SUPPLEMENTARY MATERIAL

"How will climate change modify river flow regimes in Europe?"

C. Schneider, C. L. R. Laizé, M. C. Acreman, and M. Flörke

This supplementary material contains the following information:

A – Change in monthly flow magnitudes for the single GCM projections
B – Validation of simulated WaterGAP3 flow data against observed flow data
C – Impact on the natural flow regime for different river size classes

Supplementary material (A)

In Chapter 3.4 of the paper, we present and describe monthly flow regimes of the 2050s under the exclusive effect of climate change by the ensemble mean. To provide the uncertainty range due to the three applied GCM projections, the monthly flow regimes for CNCM3, ECHAM5 and IPSL are shown in the following for each climate zone in Figures 1-6.

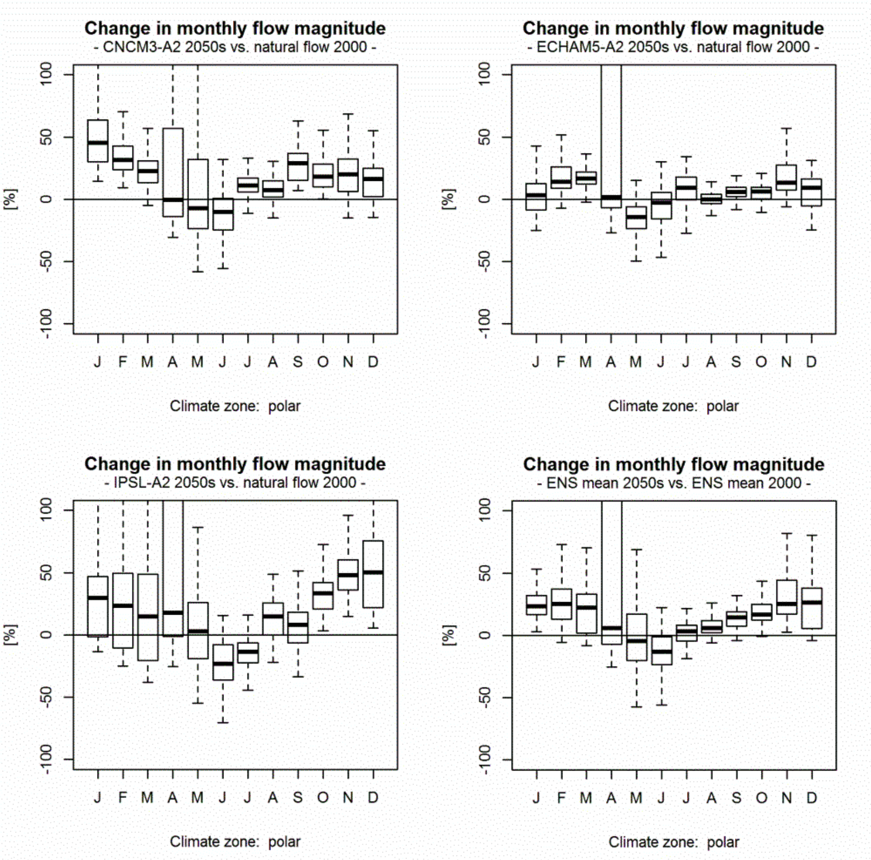

Figure 1. Change in mean monthly flow magnitude in the 2050s plotted for all grid cells of the polar climate zone for the GCM projections CNCM3-A2, ECHAM5-A2, IPSL-A2 and the ensemble mean.

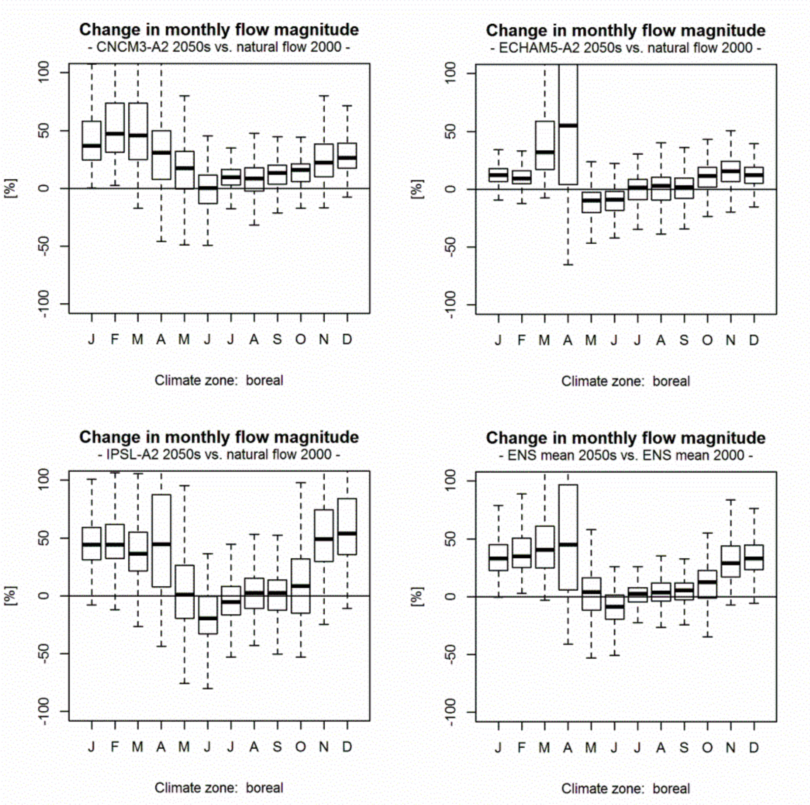

Figure 2. Change in mean monthly flow magnitude in the 2050s plotted for all grid cells of the boreal climate zone for the GCM projections CNCM3-A2, ECHAM5-A2, IPSL-A2 and the ensemble mean.

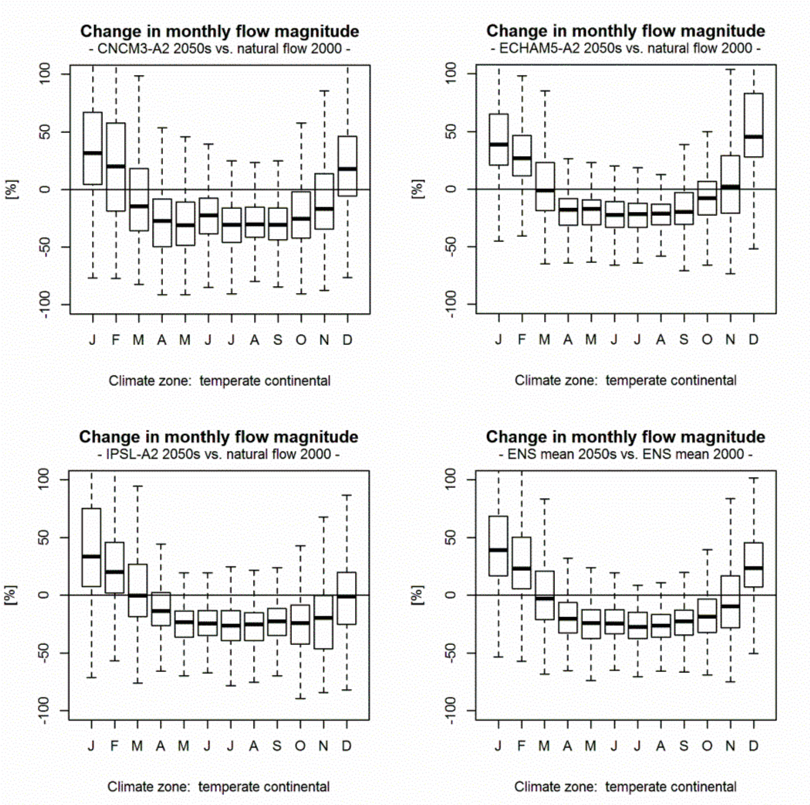

Figure 3. Change in mean monthly flow magnitude in the 2050s plotted for all grid cells of the temperate continental climate zone for the GCM projections CNCM3-A2, ECHAM5-A2, IPSL-A2 and the ensemble mean.

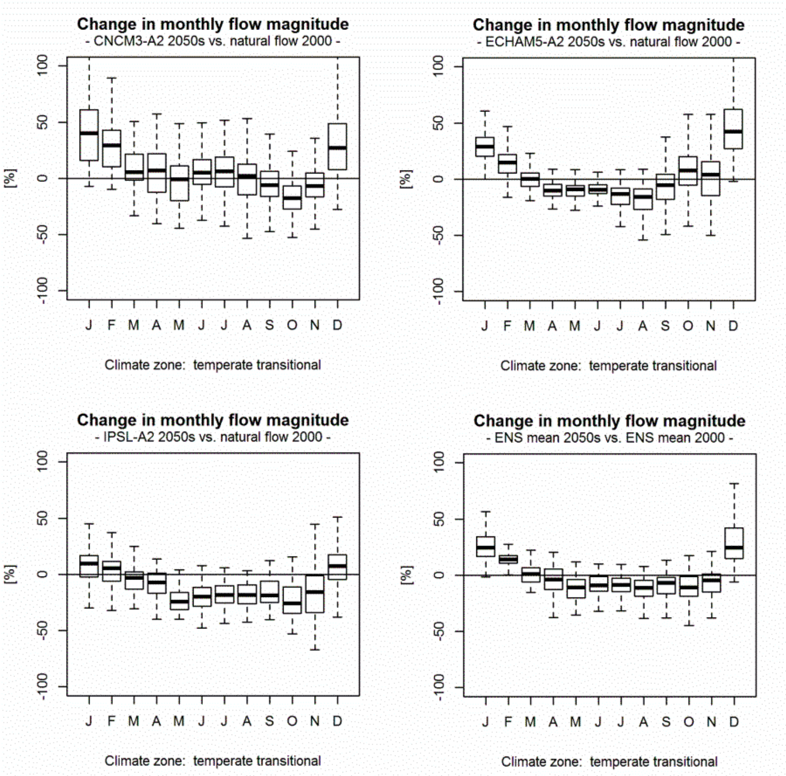

Figure 4. Change in mean monthly flow magnitude in the 2050s plotted for all grid cells of the temperate transitional climate zone for the GCM projections CNCM3-A2, ECHAM5-A2, IPSL-A2 and the ensemble mean.

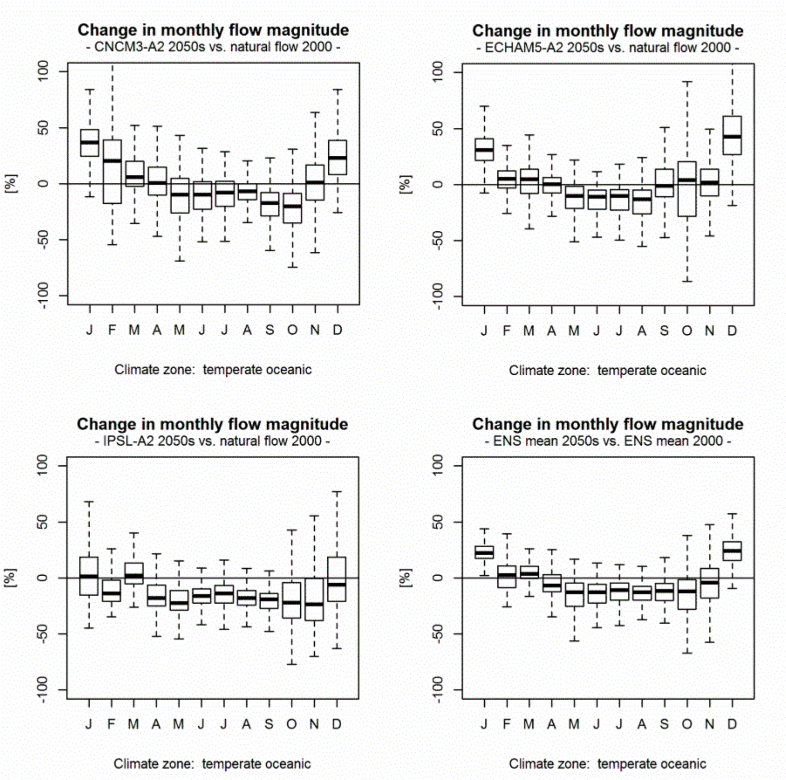

Figure 5. Change in mean monthly flow magnitude in the 2050s plotted for all grid cells of the temperate oceanic climate zone for the GCM projections CNCM3-A2, ECHAM5-A2, IPSL-A2 and the ensemble mean.

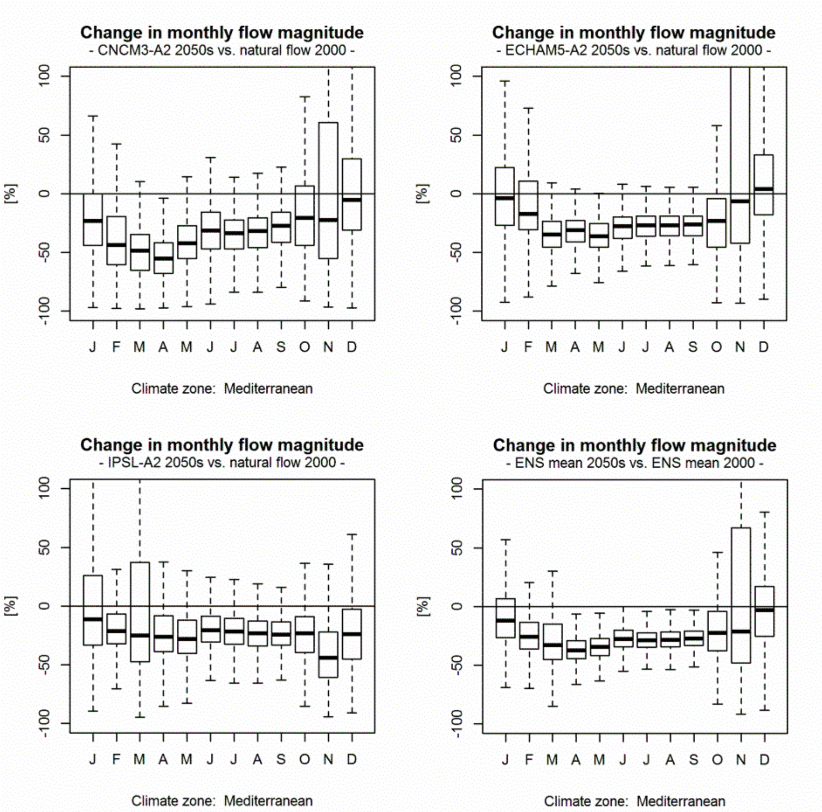

Figure 6. Change in mean monthly flow magnitude in the 2050s plotted for all grid cells of the Mediterranean climate zone for the GCM projections CNCM3-A2, ECHAM5-A2, IPSL-A2 and the ensemble mean.

Supplementary material (B)

A validation of simulated WaterGAP3 data was conducted against observed data at 238 gauging stations in Europe for the baseline period 1971-2000 (Figure 7). If related discharge data were not available at a specific station for the complete baseline period, either the period 1961-1990 was used for validation or a shorter min. 10-year period during 1961-2000. The observed data stem from the Global Runoff Data Centre (GRDC) and the Spanish Ministry of Agriculture, Food and Environment. Figure 8 presents the scatter plots for the summer month containing the correlation between observed and WaterGAP3 modelled data for the mean monthly flow. Additionally, these charts include different efficiency criteria such as the bias, weighted coefficient of determination ωr^2, modified Nash-Sutcliffe efficiency E with j=1, and the gradient. The efficiency criteria are described in more detail in Schneider et al. (2011). The scatter plots for the winter month including efficiency criteria are illustrated in Figure 9.

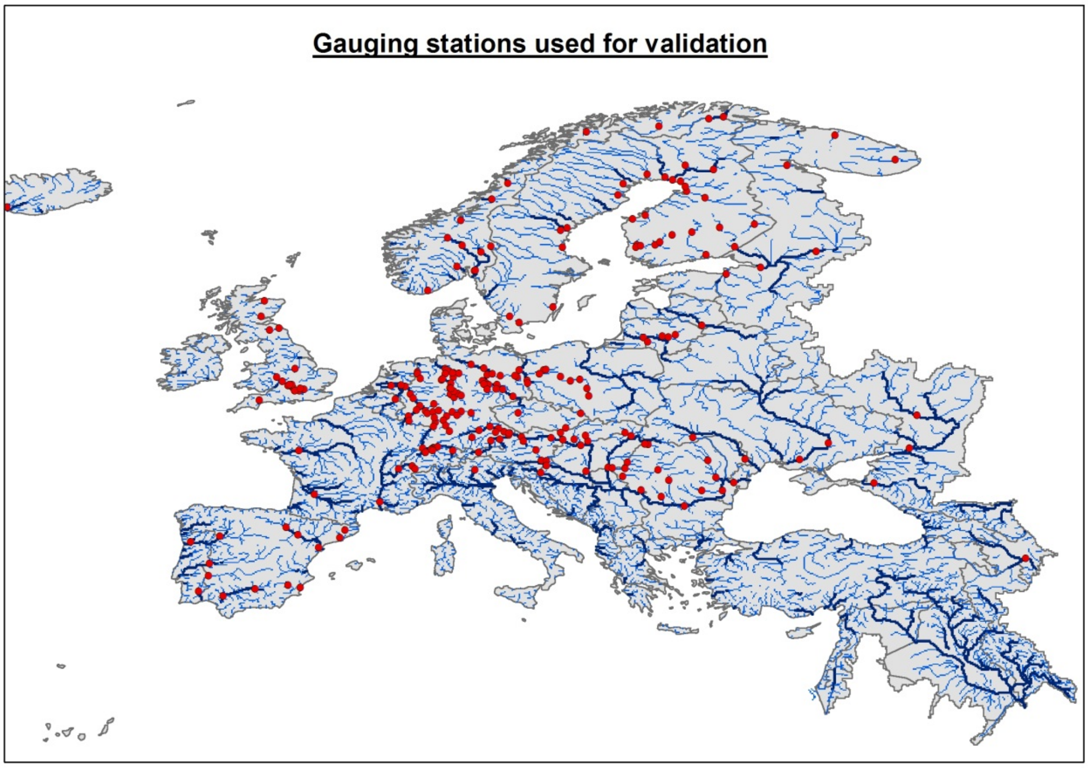

Figure 7. Selected gauging stations used to validate WaterGAP3 results against observed discharge data.

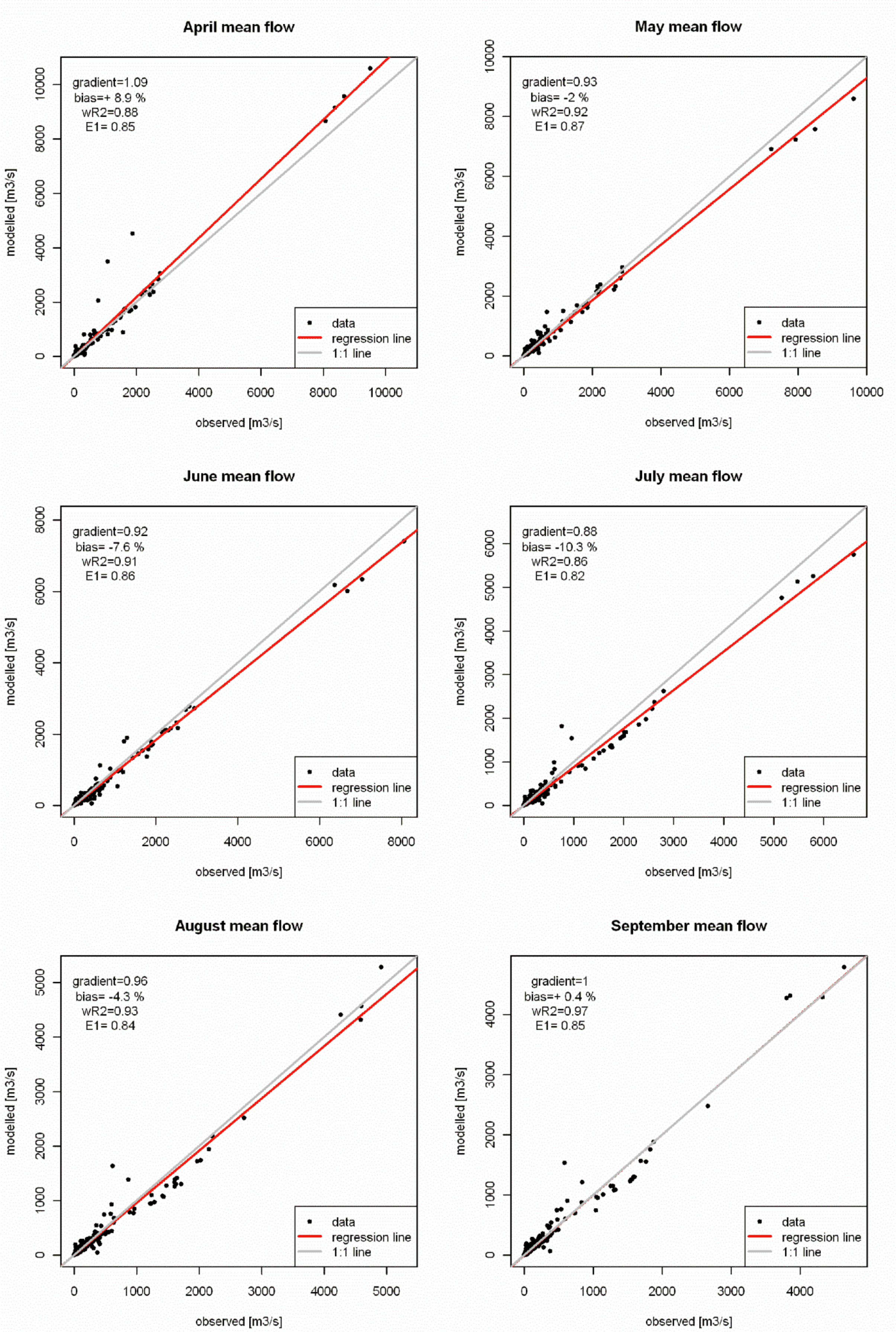

Figure 8. Scatter plot between modelled and observed mean monthly flow data of the summer month for the baseline period including efficiency criteria.

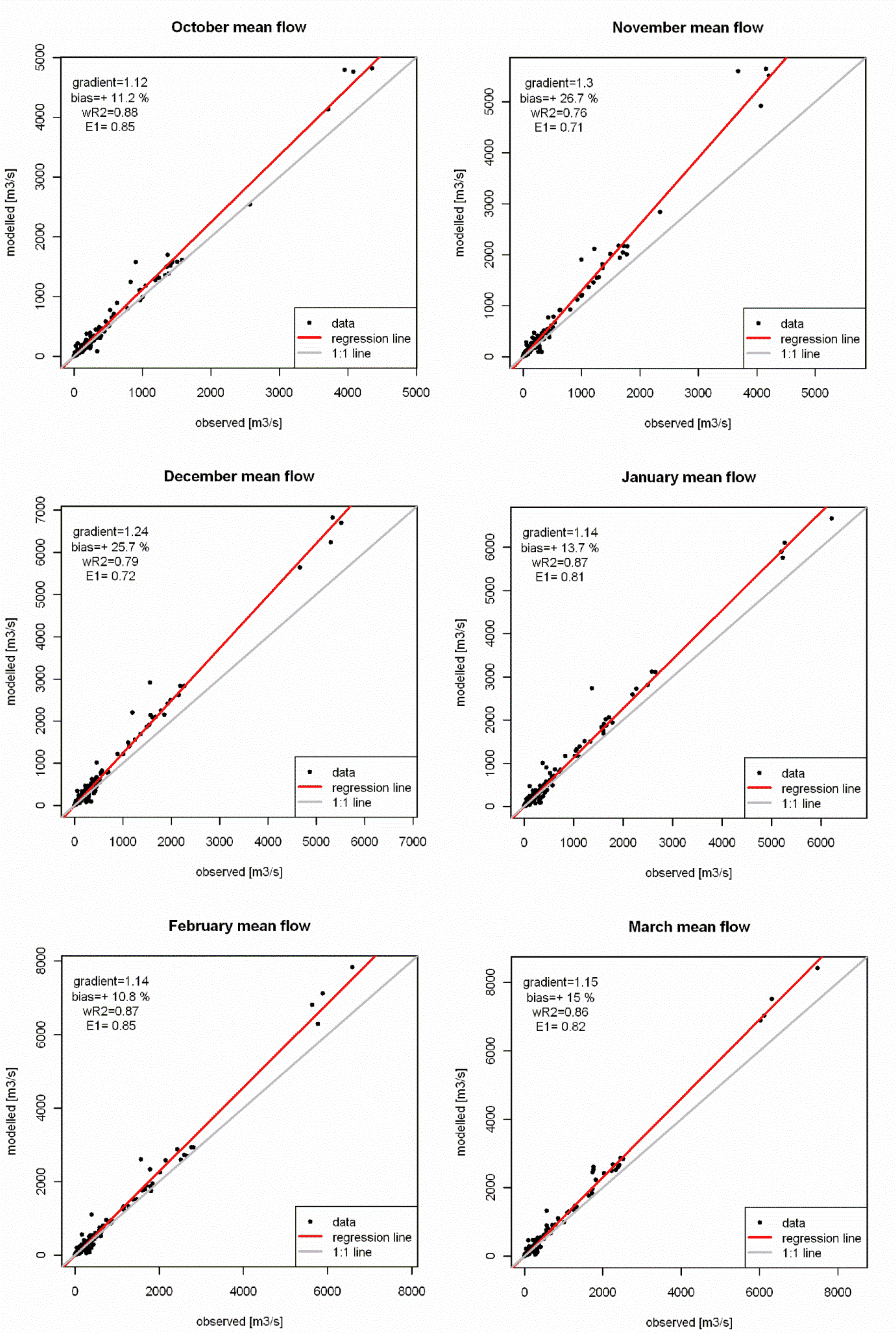

Figure 9. Scatter plot between modelled and observed mean monthly flow data of the winter month for the baseline period including efficiency criteria.

Supplementary material (C)

In Chapter 3.2 of the paper, we present the total flow regime modification under climate change for selected rivers in Europe for the 2050s. For all river sizes the same thresholds were applied and hence a quality-control check was conducted to verify whether significant differences occur when parsing rivers into different size classes. Results are presented in Figure 10 for small (Qbf: 100 – 300m3/s), medium (Qbf: 300 – 600 m3/s) and large rivers (Qbf: > 600 m3/s). The results show that smaller rivers are sligthly stronger impacted than rivers of medium or larger size. However, no significant differences were found. The statements made in our analysis can be applied for all three river size classes.

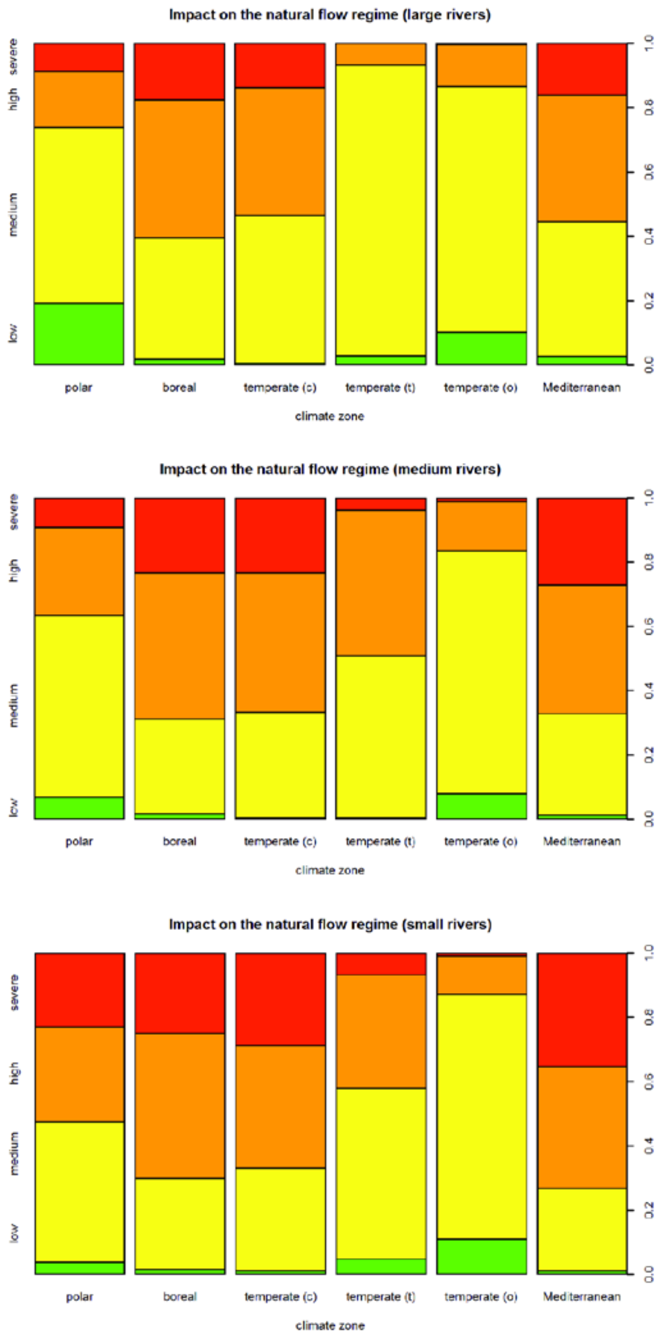

Figure 10. Impact of climate change on natural flow regimes in different climate zones presented for different river size classes in the 2050s, represented by the portion of grid cells showing low, medium, high or severe impact.