Results of the application of MAGIC to surface water sites in the UK

MAGIC has been successfully calibrated for 1499 of the 1752 surface water sites sampled in the UK for critical loads mapping. MAGIC simulations were run from 1850 to 2100 and a median taken of all simulations for each variable and each simulation year. Forecasts are based on the CLE (Current Legislated Emissions) and MFR (Maximum Feasible Reductions) scenarios.

National-scale MAGIC non-marine sulphate (xSO_4) simulations (Figure 1) highlight the clear northwest-southeast gradient in xSO_4 concentrations in surface waters across the UK, as a consequence of spatial variations in S deposition. There has already been a marked reduction in xSO_4 concentrations, which will continue under the CLE scenario and which would extend further (with many sites returning to near-background concentrations below 20 $\mu eq\ l^{-1}$) under the MFR scenario. Concentrations > 100 $\mu eq\ l^{-1}$ are predicted to persist mainly in the South Pennines, North York Moors and at some sites in southeast England. The spatial gradient in modelled NO_3 leaching (Figures 2, 3) is fairly similar, again with the highest concentrations in the South Pennines, but with high concentrations also occurring at a large number of sites in Wales. The temporal pattern in modelled nitrate (NO_3) differs from that for xSO_4, with the increase from 1970 to 2005 attributable to sustained high deposition levels, and progressive ecosystem N saturation (e.g. 238 sites with NO_3 > 20 $\mu eq\ l^{-1}$ in 1970, rising to 261 in 2005). Modest reductions in NO_3 are achieved under the CLE scenario, reducing the number of sites with NO_3 > 20 $\mu eq\ l^{-1}$ to 189 by 2050. The MFR scenario leads to considerably greater predicted improvements, including a return to near-zero NO_3 leaching in all but a small minority of sites in Scotland and the North Pennines, and an overall reduction in the number of sites with NO_3 > 20 $\mu eq\ l^{-1}$ to just 84 in 2050.

The spatial pattern of ANC and pH (Figures 4-6) reflects both the gradient of deposition, and variations in soil and geological sensitivity. For example, some sites in Northwest Scotland and the Cairngorms appear naturally acid-sensitive (although few have simulated pre-industrial ANC below the critical limit of 20 $\mu eq\ l^{-1}$), whereas sites in limestone areas of the Pennines were unaffected by acidification despite high deposition levels. In 1970, 271 sites in the dataset had a negative modelled ANC, with the main concentrations of strongly acidic sites (modelled ANC < 0 and/or pH < 4.5) were in North and Central Wales, the central Pennine chain, North York Moors, Lake District, Galloway and the Eastern Cairngorms. These areas all retain sites with negative ANC at the present day (total of 147 sites), but by 2050 sites with negative modelled ANC are largely restricted to the North York Moors, Southern and Central Pennines, Snowdonia and the Lake District (total of 62 sites).. The additional improvements predicted under the MFR scenario are again considerable, reducing the number of sites with negative ANC to 28, many of which are located in the North York Moors.

Figure 1. MAGIC modelled non-marine sulphate concentrations (μeq l^{-1}) for all calibrated GB FAB surface waters in 1970, 2005, and 2050 under the Currently Legislated Emissions (CLE) and Maximum Feasible Reduction (MFR) scenario

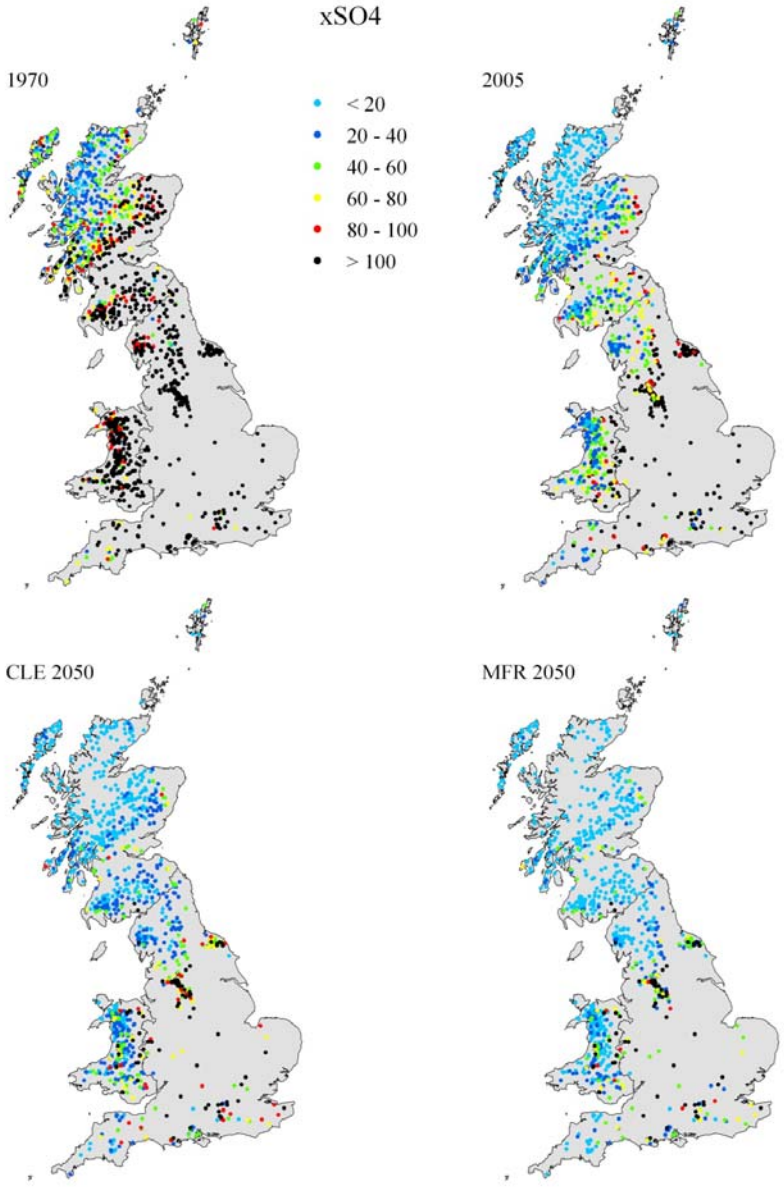

Figure 2. MAGIC modelled nitrate concentrations (μeq l^{-1}) for all calibrated GB FAB surface waters in 1970, 2005, and 2050 under the Currently Legislated Emissions (CLE) and Maximum Feasible Reduction (MFR) scenario

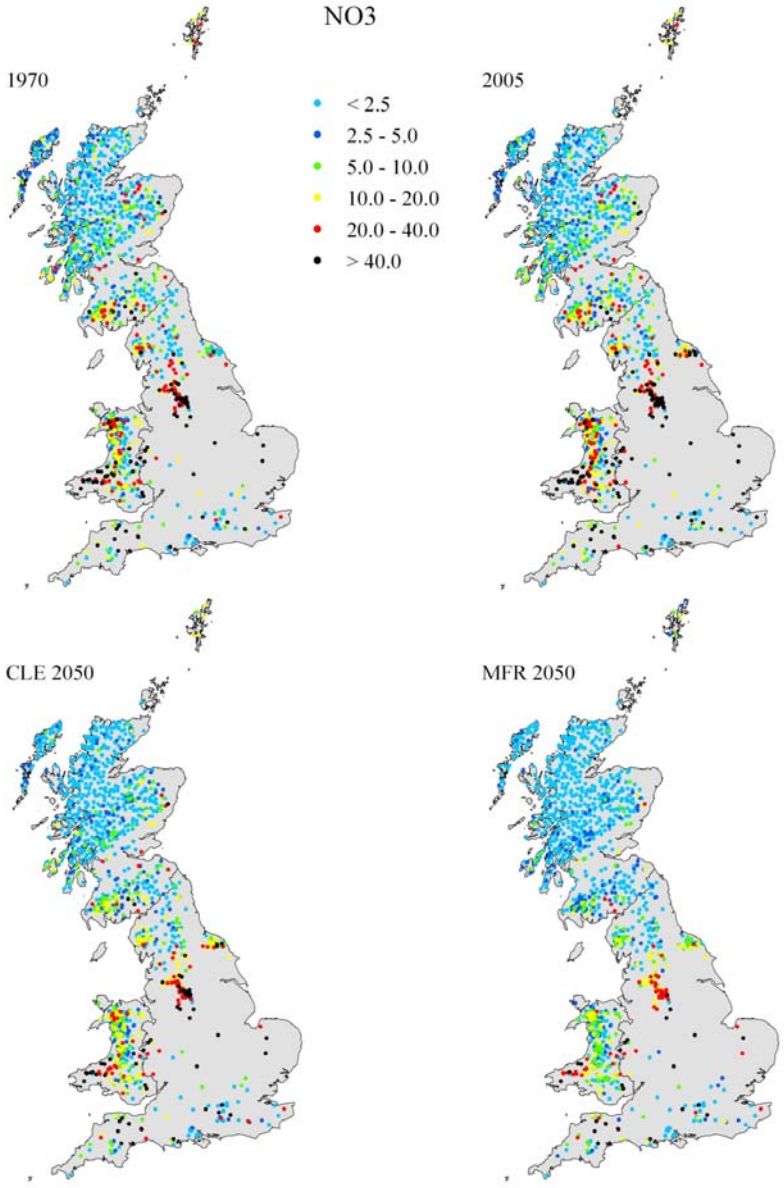

Figure 3. Percentage of calibrated FAB sites in each ANC band, by year of simulation

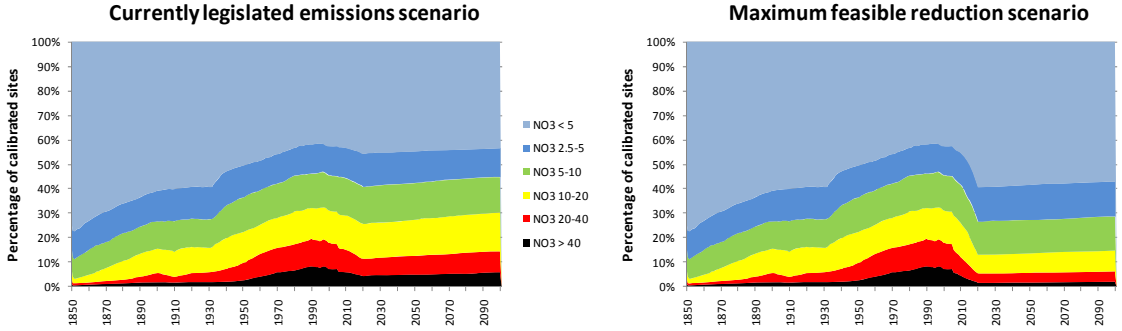

Figure 4. MAGIC modelled Acid Neutralising Capacity (μeq l^{-1}) for all calibrated GB FAB surface waters in 1970, 2005, and 2050 under the Currently Legislated Emissions (CLE) and Maximum Feasible Reduction (MFR) scenario

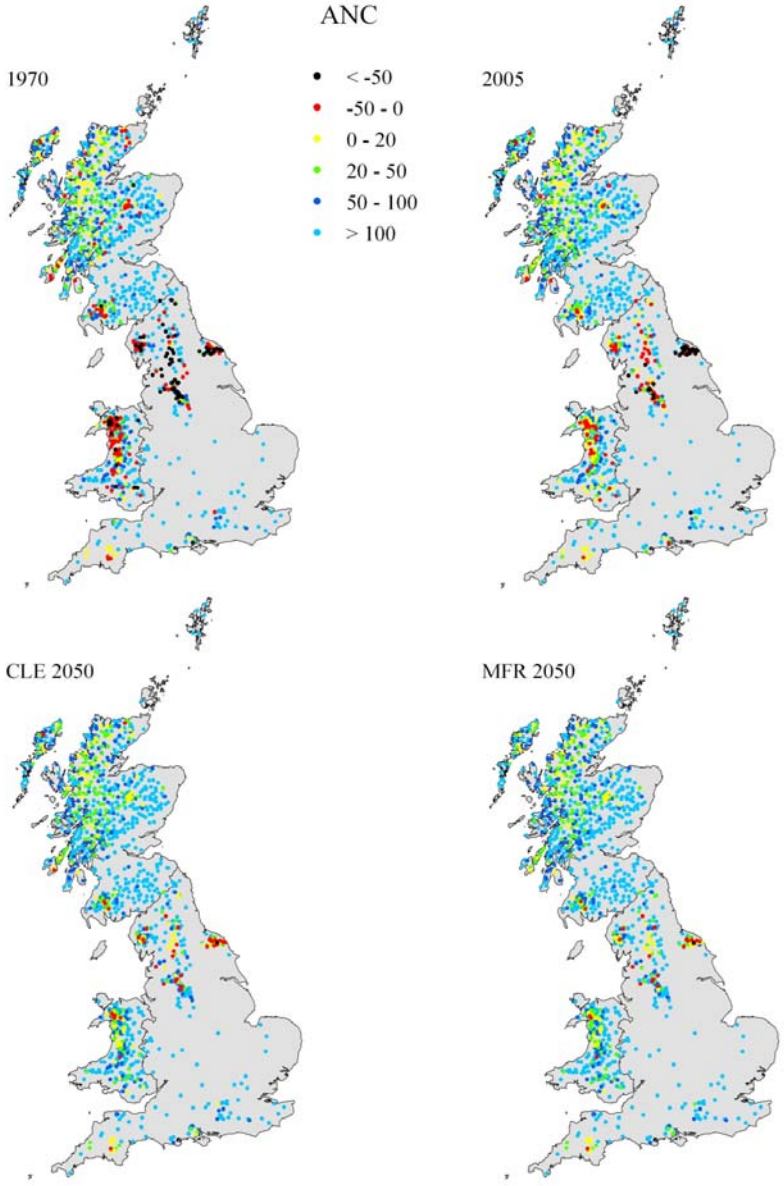

Figure 5. Percentage of calibrated FAB sites in each ANC band, by year of simulation

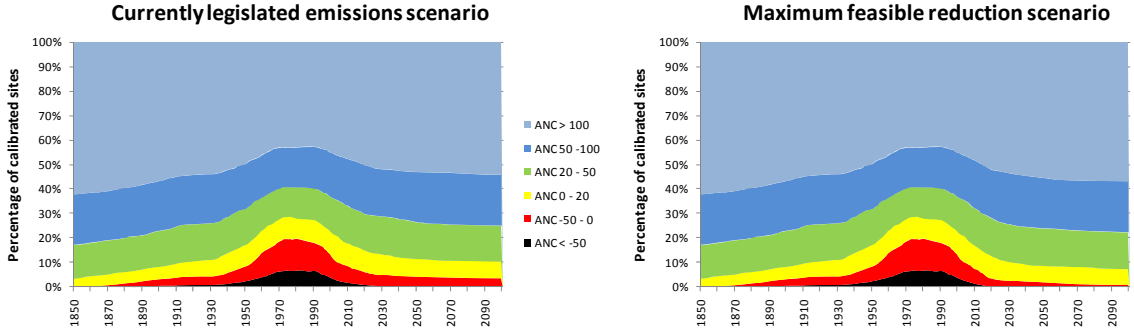

Figure 6. MAGIC modelled pH for all calibrated GB FAB surface waters in 1970, 2005, and 2050 under the Currently Legislated Emissions (CLE) and Maximum Feasible Reduction (MFR) scenario