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The value of the North American Multi Model Ensemble phase 2 for sub-seasonal hydrological forecasting

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Sub-seasonal to seasonal weather and hydrological forecasts have the potential to provide vital information for a variety of water-related decision makers. For example, seasonal forecasts of drought risk can enable farmers to make adaptive choices on crop varieties, labour usage, and technology investments. Seasonal and sub-seasonal predictions can increase preparedness to hydrological extremes that regularly occur in all regions of the world with large impacts on society. We investigated the skill of six seasonal forecast models from the NMME-2 ensemble coupled to two global hydrological models (VIC and PCRGLOBWB) for the period 1982-2012. The 31 years of NNME-2 hindcast data is used in combination with an ensemble mean and ESP forecast, to forecast important hydrological variables (e.g. soil moisture, groundwater storage, snow, reservoir levels and river discharge). By using two global hydrological models we are able to quantify both the uncertainty in the meteorological input and the uncertainty created by the different hydrological models. We show that the NMME-2 forecast outperforms the ESP forecasts in terms of anomaly correlation and brier skill score for all forecasted hydrological variables, with a low uncertainty in the performance amongst the hydrological models. However, the continuous ranked probability score (CRPS) of the NMME-2 ensemble is inferior to the ESP due to a large spread between the individual ensemble members. We use a cost analysis to show that the damage caused by floods and droughts in large scale rivers can globally be reduced by 48% (for leads from 1-2 months) to 20% (for leads between 6-9 months) when precautions are taken based on the NMME-2 ensemble instead of an ESP forecast. In collaboration with our local partner in West Africa (AGHRYMET), we looked at the performance of the sub-seasonal forecasts for crop planting dates and high flow season in West Africa. We show that the uncertainty in the optimal planting date is reduced from 30 days to 12 days (2.5 month lead) and an increased predictability of the high flow season from 45 days to 20 days (3-4 months lead). Additionally, we show that snow accumulation and melt onset in the Northern hemisphere can be forecasted with an uncertainty of 10 days (2.5 months lead). Both the overall skill, and the skill found in these last two examples, indicates that the new NMME-2 forecast dataset is valuable for sub-seasonal forecast applications. The high temporal resolution (daily), long leads (one year leads) and large hindcast archive enable new sub-seasonal forecasting applications to be explored. We show that the NMME-2 has a large potential for sub-seasonal hydrological forecasting and other potential hydrological applications (e.g. reservoir management), which could benefit from these new forecasts.