Ensemble sub-setting for dynamical downscaling of global seasonal climate forecasts

Karlsruhe Institute of Technology

Patrick Laux

Campus-Alpin

1. Motivation:

- **Global seasonal climate forecasts** (GSCFs) provide crucial information for water management, but are too coarse for decision support on local scales
- Since initial conditions (ICs) are not perfectly known, **perturbed ensemble simulations** are used to quantify IC uncertainties of the solution space
- **Dynamical downscaling** provides suitable approach to bridge the gap from global to local scales, providing physically consistent hydrometeorological variables
- **Problem: computational resources usually permit downscaling of the full forecast ensemble**

→ Sub-setting approach to select suitable members for dynamical downscaling

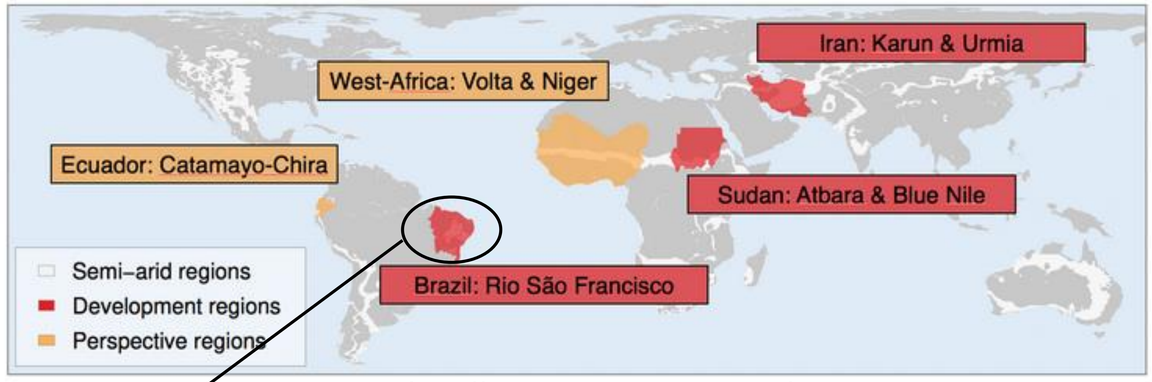
2. Sub-setting approach:

The backward elimination ensemble search algorithm (Thober and Samaniego, 2014) is applied for the ECMWF System 4 (S4) seasonal precipitation hindcasts for the wet seasons 2001–2010 and different regions (see section 3):

1. Select the full ensemble (all members) as the "ensemble seed",
2. Sequentially remove one member from the ensemble seed and evaluate the corresponding performance (here: the spatial RMSE between S4 and GPCC precipitation data),
3. Repeat step 2 for the remaining members,
4. Replace the old "ensemble seed" with the combination exhibiting the best performance in steps 2 and 3,
5. Repeat steps 2 to 4 until the "ensemble seed" contains 1 single member only,
6. Evaluate the performance of the optimization

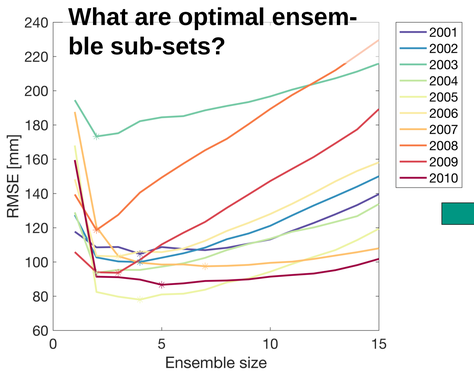
3. Study regions:

- Semi-arid regions of BMBF-SaWaM (seasonal water management in semi-arid regions), which suffer from severe water scarcity
- Regions, where partners have experience and collaborations

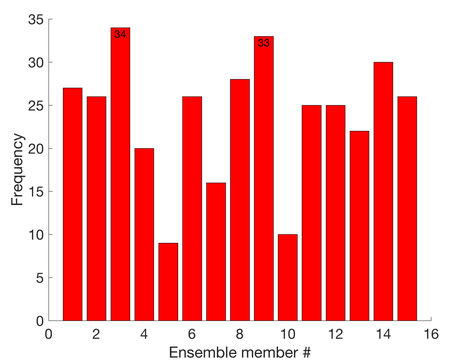


http://www.grow-sawam.org/

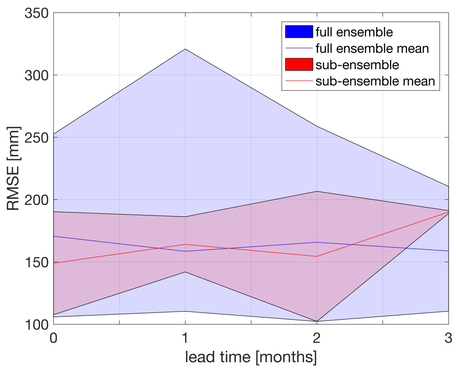
4. Selected results for NE Brazil:



RMSE of different ensemble sizes, obtained by the backward elimination ensemble search approach. The results for the 3-month lead time for the DJF seasonal precipitation forecasts is presented exemplarily (optimum member solution marked by *).



Occurrence frequencies of members of the optimal solution → weighted solution of all lead times (1-3 months, single weight) and 3-month lead time (double weight) → members 3 and 9 are found to be significant based on a permutation test (1000 realizations, alpha=0.01).



Range of the RMSE values [mm] of the identified members of the sub-ensemble compared to the members of the full ensemble in order to predict the DJF season in Brazil with lead times from 0–3 months.

5. Conclusion and future work

- Objective approach to support climate modellers in selecting ensemble members for dynamical downscaling
- Frees up resources to explore uncertainties from different RCM physics parametrization options or uncertainties from climate impact models, such as agricultural or hydrological models
- Future work: besides RMSE, include probabilistic performance measure(s) in sub-setting approach

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Contact: Patrick Laux, Institute of Meteorology and Climate Research (IMK-IFU), KIT, Email: patrick.laux@kit.edu