SECTION 2: GRID DESCRIPTION SECTION (GDS)

The purpose of the (optional) GDS is to provide a grid description for grids not defined by number in Table B.

Octet no.	GDS Content
1 - 3	Length in octets of the Grid Description Section
4	NV, the number of vertical coordinate parameters
5	PV, the location (octet number) of the list of vertical coordinate parameters, if present or PL, the location (octet number) of the list of numbers of points in each row (when no vertical parameters are present), if present or 255 (all bits set to 1) if neither are present
6	Data representation type (See Table 6)
7 - 32	Grid description, according to data representation type, except Lambert, Mercator or Space View (see Table D).
or	
7 - 42	Grid description for Lambert or Mercator grid (see Table D)
or	
7 - 44	Grid description for Space View perspective grid (see Table D)
PV	List of vertical coordinate parameters (length = NV x 4 octets); if present, then PL = 4 x NV + PV
PL	List of numbers of points in each row, used for quasi-regular grids (length = NROWS x 2 octets, where NROWS is the total number of rows defined within the grid description)

Note: NV and PV relate to features of GRIB not, at present, in use in the National Weather Service. See the WMO Manual on Codes for the descriptions of those features.

PL is used for "quasi-regular" or "thinned" grids; e.g., a lat/lon grid where the number of points in each row is reduced as one moves poleward from the equator. The reduction usually follows some mathematical formula involving the cosine of the latitude, to generate an (approximately) equally spaced grid array. The association of the numbers in octet PL (and following) with the particular row follows the scanning mode specification in Table 8.

TABLES FOR THE GDS

TABLE 6. DATA REPRESENTATION TYPE
(GDS OCTET 6)

VALUE	MEANING
0	Latitude/Longitude Grid - Equidistant Cylindrical or Plate Carree projection
1	Mercator Projection Grid
2	Gnomonic Projection Grid
3	Lambert Conformal, secant or tangent, conical or bipolar (normal or oblique) projection
4	Gaussian Latitude/Longitude
5	Polar Stereographic projection Grid
6	Universal Transverse Mercator (UTM) projection
7	Simple polyconic projection
8	Albers equal-area, secant or tangent, conic or bi-polar,
9	Miller's cylindrical projection
10	Rotated latitude/longitude grid
11-12	Reserved
13	Oblique Lambert conformal, secant or tangent, conical or bipolar, projection
14	Rotated Gaussian latitude/longitude grid
15 - 19	Reserved
20	Stretched latitude/longitude grid
21-23	Reserved
24	Stretched Gaussian latitude/longitude grid
25-29	Reserved
30	Stretched and rotated latitude/longitude grids
31-33	Reserved
34	Stretched and rotated Gaussian latitude/longitude grids
35-49	Reserved
50	Spherical Harmonic Coefficients
51 - 59	Reserved
60	Rotated spherical harmonic coefficients
61-69	Reserved
70	Stretched spherical harmonics
71-79	Reserved
80	Stretched and rotated spherical harmonic coefficients

TABLE 6. DATA REPRESENTATION TYPE
(Continued)

81-89	Reserved
90	Space view perspective or orthographic
91 - 191	(reserved - see Manual on Codes)
192 - 254	Reserved for local use
	NCEP usage follows
192 - 200	available - See Chief, NCEP Central Operations
201	Arakawa semi-staggered E-grid on rotated latitude/longitude grid-point array
202	Arakawa filled E-grid on rotated latitude/longitude grid-point array
203 - 254	available - See Chief, NCEP Central Operations

TABLE D. Sundry Grid Definitions

LATITUDE/LONGITUDE GRIDS
INCLUDING GAUSSIAN
(GDS Octets 7 - 32)

OCTET NO.	CONTENT & MEANING
7 - 8	Ni - No. of points along a latitude circle
9 - 10	Nj - No. of points along a longitude meridian
11 - 13	La_1 - latitude of first grid point units: millidegrees (degrees x 1000) values limited to range 0 - 90,000 bit 1 (leftmost) set to 1 for south latitude
14 - 16	Lo_1 - longitude of first grid point units: millidegrees (degrees x 1000) values limited to range 0 - 360,000 bit 1 (leftmost) set to 1 for west longitude
17	Resolution and component flags (Table 7)
18 - 20	La_2 - Latitude of last grid point (same units, value range, and bit 1 as La_1)
21 - 23	Lo_2 - Longitude of last grid point (same units, value range, and bit 1 as Lo_1)
24 - 25	Di - Longitudinal Direction Increment (same units as Lo_1) (if not given, all bits set = 1)
26 - 27	<u>Regular Lat/Lon Grid</u>: Dj - Latitudinal Direction Increment (same units as La_1) (if not given, all bits set = 1) or <u>Gaussian Grid</u>: N - number of latitude circles between a pole and the equator Mandatory if Gaussian Grid specified
28	Scanning mode flags (See Table 8)
29 - 32	Reserved (set to zero)

TABLE D. Sundry Grid Descriptions
(continued)

Notes:

1) The latitude and longitude of the first and last grid points should always be given, for regular grids.

2) If a quasi-regular grid is to be described, in which all the rows or columns do not necessarily have the same number of grid points, either Ni (octets 7-8) or Nj (octets 9-10) and the corresponding Di (octets 24-25) or Dj (octets 26-27) shall be coded with all bits set to 1 (missing).

3) A quasi-regular grid can be defined only for rows or columns, but not both simultaneously. The first point in each row (column) shall be positioned at the meridian (parallel) indicated in octets 11-16. The grid points shall be evenly spaced in latitude (longitude).

4) For Gaussian grids only the rows can be rendered quasi-regular; the first point shall be located at the meridian given in octets 14-16 and the last point at the meridian given in octets 21-23.

TABLE D. Sundry Grid Descriptions
(continued)

ARAKAWA SEMI-STAGGERED E-GRID
ON ROTATED LATITUDE/LONGITUDE GRID
(GDS Octets 7 - 32)

OCTET NO.	CONTENT & MEANING
7 - 8	Ni - Total number of actual data points included on grid
9 - 10	Nj - Dummy second dimension; set = 1
11 - 13	La_1 - latitude of first grid point units: millidegrees (degrees x 1000) values limited to range 0 - 90,000 bit 1 (leftmost) set to 1 for south latitude
14 - 16	Lo_1 - longitude of first grid point units: millidegrees (degrees x 1000) values limited to range 0 - 360,000 bit 1 (leftmost) set to 1 for west longitude
17	Resolution and component flags (Table 7)
18 - 20	La_2 - Number of mass points along southernmost row of grid
21 - 23	Lo_2 - Number of rows in each column
24 - 25	Di - Longitudinal Direction Increment (same units as Lo_1; value must be supplied)
26 - 27	Dj - Latitudinal Direction Increment (same units as La_1; value must be supplied)
28	Scanning mode flags (See Table 8)
29 - 32	Reserved (set to zero)

Note: The rotation of the latitude/longitude grid is such that the intersection of the "prime meridian" and the "equator" has been located at the central latitude and longitude of the area represented.

TABLE D. Sundry Grid Descriptions
(continued)

ARAKAWA FILLED E-GRID ON ROTATED
LATITUDE/LONGITUDE GRID
(GDS Octets 7 - 32)

OCTET NO.	CONTENT & MEANING
7 - 8	Ni - Total number of actual data points included on grid
9 - 10	Nj - Dummy second dimension; set = 1
11 - 13	La_1 - latitude of first grid point units: millidegrees (degrees x 1000) values limited to range 0 - 90,000 bit 1 (leftmost) set to 1 for south latitude
14 - 16	Lo_1 - longitude of first grid point units: millidegrees (degrees x 1000) values limited to range 0 - 360,000 bit 1 (leftmost) set to 1 for west longitude
17	Resolution and component flags (Table 7)
18 - 20	La_2 - Number of (zonal) points in each row
21 - 23	Lo_2 - Number of (meridional) points in each column
24 - 25	Di - Longitudinal Direction Increment (same units as Lo_1; value must be supplied)
26 - 27	Dj - Latitudinal Direction Increment (same units as La_1; value must be supplied)
28	Scanning mode flags (See Table 8)
29 - 32	Reserved (set to zero)

Note: The rotation of the latitude/longitude grid is such that the intersection of the "prime meridian" and the "equator" has been located at the central latitude and longitude of the area represented.

TABLE D. Sundry Grid Descriptions
(continued)

POLAR STEREOGRAPHIC GRIDS
(GDS Octets 7 - 32)

OCTET NO.	CONTENT & MEANING
7 - 8	Nx - Number of points along x-axis
9 - 10	Ny - Number of points along y-axis
11 - 13	La1 - Latitude of first grid point
14 - 16	Lo1 - Longitude of first grid point
17	Resolution and component flags (see Table 7)
18 - 20	Lov - The orientation of the grid; i.e., the east longitude value of the meridian which is parallel to the y-axis (or columns of the grid) along which latitude increases as the y-coordinate increases. (Note: The orientation longitude may, or may not, appear within a particular grid.)
21 - 23	Dx - the X-direction grid length (see Note 2)
24 - 26	Dy - the Y-direction grid length (see note 2)
27	Projection center flag (see note 5)
28	Scanning mode (see Table 8)
29 - 32	Set to 0 (reserved)

NOTES:

1. Latitude and longitude are in millidegrees (thousandths)

2. Grid lengths are in units of meters, at the 60 degree latitude circle nearest to the pole in the projection plane.

3. Latitude values are limited to the range 0 - 90,000. Bit 1 is set to 1 to indicate south latitude.

4. Longitude values are limited to the range 0 - 360,000. Bit one is set to 1 to indicate west longitude.

5. Octet 27:
Bit 1 set to 0 if the North pole is on the projection plane.
Bit 1 set to 1 if the South pole is on the projection plane.

6. The first and last grid points may not necessarily be the same as the first and last data points if the bit map section (BMS) is used.

7. The resolution flag (bit 1 of Table 7) is not applicable.

TABLE D. Sundry Grid Descriptions
(continued)

LAMBERT CONFORMAL SECANT OR TANGENT CONE GRIDS
(GDS Octets 7 - 42)

OCTET NO.	CONTENT & MEANING
7 - 8	Nx - Number of points along x-axis
9 - 10	Ny - Number of points along y-axis
11 - 13	La1 - Latitude of first grid point
14 - 16	Lo1 - Longitude of first grid point
17	Resolution and component flags (see Table 7)
18 - 20	Lov - The orientation of the grid; i.e., the east longitude value of the meridian which is parallel to the y-axis (or columns of the grid) along which latitude increases as the y-coordinate increases. (Note: The orientation longitude may, or may not, appear within a particular grid.)
21 - 23	Dx - the X-direction grid length (see note 2)
24 - 26	Dy - the Y-direction grid length (see Note 2)
27	Projection center flag (see note 5)
28	Scanning mode (see Table 8)
29 - 31	Latin 1 - The first latitude from the pole at which the secant cone cuts the spherical earth. (See Note 8)
32 - 34	Latin 2 - The second latitude from the pole at which the secant cone cuts the spherical earth. (See Note 8)
35 - 37	Latitude of southern pole (millidegrees)
38 - 40	Longitude of southern pole (millidegrees)
41 - 42	Reserved (set to 0)

NOTES:

1. Latitude and longitude are in millidegrees (thousandths)

2. Grid lengths are in units of meters, at the intersection latitude circle nearest to the pole in the projection plane.

3. Latitude values are limited to the range 0 - 90,000. Bit 1 is set to 1 to indicate south latitde.

4. Longitude values are limited to the range 0 - 360,000. Bit one is set to 1 to indicate west longitude.

TABLE D. Sundry Grid Descriptions
(continued)

5. Octet 27:
   Bit 1 set to 0 if the North pole is on the projection plane.
   Bit 1 set to 1 if the South pole is on the projection plane.
   Bit 2 set to 0 if only one projection center used
   Bit 2 set to 1 if projection is bipolar and symmetric

6. The first and last grid points may not necessarily be the same as the first and last data points if the bit map section (BMS) is used.

7. The resolution flag (bit 1 of Table 7) is not applicable.

8. If Latin 1 = Latin 2 then the projection is on a tangent cone.

MERCATOR GRIDS
(GDS Octets 7 - 42)

OCTET NO.	CONTENT & MEANING
7 - 8	Ni - Number of points along a latitude circle
9 - 10	Nj - Number of points along a longitude meridian
11 - 13	La1 - Latitude of first grid point
14 - 16	Lo1 - Longitude of first grid point
17	Resolution and component flags (see Table 7)
18 - 20	La2 - latitude of last grid point
21 - 23	Lo2 - longitude of last grid point
24 - 26	Latin - The latitude(s) at which the Mercator projection cylinder intersects the earth.
27	Reserved (set to 0)
28	Scanning mode (see Table 8)
29 - 31	Di - the longitudinal direction increment (see Note 2)
32 - 34	Dj - the latitudinal direction increment (see note 2)
35 - 42	Reserved (set to 0)

NOTES:

1. Latitude and longitude are in millidegrees (thousandths)
2. Grid lengths are in units of meters, at the circle of latitude specified by Latin.
3. Latitude values are limited to the range 0 - 90,000. Bit 1 is set to 1 to indicate south latitude.
4. Longitude values are limited to the range 0 - 360,000. Bit one is set to 1 to indicate west longitude.
5. The latitude and longitude of the last grid point should always be given.
6. The first and last grid points may not necessarily be the same as the first and last data points if the bit map section (BMS) is used.

TABLE D. Sundry Grid Descriptions
(continued)

SPACE VIEW PERSPECTIVE OR ORTHOGRAPHIC
(GDS Octets 7-44)

OCTET NUMBER	CONTENTS
7-8	Nx - number of points along x axis (columns)
9-10	Ny - number of points along y axis (rows or lines)
11-13	Lap - latitude of sub-satellite point
14-16	Lop - longitude of sub-satellite point
17	Resolution and component flags (Table 7)
18-20	dx - apparent diameter of earth in grid lengths, in x direction
21-23	dy - apparent diameter of earth in grid lengths, in y direction
24-25	Xp - X-coordinate of sub satellite point
26-27	Yp - Y-coordinate of sub-satellite point
28	Scanning Mode (Table 8)
29-31	the orientation of the grid; i.e., the angle in millidegrees between the increasing y axis and the meridian of the sub-satellite point in the direction of increasing latitude (see Note 3).
32-34	Nr - the altitude of the camera from the earth's center, measured in units of the earth's (equatorial) radius (See Note 4).
35-44	reserved

Notes:

(1) It is assumed that the satellite is at its nominal position, i.e., it is looking directly at its sub-satellite point.

(2) Octet 32-34 shall be set to all ones (missing) to indicate the orthographic view (from infinite distance).

(3) It is the angle between increasing y axis and the meridian 180 degrees east if the sub-satellite point is the North pole; or the meridian 0 degrees, if the sub-satellite point is the south pole.

(4) The apparent angular size of the earth will be given by 2 * asin (1/Nr).

(5) The horizontal and vertical angular resolutions of the sensor (Rx and Ry), needed for navigation equations, can be calculated from the following

$$Rx = 2 * \text{asin}(1/Nr) / dx$$

$$Ry = 2 * \text{asin}(1/Nr) / dy$$

TABLE D. Sundry Grid Descriptions
(continued)

SPHERICAL HARMONIC COEFFICIENTS
(GDS Octets 7 - 32)

OCTET NO.	CONTENT & MEANING
7 - 8	J - Pentagonal Resolution Parameter
9 - 10	K - Pentagonal Resolution Parameter
11 - 12	M - Pentagonal Resolution Parameter
13	Representation Type (See Table 9)
14	Coefficient Storage Mode (See Table 10)
15 - 32	Set to zero (reserved)

TABLE 7 - RESOLUTION AND COMPONENT FLAGS
(GDS Octet 17)

Bit	Value	Meaning
1	0	Direction increments not given
	1	Direction increments given
2	0	Earth assumed spherical with radius = 6367.47 km
	1	Earth assumed oblate spheroid with size as determined by IAU in 1965: 6378.160 km, 6356.775 km, f = 1/297.0
3-4		reserved (set to 0)
5	0	u- and v-components of vector quantities resolved relative to easterly and northerly directions
	1	u and v components of vector quantities resolved relative to the defined grid in the direction of increasing x and y (or i and j) coordinates respectively
6-8		reserved (set to 0)

Note: If the GDS is **not** included in a message then any wind components are assumed to be resolved relative to the grid specified in the PDS with u and v defined as positive in the direction of increasing x and y (or i and j) coordinates respectively.

TABLE 8. SCANNING MODE FLAG
(GDS Octet 28)

BIT	VALUE		MEANING
	1	0	Points scan in +i direction
		1	Points scan in -i direction
	2	0	Points scan in -j direction
		1	Points scan in +j direction
	3	0	Adjacent points in i direction are consecutive (FORTRAN: (I,J))
		1	Adjacent points in j direction are consecutive (FORTRAN: (J,I))
	4-8		reserved; set = 0

Note: i direction is defined as west to east along a parallel of latitude, or left to right along an x axis.

j direction is defined as south to north along a meridian of longitude, or bottom to top along a y axis.

TABLE 9. SPECTRAL REPRESENTATION TYPE
(GDS Octet 13)

VALUE	MEANING
1	Associated Legendre Polynomials of the First Kind with normalization such that the integral equals 1
2	Indicates spherical harmonics - complex packing

TABLE 10. COEFFICIENT STORAGE MODE
(GDS Octet 14)

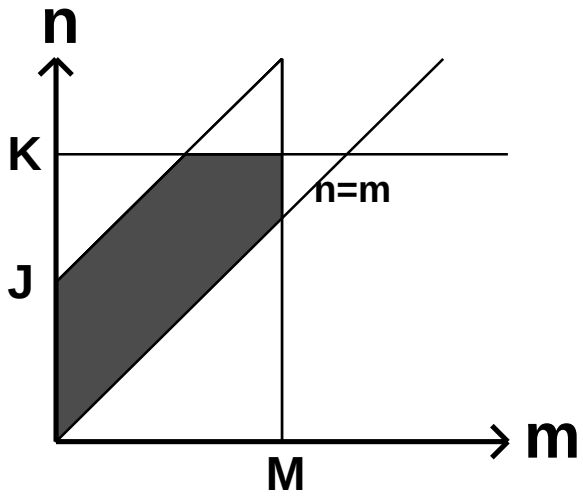
VALUE	MEANING
	The complex coefficients X_n^m are stored for $m \geq 0$ as pairs of real numbers $Re(X_n^m)$, $Im(X_n^m)$ ordered with n increasing from m to N(m), first for m = 0 and then for m = 1, 2, 3,...M. The real part of the (0,0) coefficient is stored in octets 12-15 of the BDS, as a floating point number in the same manner as the packing reference value, with units as in Table 2. The remaining coefficients, starting with the imaginary part of the (0,0) coefficient, are packed according to the GRIB packing algorithm, with units as given in Table 5, in octets 16 and onward in the BDS.
Indicates spherical harmonics - complex packing	

NOTES ON SPECTRAL TRUNCATION:

Using the associated Legendre Polynomials of the First Kind, P_n^m, as typical expansion functions, any variable x(? , µ), which is a function of longitude, ? , and sin(latitude), µ , can be represented by

$$x(l,m) = \sum_{m=-M}^{M} \sum_{n=|m|}^{N(m)} X_n^m P_n^m(m) e^{m\,li}$$

In the summations, M is the maximum zonal wave number that is to be included, and K & J together define the maximum meridional total wave number N(m), which, it should be noted, is a function of m. A sketch shows the relationships:



In this figure, the ordinate, n, is the zonal wave number, the abscissa, m, is the total meridional wave number, the vertical line at m = M is the zonal truncation, and the

diagonal passing through (0,0) is the line n = m. The Legendre Polynomials are defined only on or above this line, that is for $n \geq m$. On the n-axis, the horizontal line at n = K indicates the upper limit to n values, and the diagonal that intersects the n-axis at n = J indicates the upper limit of the area in which the Polynomials are defined. The shaded irregular pentagon defined by the n-axis, the diagonal from n = J, the horizontal n = K, the vertical m = M, and the other diagonal n = m surrounds the region of the (n x m) plane containing the Legendre Polynomials used in the expansion.

This general pentagonal truncation reduces to some familiar common truncations as special cases:

Triangular:	K = J = M and N(m) = J
Rhomboidal:	K = J + M and N(m) = J + m
Trapezoidal:	K = J, K > M and N(m) = J

In all of the above m can take on negative values to represent the imaginary part of the spectral coefficients.