Answer from HRD Dated: 1/30/2023

L3H Response:

Radar resolution with changing range scale is related to the display resolution per pixel on the display and not the radar resolution.

I'm afraid we don't quite understand this statement. We can, however, confirm from the HWX CfRadial data from the 7/19/2022 MMR test flight:

(<https://seb.omao.noaa.gov/pub/acdata/2022/RADAR_MMR/20220719I1/N43_20220719I1C3X_2022_07Jul_19_21_31_07_NC.zip>)

At 213238 UTC, when a 40 nm maximum range setting was used, the range info is:

float range(range) ;
                range:standard\_name = "projection\_range\_coordinate" ;
                range:long\_name = "Range\_from\_instrument\_to\_center\_of\_gate" ;
                range:units = "meters" ;
                range:spacing\_is\_constant = "true" ;
                range:axis = "radial\_range\_coordinate" ;
                range:meters\_to\_center\_of\_first\_gate = 40 ;
                range:meters\_between\_gates = 59 ;
                range:num\_of\_range\_cells = 1248 ;

At 213251 UTC, when a 80 nm maximum range setting was used, the range info is:

        float range(range) ;
                range:standard\_name = "projection\_range\_coordinate" ;
                range:long\_name = "Range\_from\_instrument\_to\_center\_of\_gate" ;
                range:units = "meters" ;
                range:spacing\_is\_constant = "true" ;
                range:axis = "radial\_range\_coordinate" ;
                range:meters\_to\_center\_of\_first\_gate = 40 ;
                range:meters\_between\_gates = 119 ;
                range:num\_of\_range\_cells = 1312 ;

So we conclude that the range gate spacing, which radar meteorologists for practical purposes have always equated with data resolution, is varied with changing maximum range. The number of range gates, however, varies far less as the maximum range is changed. It appears then that the mode-range settings are designed to keep the amount of data approximately constant  from one range setting to the next. Is this an accurate assessment?

The waveform resolution in NAW is constant for all operator selected range scales
The waveform resolution in HWX is constant for all operator selected range scales

We agree, based on the mode-range tables provided to us (which we greatly appreciate), that the shape of the waveform isn't changing. Is this what is being stated here?

The HWX mode range scale selection does impact unambiguous velocity and range (reducing range ambiguity increases velocity ambiguity)

We agree, based on the mode-range tables provided to us.

The MSDC (Control Display) does have a zoom function when in a set range scale.

We very much appreciate the clarification here. As scientists on the aircraft, we simply see the display changing and what appears to be the maximum range of data changing on occasion. We weren't aware that the user could maintain a fixed maximum range and then restrict the display range (i.e., zoom) without changing the data recording. This actually addresses our primary concern.

------------------------------------------------------------------------------------
Paul Reasor, Ph.D.

Below is our feedback for Jeff Price regarding the CfRadial, inserted in red into his itemized list. Let us know if further clarification is needed. My next email will respond to the Maximum Range and resolution issue.

Regards,

Paul

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DBZ:

Values, in the NC file, for DBZ are integer values of the 8 bit byte storage.

Yes, we concur.

Each bit increment is 0.375 db (Amplitude resolution)

If this can be done, that would be preferred (for 2022-season MMR data, each bit increment is 1 dB, which is a bit too coarse for research purposes)

DBZ is calculated by multiplying the integer value in the DBZ dataset by 0.375

Yes. In CfRadial 1.3 language: Float\_DBZ = Byte\_DBZ\*scale\_factor + add\_offset, so scale\_factor=0.375

The above provides ~96DB useable range, I assume 65 to 70DBZ would be max signal of interest?

We concur. 65-70 dBZ would be our max signal of interest (see below for our recommendation for add\_offset)

ELTA can set a threshold to separate non radar return from radar return, the FillValue can be applied to values at or below threshold

We recommend add\_offset=-20.0 dB.(for 2022-season MMR data, add\_offset is effectively 0)

Then, Float\_DBZ = Byte\_DBZ\*0.375 - 20.0

So for Byte\_DBZ = [1,255] -> Float\_DBZ = [-19.625,75.625] ... this range would be suitable for a research radar.

FillValue should then be set to (byte) 0 to reflect reflectivity values at/below add\_offset or simply noise (below the MDS)..

In summary, byte DBZ = 0 should be reserved for locations where the threshold has not been met. Otherwise, values should range from [1,255], corresponding

to actual (float) values ranging from [-19.625,75.625] per the desired scale\_factor and add\_offset.

The following are questions on what the preferred DBZ formatting would be:

Add to the attributes, scale\_factor and add\_offset:

Scale\_factor =0.375db

Yes, we concur.

How would you recommend applying an add\_offset?
See above. We recommend add\_offset=-20.0dB (this would be consistent with research radars)

What threshold would you use for the fillvalue?

See above. Byte DBZ = 0 would correspond to -20.0 dB or noise

Would the fillValue be define under the DBZ field or as global?

Since fillValue should be byte 0, it should be defined under the DBZ field only

What would the comment state? “DBZ:Comment =

DBZ:Comment = "FillValue represents below MDS or add\_offset";

The equation is unnecessary as long as we're conforming to the above equation from Cfradial 1.3 and the understanding there of scale\_factor and add\_offset (stated in the attributes).

The comment above clarifies for the user how to interpret byte 0.

Suggested format:

byte DBZ(time, range) ;

                        DBZ:long\_name = "DBZ" ;

                        DBZ:units = "dB" ;

                        DBZ:coordinate = "time range" ;

                        ~~DBZ: \_FillValue = -9999;~~

                        DBZ: \_FillValue = 0;

                        DBZ: scale\_factor = 0.375;

                        ~~DBZ: add\_offset = 0;~~

                        DBZ: add\_offset = -20.0;

DBZ:grid\_mapping = "grid\_mapping" ; <-- What does this mean? Why is it necessary?

                        ~~DBZ:Comment = "To calculate amplitude in DBZ use DBZ = (Raw\_Value + add\_offset) \* scale\_factor; “~~

                        DBZ:Comment = "FillValue represents below MDS or add\_offset";