



# **Regional climate modelling and regional climate information**

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# Overview

Context

(Regional) climate modelling

IPCC assessment of regional changes

Applications of PRECIS projections to motivate  
impacts assessments

Summary



# The context: the need for regional climate information

The global and continental-scale evidence-base is clear: climate is changing with many serious consequences

**Further and larger climate changes are unavoidable and the need to adapt to these is accepted**

More specific information on climate change is required for many policy-makers and decision-makers:

- Clarifying the role of anthropogenic change
- Detailed regional projections and their reliability



# (Regional) climate modelling

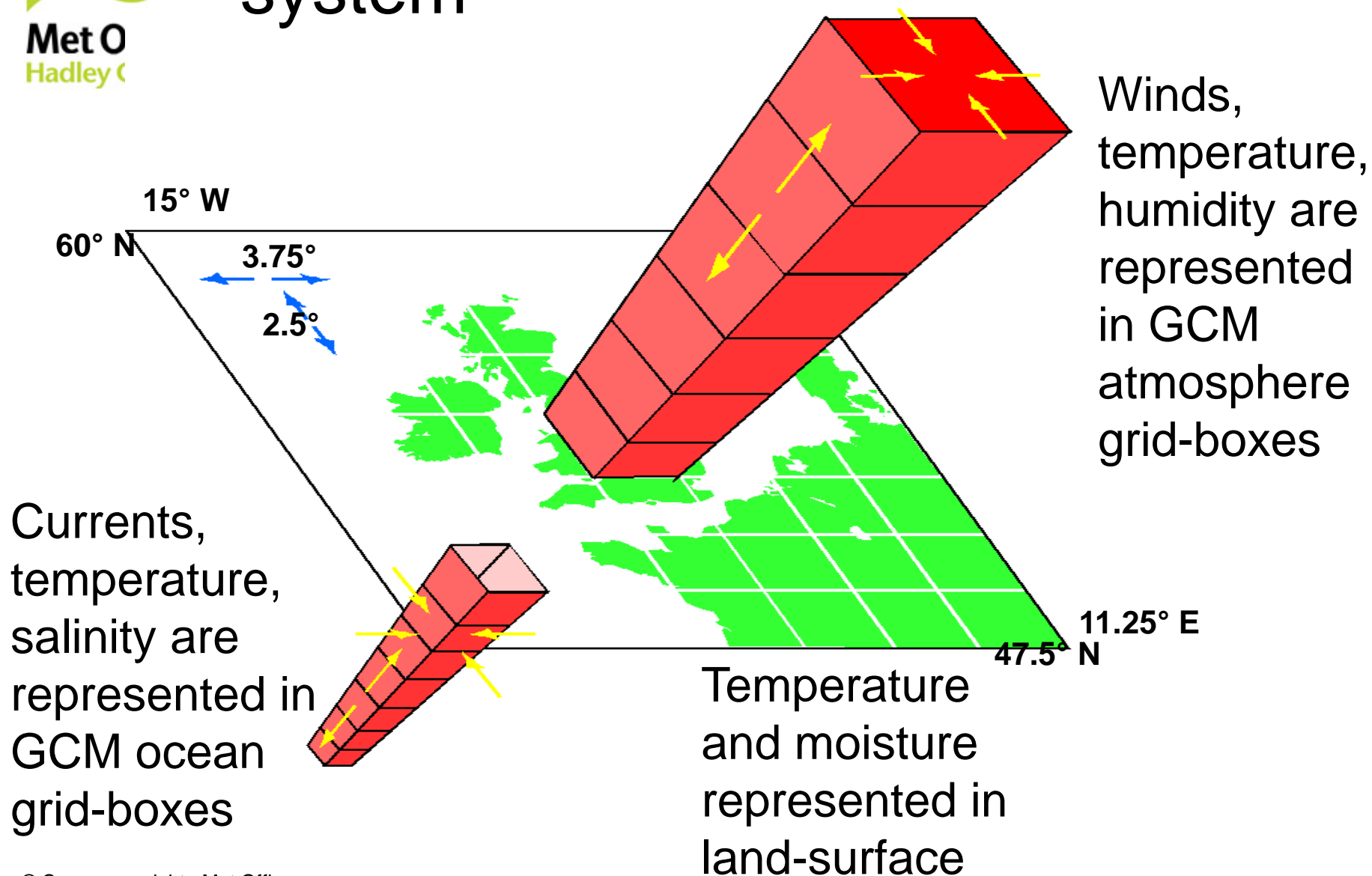
The climate system is complex and globally interconnected – thus to understand and predict climate change requires the application of global climate models (GCMs)

GCMs represent the important physical processes in the climate system

GCMs generate sequences of large-scale weather events  
Statistics of the GCM weather-events define the simulated past, present or future climate

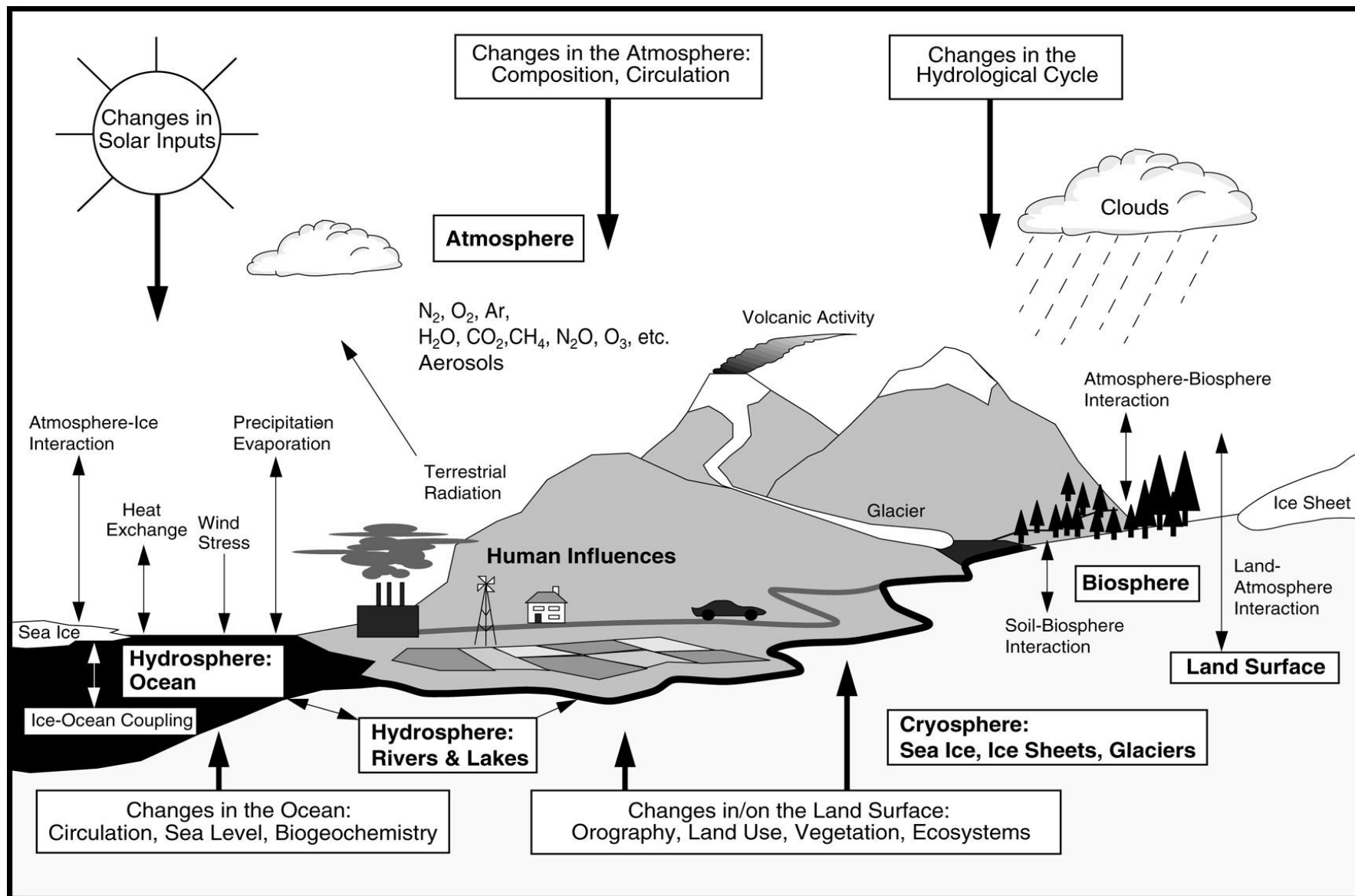
GCMs operate at resolutions of 150-300km and so cannot provide detailed climate information

# GCM representation of the climate system

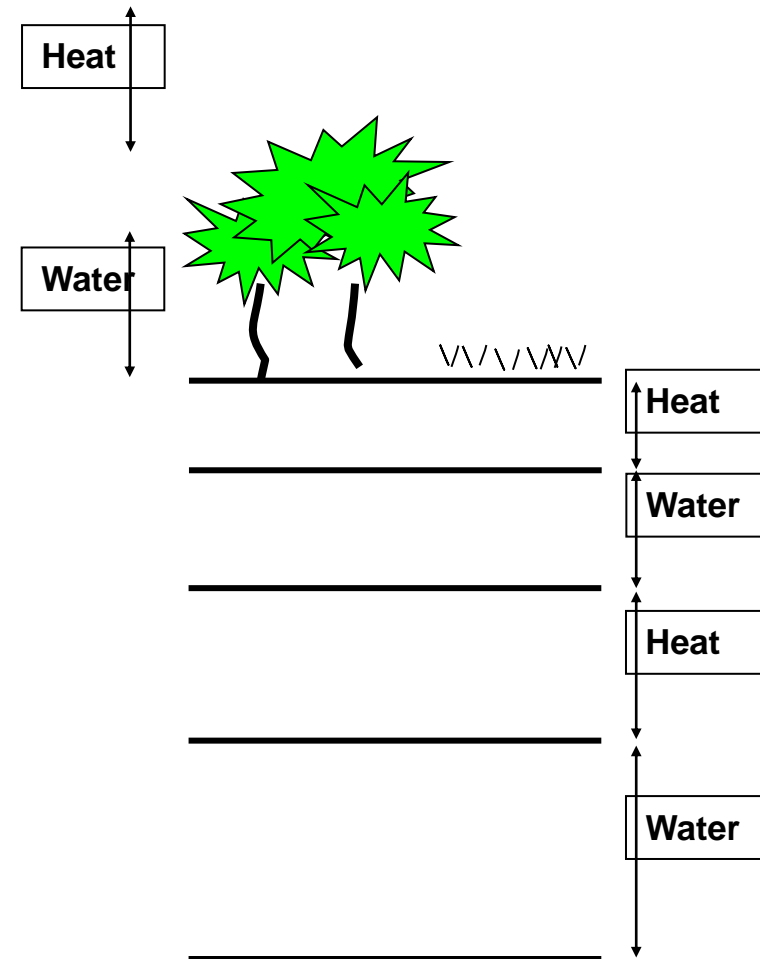
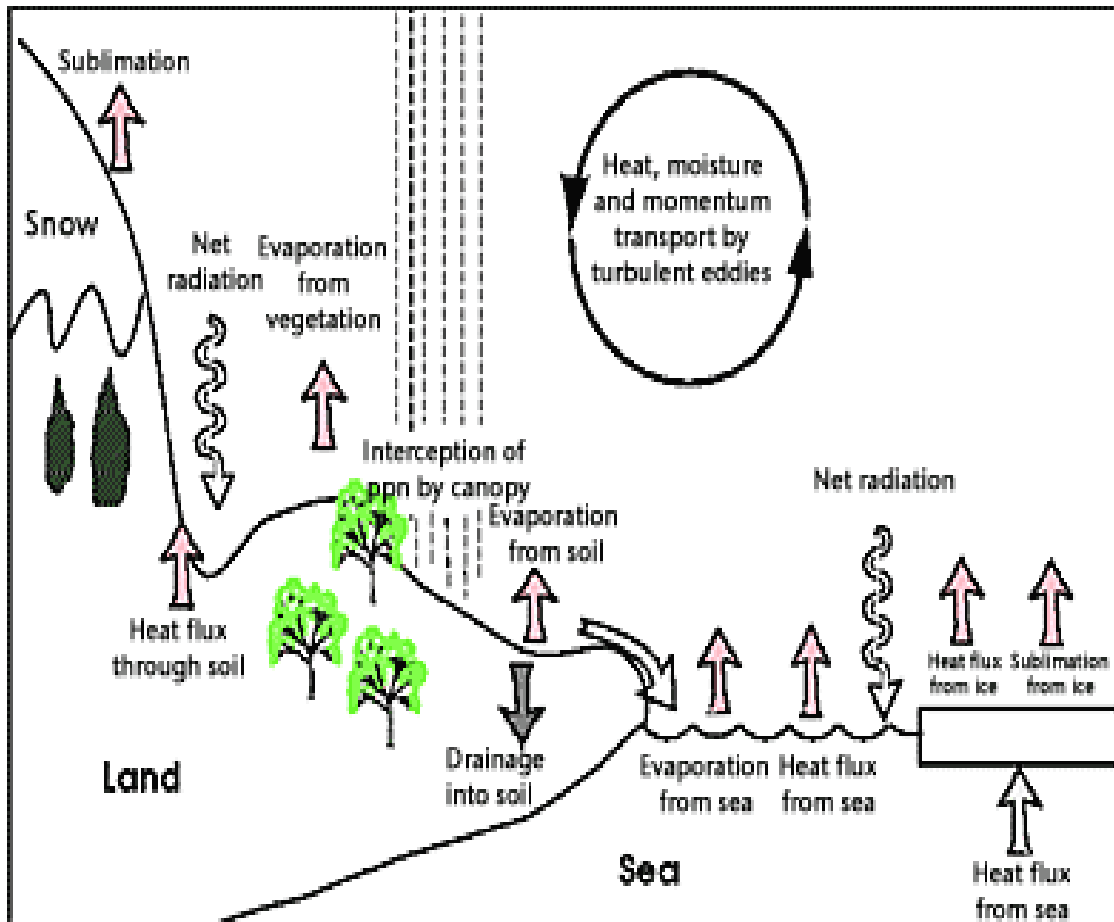




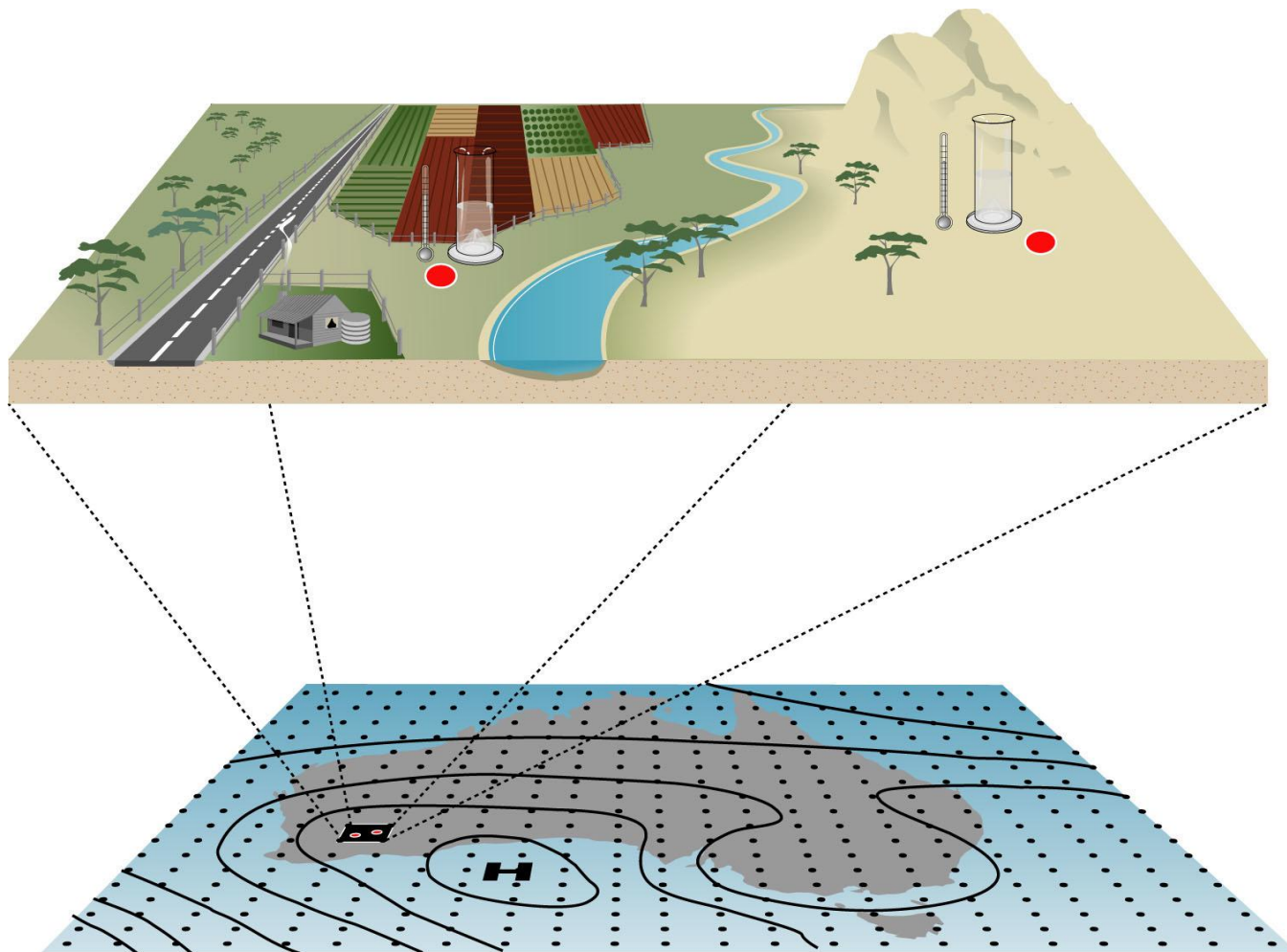
# GCM physical processes



# Boundary layer and land-surface processes



# Adding regional detail

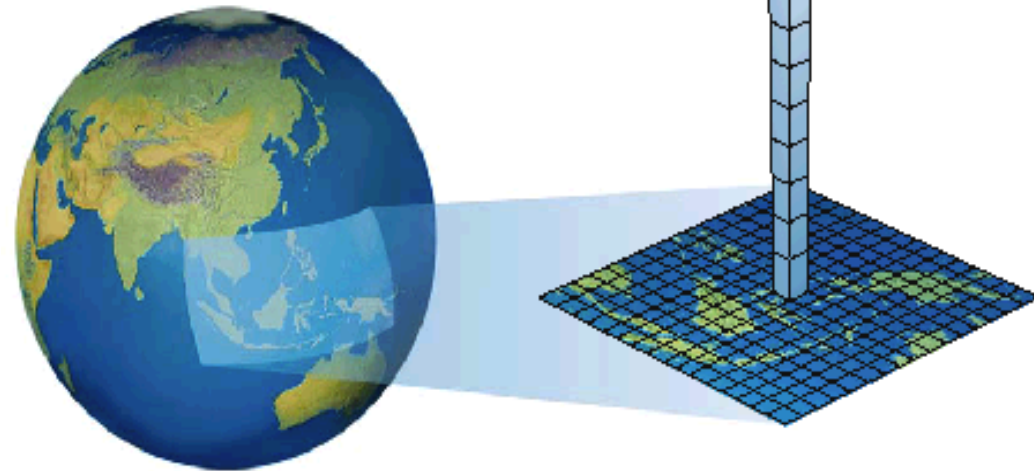
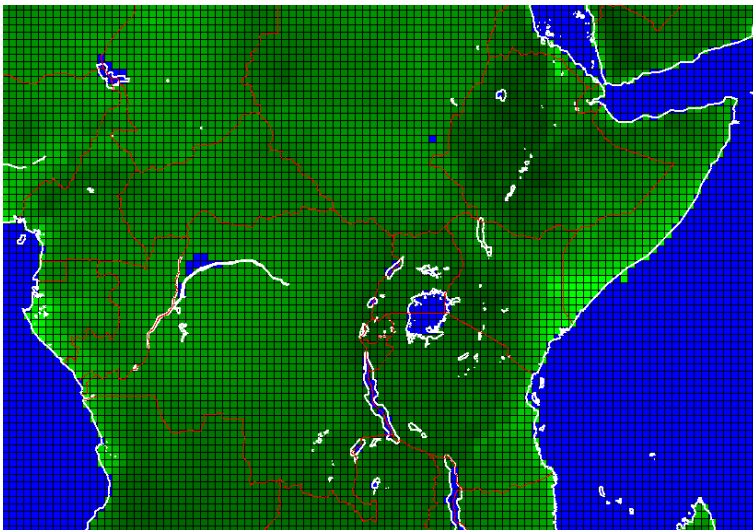


... from a global climate model (GCM) grid  
to particular locations of interest.



# Regional climate models: deriving detailed climates

Regional climate models represent the climate system at high resolution (25-50km) over a limited area

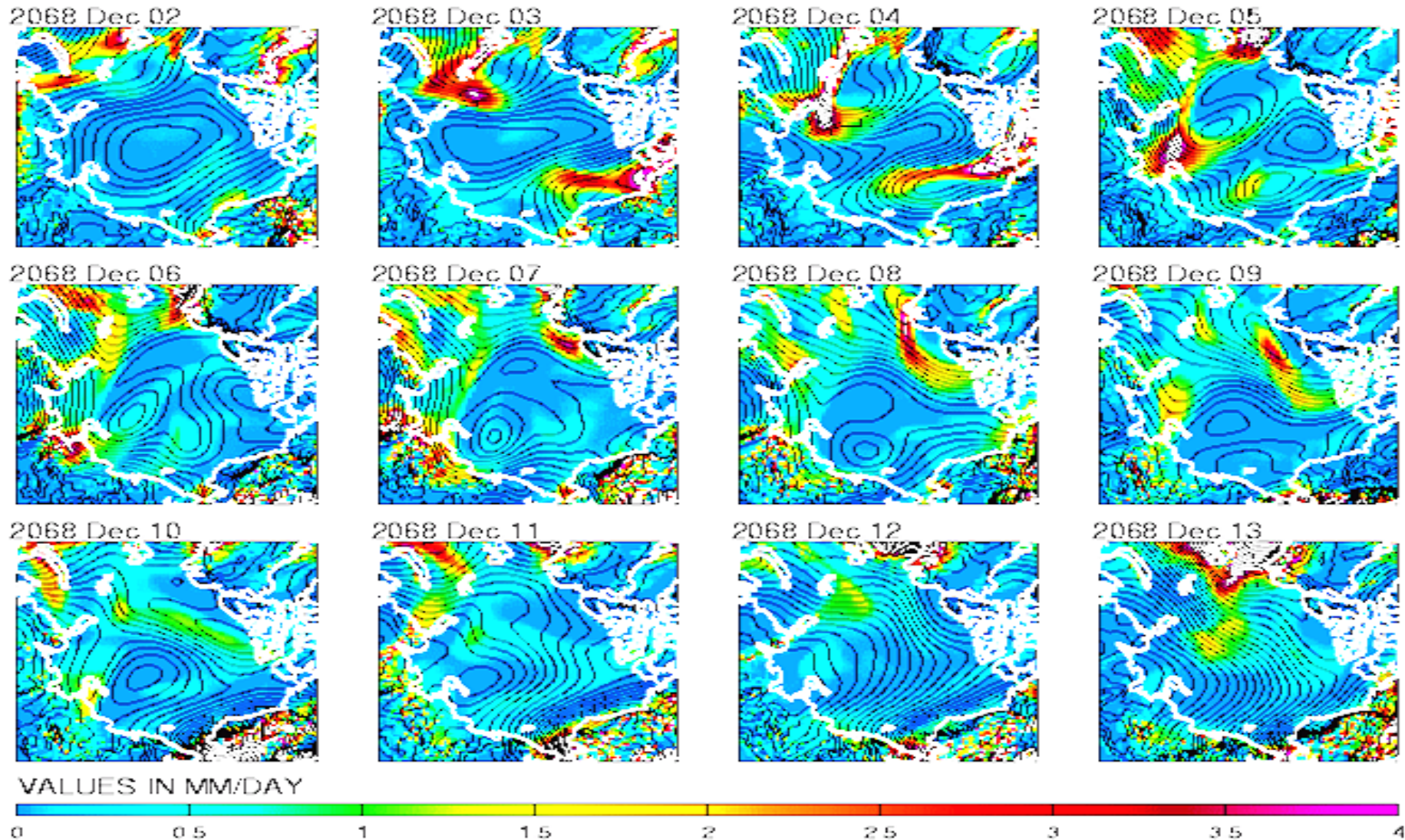


To obtain the global influence on regional climate RCMs use boundary conditions from GCMs or observations



# Daily weather events from an RCM embedded in a GCM

Daily precipitation and surface pressure over the Arctic



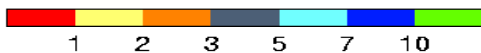


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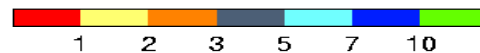
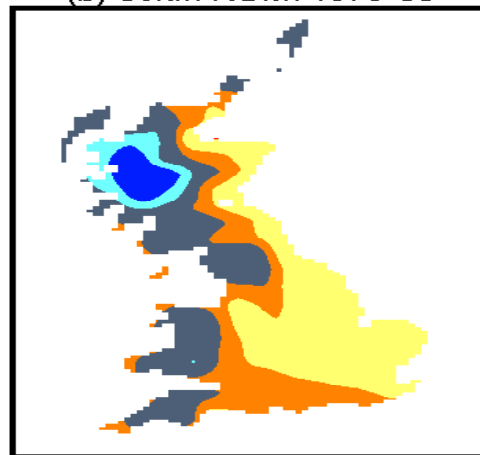
**300km  
Global  
Model**

# Adding regional detail: Winter precipitation over Britain

(a) 300km GCM: 1979-83

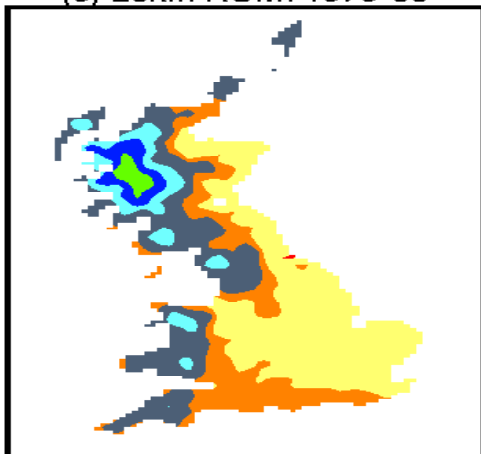


(b) 50km RCM: 1979-83



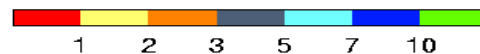
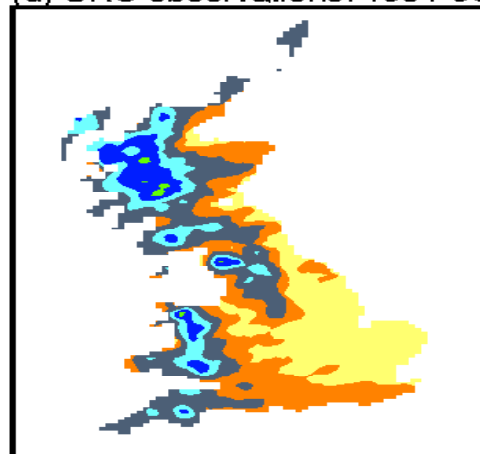
**50km  
Regional  
Model**

(c) 25km RCM: 1979-83



**25km  
Regional  
Model**

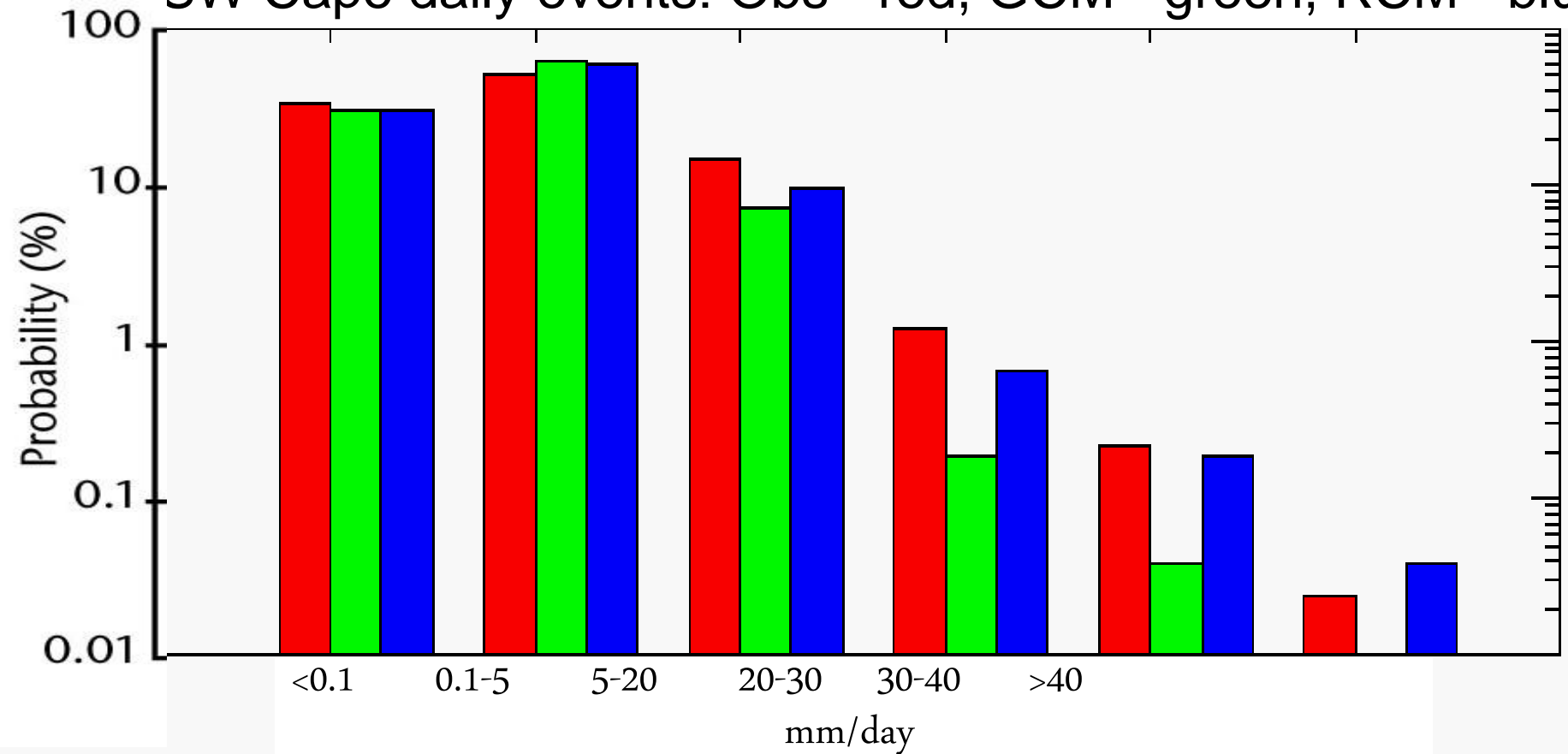
(d) CRU observations: 1961-90



**Observed  
10km**

# Adding regional detail: Realistic daily precipitation over South Africa

SW Cape daily events: Obs - red, GCM - green, RCM - blue





# IPCC AR4 assessment of regional changes and results for Africa

Robust statements about regional climate change were made after examining multiple lines of evidence including:

- Observed changes in the region;
- Global model projections over the region;
- Available information from downscaling;
- Understanding of the physical processes driving the changes;
- This gave a broad overview of likely sub-continental changes in seasonal temperature and, in some regions, (BUT NOT W, AFRICA) precipitation





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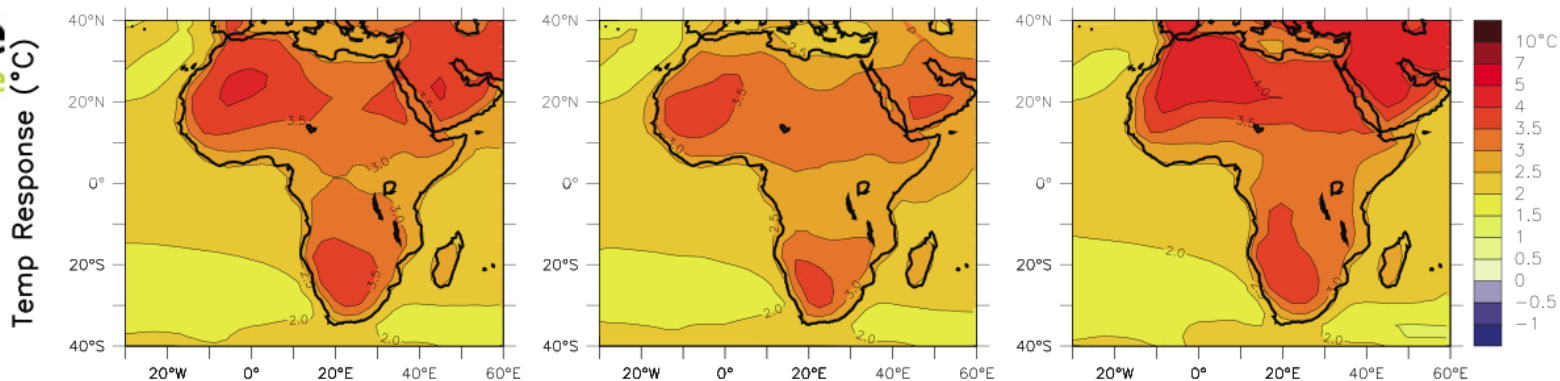
$\Delta T$

# IPCC multi-model summary of temperature and rainfall changes

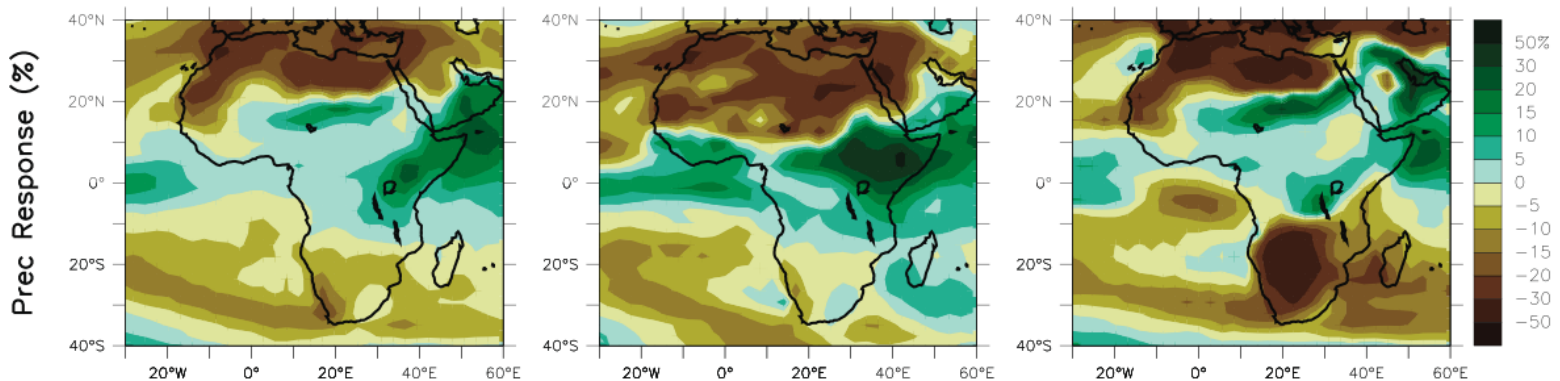
Annual

DJF

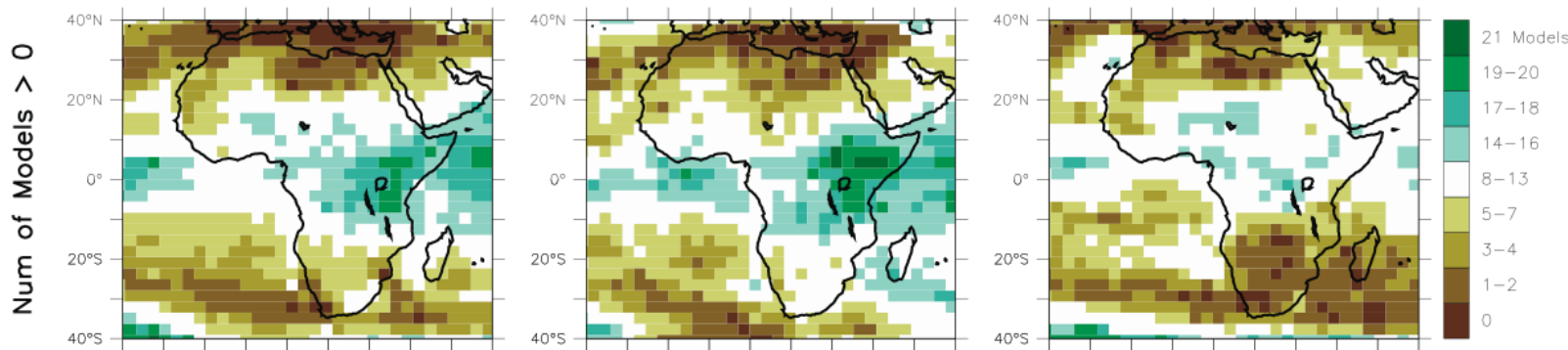
JJA



$\Delta P$



$|\Delta P|$   
agree-  
ment



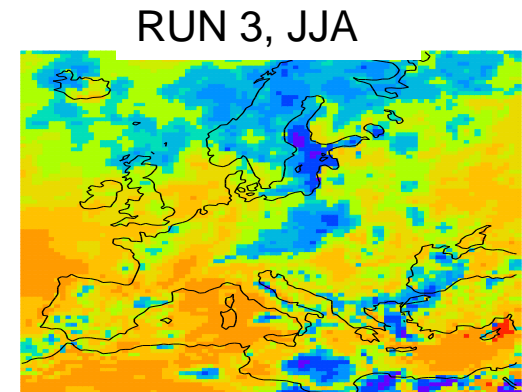
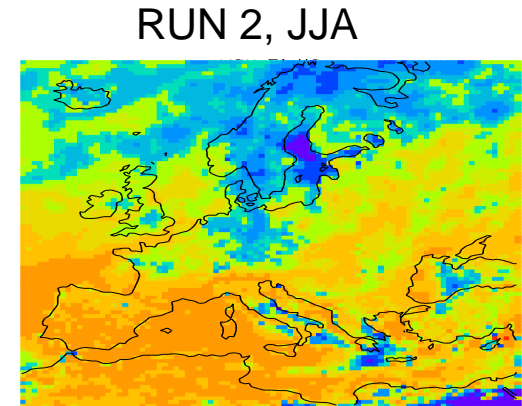
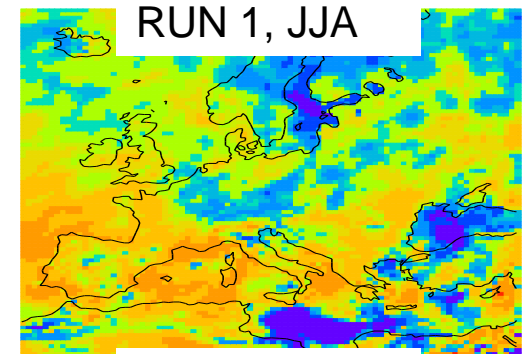
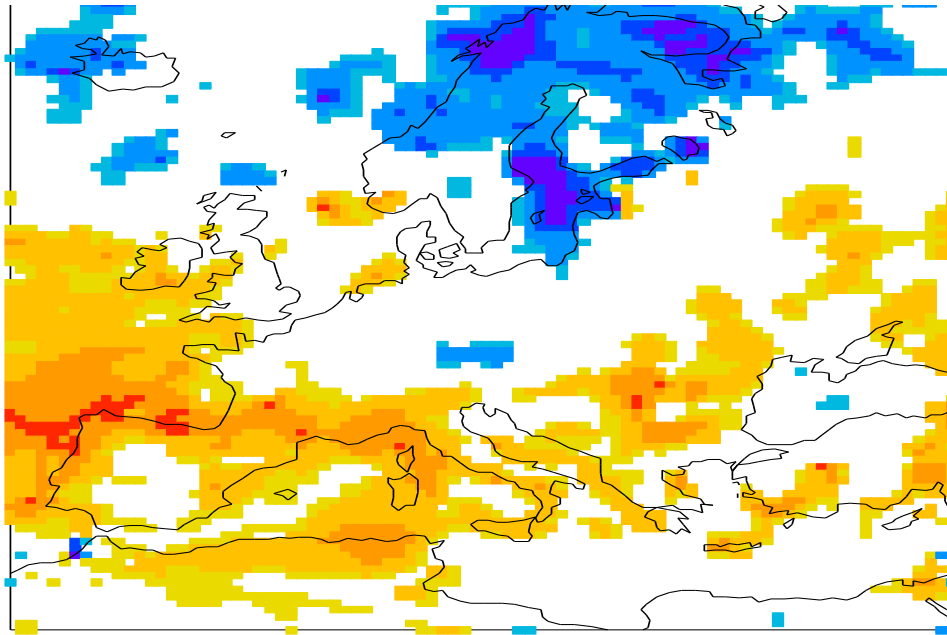


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# A cautionary tale: projected heavy heavy precipitation in summer

One model run three times to simulate the same climate change gives:

- consistent message over large scales
- different local details
- map below shows areas where there is no clear signal



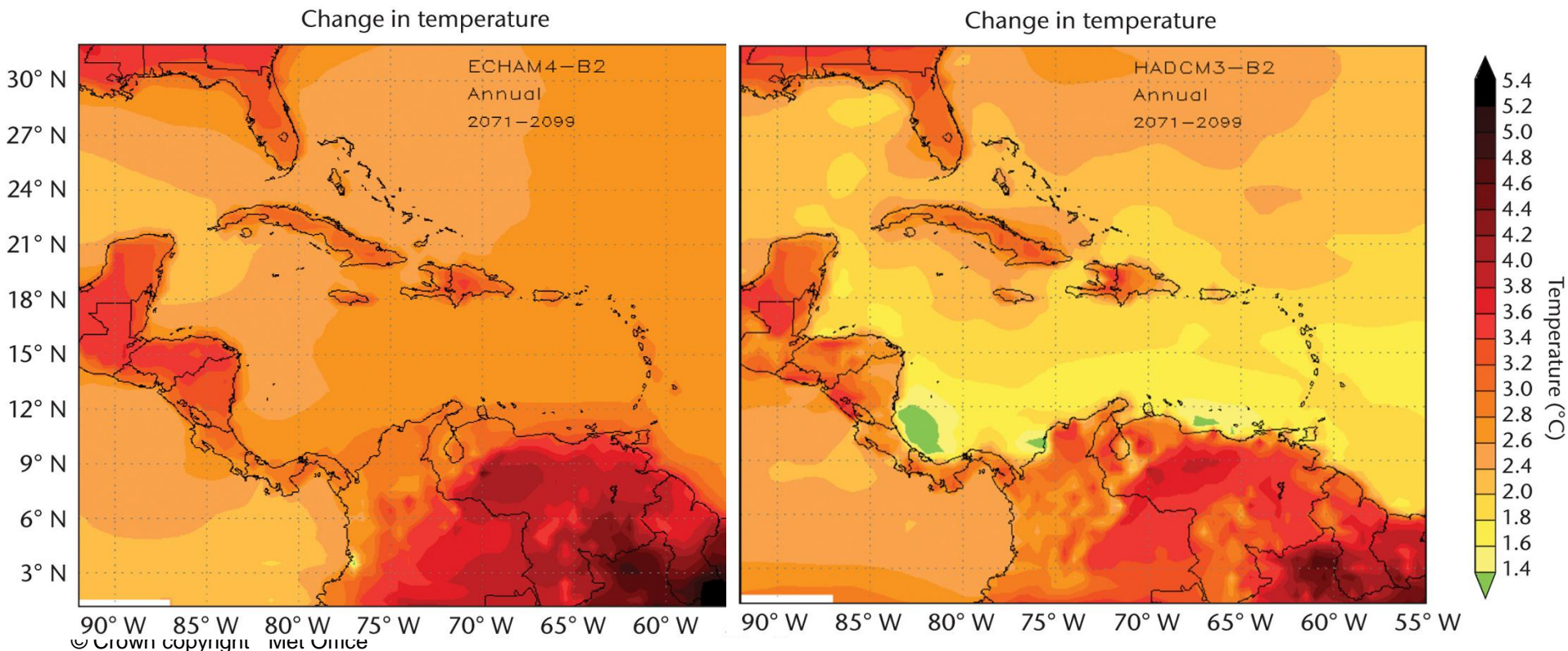


# Application of PRECIS to motivate impacts assessments



# Large temperature changes expected over land areas

- High resolution modelling delivers consistent message on large warming over land even with different sea temperature changes
- Temperature changes  $>3\text{K}$  by 2080s under the B2 scenario



# Impact on Caribbean crops of a 2°C temperature rise

Crop	Temperature Change (°C)	% Change in Precipitation	Yield (kg/ha)	Change in Yield
<b>Rice</b>	<b>0</b>	<b>0</b>	<b>3356</b>	
	<b>+2</b>	<b>+20</b>	<b>3014</b>	<b>-10%</b>
	<b>+2</b>	<b>-20</b>	<b>2888</b>	<b>-14%</b>
<b>Beans</b>	<b>0</b>	<b>0</b>	<b>1354</b>	
	<b>+2</b>	<b>+20</b>	<b>1164</b>	<b>-14%</b>
	<b>+2</b>	<b>-20</b>	<b>1093</b>	<b>-19%</b>
<b>Maize</b>	<b>0</b>	<b>0</b>	<b>4511</b>	
	<b>+2</b>	<b>+20</b>	<b>3737</b>	<b>-22%</b>
	<b>+2</b>	<b>-20</b>	<b>3759</b>	<b>-17%</b>



# Summary

Clear messages are emerging on how temperature and sea-levels will change over W Africa

For future W African precipitation currently need to include observations of past variations and future projections

To provide detailed scenarios of future climate including information on extremes use RCM projections of future climate change and past observations combined, where necessary, with RCM simulations of the last 50 years



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# Thanks for your attention

# Questions?