

Review for the article “Cloud Classification of ground-based infrared images combining manifold and texture features” by Qixiang Luo, Yong Meng, Lei Liu, Xiaofeng Zhao and Zeming Zhou

In the article “Cloud Classification of ground-based infrared images combining manifold and texture features” the authors introduce a new method to identify cloud regimes from ground based cloud imagers. They base their study on a dataset from the Whole-Sky Infrared Cloud Measurement System, which provides zenith and whole sky images. The clouds in the images have been classified by two independent experts, and the image is only used in case they agree. The authors define a feature vector basing on the grey level co-occurrence matrix, which provides the measures energy, entropy, contrast and homogeneity; and on manifold features which are constructed by computing the regional covariance descriptor and mapping it into its tangent space. With their new method, the authors reach a slightly higher accuracy (by 3 to 5 %) compared to earlier methods of Liu and Cheng. The structure and the content of the paper are ok, but it lacks clarity in several places. Also, the language should be improved. I recommend major revisions. Please find my specific comments below:

Major comments

The article lacks some clarity. With regard to the underlying dataset, the authors explain how it is obtained and how the cases are chosen. However, in Section 3, “Experiments and discussion” the authors talk of “conducting each experiment 50 times on two datasets” (p.6, l.25). It is not clear to me what experiments are meant and in which way it can be repeated 50 times. Please state very clearly what you do and mean by this.

You mention a “Support Vector Machine” (SVM), which is used to perform the cloud classification. It is not clear what that actually is. Please extend the respective part a little bit, or give a citation at the very least.

The mathematical framework of a manifold is explained in quite detail. It distracts a little bit from the final result, the feature vector (supposedly Eq. 11). It would add much clarity to extend Sec. 223 “Combining manifold and texture features” and clearly state what you are now using for a cloud classification. You could also add information about the SVM here. Overall it is difficult to assess why this manifold features play a bigger role, or if for example other parameters would add equally much information. The mathematics behind the manifold feature vector is rather complicated, and a physical interpretation is hardly possible. Why has this vector been chosen? Would the addition of different, more easily physically interpretable parameters also lead to a higher hit rate in the classification? Is this more a “fitting problem” (more parameters → better fit) or is it more physically based? Please justify the choice of your metrics more.

The preselection of the data used in this study is done by employing two experienced experts, and the images are only chosen if both of them agree on the cloud type. Does that not already mean a very strong constraint on the images with regard to their clarity? Does it affect the study result? How would the algorithm perform under realistic conditions, where images are not preselected? Is there a quality flag involved? Is there a way to further improve the classification?

Please also give some insight how to assess your improvement of the classification. Depending on the case and fraction it is somewhere between 2 and 10% it seems. Is that a great improvement? Does it depend on the choice of cases?

Minor comments

Abstract: Overall, it already assumes a great background knowledge of the reader.

P1, 110: “the” Support Vector Machine → I think it is an overarching concept. “a” Support Vector Mache.

P1, 113: Specify some numbers here (higher by how much?)

P1, 116 and following: Somewhere you should mention and cite CloudNet (<http://www.cloud-net.org>) which are quite capable of identifying cloud types. Or do you only focus on large scale cloud structures? (The you should clarify that, because cloud classification implies that you look at the cloud type also.).

P1, 123,24: “weaken their credibility”, please check the use of the word “credibility”.

P1 123 – P2, 113: This seems like an itemization of the existing methods. In which way do they connect to your method? Why do you later on chose just two of them (Liu, Cheng) to compare to?

P2, 15 “parallelepiped” → typo

P2, 110: Support Vector Machine needs a citation, it is not generally known.

P.2, 114 – 120: You state that colour images provide more information. Make clearer why infrared images are used anyway.

P.2, 121 – 124: Make it clear why manifolds are chosen. There are many mathematical constructs, it is not obvious why this way is chosen. Very clearly state here what the novelty and potential of your method is.

P.2, l 31: “...displayed the best performance in the 10-fold cross validation overall”, it is not clear what 10-fold cross validation you mean.

P.3, 16: “...ground-based passive system that an uncooled microbolometer ... is used.” → “...ground-based passive system that uses an uncooled microbolometer ...”

P.3, l 9: Are the pixels size or resolution?

P.3, 120: It is not clear why a historical dataset would not contain a complex mixture of cloud types compared to a dataset of the present.

P.3, 122: comprised of 100 images in each category

P.3, 126: the number of cases with stratiform clouds, cumuliform clouds, ...

P.3, 129: “which is the area of clouds rather than the parts out of the circle” → what do you mean by “parts out of the circle”?

P.4, 15: Only later clear what “non-Euclidean features” are

P.4, 122: “...mean values in four directions are obtained as texture feature”, mean over what? And what directions?

P.5, l10: This is supposedly a d times d matrix. Should the d not show up in this equation as an index or something?

P.6, l13: This is not an equation, it lacks a left side. P.6, Section 2.3: Needs some more explanation or at the least citations. SVM not understandable from this.

P.6, l.21: What do you mean by “voting policy”?

P.6, Section 3, beginning: Here, it should be clarified at the very latest what you mean by “experiment” in your context.

P.7, l21: Do you really mean “confusion matrix”?

P.7, l24: cululiform → cumuliform

P.7, l27: “has reached” → “is reached”

P.7, l30: exits → exists

P.8, l4: “when 1/2 for training.” → “when 1/2 for training is used.”

P.8, l25: There is indeed improvement, but I would not call it “dramatically”.

P.8, l26: What do you mean by “the statistical learning method”? I think this hasn't been defined before.

P.8, l32: Gabor or wavelet coefficients may need a citation, not generally known.

P.9, l3: “on the both” → “on both,”

Images and Tables:

Please provide more telling captions.

Table 4 and 5: The $1/10$, $1/2$ and so on are not clear