Impacts of climate change on extreme weather, food and water resources at 1.5°C and 2°C global warming

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Summary

We used a new model of the global atmosphere (HadGEM3-GC2) to simulate climate change and its impacts at global warming of 1.5°C and 2°C above pre-industrial, at a higher level of detail (60km resolution) than models previously used in reports by the Intergovernmental Panel on Climate Change. We performed 6 simulations, each using different patterns of sea surface temperature change to cause the model to simulate different regional climate changes that are all possible outcomes in 1.5°C and 2°C warmer worlds. We analysed the simulated changes in weather extremes, used a calculation developed by the World Food Programme to see how these changes affected the relative vulnerability to food insecurity in different developing countries, and used the outputs to drive a model of global river flows.

Heatwaves

We first found the temperatures of the hottest 10% of time in each place. We then looked at how long the temperatures rose above that in a 2°C warmer world (Figure 1a), and the difference between 2°C and 1.5°C worlds (Figure 1b). The maps show the averages of the 6 simulations. At 2°C, the current hottest 10% temperature was exceeded 20% of the time in mid-latitudes and more than 50% in the tropics. These increases roughly halved at 1.5°C.

Figure 1. Percentage of time with temperatures above the current hottest 10%

(a) 2°C global warming (b) 2°C -1.5°C global warming

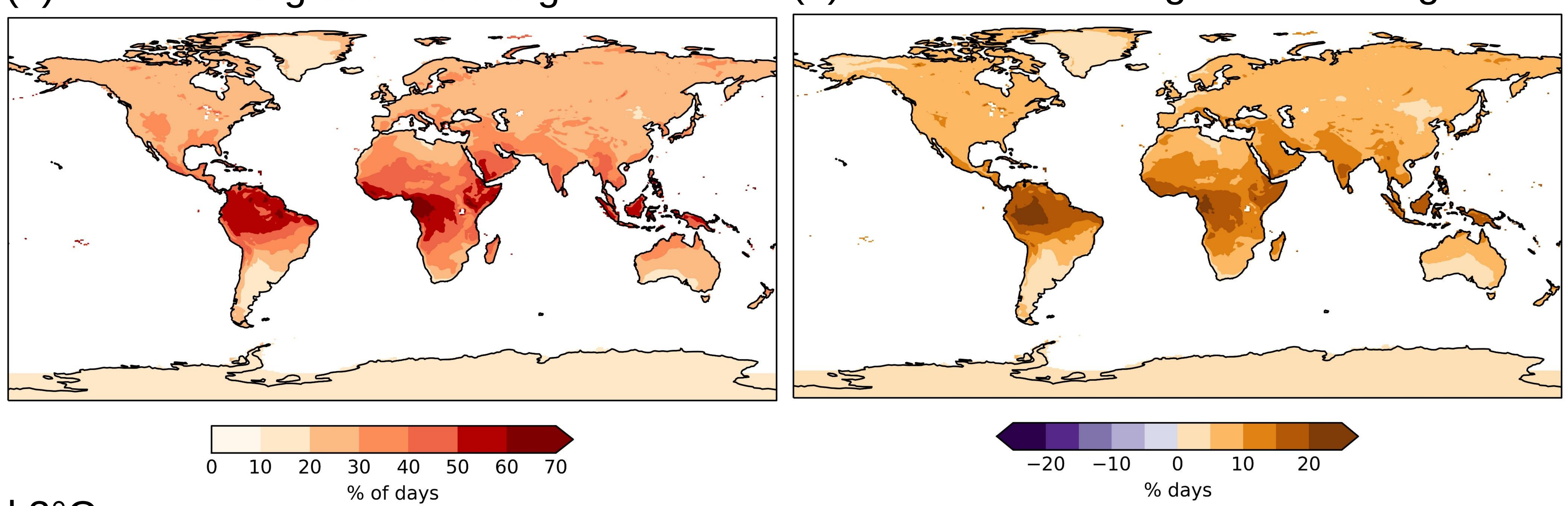
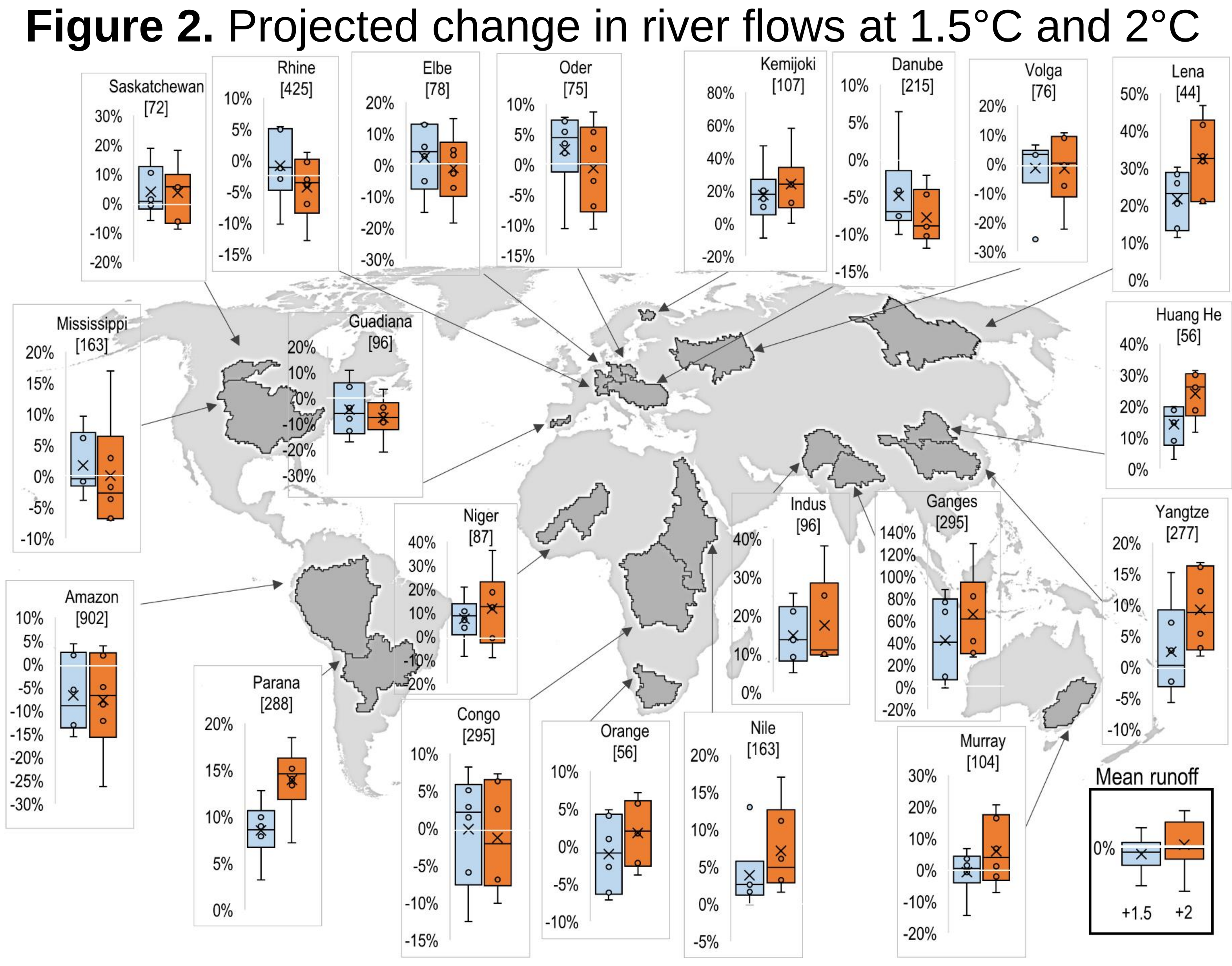


Figure 2. Projected change in river flows at 1.5°C and 2°C

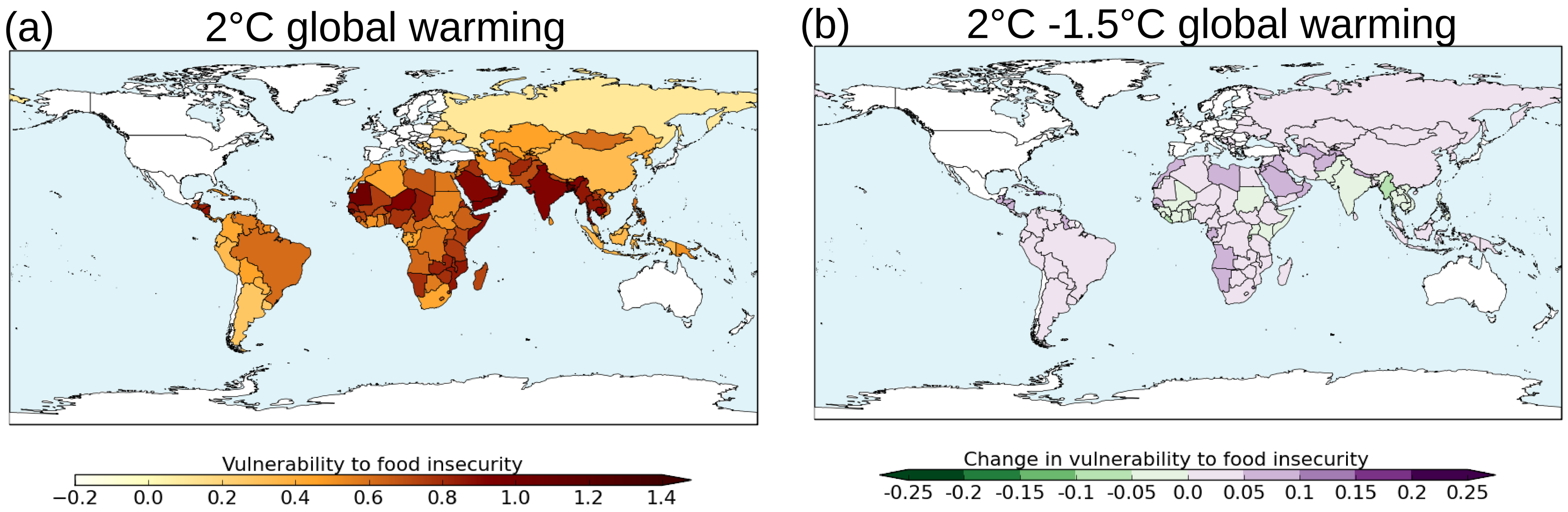


River flows

We simulated the changes in flows of the world's major rivers at 1.5°C and 2°C global warming compared to the present day (Figure 2). The bar charts show the range of results from the 6 simulations for each basin. For many basins, some simulations gave decreased flows while others gave increased flows. For example, at 2°C, projected changes in flow of the Amazon range from a 5% increase to a 25% decrease. However, some basins in south and east Asia are projected to see increased flow in all simulations. The changes and uncertainty are generally smaller at 1.5°C.

Figure 3. Projected changes in the Hunger and Climate Vulnerability Index

(a) 2°C global warming (b) 2°C -1.5°C global warming



Vulnerability to food insecurity

For each developing country, we calculated the World Food Programme's Hunger and Climate Vulnerability Index (HCVI) using economic factors such as poverty and transport infrastructure combined with drought and heavy rain simulated for 1.5°C and 2°C climates (Figure 3). Approximately 75% of countries were calculated as more vulnerable at 2°C than 1.5°C. The maps show the average of 6 simulations.

Conclusions

- Changes in river flows and vulnerability to food insecurity are generally projected to be larger at 2°C than 1.5°C global warming.
- Temperatures exceeded for 10% of the time under present-day climate are projected to be exceeded for 5 – 20% of the time at 1.5°C global warming, and 20 – 50% at 2°C
- Changes in river flows are highly uncertain, and for many rivers could either increase or decrease, with larger changes at 2°C than 1.5°C. Changes range from a few % to 100%. River flows in south and east Asia are projected to increase in all our simulations.
- Vulnerability to food insecurity depends on non-climatic factors as well as climate, but generally increases with global warming.

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