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Towards an automatic statistical model for seasonal precipitation prediction and its application to Central and South Asian headwater catchments

Lars Gerlitz, Abror Gafurov, Heiko Apel, Katy Unger-Sayesteh, Sergiy Vorogushyn, and Bruno Merz
Helmholtz-Zentrum Potsdam - Deutsches GeoForschungsZentrum GFZ, Potsdam, Germany (lars.gerlitz@gfz-potsdam.de)

Statistical climate forecast applications typically utilize a small set of large scale SST or climate indices, such as ENSO, PDO or AMO as predictor variables. If the predictive skill of these large scale modes is insufficient, specific predictor variables such as customized SST patterns are frequently included. Hence statistically based climate forecast models are either based on a fixed number of climate indices (and thus might not consider important predictor variables) or are highly site specific and barely transferable to other regions.

With the aim of developing an operational seasonal forecast model, which is easily transferable to any region in the world, we present a generic data mining approach which automatically selects potential predictors from gridded SST observations and reanalysis derived large scale atmospheric circulation patterns and generates robust statistical relationships with posterior precipitation anomalies for user selected target regions. Potential predictor variables are derived by means of a cellwise correlation analysis of precipitation anomalies with gridded global climate variables under consideration of varying lead times. Significantly correlated grid cells are subsequently aggregated to predictor regions by means of a variability based cluster analysis. Finally for every month and lead time, an individual random forest based forecast model is automatically calibrated and evaluated by means of the preliminary generated predictor variables.

The model is exemplarily applied and evaluated for selected headwater catchments in Central and South Asia. Particularly the for winter and spring precipitation (which is associated with westerly disturbances in the entire target domain) the model shows solid results with correlation coefficients up to 0.7, although the variability of precipitation rates is highly underestimated. Likewise for the monsoonal precipitation amounts in the South Asian target areas a certain skill of the model could be detected. The skill of the model for the dry summer season in Central Asia and the transition seasons over South Asia is found to be low. A sensitivity analysis by means on well known climate indices reveals the major large scale controlling mechanisms for the seasonal precipitation climate of each target area. For the Central Asian target areas, both, the El Nino Southern Oscillation and the North Atlantic Oscillation are identified as important controlling factors for precipitation totals during moist spring season. Drought conditions are found to be triggered by a warm ENSO phase in combination with a positive phase of the NAO. For the monsoonal summer precipitation amounts over Southern Asia, the model suggests a distinct negative response to El Nino events.