

NOTES AND CORRESPONDENCE

The Unit Symbol for the Logarithmic Scale of Radar Reflectivity Factors

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ABSTRACT

This note argues that the proper symbol for the logarithmic unit of radar reflectivity factor is dBz. The basis for this contention lies in both customary engineering practice and the international standard for unit symbols.

Decibel notation for units on the logarithmic scale of radar reflectivity factors came into being 40 years ago (Rogers and Smith 1996). The unit symbol was first rendered as “dBz” [see Dennis et al. (1971) or Boyd and Musil (1970); Chisholm (1970); Orville et al. (1970); and Smith (1970)] but subsequently became corrupted to “dBZ,” “dB(Z),” “dBZ,” and (perhaps worst of all) “dBZ_e” [the American Meteorological Society (AMS) Committee on Radar Meteorology recommended changing from dB(Z) to dBZ or dBZ (the italic character is current AMS journal house style) in the mid-1980s]. International Standard ISO 31-0 (International Organization for Standardization 1992) is applicable to the subject of symbols for quantities and units. Consideration of that standard and the other matters discussed below indicates that the original dBz symbol is preferable, and I think it should be adopted by the AMS and practitioners of radar meteorology in general.

Two lines of argument support this contention. First, consider the following expression that might appear in this journal (Editor’s Note: with the *z* italicized) or elsewhere:

$$Z = 50 \text{ dBz.}$$

The symbol on the left indicates the quantity of interest (not the “parameter,” a term badly misused in our community, as a check with the “Wikipedia” online encyclopedia would show; see also annex A.3.1 of ISO 31-0);

a numerical value and a unit symbol appear on the right. Including information about the quantity in the unit symbol would be redundant and also contravenes the international standard as discussed below.

The notion that the unit symbol indicates “decibels of reflectivity factor” is misguided. The decibel scale of reflectivity factor *levels* indicates the logarithm of the ratio of the value of *Z* or *Z_e* to some reference level,¹ taken for convenience to be 1 mm⁶ m⁻³. Hence, the proper connotation of the symbol is “decibels with respect to a reference level of 1 mm⁶ m⁻³.” The suffix to “dB” serves to indicate the reference level, not to indicate the physical quantity involved. Meteorologists might be excused for misconstruing this, because logarithmic scales of this type are not common in the atmospheric sciences. Engineers in the community ought to know better: They do not use “dBp” for “decibels of power.”

The second basis for this contention is found in specific language in ISO 31-0. Some relevant excerpts and their implications include the following (from ISO 31-0, section 3.2.1: International Symbols for Units): “. . . They shall be printed in roman (upright) type. . . The unit symbols shall in general be printed in lower case letters except that the first letter is printed in upper case

¹ Strict usage would require a different quantity symbol in the equation above (one possible approach appears in Rinehart 2004), because *Z* is normally defined on a linear scale. According to section 2.2.1 (note 2) of ISO 31-0, “The ratio of two quantities of the same kind and any function of that ratio, such as the logarithm of the ratio, are different quantities.” However, experience suggests that confusion will rarely arise as long as the units are clearly specified.

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when the name of the unit is derived from a proper name.” Hence, the B symbol is used for the bel (derived from Bell). This clause indicates that use of any uppercase letter [such as Z, (Z), or Z_e , or an italicized form such as *Z*] as part of the unit symbol would not be appropriate. The excerpt continues: “Any attachment to a unit symbol as a means of giving information about the special nature of the quantity or context of measurement under consideration is incorrect.” This clause further deprecates any use of Z_e as part of the unit symbol.

The ISO standard provides no guidance with respect to any suffix to be included in a unit symbol. However, the addition of a suffix to dB here to indicate the reference level also helps to avoid possible confusion with other quantities often expressed in decibel units. Analogy seemed appropriate with the custom adopted in communication and electronics engineering, where the suffix “m” is added to the dB symbol (resulting in dBm) for units of power level to denote a reference level of 1 m W. [Sometimes a reference level of 1 W is employed, with the symbol dBW conforming to the first quotation above from section 3.2.1 of ISO 31-0; on occasion other quantities are also expressed in decibel units, although that finds no favor with the ISO.] The following guidance in ISO 31-0 (section 3.2.4: Printing and Use of Prefixes), which applies to prefixes such as the “d” in dB, would also seem appropriate for any suffix: “... Symbols for prefixes should be printed in roman (upright) type without a space between the symbol for the prefix and the symbol for the unit.”

Such considerations led to the original formulation of the dBz symbol, with the lowercase z suffix being appropriate because no proper name is involved. On the basis of the foregoing discussion, I argue that dBz should be adopted as the appropriate symbol for the logarithmic unit of reflectivity factor levels.

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