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Ground Clutter Identification for Operational Weather Radar Based on Machine Learning

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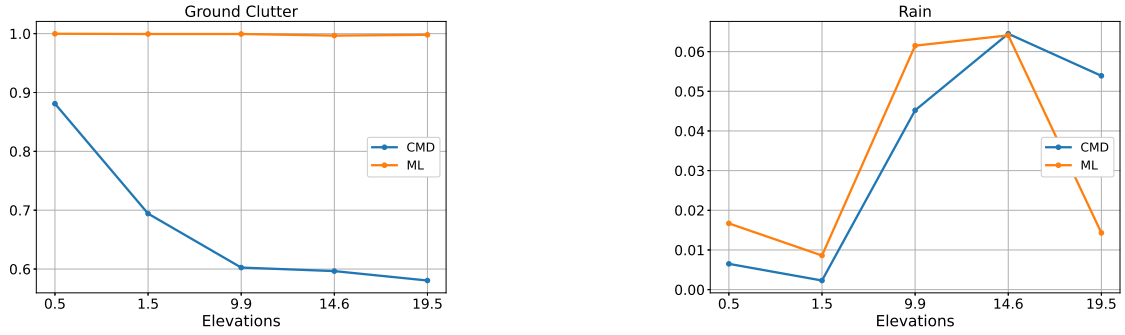
The ground clutter contaminates weather radar data near the ground, it leads to further bias of the precipitaion estimation if not properly filtered. Before filtering ground clutter we need a algorithm to detect ground clutter from radar echo. The CMD(Clutter Mitigation Decision) method developed by NCAR[1, 2] is one of widely used alogrithm for ground clutter identification in weather radar community. However, CMD still has some limitations, firstly it's hard to determine clutter in presence of zero-velocity weather signal with narrowspectrum width, it's also difficult determine sidelobe echo as clutter at high elevation, finally it's optimized for Nexrad, which is S band klystron radar, but there are weather radar working in different band (C/X), and with different techniques(Magtron/Klystron/Solid State/Phased Array), it's impratical to tune CMD fuzzy logical interests for every type of radar.

Deep learning are the algorithms adopting computational methods to learn information directly from data without relying on a predetermined equation as a model. The algorithms can adaptively improve their performance with increasing number of samples. It's evident that using deep learning to train the data can result in a fairly good ground clutter idenfication algorithm.

By collecting IQ data during clear air and precipitation, zero-velocity IQ are selected and preprocessed to generate features such as CPA,SPIN,TDBZ,and standard deviation of ZDR and PHIDP for dual polarization, which are similar as CMD algorithm[2], every range bin is marked as weather or clutter subsequently, all the features and flags are fed into a neural networks which have 6 inputs and 2 hidden layers. Finally the training result is saved and loaded by radar signal processor for real time processing.



(a) PD of Clutter

(b) FA of Rain

Figure 1. Performance of CMD and ML algorithm for detection of ground clutter and false alarm of zero velocity rain.

Figure 1 shows the ML based algorithm has a significant improvement in clutter detection, especially for high elevations, while keeps similar low false alarm rate of zero velocity rain as CMD.

References

[1] J C Hubbert, M Dixon, S M Ellis, and G Meymaris. Weather Radar Ground Clutter. Part I: Identification, Modeling, and Simulation. *Journal of Atmospheric and Oceanic Technology*, 26(7):1165–1180, jul 2009.

[2] J C Hubbert, M Dixon, and S M Ellis. Weather Radar Ground Clutter. Part II: Real-Time Identification and Filtering. *Journal of Atmospheric and Oceanic Technology*, 26(7):1181–1197, jul 2009.