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

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MINISTERIO DE CIENCIA E INNOVACIÓN

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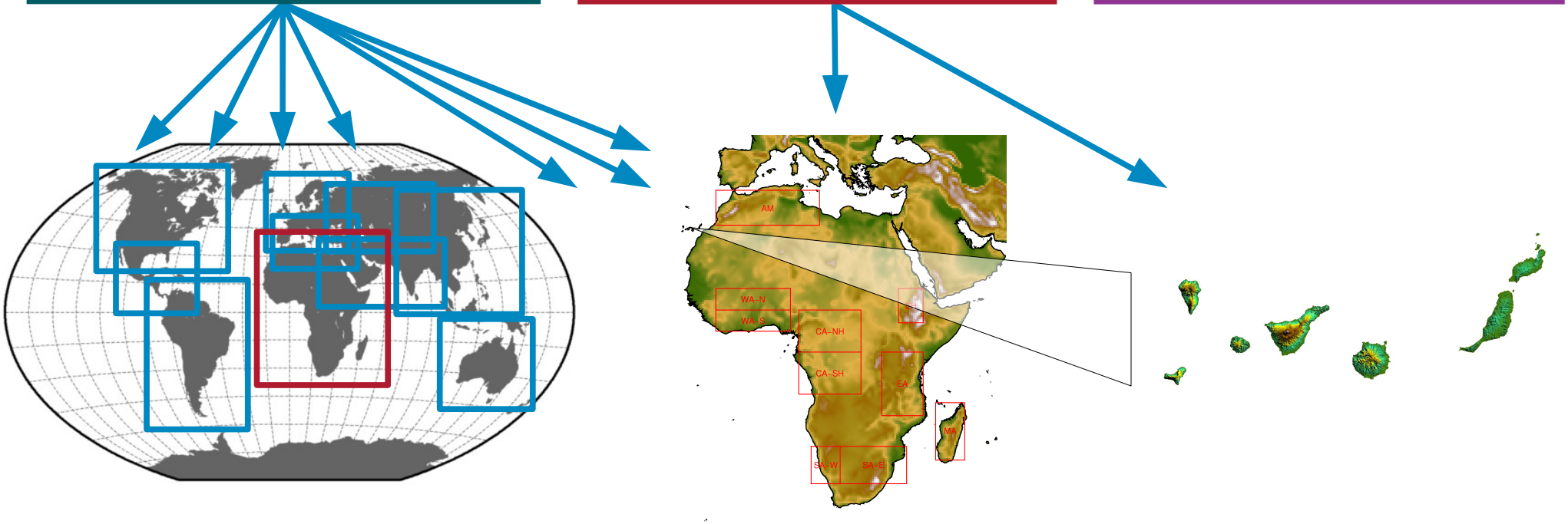
WRF

Grid computing

ROMS

Canary islands



WRF modifications and tools

Coordination / dissemination

WRF

Grid computing | ROMS | Canary islands

- The Advanced Research WRF (ARW) core is a flexible dynamical downscaling tool including:
  - Many state-of-the-art physical parameterizations
  - Several grid projections
  - Multiple nesting (one- and two-way)
  - Nudging options (grid and spectral)

- This flexibility makes WRF an ideal tool for downscaling experiments in different regions of the world, working at different resolutions.

WRF Framework diffusion second order

Coordination / dissemination

WRF

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

- Several groups use WRF as a regional climate downscaling tool. **CORDEX-WRF** gathers their plans and configuration (currently there are 22 groups listed):

  - Bjerknes Centre for Climate Research (University of Bergen, Norway)
  - Center for Monsoon System Research (Institute of Atmospheric Physics, CAS, Beijing)
  - School of Atmospheric Sciences, Nanjing University, Nanjing, P.R. China)
  - 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)
  - 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)
  - Grupo AIRE (Universidad de Extremadura, Spain)
  - Grupo de Observación de la Tierra y la Atmósfera (University of La Laguna. Canary Islands, Spain)
  - 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)
  - Weather and Climate Modeling Group (Western Kentucky University, USA)
  - Wind & Site Competence Centre (Vestas Technology R&D, Denmark)
  - Global Change Impact Studies Centre (GCISC), Islamabad, Pakistan
  - Hydro-Meteorology Monitoring and Modeling Group (Amazonas State University, South America, Brazil)

WRF

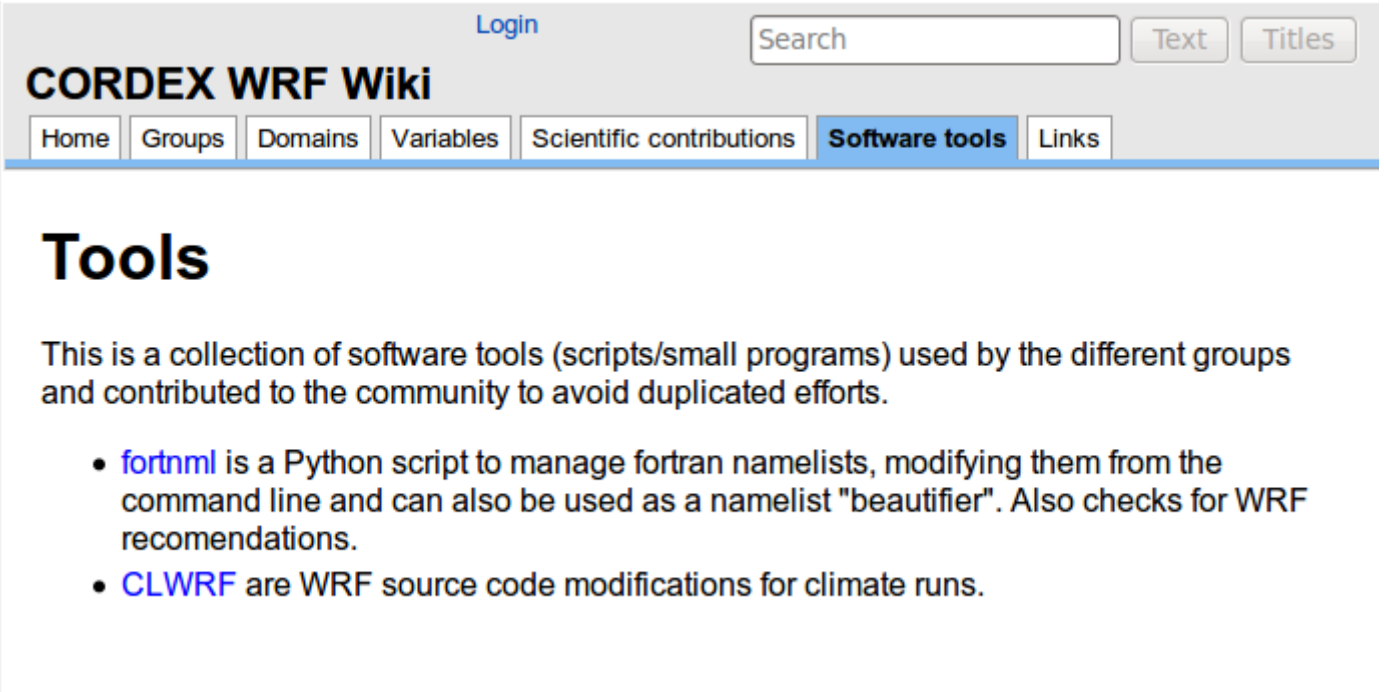
WRF as an RCM (oportunities related to CORDEX)

- WRF is under very active development, including the addition of long term run capabilities: varying SST, deep soil temp, GHG, detailed radiation and soil schemes, ...
- There are still some missing features:
  - Ability to ask for avg, max, min variables instead of instantaneous (required to meet the output requirements of any RMIP)
  - Ability to change the emission scenario (currently hard-coded to A2 in cam3 radiation package and fixed concentrations in others)
  - ...
- Others are a bit hidden: calendar changing options
- These issues are currently solved individually by each group
  - e.g. in UC we call it CLWRF

WRF

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

CORDEX-WRF is also a place to share developments of the model or associated 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

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:

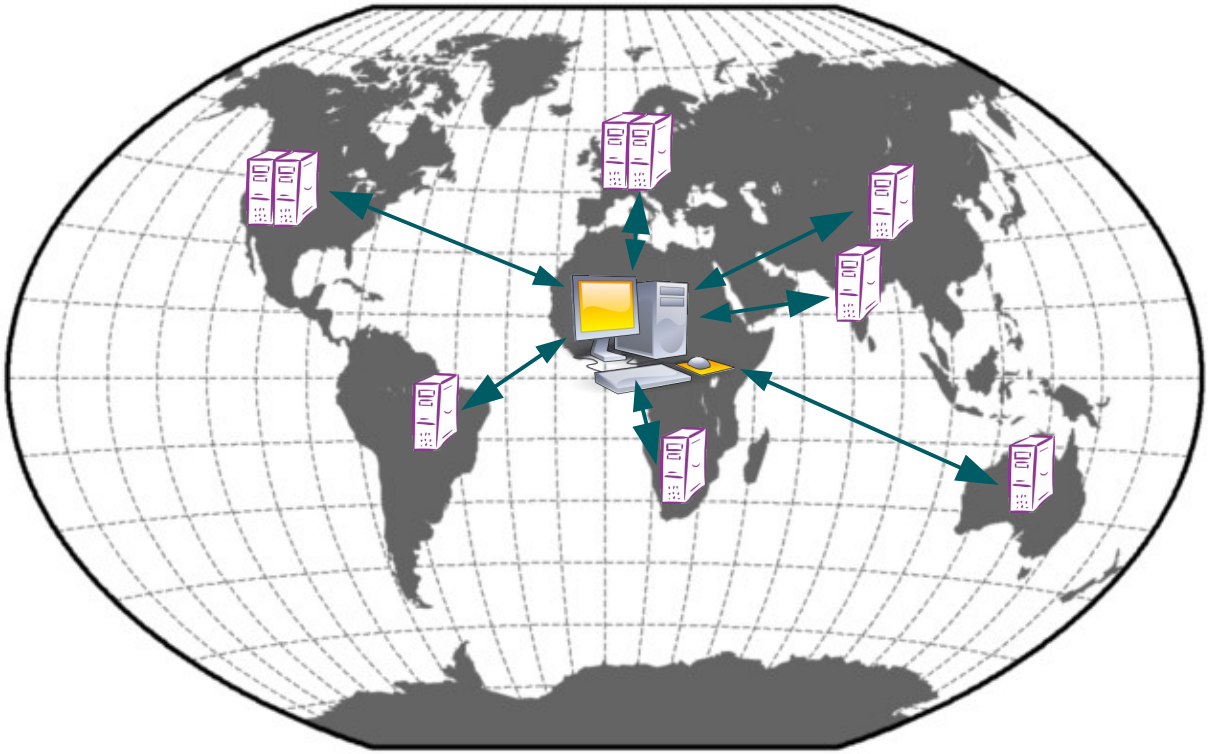
- Diagnostic and post-processing tools
- WRF4G framework
- WRF-ROMS coupling

Coordination / dissemination

Grid computing

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

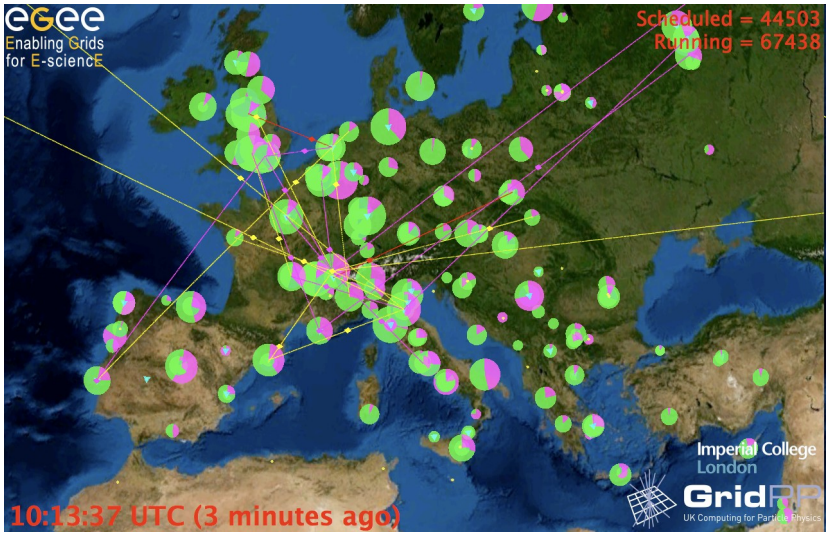
A software layer (middleware) provides **transparent access** to the distributed resources.



Grid computing

Example: EGI infrastructure

- 150.000 CPUs
- 70 PB
- 260 sites worldwide
- Arquitectures: i386,x86_64
- LRMS: torque, sge, lsf, bqs



Another example: Earth System Grid (only storage)

- Infraestructure 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 the Grid or on local resources in a transparent way.

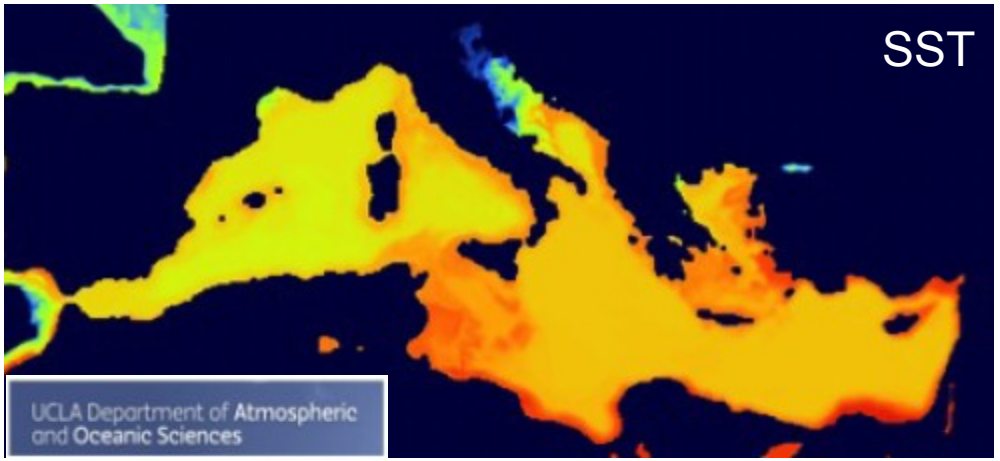
Within CORWES, we plan to face the **challenge of performing regional climate simulations on the Grid** using WRF4G.

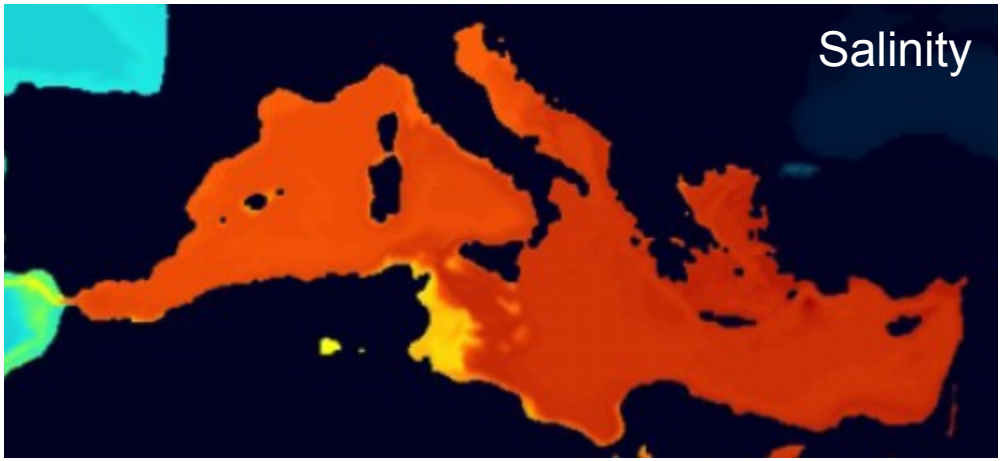
This could become a **source of computer power for developing countries**.

WRF

ROMS

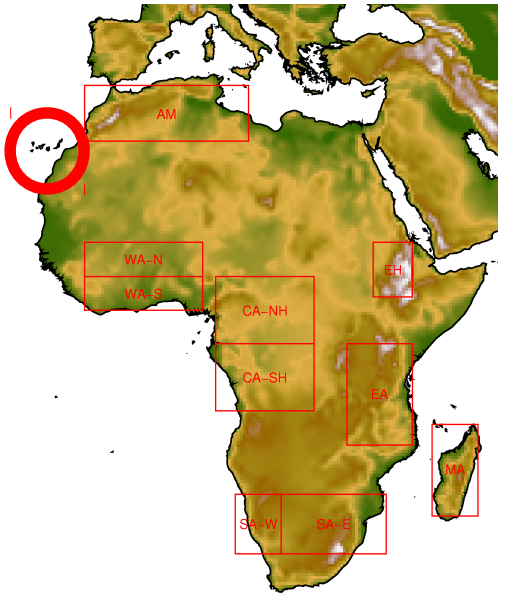
- The **Regional Ocean Modeling System** will be interactively coupled to WRF to investigate the role of the air-sea coupling at regional scale.
- The African domain within CORWES will be simulated with prescribed SST and coupled to the ocean
- Also, high resolution simulations for the Canary islands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



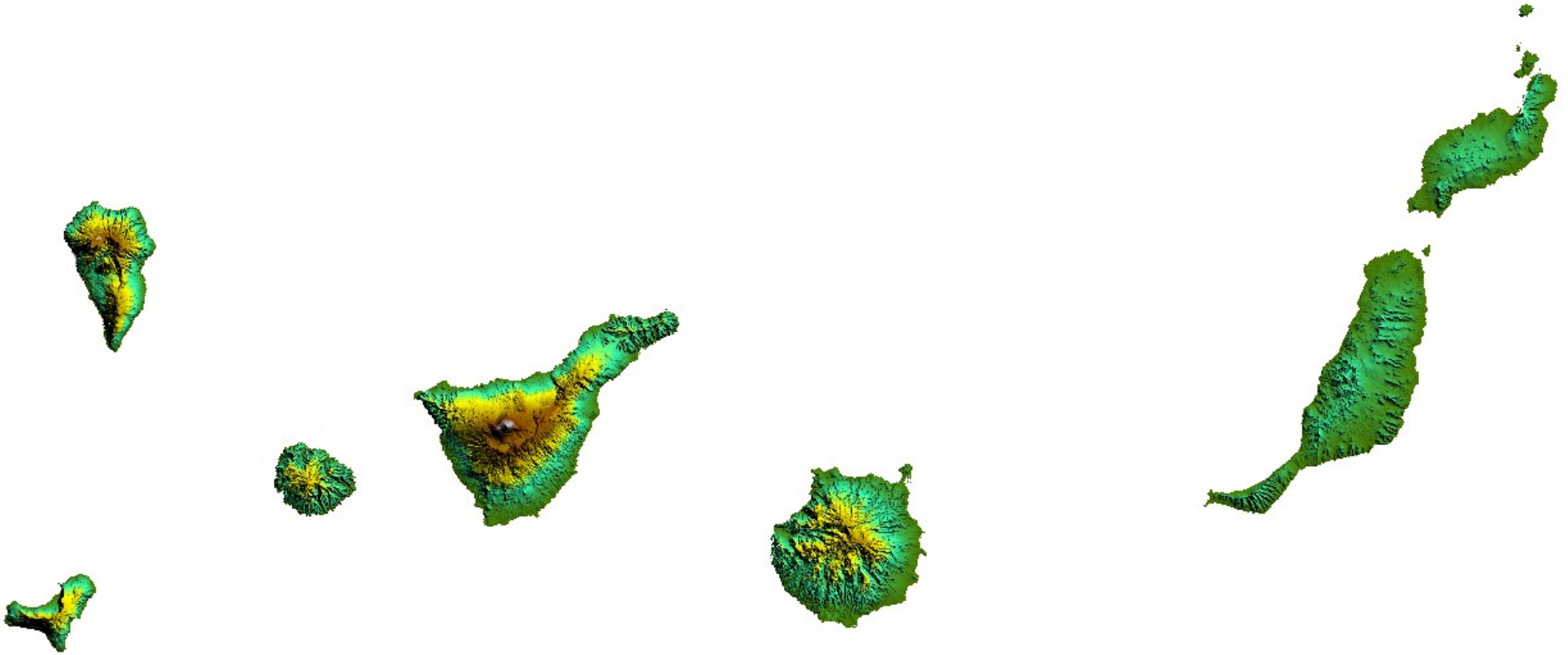


Canary islands

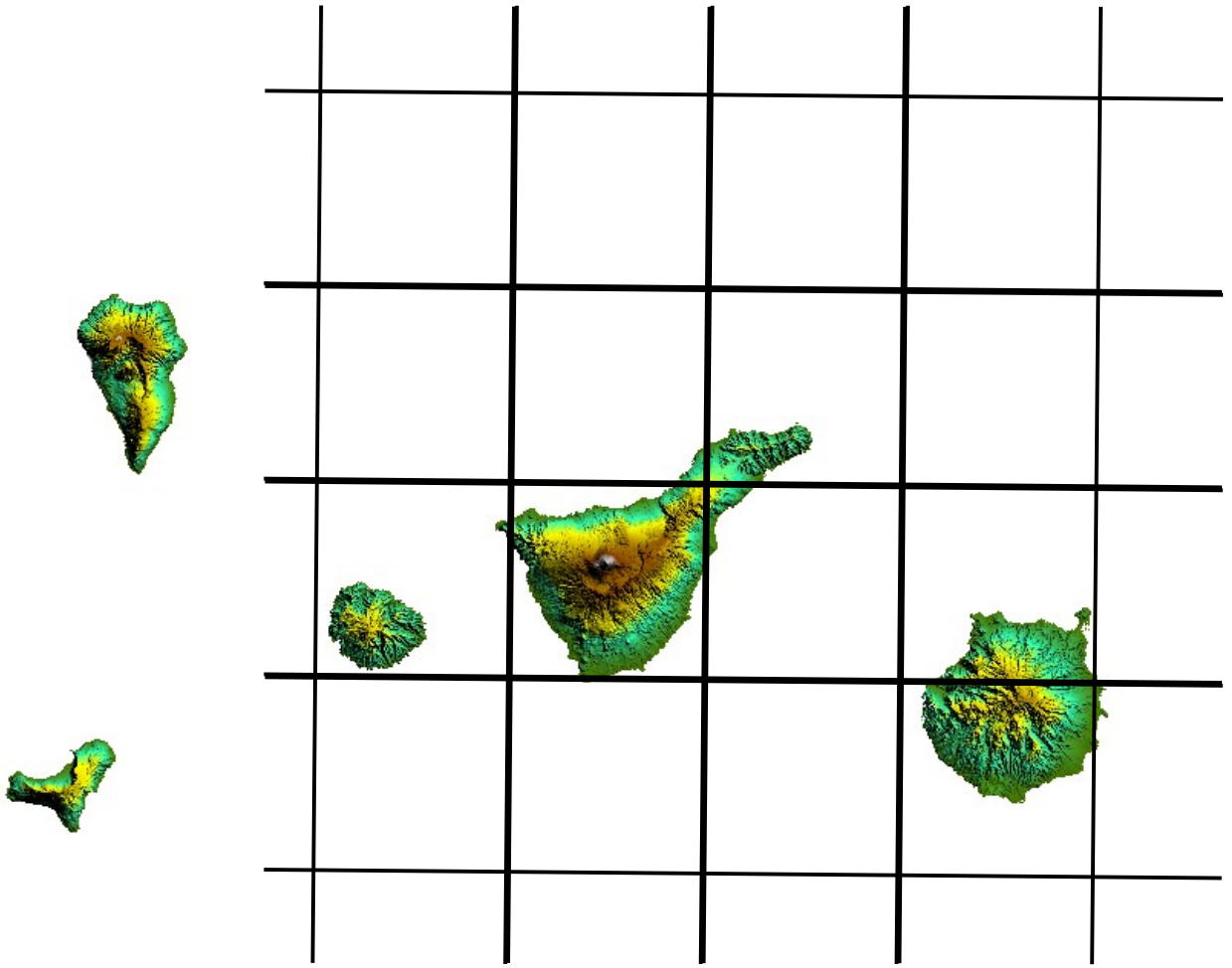
- Challenging region
  - Very complex topography over a small region
  - Large impact of local forcings on climate
  - Important oceanic and African influences



Canary islands

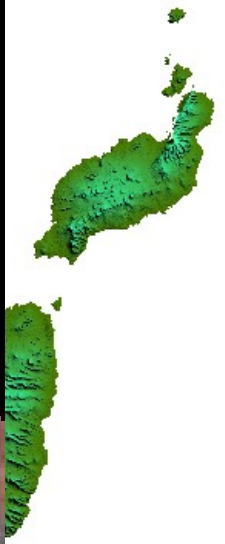


Canary islands



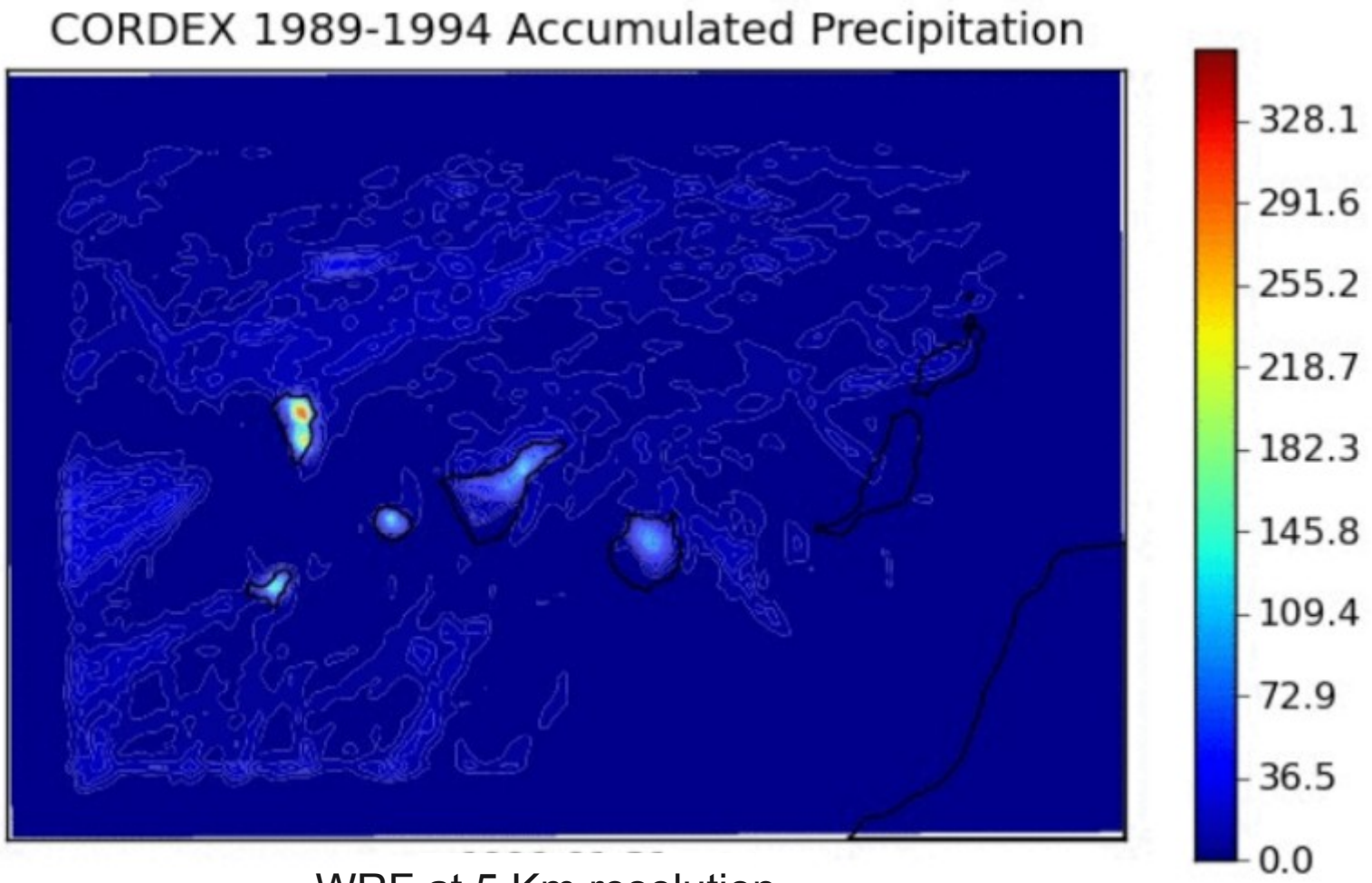
50 Km mesh

Canary islands



WRF

Canary islands



WRF at 5 Km resolution

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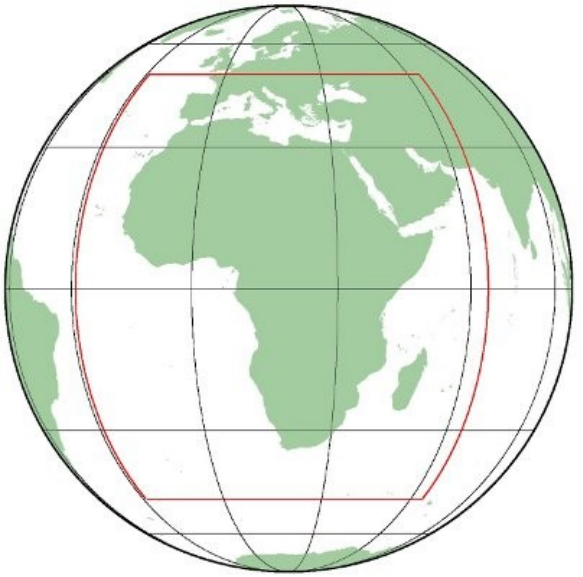
Sensitivity simulations

Poster on Wednesday

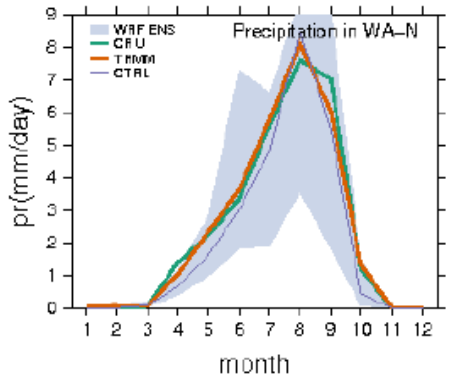
- Sensitivity experiment on the (north-extended) African domain
  - WRF v3.1.1
  - One year (1998)
  - 50 Km resolution

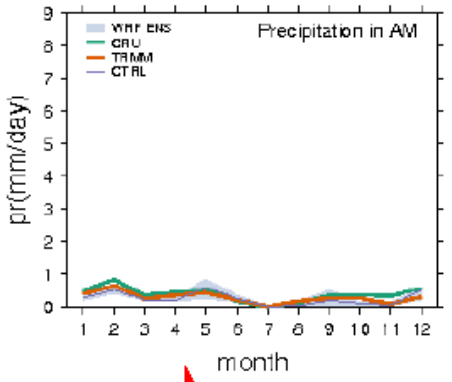


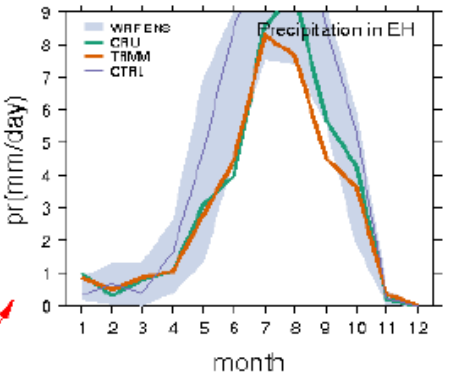
CTRL
(CUKF, RAC3, LSRU, BLYS)

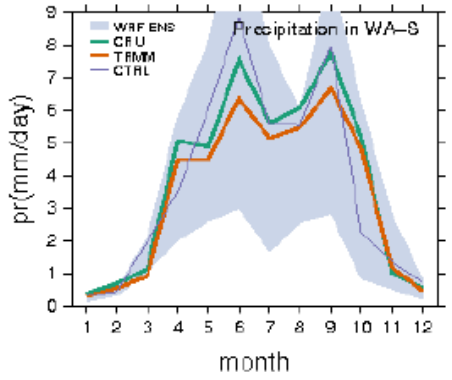
Cumulus	**Radiation**	**Land surface**		**Boundary Layer**
CUBM	RARR	LSNO	BLPX	BLMY
CUGD	RARG			

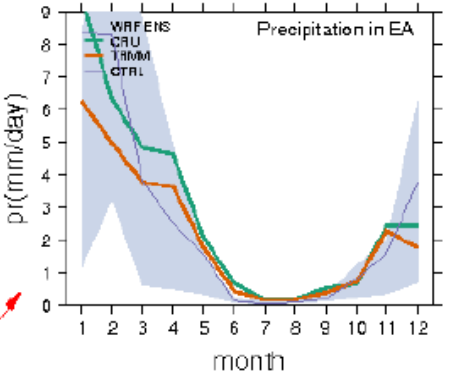
Monthly annual cycle
Precipitation

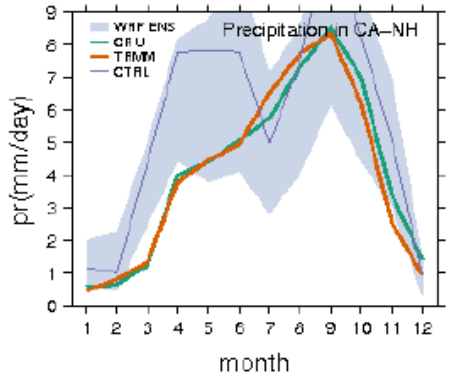


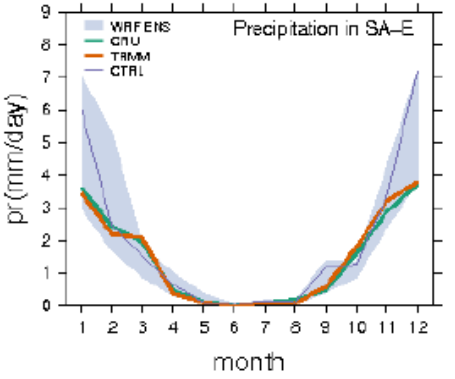


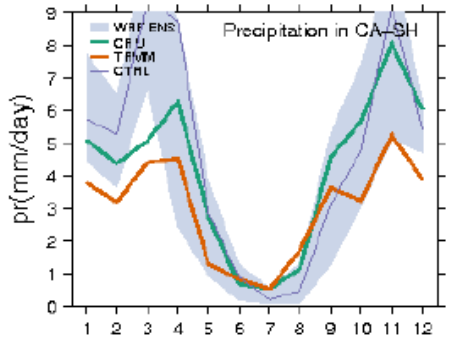


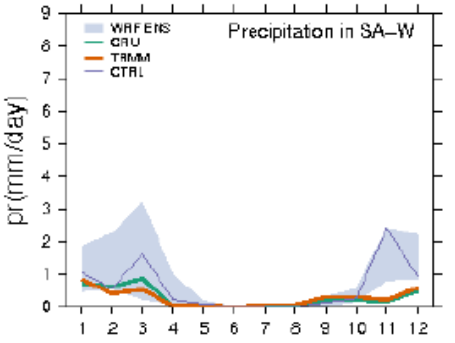


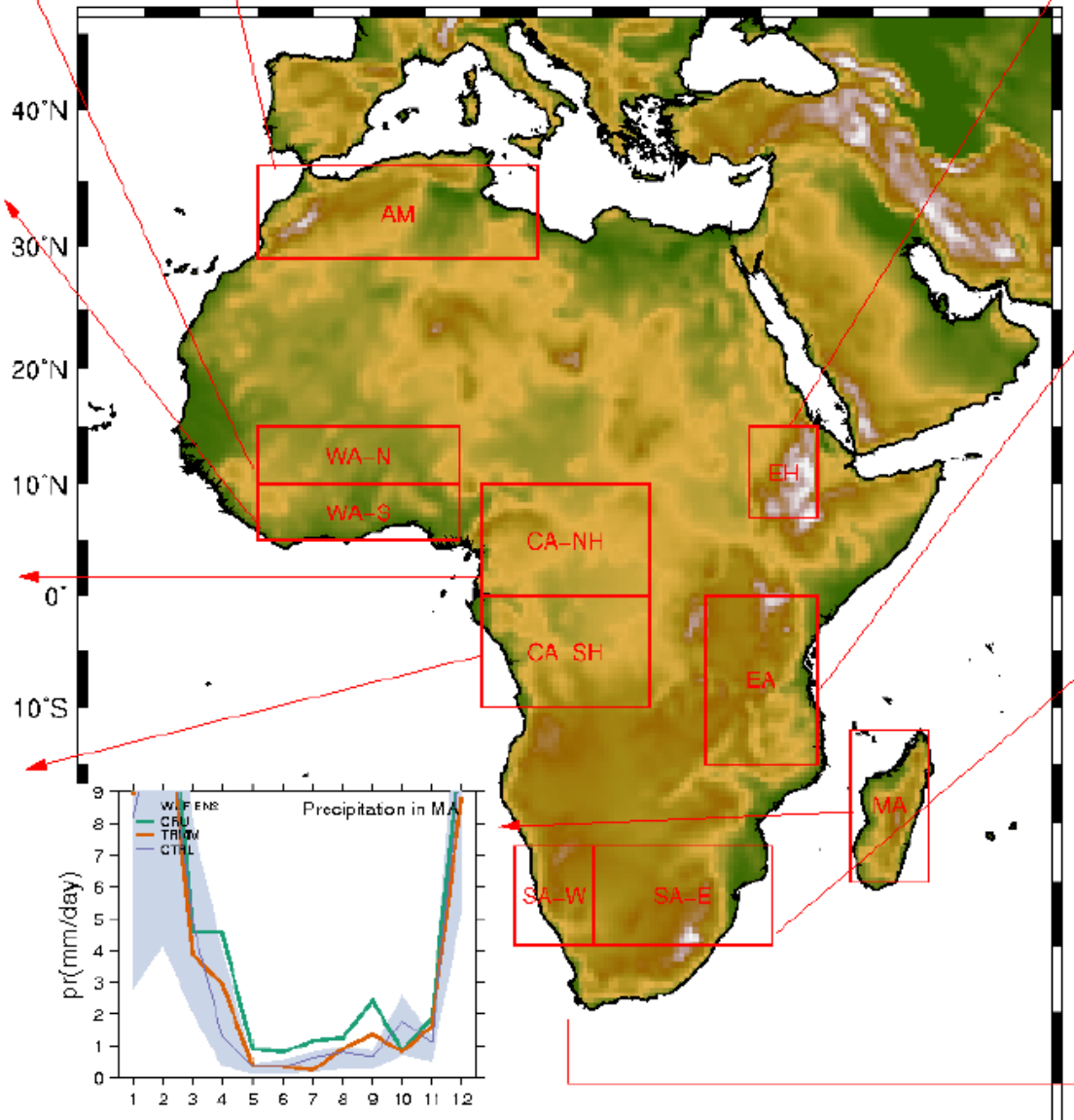


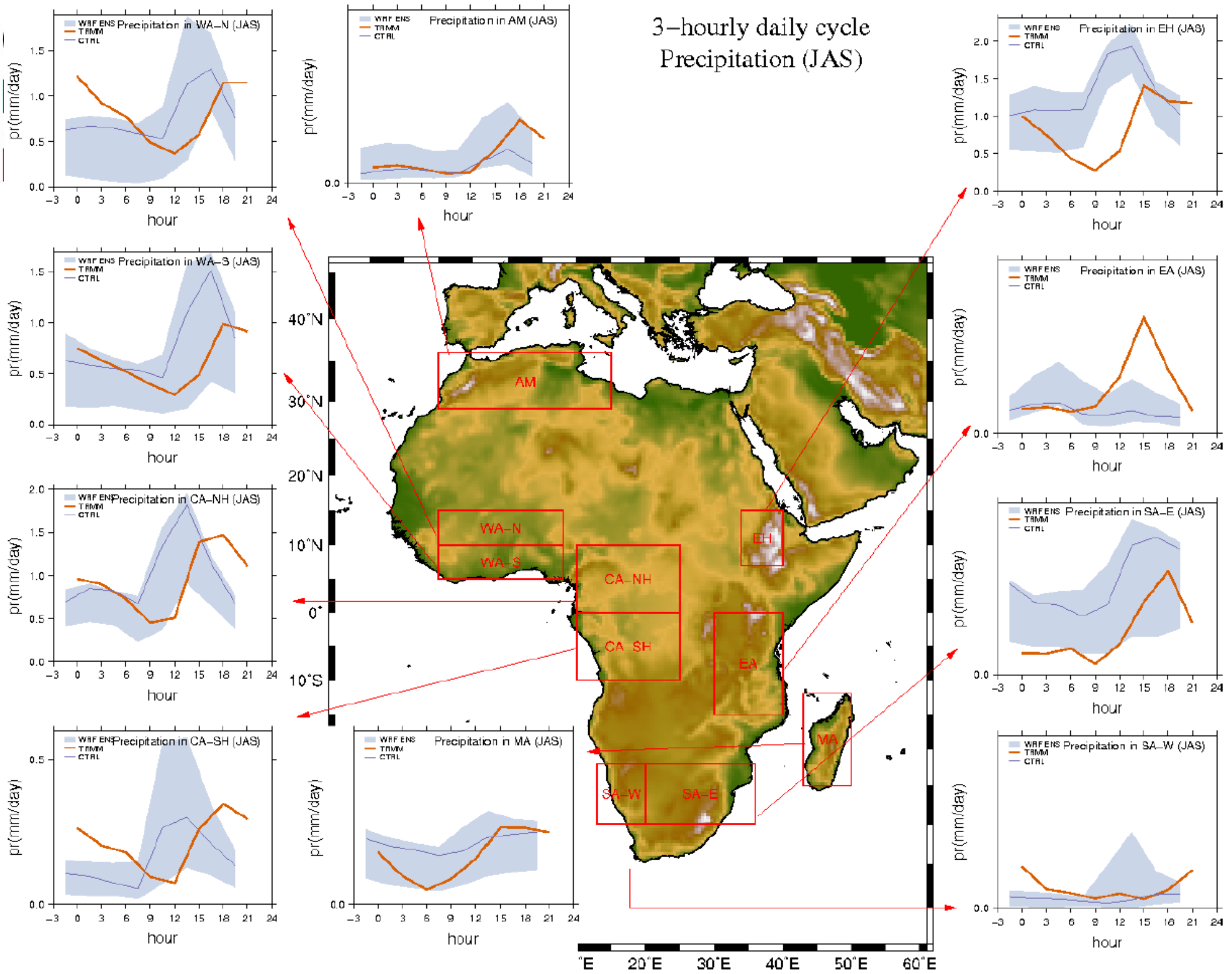











3–hourly daily cycle
Precipitation (JAS)
Precipitation in WA–N (JAS)
Precipitation in AM (JAS)
Precipitation in EH (JAS)
Precipitation in WA–S (JAS)
Precipitation in EA (JAS)
Precipitation in CA–NH (JAS)
Precipitation in SA–E (JAS)
Precipitation in CA–SH (JAS)
Precipitation in MA (JAS)
Precipitation in SA–W (JAS)
WRF ENS
TRMM
CTRL
pr(mm/day)
hour
AM
WA–N
WA–S
CA_NH
CA_SH
EH
EA
MA
SA–W
SA–E
40°N
30°N
20°N
10°N
0°
10°S
°E
20°E
30°E
40°E
50°E
60°E

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Thank you!

Contact: fernandej@unican.es

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CORWES Task Diagram