Establishing an Arab Domain within CORDEX

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What is meant by “Domain”?

A specific region of the globe to be investigated in more detail with regional climate models (RCMs)
Example Domains

A specific region of the globe to be investigated in more detail with regional climate models (RCMs)
What is “CORDEX”?

**Coordinated Regional Climate Downscaling Experiment**

A multi-region, multi emission scenario, ensemble of RCMs & SDs downscaling an ensemble of GCMs for Regional Climate studies to support impact assessment and adaptation planning

Organised under WCRP (World Climate Research Programme) with participating climate research institutes worldwide
What is “CORDEX”?

Coupled Model Intercomparison Project (CMIP3 & CMIP5) provides freely accessible climate simulations from global models, but at coarse resolution (150-300 km)

Growing need from society for climate change related information on regional scale with high spatial resolution

Note: CMIP5 – framework for GCM projections to be used in IPCC 5th Assessment Report (AR5)
General Aims and Plans for CORDEX

Coordinate high-resolution Regional Climate Modelling worldwide

Provide a set of high-resolution regional climate scenarios for the majority of land-regions of the globe

Make these data sets available and useable to the impact and adaptation communities, with a common diagnostic set and format located at central archives (following CMIP5)

Provide a framework for testing Regional Climate Models and Downscaling techniques for the recent past and future scenarios

Foster coordination between downscaling efforts around the world and encourage local participation in this process (esp. in developing nations)

Together with CMIP5, provide climate simulation data to support IPCC AR5
More specific aims and plans for CORDEX

Develop a matrix of RCD (regional climate downscaling) simulations that employ:

1. **Multiple GCMs** as boundary conditions (BCs)
2. **Multiple realizations** of a given (single) GCM as BCs
3. **Multiple RCMs** driven by a given GCM over a given domain
4. **More than 1 representative greenhouse gas emissions scenario**
5. **With common RCM domains** and resolution
6. **With common RCM output** variables and frequency
7. **In a common format** closely following CMIP5
8. **Results freely available** for subsequent access and use
CORDEX Standards

1. Use of GCMs according to CMIP5 output protocols.
   At least 1 RCP4.5 and 1 RCP8.5 member (1950-2100).

2. The standard RCM resolution is 50km (many groups plan to also run higher resolutions for selected domains).

3. All RCMs should first be run using ERA-interim boundary conditions (1989-2008) over that region for model evaluation. (best possible representation of observed climate)
CORDEX Domains

first focus on the African continent
Needs for the Arab Region Domain

» Setup an RCM domain for the entire Arab Region

» All Arab countries should be covered
  *(Comoros to be treated separately)*

» All river drainage basins should be included

» Present climate should be well-represented
The Arab Domain: selection

- no clear guidance to select a domain (avoid complex topography and regions of strong convection at the boundaries, not always possible)
- sensitivity studies: run simulations for several domain configurations

1. ARABD  “reference” smallest domain (orange)
2. ARABD-E eastward ext. (blue)
3. ARABD-N northward ext. (white)
4. ARABD-NE north-east (red)
5. ARABD-EG Egyptian UNESCO group (black)
Sensitivity Analysis of the Proposed RCM Domain for the Arab Region

Start reference boundary: ARABD
Sensitivity Analysis of the Proposed RCM Domain for the Arab Region

Start reference boundary: ARABD-E
Sensitivity Analysis of the Proposed RCM Domain for the Arab Region

Start reference boundary: ARABD-N
Sensitivity Analysis of the Proposed RCM Domain for the Arab Region

Start reference boundary: ARABD-NE
Sensitivity Analysis of the Proposed RCM Domain for the Arab Region

Start reference boundary: ARABD-EG
Simulations and observations

Simulations

- RCA4 RCM (SMHI, intermediate version) driven by the ERA-Interim for 1997-2008, 1997 is spin-up year, the **1998-2008 period for analysis**
- Precipitation (pr), 2m temperature (tas), sea level pressure (slp)
- seasonal mean maps
- annual cycle averaged over sub-regions

Gridded Observations and reanalysis:

- TRMM-3B42 (satellite + ground, daily: pr)
- GPCP11 (satellite + ground, daily: pr)
- GPCC5 (ground, monthly: pr)
- CRU v. 31 (ground, monthly: pr, tas)
- Univ. of Delaware, v. 2.01 (ground, monthly: pr, tas)
- ERA-Interim Reanalysis (daily: pr, tas, psl)
Precipitation (JJA)
Precipitation bias (JJA)

Precipitation (pr) | JJA | 1998-2008

GPCP11

GPCC5

ERA-INTERIM

RCA4 ARABD

RCA4 ARABD-E

RCA4 ARABD-N

RCA4 ARABD-NE

RCA4 ARABD-EG

mm/day RCA4 - GPCP
Temperature bias (JJA)

2m Temperature (tas) | JJA | 1998-2008

- CRU31
- UDEL201
- ERA-INTERIM
- RCA4 ARABD
- RCA4 ARABD-E
- RCA4 ARABD-N
- RCA4 ARABD-NE
- RCA4 ARABD-EG

°C (OBS, RCA4) - CRU
Sea Level Pressure bias (JJA)

Sea level pressure (psl) | JJA | 1998-2008

- ERA-INTERIM
- RCA4 ARABD
- RCA4 ARABD-E
- RCA4 ARABD-N
- RCA4 ARABD-NE
- RCA4 ARABD-EG

-8 -6 -4 -2 0 2 4 6 8

hPa

hPa RCA4 - ERAINT
Atlas Mountains (annual cycle)

Precipitation

Temperature

Sea level pressure

[Graphs showing seasonal variations in precipitation, temperature, and sea level pressure for different regions, with legends indicating data sources and models.]
Tigris and Euphrates (annual cycle)

**Precipitation**

- TRMM
- GPCP
- ERAINT

**Temperature**

- ERAINT

**Sea level pressure**

- RCA4-ARABD
- RCA4-ARABD-E
- RCA4-ARABD-NE
- RCA4-ARABD-EG

Map of the region showing precipitation trends.
Mediterranean (annual cycle)

**Precipitation**

- TRMM
- GPCP
- ERAINT

**Temperature**

- ERAINT

**Sea level pressure**

- RCA4-ARABD
- RCA4-ARABD-E
- RCA4-ARABD-NE
- RCA4-ARABD-EG

Map of the Mediterranean region with temperature and precipitation data overlaid.
Ethiopian Highlands (annual cycle)

Precipitation

Temperature

Sea level pressure

Map of the region with a highlighted area.
5 different domains:
- precipitation – small difference across the domains
- temperature – smaller biases for the smallest “reference” ARABD and ARABD-E (east);
- SLP – conclusions are similar to temperature
- ARABD “reference” smallest domain (orange)
- Further consultation (ACSAD, KAU) led to adjustments east and north
More sensitivity tests
**Final Arab Domain**

**CORDEX ARAB DOMAIN** | 0.44° (50 km)

**ACTIVE DOMAIN**

**FULL DOMAIN (SMHI-RCA4)**

**ARB-44**: 26.4W-75.24E; 6.6S – 44.88N (232x118), established as the Arab-CORDEX Domain (RCMs with the rotated grid)

RCMs with other coordinates: active domain **27W-76E; 7S – 45N**

Full domain (boundary zone) is different for different RCMs
Final Arab Domain
Approved as Official CORDEX Domain

CORDEX domains for model integrations (updated on 18/06/2012)

This note presents the regions used for the CORDEX regional climate model integrations project and defines the RCM interior domain, i.e. the area left once the relaxation zone is excluded. Some of the domain non-rotated coordinates are shown in bold and indicate the latest corrected values from the previous document. The major difference from the one updated on 25/02/2010 is the inclusion of a new domain covering the Arab region to a total of 13 CORDEX regions.

Note that the grid resolution is set to 0.44 degree by 0.44 degree for the RCMs using a rotated pole system where the model operates over an equatorial domain with a uniform resolution of approximately 50km.

1. Domain definition

Each of the regions presented is defined by the following parameters:

A) Parameters needed by an RCM using a rotated pole coordinate system:

1. Coordinates of the rotated pole in rotated coordinates: RotPole(Longitude, Latitude)
2. Coordinates of the Top Left Corner (TLC) in rotated coordinates: TLC(Longitude, Latitude)
3. Number of grid point in the East-West direction: Nx
4. Number of grid point in the South-West direction: Ny

B) Parameters for RCM using other system coordinates (in non-rotated coordinates):

5. Coordinates of the TLC, Centre point of the Northern Boundary (CNB) and Top Corner (TRC) in non-rotated coordinates: TLC(Longitude, Latitude), CNB(Longitude, Latitude), TRC(Longitude, Latitude)
6. Coordinates of the Centre point of the Eastern Boundary (CEB), Centre point of the Western Boundary (CWB), Centre point (CPD), Centre point of the Southern Boundary (CSB) in non-rotated coordinates: CEB(Longitude, Latitude), CWB(Longitude, Latitude), CPD(Longitude, Latitude), CSB(Longitude, Latitude)
7. Coordinates of the Bottom Left Corner (BLC), Centre point of the South-East Corner (CSB) and Bottom Right Hand Corner (BRC) in non-rotated coordinates: BLC(Longitude, Latitude), CSB(Longitude, Latitude), BRC(Longitude, Latitude)

For rotated polar RCMs (in rotated coordinates):

RotPole (180.0, 90.0) TLC (333.6, 44.88) N=232 Ny=118

For non-rotated polar RCMs (in actual coordinates):

TLC (333.0, 45.0) CNB (24.5, 45.0) TRC (76.0, 45) CWB (333.0, 19.0) CPD (24.5, 19.0) CEB (333.0, 19.0) BLC (333.0, -7) CSB (24.5, -7) BRC (76.0, -7)

Documents:
- CORDEX archive design (version 1.0)
- Addressing climate information needs (WMO Bulletin, July 2009)
- General set of instructions for CORDEX projects
- Description of the CORDEX domains
- Form to be completed in order to receive global conditions

http://wcrp.ipsl.jussieu.fr/SF_RCD_CORDEXCORDEX.html

Not online yet!
Final Arab Domain
Approved as Official CORDEX Domain

http://cordex.dmi.dk

Now!

CORDEX Archive Design, version 1.0
Ole B Christensen¹, Bill Gutowski² and

This is a revised and changed version of the document
http://wcrp.ipsl.ens.fr/RCD_Projects/CORDEX
due to a need for further specifications, and for further
GCM archive specifications as detailed in
http://cmip-pcmdi.llnl.gov/cmip5/docs/cmip5

The following recommendations apply both to CORDEX
CMIP5 GCMs, in terms of: variables to be saved,
and archiving

(a) Three classes of data are defined:
Core, relevant to all communities: monthly and
Tier 1, relevant to most communities: daily
Tier 2, higher frequency and more complete at

(b) Core data should be easily accessible as data-file

(c) Core and Tier 1 variables will be held in a central
quality controlled netCDF files conforming to

(d) Tier 2 variables will be stored locally at Model's
more informal basis, e.g. bilaterally or with project

(e) Experience from existing archives should inform
archive with the Danish Meteorological Institute (which holds the ENSEMBLES
RCM archive) taking the role as initial host for the first set of experiments. Data can be
transferred either by sending a USB disk to the DMI or can be put up for download
by the delivering institute.³

(f) All specified Core data must be present, if the model produces them (e.g., snow
depth may be exempt). Some Tier-1 variables may not be defined in the model or
may be absent for other reasons.

Table 1: These areas are defined in an equidistant longitude/latitude projection with the rotated
North Pole in the indicated regular coordinates; the rotated zero longitude is defined as going
through the regular North Pole. The number of cells is Nlon by Nlat. The boundaries are centers of
the outermost points of the rectangular area in rotated coordinates.

<table>
<thead>
<tr>
<th>CORDEX Area</th>
<th>Name</th>
<th>Resolution (deg.)</th>
<th>N_lon</th>
<th>N_lat</th>
<th>Nlon</th>
<th>Nlat</th>
<th>West</th>
<th>East</th>
<th>South</th>
<th>North</th>
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<td>South America</td>
<td>SAM-44</td>
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<td>167</td>
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<td>113.98</td>
<td>75.74</td>
<td>210</td>
<td>113</td>
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</table>

Online Now!
Overlapping CORDEX domains

ARB-44 is synchronized to AFR-44: the same grid boxes

ARB-44 downscaled at SMHI: ERA-Interim (1979-2010)
(1951-2100 downscaling scenarios running now)