Hydrol. Earth Syst. Sci. Discuss., 8, C2137–C2142, 2011
www.hydrol-earth-syst-sci-discuss.net/8/C2137/2011/

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

A. Cannon

alex.cannon@ec.gc.ca

Received and published: 13 June 2011

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

Anonymous Referee #3

Received and published: 2 June 2011

This is a very well written paper that deals with an interesting and scientifically rele-

vant study. Figures and Tables are well organized to present the main results of the study. I strongly support publication, but do have some questions/ remarks that require clarification:

Referee #3 raises many of the same issues as the first two reviewers. Where appropriate, I have copied previous responses to their concerns here.

Title

First of all, the use of the word objective in the title might be reconsidered, because the objectiveness of the parameter chosen for the comparison between the two methods of climate classification is arguable. Objectiveness results from the fact that the same parameter was used to judge the outcome but the parameter itself was not chosen objectively from the wealth of parameters one could think of. . . But I agree that it is very catchy.

I definitely agree that the comparison is somewhat unfair, as the goal of the MRT and KG classifications are ultimately different. That said, the KG classification, in part due to its use of simple rules based on climate variables, has – in my eyes – come to be seen (and used) more as a general purpose global climate classification than as a climate classification designed to discriminate vegetation types. The revised paper will address this in more detail throughout. For example, historical background on the goals of the KG classification, explicit caveats regarding the "objectivity" (or lack thereof) of the comparison, and modifications to the discussion and conclusions will be included.

An alternative title such as "Global climate classification using a multivariate regression tree: a comparison with the Köppen-Geiger system" has been proposed for use in the revision.

Abstract:

A main advantage as stated in the abstract is that the practitioner is no longer asked to "manually define classes" – however I doubt that practitioners nowadays manually

define classes, as this was already done by Köppen... "MRT generally outperforms Köppen" – the analysis presented here is far from allowing a generalisation; the outperformance depends on the aim/ and usage of the classification. Aim and usage seem to be different in nature between Köppen and MRT. MRT aims at partitioning points into homogeneous classes, while Köppen aimed at a differentiation of climate classes based on vegetation groups. The homogeneity of vegetation groups within the MRT classes is not considered at all, hence performance is not objectively judged.

The primary goal was a "fair" comparison between the KG and MRT techniques, in this case by using the same suite of variables as KG. Admittedly, this is, as raised by all referees, a point that is compromised by the role of vegetation in guiding the KG classification. The historical context of the KG classification will certainly be provided in the introduction of revised version.

In addition, the two classifications will be evaluated quantitatively in terms of a proxy of global vegetation cover, in this case Normalized Difference Vegetation Index (NDVI). A preliminary analysis has been completed for the review comments. Global values of NDVI from the NOAA AVHRR satellite were obtained and long-term annual mean and intra-annual monthly standard deviations calculated for the period 1982-2000. Values of explained variance (EV) based on the MRT and KG classifications are shown in Figure 1. The KG system performs better in terms of the annual mean at the 5 class level, but the MRT system pulls "even" at the 13 and 30 class levels. On the other hand, the MRT performs better in terms of intra-annual variability at the 5 and 13 class levels, but the KG system is comparable at the 30 class level. Ultimately, then, the MRT appears to perform better in terms of climate and equally well in terms of vegetation at the 30 class level.

"...and it is rule-based, which allows climate classes to be unambiguously defined and easily interpreted." I am actually missing that interpretation: how are the classes interpreted – why is a new classification required after all – which additional gain do these classes bring – what can be said about the areas that differ?

This was meant to reflect the fact that the MRT algorithm, unlike other commonly used automated clustering algorithms (e.g., k-means clustering) only provide the user with the final cluster solutions. Hence, there is limited ability to judge how one arrives at a given solution. In terms of "why" and "which additional gain", this does need to be presented in a clear and comprehensive fashion. The relative importance of temperature versus precipitation variables is one way in which the MRT and KG classifications differ, and this has consequences for the representativeness of the resulting classes. KG does not discriminate precipitation well relative to the MRT.

And more generally, how does this algorithm perform in the light of climate change – would predictor variables change and areas remain constant? Or would areas change? Or both? (This question might, however, be outside the scope of this study, but maybe the author has some ideas on this)

How sensitive is the algorithm to the length of time series from which climatologies are calculated? How does it perform if only 30 years are used / or the 50 years are split into two parts of 25 yrs and evaluated separately?

In terms of sensitivity to climate change, this is likely outside the scope of the study. I do think that there may be less overall sensitivity, at least in terms of global landmass that changes from one class to another, for the MRT classification than the KG classification because of the temperature dependence and insensitivity to precipitation of the latter. In terms of sensitivity in the past, this is difficult to judge with the WoldClim dataset as the climatological averages are only available for the full 50 year period.

4 MRT climate classification

"For sake of simplicity and for consistency with the Köppen Geiger rules, the same variables are chosen as predictor variables. . ." I find this a weak argumentation, I am afraid that simplicity and consistency are not adequate reasons for the choice of predictor variables. I understand the need to compare the algorithm to the Köppen classification and therefore support this choice for a first test of the method. But es-

pecially in times of "rapid improvement of computer power" as the author states, the study set-up offers a unique opportunity to test other predictor variables, which were not considered by Köppen – such as AET, PET, deviation from climatology, soil moisture, vegetation pattern and many more. Then I would find the comparison more relevant with regards to newly gained knowledge. The study as it is now, does not really offer much new knowledge and its application in current studies is doubtful. It shows, that a similar classification as the Köppen classification can be achieved if similar predictor variables are chosen, although absolute threshold values of the predictors differ.

The general ability of the MRT technique to incorporate other sources of relevant information (*AET, PET, deviation from climatology, soil moisture, etc.)* will be mentioned in the Discussion, although it is likely beyond the scope of this article to explicitly attempt to use these variables in this way here. That said, NDVI information presented above could be used as predictands to supplement the climatological variables, rather than just being used as an additional means of validating the classification that appears in the discussion paper.

Figure 5

I would like to see the same two Figures for the 30 classes, with similar colours for subclasses. I think a visual comparison of the end-result of the study would be interesting, and helpful to understand the differences between the two classifications.

The corresponding figure for the 30 class KG classification will be added to Fig. 2 for comparison. Colour matching will be somewhat tricky, but I will try to ensure as much consistency as possible.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 2345, 2011.

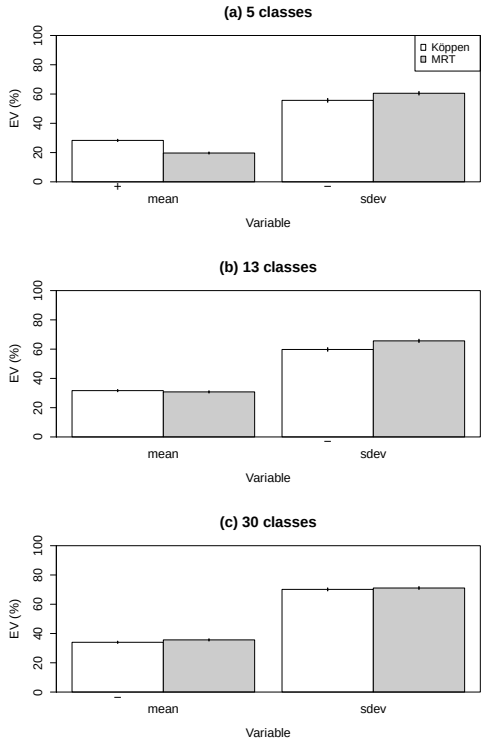

Fig. 1. EV of the MRT and KG classifications in terms of annual mean NDVI and intra-annual standard deviation of monthly NDVI.