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Hydrology and Earth System Sciences Discussions

Interactive comment on "Köppen versus the computer: an objective comparison between the Köppen-Geiger climate classification and a multivariate regression tree" *by* A. J. Cannon

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Anonymous Referee #2

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The author applies multivariate regression tree (MRT) analysis to the Koppen-Geiger climate classification variables to automatically delineate an alternate climate classification. The resultant classification is compared against Koppen-Geiger and stated to perform better than Koppen-Geiger. Generally the manuscript is well written, but requires major revision relating to the comparison with Koppen-Geiger, explanation of

the analysis methodology and the overall conclusions prior to publication.

My key concern is that the aims of the two classification systems (MRT and Koppen) are different and therefore comparisons between the two are not always meaningful. Wilcock (1968) discusses the aims of Koppen in producing his climate classification, which, roughly paraphrased, are to provide a simple/brief arrangement of climatic information to aid understanding of climate and its impact on nature (including vegetation distribution) and humanity. To this end Koppen did not optimise a metric to achieve his classification. Furthermore, he sometimes adopted rules based on natural thresholds (eg: relationships between vegetation transitions and temperature) within his classification. Thus the aims of Koppen are not translatable into numeric form to be optimised. Whereas the MRT analysis presented here is fundamentally different in aim and methodology. MRT requires a metric to optimise, in this case the difference between observed and classified mean monthly precipitation and temperature (EV, equation 4) is adopted. This choice of metric defines the aim of the MRT classification and is critical to the output of the MRT process. In MRT the optimisation process determines the classification rules, whereas in Koppen the rules, often based on nature, defined the classification.

Thus the aims of Koppen and the MRT analysis presented here are fundamentally different, which needs to be kept in mind when comparisons between the two classifications are made and discussed. The assessment of the two classifications presented in Section 5, and conclusions based on that section, rely on metrics pertaining to the MRT analysis (eg: EV). Not surprisingly MRT performs better than Koppen using these criteria. Does this mean the MRT classification outperforms Koppen? In terms of EV, which measures the difference between observed and classified mean monthly precipitation and temperature, MRT outperforms Koppen, but Koppen was not designed solely to maximise this metric (as MRT is). From my reading of the results I could argue that in terms of EV, Koppen performs remarkable well considering it was not designed to maximise EV. In the revised version of the manuscript the author needs to clearly

state that the aims and methodologies of the MRT analysis and Koppen are different and keep these differences in mind when revising the discussion and conclusions of any comparisons between the two methods.

See the first response to B. Orlowsky.

The differences in aim and methodology discussed above also raises questions about the appropriateness of the manuscript title. I recommend the title be changed to emphasise the contribution of a climate classification for mean monthly precipitation and temperature using a multivariate regression tree. "Koppen versus the computer", although appealing, is not meaningful and should be removed. Likewise the term "objective" is inappropriate in the title.

An alternative title such as "Global climate classification using a multivariate regression tree: a comparison with the Koppen-Geiger system" will be used in the revision.

An alternative MRT analysis the author might consider is whether a set of predictors other than those used by Koppen can produce a better performing classification than the MRT classification presented here.

Yes, this is a good point that deserves to be expanded on in the discussion. The reason for choosing the set of predictors used by Koppen was to facilitate comparison between the KG and MRT classifications (e.g., the rule sets are somewhat comparable), and also because these predictors are widely available and calculated because of the widespread use of the KG classification.

Another concern is the explanation of the MRT data preparation process in Section 4. It is not clear why the Koppen-Geiger variables need to be rounded for simplicity or consistency. Also the process of preparing the predictands for analysis is not well explained. Why do the grid values need to be area corrected when they are in units of millimetres and Celsius (no volumes, so area is irrelevant)? Is the predictand rescaling to mean = 0 and standard deviation = 1 applied to each grid cell or across the entire

globe? Not all readers are familiar with MRT, so more detail needs to be given regarding how and why data are prepared prior to analysis.

The MRT preprocessing will be explained more clearly. Rules in the KG classification involve rounded values (e.g., $T_{hot} \geq 22$). If the MRT were to use unrounded data (e.g., $T_{hot} \geq 22.6$), it is conceivable that the devised rules would lead to a lower model error solely because of the difference in precision. (There is a larger ruleset to pick from.) If the gridded data were kept in a geographic projection rather than an equal area projection, a residual error at a gridpoint near the poles would be given more weight in Eq. 1 than the same error at a more equatorial latitude. An alternative approach would be to weight the squared deviations in Eq. 1 by the square root of the cosine of latitude. The predictand rescaling is across the globe, i.e., each of the 12 monthly temperature and precipitation variables are rescaled to zero mean and unit standard deviation.

Specific Comments

1. Page 2348, line 26: "MRT algorithm; (ii) to" should be "MRT algorithm; and (ii) to"

Yes.

2. Not at all clear how the 95% confidence intervals in Figures 7 & 8 are calculated.

See the response to comment 8 by B. Orlowsky.

3. Not at all clear how the predicted centroids for Koppen or MRT in Figure 9 are calculated.

The centroid of the jth variable in class k is

$$Y_{.jk} = \frac{1}{N} \sum_{i=1}^{N_k} Y_{ijk}.$$

This will be added before Eq. 1 and referenced when Fig. 9 is cited in the text.

References

Wilcock AA (1968) Koppen after fifty years. Ann. Assoc. Am. Geog., 58(1), 12-28.

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