GRIB2 Encoding Details for the National Weather Service Digital Forecast Database

Background

The National Weather Service (NWS) is creating a National Digital Forecast Database (NDFD) which will contain gridded forecasts of several weather elements. In general, the weather parameters in the NDFD will be ground-based, sensible weather elements. The forecast grids that comprise the NDFD will come from multiple sources, including the NWS' Weather Forecast Offices (WFO) and the National Centers for Environmental Prediction (NCEP). The World Meteorological Organization (WMO) has adopted Edition 2 of the GRIB code as a standard for sharing <u>GRI</u> dded <u>B</u> inary data. GRIB, Edition 2 (GRIB2) will be involved in the NDFD in two ways. GRIB2 will be one of the primary formats used to transmit NDFD data to NWS customers and partners.

The purpose of this document is to describe, in detail, the techniques that will be used to encode NWS forecasts into NDFD GRIB2 bulletins. When dealing with a code as general and as flexible as GRIB2, one often encounters multiple, plausible ways to accomplish the encoding task. It is hoped that this document will clarify the many decisions made during the creation of the NDFD.

In summer of 2011, NDFD will begin making experimental CONUS GRIB2 files available that contain finer spatial resolution (2.5 km) and higher temporal resolution (1-hr, for Days 1-3) grids.

References

This document will assume that the reader has access to and a working knowledge of the WMO publication FM 92-XII GRIB *General Regularly-distributed Information in Binary Form*. This link should provide access to a version that has been formatted for web access.

The NWS has created an NDFD information web page. There you will find the latest news regarding NDFD plans and recent developments. In addition, MDL developers have written software that may be downloaded and used for accessing and decoding NDFD GRIB2 files from the NWS Telecommunications Gateway (NWSTG). To obtain the latest version of this software, follow this link.

File, and Bulletin Structure

A single file will contain multiple GRIB2 bulletins. One file will contain multiple forecast projections for a given weather element covering a specific geographic region. There are NDFD grids available for the lower 48 states (CONUS), 16 different CONUS sub-sectors, Puerto Rico, Hawaii, Guam, and Alaska. For Tropical Prediction Center grids, there are two additional domains. One domain covers the area defined by NCEP's AWIPS 227 grid. The other domain covers the Northern Pacific, as defined by NCEP's AWIPS 204 grid.

The **NDFD Oceanic domain** covers a large area of the world�s surface, and also contains forecast data provided by the Tropical Analysis and Forecast Branch of the National Hurricane Center, as well as the Ocean Prediction Center.

See this link for a detailed list of geographic sectors, filenames, and WMO header information with regards to NDFD data.

GRIB2 files for a given element and region will be split into two files, one containing the forecast grids for the period Day 1 through Day 3, the other containing the forecast grids for the period Day 4 through Day 7. These files are located in different directories at the NWSTG FTP download site.

Every NDFD GRIB file begins with a flag field separator of the format:

****nnnnnnnnnn****\lf

where the "nnnnnnnnnn" is the size in bytes of the file, (minus the separator), right justified with leading zeroes, and with a trailing "\lf". The "\lf" character represents a single octet with the decimal value of 10. The size of the Flag field separator is 19 bytes.

Following the flag field separator is a WMO "super header". Check this link for the specific format of NDFD WMO headers. The WMO super header is 21 bytes long, the trailing "\cr\cr\lf" inclusive. The "\cr" character represents a single octet with the decimal value of 13. Immediately following the super header is another flag field separator for the first GRIB2 bulletin in the file. It contains the size of the bulletin to follow.

The bulletin itself begins with a WMO header. Again, refer to the link above to get detailed information regarding the format of the header. The header contains the valid time of the GRIB2 bulletin. The WMO header is also 21 bytes long, the trailing "\cr\cr\lf" inclusive. Following the header is the packed GRIB2 grid. It begins with the ASCII text "GRIB" and ends with the ASCII text "7777". The packed data contains all the GRIB2 sections for that grid, as well as the packed grid.

Here's an example of the file format (individual components are bracketed with "< >"):

```
<file flag field separator\lf>
<WMO super header\cr\cr\lf>
<bulletin 1 flag field separator\lf>
<WMO header 1 for bulletin\cr\cr\lf>
<"GRIB"packed data7777><bulletin 2 flag field
separator\lf>
<WMO header 2 for bulletin\cr\cr\lf>
<"GRIB"packed data7777><bulletin 3 flag field
separator\lf>
.
.
.
<WMO header nn for bulletin\cr\cr\lf>
<"GRIB"packed data7777>
```

Octet Contents

The sections that follow list the contents of the GRIB2 bulletin, octet by octet. When contents are described as "Missing," all bits are set to "1" in accordance with regulation 92.1.4. When contents are described by a number, that number will be stored in the apprpriate octet.

Section 0--Indicator Section

Octet No.	Contents
1-4	"GRIB"
5-6	0
7	0 - for Meteorological Products, 2 � for Land Surface Products, 10 - for Oceanographic Products
8	2
9-16	Total length of GRIB message in octets (including Section 0)

Section 1--Identification Section

In Section 1, octets 13-19 contain the reference time for the GRIB bulletin. The NDFD is currently produced once an hour. The reference time in Section 1 represents the day/hour of the current NDFD production cycle.

Octet No.	Contents
1-4	21
5	1
6-7	8
8-9	Missing
10	1
11	0 - Value will be used to designate the version number of the GRIB2-encoding software that produced the bulletin. When changes to this published format occur, this version number will be updated.
12	1
13-14	Year (4 digits)
15	Month
16	Day
17	Hour
18	Minute
19	Second

20	0 or 1 - depending on the operational status of the encoded NDFD product (0 = operational, 1 = operational TEST)
21	1

Section 2--Local Use Section

Certain weather elements have provided particular challenges in encoding them in GRIB2. Using Section 2 to encode various forms of metadata provides one solution. For the NDFD elements Weather ("Wx"), and Hazards, MDL GRIB2 encoding software uses the Local Use section for packing metadata unique to each grid. At this time, for parameters other than Wx and Hazards, the Local Use section is omitted.

Grids of these 2 elements are stored as two distinct entities. The first entity is a grid of small integer values that will generally store very compactly in Section 6. The second entity is a series of null-terminated strings of ASCII characters called keys (either Wx or Hazard keys). The integers on the weather grid serve as indices, each pointing to one of the unique keys in the series. Each key is comprised of one or more subkeys, separated by a caret "^".

The metadata packed in the Local Use Section for the Wx and Hazard elements is a lookup table. The ASCII characters are loaded, one per octet, and then compressed using the Simple Packing Scheme for integers defined for Section 5. The Simple Packing Scheme treats the set of keys as an integer array. Each integer in the array is a decimal representation that corresponds to an ASCII character. For instance, the integer 65 translates to the ASCII character "A". The null character is represented by the integer 0, so that whenever a 0 is encountered in the array, it marks the ending of a unique key. The tables that follow show the specific contents of the Weather keys/subkeys and Hazard keys/subkeys.

Octet No.	Contents
1-4	Length of section in octets (nn)
5	2
6	1 - Simple packing flag
7-nn	The Weather/Hazard keys needed to translate the contents the grid, packed using the Simple Packing scheme

Weather Keys and Subkeys

A weather subkey has can have *up to* five parts, each part separated by colons ":".
The parts are:

◆◆ one weather type code. See Weather Type Codes, below.

◆◆ one coverage/probability code. See Coverage/probability Codes, below.

◆◆ one intensity code. See Intensity Codes, below.

◆◆ one visibility code. See Visibility Codes, below.

- zero or more attribute codes, separated by commas ",".   See Attribute Codes, below.

Weather Type Codes

Code	Meaning	Code	Meaning
<NoWx>	No Weather	T	Thunder
A	Hail	R	Rain
RW	Rain Showers	L	Drizzle
ZR	Freezing Rain	ZL	Freezing Drizzle
S	Snow	SW	Snow Showers
IP	Ice Pellets (sleet)	F	Fog
H	Haze	BS	Blowing Snow
K	Smoke	BD	Blowing Dust
FR	Frost	BN	Blowing Sand
IF	Ice Fog	IC	Ice Crystals
ZF	Freezing Fog	ZY	Freezing Spray
VA	Volcanic Ash	WP	Water Spouts

Coverage/probability Codes

Code	Meaning	Code	Meaning
<NoCov>	No Coverage/probability	Iso	Isolated
Sct	Scattered	Num	Numerous
Wide	Widespread	Ocnl	Occasional
SChc	Slight Chance	Chc	Chance
Lkly	Likely	Def	Definite
Patchy	Patchy	Areas	Areas of
Brf	Brief	Pds	Periods of
Frq	Frequent	Inter	Intermittent

Intensity Codes

Code	Meaning	Code	Meaning
<NoInten>	No Intensity	--	Very Light
-	Light	m	Moderate
+	Heavy		

Visibility Codes

The following visibility codes may appear in WFO-generated GRIB2 bulletins. The units are statute miles: <NoVis>, 0SM, 1/4SM, 1/2SM, 3/4SM, 1SM, 11/2SM, 2SM, 21/2SM, 3SM, 4SM, 5SM, 6SM, P6SM.

Attribute Codes

Code	Meaning	Code	Meaning
FL	Frequent Lightning	GW	Gusty Winds
HvyRn	Heavy Rain	DmgW	Damaging Winds
SmA	Small Hail	LgA	Large Hail
OLA	on Outlying Areas	OBO	on Bridges and Overpasses
OGA	on Grassy Areas	OR	Or
Dry	Dry	Primary	Highest Ranking
Mention	Include Unconditionally	TOR	Tornado
Mx	Mixture		

Size Limitations for NDFD National Grids

There is no (practical) limit to the number of weather keys, subkeys, etc. For NDFD grids that are national mosaics of WFO-generated grids, the following limitations will be applied:

Item	Maximum number that will be present
Weather Attributes in a Weather Subkey	5
Weather Subkeys in a Weather Key	5

Weather Key Examples

Sample Weather Key	Meaning
`Sct:SW:-:<NoVis>:`	Light scattered snow showers
`Ocnl:R:-:<NoVis>:^S:Ocnl:-:<NoVis>:^` `SChc:ZR:-:<NoVis>:`	Occasional light rain and snow, with a slight chance of light freezing rain
`Wide:FR:-:<NoVis>:OLA`	Widespread light frost in the outlying areas
`<NoWx>:<NoCov>:<NoInten>:<NoVis>:`	No weather
`Sct:RW:-:<NoVis>:^T:Iso:m:<NoVis>:`	Scattered light showers with isolated moderate thunderstorms
`Sct:T:+:<NoVis>:DmgW,LgA`	Scattered severe thunderstorms with damaging winds

	and large hail

Hazard Keys and Subkeys

A hazard key has two parts, separated by a "."
The parts are:

- a 2 letter phenomenon code. This could be something like "HW" (for High Wind), or "SV" (for Severe Thunderstorm).
- a 1 letter signifucance code. This could be either "Y" (Advisory), "S" (Statement), "A" (Watch), or "W" (Warning).

A full list of Hazard keys found on NDFD grids can be found here.

Section 3--Grid Definition Section

Section 3 will vary depending upon the map projection the grid is defined. A table listing more detailed information for each NDFD geographic region (CONUS, CONUS subsectors, Puerto Rico, Hawaii, Guam, Alaska) can be found here. Latitude and longitude values are encoded in 10^{-6} degrees. All longitudes are east.

Lambert Conformal (includes CONUS and CONUS subsectors)

Octet No.	Contents
1-4	81 - Length of section in octets (nn)
5	3
6	0
7-10	Number of data points (Nx * Ny)
11	0
12	0
13-14	30 - template number
15	1
16	0
17-20	6371200 - Radius of the earth
21	0
22-25	0
26	0
27-30	0
31-34	Nx - number of points along the X-axis. (Click here to see Nx values for all Lambert Conformal NDFD grids)
35-38	Ny - number of points along the Y-axis (Click here to see Ny values for all Lambert Conformal NDFD grids)

39-42	La1 - latitude of first grid point (Click here to see La1 values for all Lambert Conformal NDFD grids)
43-46	Lo1 - longitude of first grid point (Click here to see Lo1 values for all Lambert Conformal NDFD grids)
47	0
48-51	25,000,000 - Latitude where grid spacing is defined
52-55	265,000,000 - Orientation longitude
56-59	5,079,406 - Dx, X-direction grid length (Click here to see Dx values for Lambert Conformal NDFD grids)
60-63	5,079,406 - Dy, Y-direction grid length (Click here to see Dy values for Lambert Conformal NDFD grids)
64	0
65	80 - Scanning Mode
66-69	25,000,000 - Latin1, first secant latitude
70-73	25,000,000 - Latin2, second secant latitude
74-77	-90,000,000 - Latitude of southern pole
78-81	0 - Longitude of southern pole

Polar Stereographic (Alaska)

Octet No.	Contents
1-4	65 - Length of section in octets (nn)
5	3
6	0
7-10	Number of data points (Nx * Ny)
11	0
12	0
13-14	20 - template number
15	1
16	0
17-20	6371200 - Radius of the earth
21	0
22-25	0
26	0
27-30	0
31-34	Nx - number of points along the X-axis (Click here to see Nx values for all Polar Stereographic NDFD grids)
35-38	Ny - number of points along the Y-axis (Click here to see Ny values for all Polar Stereographic NDFD grids)
39-42	La1 - latitude of first grid point (Click here to see La1 values for all Polar Stereographic

Octet No.	Contents
	NDFD grids)
43-46	Lo1 - longitude of first grid point (Click here to see Lo1 values for all Polar Stereographic NDFD grids)
47	0
48-51	60,000,000 - LaD, Latitude where mesh length defined
52-55	210,000,000 - LoV, Orientation longitude
56-59	5,953,125 - Dx, X-direction grid length
60-63	5,953,125 - Dy, Y-direction grid length
64	0 - Projection center flag
65	80 - Scanning mode

Mercator (includes Puerto Rico, Hawaii, Guam, and Oceanic domains)

Octet No.	Contents
1-4	72 - Length of section in octets (nn)
5	3
6	0
7-10	Number of data points (Nx * Ny)
11	0
12	0
13-14	10 - template number
15	1
16	0
17-20	6371200 - Radius of the earth
21	0
22-25	0
26	0
27-30	0
31-34	Nx - number of points along the X-axis (Click here to see Nx values for all Mercator NDFD grids)
35-38	Ny - number of points along the Y-axis (Click here to see Ny values for all Mercator NDFD grids)
39-42	La1 - latitude of first grid point (Click here to see La1 values for all Mercator NDFD grids)
43-46	Lo1 - longitude of first grid point (Click here to see Lo1 values for all Mercator NDFD grids)
47	0
48-51	LaD - latitude where mesh length is defined (Click here to see LaD values for all Mercator NDFD grids)
52-55	La2 - latitude of last gridpoint (Click here to see La2 values for all Mercator NDFD grids)
56-59	Lo2 - longitude of last gridpoint (Click here to see Lo2 values for all Mercator NDFD grids)

60	80 - Scanning mode
61-64	0.0000 - Orientation angle of the grid
65-68	2,500,000 - Di, longitudinal direction grid length - (Exception: Puerto Rico = 1,250,000, and Oceanic = 10,000,000)
69-72	2,500,000 - Dj, latitudinal direction grid length - (Exception: Puerto Rico = 1,250,000, and Oceanic = 10,000,000)

Section 4--Product Definition Section

Section 4 will vary from one weather element to the next. The formats for the various elements are detailed in the following sections:

Maximum Temperature (MaxT), Minimum Temperature (MinT), Maximum Relative Humidity (MaxRH), Minimum Relative Humidity (MinRH)

Octet No.	Contents
1-4	58 - Length of section in octets (nn)
5	4
6-7	0
8-9	8
10	0
11	4 for MaxT 5 for MinT 27 for MaxRH 198 for MinRH
12	2
13	0
14	0
15-16	255
17	Missing
18	1
19-22	Hours from reference time to beginning of the valid period.
23	1
24	0
25-28	0
29	Missing
30	0

31-34	Missing
35-36	Year of end of the valid period in GMT.
37	Month of end of the valid period in GMT.
38	Day of end of the valid period in GMT.
39	Hour of end of the valid period in GMT.
40	Minute of end of the valid period in GMT.
41	Second of end of the valid period in GMT.
42	1
43-46	0
47	2 for Max, 3 for Min
48	2
49	1
50-53	12
54	1
55-58	0

Twelve-hour Probability of Precipitation (PoP12)

Octet No.	Contents
1-4	71 - Length of section in octets (nn)
5	4
6-7	0
8-9	9
10	1
11	8
12	2
13	0
14	0
15-16	Missing
17	Missing
18	1
19-22	Hours from reference time to beginning of PoP12 valid period.
23	1
24	0
25-28	0
29	Missing
30	Missing
31-34	Missing

35	Missing
36	Missing
37	1
38	Missing
39-42	Missing
43	3
44-47	254
48-49	Year of end of PoP12 valid period in GMT.
50	Month of end of PoP12 valid period in GMT.
51	Day of end of PoP12 valid period in GMT.
52	Hour of end of PoP12 valid period in GMT.
53	Minute of end of PoP12 valid period in GMT.
54	Second of end of PoP12 valid period in GMT.
55	1
56-59	0
60	1
61	Missing
62	1
63-66	12
67	1
68-71	0

Temperature, Dew point, Sky, Wind Speed, Wind Direction, Wave Height, Weather, Apparent Temperature, Relative Humidity, Wind Gust, Hazards, Haines Index

Octet No.	Contents
1-4	34 - Length of section in octets (nn)
5	4
6-7	0
8-9	0
10	Parameter Category (FM 92 GRIB, Code Table 4.1) See table below for specific values
11	Parameter Number (FM 92 GRIB, Code Table 4.2) See table below for specific values
12	2
13	0
14	0
15-16	255
17	Missing
18	1

19-22	Forecast projection in hours
23	1
24	0
25-28	0
29	0
30	-1
31-34	Missing

Parameter Categories and Parameter Numbers for Temperature, Dew point Temperature, Sky, Wind Speed, Wind Direction, Wave Height, Weather, Apparent Temperature, Relative Humidity, Wind Gust, Hazards, Haines Index

Parameter Name	Category	Number
Temperature	0	0
Dew point Temperature	0	6
Sky	6	1
Wind Speed	2	1
Wind Direction	2	0
Wave Height (see Note 1)	0	5
Weather	1	192
Apparent Temperature	0	193
Relative Humidity	1	1
Wind Gust	2	22
Hazards	19	217
Haines Index (see Note 2)	4	2

Note 1: Wave Height is defined as an Oceanographic Product in Section 0 (Indicator Section, octet 7 = 10).

Note 2: Haines Index is defined as a Land Surface Product in Section 0 (Indicator Section, octet 7 = 2).

QPF, Snow Amount, Ice Accumulation, Daily FRET, Daily FRET Departure and Total Weekly FRET

Octet No.	Contents
1-4	58 - Length of section in octets (nn)
5	4
6-7	0

8-9	8
10	1
11	6◆◆◆◆ for Daily FRET, Daily FRET Departure, and Total Weekly FRET 8 for QPF 29 for Snow Amount 227 for Ice Accumulation
12	2
13	0
14	0
15-16	255
17	Missing
18	1
19-22	Hours from reference time to beginning of valid period.
23	1
24	0
25-28	0
29	Missing
30	-1
31-34	Missing
35-36	Year of end of valid period in GMT.
37	Month of end of valid period in GMT.
38	Day of end of valid period in GMT.
39	Hour of end of valid period in GMT.
40	Minute of end of valid period in GMT.
41	Second of end of valid period in GMT.
42	1
43-46	0
47	10 for Daily FRET Departure 1◆◆ for all others
48	2
49	1
50-53	6◆◆◆◆ for QPF, Snow Amount, and Ice Accumulation 24◆◆ for Daily FRET and Daily FRET Departure 168 for Total Weekly FRET
54	1
55-58	0

Tropical Wind Speed Probabilities (Incremental and Cumulative) greater than 34, 50, and 64 knots - from Tropical Prediction Center

Octet No.	Contents
1-4	71 - Length of section in octets (nn)
5	4
6-7	0
8-9	9
10	2 - Momentum
11	1 - Wind Speed
12	2
13	0
14	0
15-16	Missing
17	Missing
18	1
19-22	0
23	103 - specified height above ground level
24	0
25-28	10 (meters)
29	Missing
30	0
31-34	0
35	Missing
36	Missing
37	1 - probability of event above upper limit
38	0
39-42	0
43	3 - scale factor of upper limit
44-47	17491 (m/s), or 25722 (m/s), or 32924 (m/s) - corresponds to 34, 50, and 64 knots
48-49	Year of end WindSpd Prob valid period in GMT
50	Month of end WindSpd Prob valid period in GMT
51	Day of end WindSpd Prob valid period in GMT
52	Hour of end WindSpd Prob valid period in GMT
53	Minute of end WindSpd Prob valid period in GMT
54	Second of end WindSpd Prob valid period in GMT
55	1
56-59	0
60	1

61	2 - (incremental probability), 192 - (cumulative probability)
62	1 - type of time increment between successive fields (hours)
63-66	6 - (incremental probability), variable number of hours from the reference time to the end time of the valid period - cumulative probability)
67	1
68-71	0

Hazard Probabilities - from Storm Prediction Center (Includes Probabilities of Tornado, Hail, and Damaging Winds, Probabilities of Extreme Tornado, Hail, and Damaging Winds, Total Probability of Severe, and Extreme Severe Thunderstorms

Octet No.	Contents
1-4	71 - Length of section in octets (nn)
5	4
6-7	0
8-9	9
10	Parameter Category (FM 92 GRIB, Code Table 4.1) See table below for specific values
11	Parameter Number (FM 92 GRIB, Code Table 4.2) See table below for specific values
12	2
13	0
14	0
15-16	255
17	255
18	1
19-22	Hours from reference time to beginning of valid period
23	1
24	0
25-28	0
29	255
30	-1
31-34	-1
35	255
36	255
37	1
38	-1
39-42	-1
43	0
44-47	0
48-49	Year of end of valid period in GMT.

50	Month of end of valid period in GMT.
51	Day of end of valid period in GMT.
52	Hour of end of valid period in GMT.
53	Minute of end of valid period in GMT.
54	Second of end of valid period in GMT.
55	1
56-59	0
60	0
61	255
62	1
63-66	24
67	1
68-71	0

Parameter Categories and Parameter Numbers for Hazard Probabilities

Parameter Name	Parameter Category	Parameter No.
Probability of Tornado	19	197
Probability of Hail	19	198
Probability of Damaging Winds	19	199
Probability of Extreme Tornado	19	200
Probability of Extreme Hail	19	201
Probability of Extreme Damaging Winds	19	202
Total Probability of Severe Thunderstorms	19	203
Total Probability of Extreme Severe Thunderstorms	19	204

Categorical Outlooks - from Storm Prediction Center (includes Convective Hazard Outlook, Fire Wx Critical and Extremely Critical Areas, and Fire Wx Critical Areas for Dry Thunderstorms) and

Tropical Cyclone Categorical Threats � from WFOs (include Tropical Cyclone Storm Surge Threat, Tropical Cyclone Flooding Rain Threat, Tropical Cyclone Tornado Threat, and Tropical Cyclone Wind Threat)

Octet No.	Contents
1-4	58 - Length of section in octets
5	4
6-7	0
8-9	8

10	Parameter Category (FM 92 GRIB, Code Table 4.1) See table below for specific values
11	Parameter Number (FM 92 GRIB, Code Table 4.2) See table below for specific values
12	2
13	0
14	0
15-16	255
17	255
18	1
19-22	Hours from reference time to beginning of valid period
23	1
24	0
25-28	0
29	255
30	-1
31-34	-1
35-36	Year of end of valid period in GMT.
37	Month of end of valid period in GMT.
38	Day of end of valid period in GMT.
39	Hour of end of valid period in GMT.
40	Minute of end of valid period in GMT.
41	Second of end of valid period in GMT.
42	1 � SPC Outlooks 2 � Tropical Cyclone Threats
43-46	0
47	1
48	255
49	1
50-53	24
54	1
55-58	0

Parameter Categories and Parameter Numbers for Categorical Outlooks and Tropical Cyclone Threats

Parameter Name	Parameter Category
Convective Hazard Outlook	19
Fire Wx Critical and Extremely Critical Areas	192
Fire Wx Critical Areas for Dry Thunderstorms	192

Tropical Cyclone Storm Surge Threat	19
Tropical Cyclone Flooding Rain Threat	19
Tropical Cyclone Tornado Threat	19
Tropical Cyclone Wind Threat	19

Climate Outlook Probability Elements - from Climate Prediction Center (Average Temperature and Total Precip Above and Below Normal for 8-14 Day Outlook, 1 Month Outlook, and Seasonal Outlook)

Octet No.	Contents
1-4	71- Length of section in octets (nn)
5	4
6-7	0
8-9	9
10	Parameter Category (FM 92 GRIB, Code Table 4.1) 0 = Temperature, 1 = Moisture
11	Parameter Number (FM 92 GRIB, Code Table 4.2) 0 = Temperature, 8 = Total Precipitation
12	2
13	0
14	0
15-16	255
17	255
18	Indicator of unit of time range - 8-14 Day Outlooks = 2 (days); Monthly and Seasonal Outlooks = 3 (months)
19-22	Time from beginning of issuance day (8-14 Day Outlooks) or issuance month (Monthly/Seasonal Outlooks) to beginning of valid period in units specified by octet 18
23	1
24	0
25-28	0
29	255
30	-1
31-34	-1
35	255
36	2 - Total Number of forecast probabilities
37	3 - Probability type
38	0
39-42	0
43	0

44-47	0
48-49	Year of end of valid period in GMT.
50	Month of end of valid period in GMT.
51	Day of end of valid periodin GMT.
52	Hour of end of valid period in GMT.
53	Minute of end of valid period in GMT.
54	Second of end of valid period in GMT.
55	1
56-59	0
60	0
61	255
62	Indicator of unit of time for time range over which statistical processing is done. 8-14 Day Outlooks = 2 (days); Monthly and Seasonal Outlooks = 3 (months)
63-66	Length of time range over which statistical processing is done. 8-14 Day Outlooks = 6 (days); Monthly Outlooks = 1 (month); Seasonal Outlooks = 3 (months)
67	1
68-71	0

Section 5--Data Representation Section

The GRIB2 standard supports eight forms of data packing. Grids transmitted as part of the NDFD will use complex packing (Data Representation Template 5.2), and optionally, second order spatial differencing (Data Representation Template 5.3).

NDFD grids will generally contain a significant number of missing values. National mosaic grids are defined to be rectangles, and they generally extend into areas where NWS WFOs do not have forecast responsibility.

Octet No.	Contents
1-4	47 or 49 - Length of section in octets (nn) (47 for Template 5.2, 49 for Template 5.3)
5	5
6-9	Total number of data points.
10-11	2 or 3
12-15	Reference value (R) as an IEEE 32-bit floating-point value. Varies from grid to grid.
16-17	Binary scale factor (E). Varies from weather element to weather element. See Element Encoding Characteristics Table for values.� For experimental fine resolution grids�.click Here.
18-19	Decimal scale factor (D). Varies from weather element to weather element. See Element Encoding Characteristics Table for values. For experimental fine resolution grids�.click Here.
20	Number of bits used for each group reference value.
21	1 (integer) for Weather grids; 0 (floating point) for all other weather elements.

22	1
23	1
24-27	Primary missing value substitute. See [Element Encoding Characteristics Table](#) for values. The values in the table will appear in the GRIB2 bulletins in Section 5, but will not appear with the data in section 7. The GRIB2 standard calls for missing values to be carried as the largest value possible in a particular group.� For experimental fine resolution grids�.click Here
28-31	0
32-47	See GRIB2 documentation.
48	2 - Order of spatial differencing (Template 5.3 only)
49	See GRIB2 documentation. (Template 5.3 only)

Section 6--Bit-map Section

Bit-maps will not be used in NDFD GRIB bulletins. Missing values will appear in those grid locations where forecasts are not valid.

Octet No.	Contents
1-4	6 - Length of section in octets (nn)
5	6
6	255

Section 7--Data Section

Octet No.	Contents
1-4	Length of section in octets (nn)
5	7
6-nn	See GRIB2 documentation.

Section 8--End Section

Octet No.	Contents
1-4	"7777"

NDFD Lambert Conformal CONUS Grid Spacing Values (Dx, DY)

	Operational Values	Experimental Values
Dx	5,079,406	2,539,703
Dy	5,079,406	2,539,703

Element Encoding Characteristics

Weather Element	Original NDFD Units	GRIB2-encoded Units	Binary Scale Factor CONUS 5 km	Binary Scale Factor - CONUS 2.5 km	Decimal Scale Factor CONUS 5 km	Decimal Scale Factor - CONUS 2.5 km	Primary Missing Value Substitute
MaxT	Fahrenheit	Kelvin	0	2	1	1	9999
MinT	Fahrenheit	Kelvin	0	2	1	1	9999
PoP12	Percent Probability	Percent Probability	0	0	0	0	9999
T	Fahrenheit	Kelvin	0	2	1	1	9999
Td	Fahrenheit	Kelvin	0	2	1	1	9999
Sky	Percentage Total sky coverage	Percentage Total sky coverage	0	0	0	0	9999
Wind Speed	Knots	ms-1	0	2	1	1	9999
Wind Direction	degrees true	Degrees true	0	0	0	-1	9999
Weather	N/A	N/A	0	0	0	0	9999
QPF	Inches	kgm-2	0	0	2	2	9999
Snow Amount	Inches	Meters	0	0	3	3	9999
Wave Height	Feet	Meters	0	0	1	1	9999
Apparent Temperature	Fahrenheit	Kelvin	0	2	1	1	9999
Relative Humidity	Percent	Percent	0	0	0	0	9999
Wind Gust	Knots	ms-1	0	2	1	1	9999
Tropical Wind Speed Probabilities (34, 50, 65 kts) Cumulative and Incremental	Percent Probability	Percent Probability	0	0	0	0	9999

Convective Outlooks/Fire Wx Outlooks	Categorical	Categorical	0	0	0	0	9999
Hazard Probabilities	Percent Probability	Percent Probability	0	0	0	0	9999
Climate Outlook Probabilities	Categorical	Categorical	0	0	0	0	9999
Ice Accumulation	Inches	kgm-2	0	0	2	2	9999
MaxRH	%	%	0	0	0	0	9999
MinRH	%	%	0	0	0	0	9999
Hazards	N/A	N/A	0	0	0	0	9999
Daily FRET	Inches	kgm-2	NA	0	NA	2	9999
Daily FRET Departure	Inches	kgm-2	NA	0	NA	2	9999
Total Weekly FRET	Inches	kgm-2	NA	0	NA	2	9999
Tropical Cyclone Storm Surge Threat	Categorical	Categorical	NA	0	NA	0	9999
Tropical Cyclone Flooding Rain Threat	Categorical	Categorical	NA	0	NA	0	9999
Tropical Cyclone Wind Threat	Categorical	Categorical	NA	0	NA	0	9999
Tropical Cyclone Tornado Threat	Categorical	Categorical	NA	0	NA	0	9999
Haines Index	Categorical	Categorical	NA	0	NA	0	9999

NDFD Grid Location and Sizes (by geographic region/sector)

Lambert Conformal

Sector Name	Item	Value
CONUS		
5 km	Nx	1073
	Ny	689
	La1	2019199
	Lo1	2384459
CONUS		
2.5 km��	Nx	2143
	Ny	1375
	La1	2019199
	Lo1	2384459
Central Great Lakes		
	Nx	173
	Ny	219
	La1	3876136
	Lo1	2715378
Central Mississippi Valley		
	Nx	197
	Ny	187
	La1	3409910
	Lo1	2646187
Central Plains		
	Nx	223
	Ny	187
	La1	3469884
	Lo1	2550276
Central Rockies		
	Nx	254
	Ny	185
	La1	3510457
	Lo1	2462040
Eastern Great Lakes		
	Nx	187
	Ny	192
	La1	3925241
	Lo1	2735126
Mid-Atlantic		
	Nx	194
	Ny	200
	La1	3139028

	Lo1	2742057
Northeast		
	Nx	187
	Ny	229
	La1	3869834
	Lo1	2812826
Northern Plains		
	Nx	252
	Ny	239
	La1	3968270
	Lo1	2546129
Northern Rockies		
	Nx	306
	Ny	228
	La1	3944028
	Lo1	2439814
Pacific Northwest		
	Nx	313
	Ny	212
	La1	3949451
	Lo1	2341168
Pacific Southwest		
	Nx	312
	Ny	252
	La1	2926025
	Lo1	2368744
Southeast		
	Nx	243
	Ny	201
	La1	2407851
	Lo1	2691026
Southern Mississippi Valley		
	Nx	199
	Ny	184
	La1	2860611
	Lo1	2640133
Southern Plains		
	Nx	314
	Ny	275
	La1	2510639

	Lo1	2528770
Southern Rockies		
	Nx	267
	Ny	190
	La1	3031159
	Lo1	2451204
Upper Mississippi Valley		
	Nx	245
	Ny	270
	La1	3818489
	Lo1	2597956

Polar Stereographic

Sector Name	Item	Value
Alaska		
	Nx	825
	Ny	553
	La1	4053010
	Lo1	1814290

Mercator

Sector Name	Item	Value
Puerto Rico		
	Nx	339
	Ny	227
	La1	1697739
	Lo1	2919721
	La2	195445
	Lo2	296016
	LaD	2000000
Hawaii		
	Nx	321
	Ny	225
	La1	180726
	Lo1	1984750
	La2	230877
	Lo2	206131
	LaD	2000000

Guam		
	Nx	193
	Ny	193
	La1	1234988
	Lo1	1436865
	La2	1679439
	Lo2	1482800
	LaD	2000000
Oceanic		
	Nx	2517
	Ny	1793
	La1	-30419200
	Lo1	129906005
	La2	80010000
	Lo2	10710000
	LaD	2000000

NDFD Hazard Keys

Code	Phenomenon/Significance	Code	Phenomenon/Significance
AF.W	Ash Fall Warning	GL.A	Gale Watch
AF.Y	Ash Fall Advisory	GL.W	Gale Warning
AS.Y	Air Stagnation Advisory	HF.A	Hurricane Force Wind Watch
BS.Y	Blowing Snow Advisory	HF.W	Hurricane Force Wind Warning
BW.Y	Brisk Wind Advisory	HI.A	Hurricane Wind Watch
BZ.A	Blizzard Watch	HI.W	Hurricane Wind Warning
BZ.W	Blizzard Warning	HS.W	Heavy Snow Warning
CF.A	Coastal Flood Watch	HT.Y	Heat Advisory
CF.S	Coastal Flood Statement	HU.A	Hurricane Watch
CF.W	Coastal Flood Warning	HU.S	Hurricane Statement
CF.Y	Coastal Flood Advisory	HU.W	Hurricane Warning
DS.W	Dust Storm Warning	HW.A	High Wind Watch
DU.Y	Blowing Dust Advisory	HW.W	High Wind Warning
EC.A	Extreme Cold Watch	HZ.A	Hard Freeze Watch
EC.W	Extreme Cold Warning	HZ.W	Hard Freeze Warning
EH.A	Excessive Heat Watch	IP.W	Sleet Warning
EH.W	Excessive Heat Warning	IP.Y	Sleet Advisory
EW.W	Extreme Wind Warning	IS.W	Ice Storm Warning

FA.A	Areal Flood Watch	LB.Y	Lake Effect Snow and Blowing Snow A
FA.W	Areal Flood Warning	LE.A	Lake Effect Snow Watch
FA.Y	Areal Flood Advisory	LE.W	Lake Effect Snow Warning
FF.A	Flash Flood Watch	LE.Y	Lake Effect Snow Advisory
FF.W	Flash Flood Warning	LO.Y	Low Water Advisory
FG.Y	Dense Fog Advisory	LS.A	Lake Shore Flood Watch
FL.A	Flood Watch	LS.S	Lake Shore Flood Statement
FL.W	Flood Warning	LS.W	Lake Shore Flood Warning
FL.Y	Flood Advisory	LS.Y	Lake Shore Flood Advisory
FR.Y	Frost Advisory	LW.Y	Lake Wind Advisory
FW.A	Fire Weather Watch	MA.S	Marine Weather Statement
FW.W	Fire Weather Warning	MA.W	Marine Weather Warning
FZ.A	Freeze Watch	MF.Y	Dense Fog Advisory
FZ.W	Freeze Warning	MH.Y	AshFall Advisory
		MS.Y	Dense Smoke Advisory