefined range same as in the reference data. Data of trimmed-off parts are filled with the value for undefined (vnul). Parameters: log filename input source data filename reference data filename (new) areaname label output data filename
gtopo	Generate topography GRID data from DEM. (To perform this process, it is required that DEM data of GRID data format are stored in a specific directory, the name of which is specified by a parameter DEMDIR in the source program "gtopo.f90", and with subdirectory tree structure of UTM zone number.) Current program assumes that terrain height is non-negative, and negative value means terrain height not available. Parameters: log filename name label coordinate number (*2) location parameters (*1) output data filename
govlay	Overlay multiple GRID data sequentially with placing slit zone, and create new GRID data. Parameters: log filename (new) areaname label coordinate number (*2) location parameters (*1) output data filename *[repeated until blank line]* input data filename
gojoin	Join multiple GRID data sequentially with placing transient zone surrounding the overlaid data, and create new GRID data.

	Parameters: log filename (new) areaname label coordinate number (*2) location parameters (*1) transient zone width (km) output data filename *[repeated until blank line]* input data filename
gmerge	Merge multiple GRID data sequentially with placing transient zone along overlapping zone, and create new GRID data. Parameters: log filename (new) areaname label coordinate number (*2) location parameters (*1) transient zone width (km) output data filename *[repeated until blank line]* input data filename
txproj	Translate GRID data into another map projection, with re-gridding. Parameters: log filename input data filename (new) coordinate number (*2) output data filename
gtrf	Translate IGRF residual GRID data into another reference model. Parameters: log filename input data filename survey year old reference model identifier (spec. and year / generation) new reference model identifier (spec. and year / generation) (new) areaname label output data filename
plmap	Draw contour map of GRID data on an A4 sheet. Parameters: log filename input GRID data filename output PS filename paper orientation ***[may be repeated below]*** contour interval (if 0, omit drawing, then parameters below must be omitted.) size of drawing supplementary items (*3) *[if next set data exist]* continue or quit
plmapc	Draw color-graded contour map of GRID data on an A4 sheet. Parameters: log filename input GRID data filename output PS filename paper orientation ***[may be repeated below]*** contour interval (if 0, omit drawing, then parameters below must be omitted.) median value of color-grading size of drawing supplementary items (*3) *[if next set data exist]* continue or quit

plmapg	Draw gray-scale grading map of GRID data on an A4 sheet. Parameters: log filename input GRID data filename output PS filename paper orientation ***[may be repeated below]*** interval of grading (if 0, omit drawing, then parameters below must be omitted.) median value of grading size of drawing supplementary items (*3) [*if next set data exist*] continue or quit
plmapl	Draw contour map of GRID data with Trackline paths on an A4 sheet. Parameters: log filename input GRID data filename StdLIN line data filename output PS filename paper orientation ***[may be repeated below]*** contour interval (if 0, omit drawing, then parameters below must be omitted.) size of drawing pen-number to draw trackline paths supplementary items (*3) [*if next set data exist*] continue or quit
plmapcl	Draw color-graded contour map of GRID data with Trackline paths on an A4 sheet. Parameters: log filename input GRID data filename StdLIN line data filename output PS filename paper orientation ***[may be repeated below]*** contour interval (if 0, omit drawing, then parameters below must be omitted.) median value of color-grading size of drawing pen-number to draw trackline paths supplementary items (*3) [*if next set data exist*] continue or quit
plmaps	Draw shaded-relief contour map of GRID data on an A4 sheet. Parameters: log filename input GRID data filename output PS filename paper orientation ***[may be repeated below]*** contour interval (if 0, omit drawing, then parameters below must be omitted.) azimuth and elevation angle of illuminant scaling for vertical size of drawing supplementary items (*3) [*if next set data exist*] continue or quit

shade	Draw shaded-relief map of GRID data on an A4 sheet. Parameters: log filename input GRID data filename output PS filename paper orientation ***[may be repeated below]*** process or skip this set data (if skip, parameters below must be omitted.) azimuth and elevation angle of illuminant scaling for vertical size of drawing supplementary items (*3) [*if next set data exist*] continue or quit
plmapcs	Draw shaded-relief color-grading map of GRID data on an A4 sheet. Parameters: log filename input GRID data filename output PS filename paper orientation ***[may be repeated below]*** interval of color-grading (if 0, omit drawing, then parameters below must be omitted.) median value of color-grading azimuth and elevation angle of illuminant scaling for vertical size of drawing supplementary items (*3) [*if next set data exist*] continue or quit
xplmap	Draw contour map of GRID data with various supplementary items. Sheet size is selectable among A4 through B0. See 'HowTo' section for detail information how to use. Parameters: log filename input GRID data filename data set number in the input file OverlayObject descriptor filename Caption specifier filename output PS filename paper size and orientation scale (in reciprocal) left and bottom margin contour interval and character size of contour-value supplementary items (*3) confirm parameters setting (process or abort) control on adding ID-label
xplmapc	Draw color-graded contour map of GRID data with various supplementary items. Sheet size is selectable among A4 through B0. See 'HowTo' section for detail information how to use. Parameters: log filename input GRID data filename data set number in the input file OverlayObject descriptor filename Caption specifier filename output PS filename paper size and orientation scale (in reciprocal) left and bottom margin contour interval and median value of color-grading

	rasterizing resolution (in 1/600 inch) supplementary items (*3) confirm parameters setting (process or abort) control on adding ID-label
xplmapcs	Draw color-graded shading map of GRID data with various supplementary items. Sheet size is selectable among A4 through B0. See 'HowTo' section for detail information how to use. Parameters: log filename input GRID data filename data set number in the input file OverlayObject descriptor filename Caption specifier filename output PS filename paper size and orientation scale (in reciprocal) left and bottom margin color grading interval and median value rasterizing resolution (in 1/600 inch) supplementary items (*3) confirm parameters setting (process or abort) control on adding ID-label

(*1) "location parameters" include Northing and Easting of Southwest corner, mesh interval and number of mesh to the North, and to the East.

(*2) If the map projection is not UTM, information of the origin will be required.

(*3) "supplementary items" include the selection whether and where to write scale bar or not, whether to write meridians and parallels, and whether to write coastlines, rivers and prefecture boundary.
(To perform drawing coastlines, rivers and prefecture boundaries, it is required that such data are stored in a specific directory, the name of which is specified by a parameter DIRSHORE in the source of library subprogram "wshore.c", and with subdirectory tree structure of UTM zone number.)

Standard GRID data file Format v2018

```
 1.   One file consists of 1 set of GRID data, or multiple sets of GRID data.
    The 2nd set or further behind of multiple sets of GRID data is restricted
    in usage, and is valid only for cases below.
      (1) 1st set GRID data indicates a distribution of any physical quantity
        on a curved surface, and the altitude distribution of the surface is
        given by 2nd set GRID data.
      (2) The file consists of a series of independent GRID data, and they are
        not used for other than illustrating each distribution.
 2.   The unit for the physical quantity (grid data) is, in principle,
    nT for magnetic field, m for altitude, 0.01 A/m for magnetization, mGal
    for gravity, or others as derived from them.  And it is recommended to use
    the value of positive 99999 in effective digits for representing null
    value (the lack of valid data).
 3.   Every data line in GRID data file may not exceed 80 bytes excluding LF
    code.  And it is recommended to be 79 bytes or less excluding LF.
 4.   Data in GRID data file may not include multi-byte characters, and
    control codes other than LF shall not be used.

Each set of GRID data is constructed as follows.
a) Comment: Before 1st Header, arbitrary lines of comment can be placed.
        Comment line has "#" on the 1st column and is 80 byte long at most.
b) 1st Header (Areaname and information of map projection)  [fixed format]
      FORMAT(a8, 4x,i4, 2i8, 2i8)
  area: 8 byte string representing Areaname or else, not starting with "#".
  nc:    coordinate number of map projection (usually UTM zone number)
             0 : Japanese transverse Mercator coordinates
          1-60 : UTM coordinates zone number
            61 : North pole UPS coordinates
            62 : South pole UPS coordinates
```

```
          65 : UTM coordinates with non-standard central meridian
          70 : Mercator projection
          71 : Lambert conformal conic projection (1 standard parallel)
          72 : Lambert conformal conic projection (2 standard parallels)
         100 : Lambert Azimuthal Equal-Area Projection
                (from the sphere with surface area equal to the earth)
         109 : Lambert Azimuthal Equal-Area Projection
                (from the sphere with equatorial radius equal to the earth)
         199 : Latitude/Longitude in minutes are regarded as distance in km
        These numbers above are for GRS ellipsoid (WGS-ITRF).
        For Bessel ellipsoid (Old Tokyo datum), add 800 to the corresponding
        projection.
  ig, kg : Latitude and Longitude (in minutes) of origin
            [neglected for nc = 1 to 62]
  i1, i2 : Latitudes (in minutes) of standard parallels
            [valid only when nc = 72]
    In general, coordinate values are X (Northing) = Y (Easting) = 0 at the
    origin.  However, in UTM (nc = 1 to 60, or 65) X = 0, Y = 500,000 (m), and
    in UPS (nc = 61 or 62) X = Y = 2,000,000 (m), at the origin.
c) 2nd Header (Grid information, null value and altitude)  [free format]
      FORMAT(2i12, 2i6, 2i6, 1x,f7.1, 1x,f7.0)   (as standard)
  ixs, iys : Northing and Easting (in m) of Southwest corner of GRID  [integer]
  mszx,mszy: mesh size (in m) towards North and East                  [integer]
  mxn, myn : mesh count (including both ends) towards North and East  [integer]
  vnul :     special value representing the lack of valid data        [real]
  alt :      observation altitude (in m)                              [real]
              (If the value = 0., the distribution of observation surface is
               given as 2nd set GRID data, and if negative (-1.), the altitude
               of observation is undefined.  For the 2nd set GRID data (i.e.,
               altitude data) this is filled with -1., though meaningless.)
d) GRID data body  [free format]
      FORMAT((f7.1, 9(1xd,f7.1)))   (as standard)
  All grid data are listed out in the order that starts from Southwest corner
  toward North, and on arriving North end proceeds to next East row.
  Next expression is the equivalent FORTRAN statement reading this data.
        read(10,*) ((f(i,k),i=1,mxn),k=1,myn)
  However, for the output programming, line break operation between rows
        do k=1,myn
          write(10,'((f7.1,9(1x,f7.1)))') (f(i,k),i=1,mxn)
        enddo
  is recommended.
```

How to use "xplmap/xplmapc/xplmapcs"

Parameters specification

```
[Assigning I/O files]
  (1) working directory name :
        filenames assigned hereafter are assumed to exist under this directory.
  (2) filename of input GRID data.
  (3) data set sequence number :  usually 1
        If the input data file includes multiple sets of GRID data, and if 2nd
        set or behind is to be processed, specify value of 2 or greater.
  (4) OverlayObject descriptor filename :
        If blank, no OverlayObject is assumed.
  (5) Caption specifier filename :
        If blank, no Caption is assumed.
  (6) output PS filename.

[Parameters on Drawing]
  (7) paper size/orientation (AiP, AiL, BiP or BiL, where i is 4,3,2,1 or 0)
  (8) scale (in reciprocal)  (e.g., specify 50000. for the scale of 1/50,000.)
  (9) left margin (cm)
 (10) bottom margin (cm)

 (11) [XPLMAP/XPLMAPC] contour interval (1/2 of color-grading) [integer]
 (11) [XPLMAPCS] color-grading interval [integer]
 (12) [XPLMAP]  character size of contour-value (cm) [if 0., no entry.]
 (12) [XPLMAPC/XPLMAPCS] median value of color-grading [integer]
 (13) [only when XPLMAPC/XPLMAPCS]
```

```
     rasterizing resolution (in 1/600 inch) [integer]
 (14) [only when XPLMAPC/XPLMAPCS]
      write color-grading(shading) legend ?  (y / n)
  (14a) [if (14)==y ] size ratio  (relative to standard size)
  (14b) [if (14)==y ] position
  (14c) [if (14)==y ] unit notation

 (15) write scale-bar ?  (y / n)
  (15a) [if (15)==y ] position
 (16) write meridians/parallels ?  (y / n)
 (17) write coastlines ?  (y / n)
  (17a) [if (17)==y ] write rivers/lakes ?  (y / n)
  (17b) [if (17)==y ] write pref. boundaries ?  (y / n)
```

[*Confirmation of parameters*]

```
 (18) (confirm parameter setting) OK ?  (y / n)
 (19) write additional ID-label ?  (y / n)
  (19a) [if (19)==y ] ID-label string
```

Overlay-Object Descriptor

(a) *Sort of Object* :

1) point, 2) circle, 3) horizontal line, 4) inclined line, 5) horizontal rectangle, 6) rectangular block, 7) mark, 8) string-style, 9) string, 10) polygon within horizontal plane, 11) undulating polygon, 12) rectangle along meridians/parallels can be specified.

Each Object generally has its own physical geometry, having attributes of not only horizontal position but also vertical depth. So, data describing the objects include depth information, but such vertical information is neglected in "xplmap/xplmapc/xplmapcs" process.

(b) *General rule of Object description* :

- If 1st column is "#", the line is neglected as a comment.
- Excluding polygon object, one object is described by 1 line. Polygon object is defined with multiple lines, and the coordinates of apexes are given from the 2nd line.
- Description of Object starts with Object keyword, and is followed by a coordinate specifier and a list of various numerical data, all in free format. (Description of string-style object is a little different.)
- Object keywords are as listed below, not necessarily in capitals.
- Coordinate specifier is either coordinate number of map projection or "*". "*" indicates that the horizontal position is defined by latitudes and longitudes, while coordinate number implies that the position is defined by the distances in km in the respective projection coordinates. The coordinate number specified must coincide with the GRID data.
- Some of numerical data list can be omitted on its rear part, which is shown as enclosed by [ ] in the list below.

(c) *List of descriptors* :

```
  0) #   (If 1st column is "#", the line is neglected as a comment.)
  1) POINT   nc   xp      yp     deep  size  [ icol ]
     POINT   *  id:fim  kd:fkm  deep  size  [ icol ]
  2) CIRCLE  nc   xc      yc     deep  radius  [ thick  icol  ityp ]
     CIRCLE  *  id:fim  kd:fkm  deep  radius  [ thick  icol  ityp ]
  3) HLINE   nc   xs      ys      xt      yt    deep  [ thick  icol  ityp ]
     HLINE   *  id:fim  kd:fkm  id:fim  kd:fkm  deep  [ thick  icol  ityp ]
  4) SLINE   nc   xs      ys     dps    xt      yt    dpt  [ thick  icol  ityp ]
     SLINE   *  id:fim  kd:fkm  dps  id:fim  kd:fkm  dpt  [ thick  icol  ityp ]
  5) HRECT   nc   xs      ys      xt      yt    deep  [ thick  icol  ityp ]
     HRECT   *  id:fim  kd:fkm  id:fim  kd:fkm  deep  [ thick  icol  ityp ]
  6) BLOCK   nc   xs      ys      xt      yt    dp1  dp2  [ thick  icol  ityp ]
     BLOCK   *  id:fim  kd:fkm  id:fim  kd:fkm  dp1  dp2  [ thick  icol  ityp ]
  7) MARK    nc   xp      yp     mark  size  [ thick  icol ]
     MARK    *  id:fim  kd:fkm  mark  size  [ thick  icol ]
  8) LSTYLE  font  size  [ angle  itcol  ibcol ]
  9) TEXT    nc   xp      yp     [ kp  text ]
     TEXT    *  id:fim  kd:fkm  [ kp  text ]
 10) HPOLYG  nc  npt  deep  [ thick  icol  ityp ]  / (  xp   ,   yp   , i=1,npt)
     HPOLYG  *   npt  deep  [ thick  icol  ityp ]  / (id:fim, kd:fkm, i=1,npt)
 11) SPOLYG  nc  npt  [ thick  icol  ityp ]  / (  xp   ,   yp   , deep, i=1,npt)
     SPOLYG  *   npt  [ thick  icol  ityp ]  / (id:fim, kd:fkm, deep, i=1,npt)
```

```
12) LRECT   nc   xs      ys      xt      yt    deep  [ thick  icol  ityp ]
    LRECT   *  id:fim  kd:fkm  id:fim  kd:fkm  deep  [ thick  icol  ityp ]

 [common] nc / * :  coordinate specifier. "*" indicates that the horizontal
                    position is defined by latitudes and longitudes.  The
                    value of "nc" must coincide with the GRID data.
          xp,xc,xs,xt / yp,yc,ys,yt :
                    Northing and Easting (in km) in the specified projection
                    coordinates ("nc").
          id:fim / kd:fkm :
                    Latitude and Longitude in the form of "Degree:Minute".
                    There may be space only between ":" and "Minute".
                    (Even if "Degree" is 0, "0:" cannot be omitted.
                     The program only calculates [Degree*60. + Minute].
                     If South latitude or West longitude is intended,
                     both "Degree" and "Minute" must have minus sign.)
          npt :     number of apexes (3 to 150)
          deep,dps,dpt,dp1,dp2 :
                    depths in m
          size / radius / thick :
                    size / radius / thickness in cm on the illustration
          icol / ityp :
                    color (-255 to 16777215)
                    / line type (0: solid, 1: broken, 2: dotted, 3: chained)
          itcol / ibcol :
                    foreground color / background color (-255 to 16777215)
            Values for "icol" / "itcol" / "ibcol" :
              monochromatic if (-255) to 0, and RGB color if 0 to 16777215.
              0 value corresponds to black, while -255 and 16777215 to white.
              If given the out-of-range value, default black foreground color
               or colorless transparent background will become effective.
 [MARK]   mark :    0: circle  1: double circle  2: square  3: rhomb
                     4: triangle  5: down triangle  6: star  7: KOME mark
                      8: plus sign  9: cross
                       others: regarded as mark=0, thick=0., icol=0
                    If thick=0. and mark<=6, inside the mark is painted with
                    specified color, and for mark=1 inside of inner circle is
                    further painted with white.
 [LSTYLE] font, size, angle :
                    Font specifying string of 3 characters or less (as used in
                    lstyle subroutine) / character height (in cm) /
                    string direction (in degrees)
 [TEXT]   kp   :  defines how to locate string referred to specified point
                      0: lower left, 1: lower right, 2: center  of string
                    is adjusted to specified point.
          text :  The string after removing the leading and trailing spaces
                    is written in.  If the first and the last characters of
                    the string are both '"' or both "'", corresponding
                    characters '"' or "'" are removed before writing.
```

Caption Specifier

```
 If 1st column is "#", the line is neglected as a comment.
 1st column is neither " ", "=" nor "#" :
     Font specifier, character height ('size'), string direction ('angle'),
   foreground color ('itcol'), and background color ('ibcol') are specified
   from the 1st column, with separated by one or more spaces.  Font specifier
   is a string of 3 characters or less, as used in lstyle subroutine.
   'size' is in cm, and 'angle' is in degrees.  'itcol' and 'ibcol' values
   (-255 to 16777215) are forwarded to lstyle subroutine.  If given the
   out-of-range value, default black foreground color or colorless transparent
   background will become effective.  Parameters 'angle' and the behind can be
   omitted on its rear part, then angle = 0., itcol = 0, and/or ibcol = 9999
   (colorless transparent) becomes effective.
 1st column is "=" :
     Position (in cm) of starting Caption string is specified with free format
   in columns 2 and after.  The position is given by rightward (Eastward) and
   upward (Northward) coordinates relative to the bottom-left corner of the
   contour map.
 1st column is " " :
     The string after removing the leading and trailing spaces is written in
```

the map, with the parameter as defined above. If the first and the last characters of the string are both '"' or both "'", corresponding characters '"' or "'" are removed before writing.
If string definitions are repeated without re-positioning by "=" line, the string will be written on the following line, with line spacing of 120% character height ('size').

Example data for XPLMAPC

```
[keyboard input (stdin) data (example)]
        (Preceding parenthized number, and the field ';' and after
         are not for input data, but only for explanation.)
  (1)   ~/kobe          ; working directory name
  (2)   amkobe.grd      ; input GRID data filename
  (3)   1               ; data set sequence number
  (4)   kobe.obj        ; OverlayObject descriptor filename
  (5)   kobe.cap        ; Caption specifier filename
  (6)   amkobe.ps       ; output PS filename
  (7)   a2l             ; paper size and orientation
  (8)   200000          ; scale (in reciprocal)
  (9)   5               ; left margin (cm)
 (10)   3               ; bottom margin (cm)
 (11)   5               ; contour interval (1/2 of color-grading) [integer]
 (12)   -30             ; median value of color-grading [integer]
 (13)   2               ; rasterizing resolution (in 1/600 inch) [integer]
 (14)   y               ; write color-grading legend ?
 (14a)  1               ;   size ratio     [if (14)==y ]
 (14b)  40 3            ;   position       [if (14)==y ]
 (14c)  (nT)            ;   unit notation  [if (14)==y ]
 (15)   y               ; write scale-bar ?
 (15a)  12 3            ;   position       [if (15)==y ]
 (16)   y               ; write meridians/parallels ?
 (17)   y               ; write coastlines ?
 (17a)  n               ;   write rivers/lakes ?      [if (17)==y ]
 (17b)  n               ;   write pref. boundaries ?  [if (17)==y ]
 (18)   y               ; (confirm parameter setting)
 (19)   y               ; write additional ID-label ?
 (19a)  KobeAM.map      ;   ID-label string   [if (19)==y ]

[Overlay-Object Descriptor data (example)]
  #
  lstyle HB  0.7  0.  0  -999
  mark  *  34:41.2  135:12.0  0  0.3  0.  0
  text  *  34:41.2  135:12.0  1  "KOBE "
  mark  *  34: 41.5  135: 30.5  0  0.3  0.  0
  text  *  34: 41.5  135: 30.5  1  "OSAKA "
  mark  *  34: 60.6  135: 46.2  0  0.3  0.  0
  text  *  34: 60.6  135: 46.2  1  " KYOTO"
  # Hankyu Kobe-Imadzu-Takarazuka line loop loc.
  spolyg   53   33   0.06  0  0
     3842.573  544.585   -5   3841.362  544.429   -1   3841.899  544.165   -1
     3843.005  543.339   -5   3844.091  542.359   -5   3845.088  540.945  -10
     3844.877  536.423   -5   3844.191  532.931   -5   3846.739  533.221  -20
     3847.844  532.711  -30   3849.007  532.481  -40   3849.796  532.384  -50
     3850.595  531.862  -45   3851.009  532.019  -45   3851.263  531.630  -50
     3851.426  531.977  -50   3851.451  532.763  -60   3851.671  533.131  -60
     3852.036  533.387  -55   3852.434  534.172  -65   3852.474  535.436  -55
     3852.859  536.510  -40   3853.337  537.301  -40   3853.154  538.457  -30
     3851.808  540.110  -30   3851.219  540.978  -30   3849.944  541.197  -30
     3849.311  541.494  -30   3848.832  542.535  -30   3846.771  543.124  -15
     3846.378  543.719  -10   3844.427  543.758   -5   3843.406  544.499   -5

[Caption specifier data (example)]
  #
  TBO  2.  0.  0  2047
  =  3.  23.
   IGRF Residuals
  #
  TB   1.  0.  0  -255
  =  26.  8.5
   Flown  in December, 1995
```

```
 Average Line Spacing: 300m
#
HO   0.75  0.  0  -255
=  26.  5.
 Flying Altitude:
 "  300m above Ground Envelope"
 Reduction Surface of this Map:
 "  200m upward Smoothed surface"
 "  above the actual flight level"
```

ANAM: Programs for Analysis of Magnetic Anomaly Data

Japanese

emag/emagf	tmcorr	emeq	emeqs	edeq	edeqs	calmas
amag/amagc	tmcfix	ameq	ameqs	adeq	adeqs	
cmag/cmagf	lcecorr	ameqc	ameqsc	adeqc	adeqsc	Standard Grid data file Format
plamag	aaptdp	cmeq	cmeqs	cdeq	cdeqs	StdLIN data Format
plamagc	galtf/galts		rpmeqs		rpdeqs	GDMP (Grid Data Manipulation)

Program Name	Function
emag **emagf**	Calculate COEF matrix to prepare for Magnetization Intensity Mapping. **emagf** takes the surface undulation into consideration with the resolution of terrain data, while **emag** approximates the source into blocks with source grid size. Here **emagf** requires the source grid size be a multiple of the grid size of terrain data. Parameters: log filename input magnetic anomaly data filename source altitude data filename source location parameters (*1) truncation of source effect (km) source bottom configuration (*2) ambient field direction magnetization direction initial value of source magnetiz. (A/m) COEF matrix output filename AMAG initial model output filename
amag **amagc**	Execute Magnetization Intensity Mapping, making use of COEF matrix from **emag/emagf** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not COEF matrix input filename AMAG model in/out filename auxiliary output filename **[amag]** number of loops (*4) **or [amagc]** convergency torelance (*5) **[amag,(*4)]** initial value of source magnetiz. (A/m) [if restart] **or [amagc]** maximum loop count
cmag **cmagf**	Calculate synthetic magnetic anomaly distribution on the specified surface caused by the result of Magnetization Intensity Mapping. **cmagf** takes the surface undulation into consideration with the resolution of terrain data, while **cmag** approximates the source into blocks with source grid size. Here **cmagf** requires the source grid size be a multiple of the grid size of terrain data. Parameters: log filename calculation altitude input filename AMAG model input filename source altitude data filename truncation of source effect (km) source bottom configuration (*2) ambient field direction magnetization direction output data filename

plamag	Draw contour map of the result of Magnetization Intensity Mapping on an A4 sheet. Surrounding source zone is masked, and the range of drawing can be limited. Parameters: log filename input AMAG data filename ref. obs.anomaly data filename no. of grids [S,N] to limit drawing range no. of grids [W,E] to limit drawing range output PS filename paper orientation contour interval (A/m) size of drawing supplementary items (scale bar, meridians and parallels, coastlines etc.)
plamagc	Draw color-graded contour map of the result of Magnetization Intensity Mapping on an A4 sheet. Surrounding source zone is masked, and the range of drawing can be limited. Parameters: log filename input AMAG data filename ref. obs.anomaly data filename no. of grids [S,N] to limit drawing range no. of grids [W,E] to limit drawing range output PS filename paper orientation color-grading interval (A/m) median value of grading (A/m) contour-line interval (A/m) size of drawing supplementary items (scale bar, meridians and parallels, coastlines etc.)
tmcorr	Correction of the effect of terrain uniform magnetization for observed magnetic anomaly GRID data. Parameters: log filename observed magnetic anomaly data filename whether removing linear trend (y) or only DC level (n) topography data filename truncation distance of source effect (km) source bottom configuration ambient field direction magnetization direction terrain corrected output filename auxiliary output filename
tmcfix	Correction of fixed terrain magnetization effect for observed magnetic anomaly GRID data. Parameters: log filename observed magnetic anomaly data filename topography data filename truncation distance of source effect (km) source bottom configuration ambient field direction magnetization direction magnetization intensity terrain corrected output filename
lcecorr	Correction of the railway loop-current effect for observed magnetic anomaly GRID data. Parameters: log filename observed magnetic anomaly data filename loop location data filename ambient field direction

	range of loop-current estimation LCE corrected output filename auxiliary output filename
aaptdp	Point-dipole source modeling for observed magnetic anomaly GRID data. Each time a fitting window is selected, one source model is fitted automatically, and its effect is removed from the observed magnetic anomaly. Parameters: log filename observed magnetic anomaly data filename ambient field direction areaname label for model anomaly model anomaly output filename areaname label for residual data residual data output filename how to define window (UTM coordinates / mesh-count) [*repeated until blank line*] data specifying window
galtf	Interpolate observation altitude of StdLIN data into GRID data. Parameters: log filename input StdLIN data filename effecting radius (km) (new) areaname label map projection coordinate number (*3) location parameters (*1) output data filename
galts	Generate GRID data of smoothed observation altitude from StdLIN data. Parameters: log filename input StdLIN data filename smoothing radius (km) (new) areaname label map projection coordinate number (*3) location parameters (*1) output data filename
emeq	Calculate CMUP matrix to prepare for Altitude Reduction by Equivalent Anomaly method [Equivalent source surface is defined as a certain distance below the specified reduction-to surface, and the magnetic anomaly distribution on the source surface is derived from observed data by an inversion analysis, then the magnetic anomaly distribution on the specified surface is calculated as a continuation operation]. Parameters: log filename input magnetic anomaly data filename reduction-to altitude data filename distance of source surface below the reduction-to surface (m) truncation of source effect (km) CMUP matrix output filename AMEQ model initializing output filename
ameq **ameqc**	Execute Altitude Reduction by Equivalent Anomaly method, making use of CMUP matrix from **emeq** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename CMUP matrix input filename AMEQ model in/out filename **[ameq]** number of loops (*4) **or [ameqc]** convergency tolerance (*5) [in case of **ameqc]** maximum loop count

cmeq	Calculate magnetic anomaly distribution on the specified reduction-to surface, from the Equivalent Anomaly distribution AMEQ derived by **ameq/ameqc** process. Parameters: log filename reduction-to altitude data filename AMEQ model input filename truncation of source effect (km) reduction result data output filename
emeqs	Calculate CMUPS matrix to prepare for Altitude Reduction by Equivalent Source Magnetization method [Equivalent source surface is defined as a certain distance below the specified reduction-to surface, and the magnetization distribution on the source surface is derived from observed data by an inversion analysis, then the magnetic anomaly distribution on the specified surface is forward calculated]. Parameters: log filename input magnetic anomaly data filename reduction-to altitude data filename distance of source surface below the reduction-to surface (m) truncation of source effect (km) ambient field direction magnetization direction CMUPS matrix output filename AMEQS model initializing output filename
ameqs **ameqsc**	Execute Altitude Reduction by Equivalent Source Magnetization method, making use of CMUPS matrix from **emeqs** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename CMUPS matrix input filename AMEQS model in/out filename **[ameqs]** number of loops (*4) **or** **[ameqsc]** convergency tolerance (*5) [in case of **ameqsc**] maximum loop count
cmeqs	Calculate magnetic anomaly distribution on the specified reduction-to surface, from the Equivalent Source Magnetization distribution AMEQS derived by **ameqs/ameqsc** process. Parameters: log filename reduction-to altitude data filename AMEQS model input filename truncation of source effect (km) reduction result data output filename
rpmeqs	Calculate reduction-to-pole magnetic anomaly distribution on the specified reduction-to surface, translating the Equivalent Source Magnetization AMEQS derived by **ameqs/ameqsc** process into vertical, and also assuming vertical ambient magnetic field direction. Parameters: log filename reduction-to altitude data filename AMEQS model input filename truncation of source effect (km) calculated reduction-to-pole data output filename
edeq	Calculate CFUP matrix to prepare for Altitude Reduction from StdLIN line data by Equivalent Anomaly method [Equivalent source surface is defined as a certain distance below the specified reduction-to surface, and the magnetic anomaly distribution on the source surface is derived from observed StdLIN data by an inversion analysis, then the magnetic anomaly distribution on the specified surface is calculated as a continuation operation]. Parameters: log filename StdLIN line data filename

	reduction-to altitude data filename distance of source surface below the reduction-to surface (m) truncation of source effect (km) CFUP matrix output filename ADEQ model initializing output filename
adeq **adeqc**	Execute Altitude Reduction from StdLIN line data by Equivalent Anomaly method, making use of CFUP matrix from **edeq** process as far as specified loop count or until converge. Parameters: log filename StdLIN line data filename CFUP matrix input filename ADEQ model in/out filename **[adeq]** number of loops (*4) **or [adeqc]** convergency tolerance (*5) [in case of **adeqc]** maximum loop count
cdeq	Calculate magnetic anomaly distribution on the specified reduction-to surface, from the Equivalent Anomaly distribution ADEQ derived by **adeq/adeqc** process. Parameters: log filename reduction-to altitude data filename ADEQ model input filename truncation of source effect (km) reduction result data output filename
edeqs	Calculate CFUPS matrix to prepare for Altitude Reduction from StdLIN line data by Equivalent Source Magnetization method [Equivalent source surface is defined as a certain distance below the specified reduction-to surface, and the magnetization distribution on the source surface is derived from observed StdLIN data by an inversion analysis, then the magnetic anomaly distribution on the specified surface is forward calculated]. Parameters: log filename StdLIN line data filename reduction-to altitude data filename distance of source surface below the reduction-to surface (m) truncation of source effect (km) ambient field direction magnetization direction CFUPS matrix output filename ADEQS model initializing output filename
adeqs **adeqsc**	Execute Altitude Reduction from StdLIN line data by Equivalent Source Magnetization method, making use of CFUPS matrix from **edeqs** process as far as specified loop count or until converge. Parameters: log filename StdLIN line data filename CFUPS matrix input filename ADEQS model in/out filename **[adeqs]** number of loops (*4) **or [adeqsc]** convergency tolerance (*5) [in case of **adeqsc]** maximum loop count
cdeqs	Calculate magnetic anomaly distribution on the specified reduction-to surface, from the Equivalent Source Magnetization distribution ADEQS derived by **adeqs/adeqsc** process. Parameters: log filename reduction-to altitude data filename ADEQS model input filename truncation of source effect (km) reduction result data output filename

rpdeqs	Calculate reduction-to-pole magnetic anomaly distribution on the specified reduction-to surface, translating the Equivalent Source Magnetization ADEQS derived by **adeqs/adeqsc** process into vertical, and also assuming vertical ambient magnetic field direction. Parameters: log filename reduction-to altitude data filename ADEQS model input filename truncation of source effect (km) calculated reduction-to-pole data output filename
calmas	Calculate theoretical magnetic anomaly distribution on the specified observation surface, caused by a symple source model (rectangular block, horizontal rectangle with infinitesimal thickness, vertical line segment with infinitesimal thickness, point with infinitesimal volume or any combination of them). Parameters: log filename observation altitude data filename calculated result output filename how to specify position (0: Coord. values / 1: Distance from SW corner) ambient field direction *[may be repeated]* Model type (1:Block, 2:hRect, 3:vLine, 4:Point) Northing (km) (Median and NS size for Block/hRect) Easting (km) (Median and EW size for Block/hRect) Depth (km) (Top and bottom for Block/vLine) [for other than Block] effective thickness/sectional area/volume Magnetization (A/m) magnetization direction *[at the end]* 0 [: Model type]

(*1) "location parameters" include Northing and Easting of Southwest corner, mesh interval and number of mesh to the North, and to the East.

(*2) "source bottom configuration" is selected from Flat Bottom or Constant Thickness model, with specification of its depth or thickness.

(*3) If the map projection is not UTM, information of the origin will be required.

(*4) If a negative value is given, the optimization is restarted from the initial state of Loop-0. Then, the 'amag' process requires an additional data for the initial value of source magnetization.

(*5) The process is finalized if the percentage of improvement in RMS mismatch is less than the specified value (default: 2%) for 5 continuous iterations, or if the RMS misfit becomes less than 0.1 nT.

Standard GRID data file Format v2018

```
 1.   One file consists of 1 set of GRID data, or multiple sets of GRID data.
     The 2nd set or further behind of multiple sets of GRID data is restricted
     in usage, and is valid only for cases below.
       (1) 1st set GRID data indicates a distribution of any physical quantity
         on a curved surface, and the altitude distribution of the surface is
         given by 2nd set GRID data.
       (2) The file consists of a series of independent GRID data, and they are
         not used for other than illustrating each distribution.
 2.   The unit for the physical quantity (grid data) is, in principle,
     nT for magnetic field, m for altitude, 0.01 A/m for magnetization, mGal
     for gravity, or others as derived from them.  And it is recommended to use
     the value of positive 99999 in effective digits for representing null
     value (the lack of valid data).
 3.   Every data line in GRID data file may not exceed 80 bytes excluding LF
     code.  And it is recommended to be 79 bytes or less excluding LF.
 4.   Data in GRID data file may not include multi-byte characters, and
     control codes other than LF shall not be used.

Each set of GRID data is constructed as follows.
a) Comment: Before 1st Header, arbitrary lines of comment can be placed.
```

```
        Comment line has "#" on the 1st column and is 80 byte long at most.
b) 1st Header (Areaname and information of map projection)  [fixed format]
      FORMAT(a8, 4x,i4, 2i8, 2i8)
  area: 8 byte string representing Areaname or else, not starting with "#".
  nc:   coordinate number of map projection (usually UTM zone number)
            0 : Japanese transverse Mercator coordinates
         1-60 : UTM coordinates zone number
           61 : North pole UPS coordinates
           62 : South pole UPS coordinates
           65 : UTM coordinates with non-standard central meridian
           70 : Mercator projection
           71 : Lambert conformal conic projection (1 standard parallel)
           72 : Lambert conformal conic projection (2 standard parallels)
          100 : Lambert Azimuthal Equal-Area Projection
                (from the sphere with surface area equal to the earth)
          109 : Lambert Azimuthal Equal-Area Projection
                (from the sphere with equatorial radius equal to the earth)
          199 : Latitude/Longitude in minutes are regarded as distance in km
        These numbers above are for GRS ellipsoid (WGS-ITRF).
        For Bessel ellipsoid (Old Tokyo datum), add 800 to the corresponding
        projection.
  ig, kg : Latitude and Longitude (in minutes) of origin
            [neglected for nc = 1 to 62]
  i1, i2 : Latitudes (in minutes) of standard parallels
            [valid only when nc = 72]
    In general, coordinate values are X (Northing) = Y (Easting) = 0 at the
    origin.  However, in UTM (nc = 1 to 60, or 65) X = 0, Y = 500,000 (m), and
    in UPS (nc = 61 or 62) X = Y = 2,000,000 (m), at the origin.
c) 2nd Header (Grid information, null value and altitude)  [free format]
      FORMAT(2i12, 2i6, 2i6, 1x,f7.1, 1x,f7.0)   (as standard)
  ixs, iys : Northing and Easting (in m) of Southwest corner of GRID  [integer]
  mszx,mszy: mesh size (in m) towards North and East                  [integer]
  mxn, myn : mesh count (including both ends) towards North and East  [integer]
  vnul :     special value representing the lack of valid data        [real]
  alt :      observation altitude (in m)                              [real]
              (If the value = 0., the distribution of observation surface is
               given as 2nd set GRID data, and if negative (-1.), the altitude
               of observation is undefined.  For the 2nd set GRID data (i.e.,
               altitude data) this is filled with -1., though meaningless.)
d) GRID data body  [free format]
      FORMAT((f7.1, 9(1x,f7.1)))   (as standard)
  All grid data are listed out in the order that starts from Southwest corner
  toward North, and on arriving North end proceeds to next East row.
  Next expression is the equivalent FORTRAN statement reading this data.
        read(10,*) ((f(i,k),i=1,mxn),k=1,myn)
  However, for the output programming, line break operation between rows
        do k=1,myn
          write(10,'((f7.1,9(1x,f7.1)))') (f(i,k),i=1,mxn)
        enddo
  is recommended.
```

StdLIN line data Format (example)

```
# Areaname: Kobe-Kyoto
# Survey Date: 1995.12.07-12.27
&A-01
  2079.02221N  8116.27649E   277.87m   -45.15nT
  2079.04052N  8116.31640E   278.58m   -44.66nT
  2079.05883N  8116.35641E   279.19m   -44.47nT
        .......
  2087.39584N  8134.25592E   275.40m   -48.38nT
  2087.41585N  8134.29643E   275.41m   -53.69nT
&    C-2r
  2088.27126N  8134.37994E   279.12m   -44.90nT
  2088.25637N  8134.33845E   279.33m   -40.81nT
  2088.24078N  8134.29646E   279.64m   -40.12nT
        .......

     Lines starting with '#' are comment information, usually placed only at
       the head of the file.  (Never be placed among series of line data.)
     Lines starting with '&' or '%' indicate the start of line data.
```

Line name (number) is described in 2nd-9th columns, and the form of the rest is not restricted. (Starting time and number of data points included are commonly described.)

In some cases, a line with no data points is defined for explicit declaration of the end of file.

All other lines are data of individual points, consisting of Latitude (in minutes), Longitude (in minutes), Altitude (in m), and Residual magnetic anomaly (in nT) data, with the format (47 columns) of

```
format(1x, f11.5, 1hN,1x, f11.5, 1hE,1x, f8.2, 1hm,1x, f8.2, 2hnT)
```

while number of columns of each data may be different for input data.

ANAMX: Programs for 3D Imaging and Generalized Crossover Analysis of Aeromagnetic Data

Japanese

eimgd	aimgn/aimgnc	aimgs/aimgsc	plsim	exdeq1/exdeq2/exdeq3	
eimga	nimgn/nimgnc	nimgs/nimgsc	plsimc	exdeq4	
	cimgn/cimgnc	cimgs/cimgsc	plxim	axdeqc/axdeqc	genroff
plimv	plimvc	fimgs/fimgsc	plximc	cxdeq	plmvarc

Program Name	Function
eimgd	Calculate CFIM matrix and FSCL scaling coefficients to prepare for 3D Magnetization Imaging analysis considering depth scaling (with/without thickness correction). Parameters: log filename input magnetic anomaly data filename source surface alt. data filename source location parameters (*1) truncation of source effect (km) ambient field direction magnetization direction spec. of layer pattern and number of layers thickness/depth of each layer (m) initial value of source magnetiz. (A/m) CFIM matrix output filename AIMG initial model output filename FSCL scaling coef. data output filename
eimga	Calculate CFIM matrix and FSCL scaling coefficients to prepare for 3D Magnetization Imaging analysis considering automatic parameter scaling (with/without thickness correction). Parameters: log filename input magnetic anomaly data filename source surface alt. data filename source location parameters (*1) truncation of source effect (km) ambient field direction magnetization direction spec. of layer pattern and number of layers thickness/depth of each layer (m) initial value of source magnetiz. (A/m) CFIM matrix output filename AIMG initial model output filename FSCL scaling coef. data output filename
aimgn **aimgnc**	Execute a **simple** 3D Magnetization Imaging analysis **without** thickness correction, making use of CFIM matrix and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename

	weight power of parameter scaling auxiliary output filename **[aimgn]** number of loops (*2) **or** **[aimgnc]** convergency torelance (*3) **[aimgn,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[aimgnc]** maximum loop count
aimgs **aimgsc**	Execute a **simple** 3D Magnetization Imaging analysis **with** thickness correction, making use of CFIM matrix and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename weight power of parameter scaling auxiliary output filename **[aimgs]** number of loops (*2) **or** **[aimgsc]** convergency torelance (*3) **[aimgs,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[aimgsc]** maximum loop count
nimgn **nimgnc**	Execute a 3D Magnetization Imaging analysis of **Norm-minimum** regularization **without** thickness correction, making use of CFIM matrix and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename weight power of parameter scaling initial weighting ratio of (SourceNorm / Residual) terms auxiliary output filename **[nimgn]** number of loops (*2) **or** **[nimgnc]** convergency torelance (*3) **[nimgn,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[nimgnc]** maximum loop count
nimgs **nimgsc**	Execute a 3D Magnetization Imaging analysis of **Norm-minimum** regularization **with** thickness correction, making use of CFIM matrix and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename weight power of parameter scaling initial weighting ratio of (SourceNorm / Residual) terms auxiliary output filename **[nimgs]** number of loops (*2) **or** **[nimgsc]** convergency torelance (*3) **[nimgs,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[nimgsc]** maximum loop count
cimgn **cimgnc**	Execute a 3D Magnetization Imaging analysis of **Compactness** regularization **without** thickness correction (minimizing number of source elements), making use of CFIM matrix

	and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename weight power of parameter scaling source support (magnetization) threshold initial weighting ratio of (SourceSize / Residual) terms auxiliary output filename **[cimgn]** number of loops (*2) **or** **[cimgnc]** convergency torelance (*3) **[cimgn,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[cimgnc]** maximum loop count
cimgs **cimgsc**	Execute a 3D Magnetization Imaging analysis of **Compactness** regularization **with** thickness correction (minimizing total source volume), making use of CFIM matrix and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename weight power of parameter scaling source support (magnetization) threshold initial weighting ratio of (SourceSize / Residual) terms auxiliary output filename **[cimgs]** number of loops (*2) **or** **[cimgsc]** convergency torelance (*3) **[cimgs,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[cimgsc]** maximum loop count
fimgs **fimgsc**	Execute a 3D Magnetization Imaging analysis of **Compactness** regularization **with** thickness correction (minimizing total source volume) and magnetiz. clipping, making use of CFIM matrix and FSCL scaling coef. from **eimgd/eimga** process as far as specified loop count or until converge. Parameters: log filename input magnetic anomaly data filename whether removing linear trend or not CFIM matrix input filename AIMG model input filename AIMG model output filename or 'U' to update infile FSCL scaling coef. input filename weight power of parameter scaling source support (magnetization) threshold source magnetization clipping initial weighting ratio of (SourceSize / Residual) terms auxiliary output filename **[fimgs]** number of loops (*2) **or** **[fimgsc]** convergency torelance (*3) **[fimgs,(*2)]** initial value of source magnetiz. (A/m) [if restart] **or** **[fimgsc]** maximum loop count

plimv	Draw perspective view contour map for each layer result of 3D Magnetization Imaging analysis on an A4 sheet. Surrounding source zone is masked, and the range of drawing can be limited. Parameters: log filename input AIMG model filename ref. obs.anomaly data filename ref. CFIM matrix filename no. of grids [S,N] to limit drawing range no. of grids [W,E] to limit drawing range topmost layer no. to draw bottommost layer no. to draw output PS filename contour interval (A/m)
plimvc	Draw perspective view color-grading map with/without contours for each layer result of 3D Magnetization Imaging analysis on an A4 sheet. Surrounding source zone is masked, and the range of drawing can be limited. Parameters: log filename input AIMG model filename ref. obs.anomaly data filename ref. CFIM matrix filename no. of grids [S,N] to limit drawing range no. of grids [W,E] to limit drawing range topmost layer no. to draw bottommost layer no. to draw output PS filename color-grading interval (A/m) median value of grading (A/m) contour-line interval (A/m) (if 0., no contour lines)
plsim	Draw section view contour map for E-W or N-S cross-section result of 3D Magnetization Imaging analysis on an A4 sheet. The range of drawing can be limited. Parameters: log filename input AIMG model filename ref. CFIM matrix filename N-S section (0) or E-W section (1) section seq. no. from W or S no. of grids [S,N] or [W,E] to limit drawing range output PS filename paper orientation contour interval (A/m) width of drawing (cm) height of drawing (cm) char.size of contour values
plsimc	Draw section view color-grading map with/without contours for E-W or N-S cross-section result of 3D Magnetization Imaging analysis on an A4 sheet. The range of drawing can be limited. Parameters: log filename input AIMG model filename ref. CFIM matrix filename N-S section (0) or E-W section (1) section seq. no. from W or S no. of grids [S,N] or [W,E] to limit drawing range output PS filename paper orientation color-grading interval (A/m) median value of grading (A/m)

	contour-line interval (A/m) (if 0., no line contours) width of drawing (cm) height of drawing (cm) [if plot contours] char.size of contour values
plxim	Draw section view contour map for arbitrary cross-section result of 3D Magnetization Imaging analysis on an A4 sheet. The range of drawing can be limited. Parameters: log filename input AIMG model filename ref. CFIM matrix filename Northing and Easting (km) of section start position Northing and Easting (km) of section end position no. of points to conform the section output PS filename paper orientation contour interval (A/m) width of drawing (cm) height of drawing (cm) char.size of contour values
plximc	Draw section view color-grading map with/without contours for arbitrary cross-section result of 3D Magnetization Imaging analysis on an A4 sheet. The range of drawing can be limited. Parameters: log filename input AIMG model filename ref. CFIM matrix filename Northing and Easting (km) of section start position Northing and Easting (km) of section end position no. of points to conform the section output PS filename paper orientation color-grading interval (A/m) median value of grading (A/m) contour-line interval (A/m) (if 0., no line contours) width of drawing (cm) height of drawing (cm) [if plot contours] char.size of contour values
exdeq1 **exdeq2** **exdeq3**	Calculate CXFUP matrix to prepare for Generalized Mis-tie Adjustment (combined with Altitude Reduction from StdLIN line data by Equivalent Anomaly method). The freedom of mis-tie adjustment is constrained to be constant level for each line (**exdeq1**), linear variation for each line (**exdeq2**), or arbitrary variation for each crossover point (**exdeq3**). [In the process of **exdeq3**, crossover points are searched for only between two line groups, traverse and tie lines, where the line names starting with B,b,C,c,X,x are assumed to be tie lines, and others traverses. The linear mis-tie variation between adjacent crossover points is assumed.]. Parameters: log filename StdLIN line data filename reduction-to altitude data filename distance of source surface below the reduction-to surface (m) truncation of source effect (km) CXFUP matrix output filename AXDEQ source model initializing output filename AXOFF offset model initializing output filename
exdeq4	For the purpose of extracting magnetic anomaly change between repeated aeromagnetic surveys different in time epochs, apply a mis-tie adjustment method similar to **exdeq3**. [The freedom of arbitrary adjustment is given to the crossover points but only for the (one

	epoch) survey lines distinguished by the line names starting with B,b,C,c,X,x. The linear mis-tie variation between adjacent crossover points is assumed.] Parameters: log filename StdLIN line data filename 0 [auto search crossovers], otherwise Spacing (m) to pick ControlPoints [in Asama style] reduction-to altitude data filename distance of source surface below the reduction-to surface (m) truncation of source effect (km) CXFUP matrix output filename AXDEQ source model initializing output filename AXOFF offset model initializing output filename
axdeq **axdeqc**	Execute Generalized Mis-tie Adjustment (combined with Altitude Reduction from StdLIN line data by Equivalent Anomaly method), making use of CXFUP matrix from **exdeq1/exdeq2/exdeq3/exdeq4** process as far as specified loop count or until converge. Parameters: log filename StdLIN line data filename CXFUP matrix input filename AXDEQ source model in/out filename AXOFF offset model in/out filename **[axdeq]** number of loops (*2) **or [axdeqc]** convergency tolerance (*3) [in case of **axdeqc]** maximum loop count
cxdeq	Calculate magnetic anomaly distribution on the specified reduction-to surface, from the Equivalent Anomaly distribution AXDEQ derived by **axdeq/axdeqc** process. Parameters: log filename reduction-to altitude data filename CXFUP matrix input filename AXDEQ source model input filename truncation of source effect (km) reduction result data output filename
genroff	The offset model AXOFF given from **axdeq/axdeqc** process is regarded as a temporal magnetic anomaly change, and is converted into a random-point (StdLIN) data of the distribution. Parameters: log filename original survey line StdLIN data filename AXOFF offset model filename output filename of random-point (StdLIN) data of magnetic variation trend removal (0: only DC, 1: Linear, or 2: none)
plmvarc	Draw color-graded contour map of magnetic variation GRID data with Trackline paths and Control points on an A4 sheet. The zones near median are painted in white, and the clolor-grading legend can be added. (The color-grading interval is set to same as the contour interval.) Parameters: log filename input mag. variation GRID data filename survey line data StdLIN filename control-points data StdLIN filename output PS filename paper orientation pen-number to draw trackline paths contour interval (= color-grading interval) median value of color-grading white zone half width [multiplier to the contour interval] size of drawing supplementary items (*4)

(*1) "location parameters" include Northing and Easting of Southwest corner, mesh interval and number of mesh to the North, and to the East.

(*2) If a negative value is given, the optimization is restarted from the initial state of Loop-0. Then, an additional data for the initial value of source magnetization is required, excluding the case of **axdeq**.

(*3) The process is finalized if the percentage of improvement in RMS mismatch is less than the specified value (default: 2%) for 5 continuous iterations, or if the RMS misfit becomes less than 0.1 nT.

(*4) "supplementary items" include the selection whether and where to write color-grading legend or not, whether and where to write scale bar or not, whether to write meridians and parallels, and whether to write coastlines, rivers and prefecture boundary.

libgm: Library Subprograms for Geophysical analysis and Graphic presentation

Japanese

PSPLOT	LINE graphics postscript output	psopn, plots, plote, pscls, epsbox plot, scisor, factor, where newpen, penatr wrect, wpolyg, wcirc
PSPAINT	SURFACE graphics postscript output	dftone, dfrgbt, dfcols, dfc40s dframe, dframo, paintm, paintw, dresol dfpcol, paintc, paintr, paintp (Example)
PTEXT	Draw Font Text and Centered Symbol	ptext, lstyle, pcstr (Example) (Symbol Font) pmark (Example)
CONT	Draw line contour map	conts, contso, contx, contr (Example)
WSHORE	Draw coastlines, etc.	wshore, rshore, pshore (Example)
IGRF	IGRF calculation	gigrf, igrfc, igrfm, sigrf, spgrf, sdgrf
XYCONV	Convert map projection	xyconv, nxycnv, utm, ikconv, nikcnv, utmik cvinit, cviken, cvenik, cvdinit, cvdiken, cvdenik
SML	Regression analysis	sm1opn, sm1ex, sm1cls, sm1rv sm2opn, sm2ex, sm2cls, sm2rv sm3opn, sm3ex, sm3cls, sm3rv
RAND	Generate random number	rand1, randg
XW84T	Geodetic translation (WGS84 <=> Tokyo datum)	xw84t, xtw84, xw84td, xtw84d
HGEOID	Get geoid height	sgeoid, hgeoid, jhgeoid
CALMA	Calculate synthetic magnetic anomaly	magafd, mpoint, mvline, mhrect, mprism, calma
LWKDIR **OPNPIN** **GETARGS**	Message output, Progress display, setting up Working directory, and Process parameters, etc.	prompt, premsg, dpcini, dpcent, strdtm, lrtrim abend, abendm, opnpin, clspin, lwkdir parmin, gparma, gparmi, gparmf, gparmd gparmif, gparmid, gparmi2, gparmf2, gparmd2 getargs

```
Library Archive File path :  /home/SHARE/lib/libgm.a

[Useful Setting]  alias  cc   'gcc \!* -L/home/SHARE/lib -lgm -lm'
                  alias  gf   'gfortran \!* -L/home/SHARE/lib -lgm'
```

Functions and entry names of all subprograms in the Library **libgm** are listed. Names of subprograms and entry names as shown above in blue are hyperlinked with indivifual HTML manual.

The source codes of all subprograms in this Library **libgm** are coded in C language, with only one exception '`getargs.f90`' coded in Fortran language. An HTML document `libgm/libcE.html` describes briefly the prototypes and functionality of C language subprograms.

---

utils: Misceraneous Utility Programs

Japanese

cats	crlf	cview	qpencode	cxtw84	utmcal	job
cat4	onlycr	cviewe	qpdecode	cxw84t	xycal	job1
cat8	onlylf	uncview	b64encode	igrfcal	cxiken	Job Control file
	hdump	hdumpe	b64decode	hgeoidcal	cxenik	Use with opnpin()

Program	Function
cats	Read specified file (or STDIN file if omitted), and write it to STDERR output without any conversion.
cat4	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the conversion of TAB (HT) code into 1-4 space(s) to match 4-cols TAB stop.
cat8	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the conversion of TAB (HT) code into 1-8 space(s) to match 8-cols TAB stop.
crlf	Read specified file (or STDIN file if omitted), and write it to STDOUT output, with inserting CR (0x0d) before LF (0x0a) not preceded by CR (0x0d), and inserting LF (0x0a) after CR (0x0d) not followed by LF (0x0a). ([LF CR] will be converted into [CR LF CR LF].)
onlycr	Read specified file (or STDIN file if omitted), and write it to STDOUT output, with removing LF (0x0a) preceded by CR (0x0d), and converting other LF (0x0a) into CR (0x0d). (Both [LF CR] and [LF LF] will be converted into [CR CR].)
onlylf	Read specified file (or STDIN file if omitted), and write it to STDOUT output, with removing CR (0x0d) followed by LF (0x0a), and converting other CR (0x0d) into LF (0x0a). (Both [LF CR] and [CR CR] will be converted into [LF LF].)
cview **cviewe**	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the 'visualize' conversion of control codes, as follows: 0x00-0x1f => 0x40-0x5f preceded by ^ , 0x80-0x9e => 0x60-0x7e preceded by ^ , 0xa1-0xfe => 0x21-0x7e preceded by ! , 0x7f => ^? , 0x9f => ^# , 0xa0 => ^$, 0xff => ^/ , ^ (0x5e) => \^ , ! (0x21) => \! , \ (0x5c) => \\ 'cviewe' treats <a1-fe> code pair as visual EUC Zenkaku character, while 'cview' treat them as invisible non-ASCII characters.
uncview	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the inverse conversion of 'cview' / 'cviewe'.
hdump **hdumpe**	Read specified file (or STDIN file if omitted), and write it to STDOUT output in the hexadecimal dump format with text representation. Code pairs of <a1-fe> are treated as visual EUC Zenkaku characters by 'hdumpe', while they are treated as the sequence of non-ASCII characters by 'hdump'.
qpencode	Read specified file (or STDIN file if omitted), and write it to STDOUT output with quoted-printable encoding conversion.
qpdecode	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the inverse conversion of quoted-printable encoding.
b64encode	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the Base64 encoding conversion.
b64decode	Read specified file (or STDIN file if omitted), and write it to STDOUT output with the inverse conversion of Base64 encoding.
cxtw84	Calculate WGS-84 coordinates. Each time Latitude, Longitude and Altitude on Old-TOKYO coordinates are given, WGS-84

	Latitude/Longitude/Altitude are calculated.
cxw84t	Calculate Old-TOKYO coordinates. Each time WGS-84 Latitude, Longitude and Altitude are given, Latitude, Longitude and Altitude on Old-TOKYO coordinates are calculated.
igrfcal	Calculate IGRF model components. First select IGRF model and time epoch. Then, each time Latitude, Longitude and Altitude are given, 5 components (F, H, Z, I, D) IGRF are calculated.
hgeoidcal	Calculate Geoid height. Each time WGS-84 Latitude and Longitude are given, Geoid height is calculated.
utmcal	Calculate UTM coordinates. First select ellipsoid and central meridian. Then, each time Latitude and Longitude are given, UTM (Universal Transverse Mercator) X and Y coordinates are calculated.
xycal	Calculate JTM coordinates. First select ellipsoid and coordinate number. Then, each time Latitude and Longitude are given, JTM (Japanese Transverse Mercator) X and Y coordinates are calculated.
cxiken	Calculate Map Projection coordinates. First select ellipsoid and coordinate number. Then, each time Latitude and Longitude are given, Map Projection coordinates (X, Y) are calculated.
cxenik	Calculate Lat. and Long. by inverse Map Projection. First select ellipsoid and coordinate number. Then, each time plane rectangular coordinates are given, Latitude and Longitude are calculated.
job	A series of Job steps are executed according to the Control file. [Usage] job (Control-filename):(Tag-name) Job starts from the step with the tag ":(Tag-name)" in the Control file (See bellow). If ":(Tag-name)" is omitted, Job starts from the beginning. But if only "(Tag-name)" is omitted, the tag ":" is assumed.
job1	One Job step is executed according to the Control file. [Usage] job1 (Control-filename):(Tag-name) Executes only one Job step with the tag ":(Tag-name)" in the Control file (See bellow). The omission rule of Tag-name is same as for 'job'.

Job Control File Format (Example) ("job.cntl")

```
    .                   ;# ":(Tag-name)" line specifies the command, and the
    .                   ;# following lines with no ":" on the 1st column are
    .                   ;# piped to STDIN as an input data.
    .                   ;# ";#" and rearward is neglected as a comment.
    .                   ;# Data lines before the 1st command have no effect.
:st1 cat - > temp.data  ;# Job step. Following 3 lines are input data.
  Here is data lines.
  2nd line data
  Last data
:step2                  ;# If no command, no operation is caused.
  abc 123               ;# Data for No operation step have no effect.
:job3   prog            ;# Job step executing 'prog' with no data.
:   calc                ;# Job step executing 'calc' with 4 line data.
     1
    22
   333
  4444
:end                    ;# (explicit expression of data end, may be omitted.)
```

```
          The command string is in the form of "(prog) [parm]" (redirection
        may be specified).  If the mechanism of 'opnpin()' is utilized, 'parm'
        indicates the Input-filename[:Tag-name] to read parameters.  Then, if
        single minus sign "-" is given as parm, parameters are read from STDIN,
        which is equivalent to omitting 'parm'.  (However, if "-" is used as
        1st argument, further argument(s) may be used.  'opnpin()' always
```

interprets the 1st argument specifies the parameter Input-file.)

Example of using 'opnpin()' mechanism ("sample.cntl")

```
:start                  ;# If no command, no operation is caused.
  data 123              ;# Data for No operation step have no effect.
##############################
:step1  despike         ;# Job step. Following lines are input data.
 /home/nktk/data/shitara            ;#  ";#" and rearward is neglected during
#                                        parameter input.  Lines starting with
#                                        "#" are also neglected as comments.
 shitara.log                        ;# If opnpin() input and standard input are
 shitara.amp                        ;#  mixed, both data should be mixed up and
 shitara.ampd                       ;#  arranged in the actual order to be
#                                       read-in by the program.
##############################
:surv     xldpn   parm.data:xldn1   ;# Job step.
#               Parameter data is read-in from another file 'parm.data'.
#               As the standard input STDIN does not care of "#" heading,
#               here is 4 data lines if the program 'xldpn' read STDIN data.
##############################
:chkmag1   pchkmag  -               ;# Job step.
#               "-" indicates that the parameters for 'opnpin()' mechanism is
#               read from the following data lines.  During its parameter
#               input, ";#" and rearward in each line and lines starting with
#               "#" are neglected as comments.
 /home/nktk/data/shitara            ;# working dir.
 shitara.log                        ;# log file (blank for NoLogging)
 shitara.ampd                       ;# input filename
 pchkmagd.ps                        ;# output PS filename
##############################
:data4                  ;# No operation step. (Defines data for "chkmag2" step)
 /home/nktk/data/shitara      ;# Data for No operation step have no effect.
 shitara.log                  ;#  Taking advantage of it, parameter data (file
 shitara.ampd                 ;#  input) for another step can be described in
 pchkmagd.ps                  ;#  the same file.
##############################
:chkmag2   pchkmag  sample.cntl:data4     ;# Job step.
#                 Standard input STDIN data can be described here.
#                 'opnpin()' parameter input filename "sample.cntl" is this
#                 file itself, and the data lines following the ":data4" tag
#                 are read for parameter input.
##############################
:end                    ;# (explicit expression of data end, may be omitted.)
```

Example of parameter data file ("parm.data")

```
:chkmag1                      ;# ineffective for "parm.data:xldn1" parameter
#                                 ";#" and rearward in each line is neglected
#                                 during parameter input.  Lines starting with
#                                 "#" are also neglected as comments.
#                                 Any command string may exist on the Tag line,
#                                 with no effect.
 /home/nktk/data/shitara            ;# working dir.
 shitara.log                        ;# log file (blank for NoLogging)
 shitara.ampd                       ;# input filename
 pchkmagd.ps                        ;# output PS filename
##############################
:xldn1              ;# parameter data for the "surv" step above ("sample.cntl")
 /home/nktk/data/shitara            ;# working dir.
 shitara.log                        ;# log file
 lines.inf                          ;# lines.inf filename
 shitara.amp                        ;# output filename
 2003.1                             ;# Year of survey
 9                                  ;# IGRF generation
##############################
:end
```

How to execute as a BATCH JOB

```
After making Job Control File "job.cntl" (and parameter files
if necessary) as above, the command
     % job job.cntl
causes the execution on the foreground.
If background execution is desired, use 'at' command.
     % echo job job.cntl | at now
The completion of the background Job will be notified by E-mail.
```

[Info] How to generate DEM40 data files

Among program group GDMP, program **gtopo** creates grid data of topographic height from DEM40 data files. Here, DEM40 is a group of files of terrain elevation data in Japan, reconstructed from Digital Maps (50m mesh elevation, Japan-I, Japan-II and Japan-III) by the Geographical Survey Institute, Japan (GSI). The following process is applied in the reconstruction.

1. Geodetic system conversion from Tokyo Datum to WGS84, including the correction for the distortion of GSI's Tokyo Datum,
2. Mesh interpolation from [1/40 min.Lat. × 3/80 min.Long.] into [1/40 min.lat. × 1/40 min.Long],
3. Conversion from each 'standard area mesh' [40 min.Lat. × 1 deg.Long.] file to each [1 deg.Lat. × 1 deg.Long.] area file,
4. Conversion from the center value of mesh-element to the value at grid lines crossing,
5. Replacing negative land elevation to 0., and sea area data to -1.,
6. Generated data files are divided into subdirectories of UTM zone.

The source code "**genDEM40m.f90**" of the Fortran program realizing the process above is presented at the bottom of this page.
The correction for the distortion of GSI's Tokyo datum is known in a form of "Enhance_Par" provided by GSI,
http://www.gsi.go.jp/MAP/CD-ROM/sekaitaiou/2500Conv/Enhance_Par.exe
(Self-extracting archive), which could be approximated into the corrections onto the geodetic translation by 'xw84t' subprogram (entry name 'xtw84') with deviding into several zones.
The path names of input data to this program are given as '`GSI50dem/`*`xxxx`*`/`*`xxxxyy`*`.MEM`' for the area of primary mesh code *xxxx*, and secondary mesh code *yy*. Output data file for [1 deg.Lat. × 1 deg.Long.] range with SW corner at (*ii*deg.N, *kkk*deg.E) becomes the path name of "`dem40/Z`*`jj`*`/N`*`ii`*`E`*`kkk`*`.alt`", where *jj* is the UTM zone nunber. Before running this program, output directory **dem40** and subdirectories **dem40/Z51/**, **dem40/Z52/**, **dem40/Z53/**, **dem40/Z54/**, **dem40/Z55/**, **dem40/Z56/** must be created, if necessary. Run time of the program would be of the order of tens minutes because of a large size storage data handling.

To prepare for using the program **gtopo**, move the directory dem40 above (consisting of 120 files, about 45 MB each) under the absolute directory path of '**`/home/SHARE/data/DEM/`**', as defined as constant parameter DEMDIR in the 'gtopo.f90' source.

```
!---- Source program of generating DEM40 data files
!
  integer :: mh(200,200)
  real :: h(2800,2000), a(2401,2401)
  character(24) :: fnam1, fnam2;
  character(8) :: area;  character(6) :: cmesh, code
  logical :: exist

  do lli=20,45;  do llk=122,153
    llj = llk/6 + 31
    llc = lli*1000 + llk
    if ((lli < 24)  .and. (llc /= 20136)) cycle
    if ((llk > 145) .and. (llc /= 24153)) cycle

    write(fnam2,'(a7,i2,a2,i2,a1,i3,a4)')   &
          'dem40/Z', llj, '/N', lli, 'E', llk, '.alt'
    kc = 0
    if ((llc == 25131) .or. (llc == 32139)) kc = 1
    if ((llc >= 24122) .and. (llc <= 24125)) kc = 1
    do i=1,2800; do k=1,2000;  h(i,k) = -1.;  enddo; enddo
    key = 0
    ins = lli*12 - 1
    kns = (llk-100)*8 - 1
    do in=ins,ins+13;  do kn=kns,kns+9
      ima = in / 8;  imb = in - ima*8
      kma = kn / 8;  kmb = kn - kma*8
```

```
    write(fnam1,'(a9,2i2,a1,2i2,2i1,a4)')   &
          'GSI50dem/', ima,kma, '/', ima,kma,imb,kmb, '.MEM'
    inquire(file=fnam1,exist=exist)
    if (exist) then
      open(1,file=fnam1,status='old')
      read(1,'(a6)') cmesh
      if (cmesh /= fnam1(15:20)) call abendm('mesh-code error')
      do n=1,200
        read(1,'(a6,i3,200i5)') code, nn, (mh(k,201-n),k=1,200)
        if (code /= cmesh) call abendm('mesh-code conflict')
        if (nn /= n) call abendm('format error')
      enddo
      close(1)
      is = (in-ins) * 200
      ks = (kn-kns) * 200
      do i=1,200;  do k=1,200
        if (mh(k,i) == -9999) cycle
        if (mh(k,i) <= 0) then
          h(is+i,ks+k) = 0.
        else
          h(is+i,ks+k) = float(mh(k,i)) / 10.
        endif
      enddo;  enddo
      key = 1
    endif
  enddo;  enddo
  if (key == 0) cycle

  key = 0
  wlat0 = float(lli*60);  tlat0 = wlat0 - 5.0125
  wlon0 = float(llk*60);  tlon0 = wlon0 - 7.51875
  do kw=1,2401;  do iw=1,2401
    wlat = wlat0 + float(iw-1)/40.
    wlon = wlon0 + float(kw-1)/40.
    call xw84t(wlat, wlon, 0., tlat, tlon, talt)
    if (kc == 1) then
      if      ((tlat >= 1920.) .and. (tlat <= 1960.) .and.   &
               (tlon >= 8340.) .and. (tlon <= 8400.)) then
        tlat = tlat - 0.0404
        tlon = tlon - 0.0023
      else if ((tlat >= 1520.) .and. (tlat <= 1560.) .and.   &
               (tlon >= 7860.) .and. (tlon <= 7920.)) then
        tlat = tlat + 0.2016
        tlon = tlon - 0.3138
      else if ((tlat >= 1440.) .and. (tlat <= 1500.) .and.   &
               (tlon >= 7320.) .and. (tlon <= 7560.)) then
        if (tlon >= 7500.) then
          tlat = tlat + 0.0310
          tlon = tlon - 0.0401
        else if (tlon >= 7470.) then
          tlat = tlat + 0.1527
          tlon = tlon - 0.2867
        else if (tlon >= 7443.) then
          tlat = tlat - 0.0784
          tlon = tlon - 0.1221
        else if (tlon <= 7410.) then
          tlat = tlat - 0.0782
          tlon = tlon - 0.1196
        endif
      endif
    endif
    dlat = tlat - tlat0;  ip = ifix(dlat / 0.025)
    dlon = tlon - tlon0;  kp = ifix(dlon / 0.0375)
    if ((ip <= 0) .or. (ip >= 2800) .or.   &
        (kp <= 0) .or. (kp >= 2000)) then
      write(6,*) llc
      write(6,*) '  ip=',ip, '  kp=',kp, '  iw=',iw, '  kw=',kw
      write(6,*) '  tlat=',tlat,  '  tlon=',tlon
      write(6,*) '  wlat=',wlat,  '  wlon=',wlon
      write(6,*) '  lat0=',tlat0, '  lon0=',tlon0
      call abendm('out of range')
    endif
    flat = dlat - float(ip)*0.025
```

```
    flon = dlon - float(kp)*0.0375
    if ((h(ip,kp) < 0.) .or. (h(ip+1,kp+1) < 0.) .or.   &
        (h(ip,kp+1) < 0.) .or. (h(ip+1,kp) < 0.)) then
      a(iw,kw) = -1.
    else
      h0 = h(ip,kp) + (h(ip+1,kp)-h(ip,kp))*flat
      h1 = h(ip,kp+1) + (h(ip+1,kp+1)-h(ip,kp+1))*flat
      a(iw,kw) = h0 + (h1-h0)*flon
      key = 1
    endif
  enddo;  enddo
  if (key == 1) then
    write(6,*) fnam2
    area = fnam2(11:17) // ' '
    open(2,file=fnam2,status='new')
    write(2,'(a8,4x,i4,4i8)') area, 199, lli*60, llk*60, 0, 0
    write(2,'(2i12,4i6,1x,f7.1,1x,f7.0)')   &
              0,0, 25,25,2401,2401, 9999.9, -1.
    do kw=1,2401
      write(2,'((f7.1,9(1x,f7.1)))') (a(iw,kw),iw=1,2401)
    enddo
    close(2)
  endif
enddo;  enddo
stop
end
```