A BRIEF DESCRIPTION ON NetCDF IMD RADAR DATA

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With the concept of going for a non-proprietary format, new IMD radars were brought with a provision to convert the proprietary format radar data into NetCDF format. The NetCDF format has the skeleton of 'FSL- NetCDF' with some additional headers to custom suite IMD needs. The naming and other standard NetCDF convention is preserved so that any general user of NetCDF data can utilize the radar data with much ease through freely available NetCDF readers and converters in the web.

The IMD Radar NetCDF file has

1. dimensions & data values:
   - `bin`: gives the number of available range-bins forming a radar ray
   - `radial`: gives the number of rays in a single volume sweep
   - `sweep`: gives the number of elevation angles in the volume scan data
2. variables & data values:
   - `esStartTime`: a number indicating the start time of elevation scan in seconds with reference to 1.1.1970
   - `elevationNumber`: Count sequence of elevation angles
   - `elevationAngle`: Average of the elevation angles in degrees
   - `radialAzim(radial)`: Azimuth angle for the ray in degrees
   - `radialElev(radial)`: Elevation angle for the ray in degrees
   - `radialTime(radial)`: Number indicating the start time of ray in seconds with reference to 1.1.1970
   - `siteLat`: Latitude of the radar site in degrees (north)
   - `siteLon`: Longitude of the radar site in degrees (east)
   - `siteAlt`: Altitude of the radar site in metres (AMSL)
   - `firstGateRange`: Starting range of first radar-bin of the ray in meters
   - `gateSize`: Range spacing of the radar bins in meters
   - `nyquist`: Measure equated to nyquist velocity (m/s) of the scan (lowPRF multiplied by radar-wavelength of the scan)
   - `unambigRange`: Unambiguous range in km of the scan (PRF dependent)
   - `calibConst`: System calibration constant values in dB
   - `radarConst`: Radar constant for Reflectivity deriving from measured return power
   - `beamWidthHori`: Horizontal beam width (angle between 3dB points)of the radar in degrees
   - `pulseWidth`: Radar propagated signal-pulse-width in micro seconds
   - `*bandwidth`: Bandwidth of the receiver in hertz
   - `filterDop`: Type of clutter filter used in number coded form
   - `elevationList(sweep)`: List of all elevation angles (in degrees) in the volume scan file
   - `azimuthSpeed`: Rotational speed in azimuthal direction of the antenna in deg/sec
   - `highPRF`: value of the higher PRF used for the scan in Hz
   - `lowPRF`: value of the lower PRF used for the scan in Hz
   - `dwellTime`: Time in mill seconds for which the sampled bins gets classified to be within the ray (depends on antenna beam-width, speed)
   - `wavelength`: Radar wave-length in centimetre

- `calI0`: Intercept of calibration fit line with the noise floor (in dBm)
- `calNoise`: Calibration noise associated with the rx
- `groundHeight`: Height of the radar station in meter (AMSL)
- `meltHeight`: Height of melting layer above radar site in meter
- `scanType`: Indication of type of scan performed (0-Unknown, 1-PPI, 2-RHI, 4-PPI Vol, 7-RHI vol)
- `angleResolution`: Angular resolution of radar data in degrees
- `logNoise`: Noise in LOG channel of the receiver in dBm
- `linNoise`: Noise in Linear channel of the receiver in dBm
- `inphaseOffset`: Offset value applied to In-phase signal during data collection
- `quadratureOffset`: Offset value applied to Quadraphase-phase signal during data collection
- `logSlope`: Slope of the LOG channel receiver calibration curve
- `logFilter`: Filter used in the LOG channel
- `filterPntClt`: Point filter to remove bin-spurious returns (0-feature not used)
- `filterThreshold`: Threshold set for the point clutter filtering
- `sampleNum`: Number of signal samples used for the moment estimation of a bin
- `SQIThresh`: Value of SQI threshold set for acquiring data
- `LOGThresh`: Value of LOG channel noise threshold set in dB for acquiring data
- `SIGThresh`: Value of signal power threshold in dB for acquiring data
- `CSRThresh`: Value of clutter correction threshold in dB for acquiring data
- `DBTThreshFlag`: Number indication to identify signal qualifiers used for reflectivity moment estimation [1-LOG, 2-SIG, 4-SQI, 8-CSR; combination yields the appropriate sum]
- `DBZThreshFlag`: Number indication to identify signal qualifiers used for clutter filtered reflectivity moment estimation [1-LOG, 2-SIG, 4-SQI, 8-CSR; combination yields the appropriate sum]
- `VELThreshFlag`: Number indication to identify signal qualifiers used for velocity [1-LOG, 2-SIG, 4-SQI, 8-CSR; combination yields the appropriate sum]
- `WIDThreshFlag`: Number indication to identify signal qualifiers used for spectral-width moment estimate [1-LOG, 2-SIG, 4-SQI, 8-CSR; combination yields the appropriate sum]
- `beamWidthVert`: vertical beam width (angle between 3dB points)of the radar in degrees
- `Z(radial, bin)`: Radar reflectivity number; recorded within the range -127 to 127; below threshold and un-scanned are to be filled with -128; scale_factor (0.5say) and a add_offset (32say) is to be used to the number to arrive at actual reflectivity value [viz if the data read in the file is -1 the radar reflectivity value is 1*0.5+32 = +32.5 dBZ]. The actual add_offset and scale_factor values shall be referred to the NetCDF file.
- `V(radial, bin)`: Radar velocity number; recorded within the range -127 to 127; below threshold and un-scanned are to be filled with -128; scale_factor and offset_add is used to the data value in arriving at

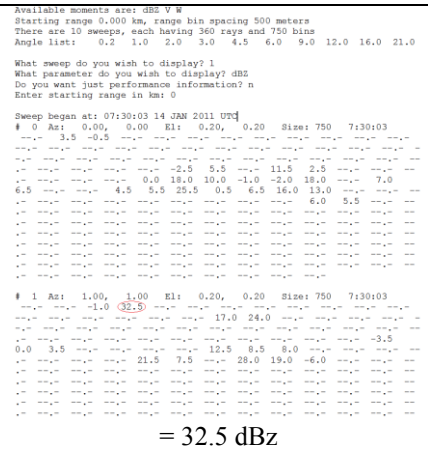
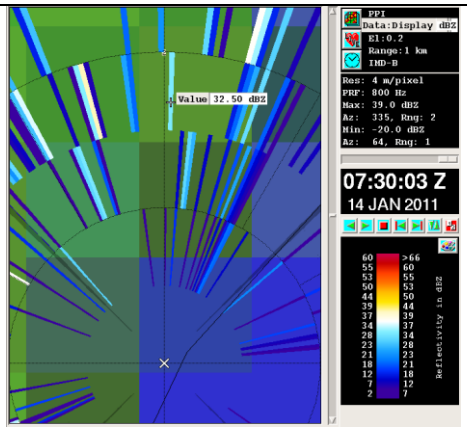
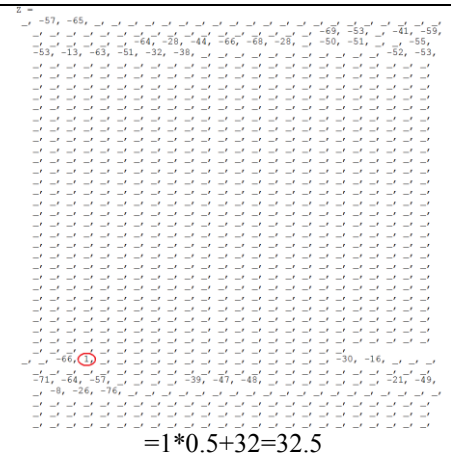
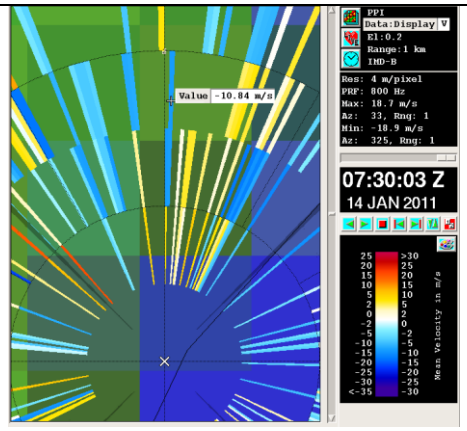
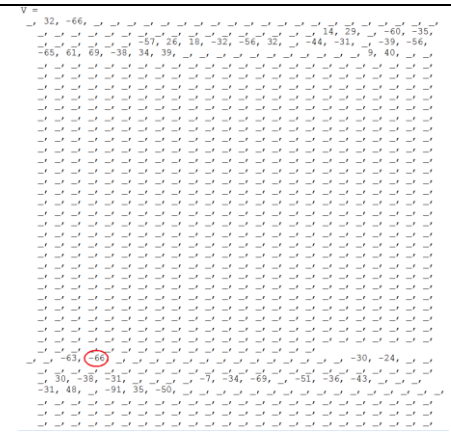
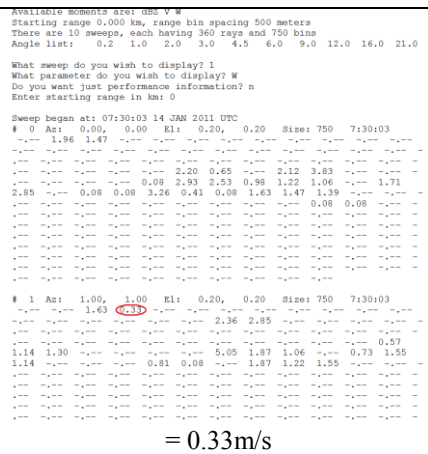
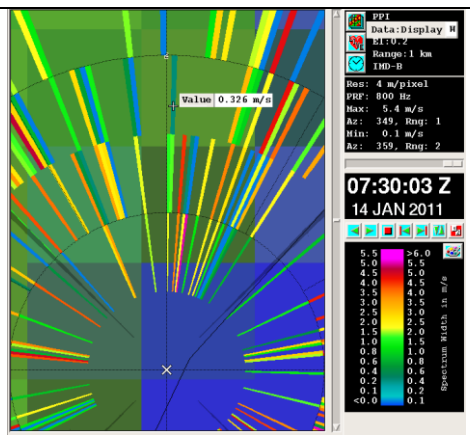
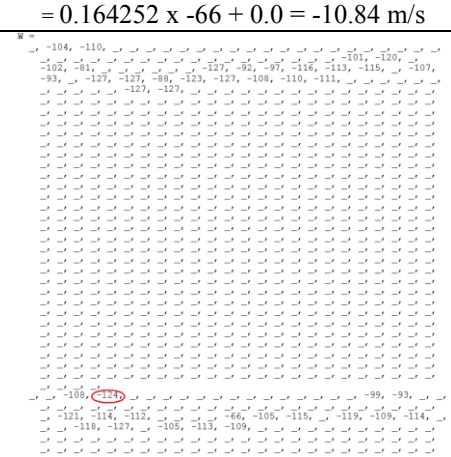
actual radial wind observed. These values can be read in the NetCDF file header.
[viz.
if scale_factor =0.164252; offset_add =0; data value=-66; then the radar radial-wind value of the bin = 0.164252 x -66 + 0.0 = -10.84 m/s]

- `W(radial, bin)`: Radar spectral-width number; recorded within the range -127 to 127; below threshold and un-scanned are to be filled with -128; scale_factor and offset_add is used to the data value in arriving at actual spectral-width. These values can be read in the NetCDF file header.
  [viz.
  if scale_factor =0.08148438; offset_add =10.43; data value=-124; then spectral-width value of the bin =0.08148438 x -124 + 10.43 = +0.326m/s]

SQI, CSR, LOG, LIN, SIG thresholds and the number of samples determines the quality of the observed signal. Point clutter Threshold, Point clutter number, Doppler filter, dBT dBZ V W Threshold flags, etc determines the improvement of weather data quality from the raw observed signals.

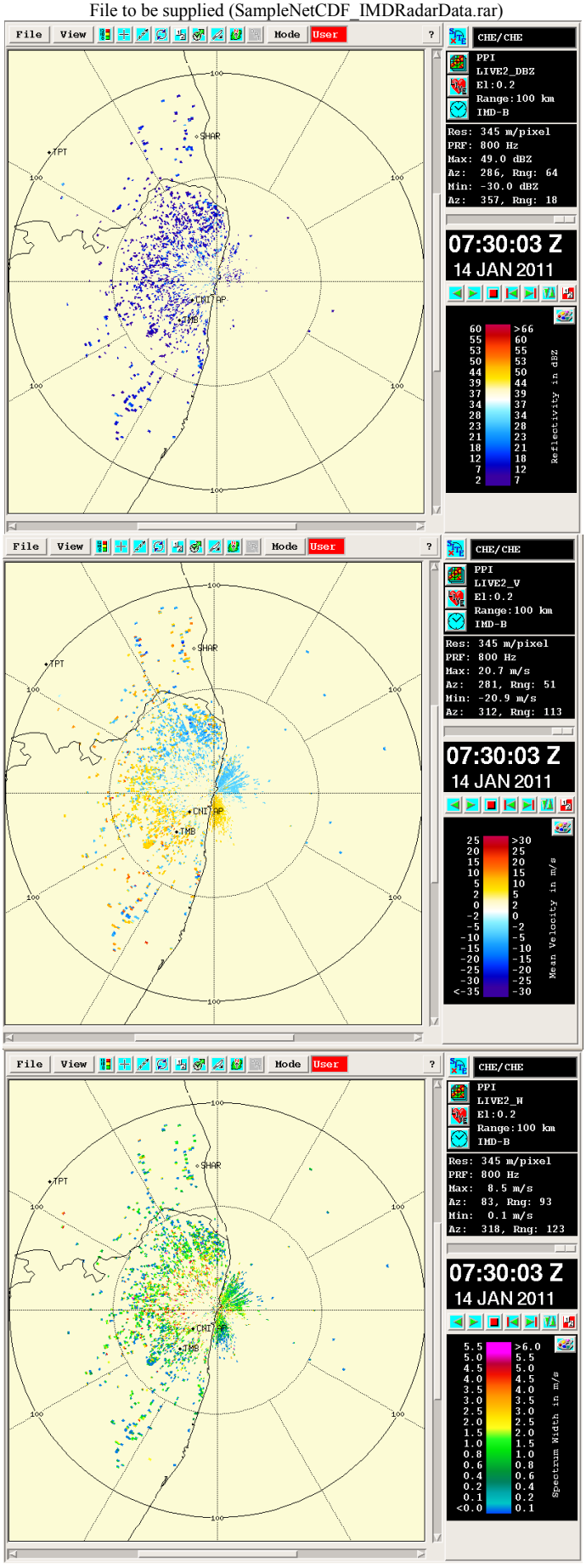
Other parameters describe the settings details of the radar, and the site. Due to the inherent properties of some of the IMD proprietary DWR data headers, certain of these parameters may not represent the actual values. All care is taken to represent the latitude and longitude coordinates of the radar locations accurately. If some other values are adherently required by the user, Radar Experts of IMD shall be approached, details can be found elsewhere.

ASCII DATA, IMAGE & NetCDF Data Comparison

Offset Scaling if any	NIL	NIL	byte Z(radial, bin) ; Z:units = "dBZ" ; Z:long_name = "Reflectivity" ; Z:polarization = "Horizontal" ; Z:scale_factor = 0.5f ; Z:add_offset = 32.f ; Z:valid_range = -127b, 127b ; Z:below_threshold = -128b ; Z:_FillValue = -128b ; byte V(radial, bin) ; V:units = "meters/second" ; V:long_name = "Velocity" ; V:polarization = "Horizontal" ; V:scale_factor = 0.164252f ; V:add_offset = 0.f ; V:valid_range = -127b, 127b ; V:below_threshold = -128b ; V:_FillValue = -128b ; byte W(radial, bin) ; W:units = "meters/second" ; W:long_name = "Spectrum Width" ; W:polarization = "Horizontal" ; W:scale_factor = 0.08148438f ; W:add_offset = 10.43f ; W:valid_range = -127b, 127b ; W:below_threshold = -128b ; W:_FillValue = -128b ;
Moment	ASCII DATA	IMAGE with Readout	NetCDF file data
'Z' Value	 = 32.5 dBz	 = 32.5 dBz	 =1*0.5+32=32.5
'V' Value	 = -10.8m/s	 = -10.84m/s	 = 0.164252 x -66 + 0.0 = -10.84 m/s
'W' Value	 = 0.33m/s	 = 0.326 m/s	 = -124*0.08148438+10.43 = +0.326m/s

TYPICAL PLOTS OF THE SAMPLE NetCDF DATA SUPPLIED

File to be supplied (SampleNetCDF_IMDRadarData.rar)



This article does not claim for completeness in all sorts to be called a universal reference, and is just to give a brief description for immediate reference and understanding to the users on the dimension, variables, and data of the IMD Radar NetCDF file.
For elaborate description on the variables, user shall refer to the terminologies of digital signal processing, radar fundamentals, NetCDF descriptors available in the web.