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A seamless global hydrological monitoring and forecasting system for water resources assessment and hydrological hazard early warning

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Sustainable management of water resources and mitigation of the impacts of hydrological hazards are becoming ever more important at large scales because of inter-basin, inter-country and inter-continental connections in water dependent sectors. These include water resources management, food production, and energy production, whose needs must be weighed against the water needs of ecosystems and preservation of water resources for future generations. The strains on these connections are likely to increase with climate change and increasing demand from burgeoning populations and rapid development, with potential for conflict over water. At the same time, network connections may provide opportunities to alleviate pressures on water availability through more efficient use of resources such as trade in water dependent goods. A key constraint on understanding, monitoring and identifying solutions to increasing competition for water resources and hazard risk is the availability of hydrological data for monitoring and forecasting water resources and hazards. We present a global online system that provides continuous and consistent water products across time scales, from the historic instrumental period, to real-time monitoring, short-term and seasonal forecasts, and climate change projections. The system is intended to provide data and tools for analysis of historic hydrological variability and trends, water resources assessment, monitoring of evolving hazards and forecasts for early warning, and climate change scale projections of changes in water availability and extreme events. The system is particular useful for scientists and stakeholders interested in regions with less available in-situ data, and where forecasts have the potential to help decision making.

The system is built on a database of high-resolution climate data from 1950 to present that merges available observational records with bias-corrected reanalysis and satellite data, which then drives a coupled land surface model–flood inundation model to produce hydrological variables and indices at daily, 0.25-degree resolution, globally. The system is updated in near real-time (< 2 days) using satellite precipitation and weather model data, and produces forecasts at short-term (out to 7 days) based on the Global Forecast System (GFS) and seasonal (up to 6 months) based on U.S. National Multi-Model Ensemble (NMME) seasonal forecasts. Climate change projections are based on bias-corrected and downscaled CMIP5 climate data that is used to force the hydrological model. Example products from the system include real-time and forecast drought indices for precipitation, soil moisture, and streamflow, and flood magnitude and extent indices. The model outputs are complemented by satellite based products and indices based on satellite data for vegetation health (MODIS NDVI) and soil moisture (SMAP). We show examples of the validation of the system at regional scales, including how local information can significantly improve predictions, and examples of how the system can be used to understand large-scale water resource issues, and in real-world contexts for early warning, decision making and planning.