Global high-resolution regionalized parameter maps for LISFLOOD based on observed streamflow from 4297 headwater catchments

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Introduction

- Regionalization approaches transfer knowledge from gauged to ungauged catchments
- Previous regionalization approaches generally:
  1. ignored the within-catchment variability in climate and landscape
  2. did not optimize the model parameters for all catchments jointly
  3. had a regional focus
- We introduce a novel regionalization approach to yield seamless, gap-free parameter maps for the LISFLOOD hydrological model underlying the Global Flood Awareness System (GloFAS)

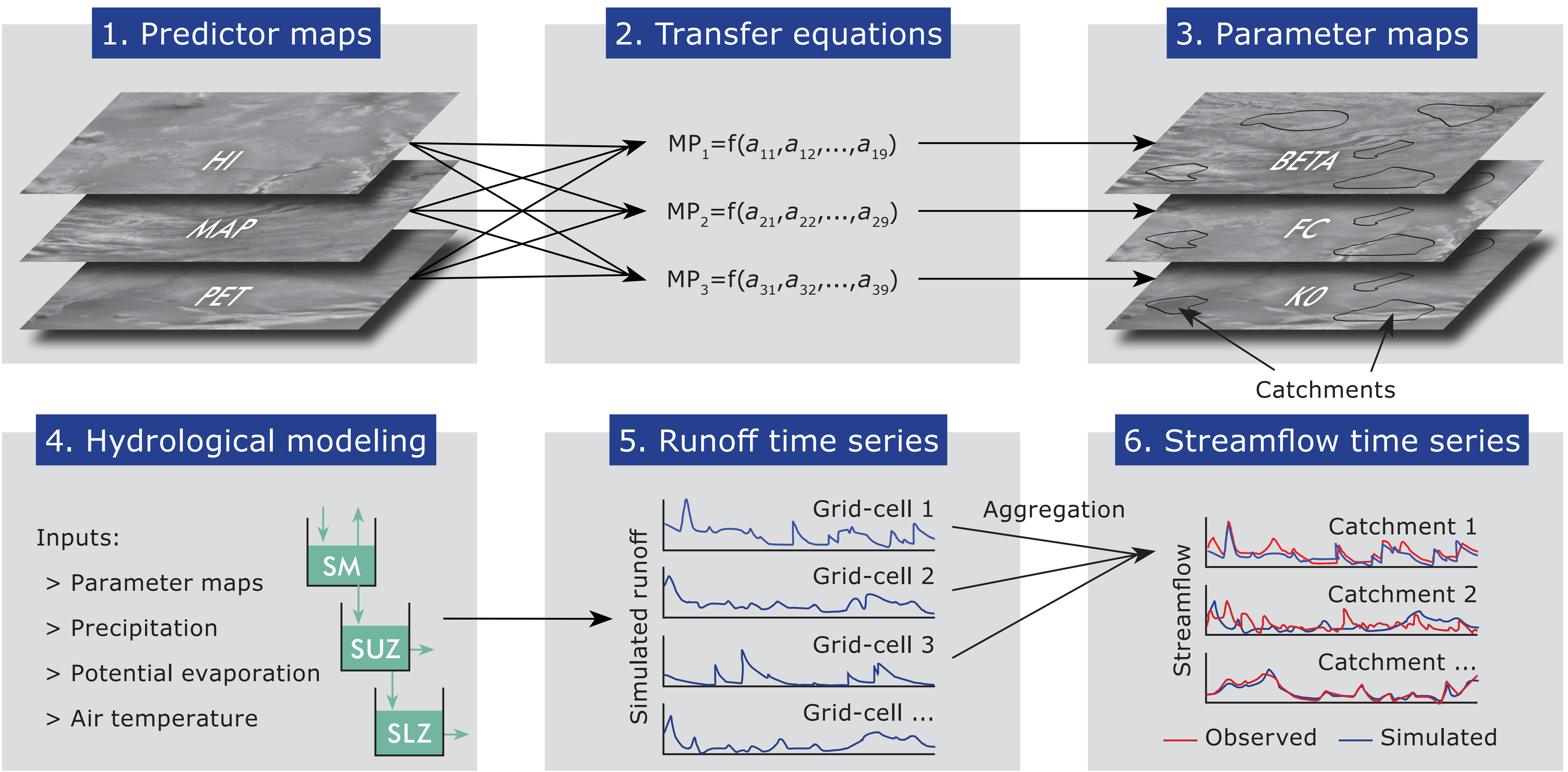

Fig. 1. Schematic diagram illustrating the main steps of our model parameter regionalization approach.

Data and methods

- The regionalization approach optimizes transfer equations linking model parameters to climate and landscape characteristics
- The optimization is performed in a fully spatially distributed fashion at high resolution (0.05°), instead of at lumped catchment scale
- The optimized equations are applied globally to produce parameter maps for the entire land surface including ungauged regions
- The approach is implemented using LISFLOOD and the Kling-Gupta Efficiency metric (KGE)
- Daily streamflow data from over 4297 small catchments (<5000 km^2) worldwide were used for the optimization

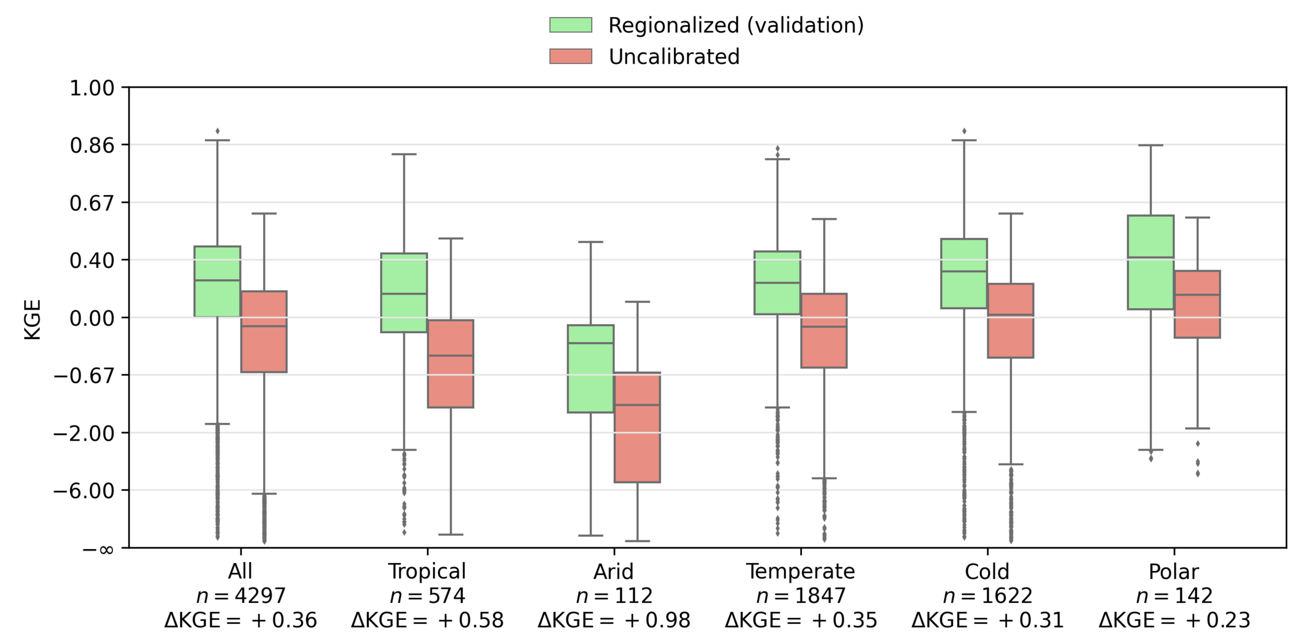

Fig. 2. Box-and-whisker plots of KGE values obtained with regionalized and uncalibrated parameters for all catchments and for the five major Köppen-Geiger climate classes.

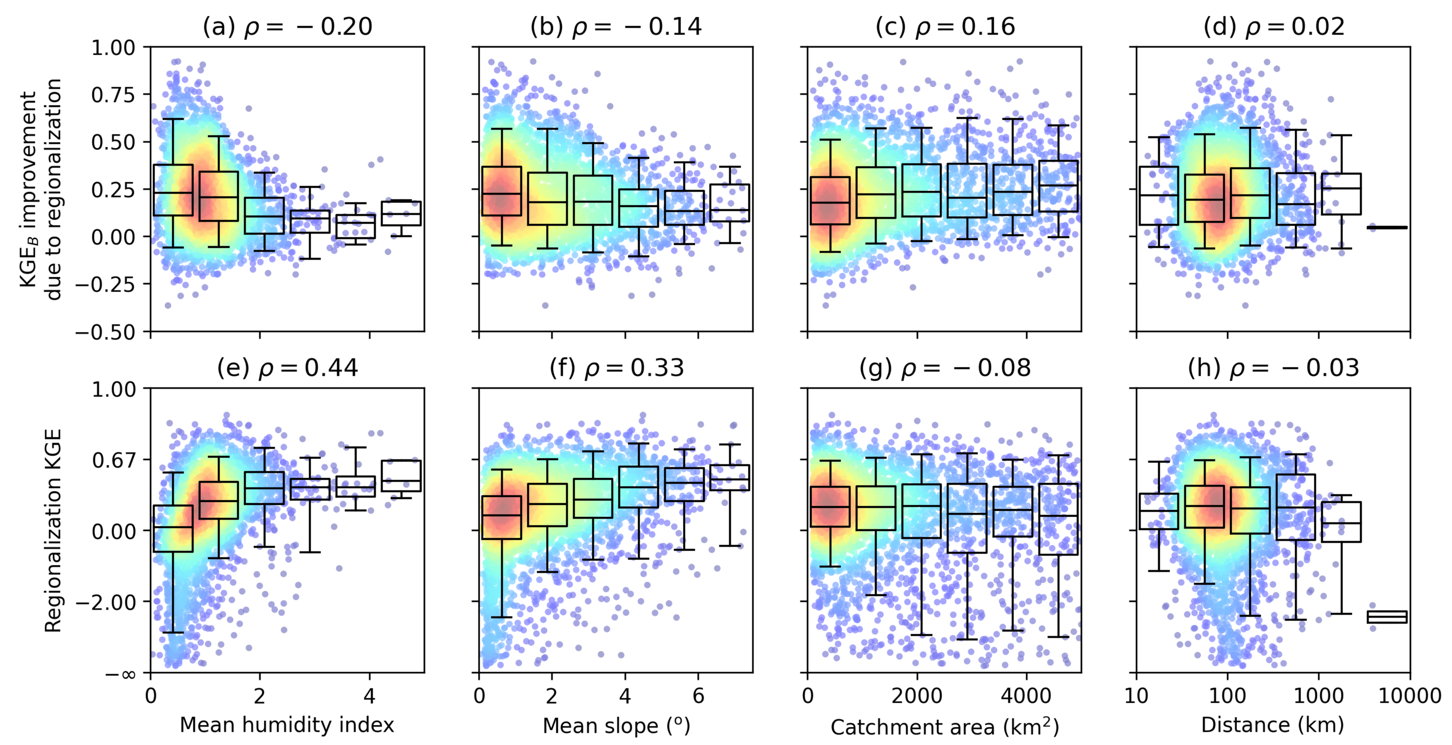

Fig. 3. Relationships between catchment characteristics and (a–d) KGE improvement scores (validation minus uncalibrated scores) and (e–h) validation KGE scores (obtained for the independent validation catchments using regionalized parameters). "Distance" is the mean distance to the ten closest catchments used for the optimization. ρ denotes Spearman's rank correlation coefficient. Each data point represents a catchment (N=4297). The boxes indicate the 25th and 75th percentiles, the line across the box indicates the median, and the whiskers indicate the 5th and 95th percentiles.

Results

- The regionalized parameters yielded, for the independent validation catchments, a median daily KGE of 0.27
- The median KGE improvement (relative to uncalibrated parameters) due to the regionalized parameters was +0.36
- These results confirm the efficacy of the regionalization approach in improving the streamflow simulation performance
- Arid catchments benefited the most from the regionalization, but after the improvement still tended to perform worst

Results continued

- Cold and polar catchments benefited the least from the regionalization, but after the regionalization still performed best
- Substantial improvements were obtained even for independent validation catchments located far away from the catchments used for the optimization
- This highlights the value of the approach for poorly gauged regions

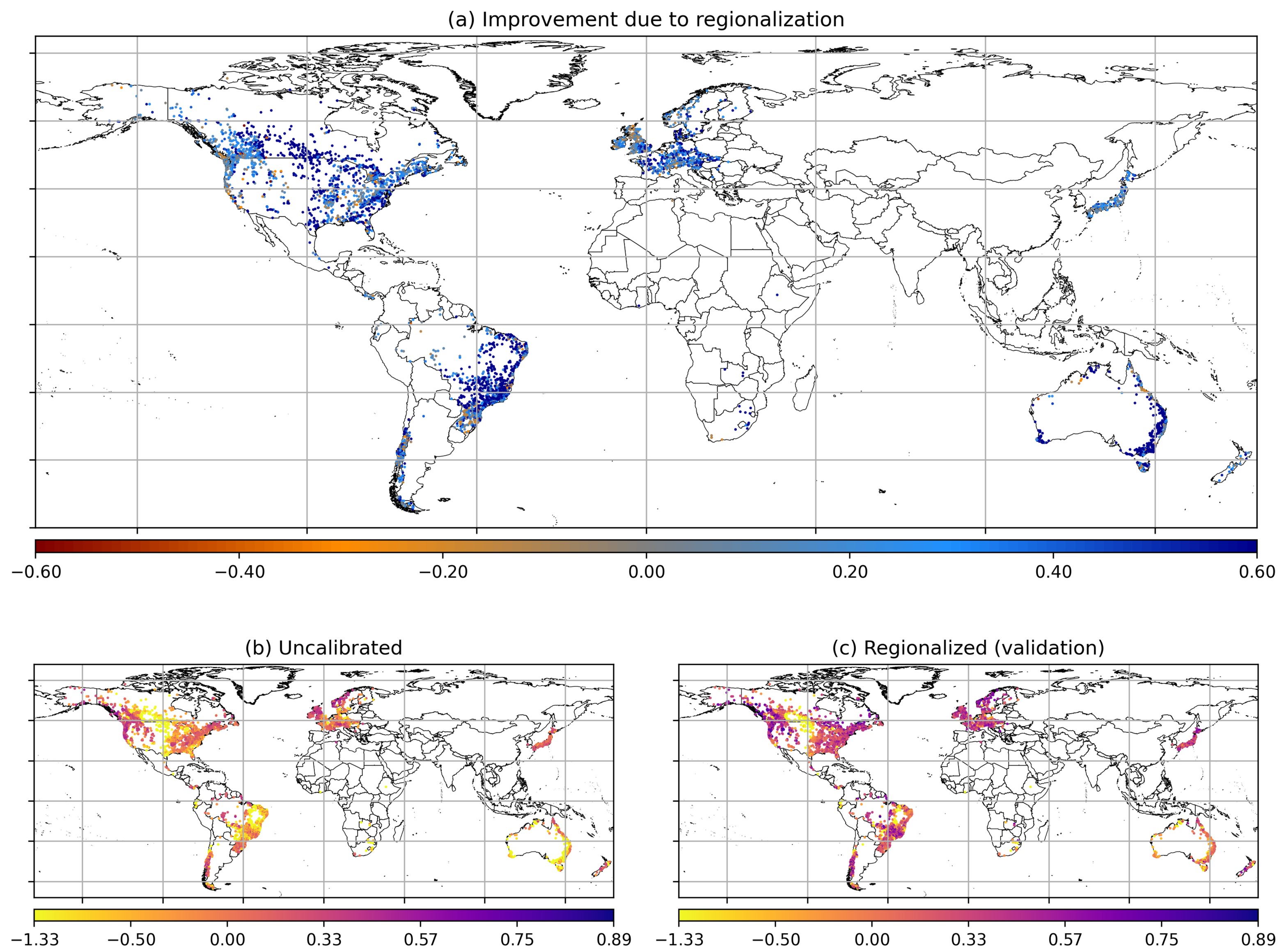

Fig. 4. (a) The improvement in KGE scores after regionalization calculated as validation minus uncalibrated KGE scores (blue indicates improved performance, while orange and red indicate deteriorated performance). (b) KGE scores for the first generation of the optimization process (i.e., using uncalibrated parameters). (c) KGE scores obtained for the independent validation catchments using regionalized parameters. Each data point represents a catchment centroid (N=4297).

Acknowledgements

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