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Atmospheric Measurement Techniques Discussions

Interactive comment on "Fuzzy logic filtering of radar reflectivity to remove non-meteorological echoes using dual polarization radar moments" *by* D. R. L. Dufton and C. G. Collier

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Let me start with the supposed advantages of the approach:

1) Fuzzy logic provides a dynamic classification that adjusts to changing atmospheric conditions and can be run in near real time. 2) The approach only requires a limited sample of training data to produce successful results, as shown here by the use of 13 to 26 scans per echo type. 3) The multi-vertex membership functions used are highly adaptable, allowing differing distributions to be specified for the range of parameters used in the scheme, while also allowing easy addition of future variables and echo

types.

Any set of rules that requires training a model on historical data, and application of the model to unseen samples will provide a dynamic classification and be highly adaptable to new data sets (points 1 and 3). Fuzzy logic, as used in this paper, is worst of such possible models because it relies on subjective human tuning. Far better is to use a principled optimization approach (support vector machines, neural networks, decision trees, etc.). Indeed, this has been done by several research groups already.

It is true that because fuzzy logic is subjective, human expertise can be used to augment a small dataset (Point 2). However, it is not clear that the dataset needs to be small for the problem for radar quality control. There was even a Kaggle contest (https://www.kaggle.com/c/how-much-did-it-rain) using dual-polarization radar data. So, why should we be using a bad model (fuzzy logic) on limited data?

Indeed, the drawbacks of using fuzzy logic become clear once you start looking at the actual paper itself. What is the relative importance of these membership functions? What is the sensitivity of these functions to the variables? For example, if the Zdr variable is miscalibrated (as it is on the NEXRAD system), how much will the resulting classification suffer? Note that questions like these can be readily answered if you were to use a principled optimization approach but can not be answered if you use a subjective approach like fuzzy logic. We have done this for polarimetric radar, and I was a little disappointed that the only paper of ours that was cited was on single-pol quality control: V. Lakshmanan, C. Karstens, J. Krause, and L. Tang, "Quality control of weather radar data using polarimetric variables," J. Atm. Ocea. Tech., vol. 31, pp. 1234–1249, 6 2014. V. Lakshmanan, C. Karstens, J. Krause, K. Elmore, A. Ryzhkov, and S. Berkseth, "Which polarimetric variables are important for weather/no-weather discrimination?," J. Atmos. Ocean. Tech., vol. 32, no. 6, p. 1209-1223, 2015.

Bottom line: Please, please, stop using fuzzy logic as a crutch. We have enough radar data to carry out more principled approaches. As a community, we can do better than

this.

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