# The Med-CORDEX initiative: towards fully coupled Regional Climate System Models to study the Mediterranean climate variability, change and impact

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## 01 | MOTIVATIONS for Med-CORDEX

- A climate change hot-spot (Giorgi, 2006)
- Many regional physical processes (cyclogenesis, regional winds, islands, narrow and shallow straits, key role of the rivers, extreme events, ...)
- Proved added-value of high-resolution RCM (Gibelin and Déqué, 2003; Gao et al. 2006; Herrmann et al. 2011)
- Proved added-value of Regional Climate System Model (RCSM) including air-sea-land-hydrology coupling (Somot et al. 2008; Artale et al. 2010)
- To serve the scientific objectives of MedCLIVAR and HyMeX
- Natural follow-on of the CIRCE project (existing modelling community)
- To share expertise and good practices in multi-component regional climate modelling
- To prepare clean model intercomparison for ARCM and RCSM
- To enhance the communication between the various communities (ocean, atmo, land, hydrology)
- To create new evaluation methods for the multi-component RCSM (best use of the new satellite products and new in-situ dataset)
- To be in phase with the HyMeX in-situ field campaign (2012-2014)
- To work together to the improvement of the RCSM and of their components (atmosphere, land surface, river, ocean)
- To deliver quality-checked regional climate products to the climate community and the impact community
- To deliver improved messages about the climate change in the Mediterranean area for the next IPCC report (IPCC-AR5)

## 02 | MODELLING and SIMULATIONS

### CORE SIMULATIONS (as for all CORDEX domains)

- One common Mediterranean domain (Med and Black Seas + catchment basin excluding the Nile + Near-Atlantic)
- Minimal Spatial Resolution: 50 km
- Simulation 1: ERA-Interim lateral forcing for validation (1989-2007)
- Simulation 2: IPCC historical run as LBC (1950-2005)
- Simulation 3: RCP8.5 scenario run as LBC (2006-2100)
- Simulation 4: RCP4.5 scenario run as LBC (2006-2100)
- One driving GCM and one transient simulation for each RCM

### TIER1 SIMULATIONS

- RCSM: Regional Climate System Model (atmosphere, ocean, land surface, hydrology, river)
- Very High resolution RCM (up to 10 km, same domain)
- Transient runs mandatory for the RCSM
- Other driving GCMs
- ERAInterim (from 1979 and after 2007)
- ERA40 forcings (1958-2001)
- The HyMeX Long Observing Period 2010-2020 for a better evaluation
- Ocean model hindcast and scenario
- Land surface model hindcast and scenario

### TIER2 SIMULATIONS

- NCEP forcing
- RCSM twin control run
- ARCM with explicit convection
- RCSM new components (aerosol, dam, irrigation, ...)
- Other RCP scenarios
- Other RCM members for a given lateral forcing
- Other GCM members
- Big-Brother approach

## 03 | The MedCORDEX MODELLING TEAM

| | | Components | Model | Developing phase | ERA40 run | ERA-Int run | Hist + RCP |
|---|---|---|---|---|---|---|---|
| RCSM | PROTHEUS *Artale et al. 2010* | ALRO | RegCM<br>BATS<br>IRIS<br>MITgcm | Ok | Ok | | |
| | MPI *Elizalde et al.* | ALRO | REMO<br>HD<br>MPIOM | Ok | Ok | Ok | Running |
| | CNRM-RCSM *(Somot et al. 2008, Herrmann et al. 2011)* | ALRO | ALADIN<br>ISBA<br>TRIP<br>NEMOMED8 | Ok | | Ok | |
| | LMD (L'Heveder et al.) | ALO | LMD<br>ORCHIDEE<br>NEMOMED8 | Ok | Ok | Ok | |
| | Univ. Belgrade (Krzic et al. 2011) | ALO | EBU<br>NOAH<br>POM | Ok | | Ok | |
| | MORCE-MED (Drobinski et al.) | ALO | WRF<br>MED12 | Ok | | Ok | |
| | UCLM/UPM | ALO | PROMES<br>ORCHIDEE<br>MOSLEF | in dvt | | | |
| | COSMO-CLM | ALO | CLM<br>MED12 | in dvt | | | |
| | UAH | ALO | REMO<br>MITgcm | In dvt | | | |
| | INSTM | ALO | LMD<br>ORCHIDEE<br>ROMS | in dvt | | | |
| | IC3 | ALO | WRF<br>ROMS | in dvt | | | |

A: atmosphere
L: land surface
R: river
O: ocean

- Up to now, 14 modeling centers have joined the Med-CORDEX initiative including groups in Italy, Spain, France, Israel, Turkey, Germany, Tunisia and Serbia
- Among them, 11 groups are going to use coupled RCSM. 6 RCSM are already running (see results)
- In addition, at least 3 groups are going to run 10km-ARCM (see results)

Details of the Regional Climate System Models

Details of the Atmosphere-only Regional Climate Models

| | | Components | Model | Developing phase | ERA40 run | ERA-Int run | Hist + RCP |
|---|---|---|---|---|---|---|---|
| ARCM | TAU | A-50km | RegCM | in dvt | | | |
| | IIBR | A-50km | RegCM | in dvt | | | |
| | Univ. Istanbul | A-50km | RegCM | in dvt | | | |
| High-resol. ARCM | CNRM | A-12km | ALADIN | Ok | | Ok | Running |
| | MPI | A-10km | REMO | in dvt | | | |
| | COSMO-CLM | A-7km | CLM | in dvt | | | |

## 04 | The MedCORDEX EVALUATING TEAM

### Challenges:

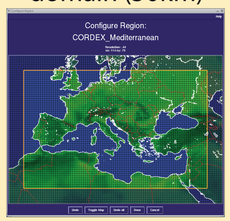
- Spatial inhomogeneous data coverage
- Need for multi-component evaluation
- Small scale features and scale interactions
- Land-sea contrast problem and low resolution of the current satellite products

### Solutions:

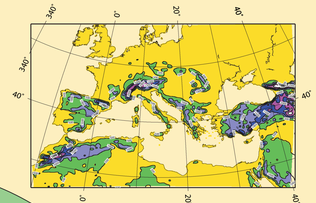
- Gather specialists of the various components and fields (process, in-situ, satellite, model)
- Take advantage of HyMeX community and field campaign
- Promote regional reanalyses
- Promote new coastal satellite products

| Process to be evaluated | Possible evaluating teams |
|---|---|
| Med Sea Water and Heat budget | UMD, ENEA, CNRM, CNRM, ICTP, ETHZ, MPI |
| Gibraltar Strait | Univ. Malagà |
| SST, SSS | ENEA, CMS, CNRM, CMM |
| Surface circulation | OGS, INGV, ENSTA |
| River | CEFREM, ENEA, CNRM, MERCATOR, MPI |
| Wind over the sea | ENEA, CMM, GUF, CNRM, Puertos de l'Estado |
| Extreme over land | LSCE, DMI, LMD |
| cloud | LMD |
| aerosols | ICTP, LA |
| Water masses | CNRM, ENSTA |
| EMT and WMT | MERCATOR, HCMR, CNR, LEGOS |
| Cyclones | FUB |
| Large-scale pattern | CERFACS |
| Atmospheric rivers and water vapor | TAU, CRC Dijon, MPI, UCM |
| Sea level | IMEDEA, NOCS, LEGOS |

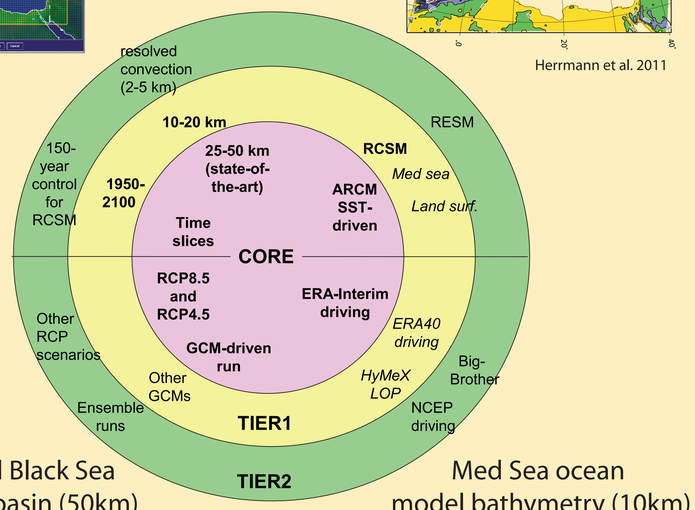
Official MedCORDEX domain (50km)




Atmospheric RCM orography and land-sea mask (10km)



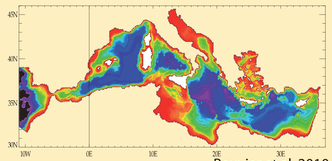
Herrmann et al. 2011




Rivers and Black Sea catchment basin (50km)

Ludwig et al. 2009

Med Sea ocean model bathymetry (10km)



Beuvier et al. 2010

## 05 | The MedCORDEX GCM/RCM MATRIX

GCM/RCM matrix for the coupled RCSM in Med-CORDEX

| RCM/GCM | | CNRM | MPI | IPSL | INGV | HadGEM | EC-Earth |
|---|---|---|---|---|---|---|---|
| RCM | ENEA | ? | ? | | | | |
| | MPI | | x | | | | |
| | CNRM | x | | | | | |
| | LMD | | | x | | | |
| | Univ. Belgrade | | | | x | | |
| | MORCE-MED | | | x | | | |
| | UCLM/UPM | | | | | ? | |
| | COSMO-CLM | | ? | | | | |
| | INSTM | | | ? | | | |
| | IC3 | | | | | | ? |
| | UAH | | ? | | | | |

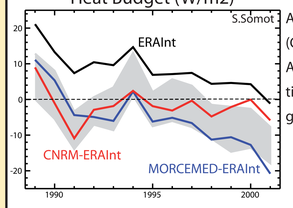
## 06 | MedCORDEX ORGANISATION

- Communication: www.medcordex.eu / hymex-ttm3@cnrm.meteo.fr / S. Somot, P. Ruti
- Reference: Ruti et al. (submitted to BAMS) "MED-CORDEX initiative for Mediterranean climate studies"
- MedCORDEX started in 2009 and is endorsed by CORDEX, MedCLIVAR and HyMeX
- Database: Monthly atmo (DMI archive), daily and sub-daily atmo, ocean, land, rivers (ENEA)

example file naming: pr_MED-44_ERAINT_evaluation_r1i1p1_CNRM-ALADIN5_v1_day_19910101_19951231.nc

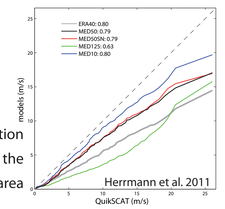
## 07 | FIRST MedCORDEX RESULTS

Medit. Sea Surface Heat Budget (W/m2)




Added-value of fully coupled RCM (CNRM-RCSM and MORCE-MED AORCM) wrt ERAInterim (interannual time series, observed estimates in grey)

Q-Q plot, wind speed (m/s)

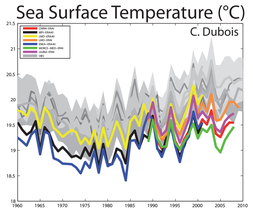



Herrmann et al. 2011

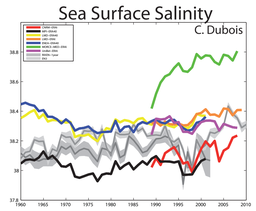
Added-value of 10km resolution ALADIN-Climate RCM over the Gulf of Lions shelf area

Evaluation (observation in grey) and intercomparison of the available Med-CORDEX ERA40 and ERA-Interim driven simulations using AORCM or RCSM for the Mediterranean average SST and SSS over the 1960-2010 period

Sea Surface Temperature (°C)




Sea Surface Salinity




MedCLIVAR HyMeX CNRS INSU Observer & comprendre METEO FRANCE Toujours un temps d'avance