SPECIAL PROJECT FINAL REPORT

All the following mandatory information needs to be provided.

Project Title:	Tailor-made seasonal forecasts for sub-Saharan Africa
Computer Project Account:	Spde4l
Start Year - End Year :	01/01/2014 – 31/12/2016
Principal Investigator(s)	Dr. Patrick Laux
Affiliation/Address:	Karlsruhe Institute of Technology Institute of Meteorology and Climate Research (KIT/IMK-IFU)
Other Researchers (Name/Affiliation):	

The following should cover the entire project duration.

Summary of project objectives
(10 lines max)

The objectives of this SP were:

i) Statistical Analysis of the raw (uncorrected) global seasonal forecasting system of ECMWF (S4) and NCEP (CFSv2) data in terms of the intra-(seasonal) rainfall distribution, such as onset, cessation of the rainy season.

ii) Bias correction of the global seasonal forecasting system of ECMWF using different bias correction methods such as quantile mapping.

iii) Spatiotemporal refinement applying dynamical downscaling of selected ensemble members based on ECMWF and NCEP data. The results will be validated using gridded precipitation observations such as GPCC.

Summary of problems encountered
(If you encountered any problems of a more technical nature, please describe them here.)

Few technical issues encountered, particularly with respect to data transfer from ECMWF server to our local servers, but finally solved.

Experience with the Special Project framework
(Please let us know about your experience with administrative aspects like the application procedure, progress reporting etc.)

Fast decision about acceptance of SP, unbureaucratic application and reporting procedures.

Summary of results
(This section should comprise up to 10 pages and can be replaced by a short summary plus an existing scientific report on the project.)

In the beginning of the special project, the regional focus was on West Africa. A statistical analysis of NCEP CFSv2 precipitation product as prediction system for the Volta Basin of West Africa has been performed and published (Siegmund et al, 2015). This work can be summarized as follows (abstract of Siegmund et al., 2015):

"Seasonal precipitation forecasts are important sources of information for early drought and famine warnings in West Africa. This study presents an assessment of the monthly precipitation forecast of the Climate Forecast System version 2 (CFSv2) for three agroecological zones (Sudan-Sahel, Sudan, and Guinean zone) of the Volta Basin. The CFSv2 performance is evaluated for the Sahel drought 1983 and for all August months of the reforecast period (1982–2009) with lead times up to 8 months using a quantile-quantile transformation for bias correction. In addition, an operational experiment is performed for the rainy season 2013 to analyze the performance of a dynamical downscaling approach for this region. Twenty-two CFSv2 ensemble members initialized in February 2013 are transferred to a resolution of 10 km × 10 km using the Weather and Research Forecasting (WRF) model. Since the uncorrected CFSv2 precipitation forecasts are characterized by a high uncertainty (up to 175% of the observed variability), the quantile-quantile transformation can clearly reduce this overestimation with the potential to provide skillful and valuable early warnings of precipitation deficits and excess up to six months in ahead, particularly for the Sudan-Sahel zone. The operational experiment illustrates that CFSv2-WRF can reduce the CFSv2 uncertainty (up to 69%) for monthly precipitation and the onset of the rainy season but has still strong deficits regarding the northward progression of the rain belt. Further studies are necessary for a more robust assessment of the techniques applied in this study to confirm these promising outcomes."

The full paper is not added to this report, but can be assessed under:
http://onlinelibrary.wiley.com/doi/10.1002/2014JD022692/abstract

After that, the regional climate outlook product for West Africa, subsequently referred to as PRESAO (operated under the umbrella of WMO) has been analysed. The following tasks were performed:

- Documentation of the forecasting techniques used by the PRESAO community
- Determination the forecast quality and value of past PRESAO forecasts, focus was on drought situations
- Analysis of potential ways to improve seasonal precipitation forecasts for the West African region

The results can be summarized as follows:

The quality of PRESAO forecast of seasonal precipitation amounts has been assessed using the Brier skill score (BSS) for Burkina Faso, Ghana, and Benin. For this reason, data from long-term synoptic stations have been used and analyzed separately. The period from 1998-2013 has been used for evaluation. PRESAO forecasts are conducted end of May for the coming 3-month period of July, August, September, i.e. with a lead time of 1 month.

It is found that the PRESAO forecast show only very limited skill. The precipitation forecast is more skillful for the dry years, however, it should be noted that the magnitude of the BSS is low. For the wet years, the forecast shows only limited skill for Benin, but no skill for Ghana and Burkina Faso (worse than prediction based on long-term climatology). In addition to that, the economic value has been

analyzed. The PRESAO forecast is beneficial in terms of its economic value (compared to a simple reference system), however, the magnitude of the skill score is low.

Towards the end of the special project, the regional focus shifted towards the Southeast Asian domain. In this study, which is based on initial work of Phan-Van et al. (2014), the ability of applying the NCEP Climate Forecast System (CFSv2) products and its downscaling using the Regional Climate Model Version 4.2 (RegCM4.2) on seasonal rainfall forecasts over Vietnam is studied.
The work has been recently submitted to *Weather and Forecasting.* The results can be summarized as follows (abstract of Paper of Tan Phan-Van et al., 2017):

"This study investigates the ability of applying the National Centers for Environmental Prediction (NCEP) Climate Forecast System (CFS) products and its downscaling using the Regional Climate Model Version 4.2 (RegCM4.2) on seasonal rainfall forecasts over Vietnam. Firstly, the CFS hindcasts (CFS_Rfc) from 1982 to 2009 are used to assess the ability of the CFS to predict the overall circulation and precipitation patterns at forecast lead times of up to 6 months. Secondly, the operational CFS forecasts (CFS_Ope) and its RegCM4.2 downscaling (RegCM_CFS) for the period 2012-2014 are used to derive seasonal rainfall forecasts over Vietnam. CFS_Rfc and CFS_Ope are validated against the CFS reanalysis, the Global Precipitation Climatology Centre (GPCC) analyzed rainfall, and observations from 150 meteorological stations over Vietnam. The results show that the CFS_Rfc can capture the seasonal variability of the Asian monsoon circulation and rainfall distribution. The higher resolution RegCM_CFS product is advantageous over the raw CFS in specific climatic sub-regions during the transitional, dry and rainy season, particularly in the Northern part in January, and in the Central Highlands of Vietnam in July."

Besides these initial works in Vietnam, another project (Improving Water Resources Management in Arid Regions (SaWaM), press release under: https://www.researchgate.net/project/SaWaM-BMBF-GROW-coordinated-by-KIT-IMK-IFU-Prof-Kunstmann) has been funded.
Methods and tools for the application-oriented transfer of regionalized global information to water management in data-sparse semi-arid regions will be developed and their performance analyzed. In a cooperation of seven scientific partners and two companies, the regional focus will be on Sudan, Iran, Brazil, Ecuador/Peru, and West Africa. For hydrological design purposes, our temporal scale covers the past up to the present, while for operational management purposes it will address the upcoming 1-12 months. SaWaM employs models addressing seasonal forecasting, water availability, sedimentation processes, and ecosystem states. Model approaches are extended by satellite-borne methods. An online prototype of a globally applicable decision support system for dry-land water management will be developed through an integrative approach in close cooperation with German business partners and local stakeholders.
In this project, the performance of the ECMWF seasonal climate forecasts (S4) will be analyzed for the selected target regions. In this context, the "added-value" of bias correction and dynamical downscaling will be investigated.

List of publications/reports from the project with complete references

Tan Phan-Van, Hiep Van Nguyen, Long Trinh Tuan, Trung Nguyen Quang, Thanh Ngo-Duc, Patrick Laux, and Thanh Nguyen Xuan (2014), Seasonal Prediction of Surface Air Temperature across Vietnam Using the Regional Climate Model Version 4.2 (RegCM4.2), Advances in Meteorology, vol. 2014, Article ID 245104, 13 pages, 2014. doi:10.1155/2014/245104.

Tan Phan-Van, Thanh Nguyen-Xuan, Hiep Van Nguyen, Patrick Laux, Ha Pham-Thanh, Thanh Ngo-Duc (2017): Evaluation of the NCEP Climate Forecast System and Its Downscaling for Seasonal Rainfall Prediction over Vietnam (submitted to Weather and Forecasting).

Siegmund, J., J. Bliefernicht, P. Laux, and H. Kunstmann (2015), Towards a Seasonal Precipitation Prediction System for West Africa: Performance of CFSv2 and High Resolution Dynamical Downscaling, J. Geophys. Res. Atmos., 120, doi:10.1002/2014JD022692.

Bliefernicht, J., J. Siegmund. J. Seidel, H. Arnold, M. Waongo, P. Laux, and H. Kunstmann (2016), Forecasting droughts in West Africa: Operational practice and refined seasonal precipitation forecasts, Oral presentation, 19th April, EGU, Vienna.

Future plans

For the SaWaM project, access to the S4 seasonal forecast data in the MARS archive is required. To perform the dynamical downscaling of the S4 analyses, another special project will be applied in the future. Currently, besides data download, first simulations are being conducted to estimate the required CPU resources.