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Seasonal forecasting of groundwater levels in natural aquifers in the United Kingdom

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Groundwater aquifers comprise the world's largest freshwater resource and provide resilience to climate extremes which could become more frequent under future climate changes. Prolonged dry conditions can induce groundwater drought, often characterised by significantly low groundwater levels which may persist for months to years. In contrast, lasting wet conditions can result in anomalously high groundwater levels which result in flooding, potentially at large economic cost. Using computational models to produce groundwater level forecasts allows appropriate management strategies to be considered in advance of extreme events. The majority of groundwater level forecasting studies to date use data-based models, which exploit the long response time of groundwater levels to meteorological drivers and make forecasts based only on the current state of the system. Instead, seasonal meteorological forecasts can be used to drive hydrological models and simulate groundwater levels months into the future. Such approaches have not been used in the past due to a lack of skill in these long-range forecast products. However systems such as the latest version of the Met Office Global Seasonal Forecast System (GloSea5) are now showing increased skill up to a 3-month lead time. We demonstrate the first groundwater level ensemble forecasting system using a multi-member ensemble of hindcasts from GloSea5 between 1996 and 2009 to force 21 simple lumped conceptual groundwater models covering most of the UK's major aquifers. We present the results from this hindcasting study and demonstrate that the system can be used to forecast groundwater levels with some skill up to three months into the future.