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 and level-3 data from the WSR-88D network via CRAFT/IRADS (Integrated Radar Data Services). The Canadian radar network data will be added in FY06. 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.

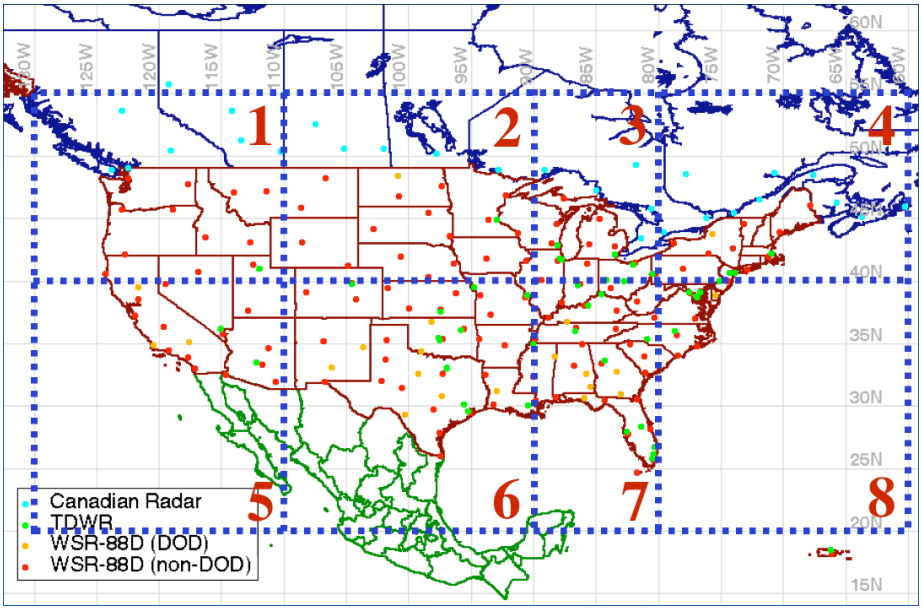

Fig. 1 The NMQ 3-D Mosaic domain and computational tiles.

- The domain parameters are shown in Table 1. The grid resolution in the west-east direction is dx (lon) = 0.01° . 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° which is 1.112km everywhere.

- 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 (ºN)	ctrlon (ºW)	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

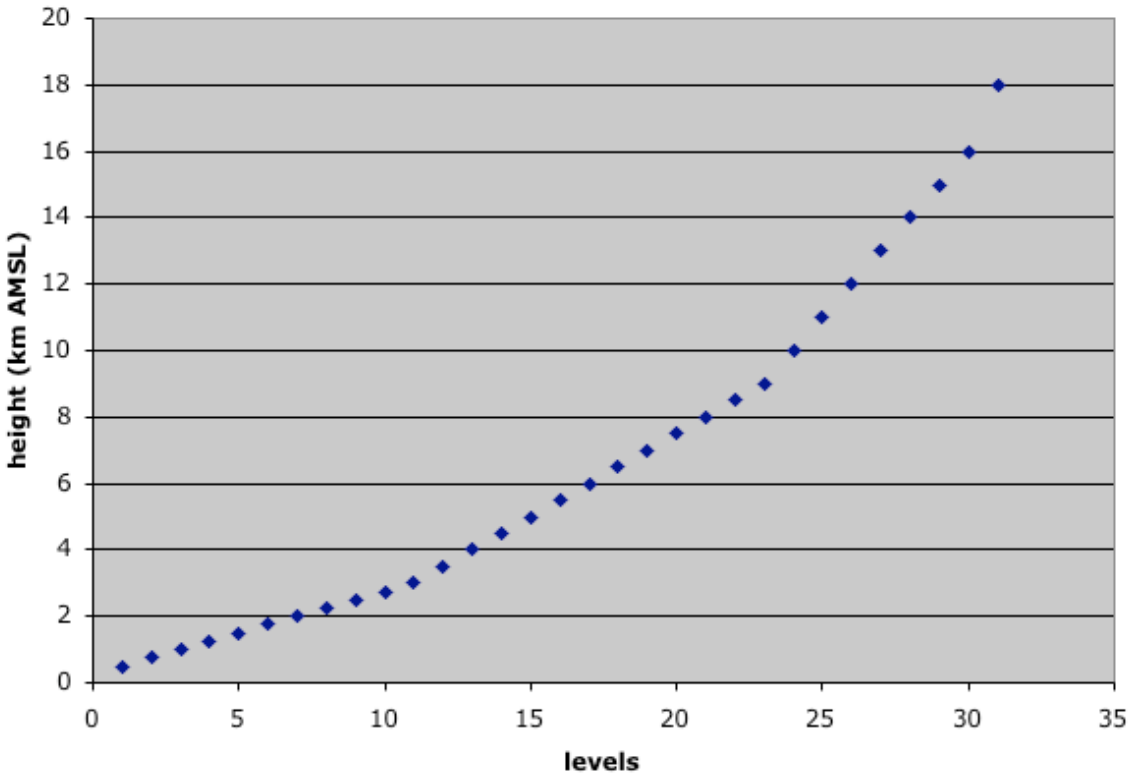

Fig.2 Height of each vertical level in the NSSL 3D CONUS reflectivity mosaic grid

III. Products

There are currently two types of products generated and available to users. These include:

1. Data files
   There are two sets of data files available to the users:
   i) 3-D reflectivity mosaic grid
   ii) 2-D storm products derived from the 3D reflectivity mosaic grid, which include the following 13 data fields:
   - composite reflectivity (cref)
   - height associated with the composite reflectivity (hgt_cref)
   - echo top (etp18)
   - 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 flag (convective/stratiform) (pcp_flag)

2. Images
   The users will be provided with access to the NMQ verification page where they can view images of the 3-D and 2-D products both in real-time and retrospectively (up to 6 months). The 2-D image products include the 13 storm products mentioned above. Additionally, the NMQ verification page will include but not limited to:

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

Please note that the new NMQ system will keep up to 1-month of 3-D and 2-D image mosaic products online. We will archive the image products older than 1-month to DVDs.

IV. Data format

We have employed the WDSS-II (Warning Decision Support System – Integrated Information) NetCDF format for both the 3-D and the 2-D data fields. The 3-D data for any given domain (tile) are stored in one file and all 2-D data fields for the tile are stored in one multi-variable NetCDF file. Note that the multi-variable format is a slight variation from the standard WDSS-II NetCDF format.

The following defines the 3-D and multi-variable WDSS-II NetCDF for Mosaic products. Note the file name format for both formats is:

YYYYMMDD-HHmm.netcdf.gz

3-D NetCDF

An example of the WDSS-II NetCDF 3-D 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.

```
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, -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

There are 13 2-D fields 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
etp18	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

An example of the WDSS-II NetCDF multi-variable 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_flag(Lat, Lon) ;
                pcp_flag:Units = "flag" ;
                pcp_flag:TypeName = " pcp_flag " ;
                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 ;
}
```

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

VII. Dissemination

The users are encouraged to use LDM to receive the products and data sets. Anonymous FTP access can be setup if needed. In addition to LDM and FTP, we will deploy ArcIMS on the NMQ system as possible interactive tool for users to customize the NMQ products and grids they wish to receive. Complementary to the current NMQ webpage, we will be utilizing the ArcIMS system as web based dissemination tool for both real time and archived products.