The MED-CORDEX experiment: underpinning simulations, preliminary validation and future steps within the Hymex context

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How do MED-CORDEX and Hymex will contribute to the regional modeling?

A Coordinated Regional Downscaling Experiment

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**International Frameworks**

- Cordex
- Hymex Scientific objectives
- Hymex Field Campaign
- Hymex Med-modeling

**Regional processes for regional modeling**
General Aims and Plans for CORDEX

Provide a set of Regional Climate Scenarios covering the period 1950-2100, for the majority of the populated land-regions of the globe.

Make these data sets readily available and useable to the impact and adaptation communities.

Provide a generalized framework for testing and applying Regional Climate Models and Downscaling techniques for both the recent past and future scenarios.

Foster coordination between Regional Downscaling efforts around the world and encourage participation in the downscaling process of local scientists/organizations.

http://wcrp.wmo.int
Hymex aims to:
- provide an accurate description of Med water cycle and its variability
- understand how the water cycle processes concur to produce the regional climate
- validate the regional ocean, atmosphere, hydrological models and improve them
- determining and improving predictability of the water cycle
- performing new regional climate scenario
Better understanding of the long-term water cycle over the Mediterranean basin: variability and trend.
The long-term water cycle: variability and trend

- The Water Budget of the Medit Sea is one of 5 scientific topics of HyMeX
- Why?
  - It constraints the yearly deep water formation rate
  - It constraints the density of the Med Sea and then the exchanges with the Atlantic ocean through the Gibraltar Strait
  - Some of the terms have an important feedback to the atmosphere: evaporation, water vapor, SST, Mixed layer heat content
  - It is a proxy of the regional climate change impact (water resource)

- Key points:
  - Multi-compartments: atmosphere, sea, continental surface, vegetation, river
  - Multi-time scales: from the daily events to the multi-decadal time scale
  - Not very well known up-to-know
  - Strongly depends on coupled processes (not only atmospherically-driven)
  - Scale interactions, non-linearities
  - Impacted by the climate change

- Frame of the WG1 « Water Budget of the Mediterranean Sea »:
  - Climate scales (from monthly to multi-decadal)
  - Dealing with the whole Mediterranean Basin (and/or large sub-basins)

- 4 main scientific questions: WG1-SQ1, SQ2, SQ3, SQ4 (see Science Plan)
Towards the modeling improvement!

Field Campaign

Regional Climate Modeling

- atmosphere
- land surface
- ocean

Regional Earth System Model
Hymex Campaign and model validation

Ocean (LOP)
Mambo buoys
EuroSites

MOOSE

Deep moorings (Hydrochanges)
The HyMeX regional climate modelling strategy should take into account the HyMeX frame (in-situ field campaign, process study, extreme events, water cycle), the IPCC-AR5 frame and deadlines and address new issues and new modelling challenges.
Modelling: General Strategy

Validation
Integrated Analysis
Intercomparison

Data Rescue

In-situ

Satellite

Reanalysis (regional)

Very-high resol. or process models

Regional Climate Modeling

atmosphere

Regional Earth System Model

land surface

ocean

process understanding

variability

Hindcast 1960-2010

LOP/EOP/SOP

model improvement

All temporal scales

21st century

scenarios
**Modelling: General Strategy**

The climate models used for hindcast and scenarios will be run with the same set-up for the LOP/EOP/SOP periods.
**WCRP-RCM-Mediterranean: a proposal**

*MedCORDEX minimal domain*

1. CIRCE RCM domain: ENEA, MPI, LMD
2. Hymex domain: CNRM
3. MedCORDEX minimal domain in white
4. Medit. And Black seas catchment basins in grey
WCRP-RCM-Mediterranean: a proposal
**WCRP-RCM-Mediterranean: a proposal**

**Modelling groups officially involved in CORDEX and interested in MedCORDEX:**
- LMD (WRF)
- ICTP-ENEA (RegCM+MIT)
- CNRM (ALADIN)
- MPI (REMO)
- UCLM (PROMES)
- WRF community
  ... SMHI, COSMOS

**ARCHIVE:**

**List of the CORE runs (STAND ALONE + COUPLED):**

- 50 km RCM (25 Km)
- 1989-2008, ERAInterim driven
- 1950-2100, Scenarios RCP4.5 and/or RCP8.5, AR5-GCM driven

Variables: FP6-ENSEMBLES list maximum

Frequency: daily outputs minimum for atmosphere variables

Size: to be asked to Ole Christensen (DMI)
International Frameworks

- Cordex
- Hymex Scientific objectives
- Hymex Field Campaign
- Hymex Med-modeling

Regional processes for regional modeling
Why a regional coupled system

Blocking

Lee cyclogenesis

Inertial instability

Mixed layer - PBL
Why a regional coupled system

Internal processes and feedbacks
Present skill of the coupled systems?
Integrated water cycle:
S → land points of the Mediterranean catch.
O → sea points of the Mediterranean basin

Regional Coupled System
RegCM3
River Routing
MIT ocean
SST Bias in XX century simulations

Fig 1: SST bias of XX century global (a-b) and regional (c-d) simulations vs. GISST data
Fig. 2 Seasonal cycle of SST over the MED basin

Color/Line Code

Global Drivers

Regional Simulations
Fig. 3 Seasonal cycle of main components of hydrological budget over the MED basin
Fig. 4 PDF of JJA values (seasonal cycle removed) of main components of hydrological budget over the MED basin
Coupling and memory

For non-stationary stochastic processes with stationary increments

\[ E[X_{t+k}X_t] \sim \sigma^2 2H(2H - 1)k^{2H-2} \quad \text{for} \quad k \to \infty. \]

0 < H < 0.5, short memory

0.5 < H < 1, long memory
Summary

- Added value of the regional coupled models
- The Mediterranean is an interesting integrator
- Hymex will offer a unique framework for modeling improvement and for demonstrating added values!!!