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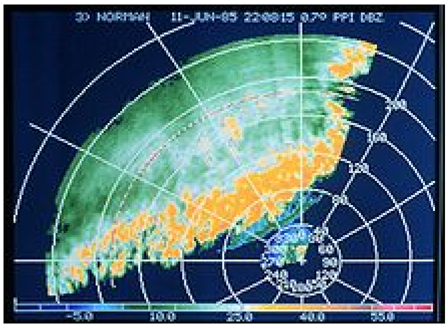
dBZ (meteorology)

dBZ stands for *decibel relative to Z*. It is a logarithmic dimensionless technical unit used in radar, mostly in weather radar, to compare the equivalent reflectivity factor (Z) of a radar signal reflected off a remote object (in mm^6 per m^3) to the return of a droplet of rain with a diameter of 1 mm (1 mm^6 per m^3).[1] It is proportional to the number of drops per unit volume and the sixth power of drops' diameter and is thus used to estimate the rain or snow intensity.[2] With other variables analyzed from the radar returns it helps to determine the type of precipitation. Both the radar reflectivity factor and its logarithmic version are commonly referred to as *reflectivity* when the context is clear.



The scale of dBZ values can be seen along the bottom of the image.

Principle

The radar reflectivity factor (**Z**) of precipitation is dependent on the number (**N**) and size (**D**) of reflectors (hydrometeors), which includes rain, snow, graupel, and hail. Very sensitive radars can also measure the reflectivity of cloud drops and ice. For an exponential distribution of reflectors, Z is expressed by:[2]

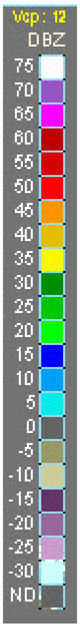
$$Z = \int_0^{Dmax} N_0 e^{-\Lambda D} D^6 dD$$

As rain droplets have a diameter of the order of 1 millimetre, Z is in mm^6m^{-3} (μm^3), a quite unusual unit. By dividing Z with the equivalent return of a 1 mm drop in a volume of a meter cube (Z_0) and using the logarithm of the result (because the values vary greatly from drizzle to hail), one obtains the dimensionless quantity dBZ:

$$dBZ \propto 10 \log_{10} \frac{Z}{Z_0}$$

dBZ values can be converted to rainfall rates in millimetres per hour using the Marshall-Palmer formula:[3]

$$\frac{\mathrm{mm}}{\mathrm{h}} = \left(\frac{10^{(dBZ/10)}}{200} \right)^{\frac{5}{8}}$$



NOAA dBZ scale for weather radar

dBZ versus Rainrate

dBZ	R (mm/h)	Rate (in/h)	Intensity
5	0.07	< 0.01	Hardly noticeable
10	0.15	< 0.01	Light mist
15	0.3	0.01	Mist
20	0.6	0.02	Very light
25	1.3	0.05	Light
30	2.7	0.10	Light to moderate
35	5.6	0.22	Moderate rain
40	11.53	0.45	Moderate rain
45	23.7	0.92	Moderate to heavy
50	48.6	1.90	Heavy
55	100	4	Very heavy/small hail
60	205	8	Extreme/moderate hail
65	421	16.6	Extreme/large hail

Other quantities

The definition of Z above shows that a large number of small hydrometeors will reflect as one large hydrometeor. The signal returned to the radar will be equivalent in both situations, so a group of small hydrometeors is virtually indistinguishable from one large hydrometeor on the resulting radar image. The reflectivity image is just one type of image produced by a radar. Using it alone a meteorologist could not tell with certainty the type of precipitation and distinguish any artifacts affecting the radar return.

In combination with other information gathered by the radar during the same scan (dual polarization products and phase shifting due to the Doppler effect), meteorologists can distinguish between hail, rain, snow, biologicals (birds, insects), and other atmospheric phenomena.

References

1. "Weather Glossary: D's" (http://www.srh.noaa.gov/jetstream/append/glossary_d.htm). *NWS JetStream*. Retrieved 2014-02-21.
2. M. K. Yau and R. R. Rogers (1989). *Short Course in Cloud Physics, Third Edition*. Butterworth-Heinemann. p. 190. ISBN 0750632151.
3. "NWS NEXRAD" (http://www.desktopdoppler.com/help/nws-nexrad.htm#rainfall%20rates). Retrieved November 7, 2010.

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This page was last edited on 22 May 2017, at 15:57.

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