

# CORWES

## A coordinated contribution to CORDEX by the Spanish WRF community

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**Santander Meteorology Group**

*A multidisciplinary approach for weather & climate*

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### Outline:

- CORDEX-WRF overview
- CORWES project



# CORDEX-WRF coordination & status

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**Thanks to the**

CORDEX-WRF community



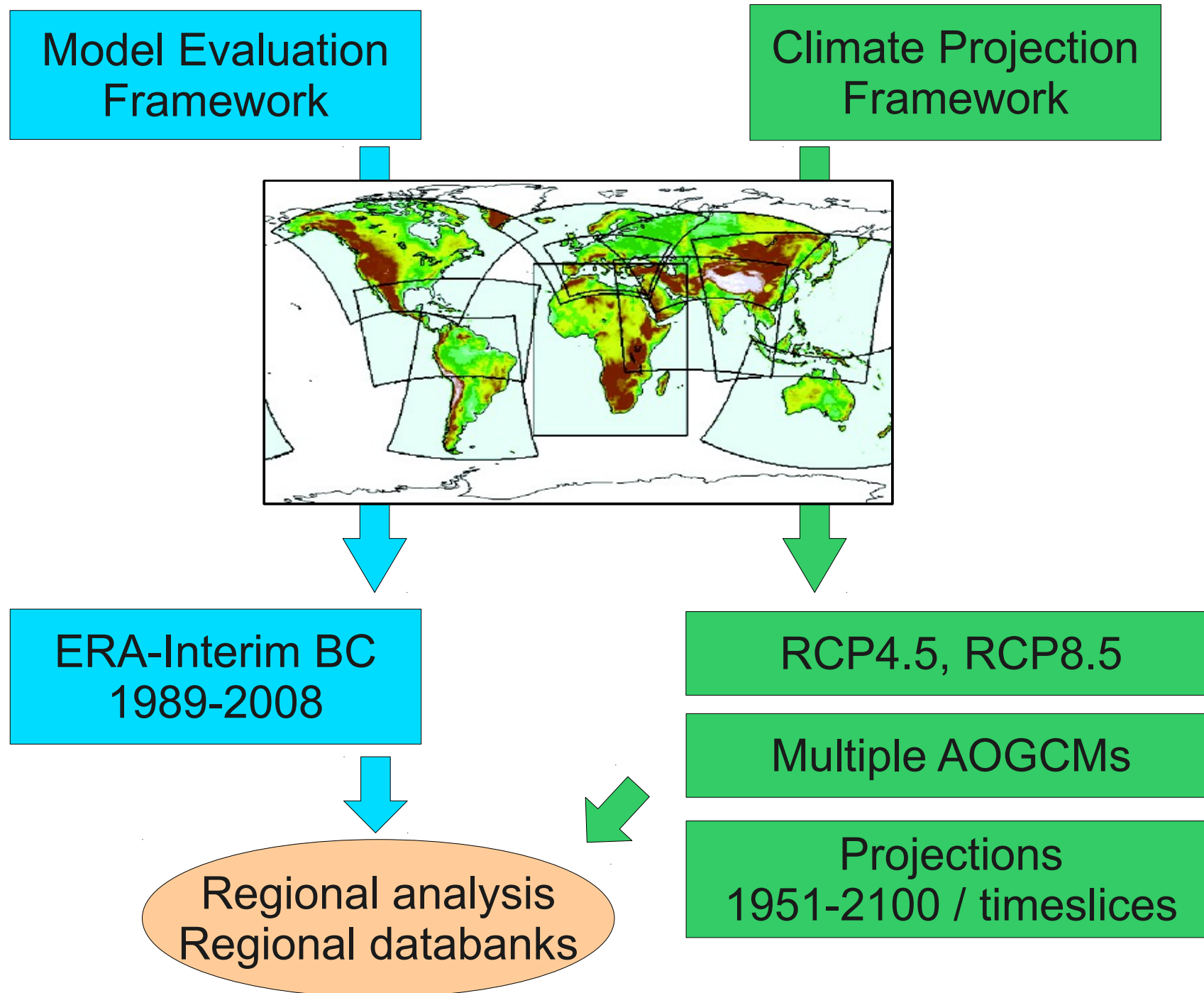


# COordinated Regional climate Downscaling EXperiment

## Strategy

- **Quality-controlled data sets of RCD-based information** for the recent past and 21st century projections, covering the majority of populated land regions on the globe. **Sampling uncertainties** arising from (i) GCM simulations (ii) GHG concentration scenarios (iii) natural climate variability (iv) different downscaling methods.
- A **common set of RCM domains** for dynamical downscaling and define a **standard set of variables**, frequency and format for output and archival at a number of CORDEX data centers
- **Coordination** of a range of RCM simulations for the defined domains, forced by analyses of observations (currently ERA-Interim) to provide a benchmark framework for model evaluation and assessment. This exercise should include also statistical downscaling (SD) methods
- Development of **Regional Analysis and Evaluation Teams** to (i) Evaluate the ensemble of RCD simulations (ii) Develop a suitable set of regional-specific metrics for RCD evaluation (iii) Collect suitable observational data to evaluate high-resolution RCD simulations (iv) Design experiments to investigate the added-value of RCDs and target future priorities in RCD research
- **Engagement of the broad RCD community** in its activities and discussions
- **Support and information** to climate impact assessment and adaptation groups interested in utilizing CORDEX RCD material in their research.

# CORDEX Phase I experiment design

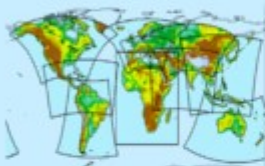




<http://cordex.dmi.dk>

## CORDEX climate data archive

Home



### CORDEX: A COordinated Regional climate Downscaling EXperiment

#### Some changes

Written by Ole Bøssing Christensen

Thursday, 07 June 2012 11:03



A lot of things are going on. There will soon be data access through the same software (ESG) as used by CMIP5. During these discussions we have reread the specifications and come up with some necessary changes, and I will very shortly edit the specifications hosted here.

Very concretely: There ought to be an institution as part of the driving model specification in the file name. For consistency reasons we will now change the file name for reanalysis-driven runs from ...\_ERAINT\_... to ...\_ECMWF-ERAINT\_...

Do remember that a reanalysis-driven simulation is NOT "historical" but "evaluation", since "historical" is reserved for GCM simulations of the past with observed forcing!

I will also standardise the specifications of regular domains; sorry that I had not done that before!

**Update** 120607.1500: I have now put the regular domains into the specifications, as well as the ECMWF correction. In the near future we should also be defining a data policy. I will keep you up to date wrt. ESG.

**Update** 120608 Some minor corrections in the specifications (consistent file name and attribute example; proper revision date).

**Update** 120611: An error was found in the Excel list: the word "Air" was missing in the long\_name attribute for Near-Surface Air Temperature -like variables. I have added a link to the most recent sheet.

**Update** 120622: An inconsistency between driving\_experiment and driving\_model\_id in the SMHI example has been corrected. I now also stress, that only fields with a non-zero level needs the redundant level dimension.

#### Main Menu

Home

Specifications

Output specs

All news

Direct download

OpenDAP

Relevant Links

<http://cordex.dmi.dk>

- Currently (Sept. 2012), holds only 2 evaluation simulations: DHMZ (EUR44) and UCLM (AFR)
- In the future, the archive will be distributed using the ESG2 technology (as CMIP5).
- There are different regional repositories to exploit/quality-check the RCD data before public release. E.g. MedCORDEX, EuroCORDEX, CORDEX-Africa, CORDEX South Asia.
- Expected release of evaluation runs: mid-2013?

- **CORDEX Science Advisory Team (3 yr mandate):**
  - Colin Jones (co-chair, Eur, Arctic)
  - Filippo Giorgi (co-chair, Med)
  - Bill Gutowski (N Am, Arctic)
  - **Silvina Solman (S Am)**
  - Won Tae Kwon (East Asia)
  - R. Krishnan (South Asia)
  - Bruce Hewitson (Africa)
  - Clare Goodess (IAV)
  - Michel Rixen (WCRP)

**Talk tomorrow**

- **2<sup>nd</sup> CORDEX Conference**, Nov 4-7 2013, Brussels organized by the EC, WCRP and IPCC WG1
  - ~end 2012 : Call for papers
  - ~March 2013: Close of call for papers
  - ~May/June 2013: Notification of acceptance
  - ~summer 2013: Registration



## What is CORDEX-WRF?

- We need to decide :-)
- Currently:
  - A wiki site as a tool for coordination
  - A distribution list for discussion/news
  - The people in this room  
(+ many others which showed an interest but couldn't attend)
- Aims?
  - Proposal, later

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Coordinated Regional Climate Downscaling Experiment (CORDEX)



# What is CORDEX-WRF?

[About](#) | [Governance](#) | [Domains](#) | [Activities](#) | [Publications](#) | [Tools](#) |

## Domains

### Africa

- Cordex Africa
- CSAG

### Australia-Asia

- [List of groups contributing to Cordex AustralAsia](#)

### Canada – USA

- [UQAM - ESCER](#)

### Europe

- [Euro Cordex Initiative](#)
- [Med-Cordex](#)
- France: [CNRM-Meteo France](#) ; Centre de Recherches de Climatologie
- Spain : [Santander Meteorology Group](#)

### South America

- [CPTEC](#)
- [CIMA](#)

### South Asia

- [CCCR](#)

[CORDEX WRF](#)  
[Wiki CORDEX climate data archive](#)



<http://wcrp.ipsl.jussieu.fr/cordex/domains.html>



## Other CORDEX communities

### **CORDEX-Africa**

<http://www.csag.uct.ac.za/cordex/cordex-africa-2>

### **Euro-CORDEX**

<http://euro-cordex.net/>

### **MedCORDEX**

[www.medcordex.eu](http://www.medcordex.eu)

### **CORDEX-AustralAsia**

<http://cordex-australasia.wikidot.com>

### **CORDEX South Asia**

<http://cccr.tropmet.res.in/cccr/home/CORDEX/aboutCordex.jsp>

...

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# Other CORDEX communities

## CORDEX-Africa

<http://www.csag.uct.ac.za/cordex/cordex-africa-2>

**EU** Analysis; Developing methods and tools to analyse atmospheric processes over Africa and how these may change into the future

**http** Foci; Addressing key meteorological and impacts knowledge gaps

**Me** Regional messages; Presenting information for key regions in the continent

**ww** Integrated approach; Bringing together climate and vulnerability-impact-adaptation scientists to identify and address key climate vulnerabilities

**CC** Capacity development; Long-term collaboration between African scientists and key global institutions for career development

**htt** Application and Adaptation; Bridging the science-society divide through transforming climate data to actionable information

**Chris Lennard, next talk**

**CC** <http://cccr.tropmet.res.in/cccr/nome/CORDEX/aboutCordex.jsp>

...

## Other CORDEX communities

### CORDEX-Africa

<http://www.csag.uct.ac.za/cordex/cordex-africa-2>

### Euro-CORDEX

<http://euro-cordex.net/>

#### Aims:

1. Coordinate **joint evaluation** in the European region:  
GCM evaluation, RCM evaluation, reference datasets.
- 2a. Coordinate the design of the EURO-CORDEX **simulation matrix**.
- 2b. Coordinate **joint analysis of climate projections** in the European region.
- 3a. Foster **cooperation with GCM community**: GCM analysis for Europe.
- 3b. Foster **cooperation with impact, adaptation, and mitigation community**:  
Error correction, ens. based products, regionally relevant CC indicators, ...
- 3c. Foster **dissemination** of EURO-CORDEX results: AR5, users

**Kirsten Warrach-Sagi, talk tomorrow**



## Other CORDEX communities

### **CORDEX-Africa**

<http://www.csag.uct.ac.za/cordex/cordex-africa-2>

### **Euro-CORDEX**

<http://euro-cordex.net/>

### **MedCORDEX**

[www.medcordex.eu](http://www.medcordex.eu)

Some specific actions of MED-CORDEX would be:

- **production** of an ensemble of **simulations with coupled Regional Climate System Models (RCSM)**, i.e with fully interactive Atmosphere-Land surface-River-Ocean components, covering the whole Mediterranean basin at high resolution;
- development of **stand-alone simulations** for all the components;
- **extending the ERA-Interim CORDEX runs to present** in order to use the most recent validation data available and the HyMeX field campaign results;
- development of **common strategies for ocean model initialization** for decadal-to-scenario simulations;

... One of the key features of MED-CORDEX is to create a **close collaboration with observational and satellite communities** (Hymex, Med-CLIVAR) in order to improve model components, and to increase the **link with the impact communities**.

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# Other CORDEX communities

**CC** The CORDEX South Asia program **brings together researchers/scientists** from the **Climate Science and those involved in vulnerability, impacts and adaptation (VIA)** research from the Asian region to interpret raw downscaled data for information on how climate processes over the continent may change, and to analyze how these changes may impact important sectors, such as health, agriculture and water security in multiple regions across the continent. The CORDEX South Asia activities are envisaged towards **building capacity and expertise within the region** to analyze, interpret and apply CORDEX results for decision making that are relevant to the knowledge needs of the South Asian region.

**Me** The keys to success of this initiative in South Asia will be in developing a means for **analysis and translation of CORDEX data in terms that are relevant to South Asia's** knowledge needs, and in developing the internal capacity to perform the analyses and in doing so create expertise at regional levels in South Asia. The first cadre of people trained on CORDEX can be called upon to help train the next generation of regional experts and advise on future expanded effort on CORDEX analysis and interpretation in South Asia, as well as on the **application of CORDEX results to inform** climate compatible development in South Asia.

## **CORDEX South Asia**

<http://cccr.tropmet.res.in/cccr/home/CORDEX/aboutCordex.jsp>

...

## Other CORDEX communities

### **CORDEX-Africa**

<http://www.csag.uct.ac.za/cordex/cordex-africa-2>

### **Euro-CORDEX**

<http://euro-cordex.net/>

### **MedCORDEX**

[www.medcordex.eu](http://www.medcordex.eu)

### **CORDEX-AustralAsia**

<http://cordex-australasia.wikidot.com>

### **CORDEX South Asia**

<http://cccr.tropmet.res.in/cccr/home/CORDEX/aboutCordex.jsp>

...

**CORDEX-WRF**

## Other CORDEX communities

### Potential aims (to be discussed):

- Produce evaluation, historical and scenario simulations for all CORDEX regions
- Coordinate the:
  - design of the evaluation simulations
  - joint evaluation of the WRF performance
  - design of the GCM/RCM/Scenario matrix
  - joint analysis of the climate projections
- Collaborate with the
  - GCM community\*
  - impacts, adaptation and mitigation communities\*
  - Region-specific CORDEX communities
  - WRF community to improve the model for regional climate
- Develop
  - common tools to process model output
  - WRF improvements for regional climate modelling
  - process-oriented regional metrics\*
  - common metrics to compare RCD results across regions
- Collect suitable observational data for evaluation\*
- Capacity building\*
- Exchange knowledge and tools
- Dissemination of the results

### CORDEX-WRF

\*Better through the regional communities?

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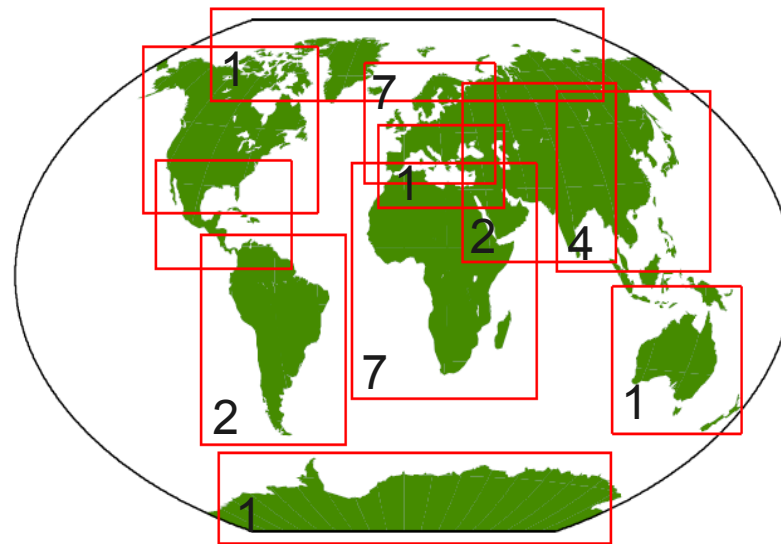
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# CORDEX-WRF

According to the CordexWrfWiki 23 groups are using WRF as a regional climate downscaling tool to perform CORDEX simulations.

Wiki site: <http://www.meteo.unican.es/wiki/cordexwrf>

Mailing list: [cordexwrf+subscribe@googlegroups.com](mailto:cordexwrf+subscribe@googlegroups.com)



Number of WRF groups interested in each region

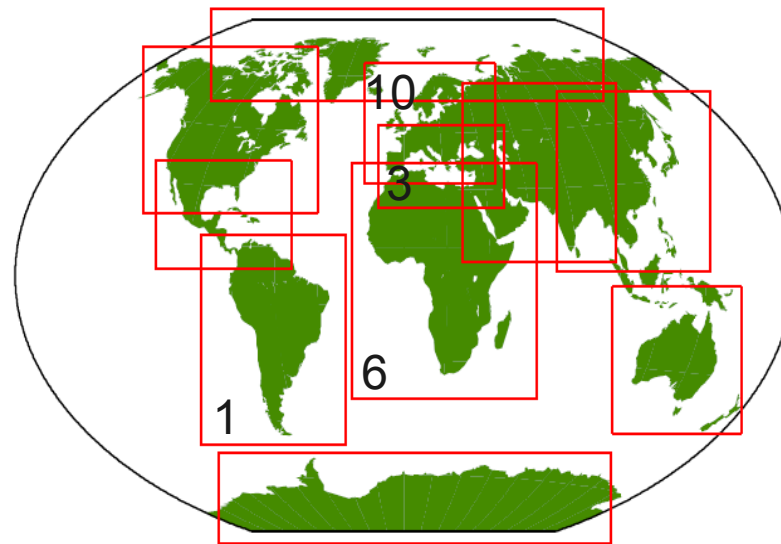
Bjerknes Centre for Climate Research (Uni Research, Bergen, Norway)  
Center for Monsoon System Research (Institute of Atmospheric Physics, CAS, Beijing)  
Climate Change Research Centre (University of New South Wales, Australia)  
Climate Dynamics and Climate Change Group (Indian Institute of Tropical Meteorology, India)  
Climate System Analysis Group (University of Cape Town, South Africa)  
Dept of Earth & Environmental Science (New Mexico Tech, USA)  
Global Change Impact Studies Centre (GCISC), Islamabad, Pakistan  
Grupo AIRE (Universidad de Extremadura, Spain)  
Grupo de Observación de la Tierra y la Atmósfera (University of La Laguna, Spain)  
Hydro-Meteorology Monitoring and Modeling Group (Amazonas State University, Brazil)  
ICARUS (National University of Ireland Maynooth, Ireland)  
Institute for Physics and Meteorology (University of Hohenheim, Germany)

Instituto Dom Luiz - Center for Geophysics (IDL-CGUL, University of Lisbon, Portugal)  
Institut Pierre Simon Laplace (Paris, France)  
National Institute of Meteorological Research (Korea Meteorological Administration, Korea)  
Polar Climate and Weather Group (University of Colorado, USA)  
Regional Atmospheric Modeling Group (University of Murcia, Spain)  
Regional Climate Modeling Lab (Iowa State University, USA)  
Santander Meteorology Group (University of Cantabria, Spain)  
School of Atmospheric Sciences, Nanjing University, Nanjing, P.R. China)  
Weather and Climate Modeling Group (Western Kentucky University, USA)  
Wegener Center for Climate and Global Change, University of Graz, Austria  
Wind & Site Competence Centre (Vestas Technology R&D, Denmark)



According to a recent survey on a shared spreadsheet, only 12 groups have **finished evaluation simulations** with WRF

Source: <http://tinyurl.com/cordex-wrf-simulations>



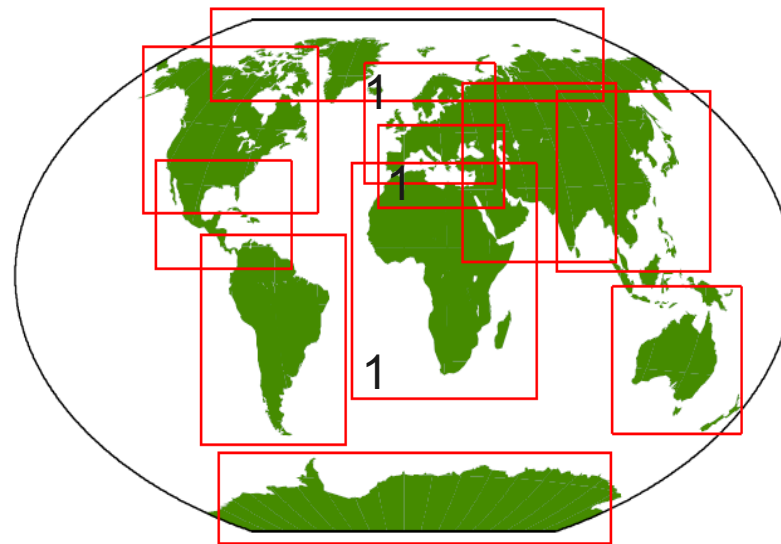
Number of evaluation simulations finished for each region

- Bjerknes Centre for Climate Research (Uni Research, Bergen, Norway)**
- Center for Monsoon System Research (Institute of Atmospheric Physics, CAS, Beijing)
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- Wegener Center for Climate and Global Change, University of Graz, Austria)
- Wind & Site Competence Centre (Vestas Technology R&D, Denmark)

According to a recent survey on a shared spreadsheet, only 3 groups have **finished historical or scenario** simulations with WRF

Source: <http://tinyurl.com/cordex-wrf-simulations>



Number of historical /  
scenario simulations  
finished for each region

**Bjerknes Centre for Climate Research (Uni Research, Bergen, Norway)**  
Center for Monsoon System Research (Institute of Atmospheric Physics, CAS, Beijing)  
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# CORDEX-WRF Wiki site

<http://www.meteo.unican.es/wiki/cordexwrf>

Login

Search

**CORDEX WRF Wiki**

[Home](#) [Groups](#) [Domains](#) [Variables](#) [Scientific contributions](#) [Software tools](#) [Links](#)

## CORDEX-WRF

• **CORDEX: COordinated Regional climate Downscaling EXperiment** is a framework aimed at improving coordination of international efforts in regional climate downscaling research. CORDEX was initiated as a result of the task Force on Regional Climate Downscaling, formed by the World Climate Research Program (WCRP). For details on CORDEX, visit the • [CORDEX website](#).

This wiki has been established to help members of the WRF community communicate their intentions for CORDEX simulation. It is also intended to allow CORDEX participants using WRF to coordinate efforts for a CORDEX region and perhaps engage in collaboration. Please note if others before you have already [registered intentions](#) to simulate a particular region and work with them to ensure the most thorough set of WRF simulations for the region, without repeating work.

We are organizing the First CORDEX-WRF Workshop. Visit • <http://corwes.webs.ull.es/workshop> and join us in Tenerife!

This website is currently open for anyone to edit and is supervised to avoid non-related posting. **Please, follow carefully the instructions to add content to this wiki.** If you are not familiar with a wiki, you may find useful the [SyntaxReference](#).

- Intended as a tool for coordination
- Useful? Other approaches?
- Not fully updated

# Santander Meteorology Group

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# CORDEX-WRF Wiki site

<http://www.meteo.unican.es/wiki/cordexwrf>



## CORDEX-WRF

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Turn into a repository of the official domains (exact grid-point match)?  
Add links to observational data relevant for each region?

Please, keep these updated

Coordination needed

Spammers are becoming an issue. Change to open content but only selected editors.

To be discussed...

## CORDEX opportunities for WRF

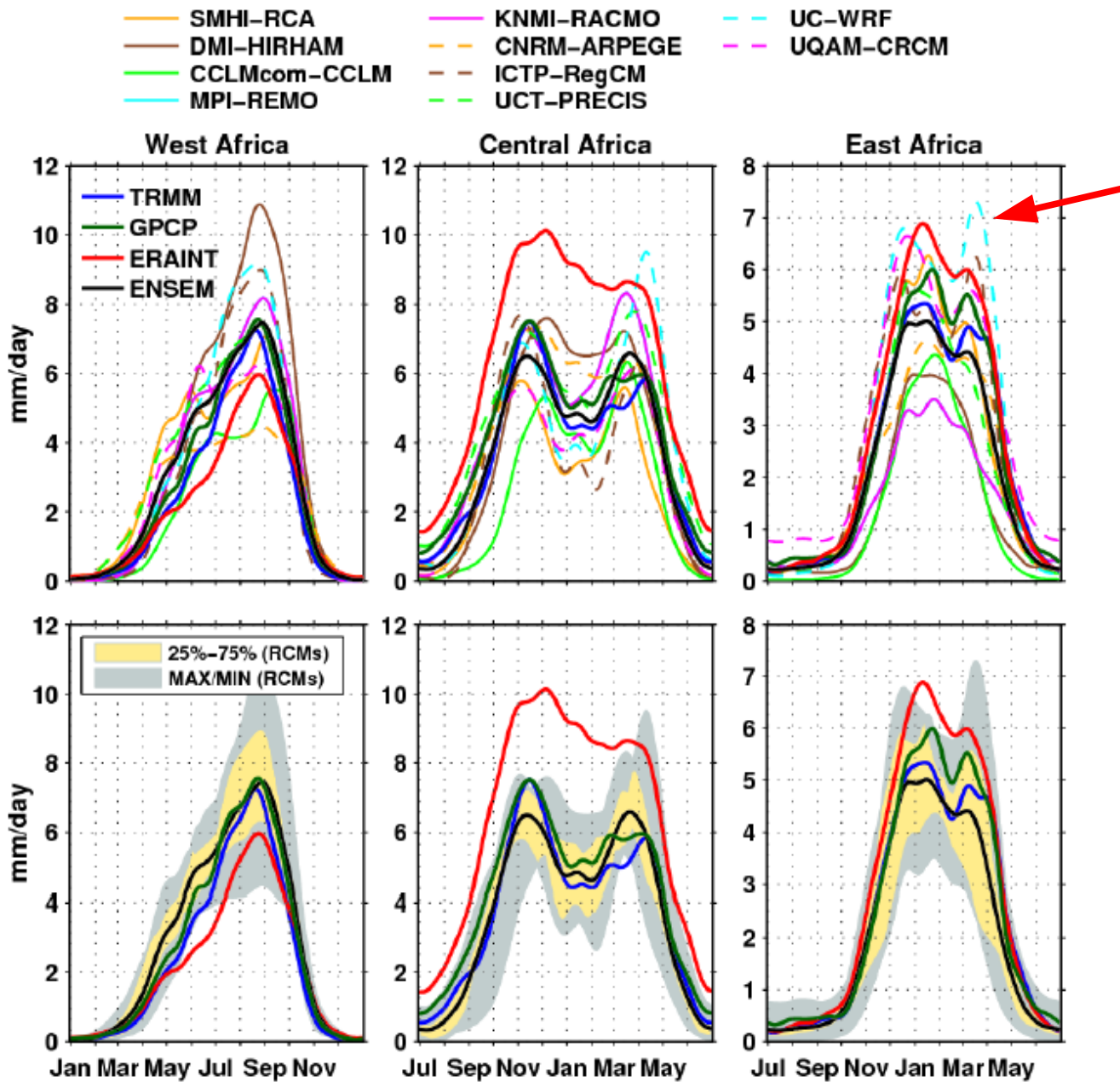
- WRF presents some singularities w.r.t. other RCMs
  - The model is run by many different groups, which are not coordinated by the developing institution (as is the case in other community models: RegCM, PRECIS, CCLM, ... )
  - Huge set of configuration options
  - It will, probably, be the only RCM run in **all** CORDEX regions, including polar regions.
- WRF is a “young” RCM
  - WRF is under very active development, including the addition of long term run capabilities: varying SST, deep soil temp. update, GHG variation, detailed radiation and soil schemes, output of averaged variables, ...
  - Are there any missing features?
  - Can we cooperate to get them?



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# WRF compared to other RCMs



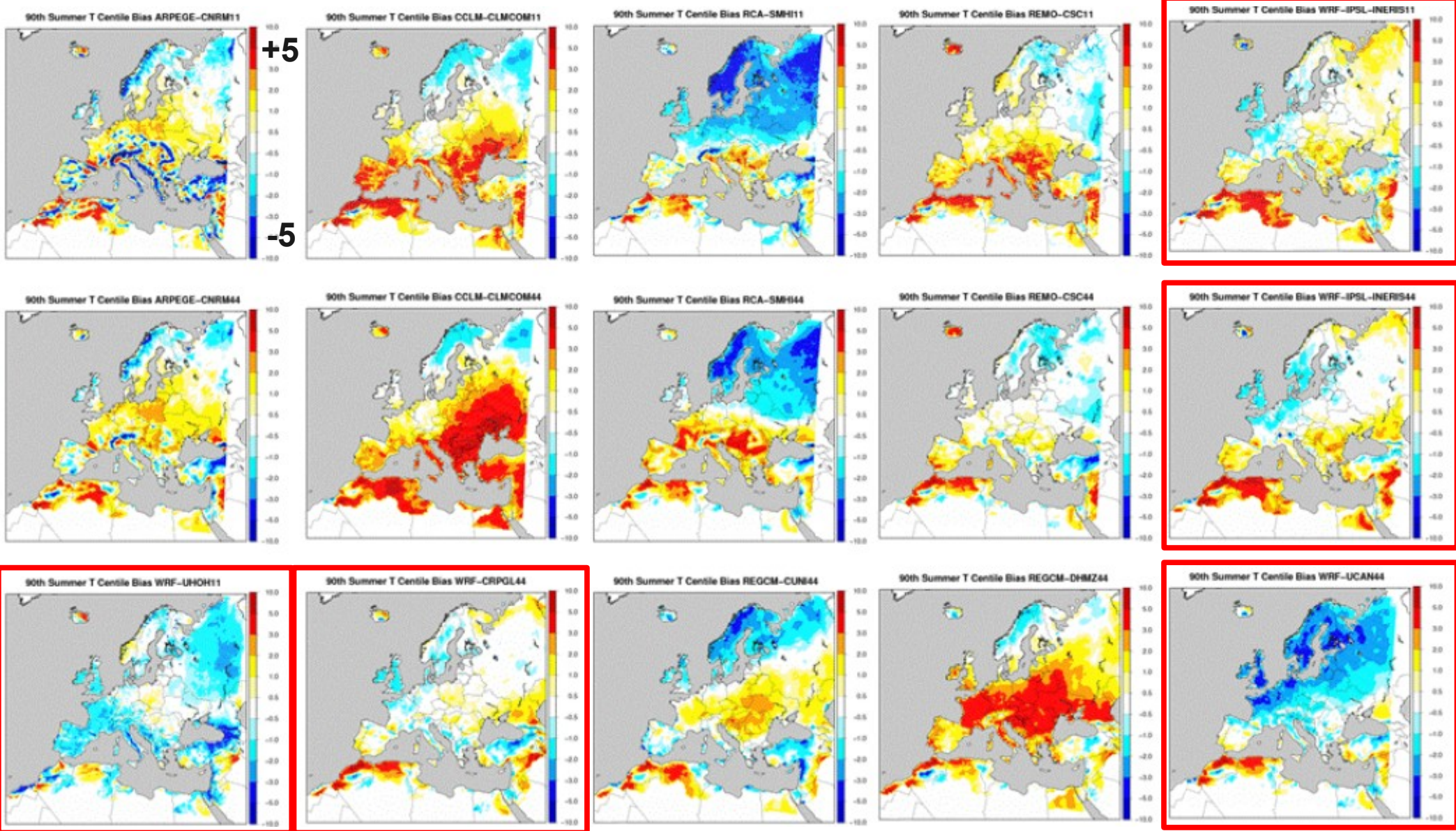
Source: Nikulin et al. (2012)  
J. Clim. 25:6057-6078



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# WRF compared to other RCMs



Source: Vautard et al. (2012)  
Submitted to Clim. Dyn.

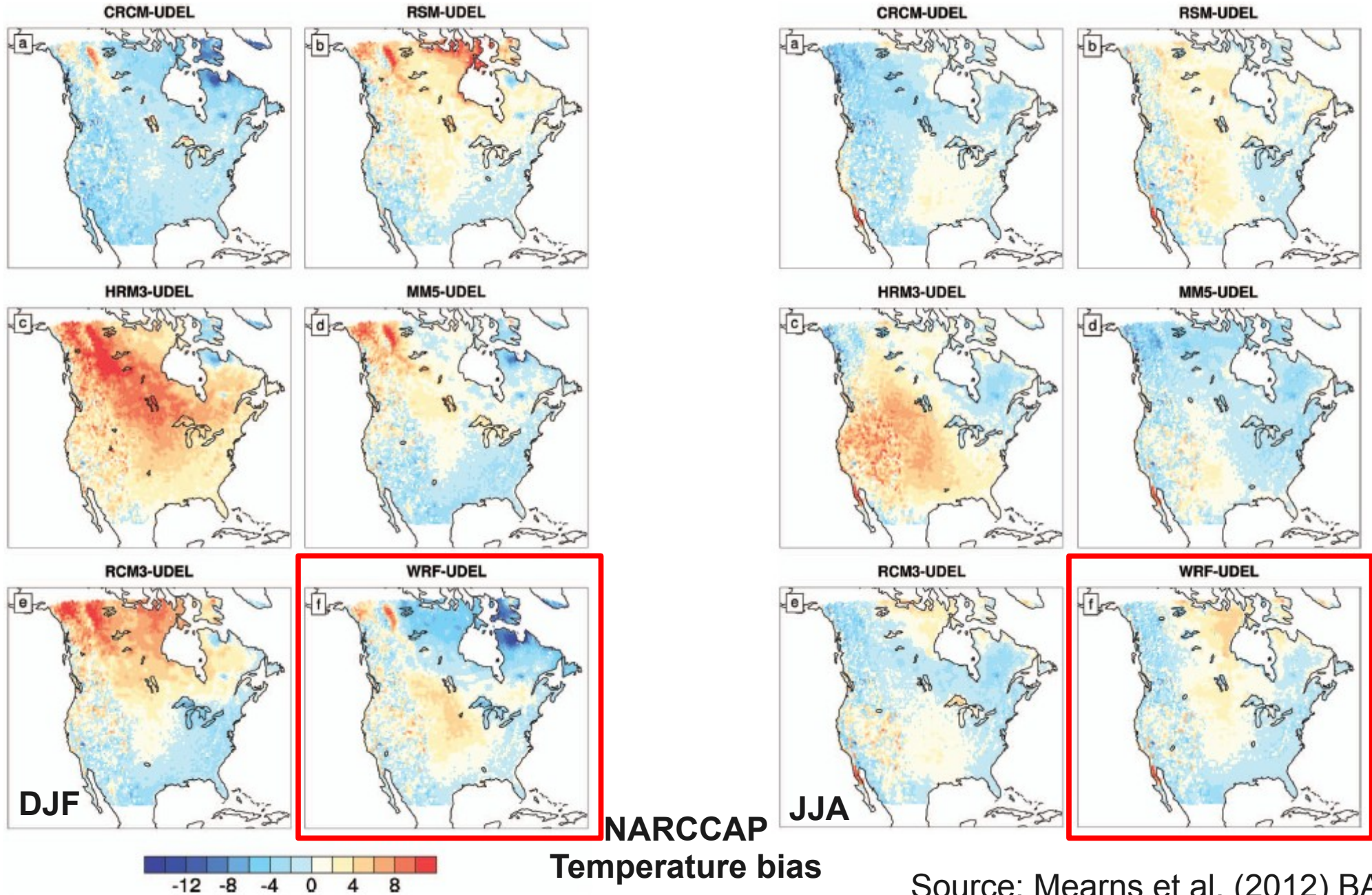
**Bias of the 90<sup>th</sup> percentile of summer (JJA) temperature**



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# WRF compared to other RCMs



NARCCAP  
Temperature bias



## Coordinated regional climate downscaling experiment using WRF: a contribution to the CORDEX initiative by the Spanish WRF community

### Universidad de Cantabria

**Jesús Fernández** (fernandej@unican.es)  
Lluís Fita → now at CCRC, UNSW  
Markel García-Díez  
Ana Casanueva

### Universidad de La Laguna

Albano González  
Juan Carlos Pérez-Darías  
Juan Pedro Díaz

### Universidad de Murcia

Pedro Jiménez-Guerrero (pedro.jimenezguerrero@um.es)  
Raquel Lorente  
Juan Pedro Montávez

### Fundación Parque Científico Murcia

Juan Alejandro Palomino

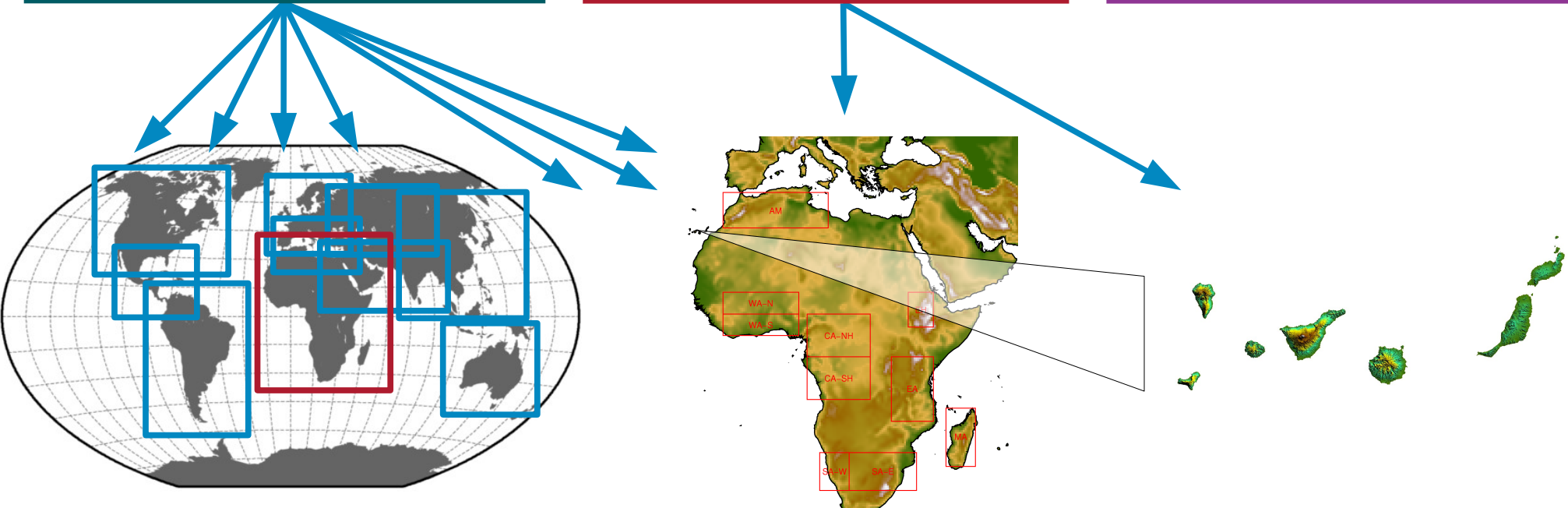


# WRF

Grid computing

ROMS

Canary islands



WRF modifications and tools

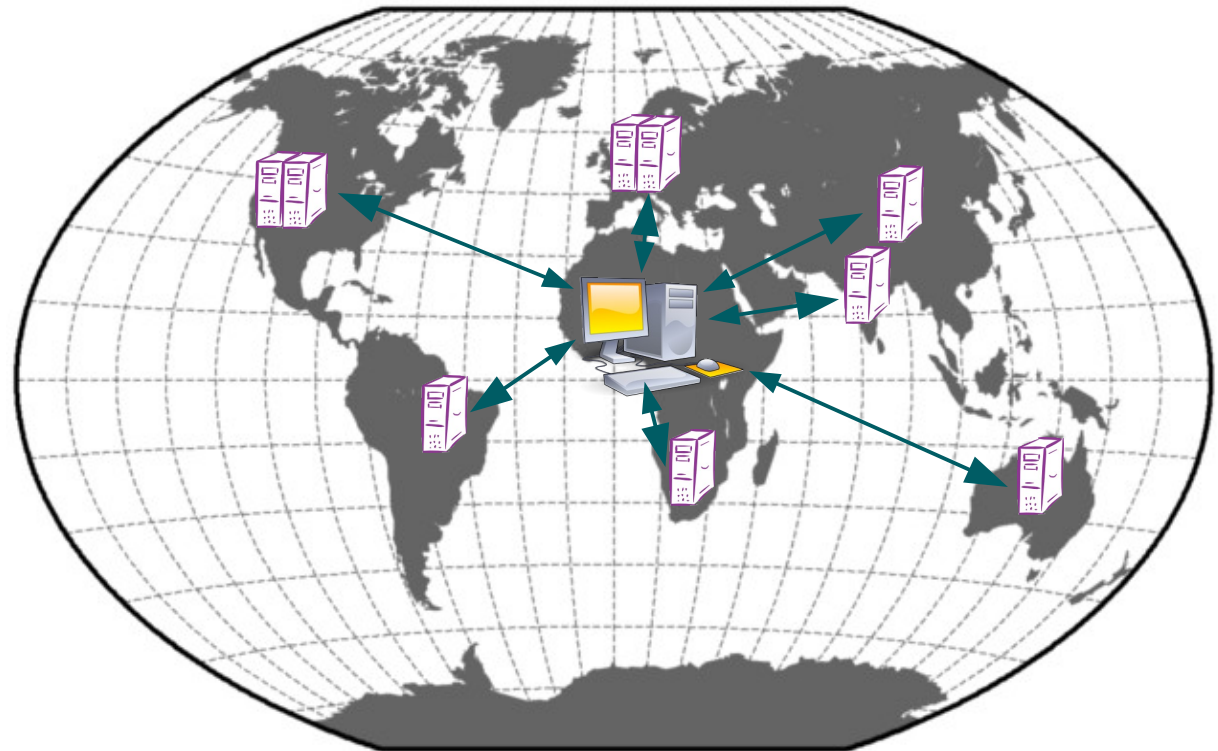
Coordination / dissemination



# Grid computing

Grid computing is a computational paradigm taking advantage of **geographically distributed computer resources**.

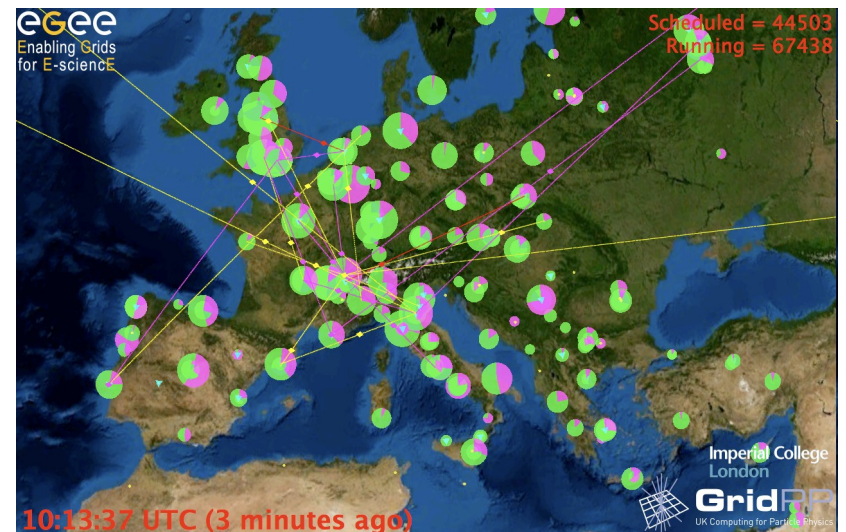
A software layer (middleware) provides **transparent access** to the distributed resources.



# Grid computing

## Example: EGI infrastructure

- 150.000 CPUs
- 70 PB
- 260 sites worldwide
- Architectures: i386,x86\_64
- LRMS: torque, sge, lsf, bqs



## Another example: Earth System Grid (only storage)

- Infrastructure shared between several NL in the US
- Holding the PCMDI CMIP3, CMIP5 and many other databases

# WRF

## Grid computing

**WRF4G**, developed by the Santander Meteorology Group, provides:

- Flexible WRF experiment design for long (climate) runs, hindcast experiments, multi-physics ensembles, etc. and ...
- ... the ability of running these experiments on different computer resources in a transparent way.

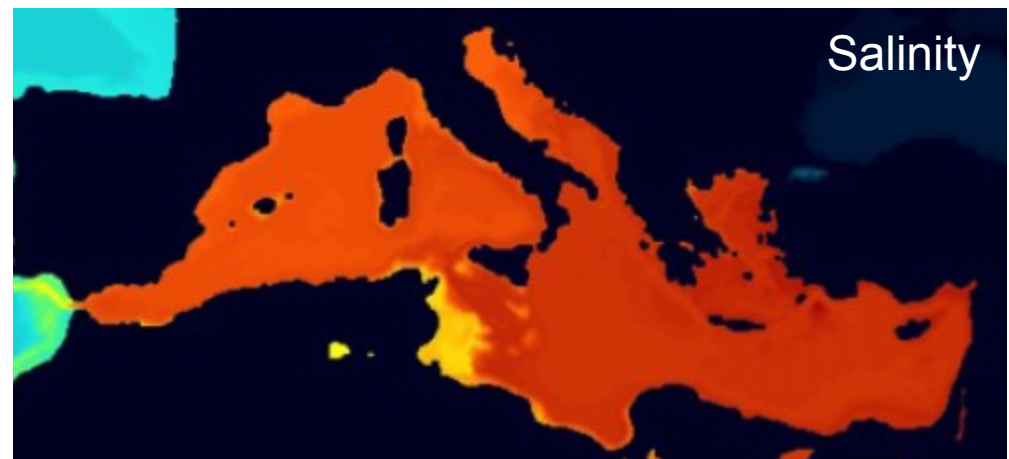
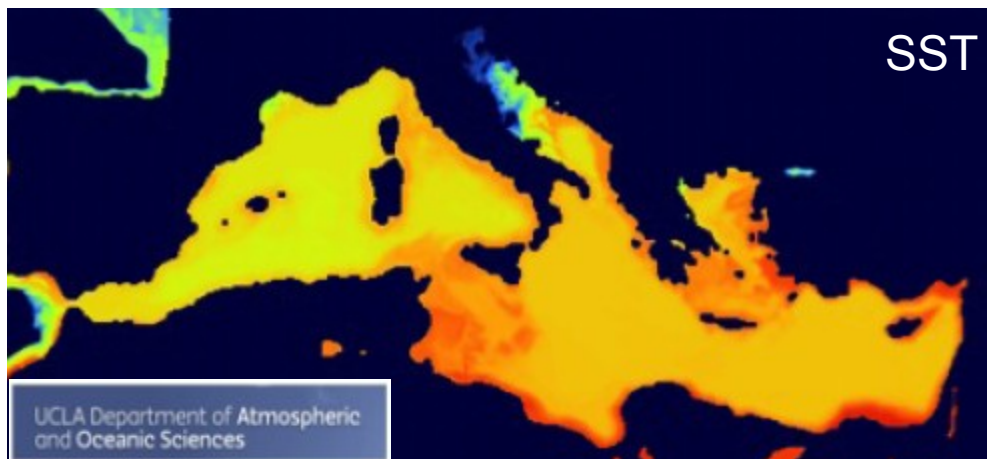
Within CORWES, we plan to face the **challenge of performing regional climate simulations on the Grid** using WRF4G.

This could become a **source of computer power for developing countries**.

# WRF

## ROMS

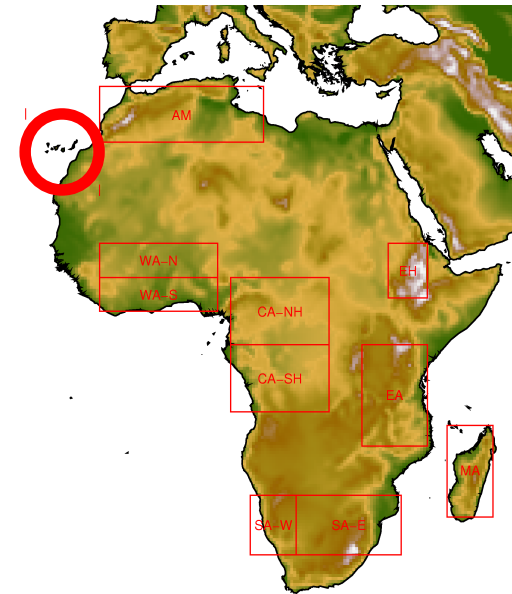
- The **Regional Ocean Modeling System** will be interactively coupled to WRF to investigate the role of the air-sea coupling at regional scale.
- The African domain within CORWES will be simulated with prescribed SST and coupled to the ocean
- Also, high resolution simulations for the Canary islands will be tested.





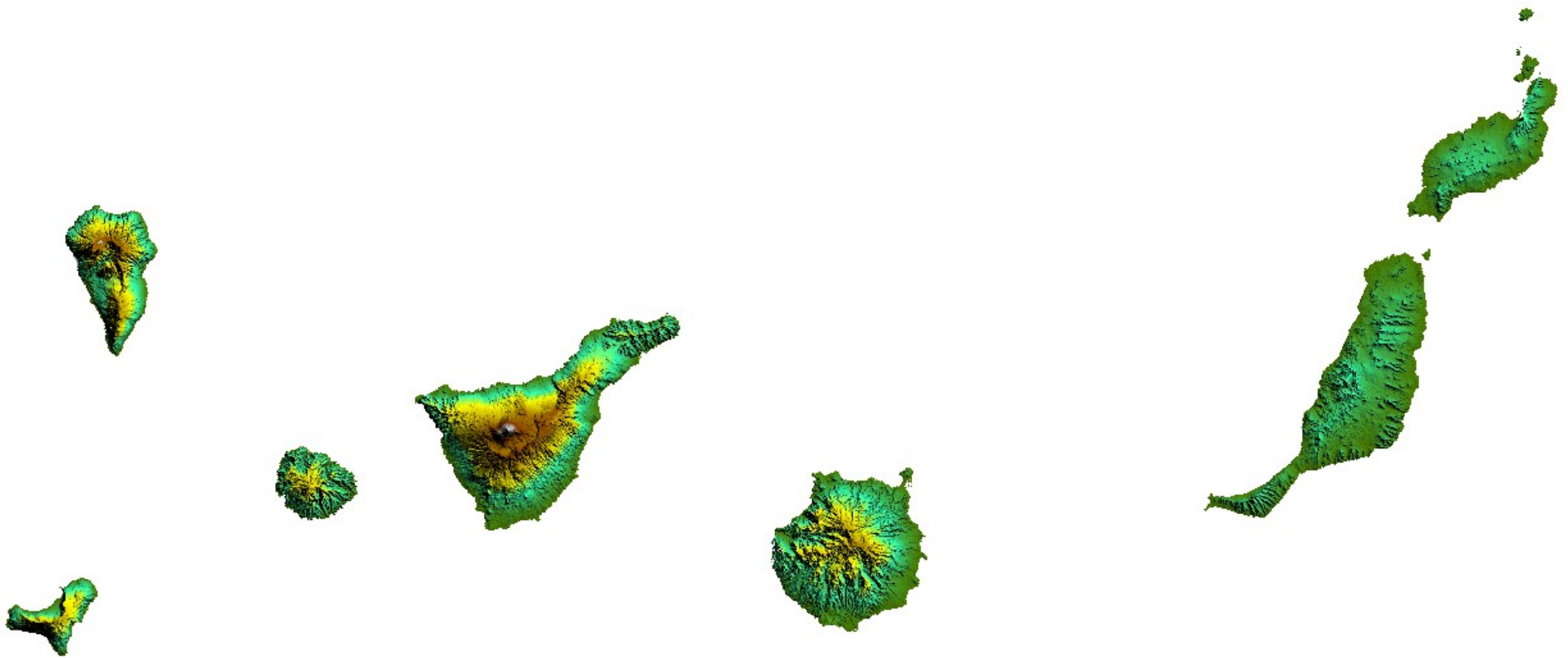
# Canary islands

- Challenging region
  - Very complex orography over a small region
  - Large impact of local forcings on climate
  - Important oceanic and African influences

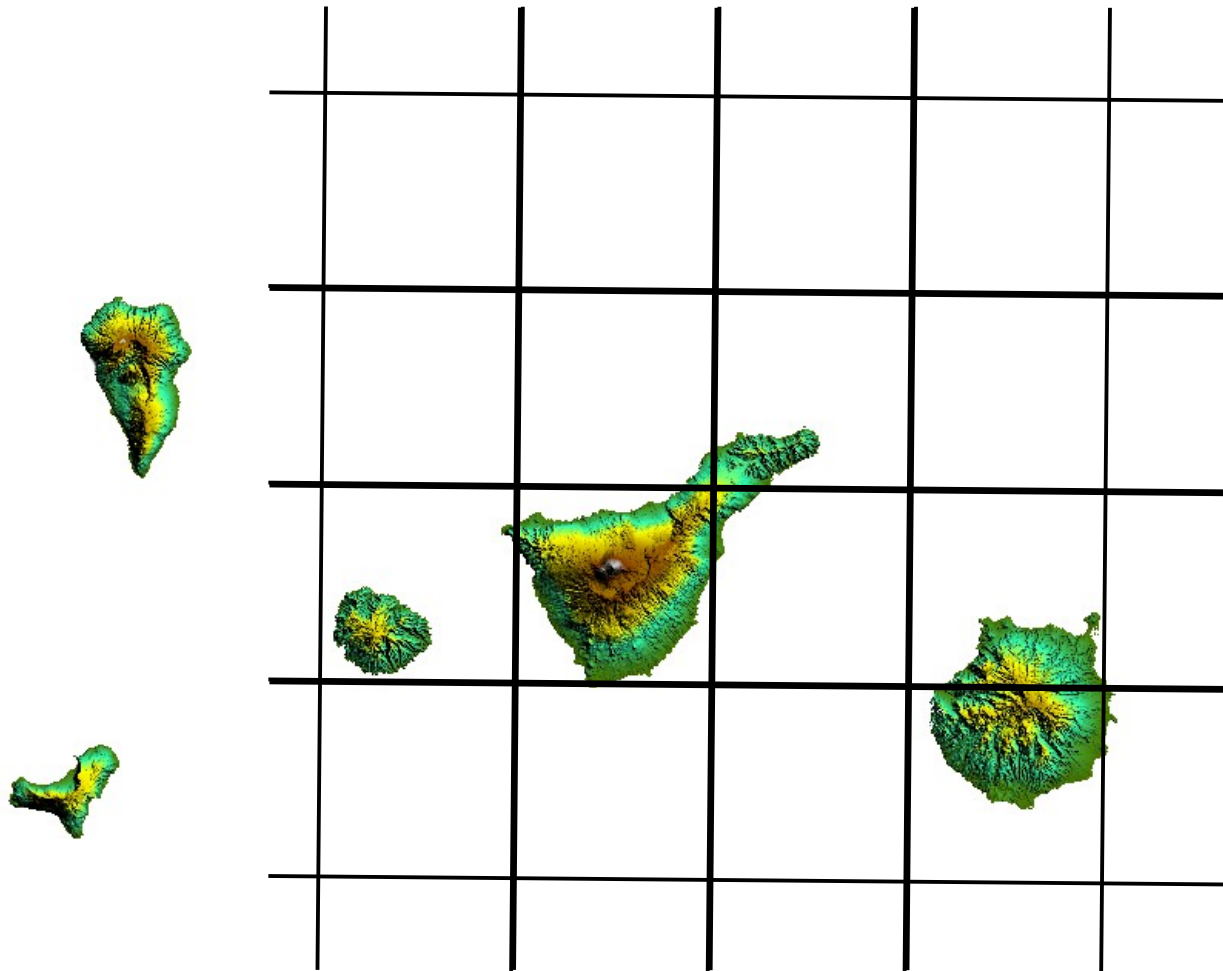




# Canary islands



# Canary islands



50 Km mesh



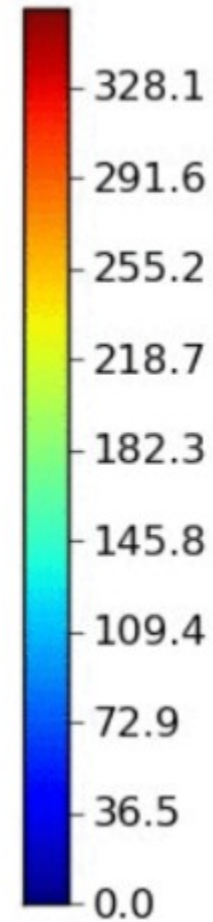
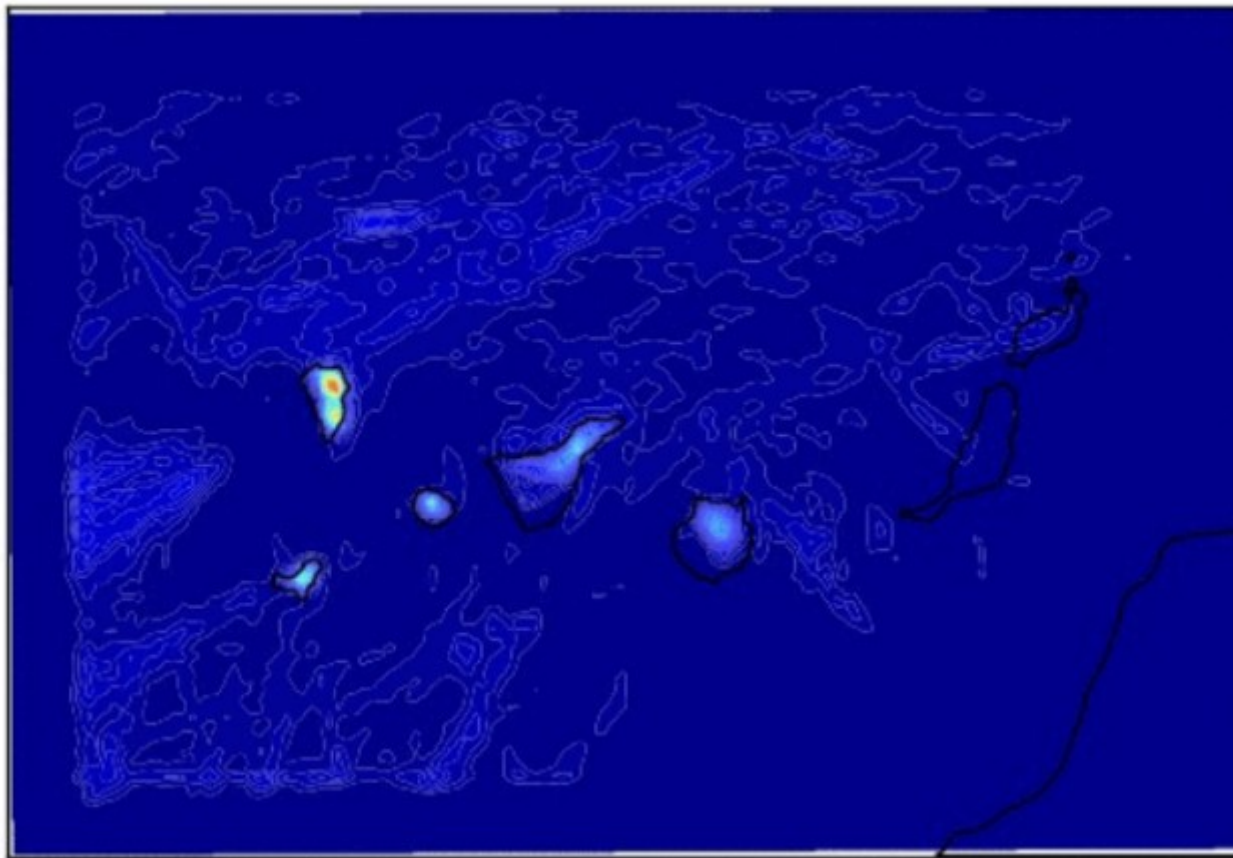
# Canary islands



# WRF

## Canary islands

CORDEX 1989-1994 Accumulated Precipitation



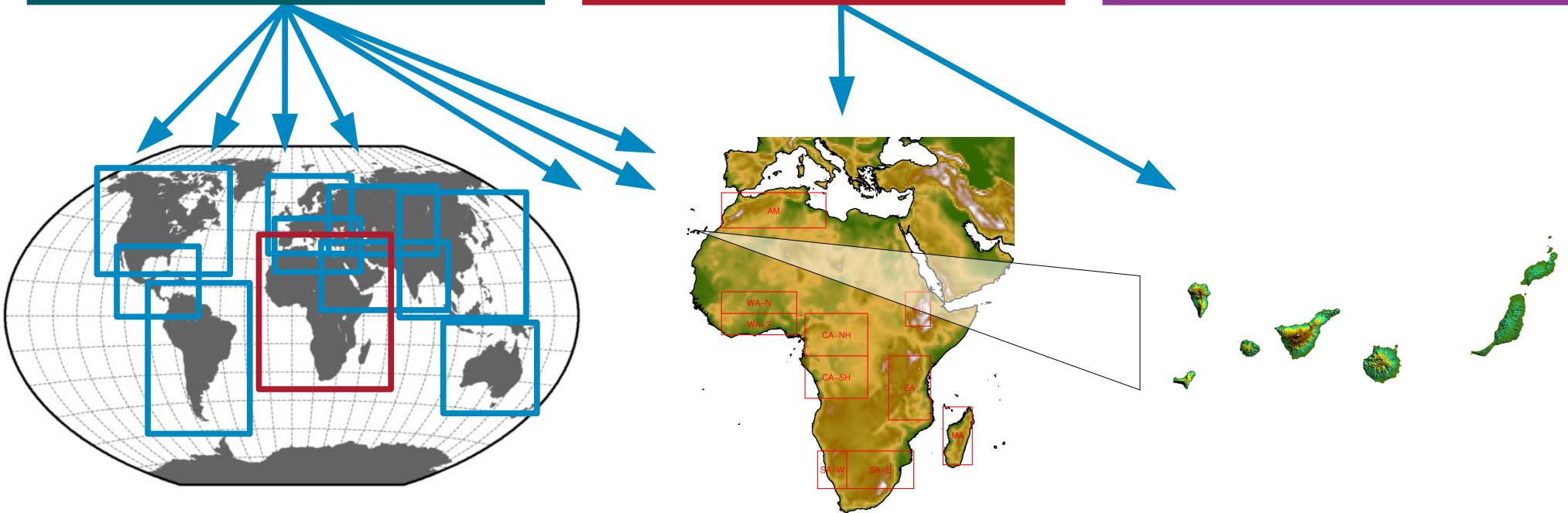
WRF at 5 Km resolution (Source: GOTA, ULL)

# WRF

Grid computing

ROMS

Canary islands



WRF modifications and tools

Coordination / dissemination



Within CORWES we **developed tools** to:

- Compute maximum/minimum variables, modify GHG concentrations in the radiation code, ...

**CLWRF** · (Partly) available in official WRF v3.3.1

- Run and monitor WRF experiments transparently across geographically distributed resources

**WRF4G** · <http://www.meteo.unican.es/software/wrf4g>

**WRF modifications and tools**

Within CORWES we **plan to develop tools** to:

- Ingest data from different GCMs
  - e.g. CMIP5 data in CMOR format
- Compute all output variables requested by CORDEX
  - e.g. Cloud cover at different heights, max 1h precip, ...
  - Some of these can be derived from existing ones, others need to be added to the model and produced as it runs.
- Post-process WRF files to comply with CORDEX format

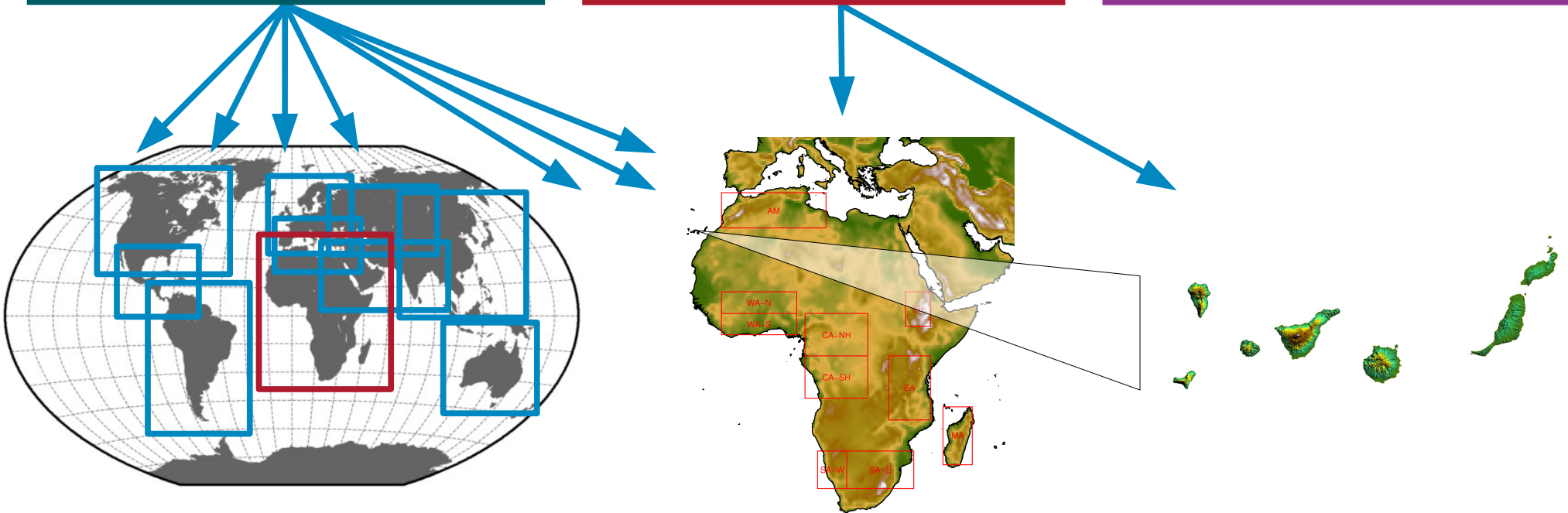
**WRF modifications and tools**

# WRF

Grid computing

ROMS

Canary islands



WRF modifications and tools

Coordination / dissemination

CORWES is primarily a project to coordinate the Spanish groups in CORDEX-WRF and focuses on transfer of knowledge and technology among groups and with the community. Open workshops are planned:

- Coordination with the CORDEX-WRF community
- Diagnostic and post-processing tools
- WRF4G framework
- WRF-ROMS coupling

**Coordination / dissemination**

CORWES is primarily a project to coordinate the Spanish groups in CORDEX-WRF and focuses on transfer of knowledge and technology among groups and with the community. Open workshops are planned:

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**1<sup>st</sup> CORDEX-WRF Workshop**

- Diagnostic and post-processing tools

**CORWES/WRF4G hands-on tutorial**

- WRF4G framework

**CORWES/WRF4G hands-on tutorial**

- WRF-ROMS coupling

**Future event**

**Coordination / dissemination**





**Coordinated regional climate downscaling experiment using WRF**  
a contribution to the CORDEX initiative by the Spanish WRF community

# Thank you!

**Contact:** [jesus.fernandez@unican.es](mailto:jesus.fernandez@unican.es)

## Composed of people from 2 institutions in Santander:

- Universidad de Cantabria ([Dept. Appl. Maths & Comp. Sci.](#))
- National Research Council ([Instituto de Física de Cantabria](#))

## A multidisciplinary approach for weather & climate

- Statistics ([Statistical downscaling, probabilistic forecasting, ...](#))
  - Work on CMIP5 GCM comparison (probably worth for later discussion)
- Numerical modelling ([MM5, WRF, CAM](#))
- Statistical physics ([e.g. error growth on dynamical systems](#))
- Computer science ([data access, metadata, GRID computing,...](#))

*Multidisciplinary approach to weather & climate*

**Santander Meteorology Group**

*A multidisciplinary approach for weather & climate*