Met Office
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Downscaling ability of the HadRM3P model over North America

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Acknowledgments

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Contents

- The issue of climate downscaling
- Description of HadRM3P model
- Results from the HadCM3-driven climate change simulation
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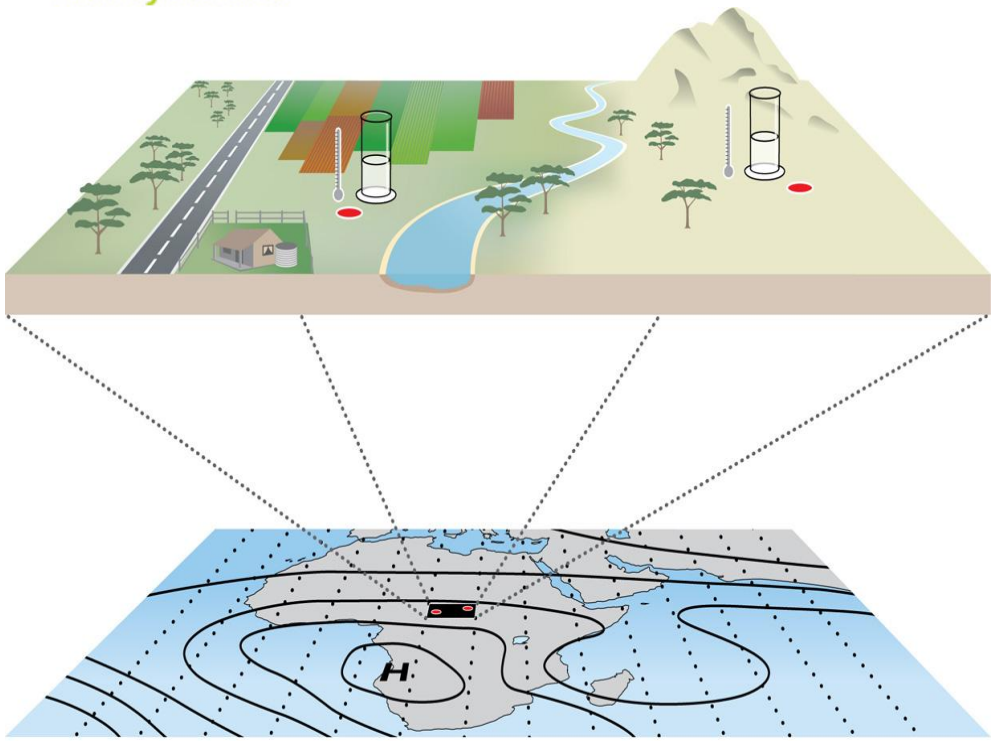
What is climate downscaling?

- Set of techniques that allows fine scale information to be derived from GCM output.
- Smaller scale climate results from an interaction between global climate and local physiographic details
- The climate impacts community needs high-resolution climate change scenario to assess vulnerability and possible adaptation strategies
- AOGCM projections lack that regional scale detail due to coarse spatial resolution



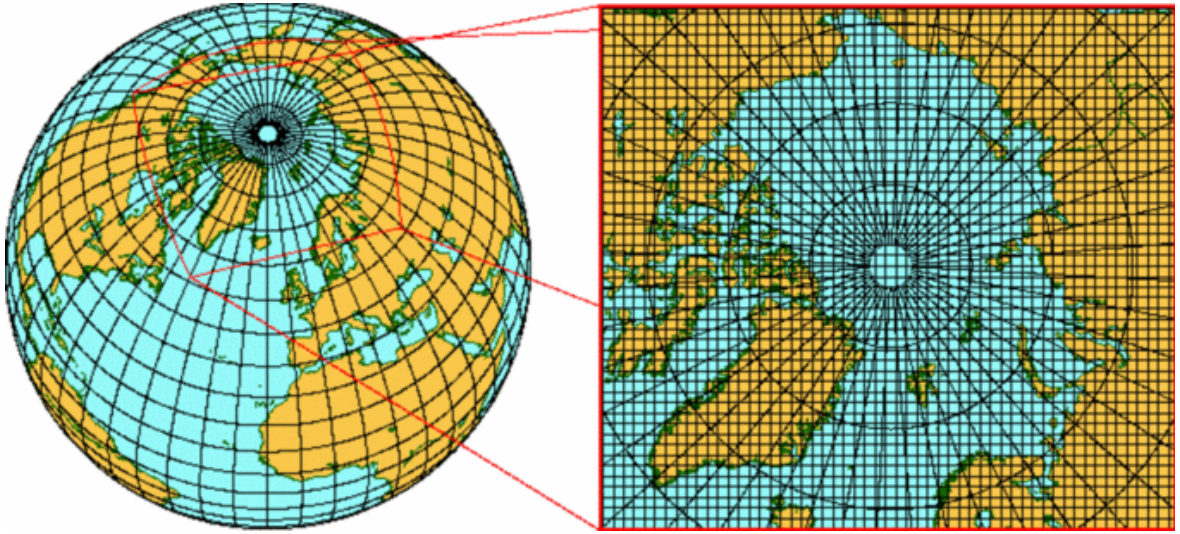
Local / Regional: the scale at which much of climate change related information is most needed

Continental: the scale of much of the reliable information coming from Global Climate Models (GCMs)

RCMs can bridge the gap between regional and global climate

Regional Climate Model (RCM)

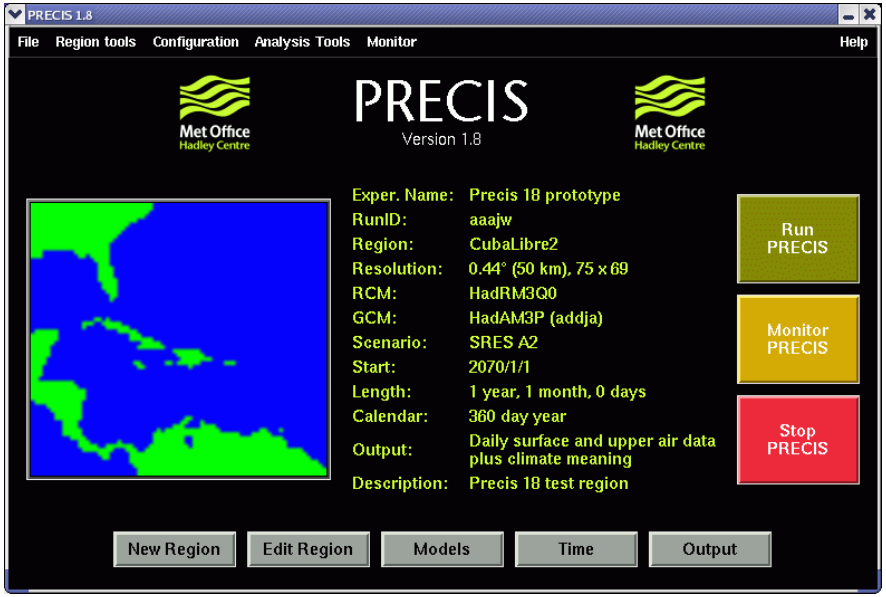
- Covers a limited area of the Earth's surface instead of the entire Earth
- Like GCMs, RCMs contains representations of the atmosphere, land and surface, and generate weather (and therefore climate)

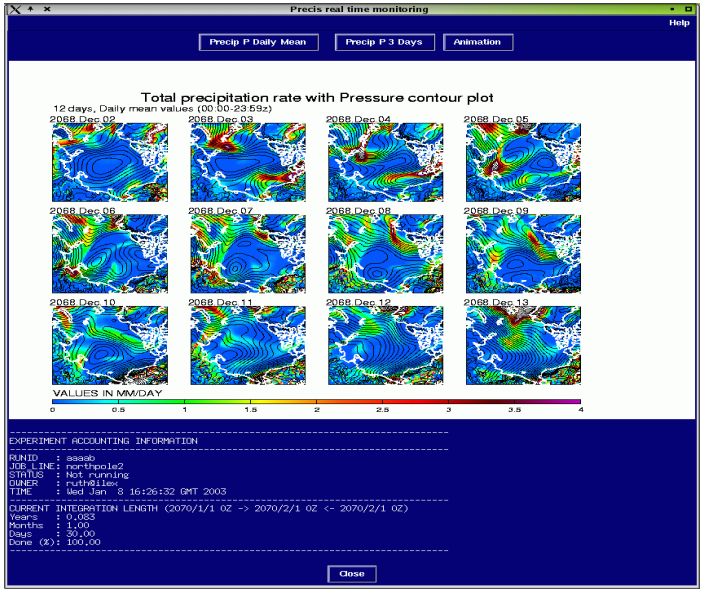


HadRM3P regional climate model

The HadRM3P model

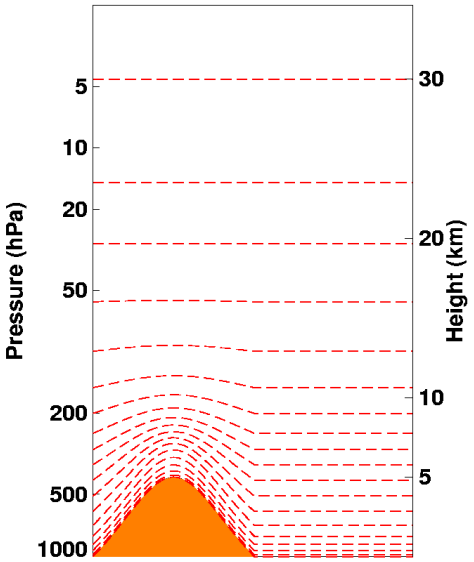
- It is the RCM used in the Providing REgional Climates for Impacts Studies (PRECIS) modelling system
- Can be run over any area of the globe

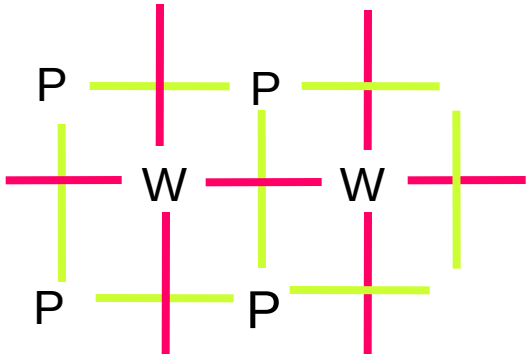




The model grid

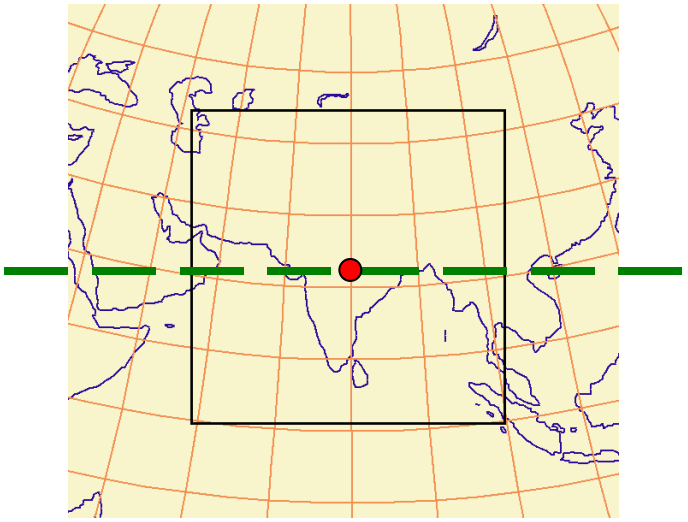
- Hybrid vertical coordinate
  - Combination of terrain following and atmospherics pressure
  - 19 vertical levels (lowest at 50m, highest at 5Pa)
- Regular lat-lon grid in the horizontal
  - ‘Arakawa B’ grid layout
    - P = pressure, temperature and moisture related variables
    - W = wind related variables



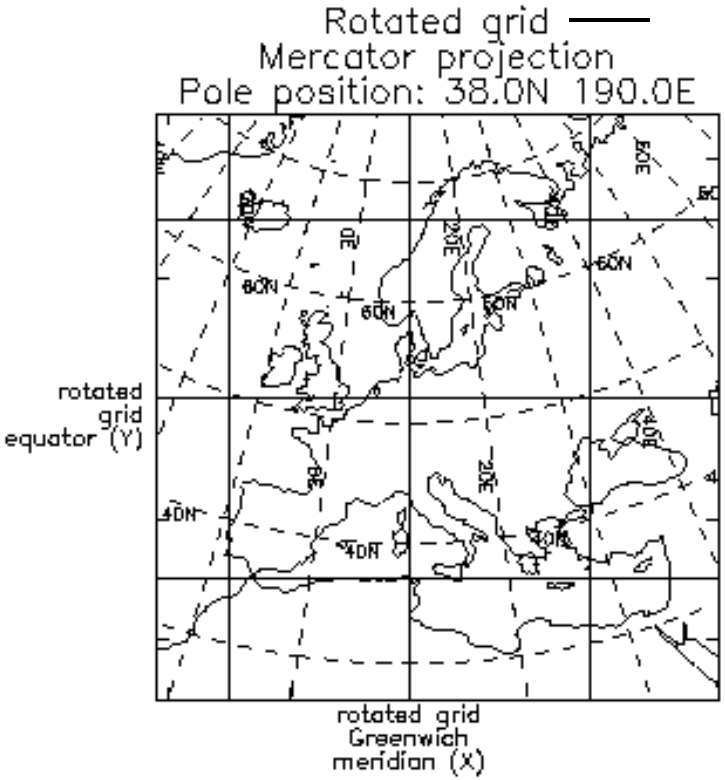


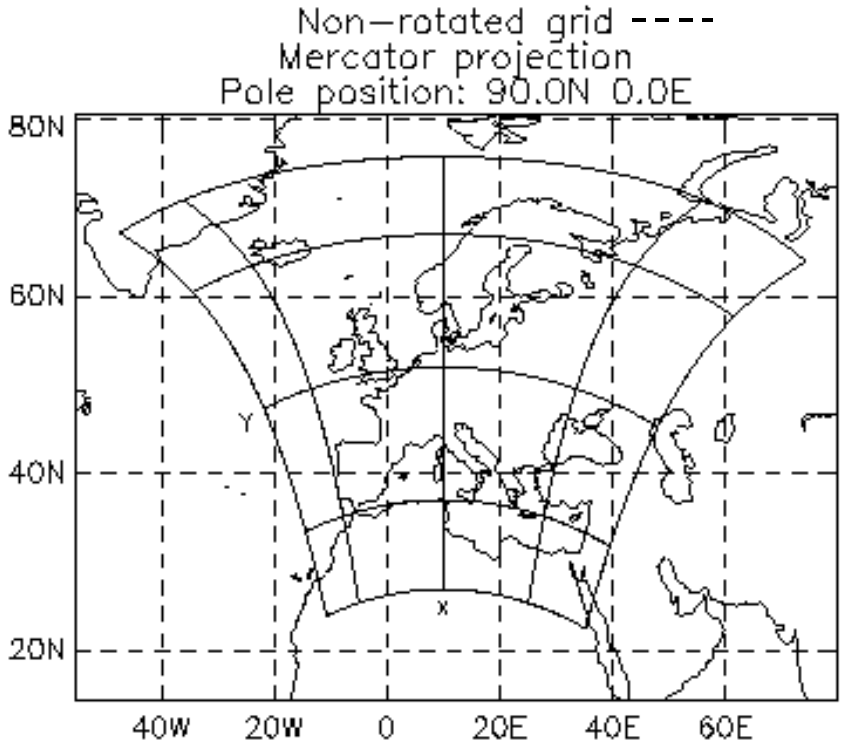
The coordinates system

- The coordinate pole of HadRM3P grid is usually rotated
  - The RCM's north pole is not in the usual position
- This ensures numerical stability without the need for non-physical filtering
  - Avoids high latitudes where filtering is necessary
- RCM grid boxes are quasi-regular in area
  - All grid boxes are near the equator



Rotated pole example



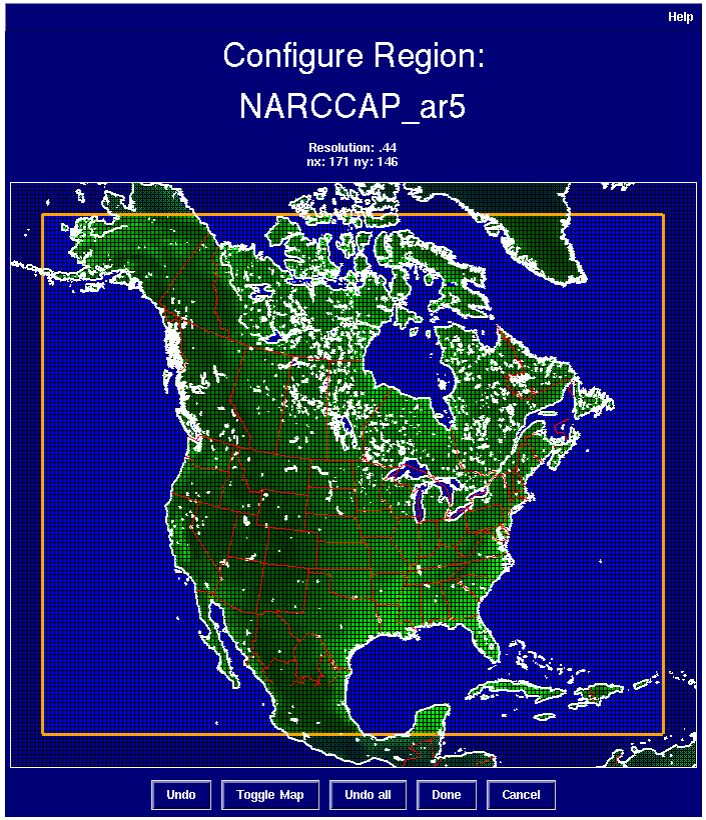


Full RCM domain on its own rotated lat-lon grid

Full RCM domain projected onto the regular lat-lon grid

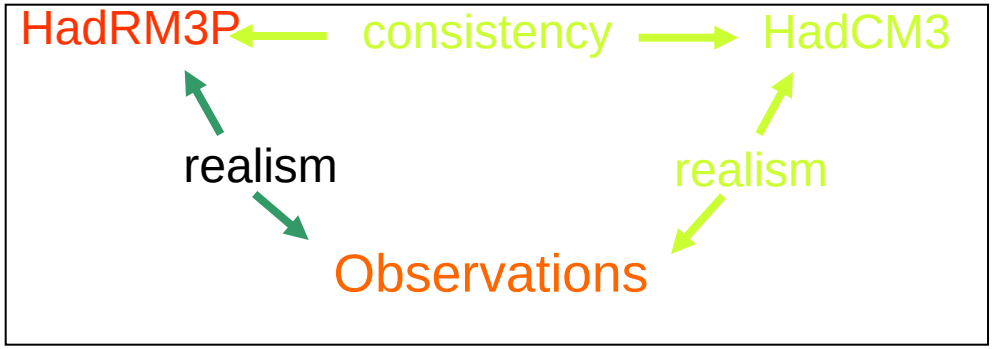
Preliminary results from the HadCM3 driven experiments

Experimental Set-up



- The 50km resolution HadRM3P was nested within the HadCM3 GCM, and run in two time-slices: 1968-2000 and 2038-2070 under SRES A2 emission scenario
- The model timestep was 5 minutes
- Domain size is 171x146, and interior domain corresponds to the NARCCAP region
- The outer 8 grid boxes were discarded along with the first two years of the model output data, establishing a 31 year common period

How to assess the RCM performance in simulating the current climate?



- Compare like with like
  - RCM only has skill at spatial scales resolved by its grid (fine)
  - Aggregate or interpolate RCM or observed data
- Can not compare individual RCM years with correspond observed years (same reason as with GCM)
- Errors are a combination of three errors:
  - 1) Physical errors in the GCM affecting the LBCs
  - 2) RCM/GCM consistency errors
  - 3) Physical errors in the RCM

Large-scale consistency between HadRM3P and HadCM3?

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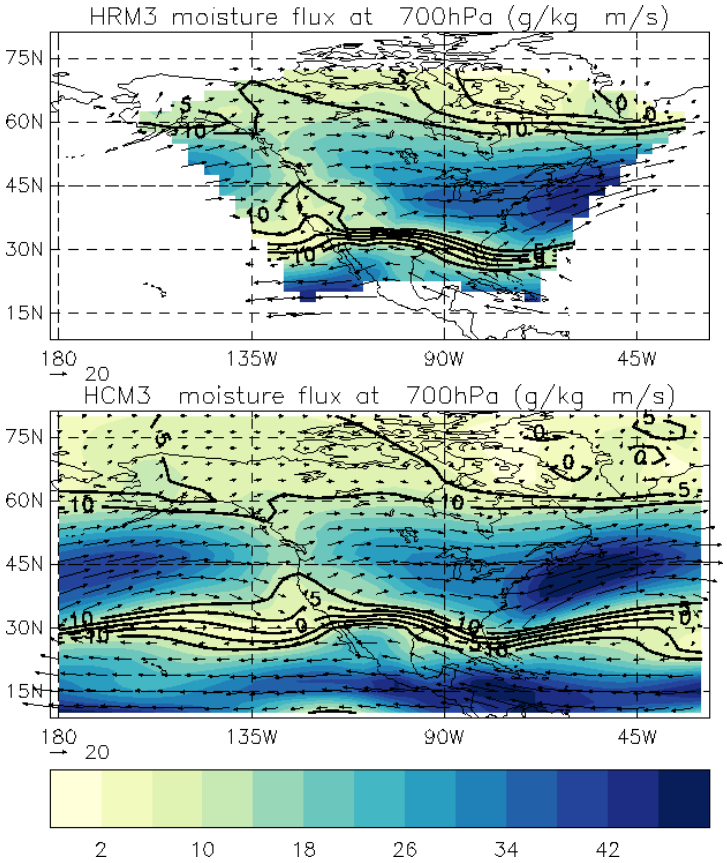
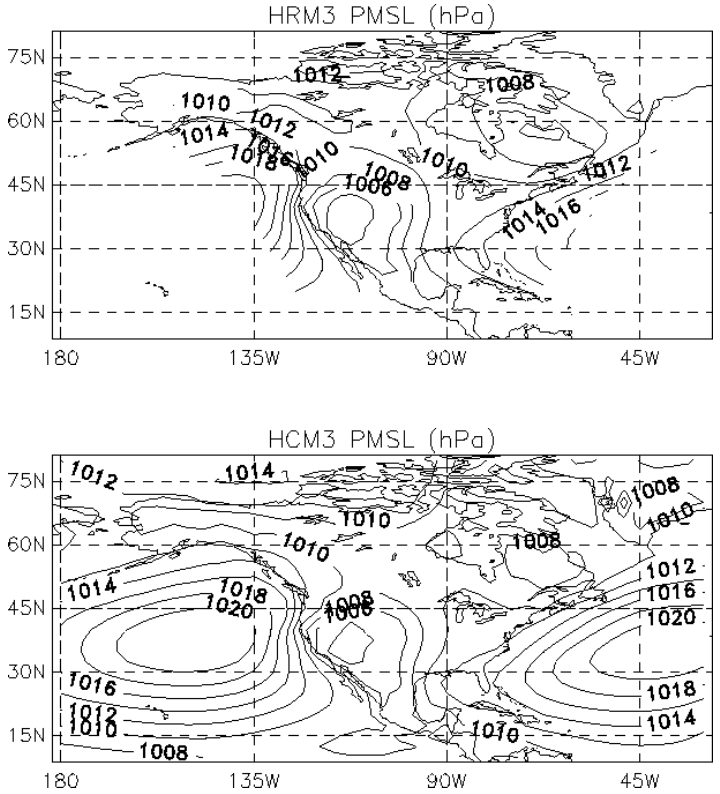
700 hPa advection of humidity



HadRM3P

HadCM3

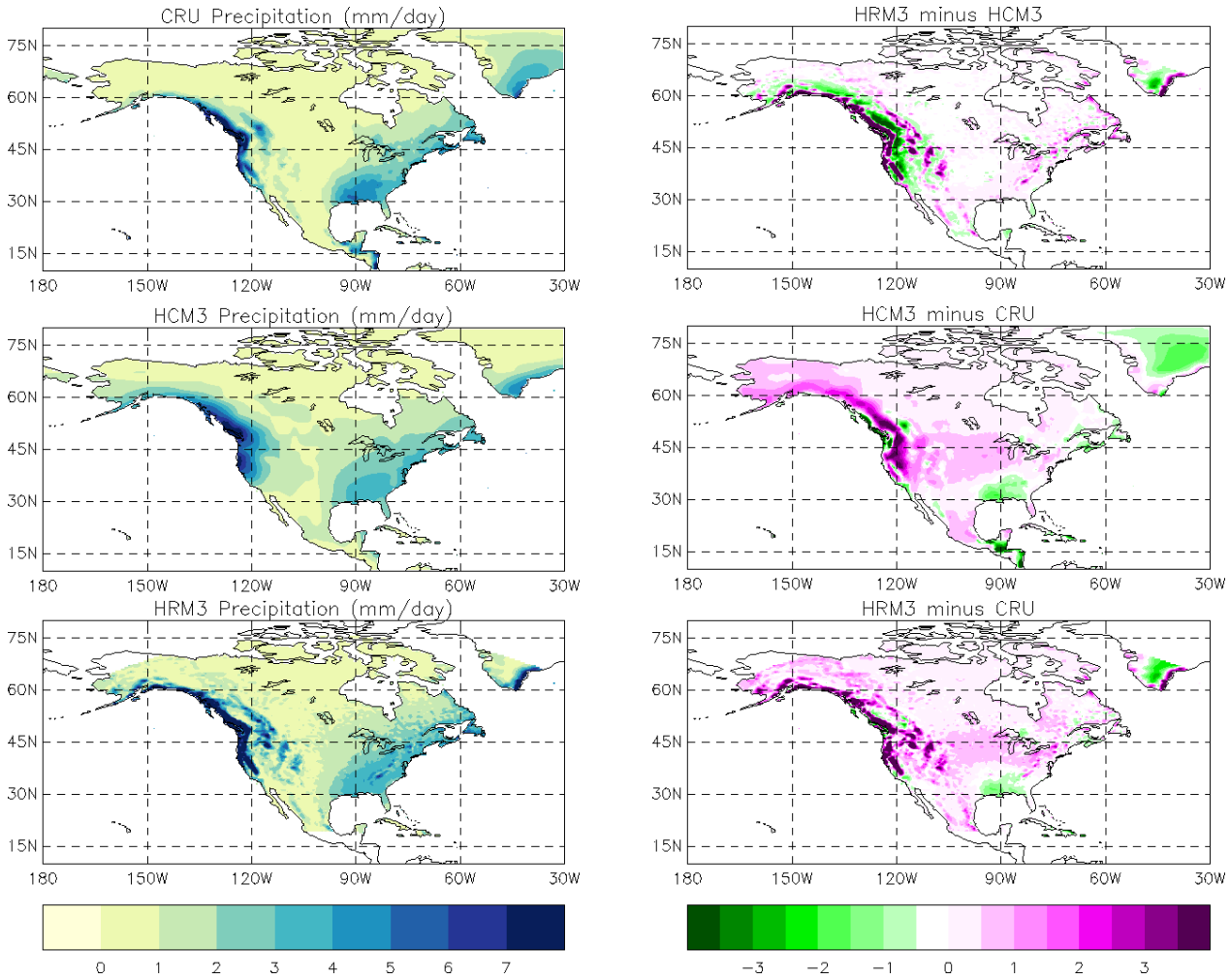
Mean sea level pressure



These results are computed for mean JJA 1971-2000, and on the GCM grid

The realism of HadRM3P and HadCM3

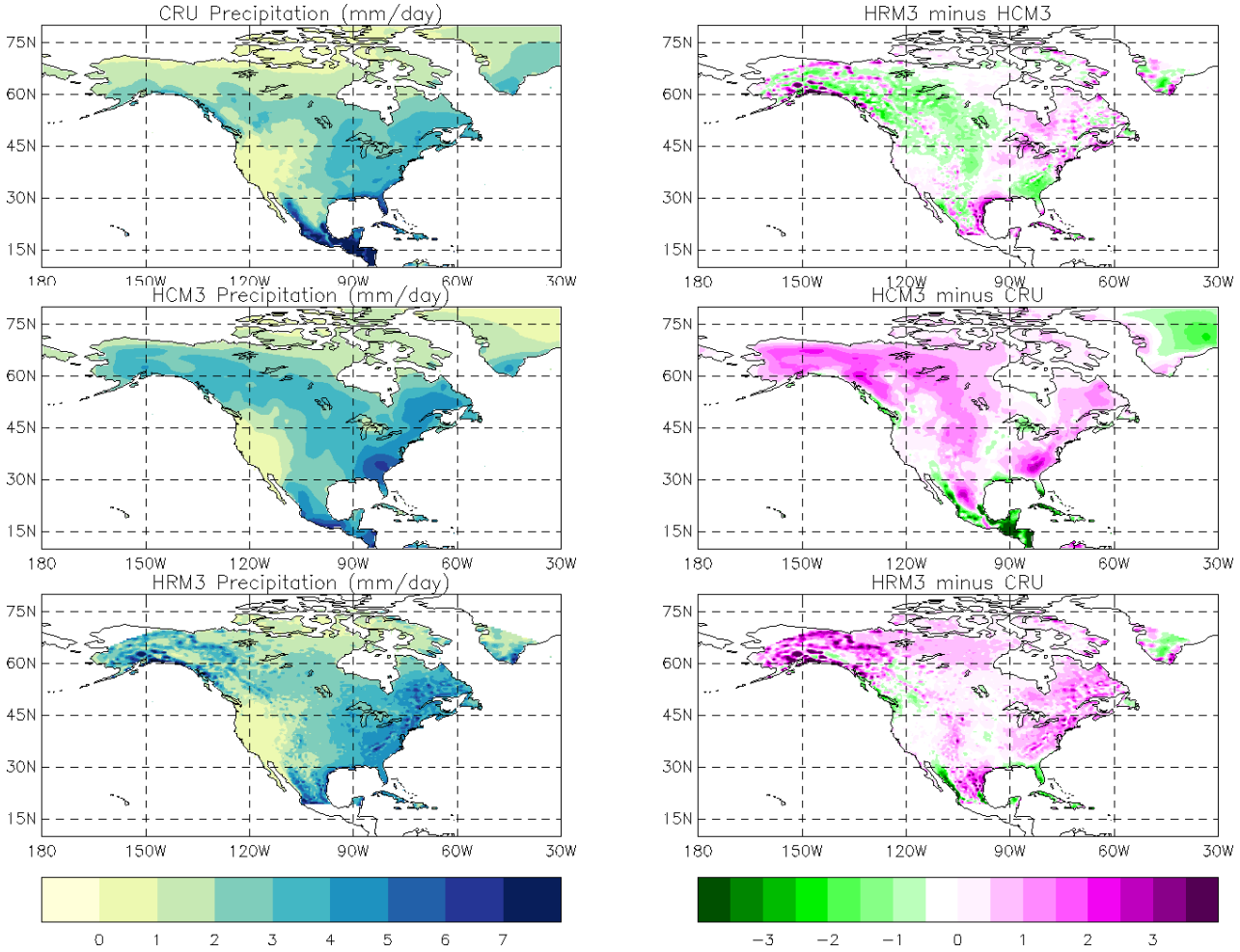
- Models realistically capture the mean winter precipitation
- Similarities between HadRM3P and HadCM3 biases
- Important differences occurs in areas of complex orography



Mean DJF 1971-2000 precipitation and anomalies

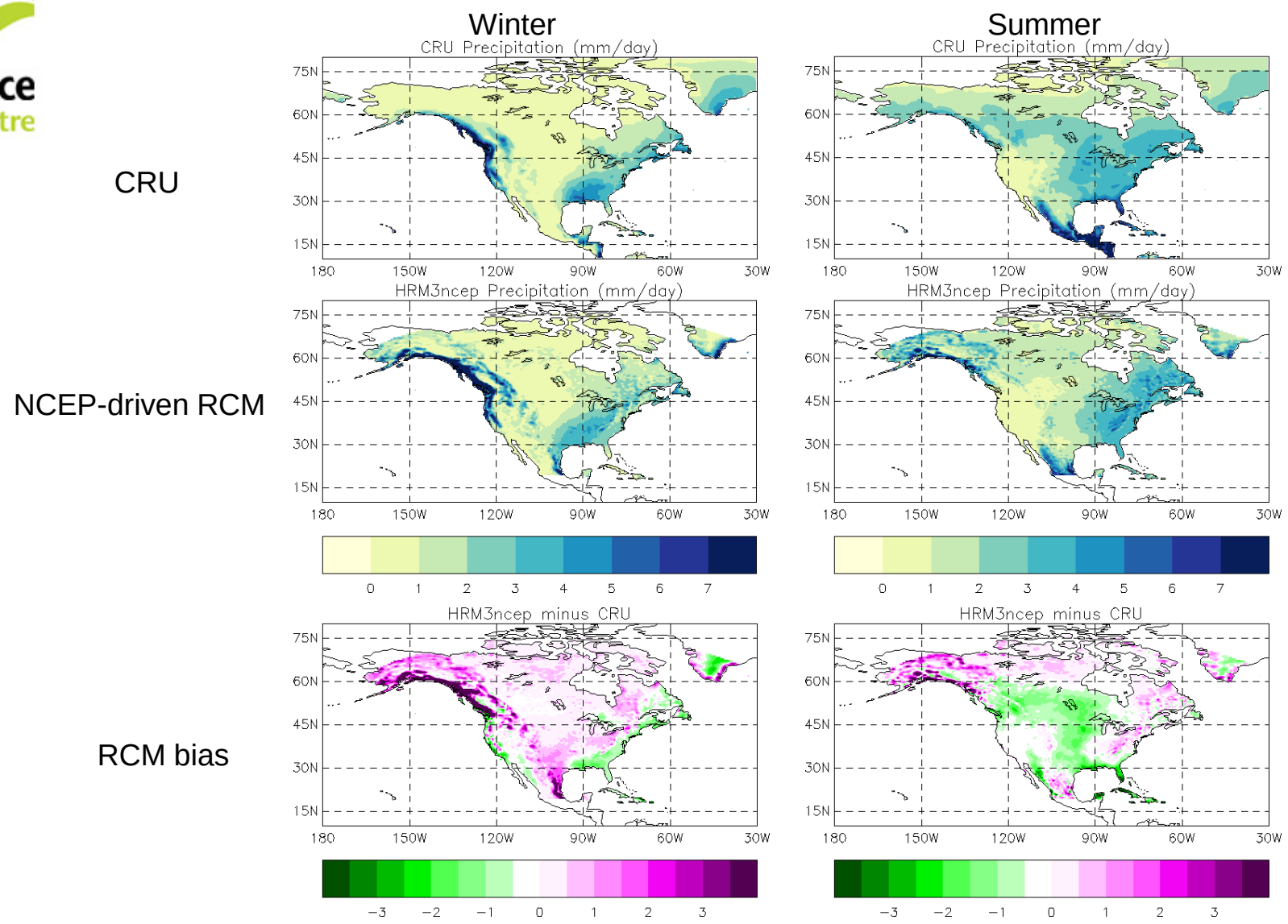
Summer mean precipitation is also well captured by the two models

- HadRM3P biases are largely reduced over domain,



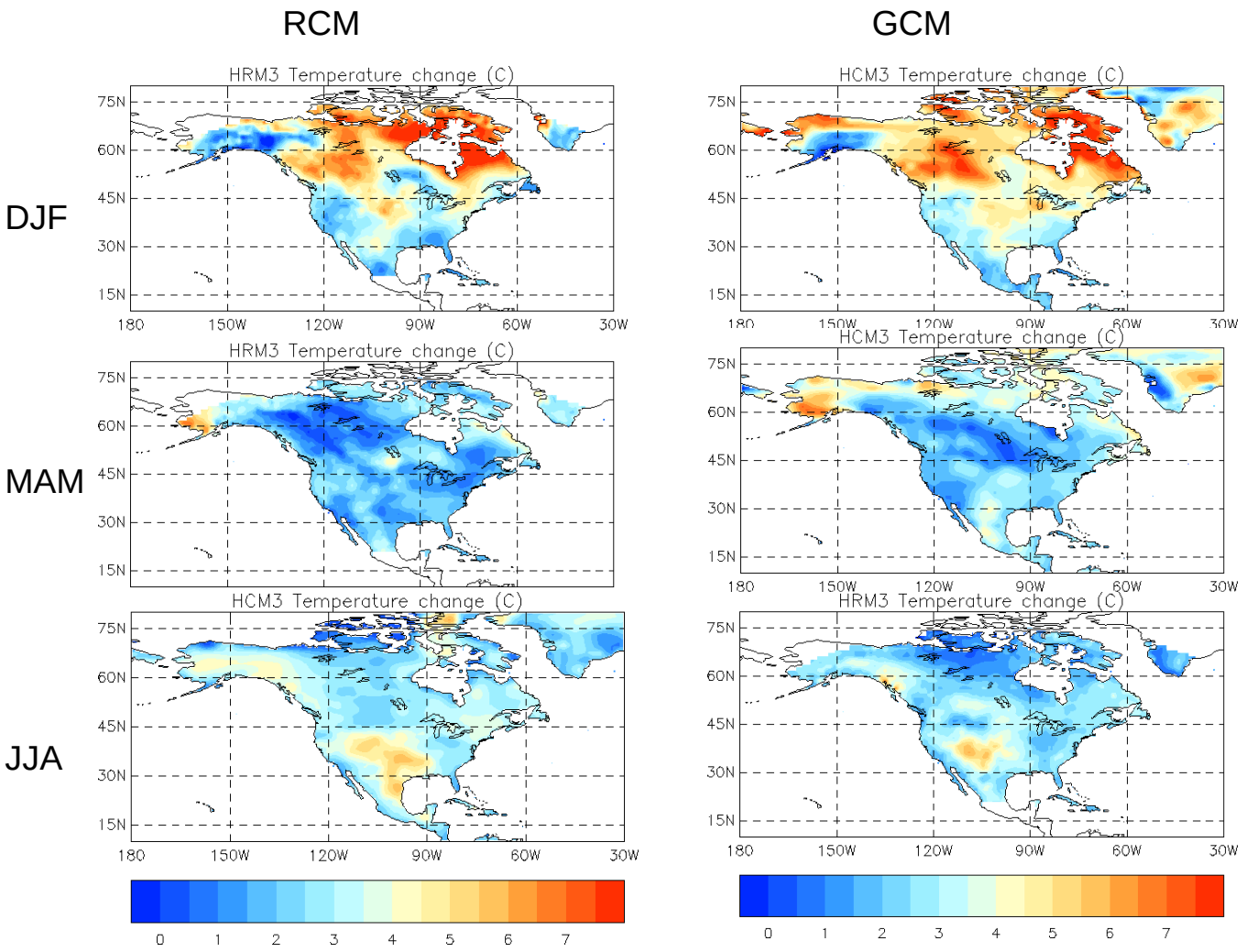
Mean JJA 1971-2000 precipitation and anomalies

Model response when HadRM3P is nested within the NCEPR2-reanalyses



1981-2000 Mean seasonal precipitation and biases

There is a consistency in the anticipated temperature change signal of HadRM3PvsHadCM3



Projected seasonal changes in temperature, between 1971-2000 and 2041-2070

Concluding remarks

- The HadRM3P model is first used successfully to downscale a climate scenario from HadCM3 over North America
- Overall, the regional climate showed a good agreement with the large-scale driving fields and add some value to the GCM
- HadRM3P simulates realistically the mean surface features of the twentieth century climate
- More work is needed to assess the reliability of the anticipated regional climate projection