

From global forecasts towards regional decision support: Development of a full-fledged seasonal forecasting framework for semi-arid regions

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Contents

- Overview of the framework
- The four semi-arid study domains
- Regionalization
- Performance of post-processed seasonal forecasts
- Publication
- Visualization

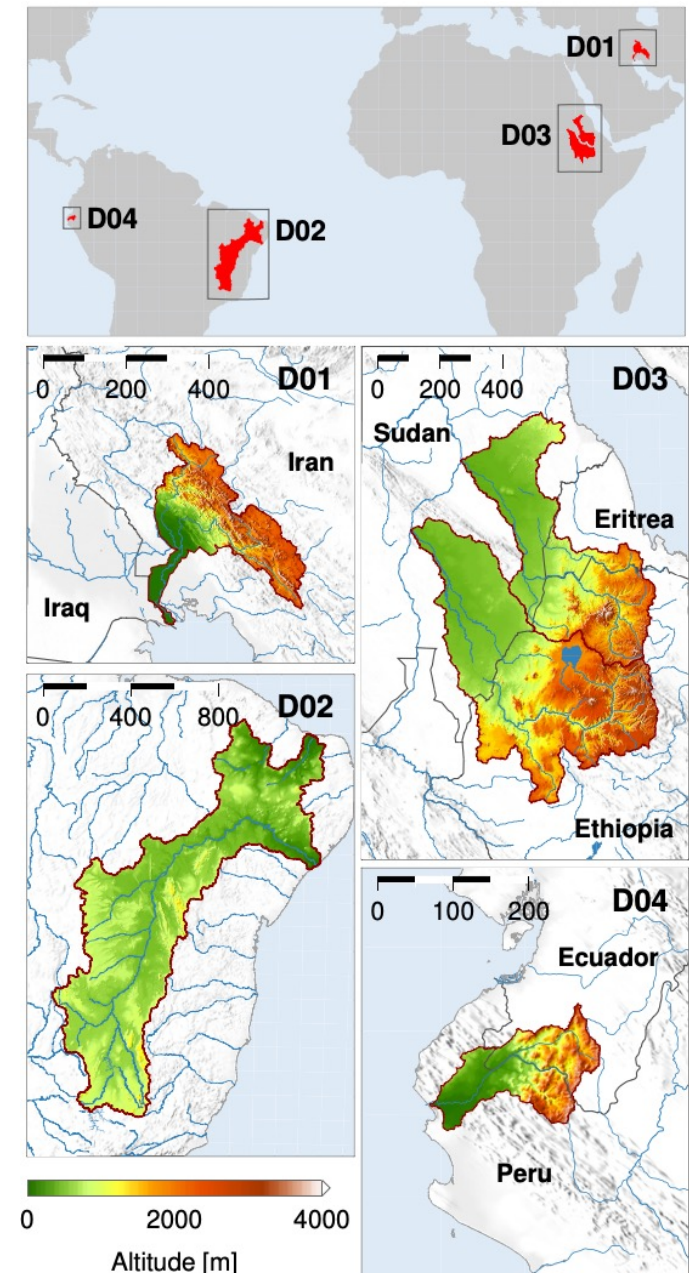
Overview

Development of an operational seasonal forecasting system for several semi-arid river basins and domains:

- We use ensemble forecasts from ECMWFs seasonal forecasting system SEAS5 (25 members from 1981 to 2016, 51 members from 2017; daily forecasts from the first of each month for the coming 215 days; spatial resolution of approx. 36km)
- Forecasts are corrected towards ERA5-Land (offline re-run of ERA5s land surface component with an enhanced resolution of 9km).
- Operational download, regionalization, post-processing and visualization: new tailored forecasts are available approx. 1 day after the ECMWF release
- The development was conducted within the [SaWaM-Project](#), which was part of BMBFs funding measure [GRoW](#)

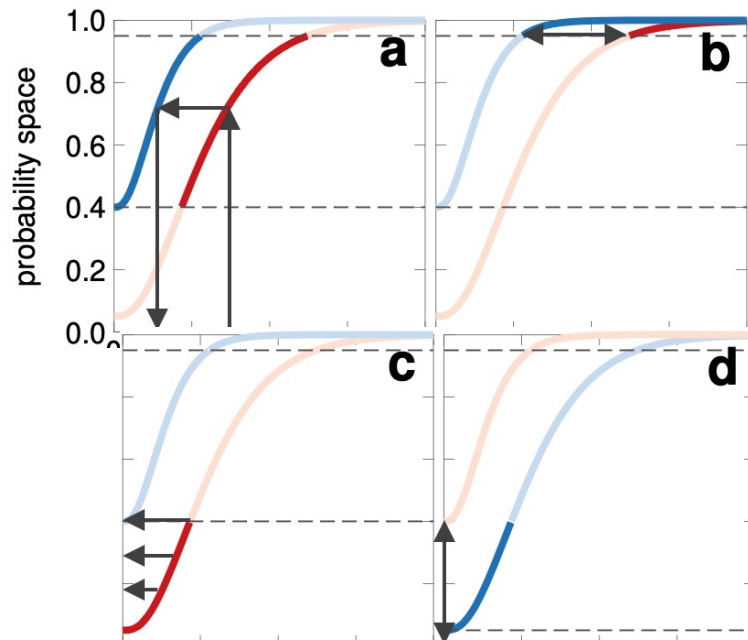
The four semi-arid study domains

- Four climate sensitive domains across Iran, Brazil, Ethiopia/Sudan, Ecuador/Peru
- Five river-basins (Karun, São Francisco, Blue Nile, Tekeze-Atbara, Catamayo-Chira)
- Similar topographic and climatic conditions (mountainous headwaters, dry and flat lower reaches, distinct rainy and dry seasons)
- All basins are highly managed: the rivers are crucial for water supply for drinking water, irrigation, hydropower generation, etc.



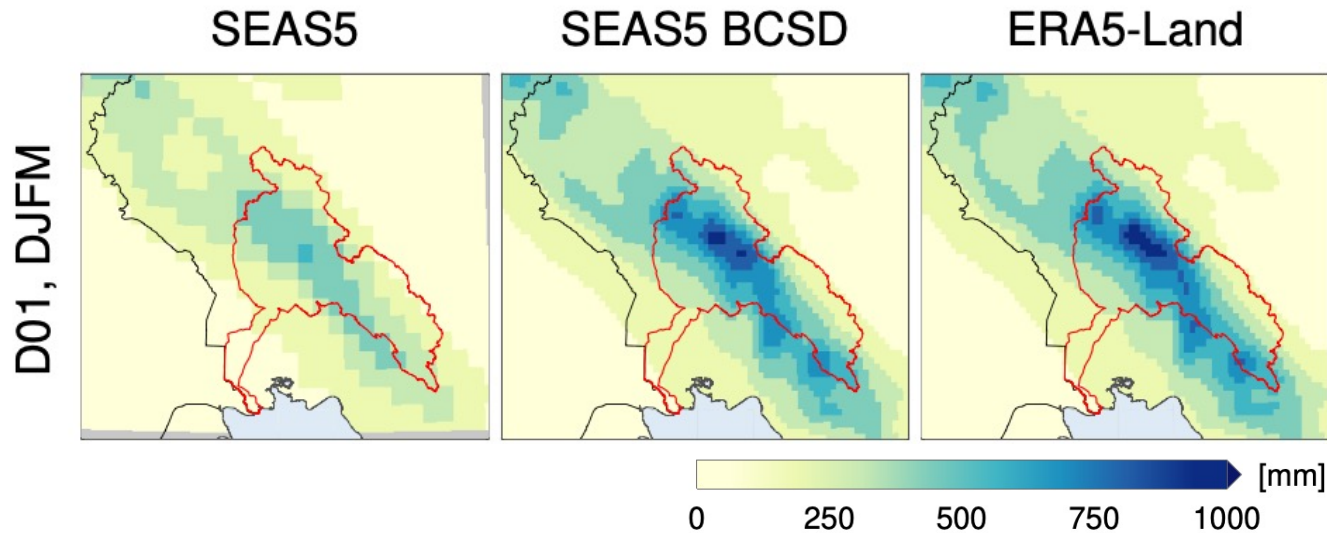
Regionalization

1. Bilinear interpolation of SEAS5 (approx. 35km) to the ERA5-Land grid (0.1°)
2. Bias-correction using empirical quantile mapping → **SEAS5 BCSD**
3. Computation of categorical forecasts, indicators, etc.



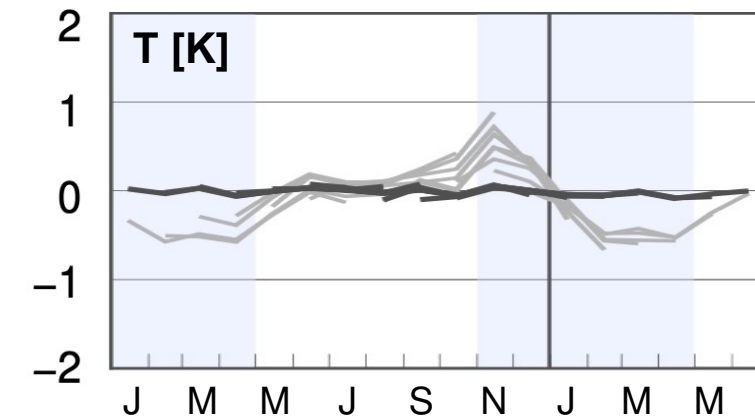
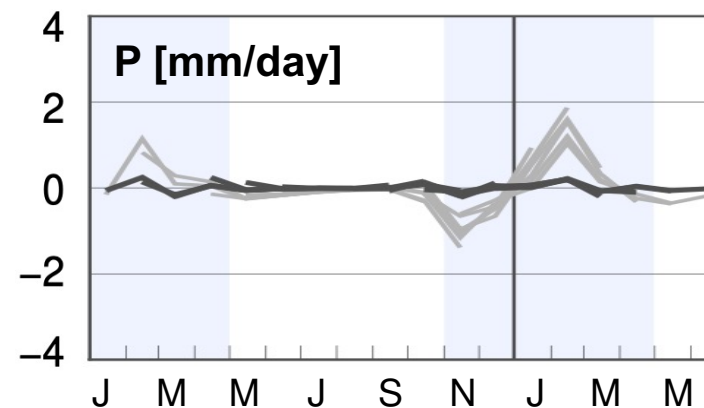
- a) Empirical quantile mapping between model-based (red) and reference (blue) data → CDFs are estimated using a 31-day-window around the forecasted day during the reference period from 1981 to 2016
- b) Delta-approach for correcting extreme values above the maximum quantile
- c) Correction of precipitation intermittency when the dry-day probability of the reference (lower dashed line) is higher
- d) Correction of precipitation intermittency when the dry-day probability of the reference is lower

Performance of post-processed forecasts



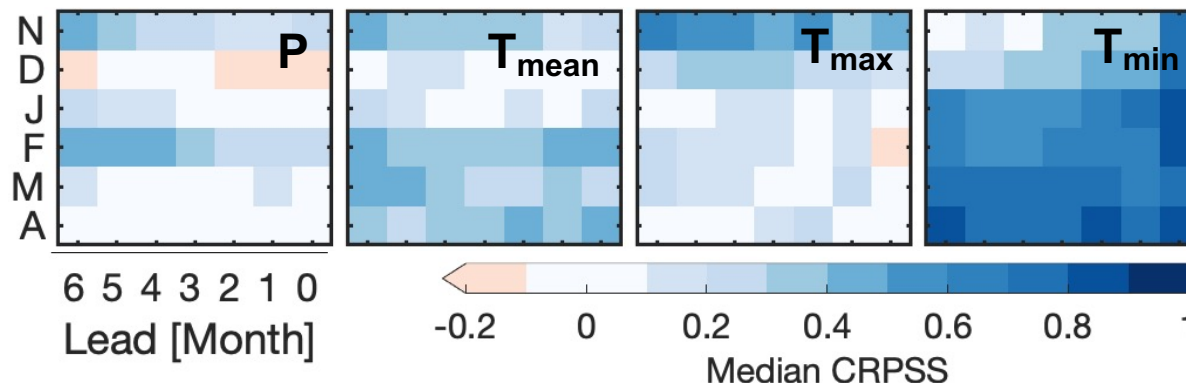
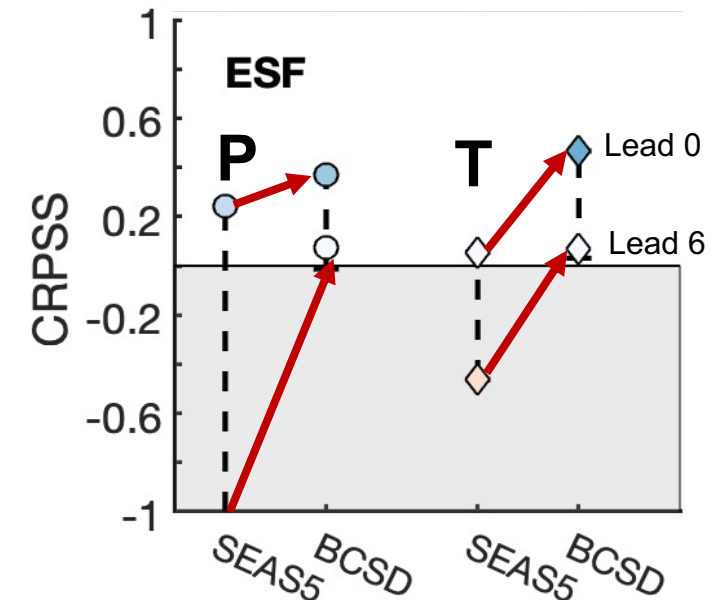
Total seasonal precipitation during the rainy season averaged from 1981 to 2016 over the Karun basin (D01): SEAS5 BCSD and ERA5-Land show similar patterns and magnitudes, while the raw forecasts assume much lower rainfall amounts.

Biases between ERA5-Land and SEAS5 before (grey) and after (black) bias-correction averaged from 1981 to 2016 over the São Francisco Basin for precipitation (P) and temperature (T): SEAS5 BCSD shows biases close to 0 and no seasonality throughout the whole year



Performance of post-processed forecasts

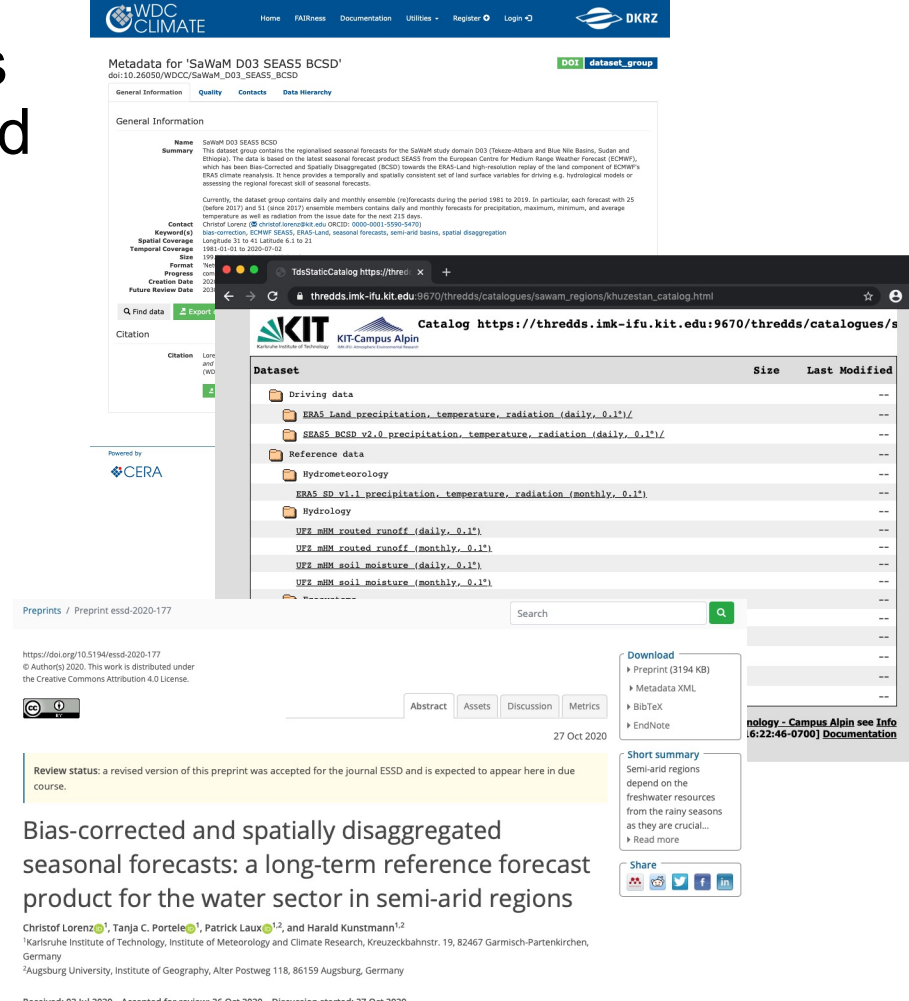
The Continuous Ranked Probability Skill Score (CRPSS) evaluates the level of agreement between the statistical distribution of the ensemble forecasts and reference information (here: ERA5-Land). While the raw forecasts (SEAS5) show negative skill scores (i.e. worse than the climatology), the forecast skill of precipitation (P) and temperature (T) forecasts is substantially improved by SEAS5 BCSD.



Blue areas indicate forecasted months where SEAS5 BCSD has higher skill scores than SEAS5; this can be achieved over most months and variables across the four study domains (here: the Rio São Francisco Basin).

Publication

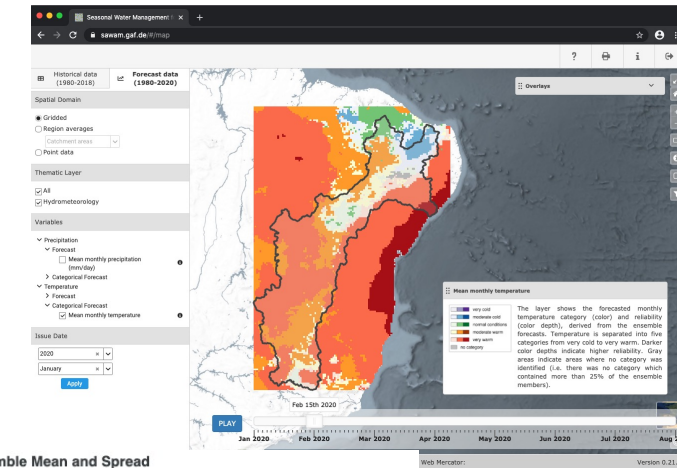
- The full repository of daily and monthly re-forecasts from 1981 to 2019 is publicly available via the World Data Center for Climate ([WDCC](https://wcc.mann-juergen-fraunhofer.de/))
- Operational forecasts as well as derived forecast measures are published via the [KIT Campus Alpin THREDDS](https://thredds.imk-ifu.kit.edu/) (also supports OGC WMS, OGC CSW, OpenDAP, etc.); please contact Christof.Lorenz@kit.edu for getting access
- SEAS5 BCSD has been also published in [ESSD](https://essd.copernicus.org/)



The image shows two overlapping web browser windows. The background window is the WDC CLIMATE website, displaying the metadata for 'SaWaM D03 SEAS5 BCSD'. It includes sections for General Information, Contact, and Citation. The foreground window shows a THREDDS catalog at the URL https://thredds.imk-ifu.kit.edu/9670/thredds/catalogues/sawam_regions/khuzestan_catalog.html. The catalog lists various datasets such as 'Driving data', 'Reference data', and 'Hydrology' with their respective sizes and last modified dates. A 'Download' button is visible in the bottom right corner of the THREDDS window.

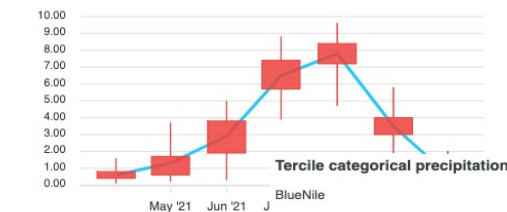
Visualization

- Development of an Online Decision Support System by the GAF AG, which shows the most important forecasting measures:
 - Categorical precipitation and temperature forecasts
 - Ensemble statistics
 - Spatial forecasts as well as area-averaged information
- Data is operationally embedded from the KIT Campus Alpin TDS:
 - Spatial data via WMS
 - Time-Series-Data via OpenDAP
 - Ancillary information (legends, documentation, etc.) via HTTP

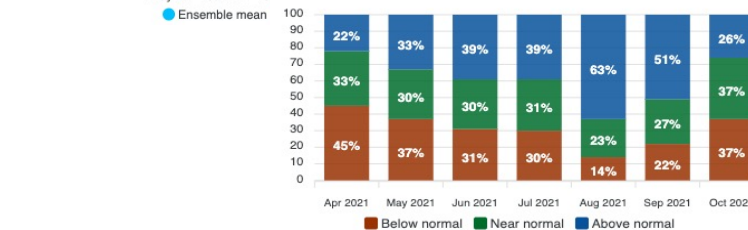


Ensemble Mean and Spread

BlueNile



BlueNile



What's next?

- Extension of SEAS5 BCSD (more variables, more domains, more indicators)
- Evaluation of further regionalization approaches (ML-based, Copulas, Multivariate approaches)
- Implementation of SEAS5 BCSD in national forecasting platforms across the four study domains

Acknowledgements

We would like to thank the BMBF for funding the SaWaM-Project within the GRow-funding-measure!



We would also like to thank the whole SaWaM-Team for contributing to this work!

