Zh-R relations of solid precipitation derived by direct comparison of observations in the Niigata area

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The relations between radar reflectivity factor (Zh) and precipitation rate (R) for various solid precipitation particles were derived by direct comparison of simultaneous observations of Zh, R and types of precipitation particles in the Niigata area. The relation was assumed to be the form of Zh=BR^1.67. The analysis was limited during the period when the temperature was below 0 ºC. Zh is from observations by the radar at the Snow and Ice Research Center (SIRC), NIED, at Nagaoka. R and particle type was observed at a ground observation site located at 34.4 km distance from SIRC. Observation facilities were set up in a wind protection net. Zh of a PPI scan of the lowest available elevation was averaged within an area of about 10 km square on the windward side of the ground observation site. The solid precipitation particles were classified into several types. The Zh averaging and particle type classification was made in 10-minute intervals, and if one precipitation type continued for 0.5 to several hours, then the period was defined as a ‘case’. Finally, 59 cases were derived for analysis of Zh-R relations.

The coefficient B for the 59 cases were derived and compared. B for graupel cases were roughly twice that for rimed and heavily rimed particle cases, although the ranges of values were overlapped. Small particle cases and graupel cases showed similar B. Less rimed particle cases during cold outbreak showed large B. an unrimed particle case during cold outbreak was showed the largest B. South-coast cyclone (SCC) cases showed the smallest B. All B except that for the SCC case was within the variation of Zh-R relations of snow aggregates compiled and examined by Rasmussen et al. (2003). B for unrimed particle was large, decrease as the degree of riming increase, then increase when the degree of riming became largest, that is, B for graupel. The exception was the B for the SCC cases: The particles were unrimed and B was very small. The B values for various types of particles and cases were summarized in Table 1 with the equations from literatures.

Table 1 Zh-R relations for various types of solid precipitation particles and cases.

Keywords: solid precipitation, Z-R, observation

Type of particle / Case	Zh-R relation
Graupel (OH)	$Zh = 202R^{1.6}$
Dry to Wet/Rimed (R03)	$Zh = (57.3 \text{ to } 533.5)R^{1.67}$
Graupel	$Zh = 215.3R^{1.67}$
Small particles	$Zh = 179.8R^{1.67}$
Heavily rimed particles	$Zh = 72.7R^{1.67}$
Dry rimed particles	$Zh = 116.7R^{1.67}$
Less rimed particles	$Zh = 344.3R^{1.67}$
Largest-B case	$Zh = 472.5R^{1.67}$
South-coast cyclone cases	$Zh = 45.9R^{1.67}$

OH : Ohtake, T. and T. Henmi, 1970: Radar reflectivity of aggregated snowflakes. Preprints, 14th Conf. on Radar Meteorology, Tucson, AZ, Amer. Meteor. Soc., 209-210.

R03 : Rasmussen, R., M. Dixon, S. Vasiloff, F. Hage, S. Knight, J. Vivekanandan and M. Xu, 2003: Snow nowcasting using a real-time correration of radar reflectivity with snow gauge accumulation. J. Appl. Meteor., 42, 20-36.

Other relations were derived in this study.