The science behind the Hydrological Outlook seasonal groundwater level forecasts

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1 Overview

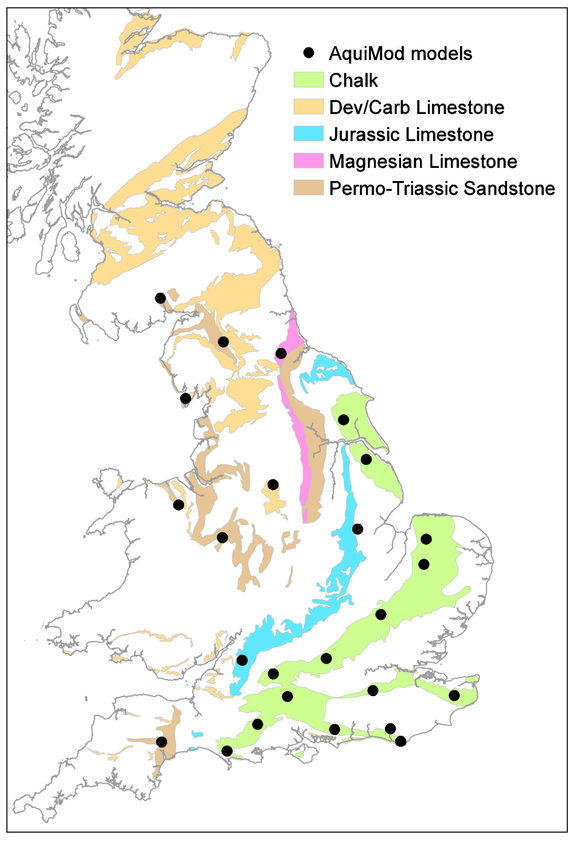

Figure 1 AquiMod model locations.

As part of the Hydrological outlook, the BGS use state of the art climate ensemble forecasts from the Met Office Global Seasonal forecasting system (GloSea5) which are downscaled and then used to drive 25 AquiMod groundwater models distributed over the UK's major Aquifers (Figure 1). Consequently, a probabilistic groundwater level forecast is produced for each site. An outline of the seasonal groundwater level forecasting system employed for the Hydrological Outlook is shown in Figure 2.

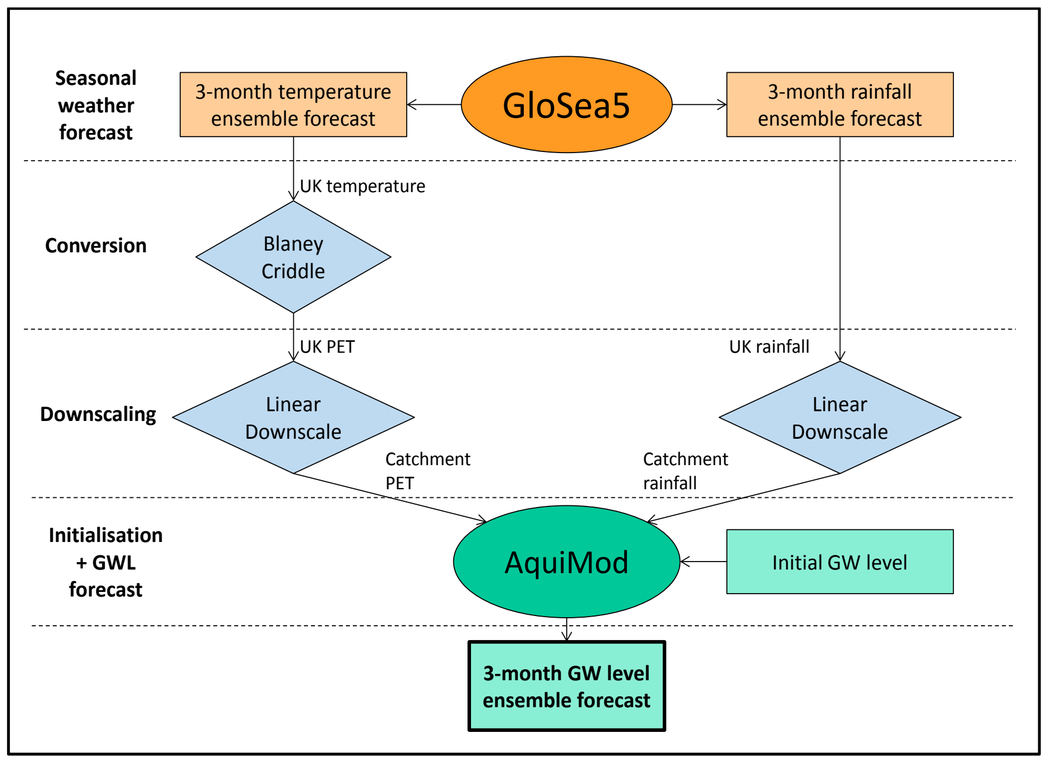

Figure 2 Overview of groundwater level seasonal forecasting sequence.

2 GloSea5

Until recently, long-range meteorological forecasts have demonstrated only modest levels of skill. GloSea5 demonstrates high levels of skill, especially in predicting year to year fluctuations in the winter surface NAO (Figure 3), an important factor for the seasonal climate around the Atlantic basin (Scaife et al., 2014). It is used to produce a 42-member ensemble forecast of lumped rainfall and temperature over the UK up to 3-months ahead. Temperature is then translated into potential evapotranspiration using the Blaney-Criddle equation (Allen, 1986), which is downscaled with the rainfall forecasts for each groundwater model.

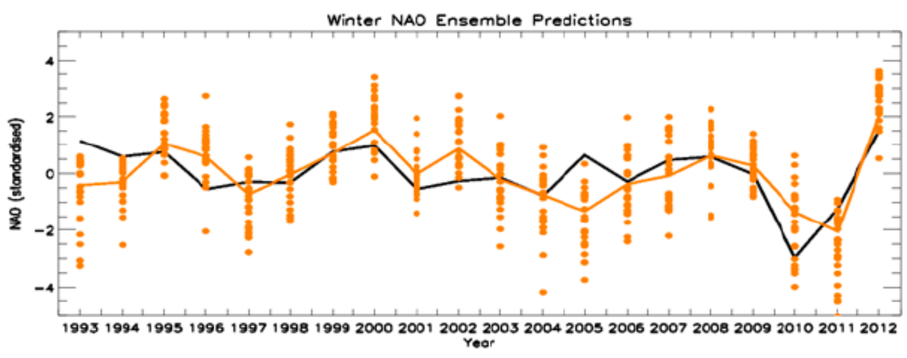

Figure 3 NAO observations (black line). Individual GloSea5 ensemble members (orange dots) and mean forecasts (orange line) (Scaife *et al.*, 2014).

3 AquiMod

AquiMod is a lumped conceptual groundwater model that simulates groundwater level fluctuations at an observation borehole. It consists of three modules which represent the soil, unsaturated and saturated zones (Figure 4). A Monte Carlo approach was adopted to calibrate the model parameters at each site. An example of the simulation efficiency is shown for one of the 25 sites in Figure 5.

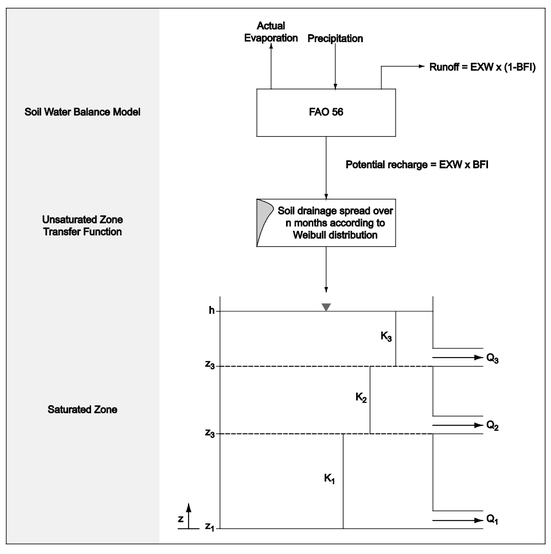

Figure 4 General structure of AquiMod.

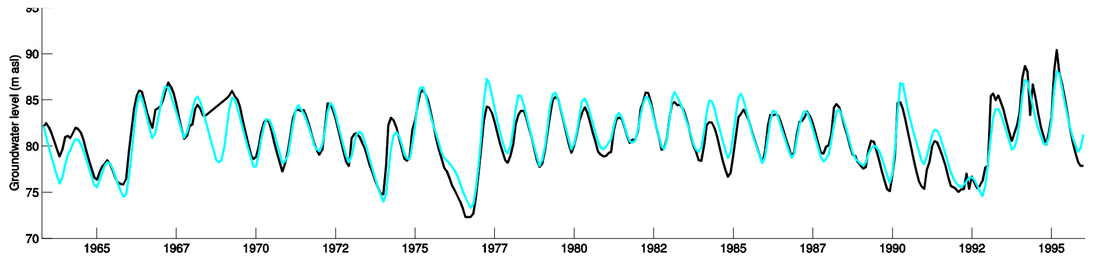

Figure 5 Example AquiMod simulated (cyan) and observed (black) groundwater levels.

4 Forecast skill

Through collaboration with scientists at the Met Office, BGS are now beginning to test the skill of this groundwater level forecasting system. After analysing the forecasts against observations over a 14 year hindcatst sequence, we have determined that the system is able to distinguish between low, normal and high levels correctly 70% of the time on average (Figure 6). With insight gained through these analyses we are continuing to improve the skill of these forecasts.

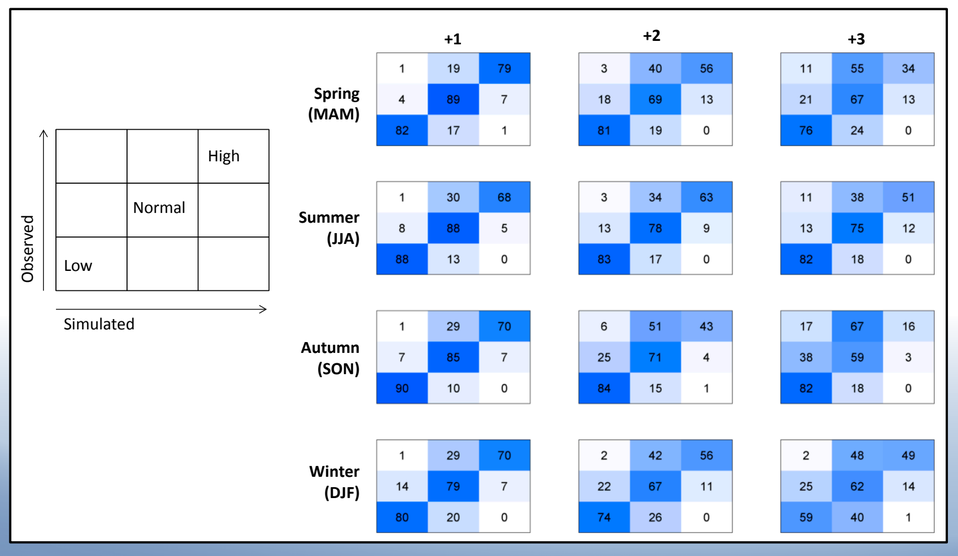

Figure 6 Contingency tables for each season and lead time. Numbers indicate percentage of time.

References

Scaife, A A, Arribas, A, Blockley, E, Brookshaw, A, Clark, R T, Dunstone, N, Eade, R, Fereday, D, Folland, C K, Gordon, M, Hermanson, L, Knight, J R, Lea, D J, MacLachlan, C, Maidens, A, Martin, M, Peterson, A K, Smith, D, Vellinga, M, Wallace, E, Waters, J, and Williams, A. 2014. Skilful Long Range Prediction of European and North American Winters. Geophysical Research Letters. DOI: 10.1002/2014GL059637.

Allen, R G. (1986). Rational Use of the FAO Blaney-Criddle Formula. Journal of Irrigation and Drainage Engineering, 112(2), 139–155.

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