Hydrol. Earth Syst. Sci. Discuss., 2, S949–S953, 2005
www.copernicus.org/EGU/hess/hessd/2/S949/
European Geosciences Union

Hydrology and Earth System Sciences Discussions

Interactive comment on "Prediction of monsoon rainfall for a mesoscale Indian catchment based on stochastical downscaling and objective circulation patterns" *by* E. Zehe et al.

E. Zehe et al.

Received and published: 16 November 2005

First we want to thank the Reviewer Francis Chiew for his thoughtful and constructive comments, which we addressed in detail below:

Reviewer: A more complete description of the methodology would be useful. Are the downscaled relationships based only on the atmospheric classification of the particular day, or are they also based on the classification of the previous day? Are the rainfall amounts on the previous day considered in the generation of the current day rainfall amounts? That is, does the method attempt to preserve the persistent in daily rainfall. Response: We will add a more detailed description of the stochastic rainfall model in the revised manuscript. The model accounts for space time continuity in rainfall through a) accounting for the autocorrelation of the rainfall time series, conditional to the CP and the day of the year and b) by accounting for the spatial covariance at a given day

also conditional to the day of the year and the CP. The second source for temporal continuity is, of course, the persistence of the CP's which is of course usually longer than one day.

Reviewer: Does the stochasticity relate only to the rainfall characteristics from a given set of atmospheric time series, or does the method also consider the stochasticity in the atmospheric time series? For example, does the method use only the one set of atmospheric classification time series (from historical data or from GCMs), or does it alsogenerate replicates of CP time series based on the historical (or GCM) characteristic? Response: Only the rainfall generation is stochastic, the input time series of CP's is deterministic in the sense that it stems from the classification of either pressure reanalysis data or (in case of a climate scenario) from a GCM

Reviewer: What other atmospheric explanatory variables were used with this methodology for central Europe? Is the use of these indicators here in addition to the solitary 500 hPA geopotential height likely to improve the results considerably? Response: In their downscaling study for the Neckar basin in Germany, Europe Stehlik and Bárdossy used exclusively CP time series classified from the 500 hPA level as predictors, which turned out to be sufficient.

Reviewer: It will be useful to report the correlations of rainfall amounts between stations, at the daily and longer time scales. You would hope that the methodology does produce the types of key results reported for the individual stations (monsoon season mean, standard deviation, maximum, etc). Most single-site daily rainfall models can produce this, but the advantage of the downscaling approach is in the downscaling of atmospheric characteristics (which can be simulated more realistically by GCMs compared to catchment rainfall) to multi-site catchment rainfalls. I doubt the method, like most approaches, can reproduce the correlations at annual and longer time scales because of accumulation effects, but should at least reproduce the rainfall correlations between stations over shorter time scales (daily amounts, totals over several days, totals over monsoon season), given the context of the paper. Response: We will provide

HESSD

2, S949–S953, 2005

correlations of observed rainfall at the stations at the monthly and daily scale. As already pointed out, the model rainfall model is a transformed multivariate normal. The description of a multivariate normal process includes essentially the inverse of the spatial covariance matrix! In our approach we use an averaged covariance, which will become clear in the new manuscript. We will provide evidence, that the model reproduces the spatial covariance. We agree strongly with F. Chiew that this is an essential point.

Reviewer: The plots can be made clearer - it is difficult to interpret the current plots. Also show (and explain clearly where it is shown), that the 95% confidence intervals/envelopes are based on simulations of many stochastic replicates (I think they are?). Are 30 stochastic replicates used throughout? Are 30 replicates sufficient? Do they converge to similar results in the key statistics? Response: The plots will be improved, as requested. We used 30 replicas/realisations of generated rainfall serious to compute the expectation of daily/ monthly rainfall totals. Please note that all the realisations are based on the same CP input time series (which is deterministic), within each generation each day has the same CP-specific rainfall probability and amount, as the CP does not change! We therefore think that 30 realisations give a reasonable estimate of the expectation of daily and especially monthly rainfall. Estimation variance of the mean is app 1/5 of the variance of the daily/monthly rainfall amounts. Nevertheless we will generate 100 realisations and compare the differences.

Reviewer: It may be useful to compare more results in the verification/validation? For example, it would be nice to know if fewer atmospheric classifications give better results in the validation, i.e., the balance between sufficient and over calibration. Response: Table 2 in the current manuscript presents the two essential quality criteria for the classifications schemes: The maximum and minimum values of the cp specific conditional daily rainfall probabilities divided be the unconditional average, we call this np, as well as The maximum and minimum values of the cp-specific conditional daily rainfall amount divided be the unconditional average, named nz. A reasonable classification

HESSD

2, S949–S953, 2005

scheme has minimum values close to zero and maximum values larger than one. This indicates, that the CP-specific conditions differ strongly from the average. Over fitting in terms of selecting a number of CP which is too large, would mean that an increase of the number of CP does not increase the difference between the maximum of np and the minimum of np. This is not the case when moving from 8 to 12 CP. It is clear, that the schemes with a lower number of CPs will not catch the same range of rainfall variability as the scheme with 12 CPs.

Reviewer: The suggestion on incorporating SST anomalies as an additional predictor variable could be useful. However, it is not entirely independent, as there must be also a connection between the CP and SST (just like rainfall and CP, and rainfall and SST) Response: This is correct, but the time scale of SST variation is much longer than the time scale of CP variation (average duration is 3-4 days). The idea is to use SST to predict the long term trend. A first generic test of this idea would be a frequency analysis to show whether the CP specific rainfall propability and amount during times of positive SST anomalies differs significantly from CP specific rainfall propability and amount during times of negative SST anomalies. We will test this in the near future.

Reviewer: Is 700-1000 mm average rainfall over a monsoon season a semi-arid climate? How wet is central Europe? Response: This is correct that from the European point of view 700 -1000 mm annual rainfall are humid conditions. However in the Anas basin this rainfall occurs during 4-5 months, the rest of the year is dry. The Manas falls dry during the dry season. That's why the region, also from the vegetation, is regarded as semi arid.

Reviewer: NCEP reanalysis is available at 2.5 degree resolution. Response: The older dataset, we used here is on 5 degree resolution. For the new revised manuscript we will use the new data set.

Reviewer: "Stochastic downscaling" or "stochastical downscaling"? Response: stochastic downscaling 

HESSD

2, S949–S953, 2005

Interactive comment on Hydrology and Earth System Sciences Discussions, 2, 1961, 2005.