



# **Impacts of climate change on rainfall, river discharge and sea level rise**

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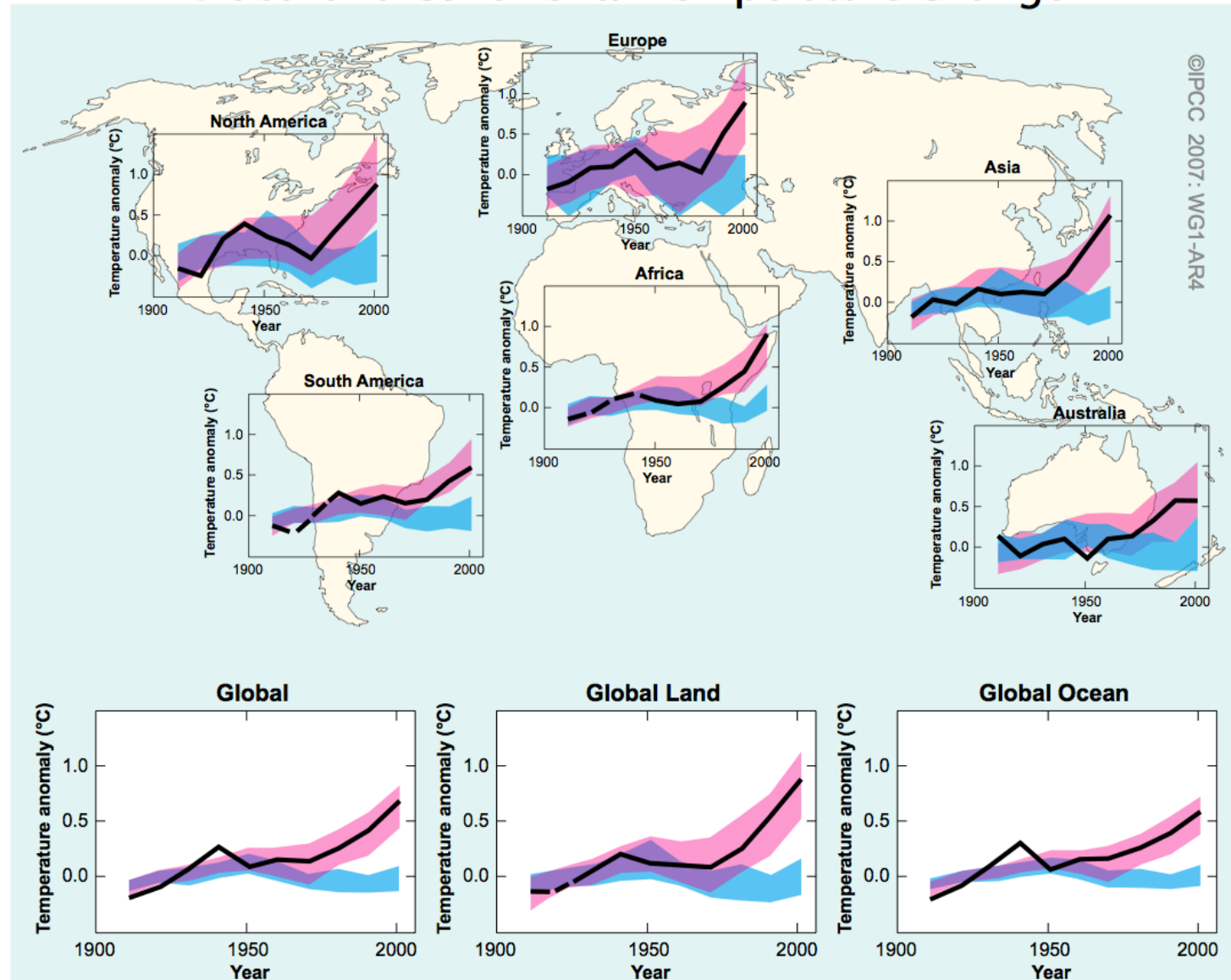
# Overview

- Introduction: Certainty of climate change
- Observed changes: Certainty and uncertainty
- Predicted changes: Certainty and uncertainty
- Conclusions and outlook

# Introduction: Certainty of climate change

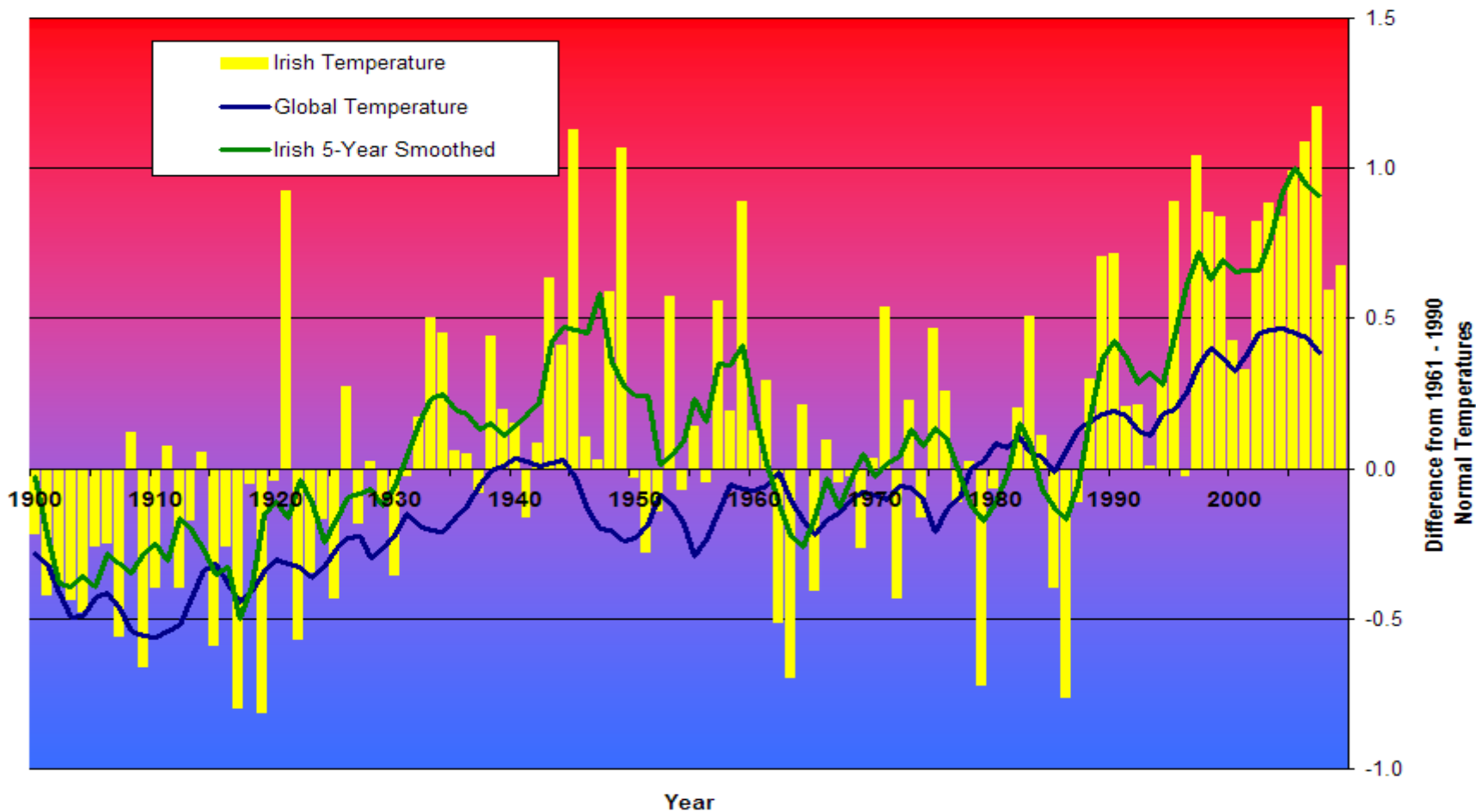
## Global and Continental Temperature Change

Continental warming  
likely shows a significant anthropogenic contribution over the past 50 years



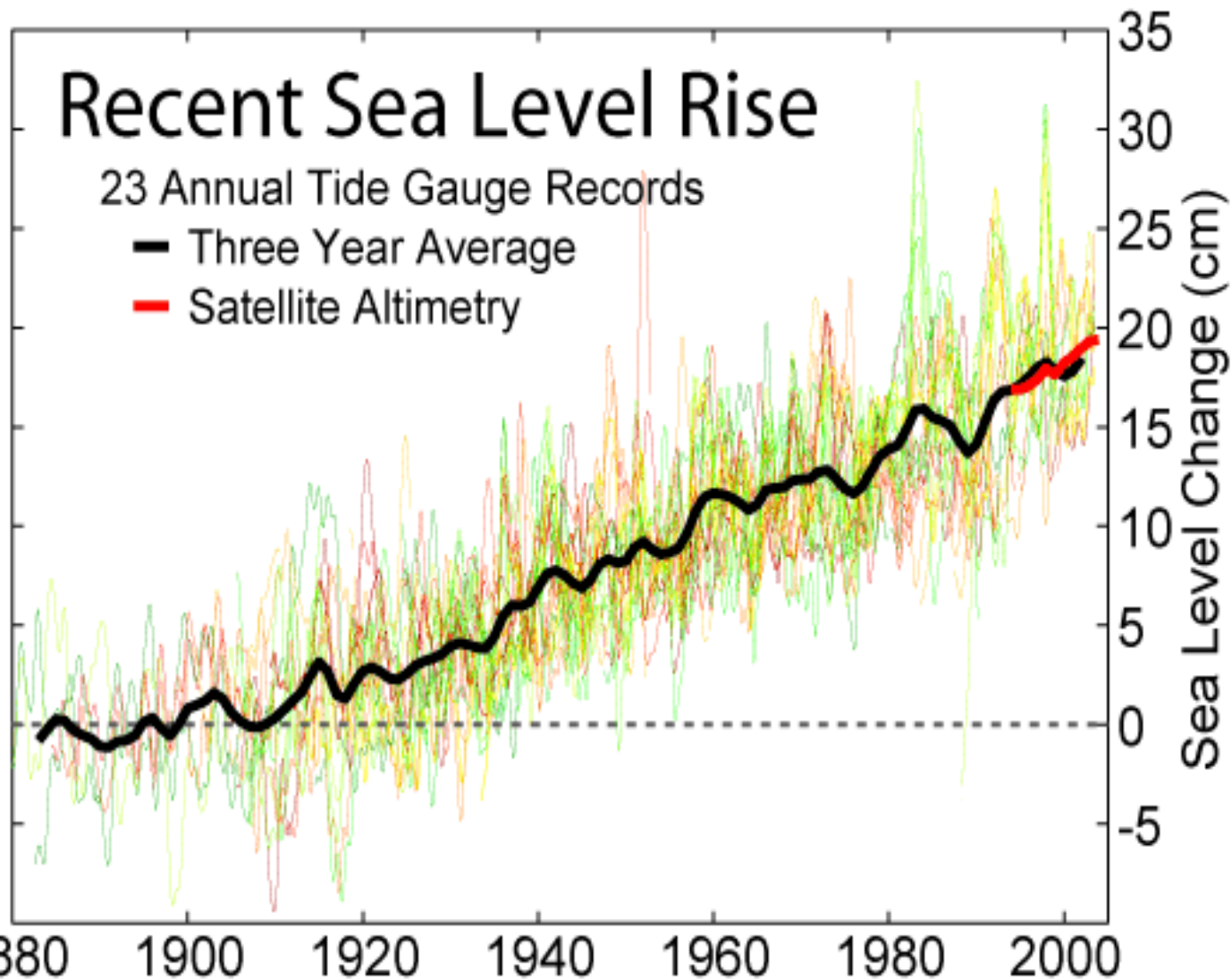
# Observed changes: Certainty and uncertainty

1900-2009 Air Temperature Difference from 1961-1990 Normal Values



*Irish and global mean temperature anomalies. The reference period is 1961-1990. For the Irish temperature data an average over the five stations Malin Head, Armagh, Birr, Valentia and Dublin Phoenix Park has been calculated. For the smoothed Irish temperature data a running 5-year mean has been applied. The global temperature data are taken from the Climate Research Unit (based on Brohan et al., 2006).*

# Observed changes: Certainty and uncertainty



Observed trend around Ireland: On average 3.5 cm/decade from 1993 to 2006.

However, regional differences due to both regional sea level changes and regional isostatic adjustments of the earth crust (Northern and Eastern sea board: +0.7 cm/decade, Western and Southern sea board: -0.5 cm /decade).

Combined effect: 2.5 cm/decade in the east, 4.5 cm/decade in the north-west

*Global sea level rise as an average over 23 geologically stable tide gauge records according to Douglas (1997) updated with records until 2004 and complemented with satellite altimetry data*

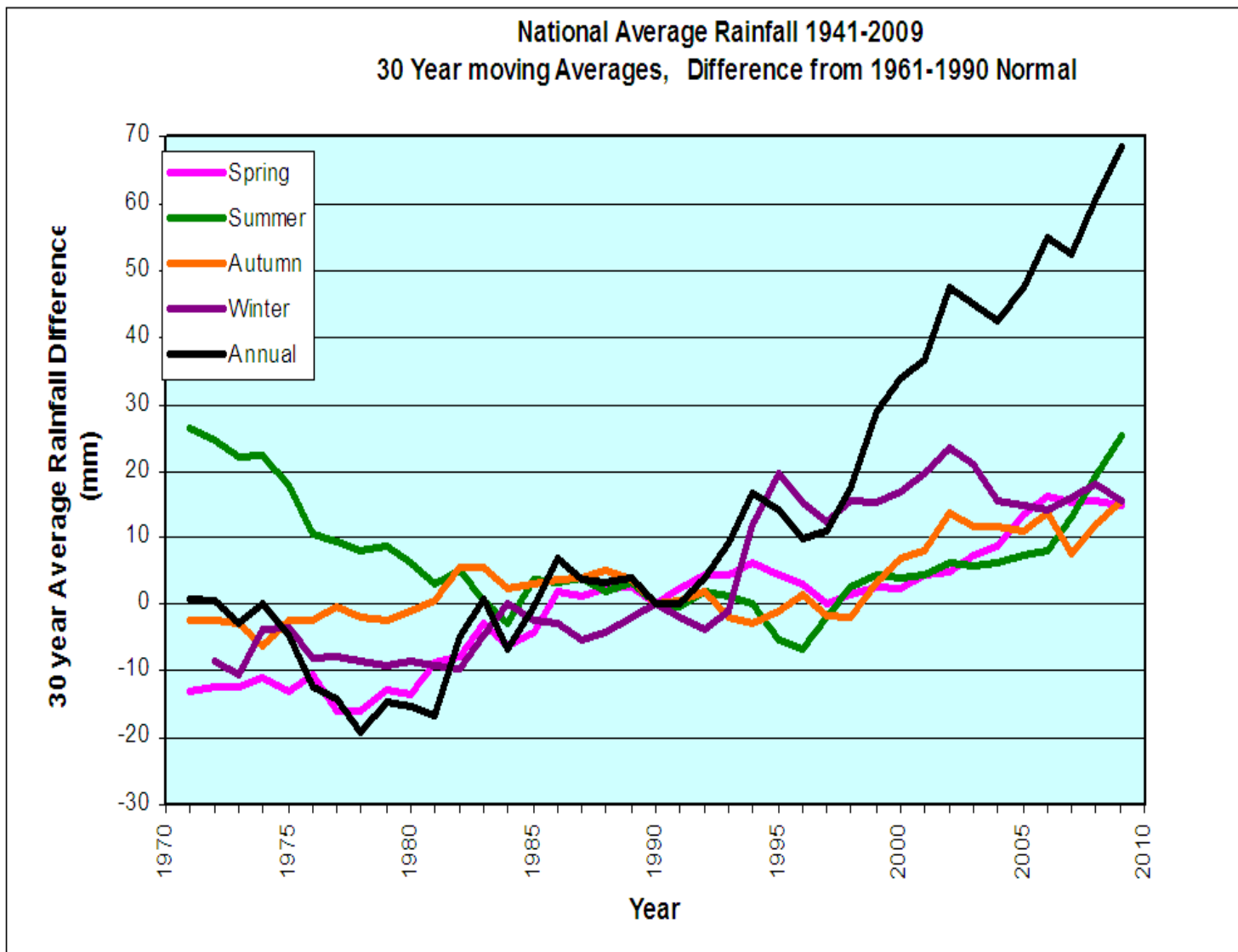
# Observed changes: Certainty and uncertainty

Increase of rainfall in all seasons bar the summer over Ireland.

In summer no clear trend can be given.

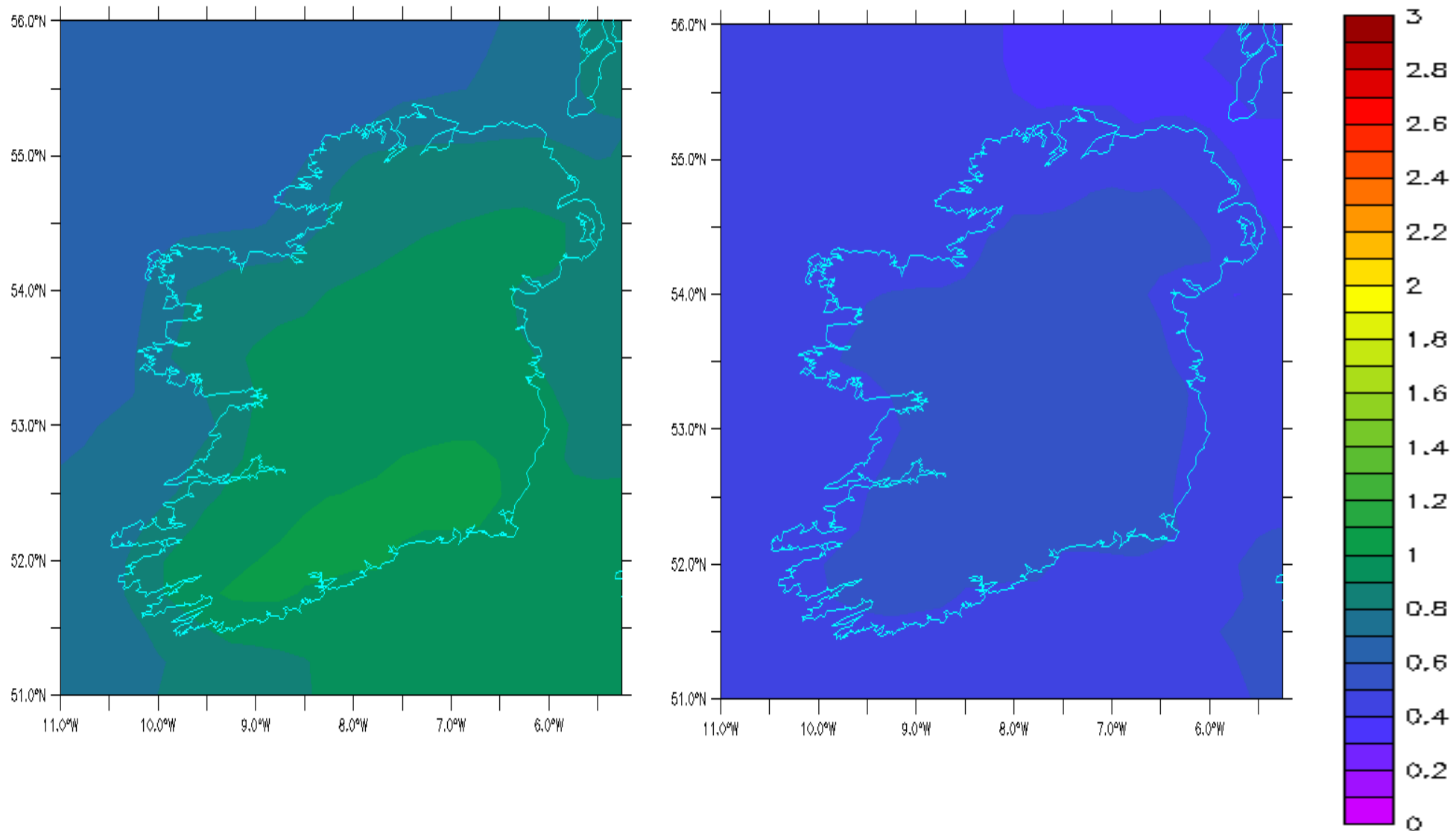
Not possible to make statements on extreme rainfall events over Ireland even though globally there is a tendency towards higher frequency of heavy rain.

River flow changes similar to rain changes; no major low flow events observed in the 2000s.



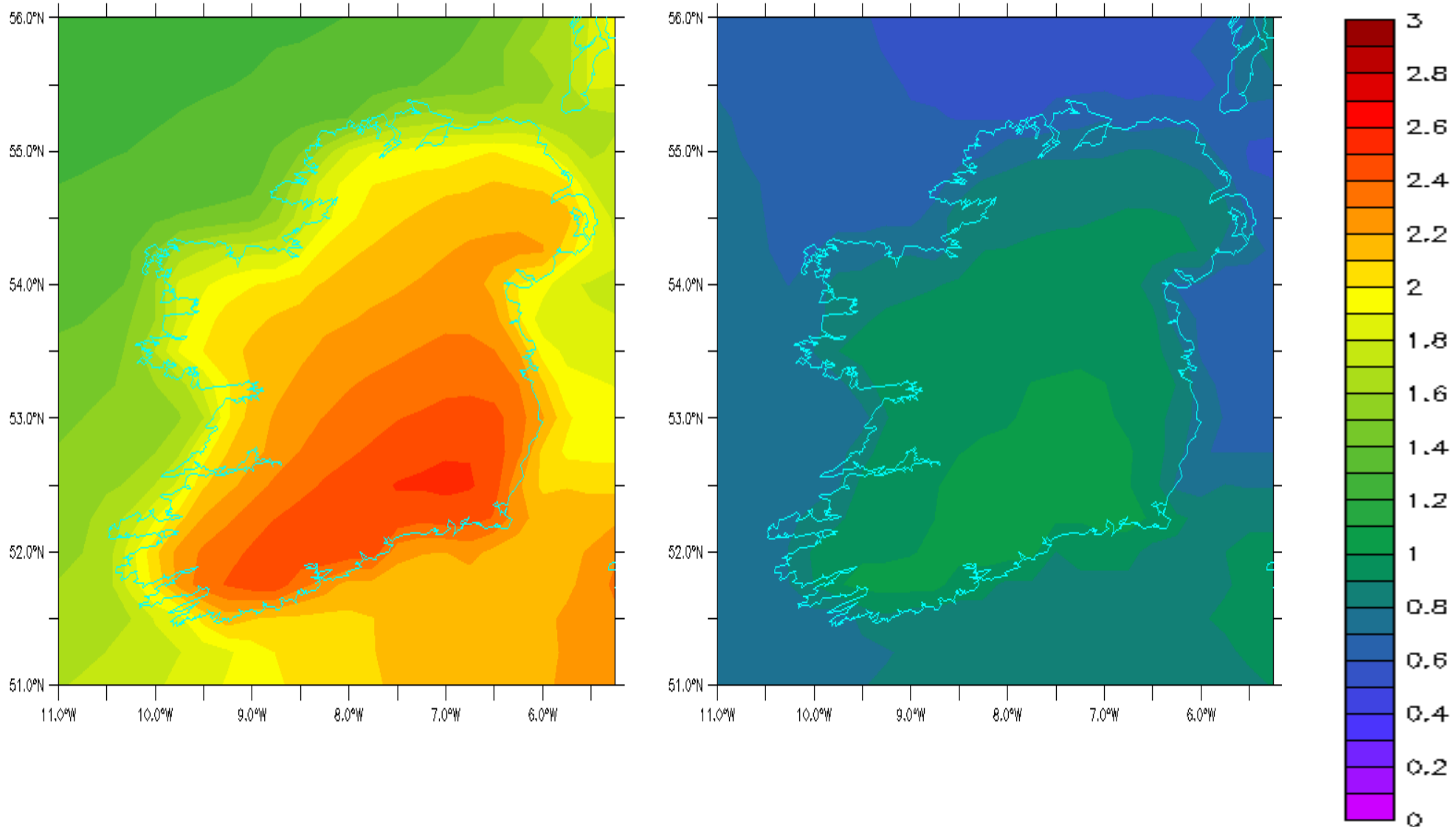
*Anomalies of 30 year moving averages of Irish rainfall from 1941-2009 compared to 1961-1990. The value of each year represents the average over the 29 years prior to the year and the year itself, e.g. the value of 2009 is the average over 1980 to 2009.*

# Predicted changes: Certainty and uncertainty



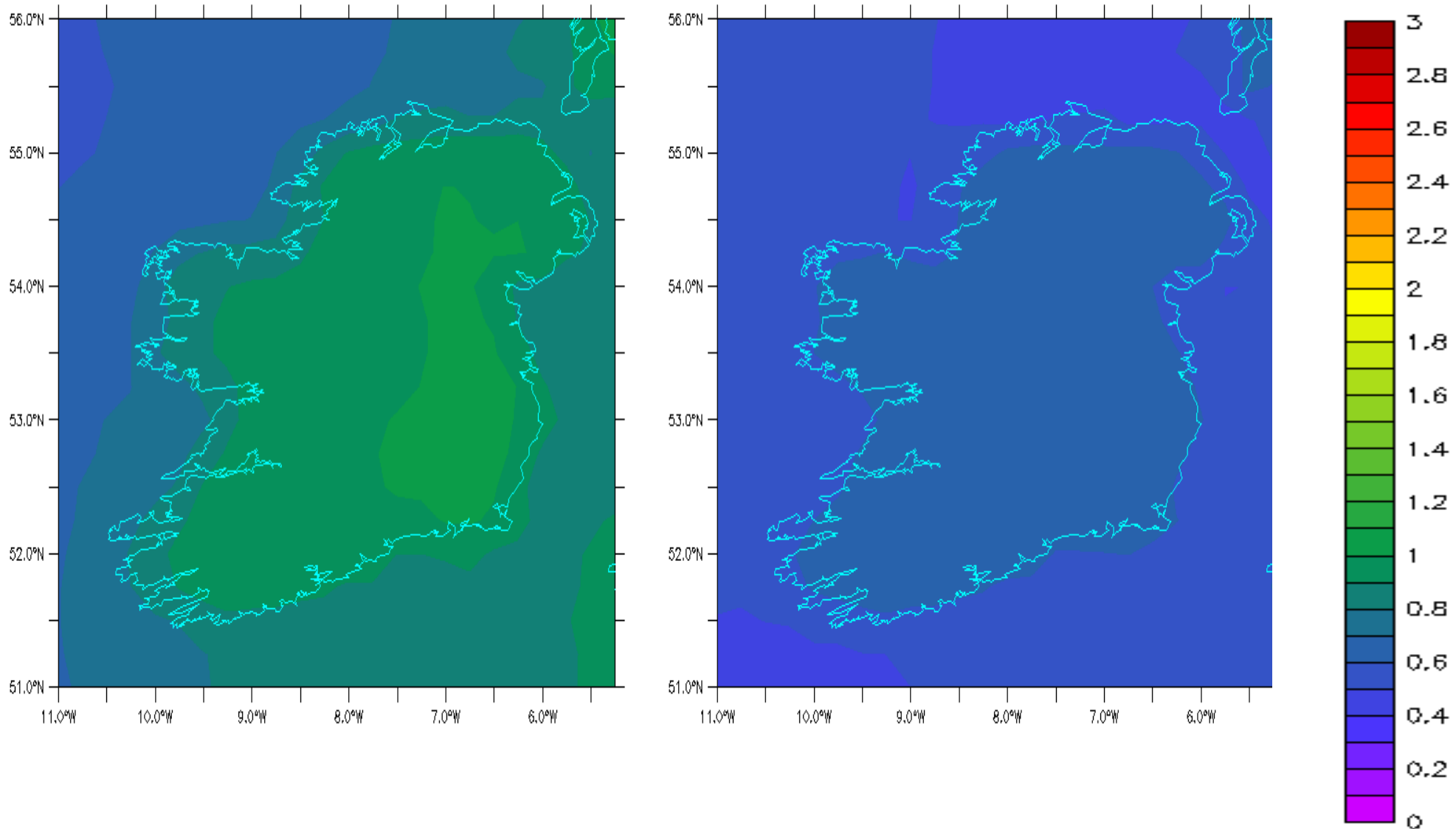
*Predicted temperature changes [°C] for summer 2021-2050 compared to 1961-1990 and standard deviation from 12 model simulations*

# Predicted changes: Certainty and uncertainty



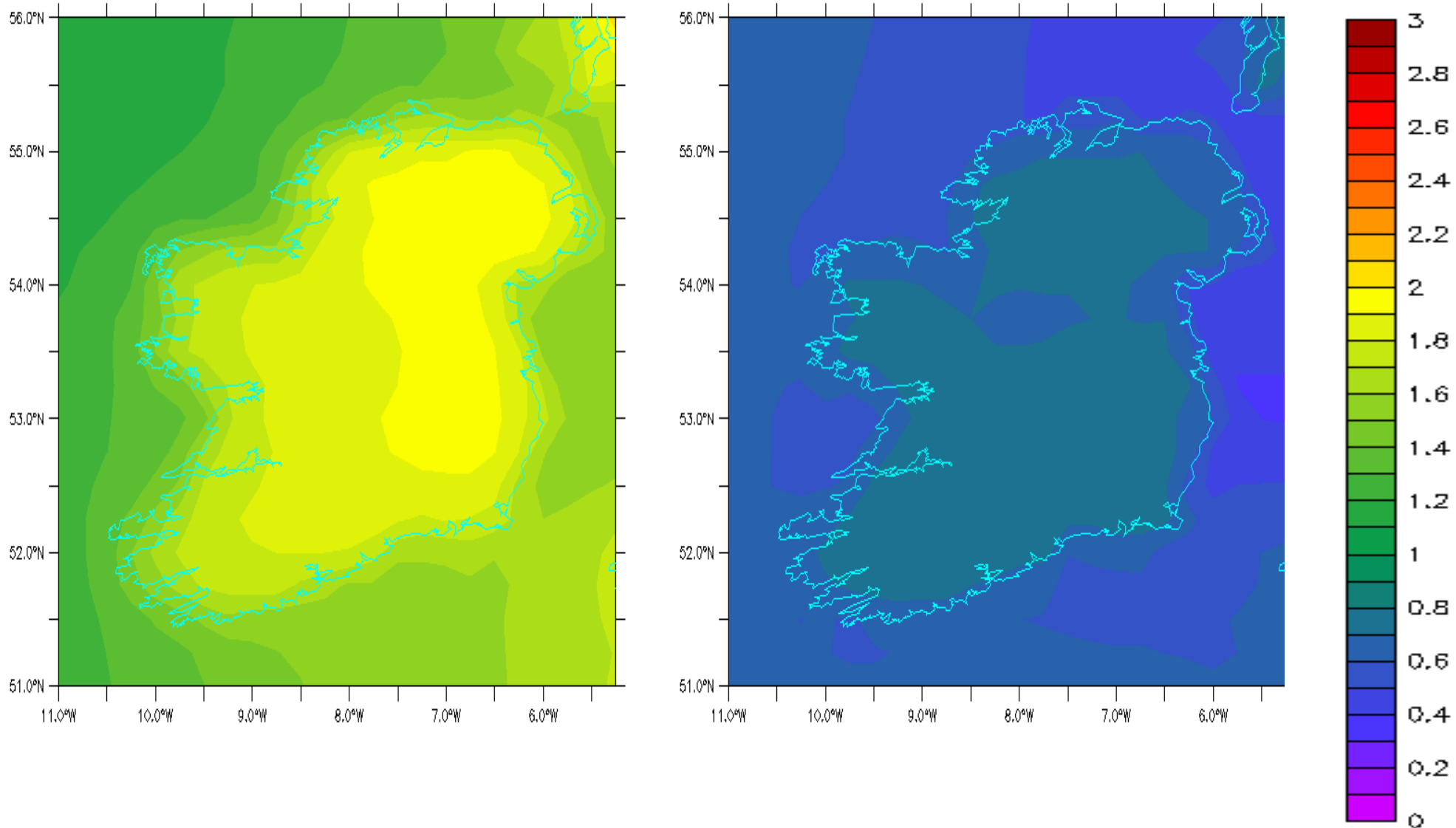
*Predicted temperature changes [°C] for summer 2071-2100 compared to 1961-1990 and standard deviation from 12 model simulations*

# Predicted changes: Certainty and uncertainty



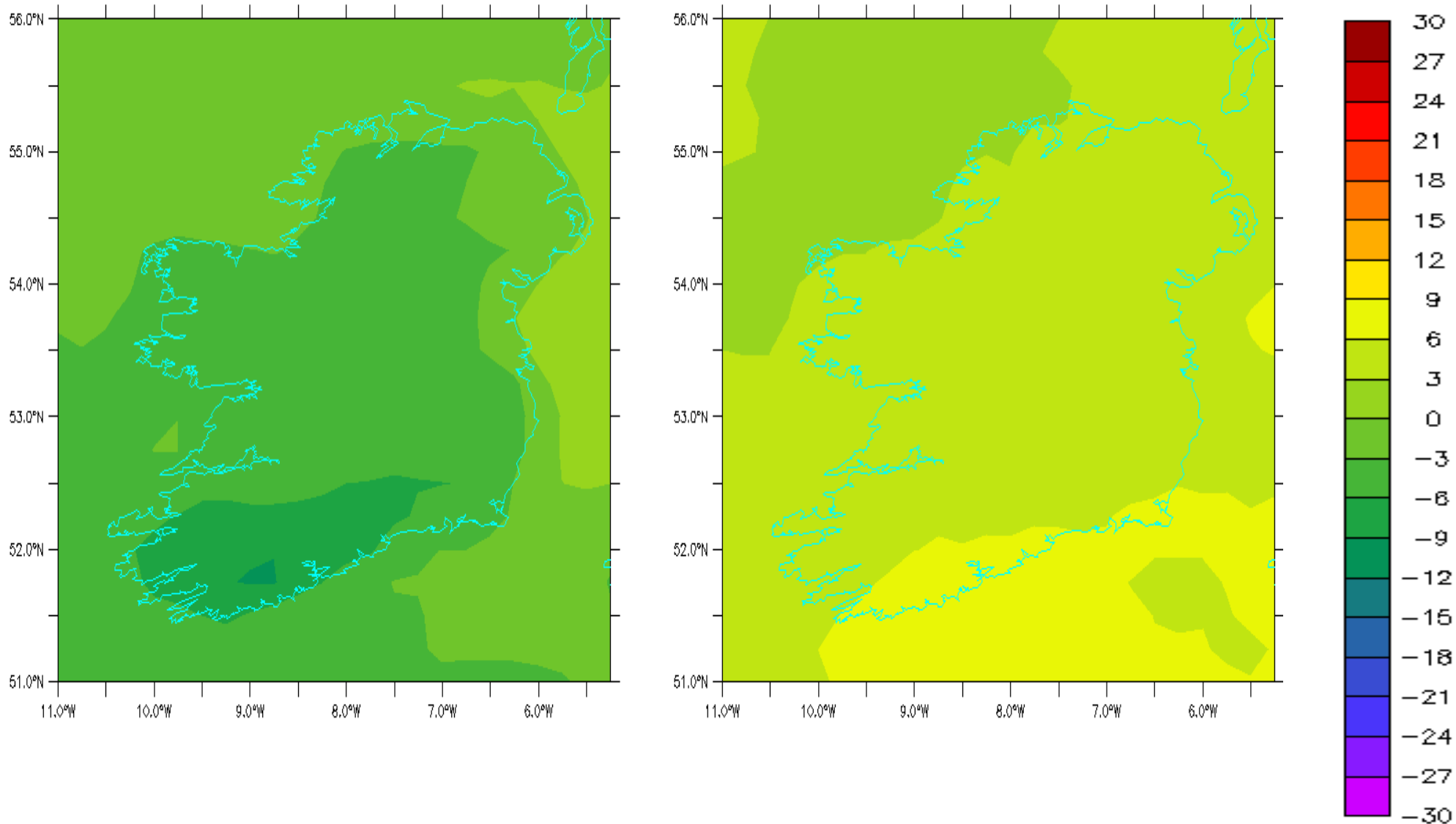
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# Predicted changes: Certainty and uncertainty



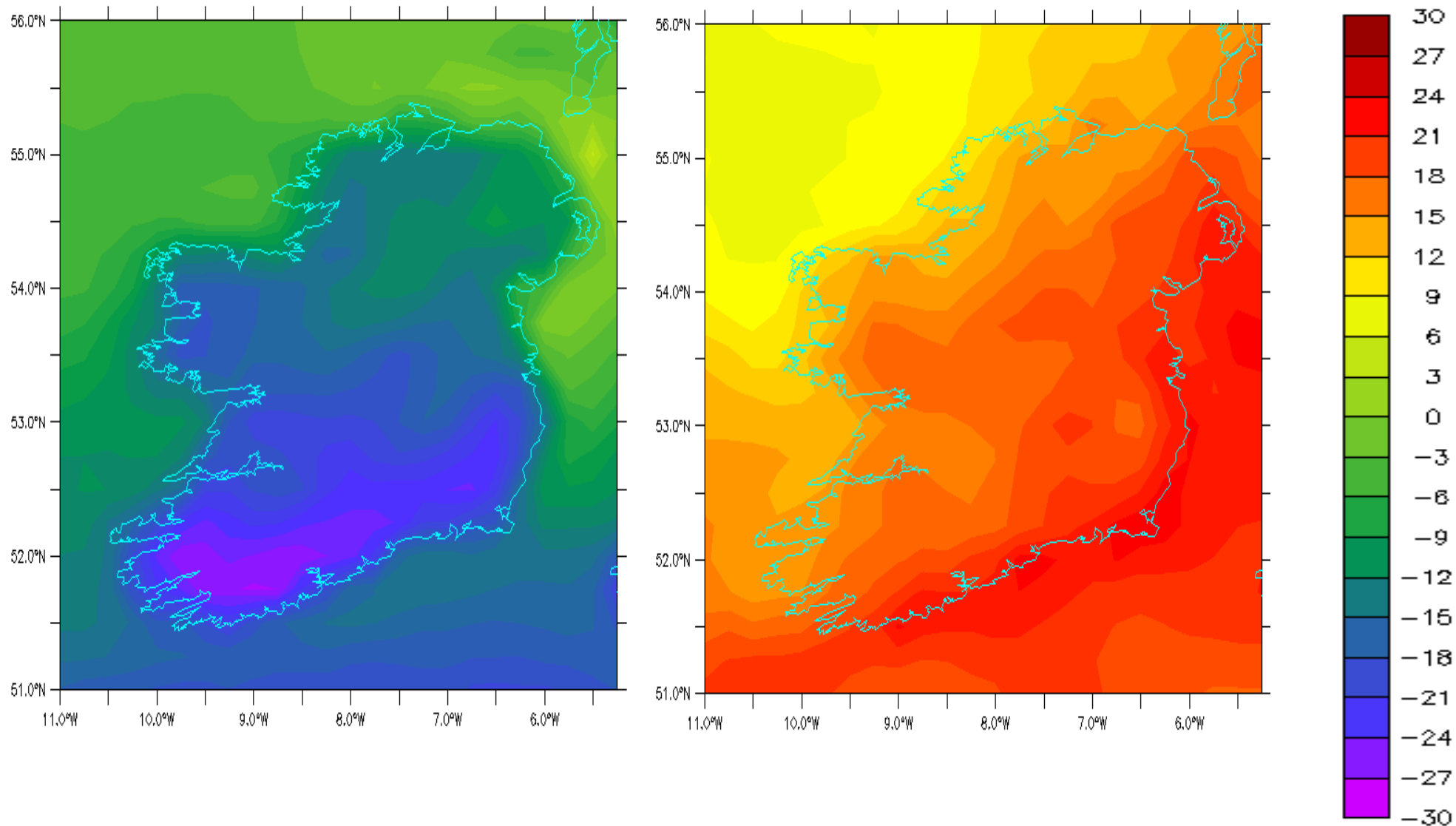
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# Predicted changes: Certainty and uncertainty



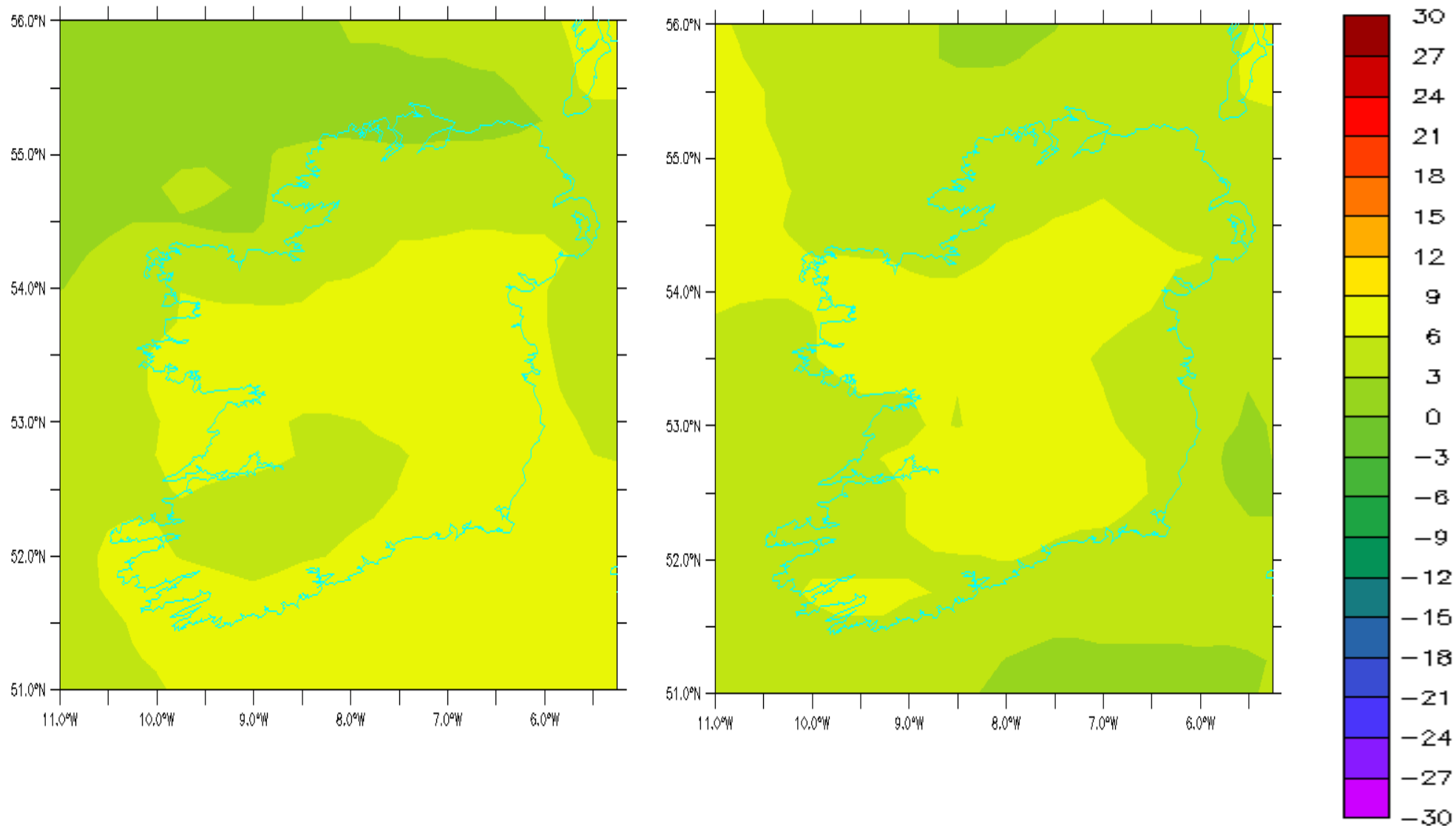
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# Predicted changes: Certainty and uncertainty



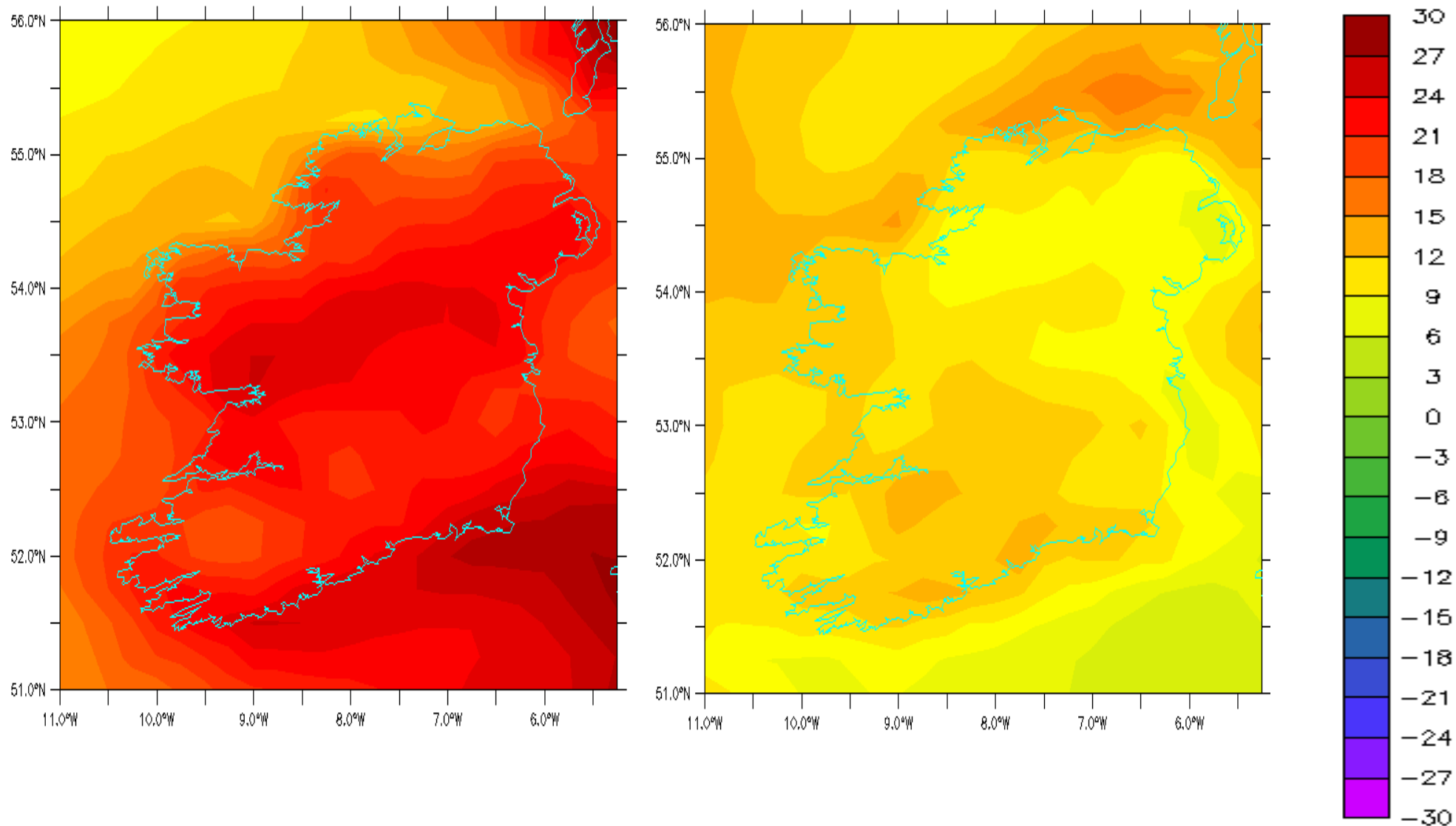
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# Predicted changes: Certainty and uncertainty



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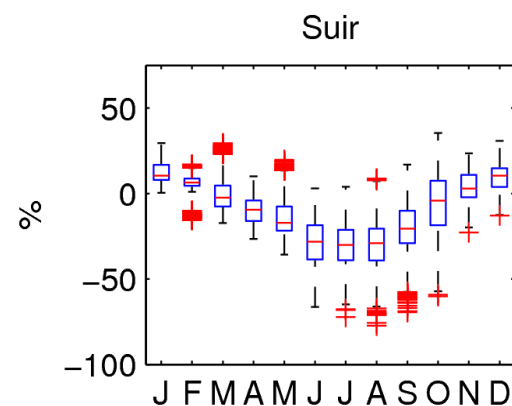
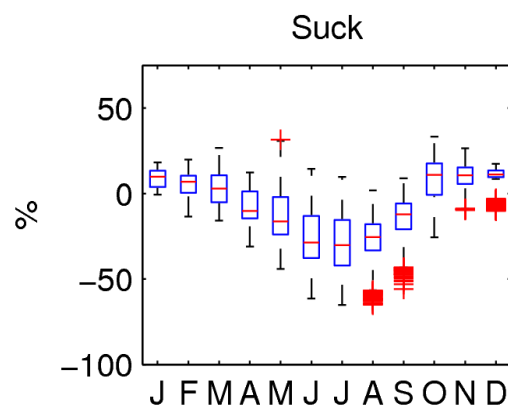
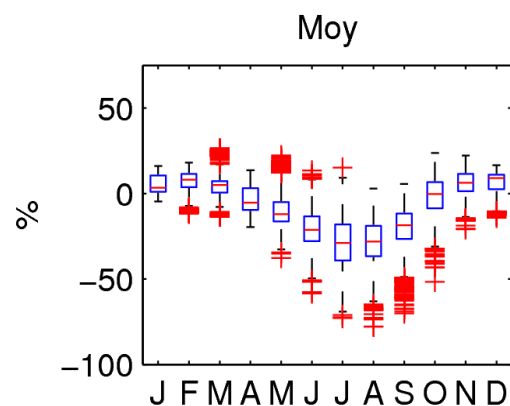
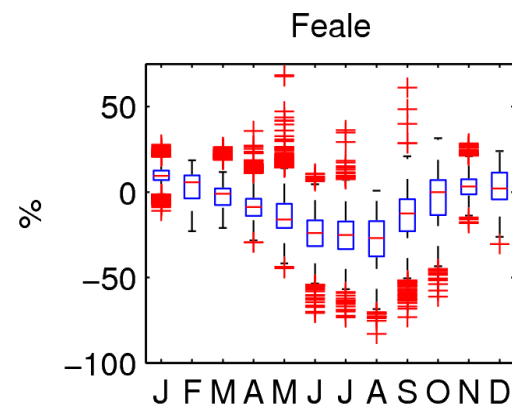
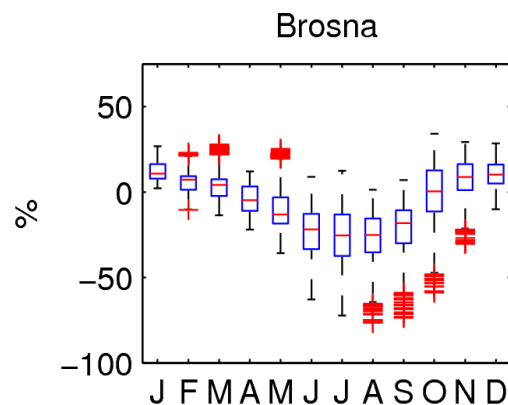
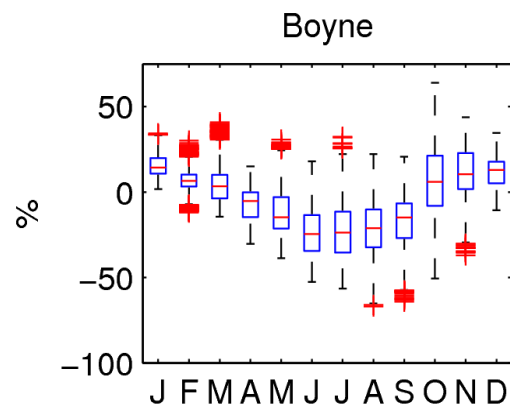
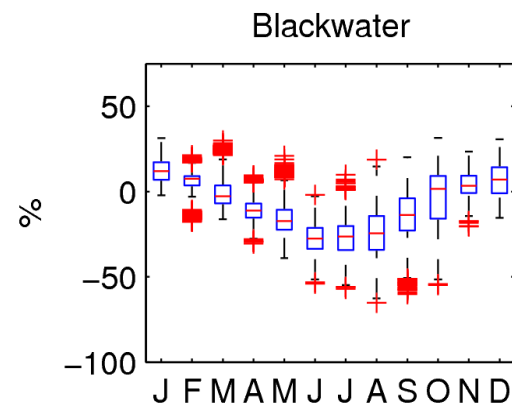
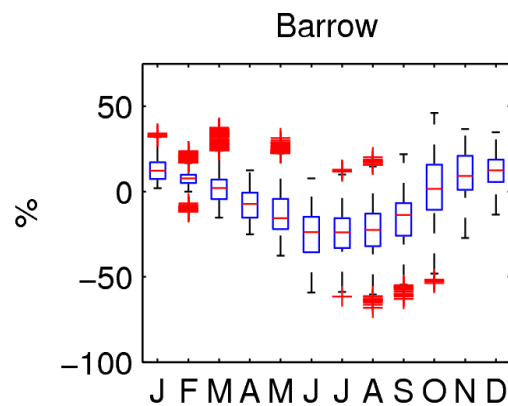
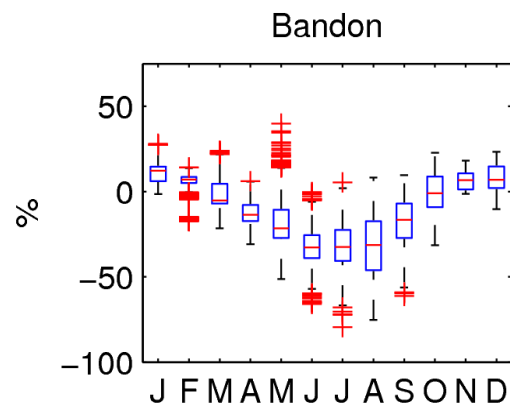
# Predicted changes: Certainty and uncertainty



*Predicted rainfall changes [ $^{\circ}\text{C}$ ] for winter 2071-2100 compared to 1961-1990 and standard deviation from 12 model simulations*

# Predicted changes: Certainty and uncertainty

Box plot of the change in river discharge [%] for all 1300 simulations. The median is indicated by a horizontal red line in the blue box, the first and third quartiles by the blue box, minimum and maximum excluding outliers by black bars and outliers (more than 1.5 interquartile ranges lower than the first quartile or more than 1.5 interquartile ranges higher than the third quartile) by red crosses.



# Conclusions

Climate change is happening and temperature and sea level have increased globally – Ireland not being an exception – and will further increase. The natural variability is superimposed on the temperature increase while the sea level is steadily increasing.

Climate models have increased in accuracy over the last decade, however uncertainties remain

Rainfall and river discharge generally show a larger uncertainty than temperature, especially extreme events

Winter rainfall and river discharge over Ireland have increased and are predicted to further increase – the prediction is uncertain though

No clear observed trend in summer rainfall. No major low discharge events in the 2000's. Large uncertainty in predicted slight decrease of summer rainfall and river discharge

Met Éireann actively involved in projects to reduce uncertainty: Contribution to development of a comprehensive earth system model and of a very high resolution regional climate model

End