The Euro-CORDEX Initiative

A new generation of regional climate scenarios for Europe

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EURO-CORDEX Basics
Specifications

- **Spatial resolution:**
  - EUR-11: 0.11 degree (12.5 km)
  - EUR-44: 0.44 degree (50 km)

- **Driving GCMs:** CMIP5

- **GHG scenarios:**
  - rcp4.5, rcp8.5 (focus)
  - rcp2.6 (few simulations)

- **Periods:**
  - Control: 1951 – 2005
  - Scenario: 2006 – 2100

Region (center of boundaries):
~ 27° N – 72° N, ~338° W – 45° E
(details: http://wcrp.ipsl.jussieu.fr/SF_RCD_CORDEX.html)
EURO-CORDEX Community

- 29 actively contribution groups
- Leading institutions in the field of regional climate modeling in Europe
- Voluntary effort, contributions are funded by the contributors
- Coordination: D. Jacob (CSC Germany) and A. Gobiet (University of Graz, Austria)

EURO-CORDEX Models

- 12 different GCMs from CMIP 5 (NorESM1-M, HadGEM2-ES, MPI-ESM-LR, CNRM-CM5, EC-EARTH, IPSL-CM5A-MR, ACCESS1-3, CanESM2, MIROC5, GFDL-ESM2M, CISRO-Mk3-6-0, CCSM4)
- 10 different RCMs: WRF (different configurations), CCLM, ALADIN, REMO, REGCM, HIRHAM, RACMO, ARPEGE, RCA, PROMES
- Inclusion of Empirical Statistical Downscaling (ESD) → under discussion
EURO-CORDEX Basics

0.44° vs. 0.11° Simulations

GCM
~150 km

EURO-CORDEX 0.44
50 km

Representation of orography
e.g., European Alps

EURO-CORDEX 0.11
12.5 km
EURO-CORDEX Basics
0.44° vs. 0.11° Simulations

Atmospheric Dynamics
Specific Humidity ~3000 m

EURO-CORDEX 0.44
~64 x computational costs

EURO-CORDEX 0.11

[CCLM-COM 0.44° Hindcast (WEGC)]
[CCLM-COM 0.11° Hindcast (BTU)]
EURO-CORDEX Basics

0.44° vs. 0.11° Simulations

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Specific Humidity ~3000 m

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EURO-CORDEX 0.11

[CCLM-COM 0.44° Hindcast (WEGC)]

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EURO-CORDEX Basics
Status EURO-CORDEX Simulations

0.11° Simulations

0.11° Hindcast
hindcast: 16

0.11° Control
control: 22

0.11° Scenarios
rcp26: 5
rcp45: 16
rcp85: 21
Σ42

0.44° Simulations

0.44° Hindcasts
hindcast: 22

0.44° Control
control: 32

0.44° Scenarios
rcp26: 8
rcp45: 26
rcp85: 26
Σ60

Σ42
Σ60
EURO-CORDEX Basics

Aims of EURO-CORDEX

1. Joint Model Evaluation
2. GCM Selection
3. Interface to Users

1B. Joint Analysis of Projections
2B. Joint Analysis of Projections
3B. Dissemination of Results
### Aims of EURO-CORDEX

1. **Joint Model Evaluation**
   - I. RCM evaluation (multi-model)
   - II. Reference datasets

2. **GCM Selection**
   - 2B. Joint Analysis of Projections

3. **Interface to Users**
   - 3B. Dissemination of Results
• Basic features of European climate captured
• Shortcomings for selected metrics, seasons and regions,
• Comparison with ENSEMBLES: Comparable, partly smaller error ranges.
Heat Waves Evaluation [Vautard et al. 2013]

Bias of 90th centile

- Heat waves well captured, but modulations in strengths
- Strong dependence on land-atmosphere processes and convection
- No improvement at higher resolution

[Vautard et al., 2013]
Added Value of High Resolution (EUR-11) Simulations

[Prein et al. 2014]

Precipitation Extremes (Q97.5)

- 8 RCMs in 0.44 and 0.11 deg. resolution
- Analysis of various aspects of extreme precipitation.
- Analysis on 0.44 deg. grid

- Clearly added value (red circles) in orographically influenced areas
- Less added value in flat regions

[Prein et al., 2014]
Evaluation Summary

• “Standard evaluation”
  • Ensemble mean biases comparable to ENSEMBLES (partly smaller error ranges)

• Simulations have skill to represent specific aspects like:
  • heat waves
  • climate classifications

• Added value of high resolution (EUR-11 compared to EUR-44)
  • demonstrated for mean and extreme precipitation.

• More studies in preparation
EURO-CORDEX Basics

Aims of EURO-CORDEX

1. **Joint Model Evaluation**
   - I. RCM evaluation (multi-model)
   - II. Reference datasets

2. **GCM-RCM Matrix**
   - I. GCM evaluation
   - II. GCM-RCM Matrix

3. **Dissemination of Results**
   - 3A. Interface to Users
   - 3B. Dissemination of Results
Principles of GCM selection in EURO-CORDEX

1. Avoid GCMs with very weak performance over Europe
2. Spread of CMIP5 simulations should be sampled adequately
3. Modeling groups decide independently on the choice of GCM
EURO-CORDEX
GCM Evaluation

1. GCM Performance [UNICAN, ETHZ, UNIGRAZ, …]

Spatial biases, annual cycles, upper air parameters evaluation, multi-parameter model performance indices, …

CMIP5 GCMs feature a range of performances

→ No distinct outlier

→ No imperative reason to disqualify specific GCMs as drivers for the EURO-CORDEX RCMs.
2. Sampling the range of climate change projected in CMIP5 [UNIGRAZ, ETHZ]

- Analysis of CMIP5 climate change signals of temperature and precipitation over Europe

- Aims:
  - Avoid giving too much weight to specific GCMs
  - Avoid biases in the ensemble mean
  - Avoid underestimation of the ensemble spread
2. Sampling EUR-11:

- 7 GCMs (MPI-ESM, CNRM-CM5, and EC-EARTH in 4 realizations each)
- Temperature change range fully sampled
- Extremely wet GCMs missing
EURO-CORDEX
GCM Selection

2. Sampling

EUR-44:

- 12 GCMs
- Temperature change range fully sampled
  - More cooler GCMs
- Extremely wet GCMs missing

EUR–44 RCP4.5 GCMs
region: CORDEX.Europe, season: annual

GCM
- BCC-CSM1.1
- CanESM2
- CCSM4
- CNRM-CM5
- CSIRO-Mk3–6–0
- EC-EARTH
- GFDL-CM3
- GFDL-ESM2G
- GFDL-ESM2M
- GISS-E2-R
- HadGEM2-CC
- HadGEM2-ES
- inmcm4
- IPSL-CM5A–LR
- IPSL-CM5A–MR
- MIROC5
- MIROC–ESM
- MIROC–ESM–CHEM
- MPI–ESM–LR
- MRI–CGCM3
- NorESM1–M
EURO-CORDEX Basics

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   II. Reference datasets

2. **GCM-RCM Matrix**
   I. GCM evaluation
   II. GCM-RCM Matrix
   III. Projections analysis

3. **Interface to Users**
   3B. Dissemination of Results
First Analysis of EUR-11 Climate Change Signals [Jacob et al., 2013]

- Analysis based on 9 (RCP45) and 10 (RCP85) 0.11 simulations
- Mean climate change
- Change in various indices relevant for Impacts, Adaptation, and Vulnerability (IAV) studies
- Results tested for robustness and significance

- EUR-11 confirms earlier findings (ENSEMBLES)
- More spatial detail
- RCMs provide higher daily precipitation intensities than GCMs

[Jacob et al., 2013]
First analyses of EURO-CORDEX (EUR-11) scenarios are available and published (Jacob et al., 2013)

- So far no large surprises compared to earlier studies (ENSEMBLES).
- More spatial details

More studies in preparation

- Hydrological Cycle [Georgievski et al.]
- Climate Types – Integrated Assessment [Halenka et al.]
- Mediterranean cyclone simulation [Gaertner et al.]
- Snow Cover Analysis [S. Kotlarski et al.] [C. Teichmann et al.]
- …
EURO-CORDEX Basics

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   - I. GCM evaluation
   - II. GCM-RCM Matrix
   - III. Projections analysis

3. **Interface to Users**
   - I. Interfaces to user community
   - II. Dissemination

3B. **Dissemination of Results**
EURO-CORDEX
User Interface

User Interface Activities

- Definition and analysis of **impact relevant indices and ensemble-based derived products** (ongoing, results partly already available)
- Provision of a **bias corrected EURO-CORDEX dataset** (ongoing)
  - Inter-comparison of BC Methods
- **User guideline** document (under development)
EURO-CORDEX Dissemination

Published Papers (several more submitted or in preparation):


- Additional Studies close to or already submitted

User Workshops

- National user workshops (organized by EURO-CORDEX community members together with suitable national institutions, Spring 2014)
Availability for Users

• **Data-Access** (similar to CMIP5):
  • Connect to and register at one of the ESGF nodes
  • Select project “CORDEX”
  • Select domain “EUR-44”, “EUR-44i”, “EUR-11”, or “EUR-11i”
Status of the EURO-CORDEX simulations and their analysis

• **71** EUR-11 and EUR-44 scenario simulations finished, ~100 planned in total

• **EUR-44 40** simulations published on ESGF

• **EUR-11 24** simulations published on ESGF
EURO-CORDEX Summary

Summary

- EURO-CORDEX is a progress compared to earlier activities:
  - spatial resolution (EUR-11: 12.5 km)
  - ensembles size (100 simulations planned)
  - community involvement (27 groups)
  - user interface

- First studies clearly indicate **added value** of high resolution.

- The **large ensemble** will allow statistically more sound estimation of expected climate change and its uncertainty.

- **First joint evaluation studies** [Kotlarski et al. 2014] and climate change analysis are **finished** [Jacob et al., 2013] and confirm previous studies (ENSEMBLES).

- Bias corrected datasets, derived indices and products, and a user guide will facilitate the dissemination in **IAV assessment**.
Thanks for your attention!

Visit EURO-CORDEX at: www.euro-cordex.net