Downscaling ability of the HadRM3P model over North America

Wilfran Moufouma-Okia and Richard Jones
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Contents

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• Description of HadRM3P model
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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?

700 hPa advection of humidity

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 occur 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,
Model response when HadRM3P is nested within the NCEPR2-reanalyses

CRU

NCEP-driven RCM

RCM bias

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