

# Development of a Practical Hydrometeor Classification Algorithm via a Bayesian Approach Using C-band Dual Polarization Radar

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The Japan Meteorological Agency (JMA) installed the first operational solid-state C-band dual polarization radar in 2016, and had begun operating four units of the same type by 2019 at the airports of Kansai, Haneda, Narita and Naha. To enhance the advanced practical use of these radars, JMA developed its proprietary Hydrometeor Classification Algorithm (HCA) based on Bayesian estimation.

The HCA supports determination of precipitation type based on posterior probability, which is proportional to the product of likelihood and prior probability. The values of  $Z_{hh}$ ,  $Z_{dr}$ ,  $\rho_{hv}$ ,  $K_{dp}$ ,  $S(\Psi_{dp})$ ,  $S(Z_{dr})$  and  $S(\rho_{hv})$  are used as input dual-polarization variables, with  $S(X)$  representing the median absolute deviation of  $X$ . The relevant likelihood functions were created by applying clustering techniques and kernel density estimation to these seven dual-polarization variables with division into 17 classes, and prior probability distribution expressed as a function of relative heights against the top of the melting layer (ML). Relative heights are estimated both from the ML detection algorithm with dual-polarization variables and from iso-temperature heights based on JMA's numerical Meso-Scale Model.

The HCA was evaluated via comparison between bins classified as wet snow and ML heights based on radiosonde data, and between bins classified as graupel or hail and initiations of lightning discharges detected from Lightning Mapping Array (LMA) data provided by the National Research Institute for Earth Science and Disaster Resilience. The results showed that an average of 92% of lightning discharge initiations were within a 5-km radius of the bins classified as graupel or hail, and that the top and bottom heights of ML levels determined from the bins classified as wet snow corresponded well with those based on radiosonde data. The results of HCA application to severe storm events will also be reported.

Keywords: Hydrometeor Classification Algorithm, Bayesian estimation, Dual polarization radar