

Bias-Corrected and Spatially Disaggregated Seasonal Forecasts: A Long-Term Reference Forecast Product for the Tekeze-Atbara and Blue Nile Basins

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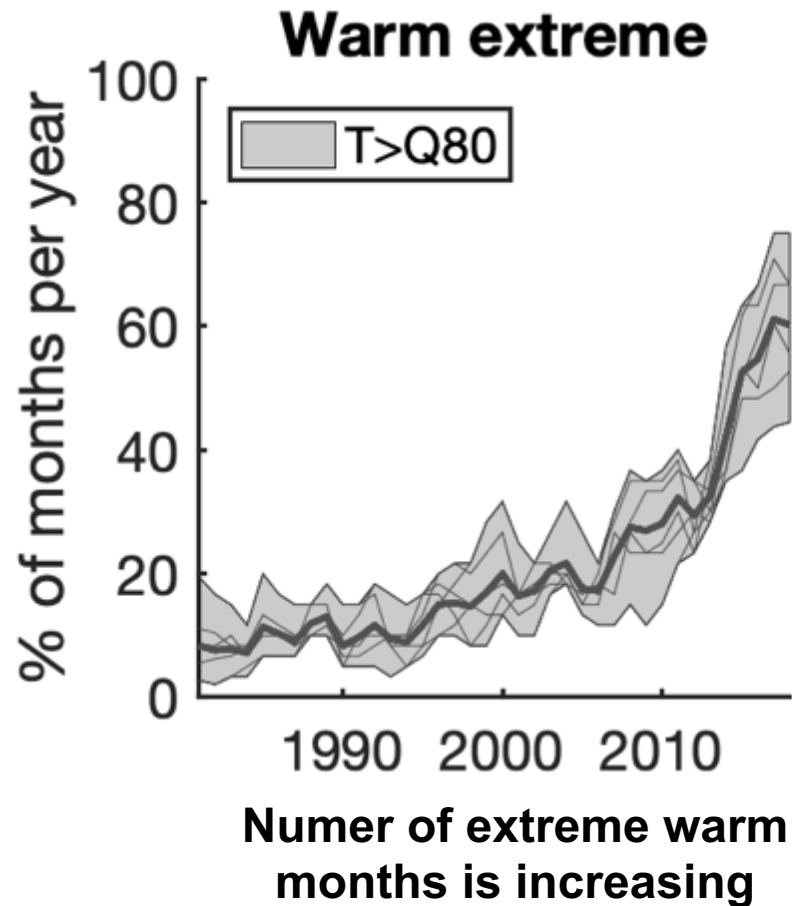
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KIT-Campus Alpin
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Climate is changing in semi-arid regions



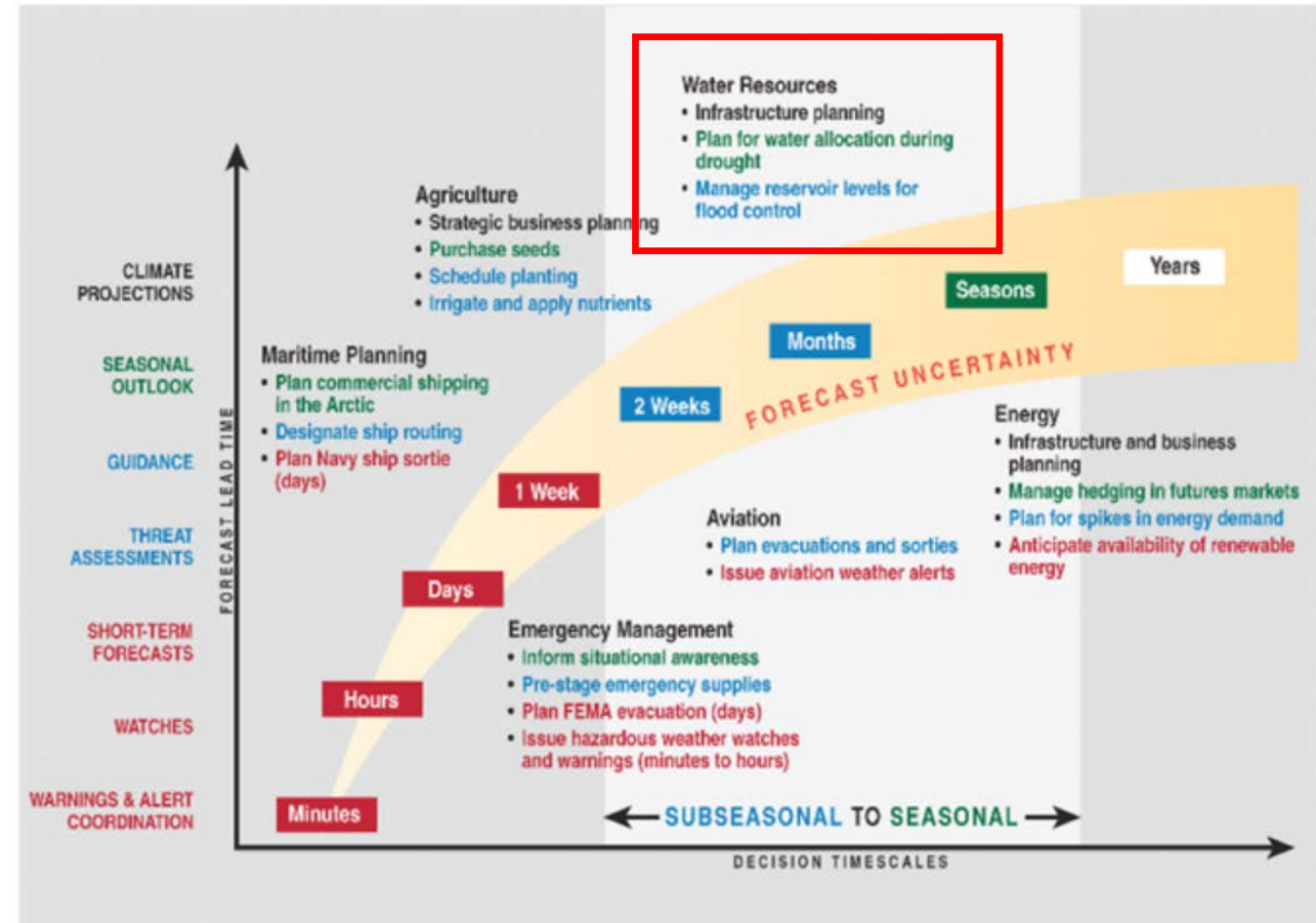
ERA5-based time-series for five semi-arid river basins including the Tekeze-Atbara and Blue-Nile Basins

Findings based on current reanalysis data – long-term trends even worse...

Long-term planning is crucial...

- Allocation of freshwater resources
- Reservoir management
- Food and drinking water security
- Hydropower generation
- Extreme event prediction
- *Example: GERD filling strategies*

Seasonal forecasts can make a decisive contribution for regional water resources management



Source: Next Generation Earth System Prediction: Strategies for Subseasonal to Seasonal Forecasts. Washington, DC: The National Academies Press. doi: 10.17226/21873.

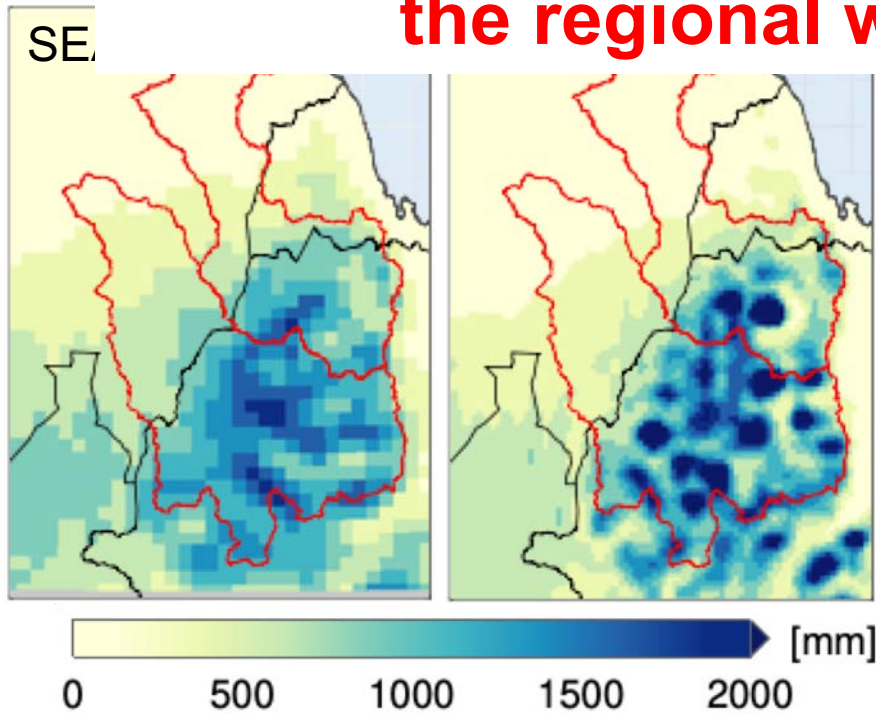
Seasonal forecasts: a short overview

- Ensemble forecasts time-periods up to 1 year ahead
- Global products from major meteorological centers (ECMWF, Met Office, Météo France, DWD, NCEP, etc.)
- Predictability on seasonal time-scales through MJO, ENSO, soil moisture, snow cover and sea ice, etc.*
- Here: ECMWFs actual seasonal forecasting system SEAS5
 - Spatial resolution of 36km; output on 6-hourly, daily and monthly time-scales, freely available via ECMWF and Copernicus
 - 25 (from 1981 to 2016) and 51 (from 2017) ensemble member

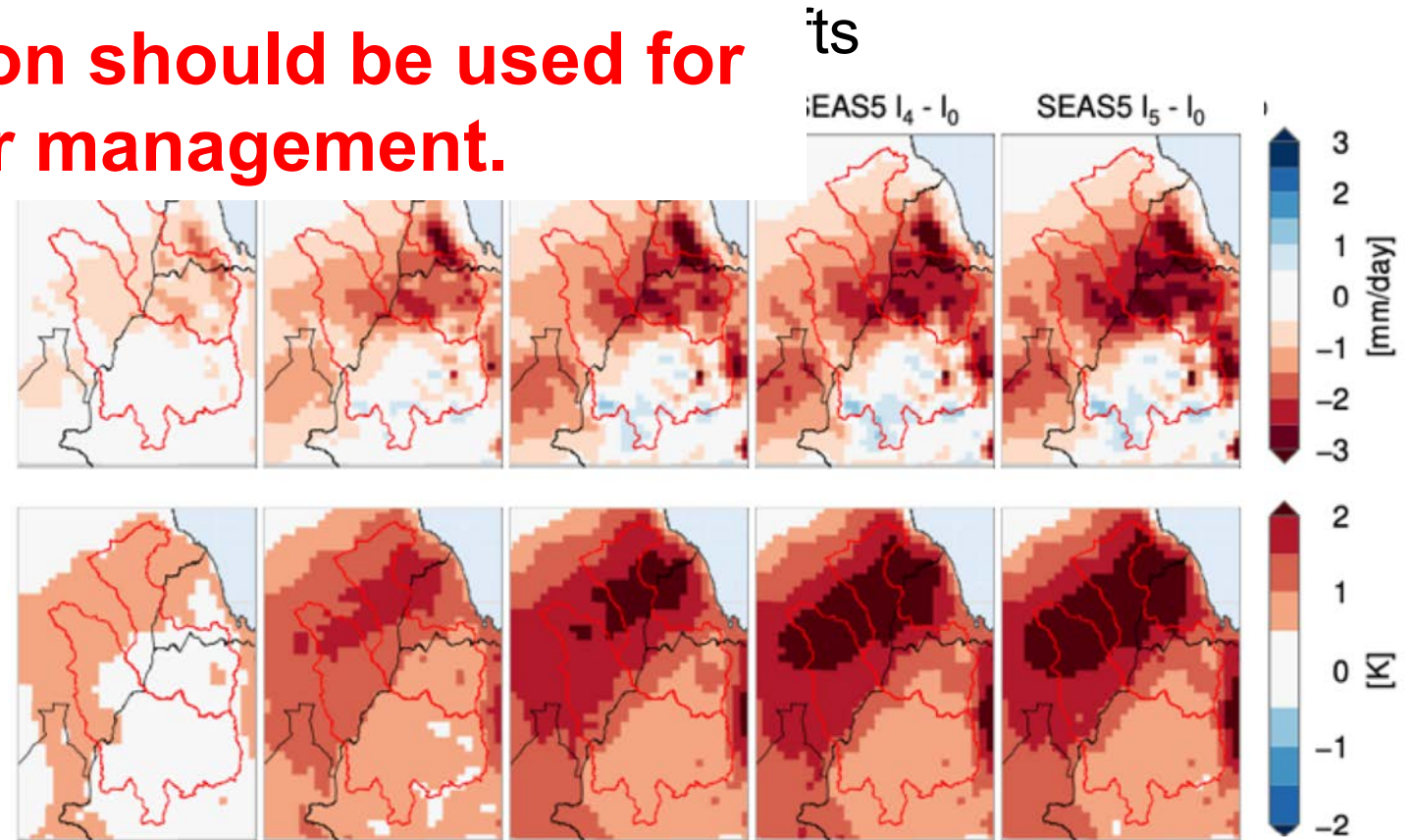
*Vitart, F., Robertson A. and the S2S steering group Sub-seasonal to seasonal prediction: linking weather and climate. Seamless prediction of the earth system: from minutes to months, WMO-no 1156, 385-405 (2015)

Raw seasonal forecasts have issues

Post-processing of seasonal forecasts is crucial if such information should be used for the regional water management.

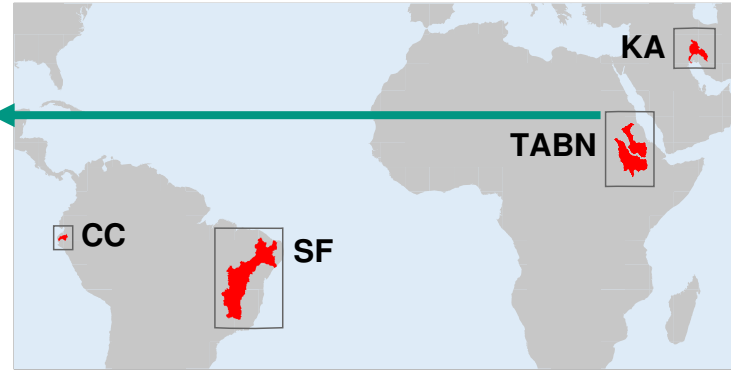
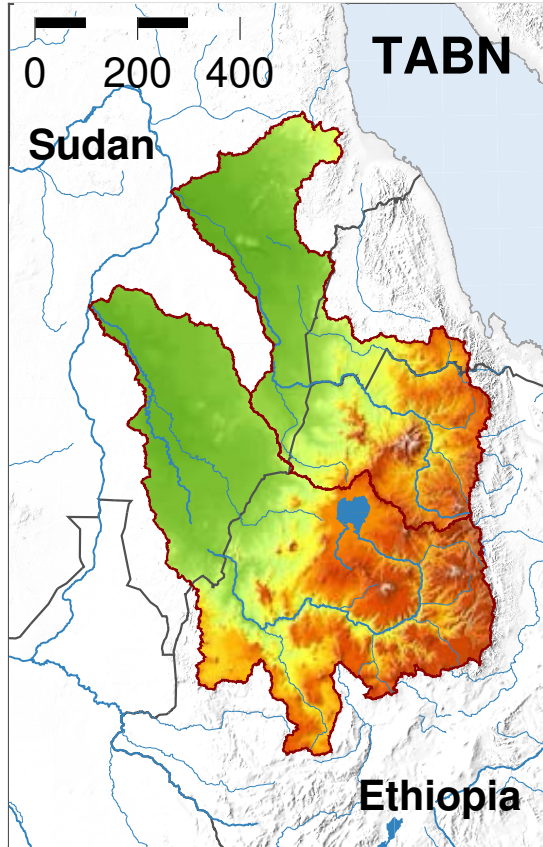


Seasonal precipitation sum from June to September, averaged over the period 1981 to 2016



Differences of precipitation (top) and temperature (bottom) forecasts for July between different lead times, averaged over the period 1981 to 2016

Objectives in a nutshell

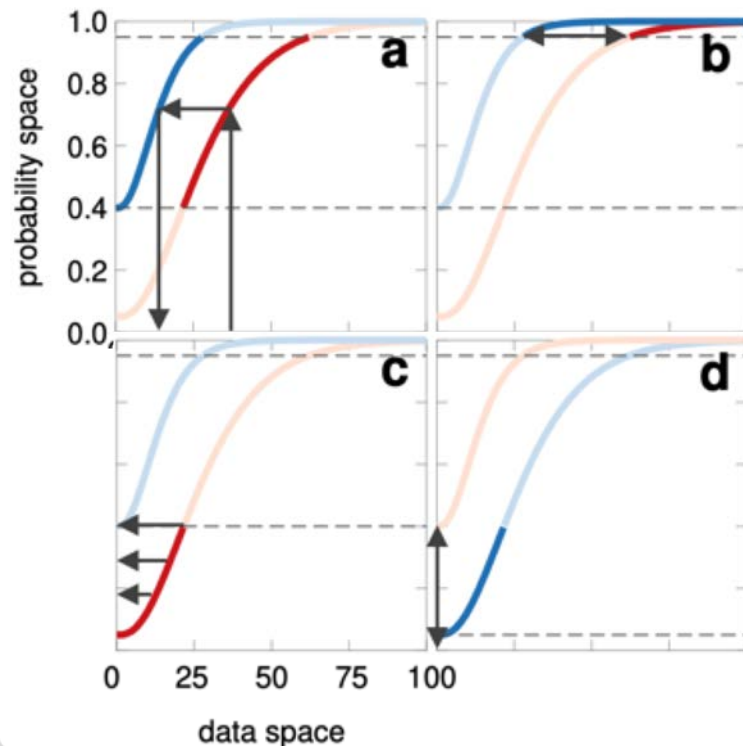


■ **Development of regionalized seasonal forecasts** for the Tekeze-Atbara and Blue Nile Basins (Sudan, Ethiopia, and Eritrea)

- **Bias-Correction and Spatial Disaggregation (BCSD)** of ECMWFs seasonal forecast product **SEAS5** towards **ERA5-Land**, which is the offline re-run of ERA5s land surface component with an enhanced resolution of 9km.
- **Free publication** of the dataset to **build capacity and knowledge** in the field of **seasonal ensemble forecasts**.
- **Operationalization** for providing **up-to-date seasonal forecasts and derived products** for supporting the regional water management

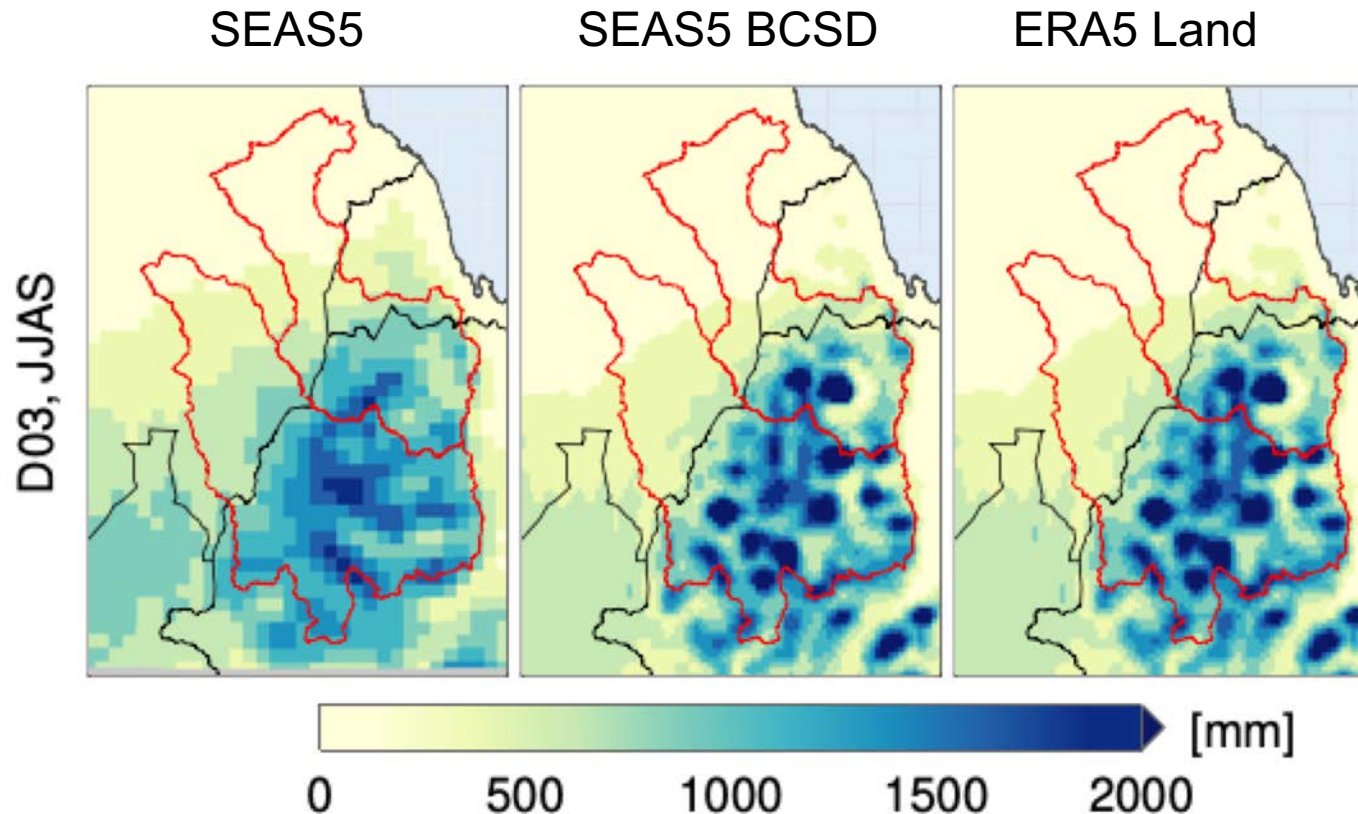
From raw SEAS5 to SEAS5 BCSD

1. Bilinear interpolation of SEAS5 (approx. 35km) to the ERA5-Land grid (0.1°)
2. Bias-correction of daily precipitation, temperature, and radiation using empirical quantile mapping
3. Computation of categorical forecasts, drought indicators, etc. including performance analyses



- 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

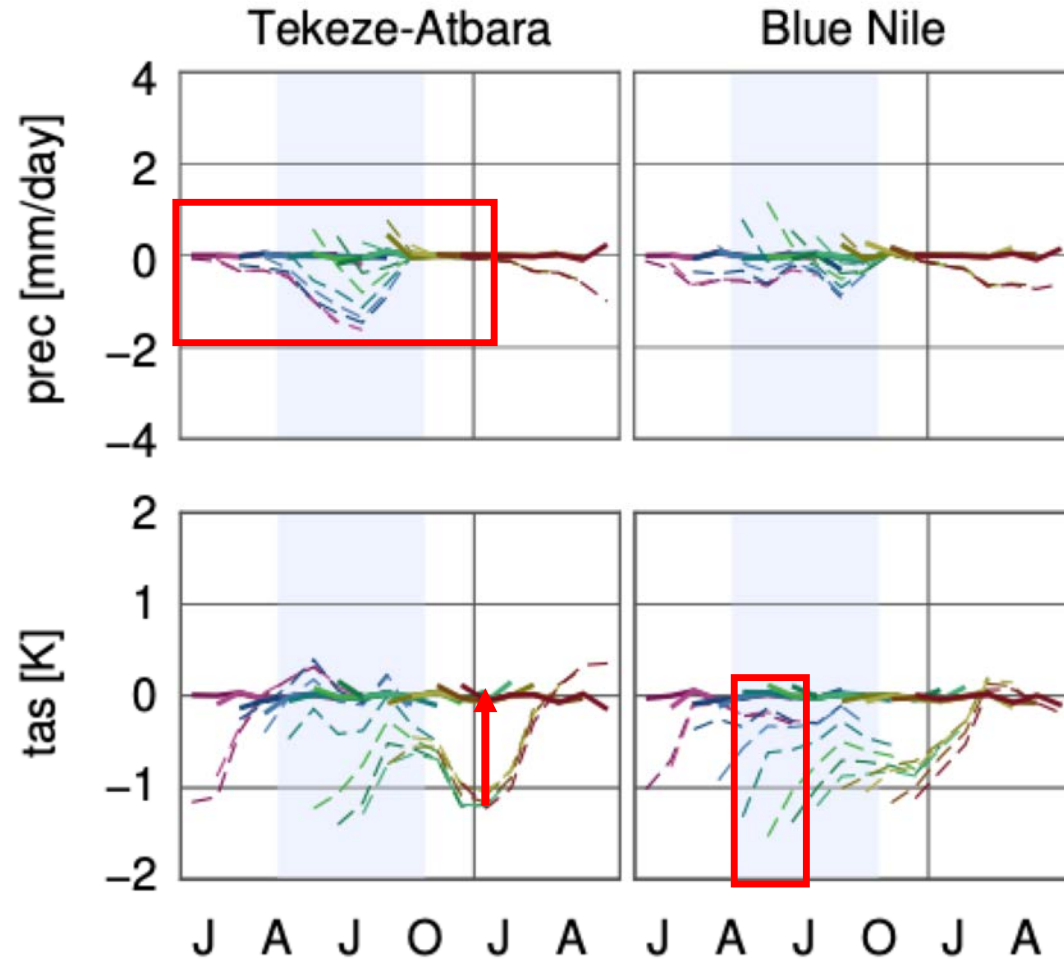
Improvement of total seasonal precipitation



Seasonal precipitation sum from June to September, averaged over the period 1981 to 2016

**Substantially improved
level of agreement
w.r.t. ERA5 Land**

Improvement of area-averaged forecasts



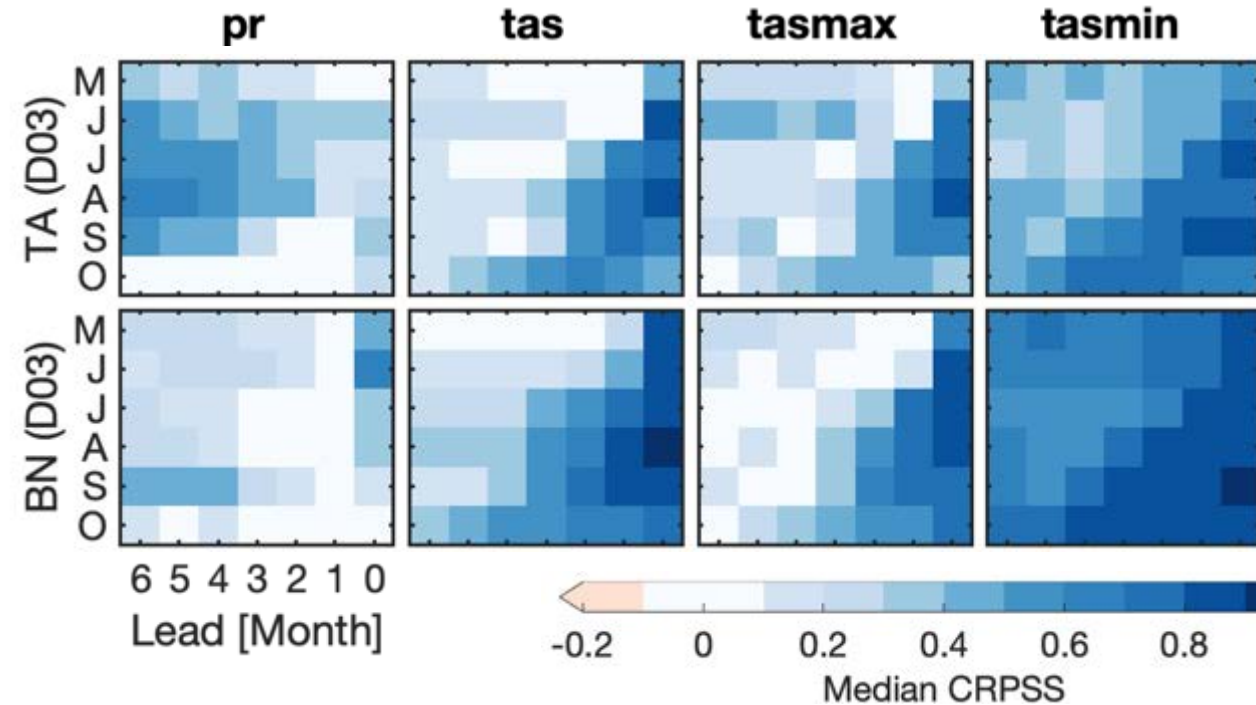
Biases of area-averaged precipitation (top) and temperature (bottom) forecasts for the Tekeze-Atbara (left) and Blue Nile (right) basins of raw SEAS5 (dashed) and SEAS5 BCSD (straight) from different issue dates (colors)

- Biases after BCSD are close to 0
- Seasonality of biases is (almost) eliminated
- Improved consistency across lead-times



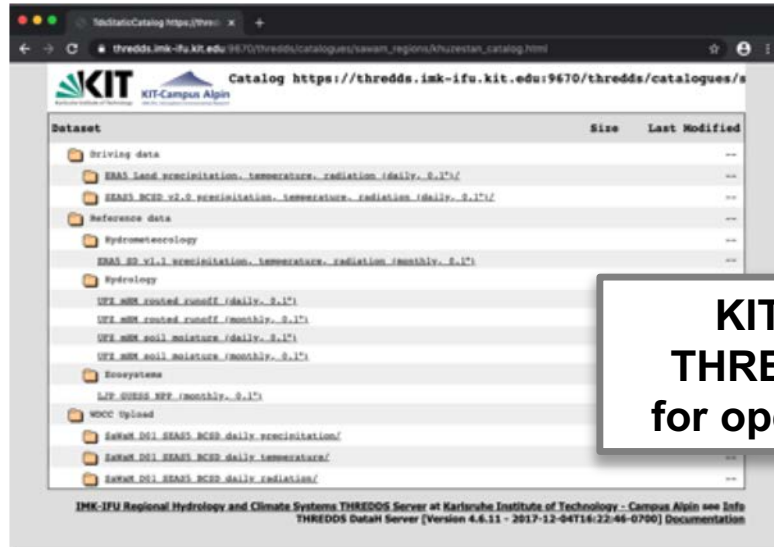
SEAS5 BCSD vs. SEAS5 (raw) vs. ERA5 Land

- CRPSS: level of agreement between the statistical distribution of the ensemble forecasts and reference information (here: ERA5 Land)
- Raw forecast skill is quite weak across the basins (indicated by reddish CRPSS values below 0)
- CRPSS becomes positive after BCSD, particularly for temperature and low-lead precipitation forecasts (indicated by blueish CRPSS values above 0)
- Compared to the raw forecasts, BCSD shows an improvement across all lead-times and variables.



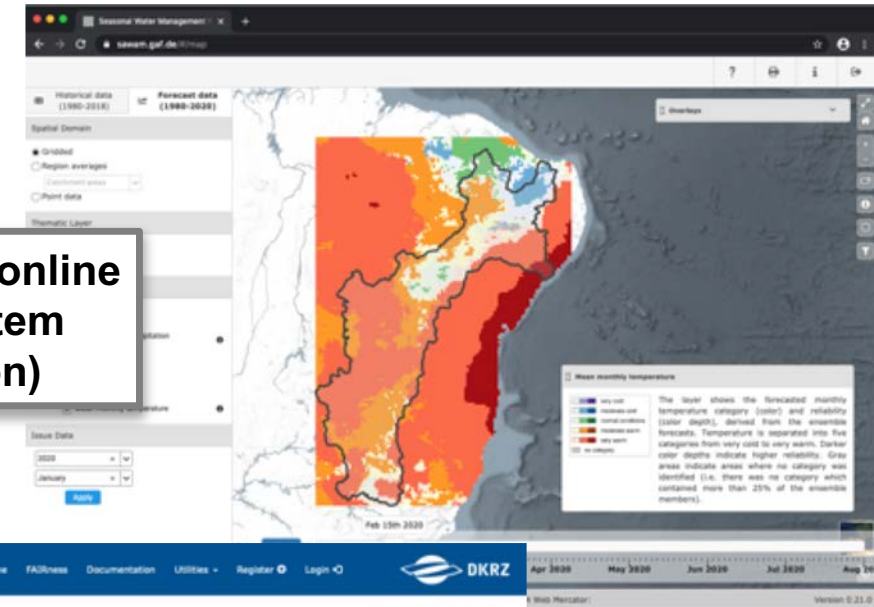
BCSD is a simple, but effective method for reducing biases and model drifts.

Publication, visualization and dissemination of SEAS5 BCSD



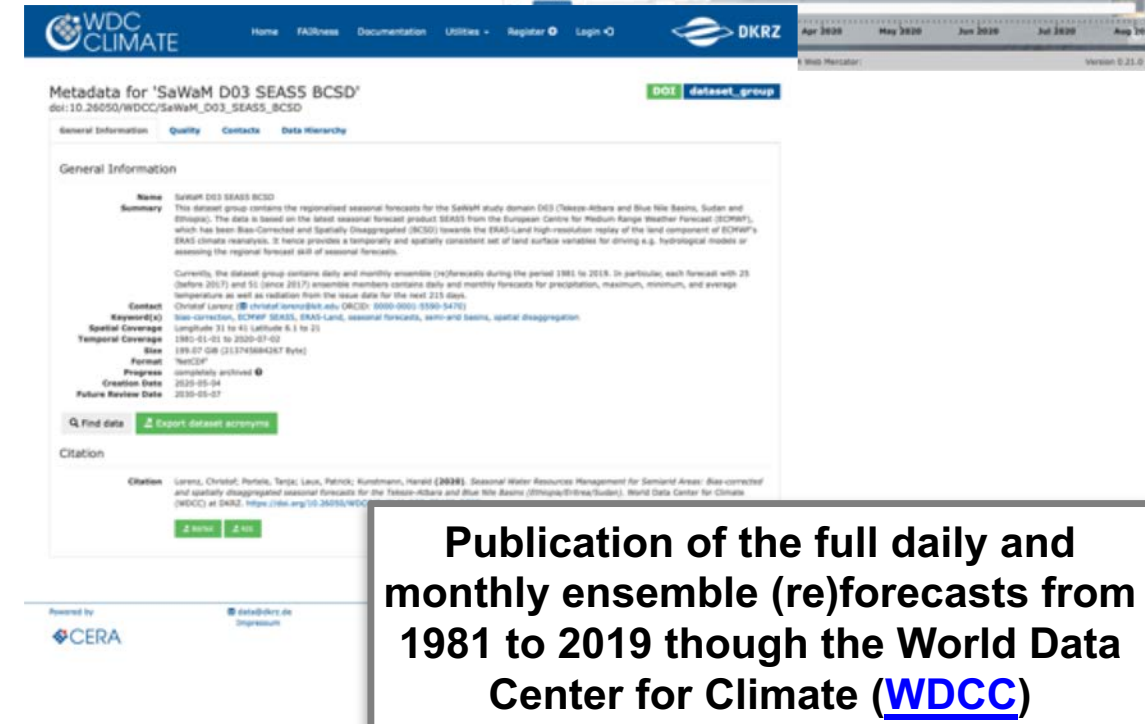
**KIT Campus Alpin
THREDDS Data Server
for operational products**

**Joint development of an online
Decision Support System
(will be released soon)**



Dissemination of operational BCSD forecasts and derived products to local authorities:

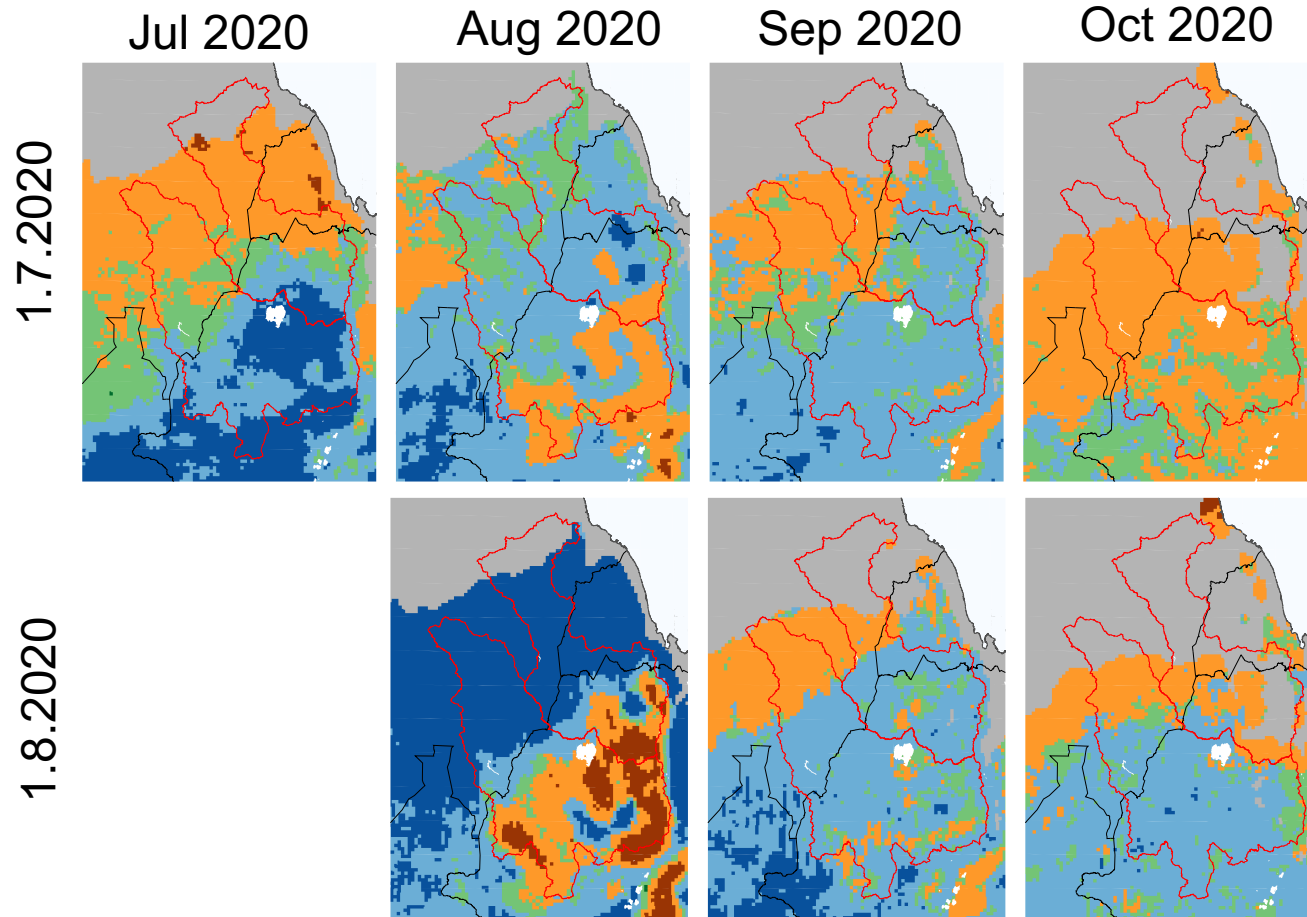
- Sudan: *Ministry of Irrigation and Water Affairs, Sudanese Meteorological Association (SMA)*
- Iran: *Khuzestan Water and Power Authority (KWPA)*
- Ecuador: *National Meteorological Agency of Ecuador (INAMHI)*
- Brazil: *Foundation Cearense for Meteorology and Water Management (FUNCEME)*



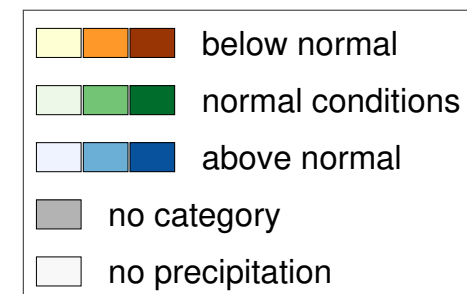
**Publication of the full daily and
monthly ensemble (re)forecasts from
1981 to 2019 through the World Data
Center for Climate ([WDCC](https://www.wdc-climate.org/))**

What about the current forecast?

Categorical (tercile) precipitation forecasts from 1.7.2020 and 1.8.2020



- SEAS5 BCSD predicts above normal conditions during July and September 2020 across the Ethiopian Highlands
- In August 2020, in particular across the higher-altitude regions, below normal conditions are predicted.
- Overall, the predictions until September show similar categories, which indicates quite stable conditions.



Summary

- Seasonal forecasts can significantly improve the water management and climate proofing in semi-arid regions (...and can help to develop climatically reasonable filling strategies)
- Raw forecasts are often not directly applicable (bad resolution, biases, etc.)
- We have applied a BCSD-approach for computing spatially and temporally consistent seasonal forecasts for a domain which includes the Tekeze-Atbara and Blue Nile basins
- Our product shows much higher forecast skill compared to the raw forecasts
- All data is freely available; operational forecasts are produced every month!



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Thank you for your attention.

More information: www.grow-sawam.org

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