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Deep Learning improved seasonal forecasts for the Blue Nile Basin

Rebecca Wiegels[1], Luca Glawion[1], Julius Polz[1], Christian Chwala[1], Jan Niklas Weber[1], Tanja C. Schober[1], Christof Lorenz[1], and Harald Kunstmann[1,2]
[1]Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology, Campus Alpin, Garmisch-Partenkirchen, Germany
[2]Institute of Geography, University of Augsburg, Augsburg, Germany

Seasonal predictions are essential in mitigating damage to people and nature as a result of climate change and extreme events by improving timely decision-making particularly for water and irrigation management. The newly constructed Grand Ethiopian Renaissance Dam, located in the Blue Nile (BN) Basin in Ethiopia at the border to Sudan, increases the urgency of optimized transboundary water management and improved seasonal predictions. However, the global seasonal forecasting systems have known limitations such as biases and drifts. Specifically at regional level, such as in the highlands of Ethiopia, the seasonal predictions need accurate post-processing. Recent developments have shown the large potential of Deep Learning (DL) applications to improve weather and climate predictions. The goal of this study is to improve the global seasonal forecasting system SEAS5 of ECMWF specifically for the BN Basin using DL approaches such as conventional Convolutional Neural Networks (CNN) or more advanced Adaptive Fourier Neural Operators (AFNO). We present first results for improving and downscaling SEAS5 global seasonal precipitation forecasts in the BN Basin with a particular emphasis on ensemble generation and calibration. The neural networks are trained with ERA5-Land-reanalysis data as a ground-truth, which has a higher resolution than SEAS5 (~9km compared to ~36km). This additional downscaling step allows us to consider the high variations in precipitation intensities in the Ethiopian highlands. The results show that the applied DL models have high potential in improving forecasting scores such as the continuous ranked probability skill score. They therefore allow for improved timely decision-making for water management in the transboundary BN Basin.