Geophysical Research Abstracts
Vol. 19, EGU2017-9629-1, 2017
EGU General Assembly 2017

High-resolution hydrological seasonal forecasting for water resources management over Europe

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To support the decision-making process at the seasonal time scale, hydrological forecasts with a high temporal and spatial resolution are required to provide the level of information needed by water managers. So far high-resolution seasonal forecasts have been unavailable due to 1) lack of availability in meteorological seasonal forecasts, 2) the coarse temporal resolution of meteorological seasonal forecasts, requiring temporal downscaling, and 3) lack of consistency between observations and seasonal forecasts, requiring bias-correction.

As part of the EDgE (End-to-end Demonstrator for improved decision making in the water sector in Europe) project, we have created a unique dataset of hydrological seasonal forecasts derived from four atmospheric circulation models (CanCM4, FLOR-B01, ECMF, LFPW) in combination with four global hydrological models (PCR-GLOBWB, VIC, mHM, Noah-MP). The forecasts provide daily values at 5-km spatial resolution and are bias corrected against E-OBS meteorological observations. Consistency in the LSM parameterization ensures synergy in the hydrological forecasts, resulting in 208 forecasts at any given day over Europe. The forecast results are communicated to stakeholders via Sectoral Climate Impact Indicators (SCIIs) that have been co-designed in collaboration with end-users and stakeholders inside the EDgE project. An example of an SCII is the percentage of ensemble realizations above the 10th percentile of monthly river flow or below the 90th percentile, including the persistency in the forecast with increasing lead times.

Results show that skillful discharge forecasts can be made throughout Europe 3 months in advance, with predictability up to 6 months for Northern Europe due to the impact of snow. The predictability of soil moisture is limited to the first three months, due to the significant impact of precipitation and the short memory in the initial conditions (only for the first month). The groundwater recharge predictability surpasses 6 months throughout Europe, with the lowest forecast skill for western Europe. The SCIIs directly quantify the forecast uncertainty and proof to be a good way to communicate these to stakeholders.

Overall the new system provides an unprecedented ensemble for seasonal forecasts with significant skill over Europe to support water management. The consistency in both the meteorological forecasts and the LSM parameterization ensures a stable and reliable forecast framework and methodology, even if additional models are added in the future.