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Interactive comment on "Does objective cluster analysis serve as a useful precursor to seasonal precipitation prediction at local scale? Application to western Ethiopia" *by* Ying Zhang et al.

Anonymous Referee #1

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The manuscript aims at developing a statistically based seasonal precipitation forecast model for Western Ethiopia. The target area is separated into homogeneous regions by means of a k-means cluster analysis of summer precipitation amounts. Eight regions with similar precipitation variability are defined. For each of them, a linear regression based forecast model is calibrated. Results are compared with a general forecast for the entire region and are found to be superior. In a final step the forecast is down-scaled to a high resolution grid, again by means of a liner regression approach. The target of the study is timely, since local precipitation predictions are often required for water management and planning, and the manuscript is well structured and easy to follow. However I have some serious concerns about the calibration and particularly

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the evaluation of the statistical model. Further I would recommend to give some detailed information on the climate characteristics of the cluster regions and the major large scale influences.

1) Introduction, clustering and different predictor variables: An introduction into the climate of the target region is missing. Further, a detailed analysis of the precipitation characteristics of each cluster would be a basis for the interpretation of the modeling results. Some of the precipitation time series in Fig. 5 look highly correlated. Are simple statistical techniques really able to forecast those slight differences? And if, which predictor variables are responsible for the spatial variations of precipitation in Western Ethiopia? An analysis of the predictor-predictant relationships for each cluster would not only give some insights into the model structure and the large scale climate mechanisms of the target area, but also help to support (or scrutinize) the results of the modeling exercise.

2) Calibration of the statistical model and overfitting: Correlations between cross-validated modeling results and observations in the order of 0.7-0.85 are very high (in fact they exceed the skills of well known forecast models) and are questionable. I believe, that those results are due to overfitting (particularly due to the predictor selection). The predictors for each of the clusters are selected based on all years, the cross-validation is only performed for the calibration of the linear model. In order to fully evaluate the model skill, the predictor selection must be included in the cross-validation (i.e. chose predictors at each step of the cross validation, e.g. based on a correlation threshold). Most likely the model skill will significantly drop, I could imagine that a step wise selection of predictors might slightly improve the results.

3) Evaluation of the Downscaling approach: As the predictor selection, the downscaling procedure is not included in the cross-validation. I recommend to conduct the cross-evaluation for the entire modeling chain. That means, the predictor selection, cluster forecast and downscaling approach need to be calibrated based on (n-1) years, in order to forecast gridded precipitation for the remaining year.

In general, one should be aware, that there is a linear dependence of the cluster based and the gridded forecast. Thus, the downscaling approach will better reproduce the local climate, however the variability (drought and moist years) will be equal to the culstered result. The term “gridded” forecast is somehow misleading – I would prefer “downscaling of regional forecast”

Detailed remarks: 1) The abstract is very short and could certainly be more informative (e.g. by including some results)

2) The discussion of state of the art forecasting models in the introduction is very short. Particularly during recent years, several studies investigated the skill of statistical models for regional scale precipitation forecasts (some of them are even based on clustering or PCA). I would recommend to better discuss the literature and the advantage of your approach in the introduction. See for example:

Hertig, E. and Jacobeit, J.: Predictability of Mediterranean climate variables from oceanic variability. Part II: Statistical models for monthly precipitation and temperature in the Mediterranean area, Clim. Dynam., 36, 825–843, doi:10.1007/s00382-010-0821-3, 2010.

Suárez-Moreno, R. and Rodríguez-Fonseca, B.: S4CAST v2.0: sea surface temperature based statistical seasonal forecast model, Geosci. Model Dev., 8, 3639–3658, doi:10.5194/gmd-8-3639-2015, 2015.

Gerlitz, L., Vorogushyn, S., Apel, H., Gafurov, A., Unger-Shayesteh, K. & Merz, B.: A statistically based seasonal precipitation forecast model with automatic predictor selection and its application to central and south Asia, HESS 20, 4605–4623 , doi:10.5194/hess-20-4605-2016 , 2016.

3) The predictor selection is based on correlation maps, and regions with potential forecast skill are identified (see Tab.1). Please map the regions and show the correlation maps for some clusters.

4) P7,l10: PCAs are cross-validated. This is somehow unclear to me. PCA is usually used for dimension reduction. Is the cross-validation done for the loadings of the pca in order to investigate how these change based on different input data?

5) Dynamical Models: The section on dynamical models is poorly integrated. Please give some more information on the models in general. If (as expected) the skill of the statistical model drops as a consequence of the cross-evaluation, a more detailed comparison of skills might be interesting.

6) P9,l15: Please give some more information on the performance measures (BIC, AIC, GCV).

7) P10: How exactly is the envelope (uncertainty interval) calculated? Is this based on the assumption that cross-validated residuals of the regression are normal distributed?

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