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Encoding and decoding GRIB data **M 1.9/3**

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(GRIBEX)

J.D.Chambers

References:

WMO publication No. 306 - Manual on Codes.

May 1994 Original version.

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This paper describes the GRIBEX subroutine for encoding and decoding GRIB code messages developed at the European Centre for Medium-range Weather Forecasts, Reading, U.K.

The principal architect of the software over many years was John Hennessy in the Meteorological Applications Section of the Operations Department.

The GRIBEX software is available from ECMWF. It is liable to change from time to time as extensions are made to the GRIB format and, in particular, as local extensions are made in the usage of section 1 by ECMWF.

Designed and printed at ECMWF.

John D.Chambers

May, 1994.

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Input parameters for all options.

The following parameters must be setup with input values before calling GRIBEX:

- HOPER - the requested encoding/decoding action (see Table 1).
- KLENP - the length of the real values array, PSEC4.
- KLENG - the length of the GRIB code array, KGRIB.
- KRET - a flag showing how the subroutine should respond to an error.

HOPER

Table 1: Values for HOPER

Value	The requested action
'A'	Code 8-bit data without scaling, e.g. satellite data or image data.
'B'	Decode 8-bit data without scaling, e.g. satellite data or image data.
'C'	Code data in GRIB code. (With or without bitmaps).
'D'	Decode data from GRIB code. If ECMWF pseudo-GRIB data is encountered, only sections 0 and 1 are decoded and the return code is set to -6.
'G'	Special decoding for graphics purposes. The reference value is returned in PSEC4(1). The binary scale factor is returned in PSEC4(2). An offset bit pointer to coded data values is returned in KSEC4(34).
'I'	Decode only the identification sections 0, 1 and 2 of GRIB or pseudo-GRIB data.

Table 1: Values for HOPER

Value	The requested action
'L'	Return only the length of the GRIB message in bytes, and the GRIB Edition number. The length does not include any bytes added to round the message length to a multiple of 120. This option also works for pseudo-GRIB data.
'M'	Code data in GRIB code and, if a bitmap is encountered, make the GRIB message full length, i.e. the same length as if all data values were given.
'R'	Decode data from GRIB code and, if a quasi-regular gaussian grid is encountered, convert it to a regular grid.
'S'	Decode initialised analysis data from GRIB code and, if data is in the experimental edition of GRIB, set the time range indicator flag. In the experimental edition there was no distinction between initialised and uninitialised analyses.
'X'	Extract data values for upto 4 points from a GRIB coded gaussian or latitude/longitude field, without unpacking data at other points. See words 34 to 42 of KSEC4 below.
'Z'	Decode data from GRIB code. If a bitmap is encountered, only sections 0,1 and 2 are decoded and the return code is set to -5.

KLENP

Number of elements in array PSEC4.

KLENG

Number of elements in array KGRIB.

KRET

Indicates how GRIBEX should respond to an error:

0	Abort if an error is encountered.
Non- zero	Return to the calling routine, even if an error is encountered.

Input for coding, output from decoding.

The following parameters are used either to provide data when encoding, or to receive data when decoding:

- KSEC1 - INTEGER parameters for section 1, the product definition section.
- KSEC2 - INTEGER parameters for section 2, the product definition section.
- PSEC2 - REAL parameters for section 2, the grid definition section.
- KSEC3 - INTEGER parameters for section 3, the bitmap section.
- PSEC3 - REAL parameters for section 3, the bitmap section.
- KSEC4 - INTEGER parameters for section 4, the binary data section.
- PSEC4 - data values to be packed, or which have been unpacked.
- KGRIB - an array containing GRIB coded data.
- KWORD - number of words of KGRIB occupied by coded data.

KSEC1

An INTEGER array of at least 25 elements, containing parameters for GRIB code section 1, the product definition section. When section 1 contains data for ECMWF local use, KSEC1 should be sized accordingly; for example, for ensemble forecasts, the size of the array is (53+N) elements, where N is the number of ensemble forecasts.

See the WMO Manual on Codes for code tables.

Table 2: Values for KSEC1

Value	Word contents
1	Version number of code table 2.
2	Identification of centre (code table 0).
3	Generating process identification number (allocated by the originating centre).
4	Grid definition. (NNN catalogue number of grid used by the originating centre. See Volume B of WMO publication No.9).

Table 2: Values for KSEC1

Value	Word contents
5	Flag showing whether sections 2 and 3 are present. (Code table 1). 0 Sections 2 and 3 omitted. 128 Section 2 included, Section 3 omitted. 64 Section 2 omitted, Section 3 included. 192 Sections 2 and 3 included.
6	Parameter indicator. (Code table 2).
7	Type of level indicator. (Code table 3). Or, satellite identifier. Satellite usage is as defined by INPE/CPTEC and used by ECMWF, pending final definition by WMO.
8	Height, pressure, etc. of level. (Code table 3). Single level or top of layer, or satellite spectral band. Satellite usage is as defined by INPE/CPTEC and used by ECMWF, pending final definition by WMO.
9	Height, pressure, etc. of level. (Code table 3). Bottom of layer, if word 6 indicates a layer.
10	Year of century. Reference time of data. Date and time of start of averaging or accumulation.
11	Month
12	Day
13	Hour
14	Minute
15	Time unit indicator. (Code table 4)
16	P_1 - Time period (number of time units) 0 for analyses or initialised analyses.
17	P_2 - Time period (number of time units). Or, time interval between successive analyses, initialised analyses or forecasts undergoing averaging or accumulation. Otherwise set to zero.

Table 2: Values for KSEC1

Value	Word contents
18	Time range indicator. (Code table 5).
19	Number of products included in an average, when the time range indicates an average or accumulation. Otherwise set to zero.
20	Number of products missing from an average, when the time range indicates an average or accumulation. Otherwise set to zero.
21	Century of reference time of data.
22	Reserved. Set to 0.
23	Decimal scale factor.
24	Flag field to indicate local use in Section 1. 0 No local use in section 1. 1 Local use in section 1.
25-36	Reserved for WMO reserved fields. Set to 0.
37	ECMWF local GRIB use definition identifier. This is a number which indicates the contents of words 38-nn. See ECMWF local GRIB usage definitions for values of KSEC(37) onwards.

KSEC2

INTEGER parameters in GRIB code section 2, grid description section.

INTEGER array of at least (22 + n) words, where n is the number of parallels or meridians in the quasi-regular (reduced) gaussian grid or a latitude/longitude grid.

Notes: Latitudes, longitudes are in millidegrees.
Latitude values in the range 0-90000.

Longitude values in the range 0-360000.
Southern latitudes and western longitudes are negative.

Table 3: Latitude/longitude grids or equidistant cylindrical or plate carree

Value	Word contents
1	Data representation type. (Code table 6).
2	i Number of points along a parallel.
3	j Number of points along a meridian.
4	La_1 Latitude of first grid point.
5	Lo_1 Longitude of first grid point.
6	Resolution flag. 0 Direction increments not given. Used for quasi-regular grids, but can also be used for regular grids. 128 Direction increments given. Grids must be regular.
7	La_2 Latitude of last grid point.
8	Lo_2 Longitude of last grid point.
9	D_i i direction increment.
10	Dj j direction increment.
11	Scanning mode flags. (Code table 8).
12	Number of vertical coordinate parameters.
13	Latitude of the southern pole of rotation.
14	Longitude of the southern pole of rotation.
15	Latitude of the pole of stretching.
16	Longitude of the pole of stretching.
17	0 Regular grid. 1 Quasi-regular (reduced) grid.[a]

Table 3: Latitude/longitude grids or equidistant cylindrical or plate carree

Value	Word contents
18	Earth flag. 0 Earth assumed spherical with radius 6367.47 km. 64 Earth assumed oblate spheroidal with size as determined by IAU in 1965: 6378.160km, 6356.775km, f=1/297.0)
19	Components flag. 0 Resolved u and v components of vector quantities relative to easterly and northerly directions. 8 Resolved u and v components of vector quantities relative to the defined grid in the direction of increasing x and y (or i and j) coordinates respectively.
20-22	Reserved. Set to 0.
23-nn	Number of points along each parallel in a quasi-regular grid. Number of parallels is given by N_j above. or Number of points along each meridian in a quasi-regular grid. Number of meridians is given by N_i above.

a. At the moment quasi-regular latitude/ longitude grids are not properly defined. The resolution flag field indicates whether both direction increments are given or not. One increment needs to be given. Grids can be irregular in one direction only.

Scanning mode flags (code table 8) indicate whether points are consecutive on a meridian or a parallel.

Increments are in millidegrees.

Table 4: Gaussian grids

Word	Contents
1	Data representation type. (Code table 6).
2	N_i Number of points along a parallel. Cannot be used for quasi-regular grids.

Table 4: Gaussian grids

Word	Contents
3	N_j Number of points along a meridian.
4	La_1 Latitude of first grid point.
5	Lo_1 Longitude of first grid point.
6	Resolution flag. 0 Direction increments not given. Used for quasi-regular grids, but can also be used for regular grids. 128 Direction increments given. Grids must be regular.
7	La_2 Latitude of last grid point.
8	Lo_2 Longitude of last grid point.
9	D_i i direction increment. Cannot be used for quasi-regular grids.
10	Number of parallels between a pole and the Equator.
11	Scanning mode flags. (Code table 8).
12	Number of vertical coordinate parameters.
13	Latitude of the southern pole of rotation.
14	Longitude of the southern pole of rotation.
15	Latitude of the pole of stretching.
16	Longitude of the pole of stretching.
17	0 Regular grid. 1 Quasi-regular (reduced) grid.
18	Earth flag. 0 Earth assumed spherical with radius 6367.47 km. 64 Earth assumed oblate spheroidal with size as determined by IAU in 1965: 6378.160km, 6356.775km, f=1/297.0)

Table 4: Gaussian grids

Word	Contents
19	Components flag. 0 Resolved u and v components of vector quantities relative to easterly and northerly directions. 8 Resolved u and v components of vector quantities relative to the defined grid in the direction of increasing x and y (or i and j) coordinates respectively.
20-22	Reserved. Set to 0.
23-nn	Number of points along each parallel in a quasi-regular grid. Number of parallels is given by N_j above.

Increments are in millidegrees.

Table 5: Spherical harmonic coefficients

Word	Contents
1	Data representation type. (Code table 6).
2	J Pentagonal resolution parameter.
3	K Pentagonal resolution parameter.
4	M Pentagonal resolution parameter.
5	Representation type. (Code table 9). 1 Associated legendre functions of the first kind.
6	Representation mode. (Code table 10). 1 Real part of (0,0) coefficient stored as 32-bit floating point number; other coefficients packed. 2 Complex packing.
7-11	Reserved. Set to 0.
12	Number of vertical coordinate parameters.
13	Latitude of the southern pole of rotation.

Table 5: Spherical harmonic coefficients

Word	Contents
14	Longitude of the southern pole of rotation.
15	Latitude of the pole of stretching.
16	Longitude of the pole of stretching.
17-22	Reserved. Set to 0.

Table 6: Polar stereographic

Word	Contents
1	Data representation type. (Code table 6).
2	N_x Number of points along X-axis.
3	N_y Number of points along Y-axis.
4	La_1 Latitude of first grid point.
5	Lo_1 Longitude of first grid point.
6	Reserved. Set to 0. Resolution flag is not applicable to polar stereographic.
7	Lo_V Orientation of the grid, i.e. the longitude of the meridian which is parallel to the Y-axis along which latitude increases as the Y-coordinate increases.
8	Reserved. Set to 0.
9	D_x X-direction grid length.
10	D_y Y-direction grid length.
11	Scanning mode flag. (Code table 8).
12	Number of vertical coordinate parameters.
13	Projection centre flag. 0 North pole is on projection plane. 128 South pole is on projection plane.
14-16	Reserved. Set to 0.

Table 6: Polar stereographic

Word	Contents
17	0 Regular grid. 1 Quasi-regular (reduced) grid.
18	Earth flag. - 0 Earth assumed spherical with radius 6367.47 km. 64 Earth assumed oblate spheroidal with size as determined by IAU in 1965: 6378.160km, 6356.775km, f=1/297.0)
19	Components flag. Valid values are: 0 Resolved u and v components of vector quantities relative to easterly and northerly directions. 8 Resolved u and v components of vector quantities relative to the defined grid in the direction of increasing x and y (or i and j) coordinates respectively.
20-22	Reserved. Set to 0.

Grid lengths are in metres, at the 60-degree parallel nearest to the pole on the projection plan.

Table 7: Mercator

Word	Contents
1	Data representation type. (Code table 6).
2	N_i Number of points along a parallel
3	N_j Number of points along a meridian
4	La_1 Latitude of first grid point.
5	Lo_1 Longitude of first grid point.
6	Resolution flag. 0 Direction increments not given. 128 Direction increments given.

Table 7: Mercator

Word	Contents
7	La_2 Latitude of last grid point.
8	Lo_2 Longitude of last grid point.
9	Lat_{in} Latitude at which the Mercator projection cylinder intersects the earth.[a]
10	Reserved. Set to 0.
11	Scanning mode flags. (Code table 8).
12	Number of vertical coordinate parameters.
13	D_i i direction grid length
14	D_j j direction grid length.
15-16	Reserved. Set to 0.
17	0 Regular grid. 1 Quasi-regular (reduced) grid.
18	Earth flag. 0 Earth assumed spherical with radius 6367.47 km. 64 Earth assumed oblate spheroidal with size as determined by IAU in 1965: 6378.160km, 6356.775km, f=1/297.0)
19	Components flag. 0 Resolved u and v components of vector quantities relative to easterly and northerly directions. 8 Resolved u and v components of vector quantities relative to the defined grid in the direction of increasing x and y (or i and j) coordinates respectively.
20-22	Reserved. Set to 0.

a. Grid lengths are in units of metres, at the parallel specified by Lat_{in}.

Table 8: Lambert conformal, secant or tangent, conical or bi-polar (normal or oblique) or Albers equal-area, secant or tangent, conical or bi-polar (normal or oblique)

Word	Contents
1	Data representation type (Code Table 6)
2	N_x Number of points along X-axis.
3	N_y Number of points along Y-axis.
4	La_1 Latitude of first grid point.
5	Lo_1 Longitude of first grid point.
6	Resolution flag. 0 Direction increments not given. 128 Direction increments given.
7	Lo_V Orientation of the grid; i.e. the East longitude of the meridian which is parallel to the Y-axis along which latitude increases as the Y-coordinate increases.
8	Reserved. Set to 0.
9	D_x X-direction grid length.
10	D_y Y-direction grid length.
11	Scanning mode flag (Code Table 8).
12	Number of vertical coordinate parameters.
13	Projection centre flag. 0 North pole is on projection plane. Only one projection centre is used. 128 South pole is on projection plane. Only one projection centre is used. 64 North pole is on projection plane. Projection is bi-polar and symmetric. 192 South pole is on projection plane. Projection is bi-polar and symmetric.
14	Lat_{in} 1 First latitude from the pole at which the secant cone cuts the sphere

Table 8: Lambert conformal, secant or tangent, conical or bi-polar (normal or oblique) or Albers equal-area, secant or tangent, conical or bi-polar (normal or oblique)

Word	Contents
15	Lat_{in2} Second latitude at which the secant cone cuts the sphere.
16	Reserved. Set to 0.
17	0 Regular grid. 1 Quasi-regular (reduced) grid.
18	Earth flag. 0 Earth assumed spherical with radius 6367.47 km. 64 Earth assumed oblate spheroidal with size as determined by IAU in 1965: 6378.160km, 6356.775km, f=1/297.0)
19	Components flag. 0 Resolved u and v components of vector quantities relative to easterly and northerly directions. 8 Resolved u and v components of vector quantities relative to the defined grid in the direction of increasing x and y (or i and j) coordinates respectively.
20	Latitude of the southern pole.
21	Longitude of the southern pole.
22	Reserved. Set to 0.

Notes: Grid lengths are in metres, at the 60-degree parallel nearest to the pole on the projection plane.

Table 9: Space view perspective or orthographic

Word	Contents
1	Data representation type (Code Table 6).
2	N_x Number of points along x-axis.
3	N_y Number of points along y-axis.
4	La_p Latitude of sub-satellite point.

Table 9: Space view perspective or orthographic

Word	Contents
5	Lo_p Longitude of sub-satellite point.
6	Resolution flag. 0 Direction increments not given. 128 Direction increments given.
7	d_x Apparent diameter of the earth in grid lengths in the x direction.
8	d_y Apparent diameter of the earth in grid lengths in the y direction.
9	Xp X-coordinate of sub-satellite point
10	Yp Y-coordinate of sub-satellite point
11	Scanning mode flag. (Code table 8).
12	Number of vertical coordinate parameters.
13	The orientation of the grid.
14	n_r Altitude of the camera from the earth's centre. For orthographic view from infinite distance, value is16777215.
15	Xo X coordinate of origin of sector image.
16	Yo Y coordinate of origin of sector image.
17	0 Regular grid. 1 Quasi-regular (reduced) grid.
18	Earth flag. 0 Earth assumed spherical with radius 6367.47 km. 64 Earth assumed oblate spheroidal with size as determined by IAU in 1965: 6378.160km, 6356.775km, f=1/297.0)

Table 9: Space view perspective or orthographic

Word	Contents
19	Components flag. 0 Resolved u and v components of vector quantities relative to easterly and northerly directions. 8 Resolved u and v components of vector quantities relative to the defined grid in the direction of increasing x and y (or i and j) coordinates.
20-22	Reserved. Set to 0.

PSEC2

REAL parameters for GRIB code section 2, grid definition section. A REAL array of at least (10 + nn) words, where nn is the number of vertical coordinate parameters.

Table 10: PSEC2

Word	Contents
1	Angle of rotation.
2	Stretching factor.
3-10	Reserved. Set to 0.
11	Vertical coordinate parameters. Number given in KSEC2(12)

KSEC3

INTEGER parameters for GRIB code section 3, bit map section. INTEGER array of at least 2 words.

Table 11: KSEC3

Word	Contents
1	0 Bitmap included in the GRIB message. Binary data array (PSEC4) contains a missing data indicator at points where no data is given. Non-zero Number of predetermined bitmap. Bitmap is not included in the message. Binary data array contains only valid data values.
2	The value used to indicate missing data in an INTEGER binary data array is given here. This value is supplied by the user for both encoding and decoding

PSEC3

REAL parameters for GRIB code section 3, bitmap Section. REAL array of at least 2 words.

Table 12:

Word	Contents
1	Not used.
2	The value used to indicate missing data in a REAL binary data array is given here. This value is supplied by the user for both coding and decoding.

KSEC4

INTEGER parameters for GRIB code section 4, binary data section. INTEGER array of at least 42 words.

Table 13: KSEC4

Word	Contents
1	Number of data values in array PSEC4 to be packed, or which have been unpacked. When a bit-map is used, this number includes the number of missing data values. If this number is *negative*, it indicates the *entire field is missing*, and all values in PSEC4 are 0. This is an ECMWF convention. The coded data has all the bits of its scale factor, and the exponent and mantissa of its reference value set to 1.
2	Number of bits used for each packed value.
3	Type of data. Used only if Section 2 is not included when coding data. 0 Grid point data. 128 Spherical harmonic coefficients.
4	Type of packing. 0 Simple packing. 64 Complex or second order packing.
5	Data representation. 0 Floating point data. 32 Integer data.
6	Additional flags indicator. 0 No additional flags. 16 Additional flags.
7	Reserved. Set to 0.
8	Number of values indicator. 0 Single datum at each grid point. 64 Matrix of values at each grid point.

Table 13: KSEC4

Word	Contents
9	Secondary bit maps indicator. 0 No secondary bit maps. 32 Secondary bit maps present.
10	Values width indicator. 0 Second order values constant width. 16 Second order values different widths. (Not implemented)
11	Number of bits for second order values, when of constant width. (Not implemented)
12-15	Reserved for WMO reserved flag fields. Set to 0.
16	For complex packing, pointer to the start of packed data values (i.e. the octet number). Otherwise set to 0.
17	For complex packing, scaling factor P, stored as the INTEGER value P*1000 (in the range -10000 to +10000). Otherwise set to 0.
18	For complex packing, pentagonal resolution parameter J^1 specifying the truncation of the subset of the data represented as 32-bit floating point numbers (i.e. not packed). Otherwise set to 0.
19	For complex packing, pentagonal resolution parameter K^1 specifying the truncation of the subset of the data represented as 32-bit floating point numbers (i.e. not packed). Otherwise set to 0.
20	For complex packing, pentagonal resolution parameter M^1 specifying the truncation of the subset of the data represented as 32-bit floating point numbers (i.e.not packed). Otherwise set to 0.
21-33	Reserved. Set to 0.

X decoding option.

Words 34 to 42 are used only for the 'X' decoding option, which only decodes 4 values. (See HOPER above).

Scanning mode must be from West to East and from North to South.

Table 14: KSEC4 - X decoding option

Word	Contents
34	Number of points from which data is to be unpacked. (maximum 4)
35	Number of latitude row of first value.
36	Number of longitude point of first value.
37	Number of latitude row of second value.
38	Number of longitude point of second value
39	Number of latitude row of third value.
40	Number of longitude point of third value.
41	Number of latitude row of fourth value.
42	Number of longitude point of fourth value.

Grid point matrix packing.

For grid point packing, with a matrix of values at each grid point, words 50 to (50+NC1+NC2) are used as follows:

Table 15: KSEC4 - grid matrix packing

Word	Contents
50	First dimension (rows) of each matrix.
51	Second dimension (columns) of each matrix

Table 15: KSEC4 - grid matrix packing

Word	Contents
52	First dimension coordinate values definition. (Code table 12).
53	NC_1 Number of coefficients or values used to specify first dimension coordinate function.
54	Second dimension coordinate values definition. (Code table 12).
55	NC_2 Number of coefficients or values used to specify second dimension coordinate function.
56	First dimension physical significance. (Code table 13).
57	Second dimension physical significance. (Code table 13).
58 - 59	Reserved. Set to 0.

ECMWF use of REALs

In the WMO specification, the following fields are INTEGER values. ECMWF uses ***floating-point*** values for the wave models, so these fields contain REAL values in both input and output.

Table 16: KSEC4 - ECMWF use of REALs

Word	Contents
60 - (59+NC1)	Coefficients to define first dimension coordinate values in functional form, or the explicit coordinate values.
(60+NC1)-(59+NC1+NC2)	Coefficients to define second dimension coordinate values in functional form, or the explicit coordinate values

PSEC4

Array of data values to be packed in GRIB code or which have been unpacked. When a bitmap is included in the GRIB message, this array contains missing data indicator at the appropriate places; the value used to indicate a missing value is supplied by the user in PSEC3(2) or KSEC3(2). Although declared as REAL in GRIBEX, this can be an array of INTEGER data. The value in KSEC4(5) indicates whether data is in integer or floating point format.

When ***coding*** data, PSEC4 is ***overwritten***.

KGRIB

Array containing GRIB coded data.

Output Parameters for all options.

The following parameters are returned after the call to GRIBEX:

- KWORD - the number of array elements in KGRIB occupied by GRIB code.
- KSEC0 - the number of bytes of GRIB code, and the GRIB edition number.
- KRET - an informative code.

KWORD

The number of words of KGRIB occupied by coded data. This is an output parameter from coding only. It is not required as input for decoding.

KSEC0

An INTEGER array of 2 elements.

Table 17: KSEC0

Word	Contents
1	Number of octets in the GRIB message (not including padding to a word boundary or rounding to a multiple of 120 octets).
2	GRIB edition number.

KRET

An INTEGER return code giving information about the decoding.

Negative values.

These are for information and do not indicate an error condition.

Table 18: KRET - informative codes from decoding

Value	Meaning
-2	A bitmap was encountered with all bits set to 1. Array PSEC4 contains all REAL data values
-3	A predetermined bitmap was encountered. Data has not been fully decoded; array PSEC4 contains only REAL data values. The user must use this data in conjunction with the defined bitmap.
-4	A bitmap was encountered. The data has been fully decoded; array PSEC4 contains REAL values and missing data indicators where appropriate.
-5	A bitmap was encountered. The data has not been decoded. This return code is set only by the 'Z' decoding option. (See HOPER above)
-6	ECMWF pseudo-GRIB data encountered.

Status return codes

Except for 0, these indicate that an error was encountered in the encoding or decoding.

Table 19: KRET - status codes

Value	Meaning
0	No error encountered.
201	Invalid coding/decoding option requested.
202	Number of bits per data value exceeds word length.

Table 19: KRET - status codes

Value	Meaning
203	Missing data indicated and data field contains non-zero values.
301	Error in inserting/extracting the letters "GRIB".
302	Error extracting the length of the GRIB message.
303	Error inserting/extracting the GRIB edition number.
304	Error extracting octets 22 and 23, experimental edition check.
305	Input data is not GRIB or pseudo-GRIB.
401	Error inserting/extracting the length of section 1.
402	Error inserting/extracting parameter version number.
403	Error inserting/extracting six fields, from identification of centre to indicator of type of level.
404	Error inserting/extracting height, pressure, etc. of levels.
405	Error inserting/extracting six fields, from year of century to indicator of unit of time range.
406	Error inserting/extracting period of time.
407	Error inserting/extracting time range indicator.
408	Error inserting/extracting number averaged.
409	Error inserting/extracting number missing from averages etc.
410	Error inserting/extracting century of data or reserved field.
411	Error inserting/extracting units decimal scale factor.
412	Error inserting/extracting ECMWF local data.
413	Grib edition not catered for.
499	Error found when checking values for section 1 against valid GRIB values.

Table 19: KRET - status codes

Value	Meaning
501	Error inserting/extracting length of section 2.
502	Error inserting/extracting number of vertical coordinate parameters.
503	Error inserting/extracting location of list of vertical coordinate parameters or list of numbers of points.
504	Error inserting/extracting data representation type.
505	Error inserting/extracting number of points along a parallel or meridian.
506	Error inserting/extracting latitude or longitude of first grid point.
507	Error inserting/extracting components flag.
508	Error inserting/extracting latitude or longitude of last grid point.
509	Error inserting/extracting i direction increment.
510	Error inserting/extracting number of parallels between pole and the Equator.
511	Error inserting/extracting scanning mode flags.
513	Error inserting/extracting j direction increment.
514	Error inserting/extracting J,K,M pentagonal resolution parameters.
515	Error inserting/extracting representation type or mode.
517	Error inserting/extracting latitude or longitude of southern pole.
518	Error inserting/extracting angle of rotation.
519	Error inserting/extracting latitude or of pole of stretching.
520	Error inserting/extracting stretching factor.
521	Error inserting/extracting vertical coordinate parameters.

Table 19: KRET - status codes

Value	Meaning
522	Error inserting/extracting list of numbers of points.
523	Error inserting/extracting number of points along X or Y axis.
524	Error inserting/extracting X or Y axis grid lengths.
525	Error inserting/extracting projection centre flag.
526	Error inserting/extracting latitude or longitude of sub-satellite point.
527	Error inserting/extracting diameter of the Earth in x or y direction.
528	Error inserting/extracting X or Y coordinate of sub-satellite point.
529	Error inserting/extracting orientation of the grid or camera angle.
530	Error inserting/extracting X or Y coordinates of origin of sector.
598	Representation type not catered for.
599	Error found when checking values for section 2 against valid GRIB values.
601	Error inserting/extracting length of section 3.
602	Error inserting/extracting number of unused bits at end of section 3.
603	Error inserting/extracting bitmap reference table.
604	Error inserting/extracting primary bitmap.
605	Cannot convert quasi-regular gaussian grid with a bitmap.
699	Error found when checking values for section 3 against valid GRIB values.
701	Error inserting/extracting length of section 4.

Table 19: KRET - status codes

Value	Meaning
705	Only simple packing handled.
706	Error in extracting section 4 flag field.
707	Error inserting/extracting scale factor.
708	Error inserting/extracting reference value.
709	Error inserting/extracting number of bits per data value.
710	Output array too small.
711	Error inserting/extracting REAL coefficient.
712	Error inserting/extracting data values.
713	Error inserting/extracting flag and unused bit field.
714	Decoding option is 'X' and number of values is illegal.
715	Decoding option is 'X' and scanning mode is not north to south and west to east.
716	Decoding option is 'X' and field is not gaussian or latitude/longitude grid.
717	Decoding option is 'X' and a bitmap is included.
720	Error inserting/extracting octet number at which packed data begins.
721	Error inserting/extracting extended flag field.
722	Error inserting/extracting first or second dimension of matrix.
723	Error inserting/extracting six fields, from first dimension coordinate value onwards.
724	Error inserting/extracting first or second dimension coefficients.
725	Error inserting secondary bitmaps.
799	Error found when checking values for section 4 against valid GRIB values.

Table 19: KRET - status codes

Value	Meaning
800	Error inserting/extracting the "7777" group.
802	Error inserting/extracting the length of the GRIB message.
805	End of message "7777" group not found.
806	Error in extracting primary or secondary bit maps.
807	Inconsistent values specified for complex packing in KSEC2(6) and KSEC4(4)

Defaults.

Apart from the parameter values which are passed to GRIBEX, other values are also used. These values are held in a COMMON area and have default settings which can be changed by calls to appropriate subroutines before calling GRIBEX. The defaults are described below. The values have been selected as most normally useful at ECMWF, and ease the transition to new versions of GRIB.

Debug printout.

By default debug printout is switched ***off***.

```
CALL GRSDBG (I)
```

where

I	Non-zero to switch ***on*** debug printout. 0 to switch ***off*** debug printout.

Reference value.

By default, the reference value used is the minimum of the data values.

```
CALL GRSREF (ZREF)
```

to change the value, where ZREF is REAL and is the required value.

Rounding.

By default GRIB messages are rounded to a multiple of 120 octets.

```
CALL GRSRND (I)
```

where

I	0 to switch ***off*** rounding. Non-zero to switch ***on*** rounding.

Checking.

By default, the values given are checked for consistency with GRIB code values as currently defined, when coding data. Data values are never checked.

```
CALL GRSVCK (I)
```

where

I	0, to switch ***off*** checking. Non-zero to switch ***on*** checking.

Printing

Ancillary print routines are available for the various sections of the GRIB code.

To print section 0.

```
CALL GRPRS0(KSEC0)
```

To print section 1.

```
CALL GRPRS1(KSEC0,KSEC1)
```

To print section 2.

```
CALL GRPRS2(KSEC0,KSEC2,PSEC2)
```

To print section 3.

```
CALL GRPRS3(KSEC0,KSEC3,PSEC3)
```

To print section 4.

```
CALL GRPRS4(KSEC0, KSEC4, PSEC4)
```

ECMWF local GRIB usage definitions.

Definition 1 - MARS labelling or ensemble forecast data.

Table 20: MARS labelling or ensemble forecast data values for KSEC1

Value	Word contents
37	ECMWF local GRIB use definition identifier. 1 MARS labelling or ensemble forecast data.
38	Class 1 Operations 2 Research 3 ECMWF re-analysis
39	Type 1 First Guess 2 Analysis 3 Initialised analysis 4 OI analysis 5 3 D variational analysis 6 4 D variational analysis 7 3 D variational gradients 8 4 D variational gradients 9 Forecast 10 Control forecast 11 Perturbed forecast 12 Errors in first guess 13 Errors in analysis 14 Cluster means 15 Cluster standard deviations. 16 Forecast probabilities. 20 Climatology 30 Observations 31 Quality control 32 Difference statistics 40 Image data 50 Sensitivity gradients 51 Trajectory forecasts.

Table 20: MARS labelling or ensemble forecast data values for KSEC1

Value	Word contents
40	Stream 1-1022 Satellite data stream is the satellite number as per BUFR code table 0 01 007. 50 Meteosat 3 51 Meteosat 4 52 Meteosat 5 53 Meteosat 6. 201 NOAA 9 250 GOES 6 251 GOES 7 1025 Daily archive 1035 Ensemble forecasts 1036 Sensitivity gradients/trajectory forecasts 1041 TOGA 1042 Chernobyl 1043 Monthly 1044 Supplementary data 1045 Wave 1046 Ocean 1050 Bracknell 1051 Washington 1052 Offenbach 1053 Paris 1054 Tokyo 1055 Montreal 1060 Test 1070 Monthly variance and covariance data
41	Version number or experiment identifier. (4 ASCII characters, right justified)
42	Ensemble forecast number, if word 40 = 1035. Control forecast is number 0, if word 39 = 10. Perturbed forecasts are numbered 1-nn, if word 39 =11. Set to 0 if MARS labelling.
43	Total number of forecasts in ensemble. This number includes the control forecast. Set to 0, if not an ensemble forecast.

Definition 2 - Cluster means and standard deviations.

Table 21: Cluster means and standard deviations values for KSEC1

Value	Word contents
37	ECMWF local GRIB use definition identifier. 2 Cluster means and standard deviations.
38	Class 1 Operations 2 Research
39	Type 14 Cluster means 15 Cluster standard deviations.
40	Stream 1035 Ensemble forecasts
41	Version number or experiment identifier. (4 ASCII characters, right justified)
42	Cluster number.
43	Total number of clusters.
44	Clustering method:- 1 Maximum linkage method 2 Mixed method 3 Small linkage method
45	Start time step considered when clustering (Same units of time as forecast timesteps)
46	End time step considered when clustering (Same units of time as forecast timesteps)
47	Northern latitude of domain of clustering
48	Western longitude of domain of clustering
49	Southern latitude of domain of clustering

Table 21: Cluster means and standard deviations values for KSEC1

Value	Word contents
50	Eastern longitude of domain of clustering
51	Number of cluster to which operational forecast belongs.
52	Number of cluster to which control forecast belongs.
53	N Number of forecasts belonging to the cluster, including the control forecast.
54-53+N	List of N ensemble forecast numbers.

Definition 3. Satellite image data.

Table 22: Satellite image data values for KSEC1.

37	ECMWF local GRIB use definition identifier. 3 Satellite image data.
38	Class 1 Operations 2 Research
39	Type 40 Image data

Table 22: Satellite image data values for KSEC1.

40	Stream 1-1022 Satellite data stream is the satellite number as per BUFR code table 0 01 007. 50 Meteosat 3 51 Meteosat 4 52 Meteosat 5 53 Meteosat 6. 201 NOAA 9 250 GOES 6 251 GOES 7
41	Version number or experiment identifier. (4 ASCII characters, right justified)
42	Band 0 first infrared band 1 second infrared band 10 first visible band 20 water vapour
43	Function code: interpretation of pixel value. 0 value is pixel value 1 value is temperatures in degrees K, and is 145 + pixel value. 255 translation table follows

Definition 4. Ocean model data.

Used for storing ocean model data in GRIB code. A separate version of code table 2 is

Table 23: Ocean model values for KSEC1

37	ECMWF local GRIB use definition identifier. 4 Ocean model data.
38	Class 1 Operations 2 Research
39	Type 16 Forecast probabilities.
40	Stream 1035 Ensemble forecasts
41	Version number or experiment identifier. (4 ASCII characters, right justified)
42	Number (for ensemble forecasts).
43	Total (for ensemble forecasts).

used for ocean data: *ECMWF local Code Table 2, Version Number 150 for FM92-VIII*

All coordinates in this local use GRIB definition are given as 4-byte INTEGERs in the following units:

Latitudes and longitudes: microdegrees

Distance (general): metres (default: can be changed)

Time: seconds (default: can be changed)

Depth below sea level: millimetres (positive downwards)

Isopycnic level: potential density - $1000*10^6$. Permitted range of values is approximately:

$$-2.147*10^9 < i < 2.147*10^9$$

At several points in the definition, there may be a need for a variable amount of supplementary data. This is indicated with '*(+info)*', and in such cases a supplementary data block is specified at the end of the local use section.

Coordinate structure definition.

The physical meaning of the (x,y,z,t) coordinate system is defined in Table 24.

Table 24: Ocean model - coordinate structure definition

Value	Word contents
44	Fundamental spatial reference system. (Planet flag) 0 Earth (centre/north pole/Greenwich) 200 Geocentric RA/dec 201 Heliocentric coordinates 255 Unspecified
45	Fundamental time reference 0 Reference time given in standard GRIB header (used for forecasts to indicate start of prediction) 1 C.E. (i.e. 0 AD) 2 Julian Day number = 0.0 100 Zero at start of arbitrary expt 255 Unspecified
46	Space unit flag (applies only if lengths ***not*** otherwise labelled) 0 metres i<128 10^{i} metres i>128 $10^{(i-256)}$ metres
47	Vertical coordinate definition (z) 0 z above origin 1 R from origin 2 h above mean sea level geopotential 3 h above ground surface 160 Geopotential depth below mean sea level (mm) 161 Ocean isopycnic surface (pot. dens.)

Table 24: Ocean model - coordinate structure definition

Value	Word contents
48	Horizontal coordinate definition (x,y) 0 Latitude/longitude (microdegrees) 1 Cartesian (fundamental origin) 2 Cartesian (shifted, rotated origin) (*+info*) 3 Regular gaussian grid (microdegrees) (*+info*) 4 Polar stereographic (*+info*) 5 Spherical harmonic coefficients (INTEGERS) (*+info*)
49	Time unit flag 0 Seconds 1 Minutes 2 Hours 3 Days 4 Years 5<i<128 $10^{(i-4)}$ years i>128 $10^{(i-256)}$ seconds
50	Time coordinate definition (t) 0 Real earth time (UTC) 1 Ideal earth time (360 * 86400s days per year)

Position definition.

A 2-dimensional field located in 4-dimensional space-time needs 2 coordinates to define where the field is located, and 2 coordinates internal to the field. The locating coordinates are specified first. Each coordinate is identified according to the following table, and should be in this order where possible:

1	t
2	z
3	x
4	y

Mixed coordinates

It is possible to specify mixed coordinates, to allow sections at angles to the coordinate system.

Table 25: Ocean model - mixed coordinates

Value	Word contents
51	Mixed coordinate field flag 0 No mixed coordinates 1 x,y coordinates mixed (*+info*) 2 x,z coordinates mixed (*+info*) 3 y,z coordinates mixed (*+info*) 4 x,t coordinates mixed (*+info*) 5 y,t coordinates mixed (*+info*) 6 z,t coordinates mixed (*+info*)
52	Coordinate 1 flag (usually time)
53	Averaging flag 0 no averaging (data on/at level 1) 1 inclusive average between level 1 and 2 2 exclusive average between level 1 and 2
54	Position of level 1 (4 byte INTEGER)
55	Position of level 2 (4 byte INTEGER) (or zero if not used)
56	Coordinate 2 flag (usually z-coordinate)
57	Averaging flag 0 no averaging (data on/at level 1) 1 inclusive average between level 1 and 2 2 exclusive average between level 1 and 2
58	Position of level 1 (4 byte INTEGER)
59	Position of level 2 (4 byte INTEGER) (or zero if not used)

An inclusive average discards land points when calculating the average, and will produce a value where there is at least one valid ocean point. An exclusive average will only produce a value if all of the points being averaged are valid.

Data grid definitions

Table 26: Ocean model - grid definition

Value	Word contents
60	Coordinate 3 flag (x-axis, usually longitude)
61	Coordinate 4 flag (y-axis, usually latitude)
62	Coordinate 4 of first grid point (4-byte INTEGER)
63	Coordinate 3 of first grid point (4-byte INTEGER)
64	Coordinate 4 of last grid point (4-byte INTEGER)
65	Coordinate 3 of last grid point (4-byte INTEGER)
66	i-increment (also stored as a 4-byte INTEGER)
67	j-increment (also stored as a 4-byte INTEGER)
68	Flag for irregular grid coordinate list 0 none 1 x-axis values (typically longitude) 2 y-axis values (typically latitude) 3 first x-axis, then y-axis values given
69	Flag for normal or staggered grid 0 normal grid (all rows have same x-coordinate system) 1 staggered grid (odd and even rows have different x-coordinate systems, e.g. Arakawa grid).

Horizontal coordinate supplement.

Table 27: Ocean model - horizontal coordinate supplement

Value	Word contents
A1-nn	Horizontal coordinate supplement (4-byte INTEGERS). Not yet defined

Mixed coordinate definition (4-byte INTEGERs)

For the linear case, assume a transformation of the form

$$x' = \alpha(x - x0) + (1 - \alpha) \times (y - y0)$$

Table 28: Ocean model - mixed coordinate definition

Value	Word contents
B1	Flag for regularity of x-y coordinate mixing 0 Mixing is regular and linear 1 Mixing is irregular, code given
	For regular, linear mixing:
B2	Alpha $*10^9$
B3	X_0
B4	Y_0
	Irregular mixing with code given:
B2	Locally defined codes to define section
B3	Locally defined codes to define section
B4	Locally defined codes to define section

Grid coordinate list (4-byte INTEGERs)

Table 29: Ocean model - grid coordinate list

Value	Word contents
C1-nn	Coordinates of irregular x and y-axes. The x-axis is given first, then the second x-axis (if staggered grid), and then the y-axis. If the x-axis is regular but staggered, the longitude of the first point of the second row should be specified as the first entry of this list.

Auxiliary array (4-byte INTEGERs)

Table 30: Ocean model - auxiliary array

Value	Word contents
D1-nn	Auxiliary array values

Table 31: Ocean model - auxiliary information

Value	Word contents
70	Flag for any further information 0 none 1 auxiliary array contains x-axis topographic depths/heights
71	Number of entries in horizontal coordinate definition supplement (1 byte only)
72	Number of entries in mixed coordinate definition(2 bytes)
73	Number of entries in grid coordinate list (2 bytes)

Table 31: Ocean model - auxiliary information

Value	Word contents
74	Number of entries in auxiliary array (2 bytes)
[64 bytes fixed]	
A1-nn	Horizontal coordinate supplement (4-byte INTEGERS). Not yet defined

Comments on setting other GRIB parameters.

The time and time-range data should be set in the main section, if possible.

The indicator of type of level should be set to 160 (depth below sea level) for all oceanographic data. The depth in metres should be set to the appropriate value if the field is a horizontal section, and to zero in all other cases.

It is assumed that the grid description section of the GRIB code is set for a latitude/longitude grid, with correct values for the number of points along parallels/meridians, and the coordinates of the first and last data points in millidegrees (or the appropriate units from this section, divided by 1000).

The coordinate increments should be given to the extent that the field is regular.

Definition 5 - Forecast probability data

Table 32: Forecast probabilities values for KSEC1

37	ECMWF local GRIB use definition identifier. 5 Forecast probability data.
38	Class 1 Operations 2 Research

Table 32: Forecast probabilities values for KSEC1

39	Type 16 Forecast probabilities.
40	Stream 1035 Ensemble forecasts
41	Version number or experiment identifier. (4 ASCII characters, right justified)
42	Forecast probability number.
43	Total number of forecast probabilities.
44	Threshold units decimal scale factor. + or - power of 10 (or zero). Top bit = 1 for negative values.
45	Threshold indicator. 1 Only lower threshold present. 2 Only upper threshold present. 3 Both upper and lower thresholds present.
46	Lower threshold value.
47	Upper threshold value.

Definition 6 - (Still to be defined).

Definition 7 - Sensitivity gradient/trajectory forecast data

Table 33: Sensitivity gradient/trajectory forecast values for KSEC1

37	ECMWF local GRIB use definition identifier. 7 Sensitivity gradient/trajectory forecast.
38	Class 1 Operations 2 Research
39	Type 50 Sensitivity gradients. 51 Trajectory forecasts.
40	Stream 1035 Ensemble forecasts
41	Version number or experiment identifier. (4 ASCII characters, right justified)
42	Forecast indicator or diagnostic number. 0 Trajectory forecast. 1 J1 diagnostic. 2 J2 diagnostic. 3 J3 diagnostic. 4 J4 diagnostic.
43	Total number of diagnostics. (= 0 for trajectory forecasts).
44	Domain. 0 Global 1 Europe 2 Northern hemisphere 3 Southern hemisphere

A sample FORTRAN program.

```
      PROGRAM GRDEMO
C
C**** GRDEMO - Program to demonstrate use of GRIBEX routine.
C
C     Purpose.
C     --------
C
C     Demonstrates use of GRIBEX routine to unpack
C     GRIB coded data.
C
C**   Interface.
C     ----------
C
C     File of GRIB coded data in file 'datafile'.
C
C     Method.
C     -------
C
C     Prints sections 0, 1, 2, 3 and 4 of GRIB message.
C
C     Externals.
C     ----------
C
C     GRIBEX
C     GRPRS0
C     GRPRS1
C     GRPRS2
C     GRPRS3
C     GRPRS4
C     PBOPEN
C     PBGRIB
C     PBCLOSE
C
C     Reference.
C     ----------
C
C     WMO Manual on Codes for GRIB definition.
C     WMO Publication No. 9, Volume B, for grid catalogue numbers.
C
C     Comments.
C     ---------
C
C     GRIBEX provides a number of packing/unpacking options.
C     See documentation for details.
C
C
C     ------------------------------------------------------------------
C
C     Arrays are dimensioned to accommodate T213/N160 data volumes.
C
      PARAMETER (JPACK=280000)
C
C     Array for integer parameters from section 0 of GRIB message.
C
      DIMENSION ISEC0(2)
C
C     Array for integer parameters from section 1 of GRIB message.
C
      DIMENSION ISEC1(60)
C
C     Array for integer parameters from section 2 of GRIB message.
C
      DIMENSION ISEC2(384)
C
C     Array for integer parameters from section 3 of GRIB message.
C
      DIMENSION ISEC3(2)
C
C     Array for integer parameters from section 4 of GRIB message.
C
      DIMENSION ISEC4(42)
C
C     Array for real parameters from section 2 of GRIB message.
C
      DIMENSION ZSEC2(96)
C
C     Array for real parameters from section 3 of GRIB message.
C
      DIMENSION ZSEC3(2)
C
```

```
C     Array for real parameters from section 4 of GRIB message.
C     This is the binary data section and the array to hold
C     the unpacked data may need to be 4 times as long as that
C     for the packed data.
C
      DIMENSION ZSEC4(JPACK*4)
C
C     Array to read in packed data.
C
      DIMENSION INBUFF(JPACK)
C
C     GRIBEX routine has a number of encoding/decoding options.
C
      CHARACTER*1 YOPER
      INTEGER FILE, JCOUNT
C
C     Clear error counter.
C
      NUMERR = 0
C
C     Lengths of INBUFF and PSEC4
C
      ILENB = JPACK
      IPUNP = JPACK * 4
C
C     Open the data file
      CALL PBOPEN( FILE, 'DATAFILE', 'R', KRET)
      IF ( KRET .NE. 0 ) THEN
        WRITE (*, *) ' Return code from PBOPEN = ',KRET
        CALL PBCLOSE(FILE, KRET)
        STOP 'Fault in PBOPEN'
      ENDIF
      ILENB = ILENB*4
C
C     Loop through GRIB products in file.
      JCOUNT = 0
C
   50 CONTINUE
      JCOUNT = JCOUNT + 1
C
C     Read packed field into INBUFF.
      CALL PBGRIB( FILE, INBUFF, ILENB, LENOUT, KRET )
      IF ( KRET .LT. 0 ) THEN
        WRITE (*, *) ' Return code from pbgrib = ',KRET
        IF ( KRET .EQ. -1) THEN
          WRITE  (*, *) ' End of file. Number of products =',(JCOUNT-1)
          CALL PBCLOSE(FILE, KRET)
          WRITE (*,*) ' GRDEMO : Number of decoding errors = ',NUMERR
          STOP 'EOF'
        ELSE
          WRITE (*, *) ' kret = ',KRET,' after ', JCOUNT,' products.'
          CALL PBCLOSE(FILE, KRET)
          STOP 'Fault in PBGRIB'
        ENDIF
      ENDIF
      WRITE (*, *) ' Return length from PBGRIB = ',lenout
C
C     'D' function to unpack entire GRIB message.
C
      YOPER = 'D'
      WRITE (*,*) ' GRDEMO : Function code = ',YOPER
C
      IERR = 1
      CALL GRIBEX (ISEC0,ISEC1,ISEC2,ZSEC2,ISEC3,ZSEC3,ISEC4,
     X             ZSEC4,IPUNP,INBUFF,ILENB,IWORD,YOPER,IERR)
C
C     Check return code.
C
      WRITE (*,*) ' GRDEMO : GRIBEX return code = ',IERR
      IF (IERR.EQ.-6) WRITE (*,*) ' GRDEMO : Pseudo-grib data found.'
      IF (IERR.GT.0) THEN
        NUMERR = NUMERR + 1
        GO TO 50
      ENDIF
C
C     Print section 0 , 1 , 2 and 3 (if present) and 4.
C     Section 1 is the product definition section.
C     Section 2 is the grid definition section.
C     Section 3 is the bit-map section.
C     Section 4 is the data section.
C
      CALL GRPRS0 (ISEC0)
      CALL GRPRS1 (ISEC0,ISEC1)
C
```

```
      IF (ISEC1(5).EQ.0.OR.ISEC1(5).EQ.64) THEN
        WRITE (*,*) ' GRDEMO : No section 2 in GRIB message.'
      ELSE
        CALL GRPRS2 (ISEC0,ISEC2,ZSEC2)
      ENDIF
C
      IF (ISEC1(5).EQ.0.OR.ISEC1(5).EQ.128) THEN
        WRITE (*,*) ' GRDEMO : No section 3 in GRIB message.'
      ELSE
        CALL GRPRS3 (ISEC0,ISEC3,ZSEC3)
      ENDIF
C
      CALL GRPRS4 (ISEC0,ISEC4,ZSEC4)
C
C     Print some vales
C     DO LOOP = 1,384
C       WRITE(*,*) ' isec2(', loop, ') = ', isec2(loop)
C     ENDDO
C
C     Print some vales
C     DO LOOP = 1,60
C       WRITE(*,*) ' isec1(', loop, ') = ', isec1(loop)
C     ENDDO
      GO TO 50
C
      END
```