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Atmospheric Measurement Techniques Discussions

Interactive comment on "Improving Cloud Type Classification of Ground-Based Images Using Region Covariance Descriptors" *by* Yuzhu Tang et al.

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Summary:

Apply region covariance descriptor (RCovD) computations to features and then use the output from the RCovD computations as input to a Bag-of-Features approach to create histograms. The histograms are classified using a support vector machine (SVN) method. The approach is applied to labelled cloud images, with some images serving as training data and the remaining images as testing data. Results of the classification are given.

Overall Comments:

From an atmospheric science perspective, a weakness in the paper in regards to its

publication in AMT is its weak link to atmospheric science applications. The Abstract contains the sentences

"Cloud types are important indicators of cloud characteristics and short-term weather forecasting. The meteorological researchers can benefit from the automatic cloud type recognition of massive images captured by the ground-based imagers. However, by far it is still of huge challenge to design a powerful discriminative classifier for cloud categorization."

and the first few sentences of the Introduction are as follows:

"Clouds have a strong impact on climate modeling, weather prediction and the Earth's energy budget balance. In recent years, the growing appeal on renewable solar energy pushes additional interest on cloud coverage measurement and cloud classification (Heinemann et al., 2006; J. Huertas, 2017; Martínez-Chico et al., 2011). Therefore, accurate cloud type classification is in great need."

Just how cloud classification as pursued in this study is applicable to climate modeling, weather prediction, Earth's energy balance, and surface solar irradiance is never made. Advancing our knowledge on these topics requires three-dimensional fields of optical depth, water content, and hydrometeor numbers, shapes, sizes, phase, and fall speeds. How results of the classification scheme have a bearing on these quantities is never made. Related to this issue is that the physical significance of the five cloud types in the 784 images of the SWIMCAT dataset and the 500 images of the Zenithal dataset is never made. For example, what is the physical significance of "patterned clouds, thick-dark clouds, thick-white clouds" and how will knowledge of their occurrence provide information on improving climate and forecast models and studies? Not clear.

This study is similar to those that occurred in the late 1980s and 1990s during the first wave of artificial intelligence/machine learning methods into the atmospheric sciences. Many studies were devoted to classifying cloud types, cloud textures, etc..., similar to

the current study, but these studies never really went anywhere because of lack of quantitative information relative to cloud optical depths, water contents, etc... How this paper will escape this same fate is not addressed.

Perhaps the proposed approach of combining RCovDs, Bag-of-Feature, and SVMs for classification has value relative to existing techniques. To assess this possibility, it would be more convincing to apply the proposed algorithm to large, vetted datasets in the artificial intelligence/machine learning community and to have this community rigorously assess its results. Along this same line of reasoning, it would strengthen the paper if a case could be made as to why the results presented in this paper using only 784 and 500 images are "impressive" as stated on Line 259 of the paper. Because not much was stated about the diversity of clouds in these few scenes, it is hard to tell if high classification accuracies in regards to them are compelling.

Overall Weaknesses:

The relevance of the paper to outstanding and important issues in weather and climate is not made in a compelling fashion.

Along this same line, the output of the classification algorithm does not contain quantitative information on fundamental hydrometeor properties. Rather, it provides classifications of cloud patterns whose fundamental importance are unknown. As a result, the significance of the results to weather and climate problems is not clear.

Finally, the datasets used in the study are relatively small and of unknown diversity and significance. From a purely algorithmic development perspective, testing it on accepted datasets for algorithm evaluation would be much more compelling.

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