

The NSSL National 3-D Reflectivity Mosaic Data Specifications and Product Suite

I. Input data sources

The NSSL National 3-D Reflectivity Mosaic system's current radar data ingest includes level-2 data from the WSR-88D network via CRAFT/IRADS (Integrated Radar Data Services). Canadian radar data is also used but with a 30-minute delay. TDWR data is currently being investigated and will be added on availability basis.

II. Domain

- The National 3D Mosaic is a major component of the NSSL's National Mosaic and QPE (NMQ) system. The NMQ domain and the radar locations are shown in Fig.1.

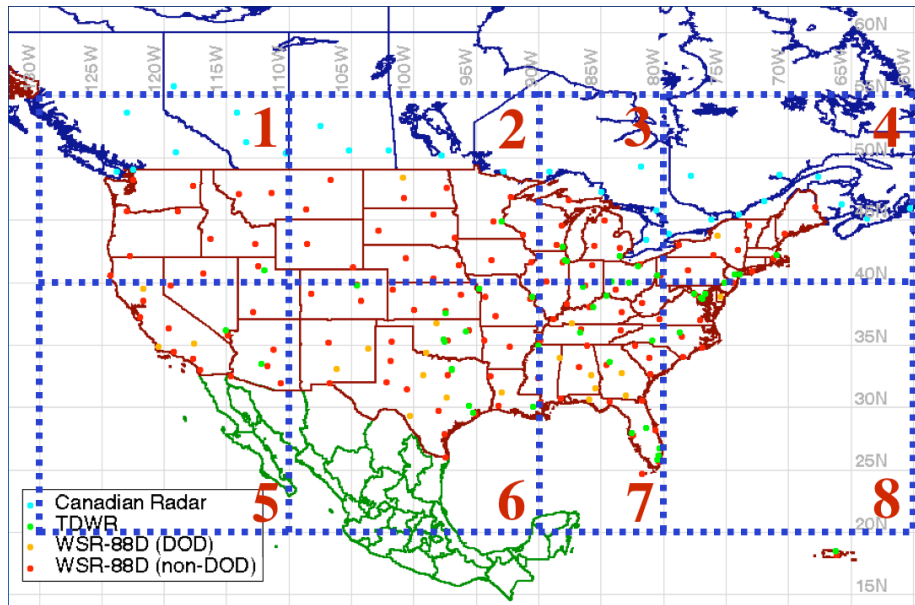


Fig. 1 The NMQ 3-D Mosaic domain and computational tiles.

- The domain parameters are shown in Table 1. The grid resolution in the west-east direction is $dx (lon) = 0.01^\circ$. This is approximately 1.045km at the southern bound of the domain and about 0.638km at the northern bound of the domain. The grid resolution in north-south direction is $dy (lat) = 0.01^\circ$ which is 1.112km everywhere. The lat/lon coordinates for a grid cell refers to the cell's center point.
- There are 31 vertical levels in the 3D Mosaic grid. The height of each level is listed in Table 2. Figure 2 shows the height distributions of the vertical levels.

Table 1 Domain parameters for the national 3D reflectivity mosaic system

Tile ID	ctrlat (°N)	ctrlon (°W)	nx	ny	nz	SW corner	NE corner
1	47.5	120	2001	1501	31	40, -130	55, -110
2	47.5	100	2001	1501	31	40, -110	55, -90
3	47.5	85	1001	1501	31	40, -90	55, -80
4	47.5	70	2001	1501	31	40, -80	55, -60
5	30	120	2001	2001	31	20, -130	40, -110
6	30	100	2001	2001	31	20, -110	40, -90
7	30	85	1001	2001	31	20, -90	40, -80
8	30	70	2001	2001	31	20, -80	40, -60

Table 2 Height of each vertical level in the NSSL 3D CONUS reflectivity mosaic grid

Level #	Height (km above mean sea level)
1	0.5
2	0.75
3	1
4	1.25
5	1.5
6	1.75
7	2
8	2.25
9	2.5
10	2.75
11	3
12	3.5
13	4
14	4.5
15	5
16	5.5
17	6
18	6.5
19	7
20	7.5
21	8
22	8.5
23	9
24	10
25	11
26	12
27	13
28	14
29	15
30	16
31	18

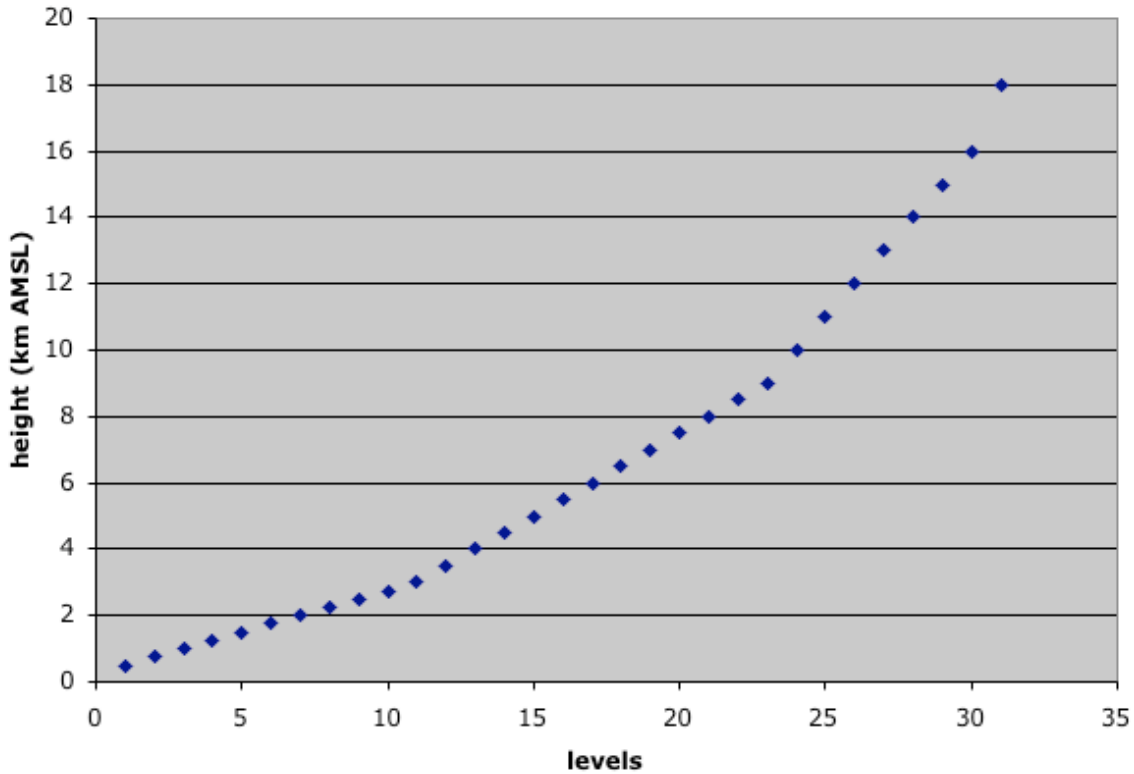


Fig.2 Height of each vertical level in the NSSL 3D CONUS reflectivity mosaic grid

III. Products

There are two types of mosaic products generated and available to users. Product availability varies as fields are added/deleted from the system.

1. Data files

- i) 3-D reflectivity mosaic grid
- ii) 2-D storm products derived from the 3D reflectivity mosaic grid, which include the following data fields:
 - composite reflectivity (cref)
 - height associated with the composite reflectivity (hgt_cref)
 - low layer composite reflectivity [0-24 kft] (lcr_low)
 - high layer composite reflectivity [24-60 kft] (lcr_high)
 - super layer composite reflectivity [33-60 kft] (lcr_super)
 - echo top (etp)
 - storm top (strmtop)
 - severe hail index (shi)
 - probability of severe hail (posh)
 - maximum estimated hail size (mehs)
 - hybrid scan reflectivity (hsr)
 - height associated with the hybrid scan reflectivity (hsrh)
 - low-level composite reflectivity (lcref)
 - height associated with low-level composite reflectivity (hgt_lcref)

- vertically integrated liquid (vil)
- VIL density (vilD)
- precipitation type (liquid/frozen) (pcp_type)
- precipitation flag (convective/stratiform/tropical/etc) (pcp_flag)
- precipitation flag (convective/stratiform only) (cs_pcp_flag) *

* Available only as HMRG binary (currently not included in netCDF)

2. Images

Users may access the NMQ QVS (<http://nmq.ou.edu>) page where they can view images of the 3-D and 2-D products both in real-time and retrospectively (up to 3 years). Additionally, the NMQ verification page includes but is not limited to:

UnQC'd composite reflectivity,
Satellite IR image,
Satellite effective cloud amount,
RUC surface temperature

IV. Data format

NMQ data is available in two main formats. The first is a native format called HMRG binary, which is available in real-time via LDM. Data in this format is single-variable. Meaning, there is a separate file for 3-D data and a series of separate files for 2-D data. An example C reader is available upon request.

NMQ data is also available in netCDF. While not exactly identical, the netCDF header and data are organized very similar to WDSS-II (Warning Decision Support System – Integrated Information) netCDF. The 3-D data for any given domain (tile) are stored in one file and *all* 2-D data fields for one tile are stored in one multi-variable netCDF file. Real-time netCDF data is available via LDM or HTTP. A 6-month archive of netCDF data is available online (available upon request).

The following subsections describe the netCDF data. Note the file name format for netCDF data is

YYYYMMDD-HHmmSS.netcdf.gz
(e.g., 20110315-123500.netcdf.gz)

3-D NetCDF

An example of the NMQ 3-D netCDF format follows. Variables seen below are defined in Table 4. In the “data” section, the first element is for the grid cell at the northwest corner of the domain at the lowest elevation.

```

netcdf 20060316-0320 {
dimensions:
    Ht = 31 ;
    Lat = 1501 ;
    Lon = 2001 ;
variables:
    short mrefl_mosaic(Ht, Lat, Lon) ;
        mrefl_mosaic:Units = "dBZ" ;
    mrefl_mosaic:Scale = 10.f ;
    float Height(Ht) ;
        Height:Units = "Meters" ;

// global attributes:
        :TypeName = "mrefl_mosaic" ;
        :DataType = "LatLonHeightGrid" ;
        :Time = 1142479200 ;
        :FractionalTime = 0.f ;
        :MissingData = -999.f ;
        :RangeFolded = -1000.f ;
        :Latitude = 55.f ;
        :Longitude = -130.f ;
        :Height = 500.f ;
        :LatGridSpacing = 0.01f ;
        :LonGridSpacing = 0.01f ;
        :attributes = "" ;

data:

mrefl_mosaic =
    -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990,
    -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990,
    -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990,
    .....

Height = 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 2750, 3000,
    3500, 4000, 4500, 5000, 5500, 6000, 6500, 7000, 7500, 8000, 8500, 9000,
    10000, 11000, 12000, 13000, 14000, 15000, 16000, 18000 ;
}

```

Table 4 Definitions for 3-D NetCDF format

Variable	Type	Description	Comment
Ht	dimension	Number of vertical levels	Current value = 31
Lat	dimension	Number of rows (ny)	
Lon	dimension	Number of columns (nx)	
mrefl_mosaic	variable	3D reflectivity data	
Scale	var attribute	Scaling factor for mrefl_mosaic	Current value = 10
Height	variable	Height of individual levels	Units = meters
TypeName	global attribute	Name of variable field	
DataType	global attribute	File format	Current value = LatLonHeightGrid
Time	global attribute	Epoch time	Units = seconds
FractionalTime	global attribute	Time stamp's milliseconds	Current value = zero
MissingData	global attribute	Missing data value	
RangeFolded	global attribute	Range folded value (not applicable)	Ignore this value
Latitude	global attribute	Latitude of NW corner	Latitude is for center of grid cell
Longitude	global attribute	Longitude of NW corner	Longitude is for center of grid cell
Height	global attribute	Height of first level	Current value = 500 meters
LatGridSpacing	global attribute	Grid spacing with respect to Latitude	Current value = 0.01 degrees
LonGridSpacing	global attribute	Grid spacing with respect to Longitude	Current value = 0.01 degrees
attributes	global attribute	Stores extra attributes/information	Current value = an empty string.

Multi-Variable NetCDF

2-D fields are stored in the multi-variable netCDF. Table 5 lists these fields and other relative information. In the “data” section, the first element is for the grid cell at the northwest corner of the domain.

Table 5 Multi-variable NetCDF fields

Name	Units	Scale	Missing Value
cref	dBZ	10	-999
hgt_cref	kmMSL	1000	-1
lcr_low	dBZ	10	-999
lcr_high	dBZ	10	-999
lcr_super	dBZ	10	-999
etp18	kmMSL	1000	-1
strmtop30	kmMSL	1000	-1
shi	n/a	10	-999
posh	%	10	-999
mehs	mm	10	-999
hsr	dBZ	10	-999
hsrh	kmAGL	1000	-1
lcref	dBZ	10	-999
hgt_lcref	kmMSL	1000	-1
vil	kg/m2	10	-999
vilD	g/m3	10	-999
pcp_flag	flag	none	-999
pcp_type	flag	none	-999

An example of the NMQ 2-D multi-variable netCDF format follows. Variables seen below are defined in Table 6.

```
netcdf 20060316-0320 {
dimensions:
    Lat = 1501 ;
    Lon = 2001 ;
variables:
    short cref(Lat, Lon) ;
        cref:Units = "dBZ" ;
        cref:TypeName = "cref" ;
        cref:MissingData = -999.f ;
        cref:Scale = 10.f ;
        cref:attributes = "" ;
    short hgt_cref(Lat, Lon) ;
        hgt_cref:Units = "kmMSL" ;
        hgt_cref:TypeName = "hgt_cref" ;
        hgt_cref:MissingData = -1.f ;
        hgt_cref:Scale = 1000.f ;
        hgt_cref:attributes = "" ;

    ....

    short pcp_type(Lat, Lon) ;
        pcp_flag:Units = "flag" ;
        pcp_flag:TypeName = " pcp_type" ;
        pcp_flag:MissingData = -999.f ;
        pcp_flag:attributes = "" ;

// global attributes:
    :DataType = "LatLonGrid" ;
    :Time = 1142479200 ;
    :FractionalTime = 0.f ;
    :RangeFolded = -99901.f ;
    :Latitude = 55.f ;
    :Longitude = -130.f ;
    :Height = 0.f ;
    :LatGridSpacing = 0.01f ;
    :LonGridSpacing = 0.01f ;

data:

    cref =
        -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990, -9990,
        .....
    }
```


Table 6 Definitions for Multi-Variable NetCDF format

Variable	Type	Description	Comment
Lat	dimension	Number of rows (ny)	
Lon	dimension	Number of columns (nx)	
Units	var attribute	Units for variable	
Scale	var attribute	Scaling factor for variable	If data is not scaled, this variable attribute will not appear.
TypeName	var attribute	Name of variable field	
attributes	var attribute	Stores extra attributes/information	Current value = empty string.
DataType	global attribute	File format	Current value = LatLonGrid
Time	global attribute	Epoch time	Units = seconds
FractionalTime	global attribute	Time stamp's milliseconds	Current value = zero
MissingData	global attribute	Missing data value	
RangeFolded	global attribute	Range folded value (not applicable)	Current value = -99901
Latitude	global attribute	Latitude of NW corner	Latitude is for center of grid cell
Longitude	global attribute	Longitude of NW corner	Longitude is for center of grid cell
Height	global attribute	Height of first level	Current value = zero meters
LatGridSpacing	global attribute	Grid spacing with respect to Latitude	Current value = 0.01 degrees
LonGridSpacing	global attribute	Grid spacing with respect to Longitude	Current value = 0.01 degrees

V. Product update cycle

The product update cycle for the CONUS 3D mosaic products is 5 minutes.

VI. Data file size

The size of netCDF 2-D product data (gzip'd) ranges from less than 1MB to ~7MB per file depending on tile size and extent of echo coverage. The netCDF 3-D mosaic grid data (gzip'd) ranges from 5MB to ~15MB per file. These estimates are based a testing period of ~1 week.

VII. Dissemination

Users are encouraged to use LDM to receive real-time products and data sets. HTTP access is also available. Archive netCDF data is available via HTTP for data less than 6-months old. In addition to LDM and HTTP, users may view data using the NMQ QVS site at <http://nmq.ou.edu>.