Hydrological extremes and feedbacks – Wp1(a and b)

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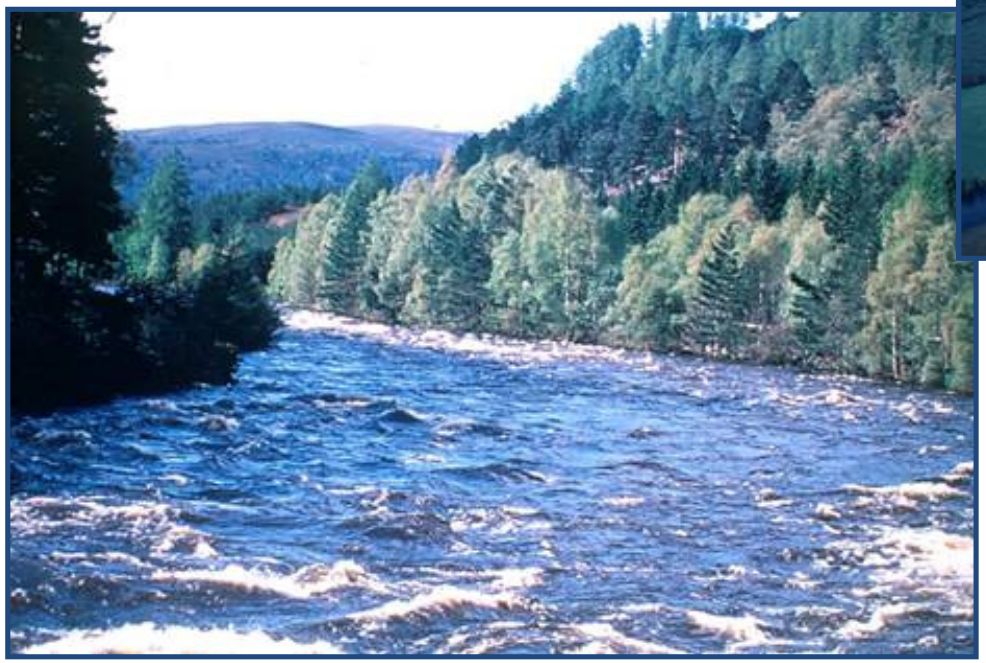
Outline

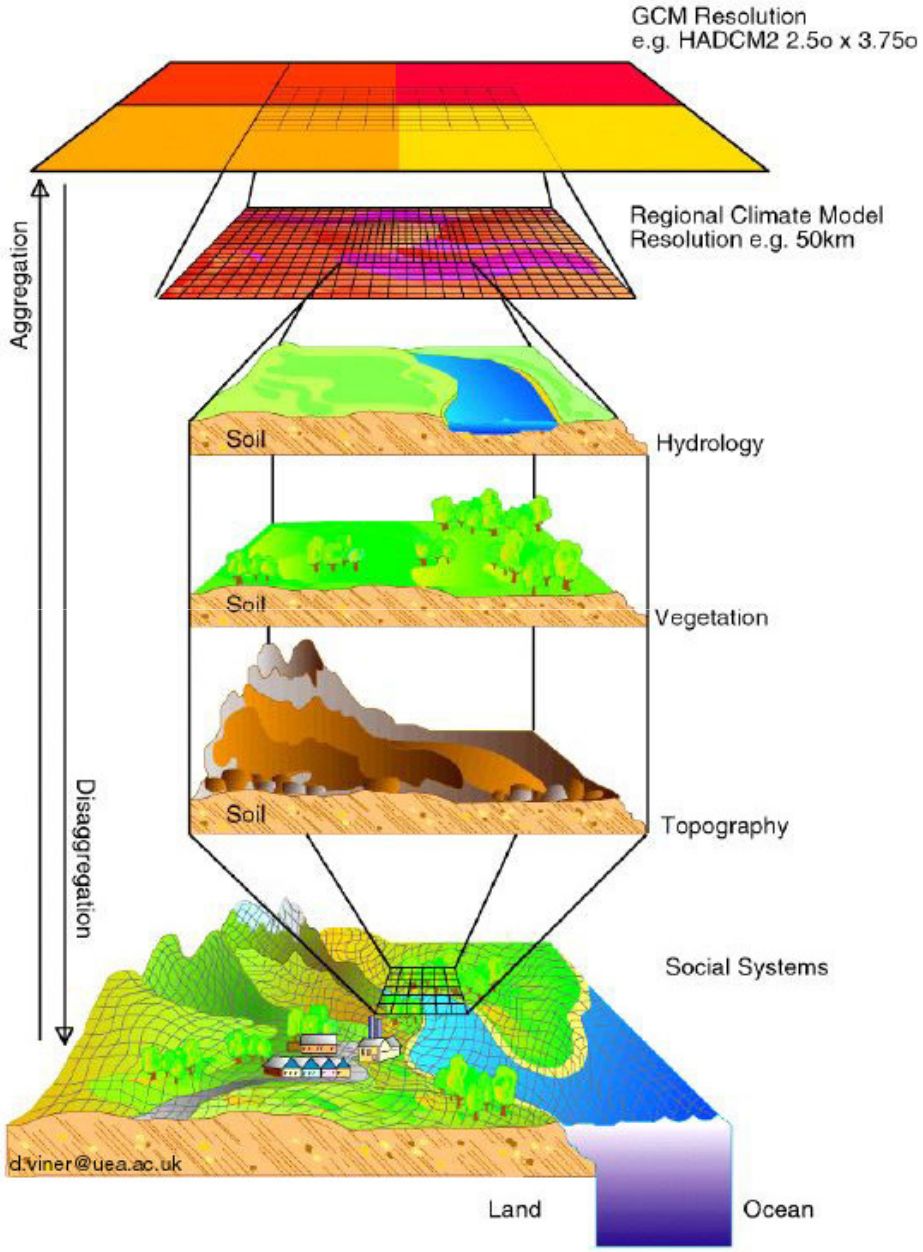
- Issues
- Methodology for Wp1 (a and b)
- Progress
- Integration

Issues

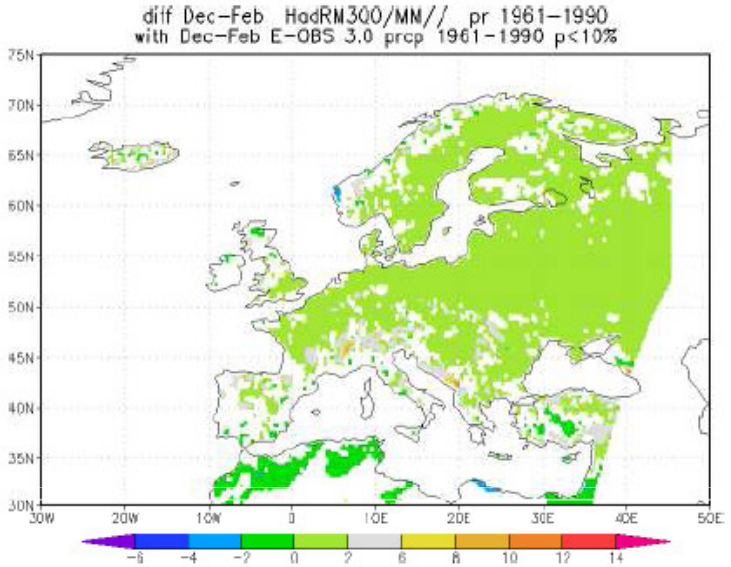


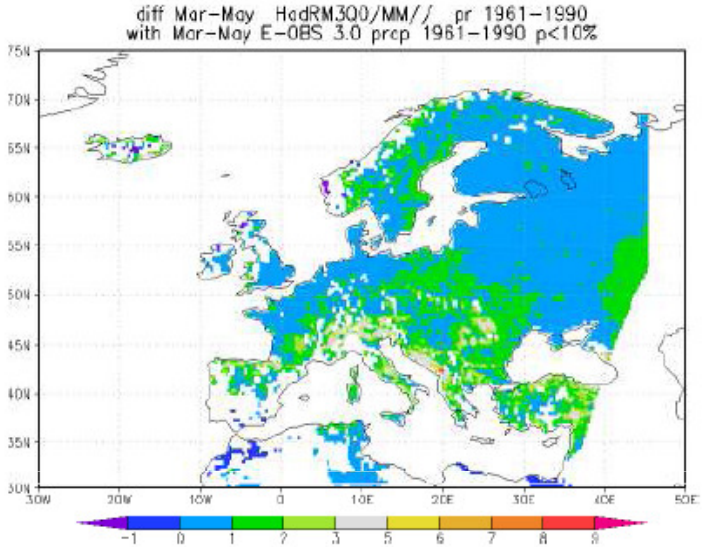
River Dee, Aberdeenshire

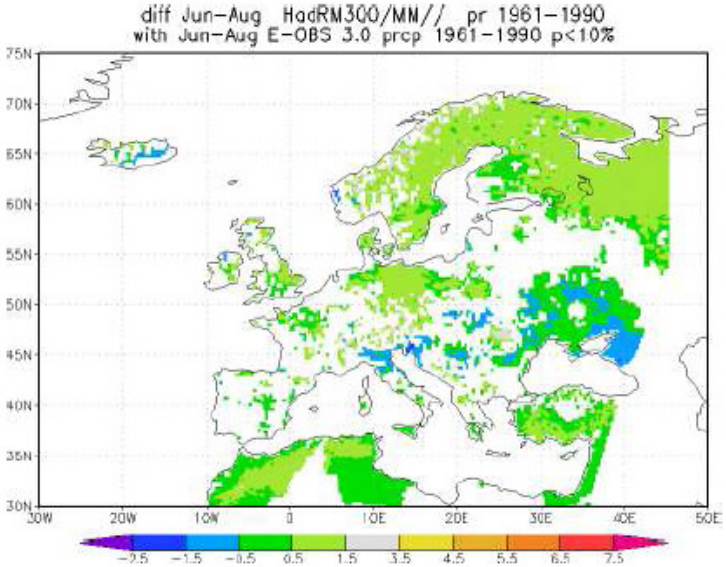
Scale problem

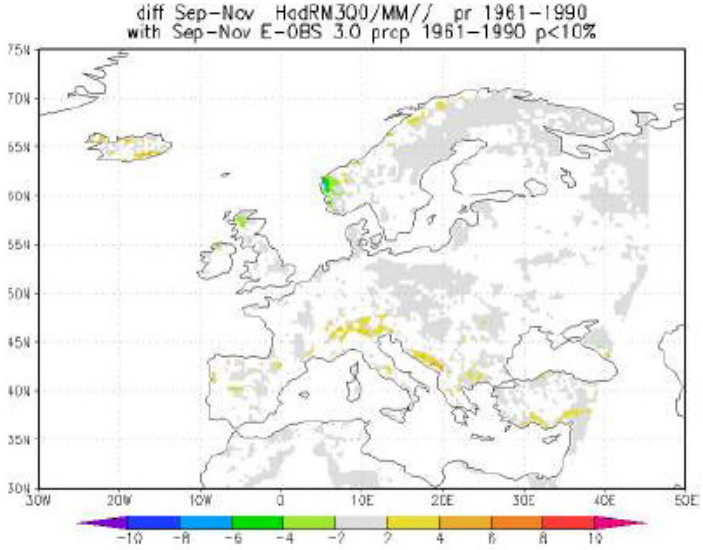


Monthly means of daily rainfall differences
HadRM3Q0 / HadCM3Q0



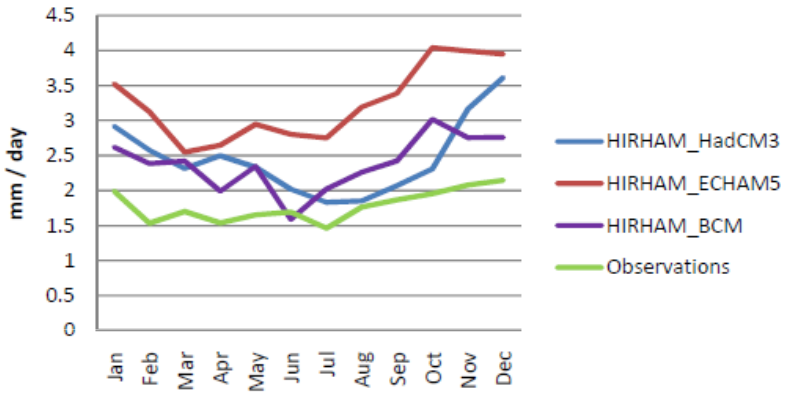




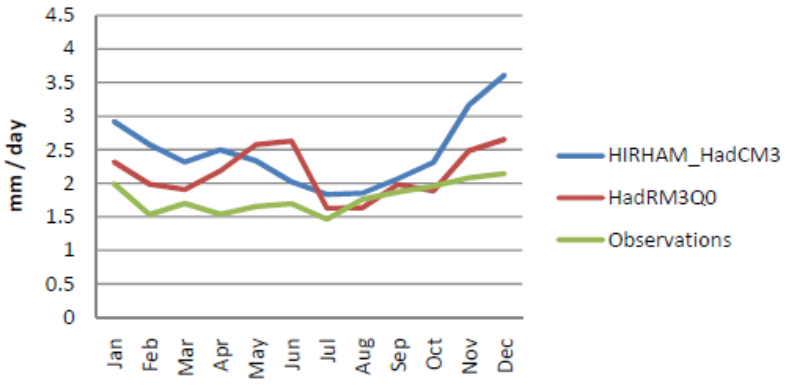


Examples of monthly averages of daily precipitation intensity: Baseline modelled data vs observations for the Thames catchment

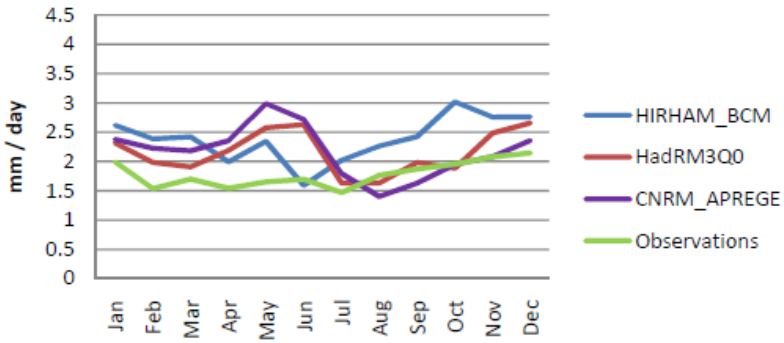
HIRHAM forced by different GCM



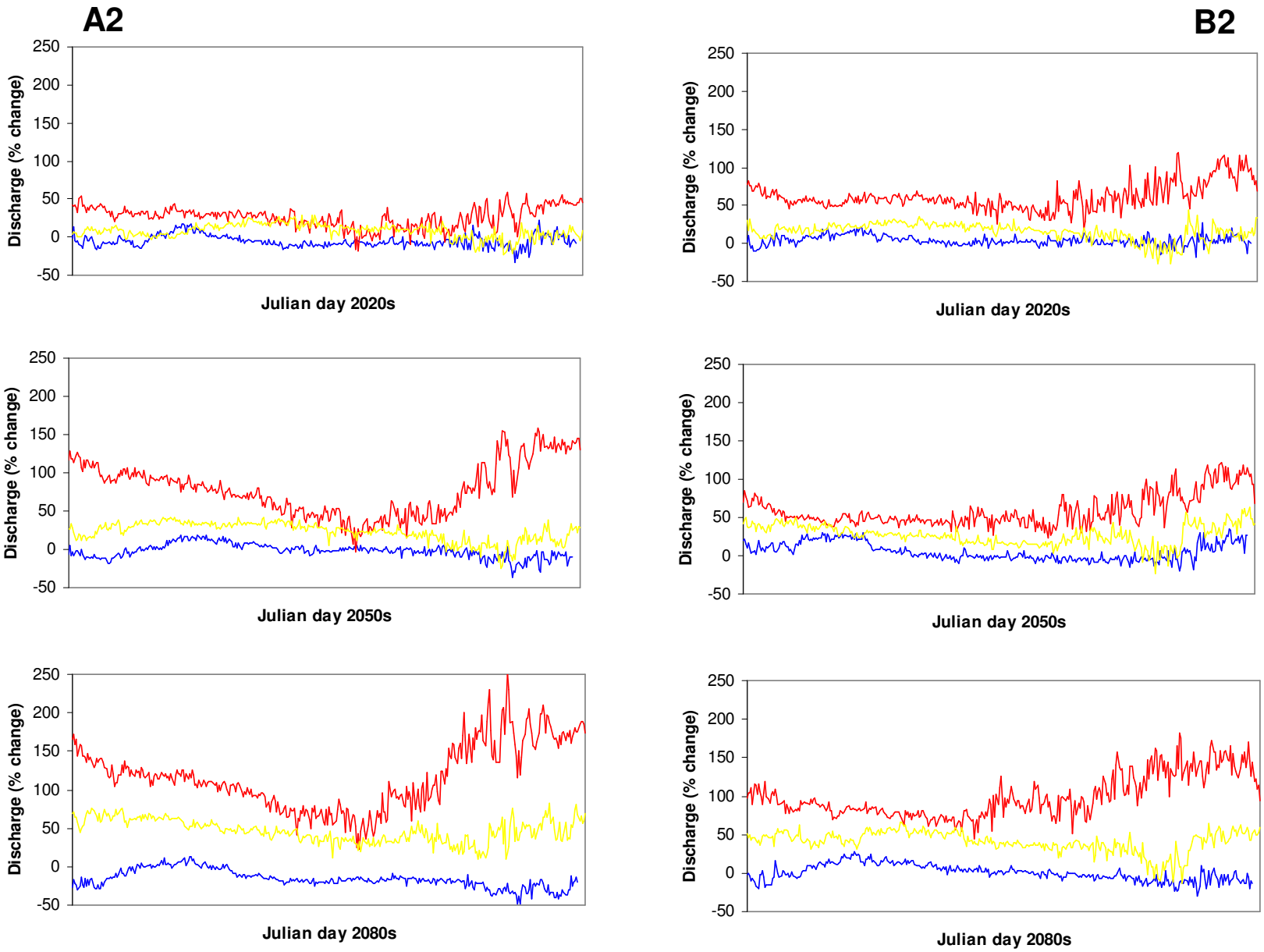
RCMs forced by HadRM3Q0



Different RCMs forced by different GCM



Percentage Change in Flows for 20s,50s and 80s for A2 and B2 Scenarios for 3 GCMs: Hadley CSIRO and CGCM2.



Key consideration

Not how to down-scale but

what to down-scale

Research questions

- What controlling climate processes at different spatial and temporal scales, in terms of ‘hydrologically interesting weather’, do GCM/RCMs represent well (model proficiency)?

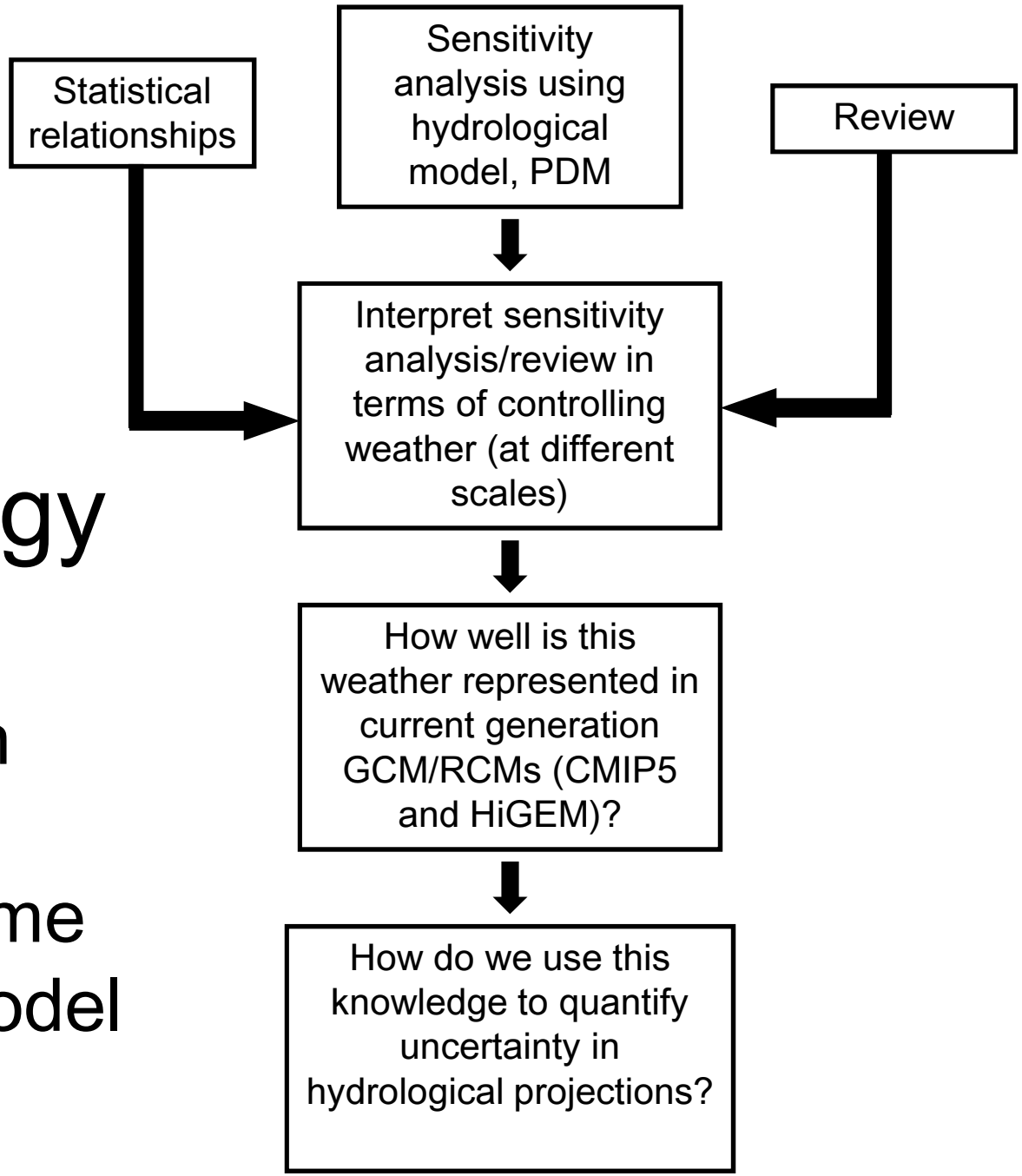
- How much uncertainty in hydrological forecasts does poor weather representation cause?

- How to use the evidence base for making more informed projections of hydrological extremes?

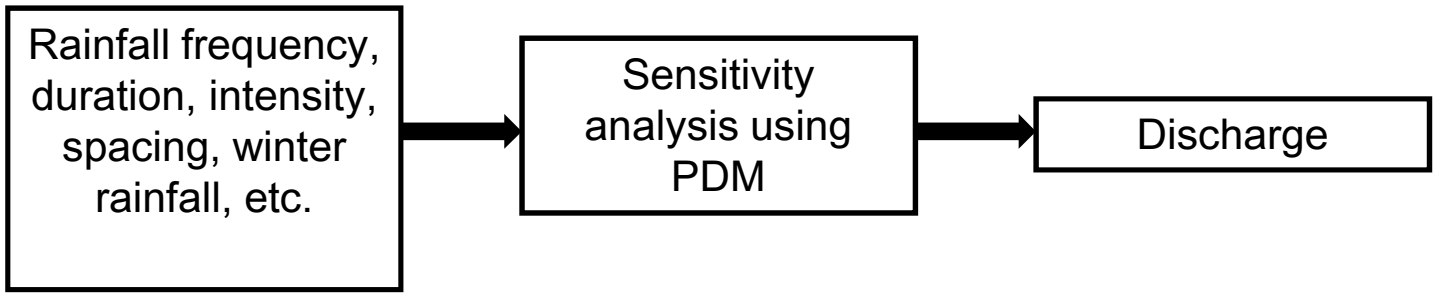
Methodology

issue driven

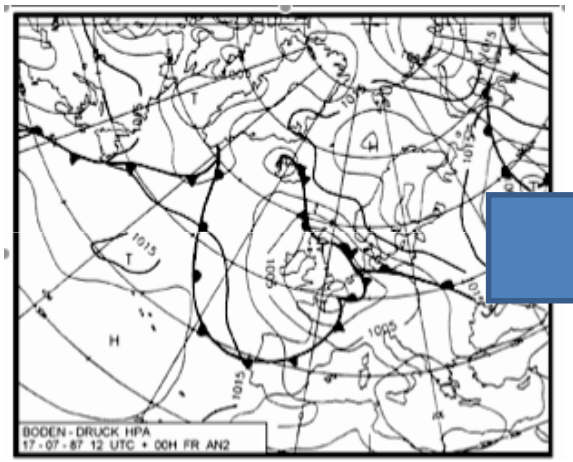
to begin assume hydrological model is truth



Sensitivity analysis

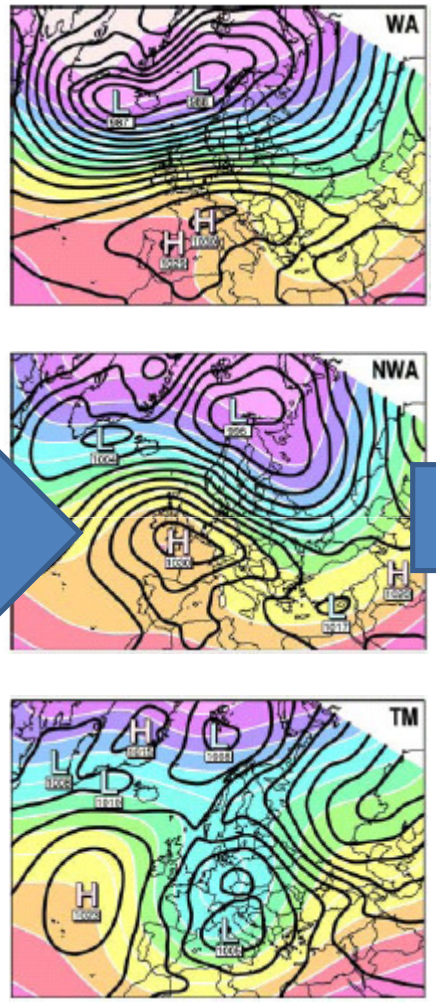


Grosswetterlagen (GWL) method for synoptic typing



Time-filtered daily-mean circulation fields

Figure from Gerstengarbe et al 1999



"Prevailing" weather type for each day

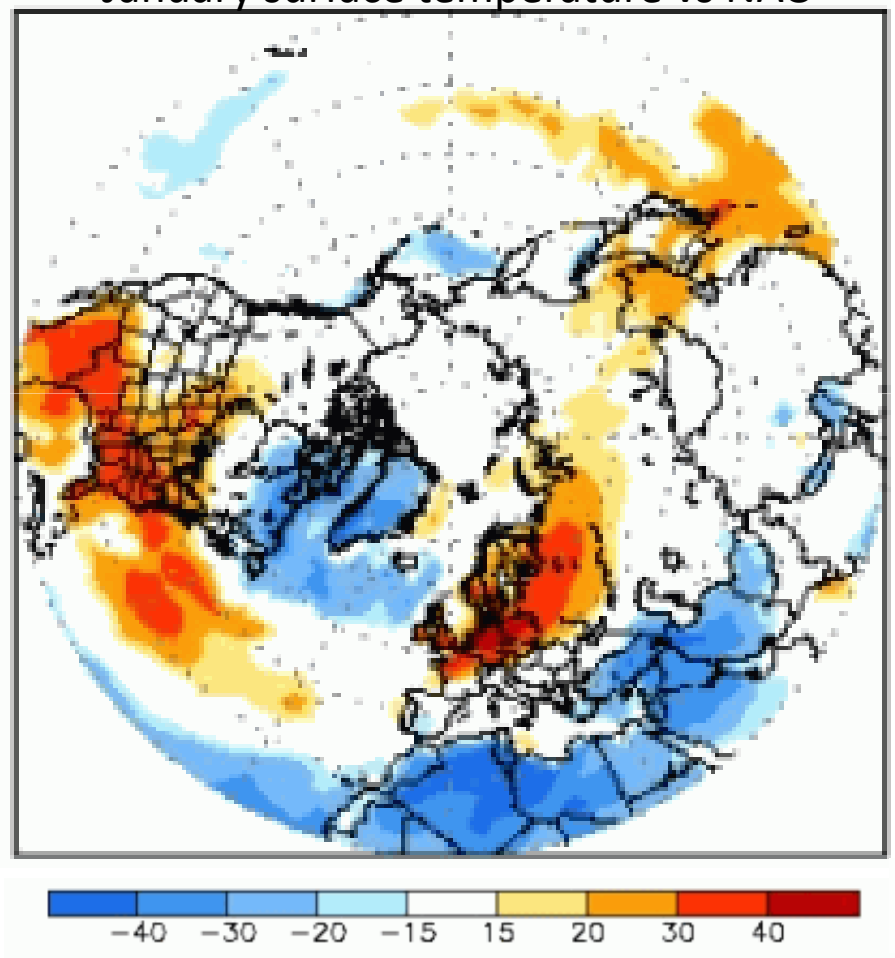
Identify which types are associated with hydrologically-relevant events

Objective correlation to 29 canonical weather types

James (2006) following Hess and Brezowsky (1952)

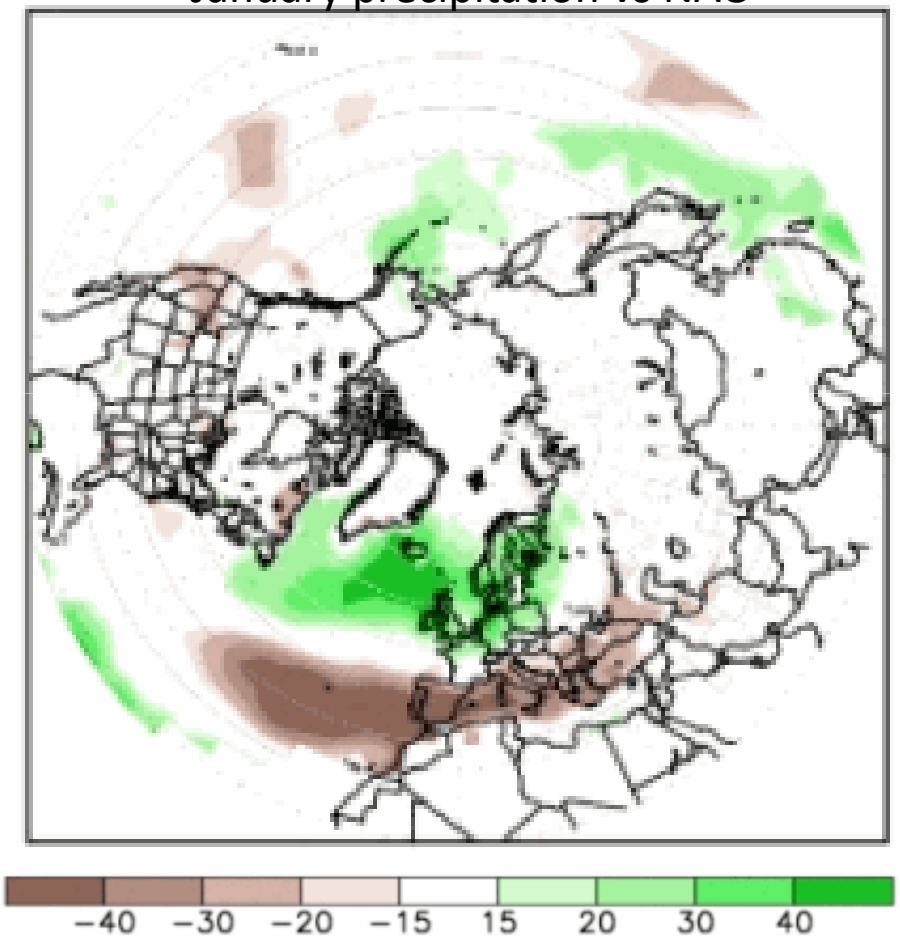
NAO and surface climate

Correlation strength:
January surface temperature vs NAO



+/- 1°C over areas of Northern Europe

Correlation strength:
January precipitation vs NAO

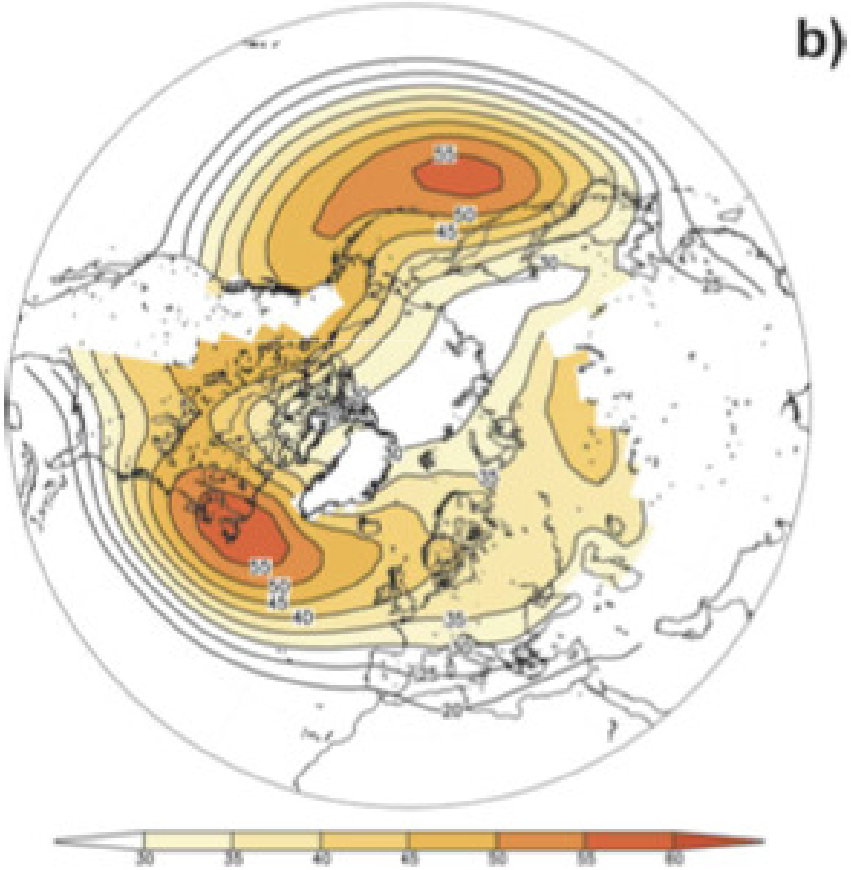


+/- => 25 mm/month over some areas of UK

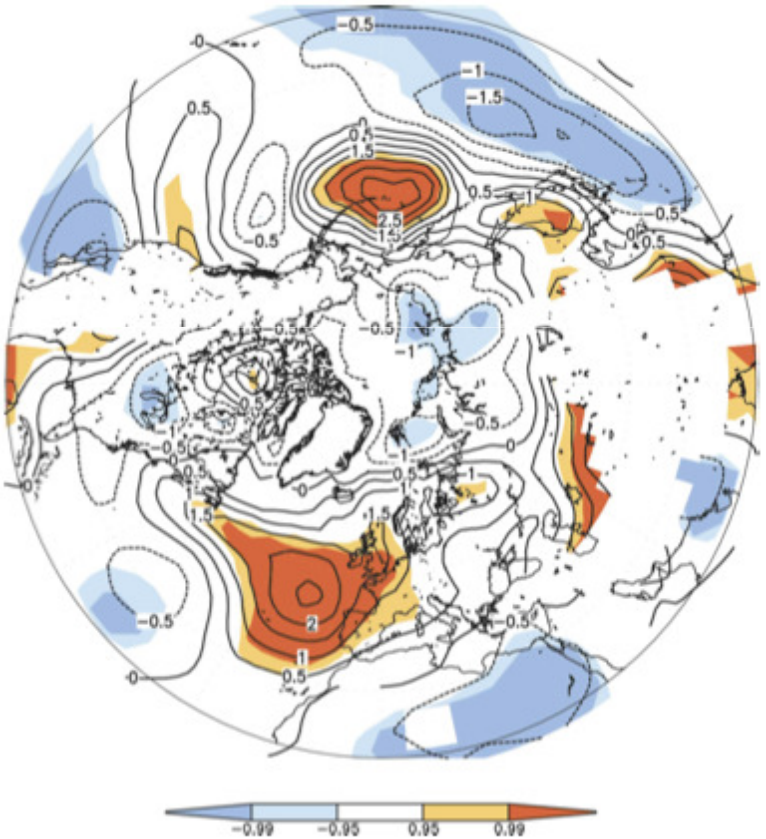
Correlations from NOAA CPC website

Climate change

IPCC AR4 (2007) winter storm tracks under present day conditions



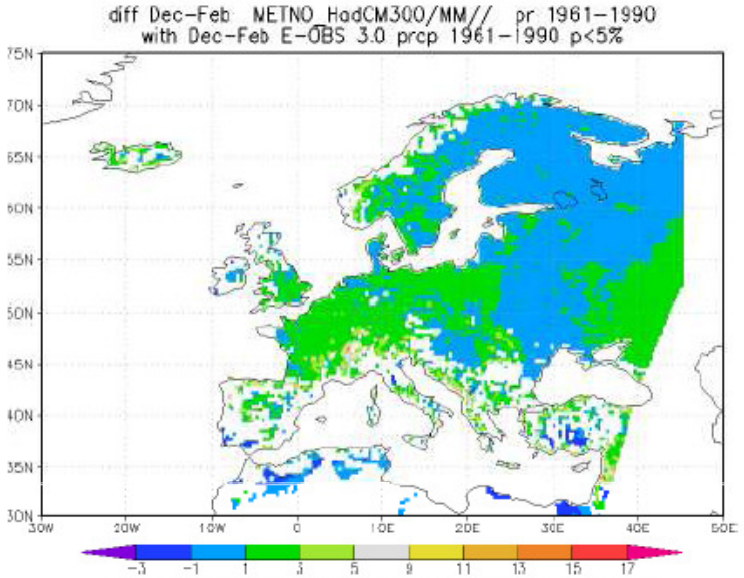
SRES A1B end of C21 change
Colours indicate statistical significance

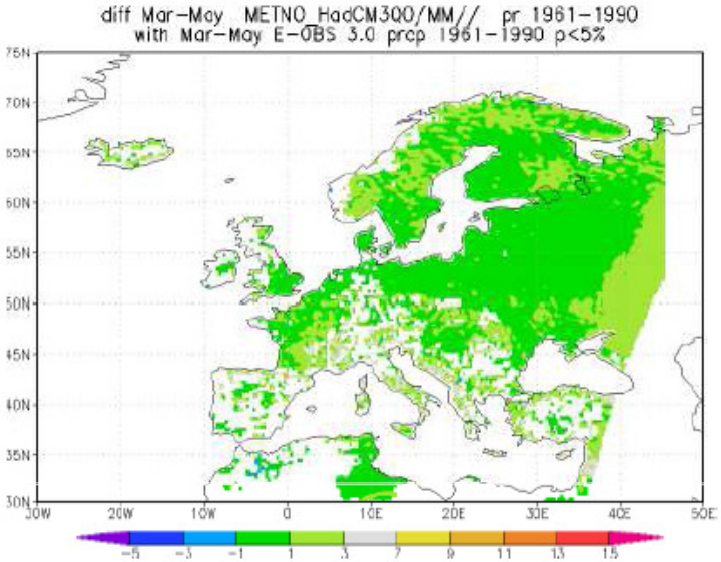


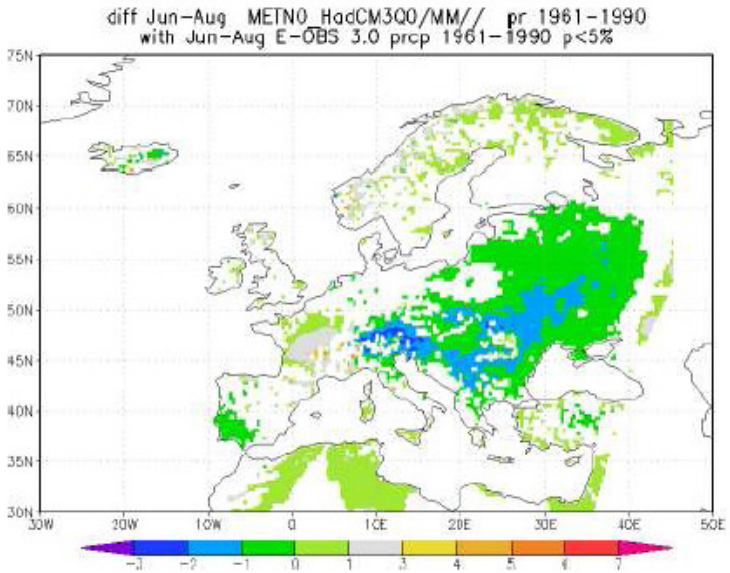
Ulbrich et al 2008

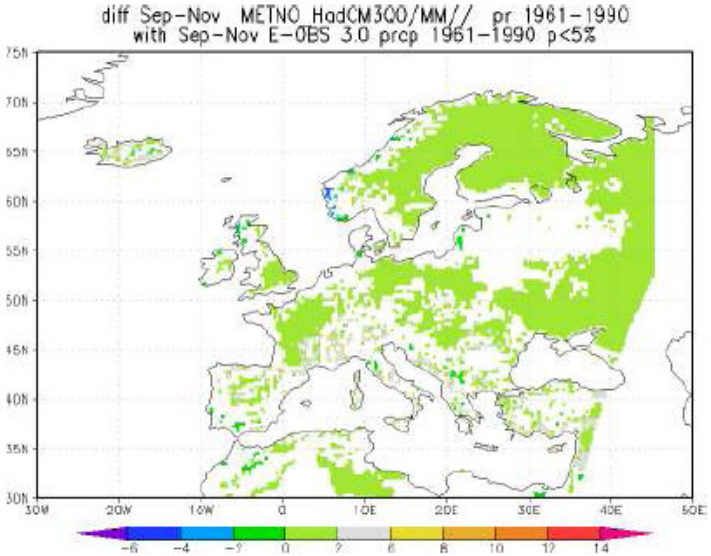
- Progress
- Integration

Monthly means of daily rainfall differences HIRHAM-HadCM3Q0

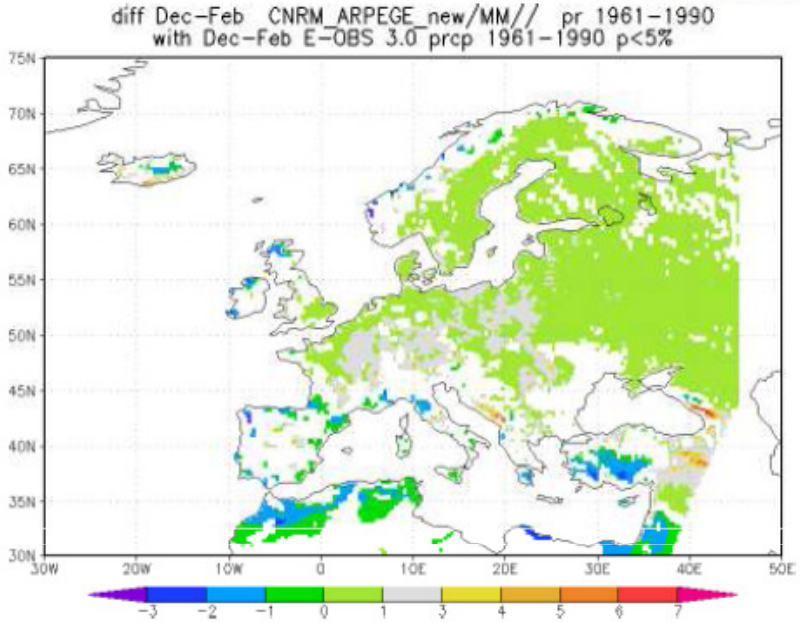


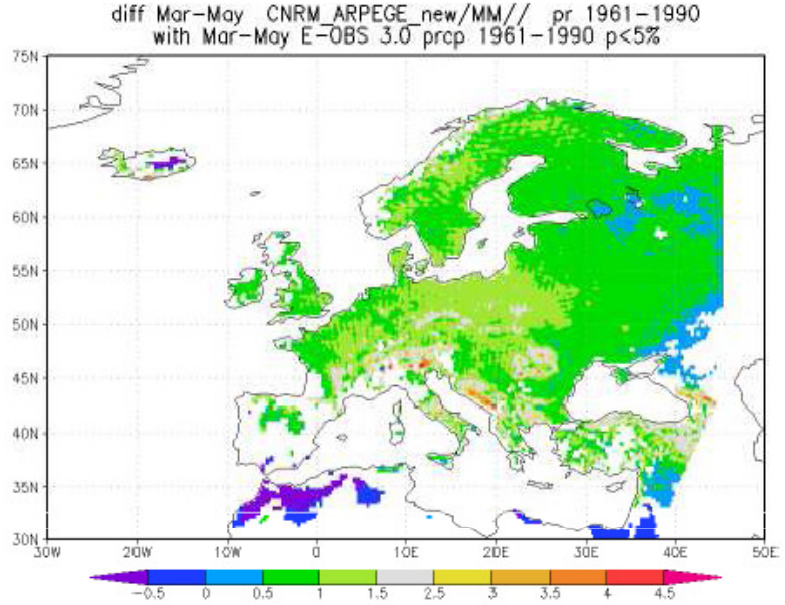


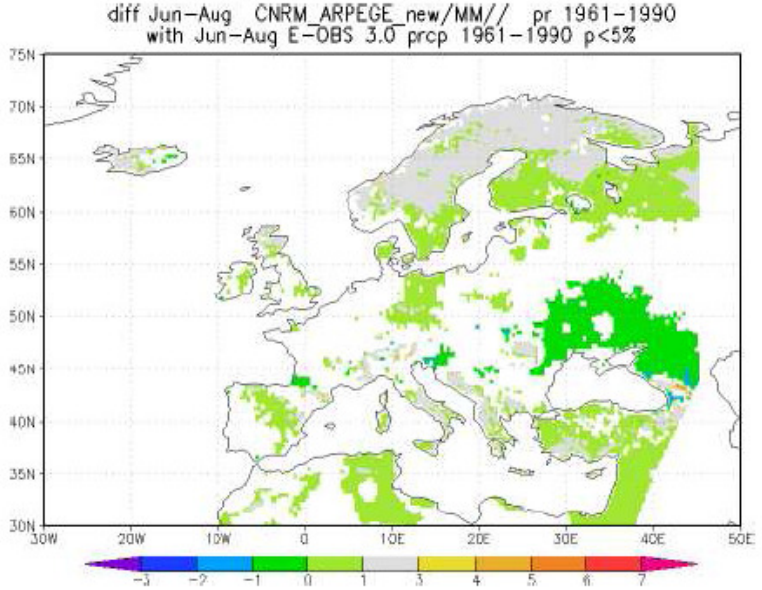


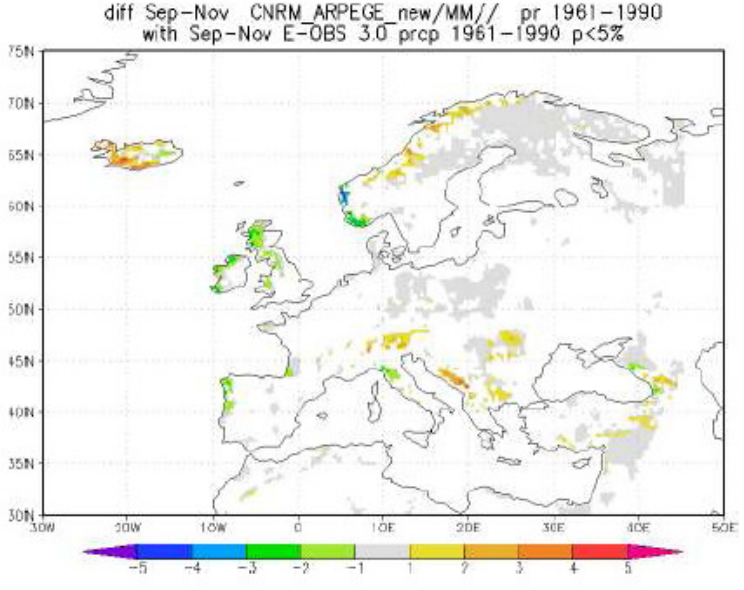


Monthly means of daily rainfall differences
CRNM / APREGE

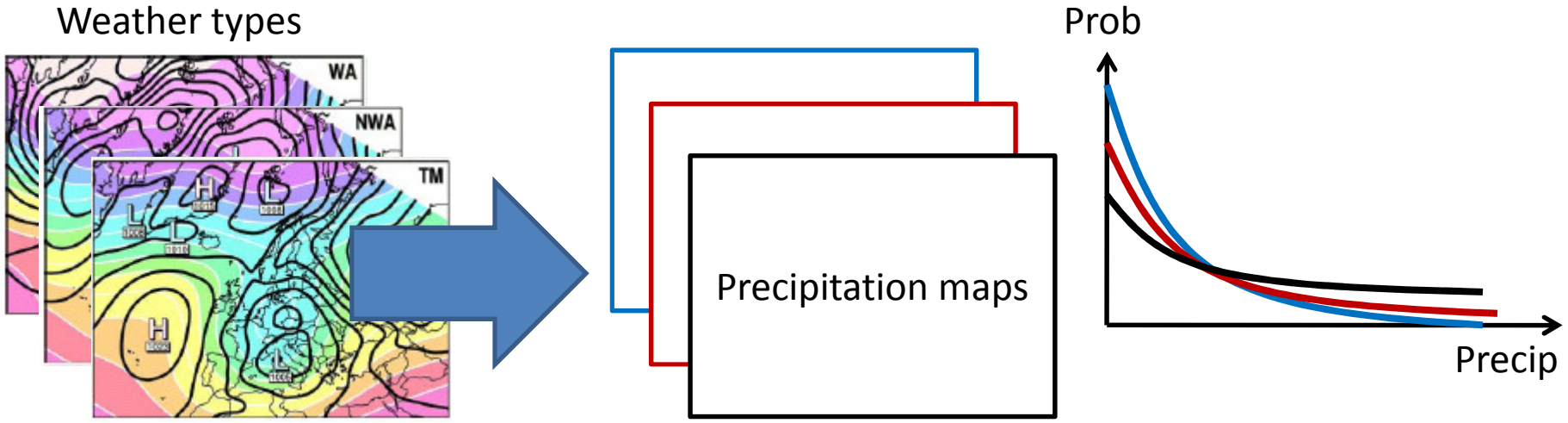




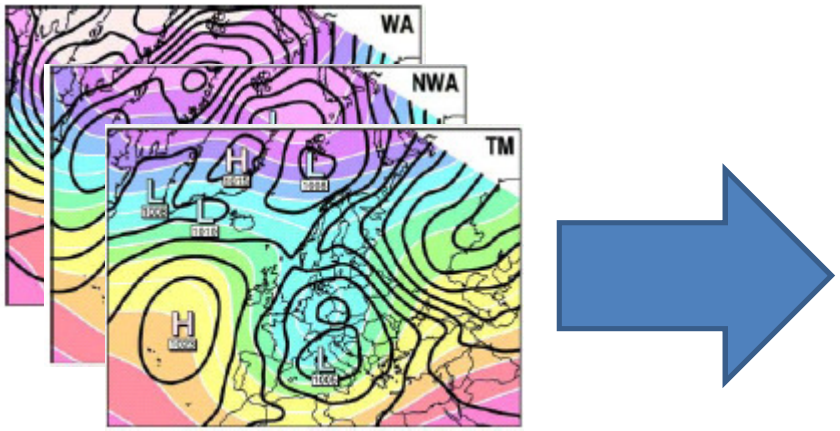




GWL method for synoptic typing



James (2006)



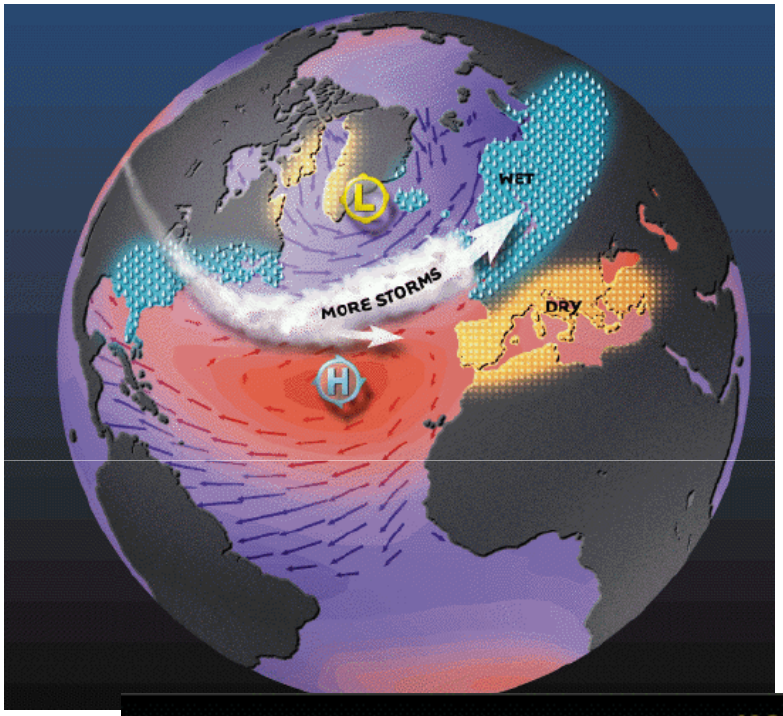
James (2006)

Frequency of occurance:

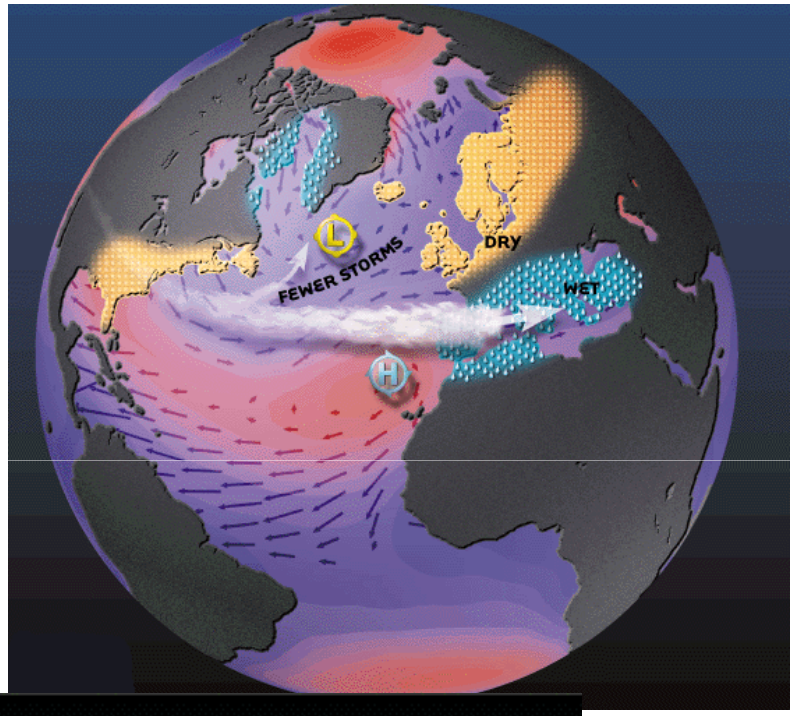
- Links to large-scale atmospheric circulation
  For example, NAO
- GCM simulations
  Present and future

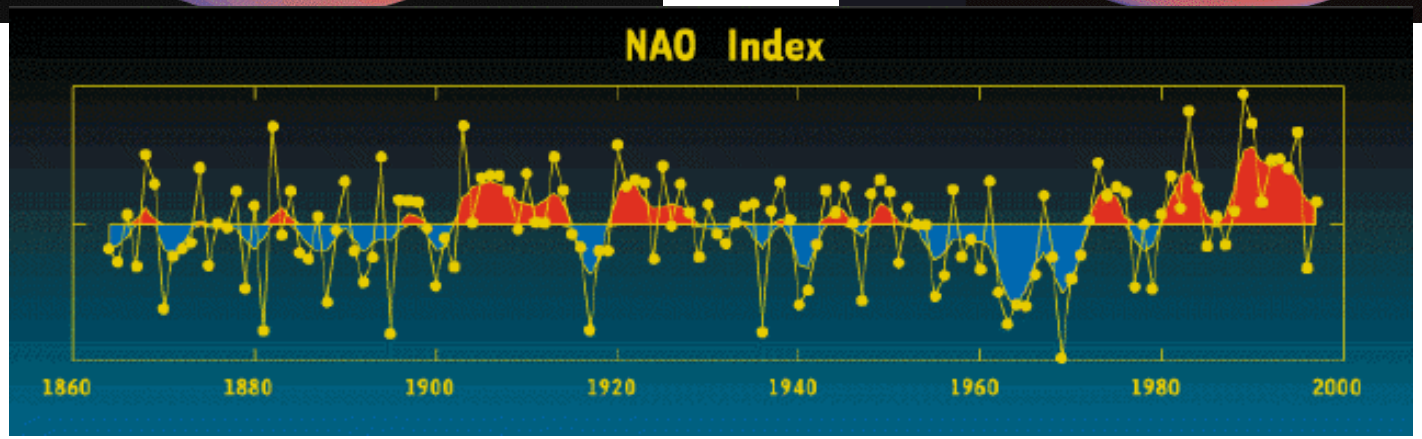
Storm tracks and the NAO

Positive



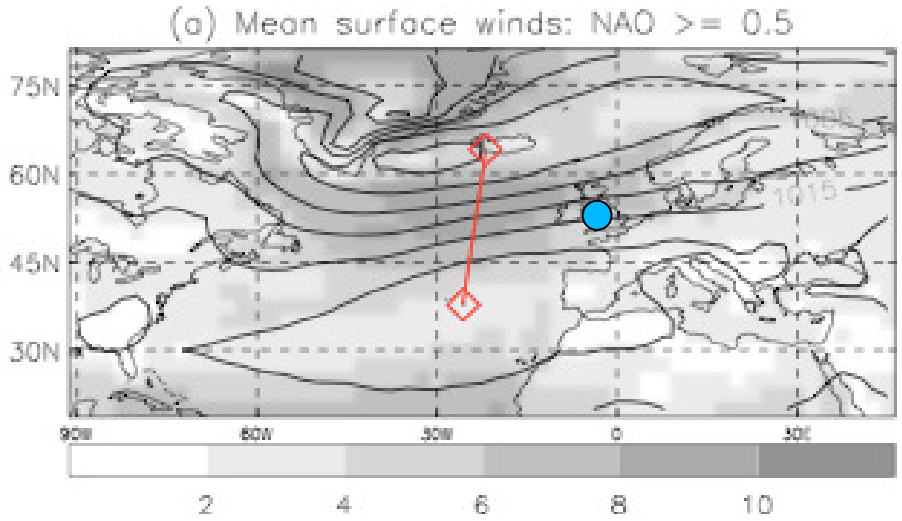
Negative

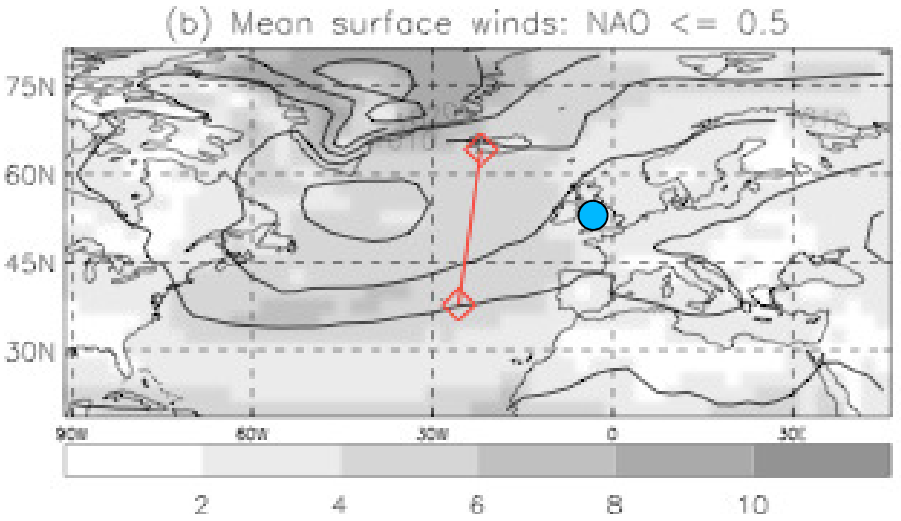




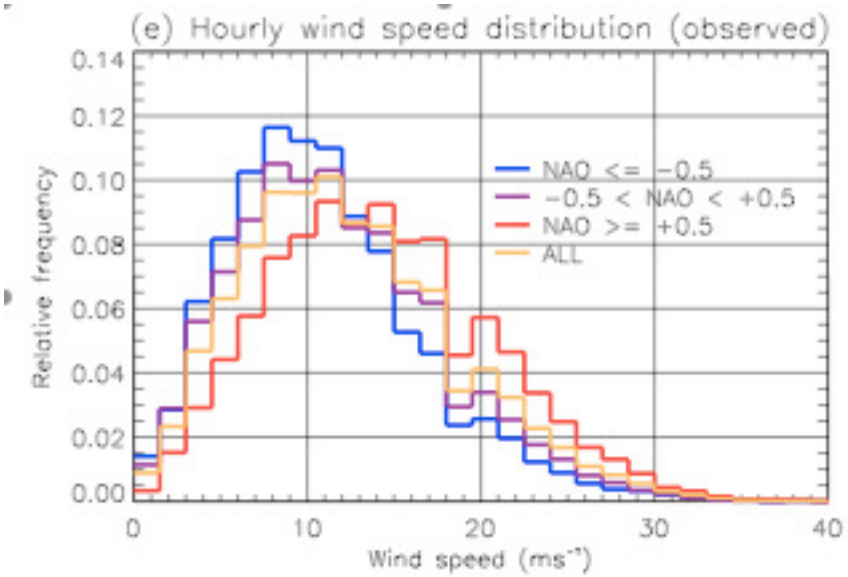
Figs: http://www.ldeo.columbia.edu/res/pi/NAO/

NAO and 10m wind speed





Based on NCEP reanalysis



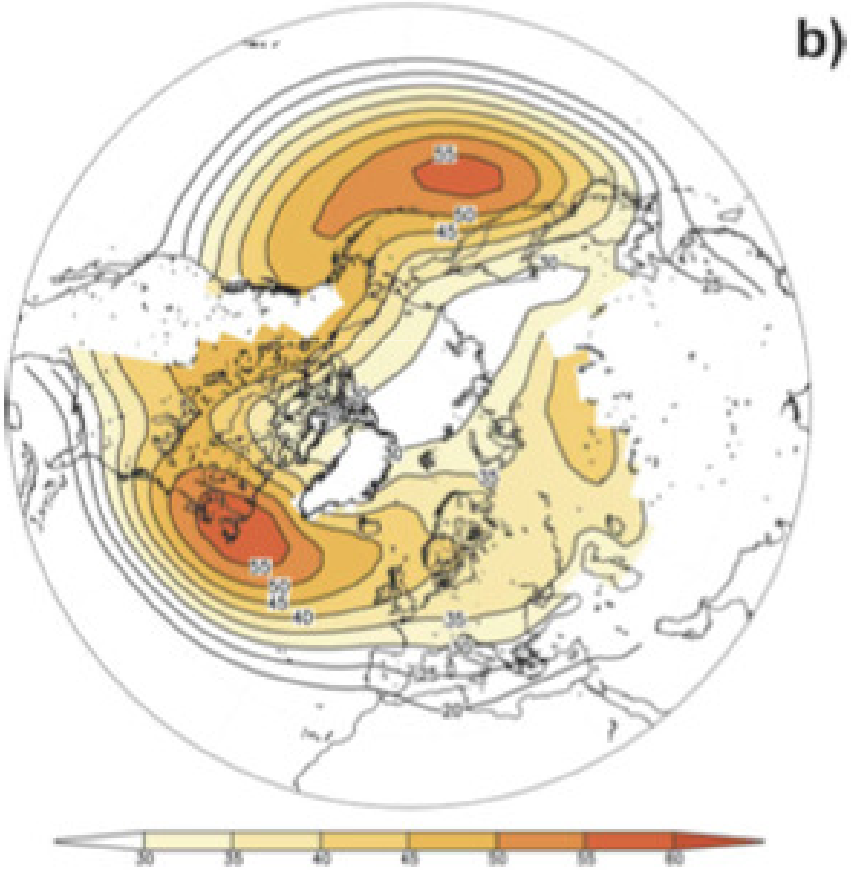
Figures from Brayshaw et al (2010)
In revision for “Renewable Energy”

Similar relationships could be derived for precipitation

PDFs of wind speed from Great Dunn Fell MIDAS station data

Climate change

IPCC AR4 (2007) winter storm tracks under present day conditions



Ulbrich et al 2008

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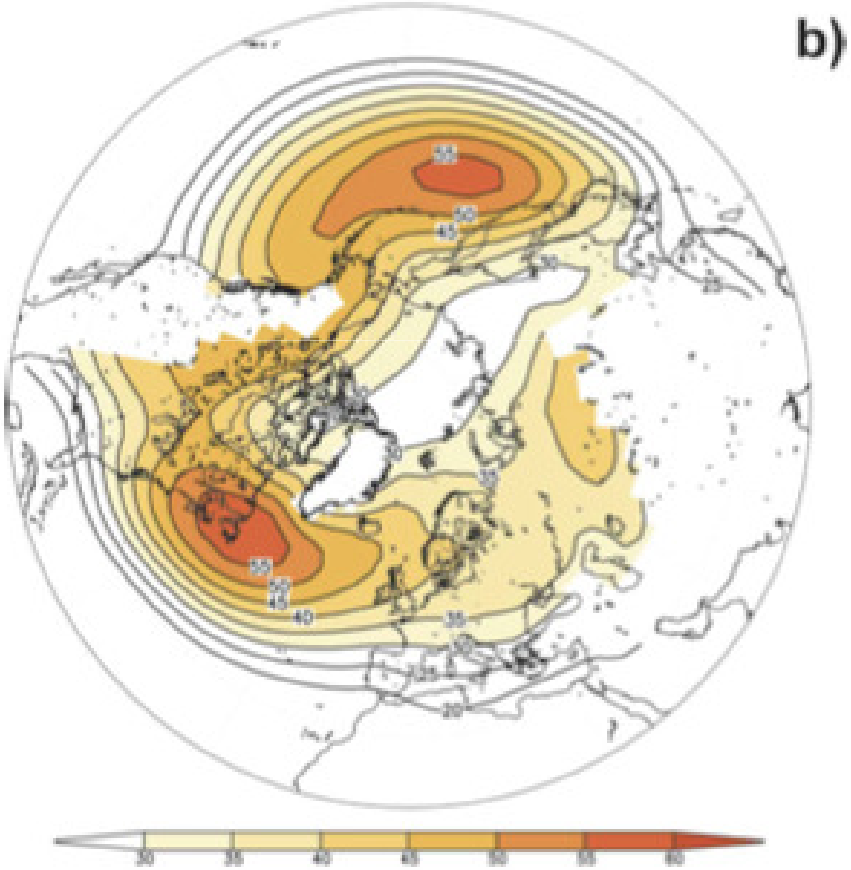

SRES A1B end of C21 change
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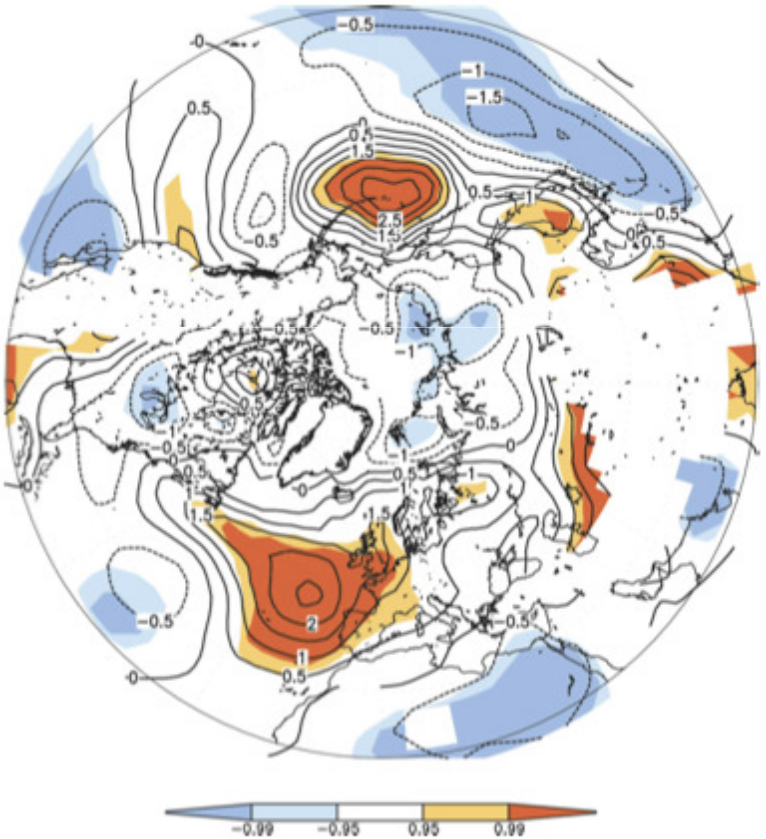

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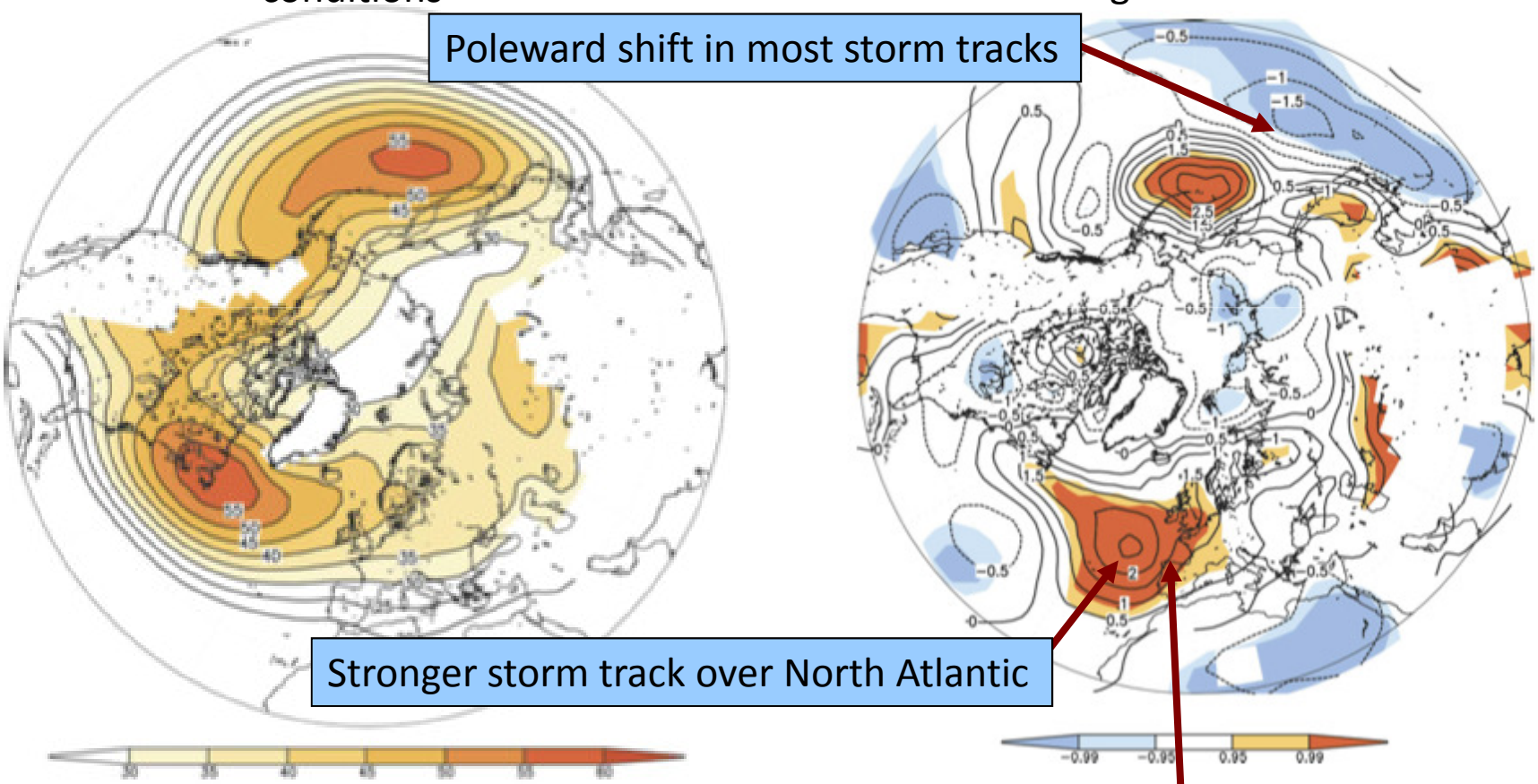

Poleward shift in most storm tracks

Stronger storm track over North Atlantic

Possibly fewer storms but “peak” storms more intense

Ulbrich et al 2008

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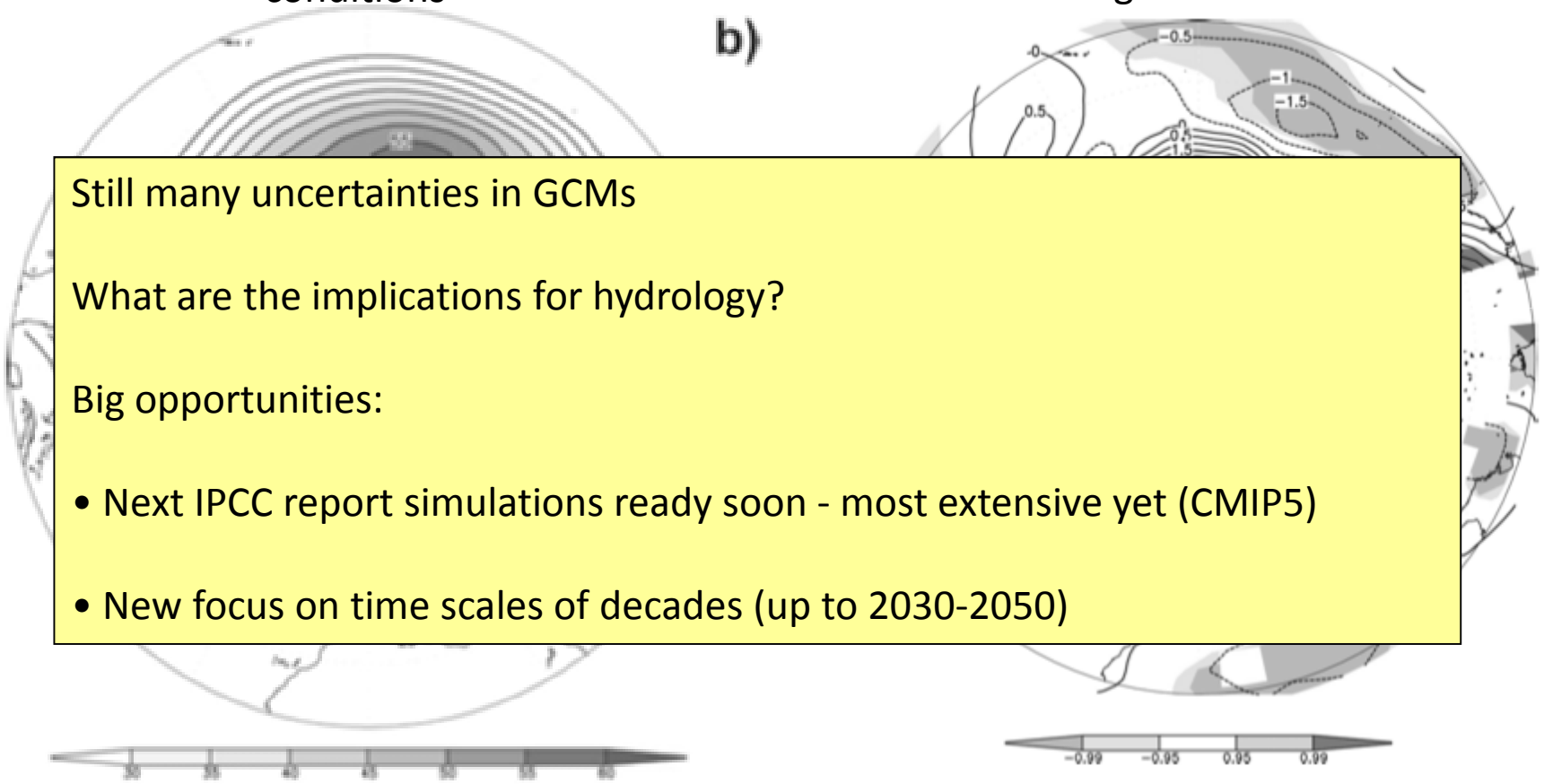


Still many uncertainties in GCMs

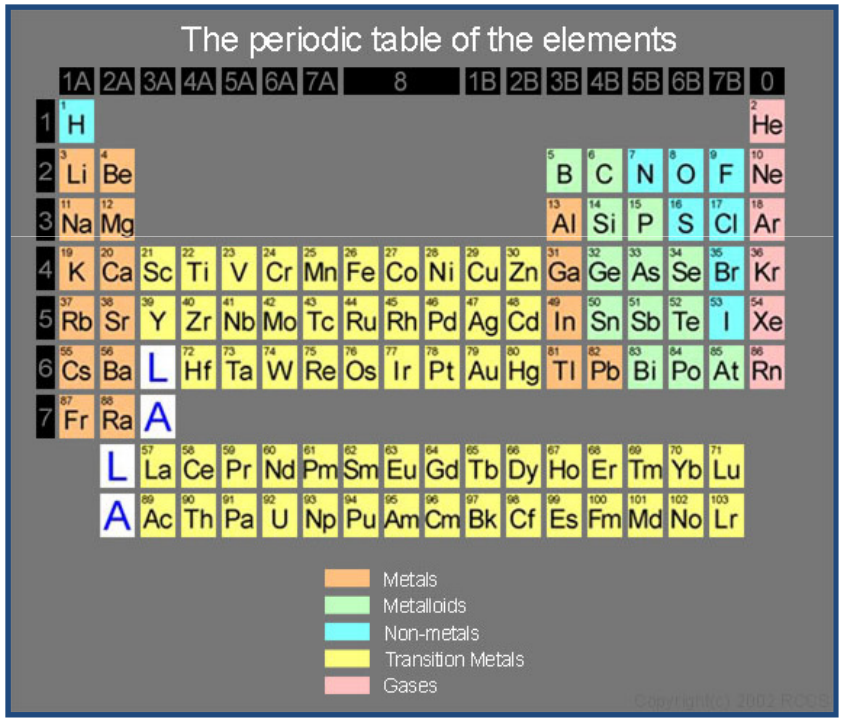
What are the implications for hydrology?

Big opportunities:

- Next IPCC report simulations ready soon - most extensive yet (CMIP5)
- New focus on time scales of decades (up to 2030-2050)

Ulbrich et al 2008

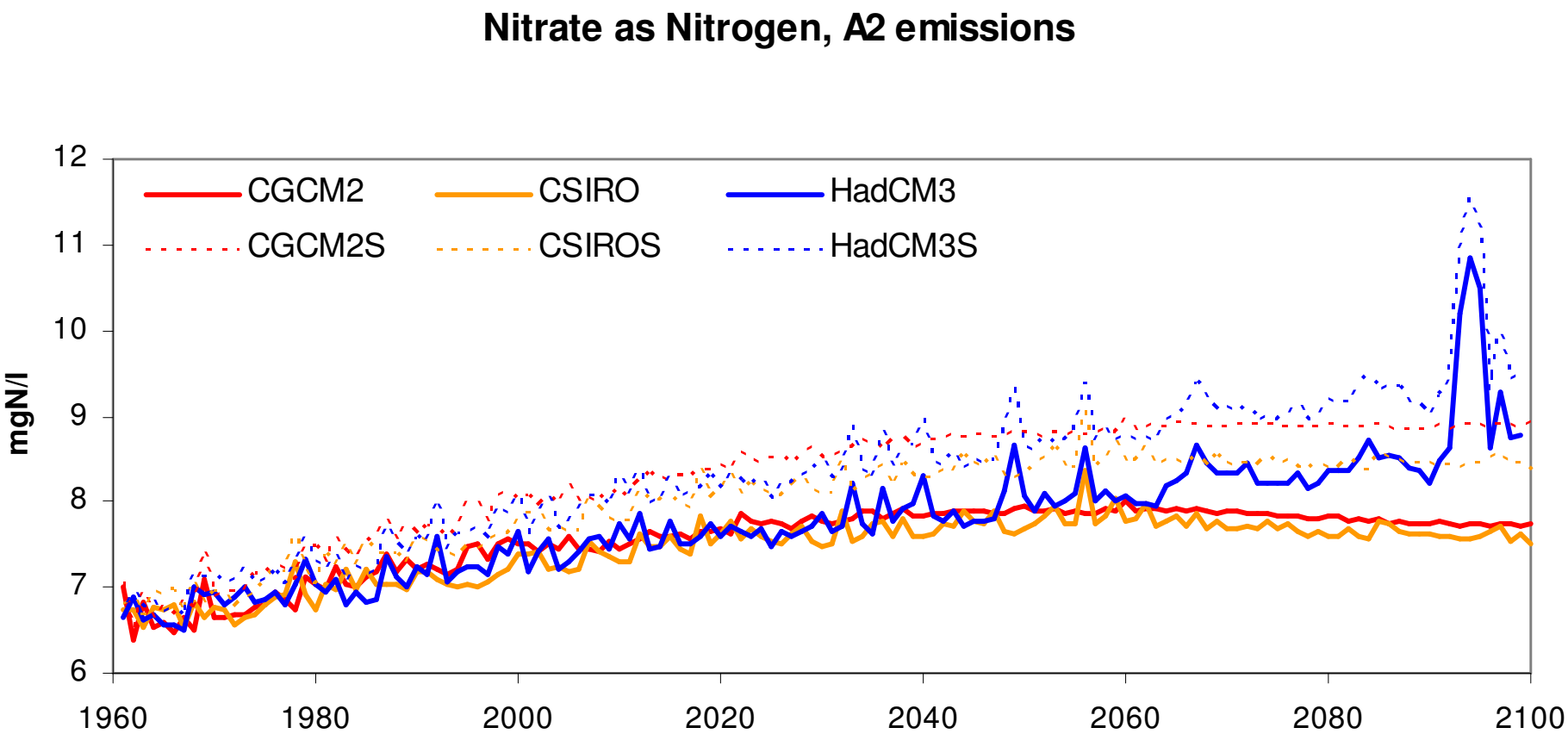
Water quality and ecology

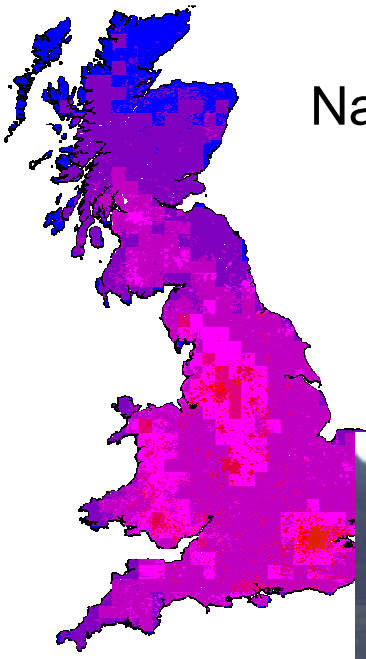


River Kennet, southern England

Salmo trutta

Projected streamwater nitrate concentrations in the River Kennet





National

10-100 km

1 m

point