Downscaling of CMIP6 for regional climate modeling: experiences from CORDEX

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on behalf of Daniela Jacob, Filippo Giorgi
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The CORDEX vision is to advance and coordinate the science and application of regional climate downscaling through global partnerships.

- To better understand relevant regional/local climate phenomena, their variability and changes, through downscaling.
- To evaluate and improve regional climate downscaling models and techniques
- To produce coordinated sets of regional downscaled projections worldwide
- To foster communication and knowledge exchange with users of regional climate information
CORDEX Domains
COordinated Regional Downscaling EXperiment (CORDEX) – Management

- CORDEX Science advisory team (SAT), 12 members

- International Project Office for CORDEX (IPOC) hosted at SMHI since January 2015 (E. O’Rourke Head).

- CORDEX archiving coordinated by IS-ENES

- Regional points of contact (POCs), 2-3 per region

SAT-2 meeting
SMHI (Sweden)
25-27 Feb., 2015
Evaluation of hindcasts
RCM multi-model ensemble evaluation

CORDEX EUR-11
CORDEX EUR-44

“Standard” Evaluation [Kotlarski et al., 2014]

Added Value of High Resolution (EUR-11) Simulations [Prein et al. 2014]

Precipitation Extremes (Q97.5)

Heat waves
Bias of 90th centile
[Vautard et al., 2013]
A study of added value using EURO-CORDEX and Med-CORDEX data

Horizontal resolutions: 1.32°, 0.44° and 0.11°

GCMs: MPI-ES-MR, EC-EARTH, CNRM-CM5, HadGEM-ES
RCMs: CCLM, RACMO, ALADIN, RegCM4.3, RCA4

Reference period: 1975-2004
Future period: 2070-2099

Observational data: EURO4M-APGD (Isotta et al., 2014)

Torma et al. (2015) JGR
Simulation of spatial precipitation patterns

Higher resolution

Increasing details in precipitation spatial distribution

Fine scale AV

[mm/day]
Change in heavy precipitation

RCP8.5: Projected changes of heavy precipitation 2071–2100 vs. 1971–2000

- Up to 45% increase in large areas in winter in Northern and Eastern Europe
- No decrease besides isolated regions in Southern Europe (mostly along coastlines)

Jacob et al. (2014)
CORDEX – Flagship Pilot Studies

Focus on smaller regions to address specific science and VIA issues

- Effects of regional forcings
  - Land-use change
  - Urbanization
  - Aerosols

- Intercomparison of different downscaling techniques
  - (e.g. RCM, ESD)

- Interactions with other WCRP projects
  - (e.g. GEWEX)

- Development of coupled Regional Earth System Models (RESMs)

- Production of large ensembles for uncertainty characterization

- Study of phenomena relevant for regional climate and impacts through targeted experiments
  - (e.g. MCS, TC, extremes, monsoon)

- Modeling (Added Value) at multiple scales, down to cloud resolving.
  - Model development

- Availability/production of high quality, high resolution, multiple variable observations

- Relevance for VIA and adaptation/policy applications
  - Distillation of actionable information
Thank you for your attention!

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Ensembles of projections are available for most domains.
Plans for CORDEX 2

• Flexible resolution for standard domains
  – \( dx = 12.5 \text{ km}, \ 25 \text{ km}, \ 50 \text{ km} \) (higher for some regions?)
• CMIP6 (+ CMIP5?) driving GCMs
  – RCP8.5, RCP4.5, RCP2.6
• Flagship Pilot Studies
  – Proposals to be elicited from the regional communities
  – Procedure/criteria for endorsement of FPS to be designed
  – Consistent framework across FPSs
• Better integration of statistical downscaling
• ESGF framework for data storage and provision
• More emphasis on process-based model assessment and development
• Third CORDEX Conference, Stockholm, 17-20 May 2016
Emerging scientific challenges

• Added value
  Internal variability & added value as functions of scale; Very high resolution modeling; Bias correction uncertainties and consistency

• Human element
  Coupling of regional climate and urban development (e.g. coastal megacities);
  Land use change; Aerosol effects.

• Coordination of regional coupled modelling
  Ocean-ice-atmosphere; Lakes; Dynamic land surface; Natural fires; Atmospheric chemistry; Carbon cycle; Aerosols; Marine biogeochemistry

• Precipitation
  Extremes; Convective systems; Coastal storm systems; MJO/Monsoon

• Local wind systems
  Wind storms; Strong regional winds; Wind energy
Some CORDEX history

- Initial discussions across the downscaling community (mostly RCM), Toulouse 2009
- Establishment by the WCRP of the Task Force on Regional Climate Downscaling, TFRCD (2010)
- Design of Phase I CORDEX framework (Giorgi et al. 2009; Jones et al. 2011) and first CORDEX Conference (Trieste 2011)
- Establishment by the WCRP of the Science Advisory Team, SAT (2012)
  → More than 400 abstracts presented, > 500 participants.
CORDEX Phase I experiment design

Model Evaluation Framework

Climate Projection Framework

Multiple regions at 50 km grid spacing
Higher for some regions (Europe – 12 km)

AMIP like

ERA-Interim LBC 1989-2007

Regional Analysis Regional Databanks

CMIP like

Evaluation of present day GCM-driven climate runs

Scenarios (1951-2100) RCP4.5, RCP8.5

Multiple driving AOGCMs
EURO-CORDEX 2

European decadal variability and the regional forcing

Very high resolution

Investigating the uncertainty in European climate change information