



**The Abdus Salam  
International Centre for Theoretical Physics**



**2148-4**

**Fifth ICTP Workshop on the Theory and Use of Regional Climate  
Models**

*31 May - 11 June, 2010*

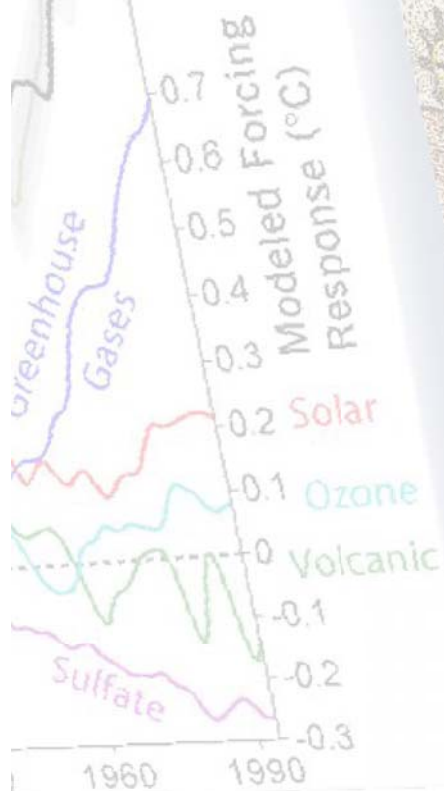
**The MED-CORDEX experiment:  
underpinning simulations, preliminary validation and future steps within the Hymex  
context**

P. Ruti  
*ENEA-Casaccia  
Rome  
ITALY*

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

**A Coordinated Regional Downscaling Experiment**

**Paolo M Ruti**





# International Frameworks

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

Regional processes for regional modeling



# General Aims and Plans for CORDEX

ESSP

DIVERSITAS

IGBP

IHDP

WCRP

# WCRP

World Climate Research Programme

**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>



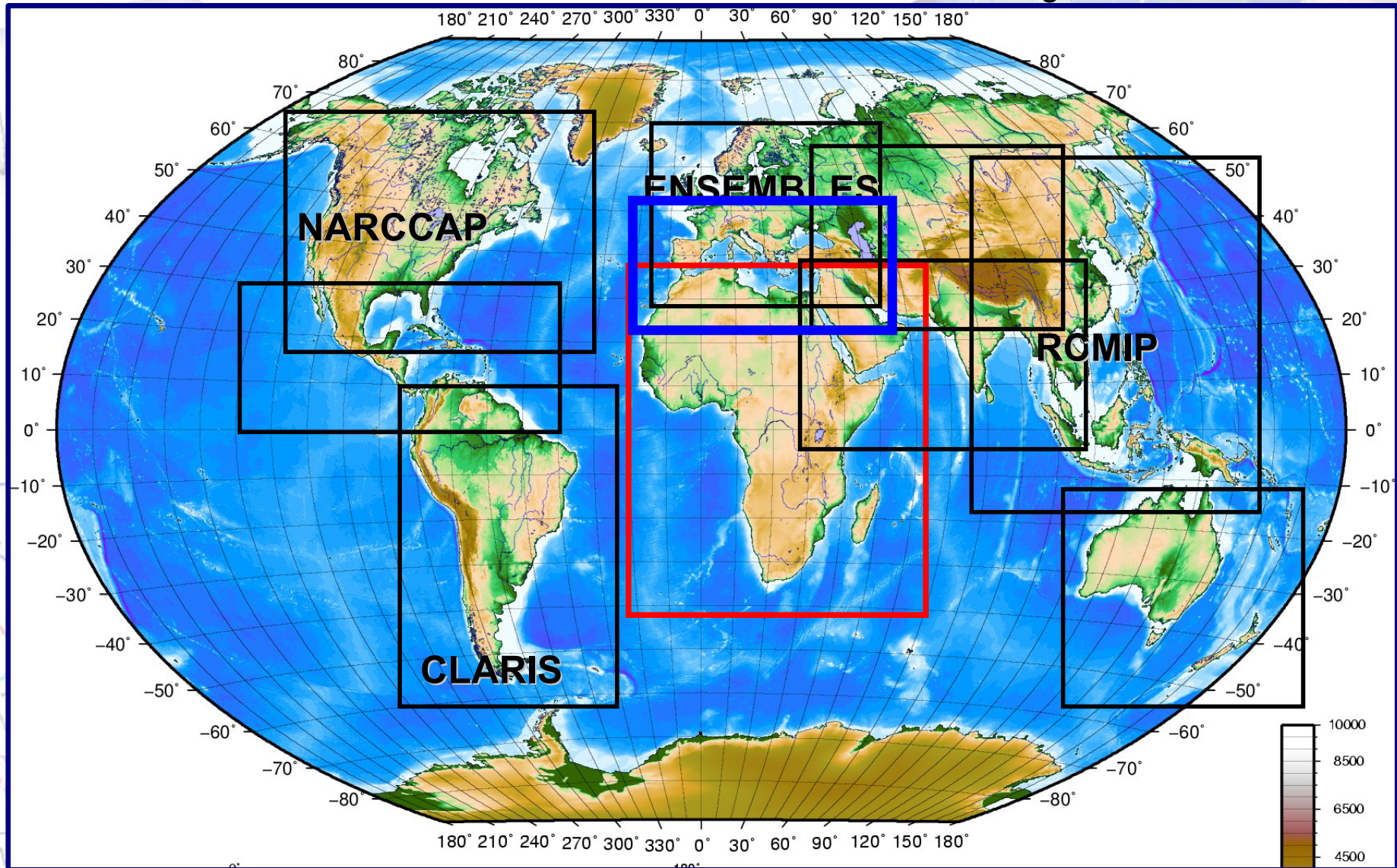
ICSU

International Council for Science



# CORDEX DOMAINS

Giorgi, WMO Bulletin 2009





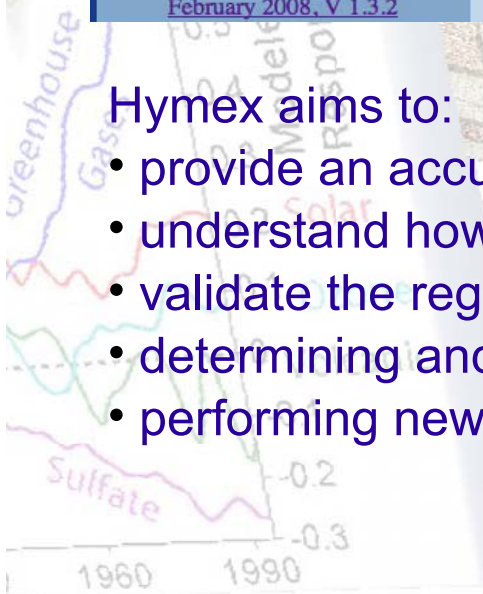
[#http://www.cnrm.meteo.fr/hymYl #](http://www.cnrm.meteo.fr/hymYl)



The screenshot shows the top section of the HyMeX website. On the left is a photograph of a coastal town. The main header features the 'HyMeX' logo in white text on a dark blue background, with a faint map of the Mediterranean region behind it. Below the logo is the subtitle 'HYdrological cycle in Mediterranean EXperiment'. A navigation menu on the left includes links for 'Français', '2nd HyMeX workshop 2-4 June 2008', 'Contribute to Working Groups', 'Subscribe to HyMeX Working Groups', 'Home page', and 'WHITE BOOK February 2008, V 1.3.2'. To the right of the menu is a large, colorful topographic map of the Mediterranean region.

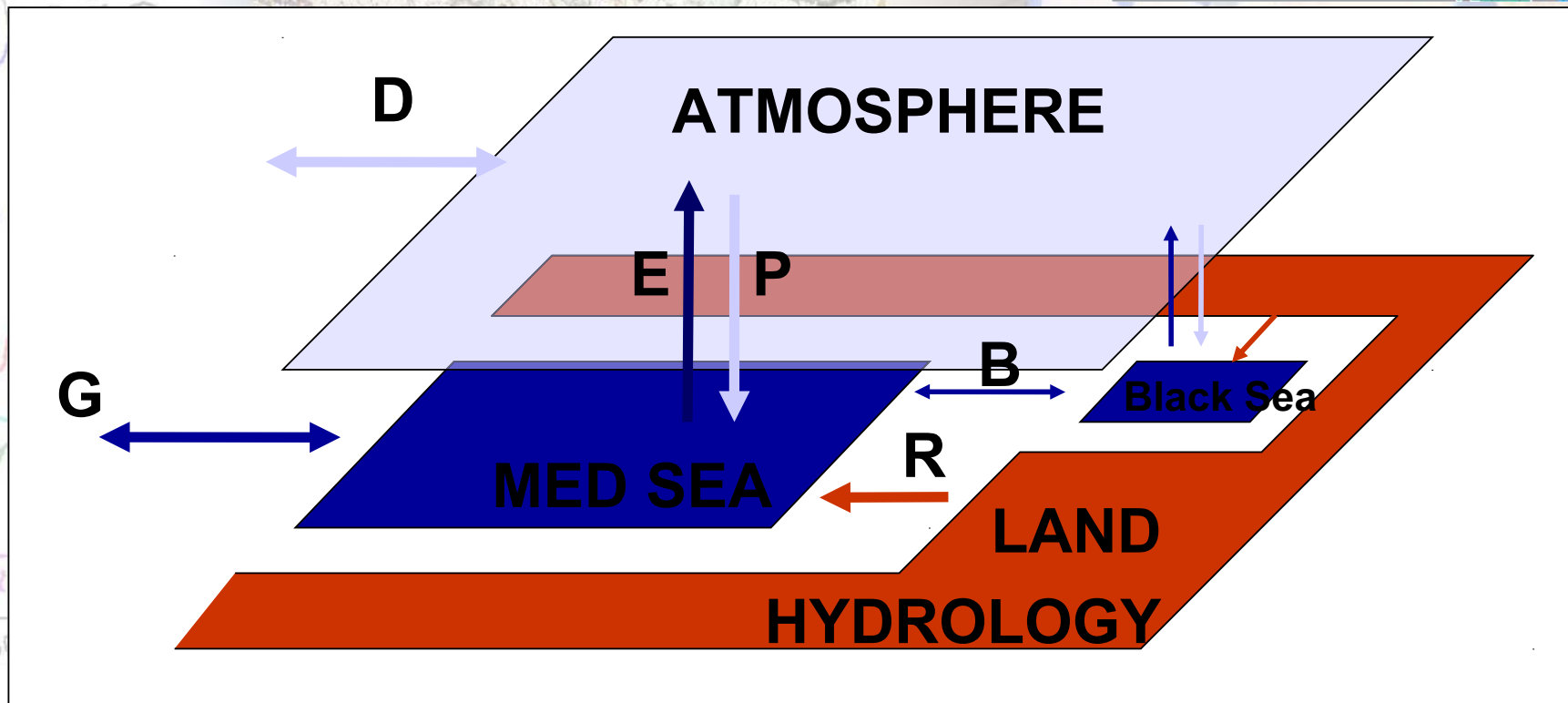
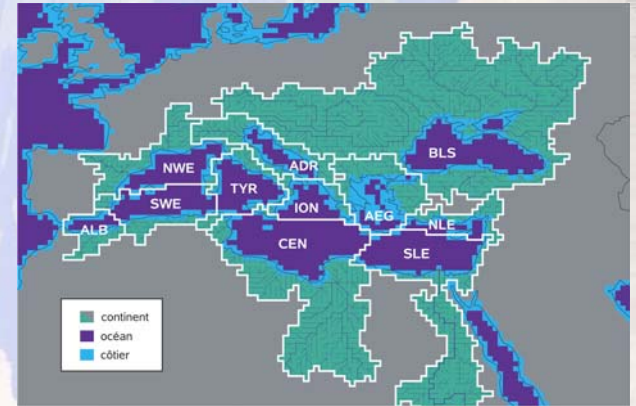
Hymex aims to:

- 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



# WG1 Mediterranean Sea Water Budget: Hymex International Implementation Plan

⇒ Better understanding of the *long-term water cycle* over the Mediterranean basin: variability and trend

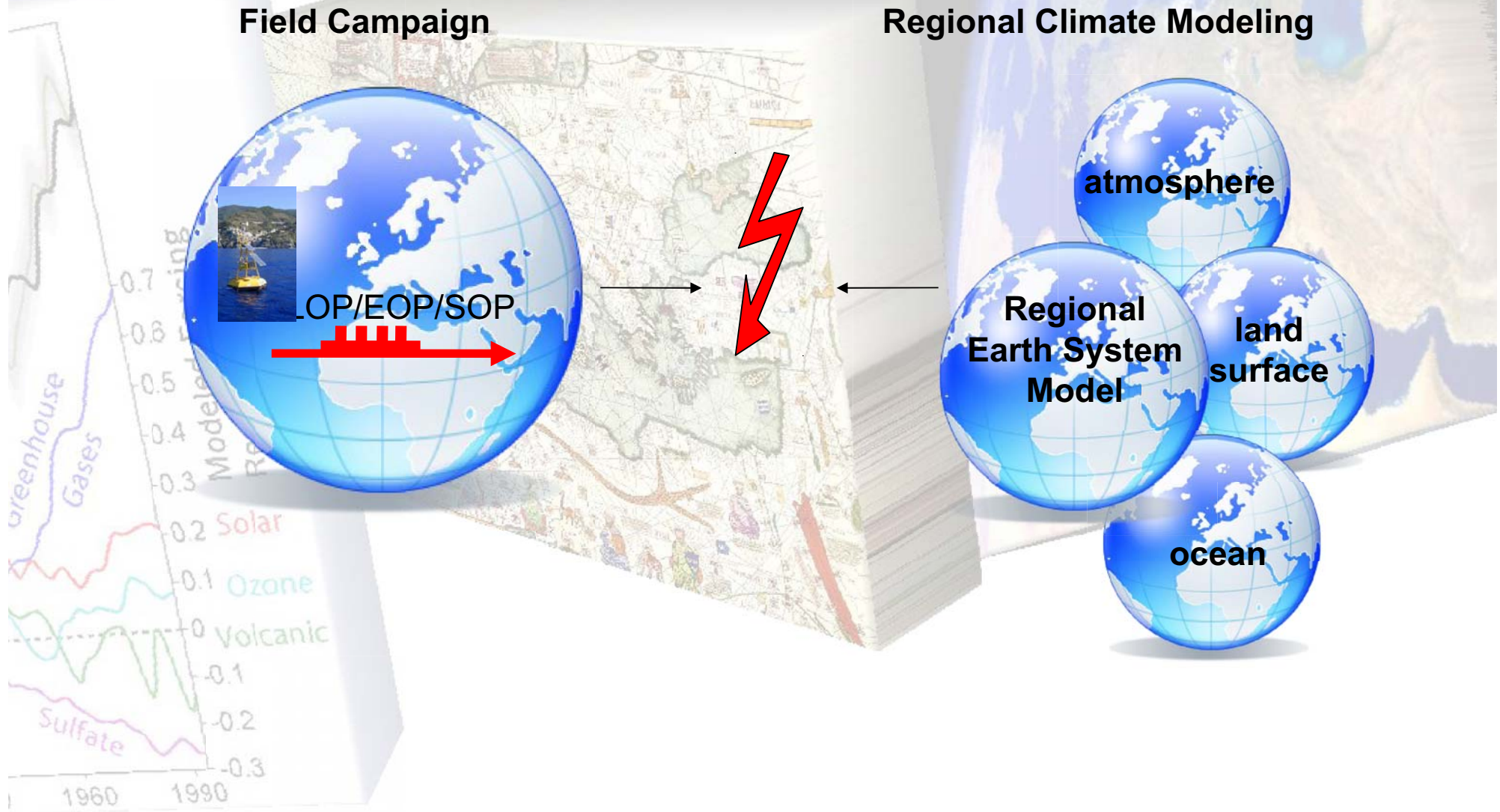




# The long-term water cycle: variability and trend

- 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!

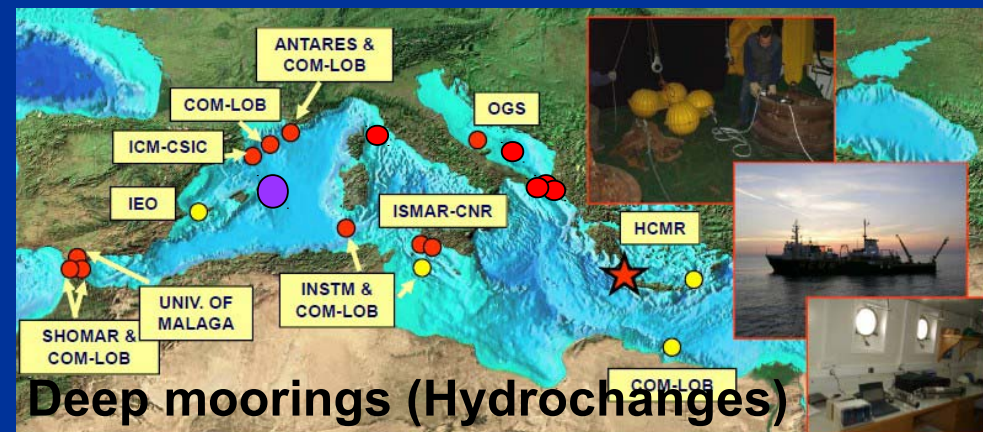
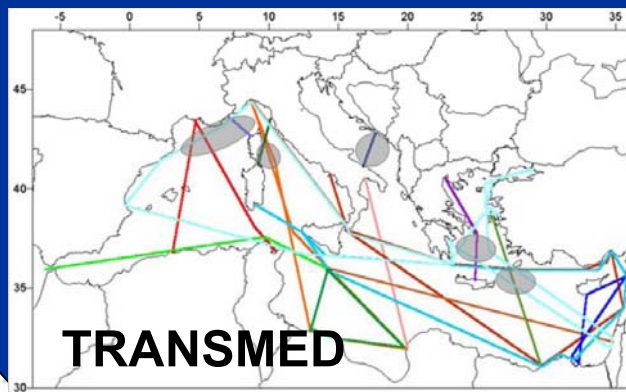


# Hymex Campaign and model validation



Ocean (LOP)

Mambo  
buoys

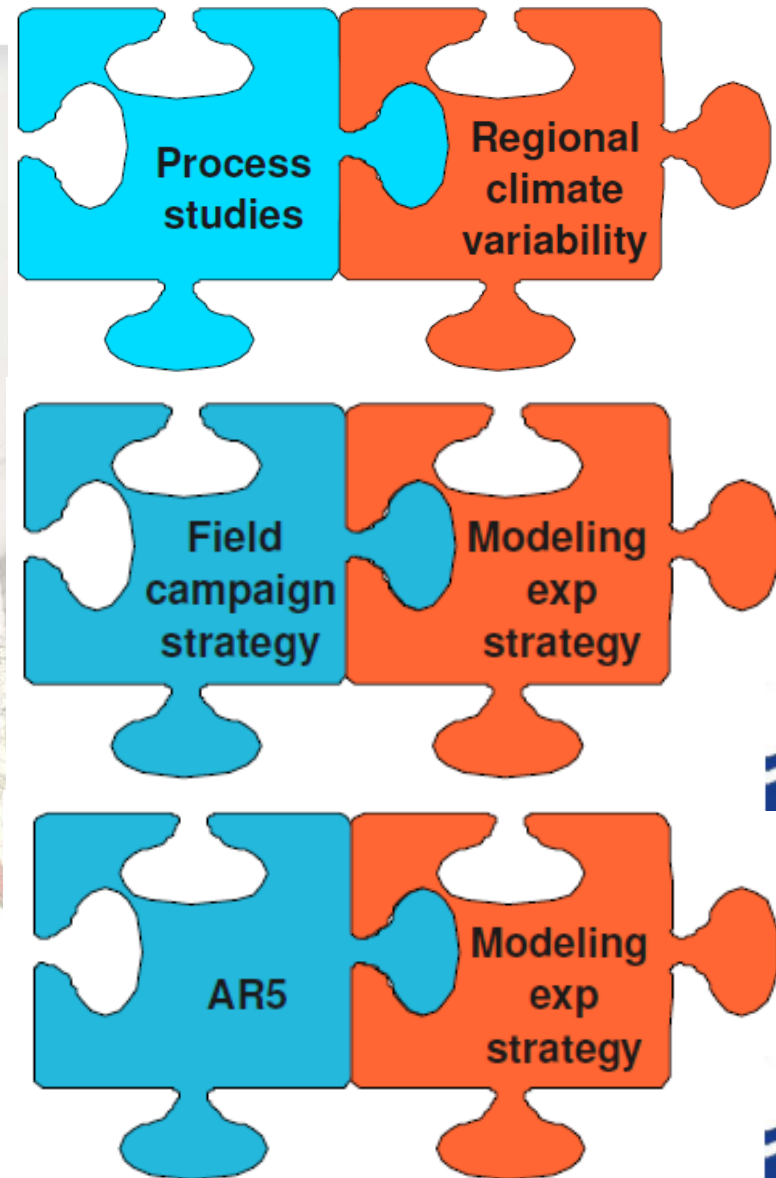
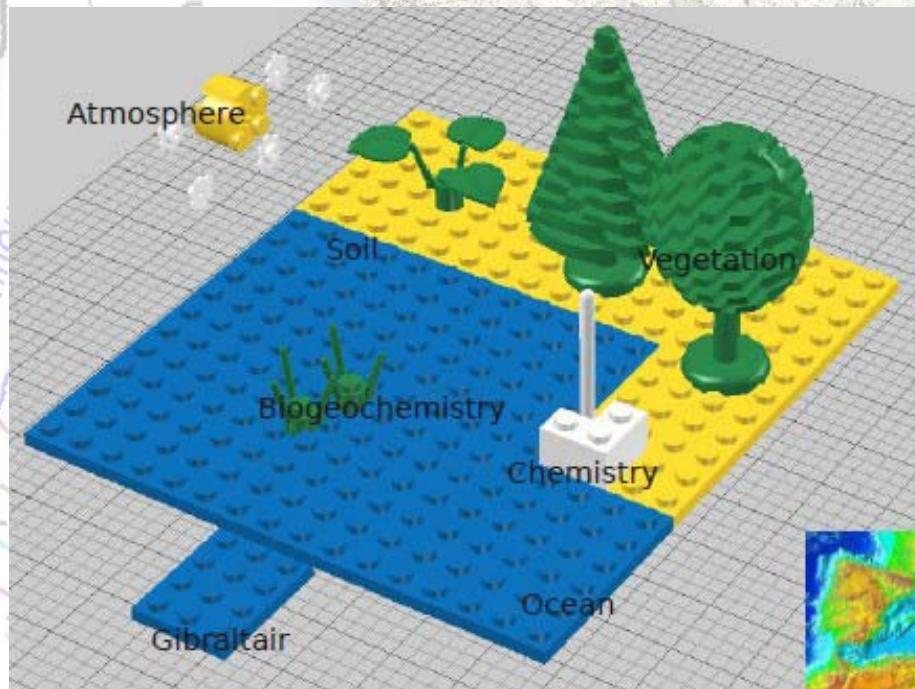


Deep moorings (Hydrochanges)

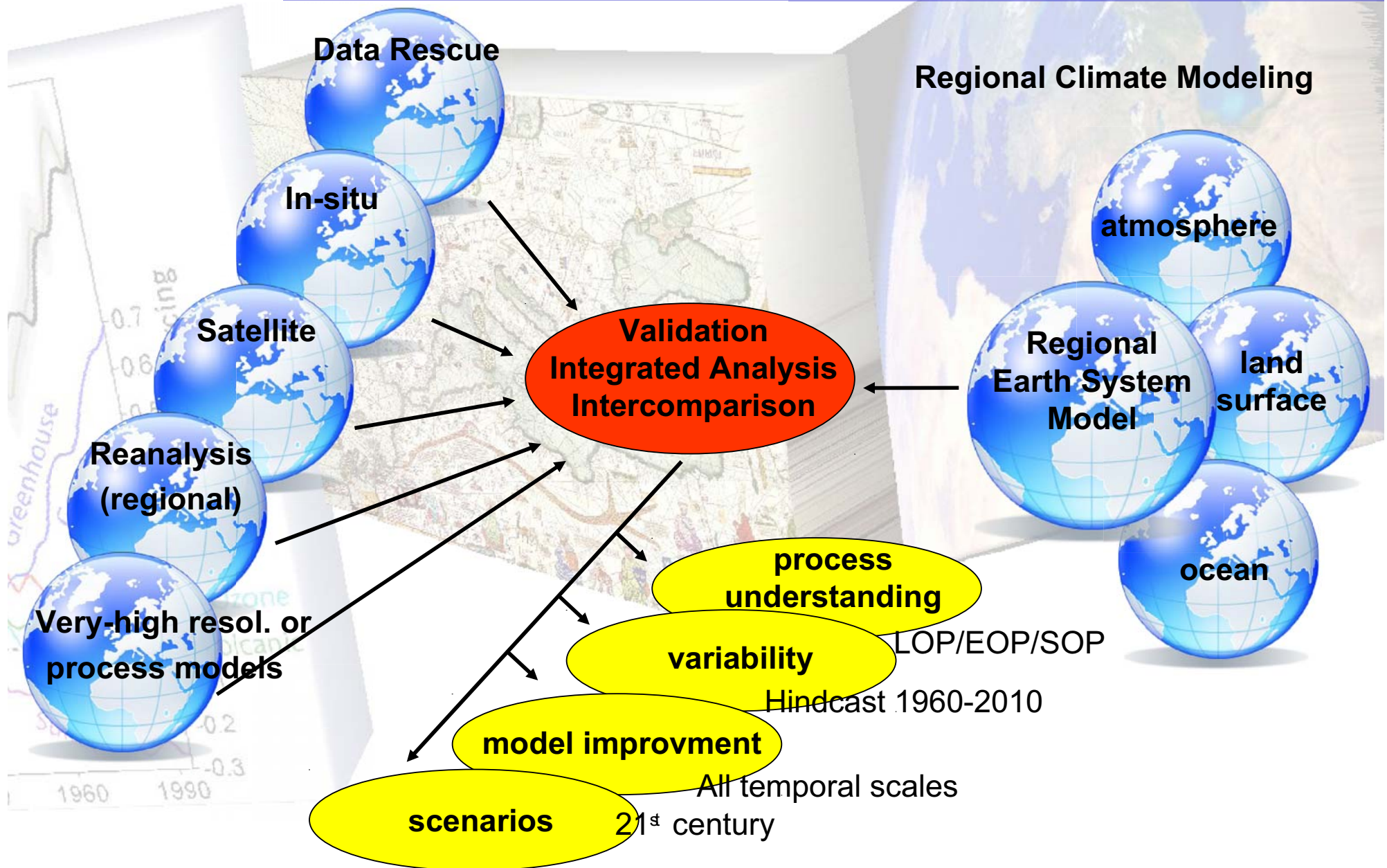


# Modelling: General Strategy

**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**



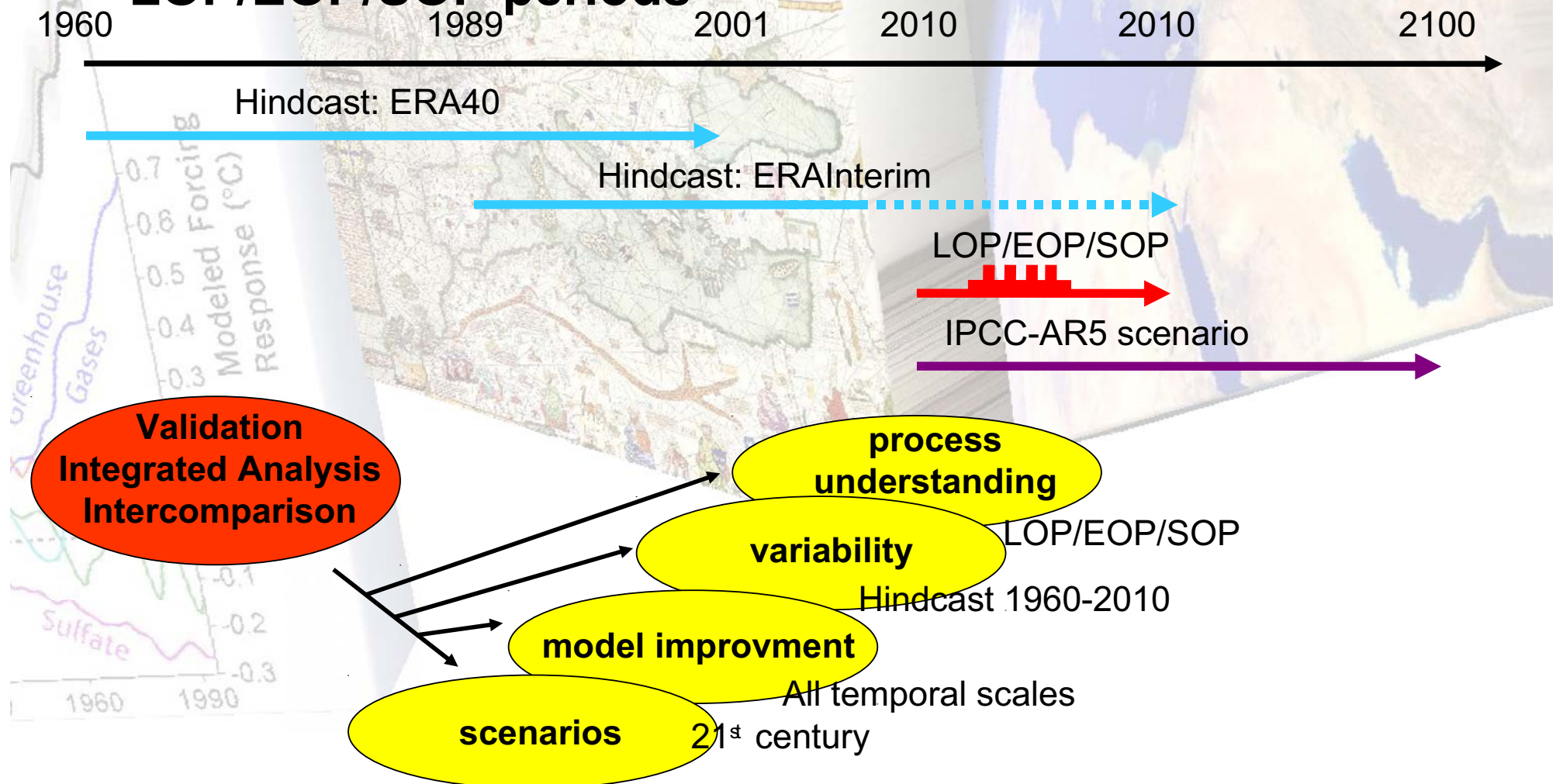
# Modelling: General Strategy





# Modelling: General Strategy

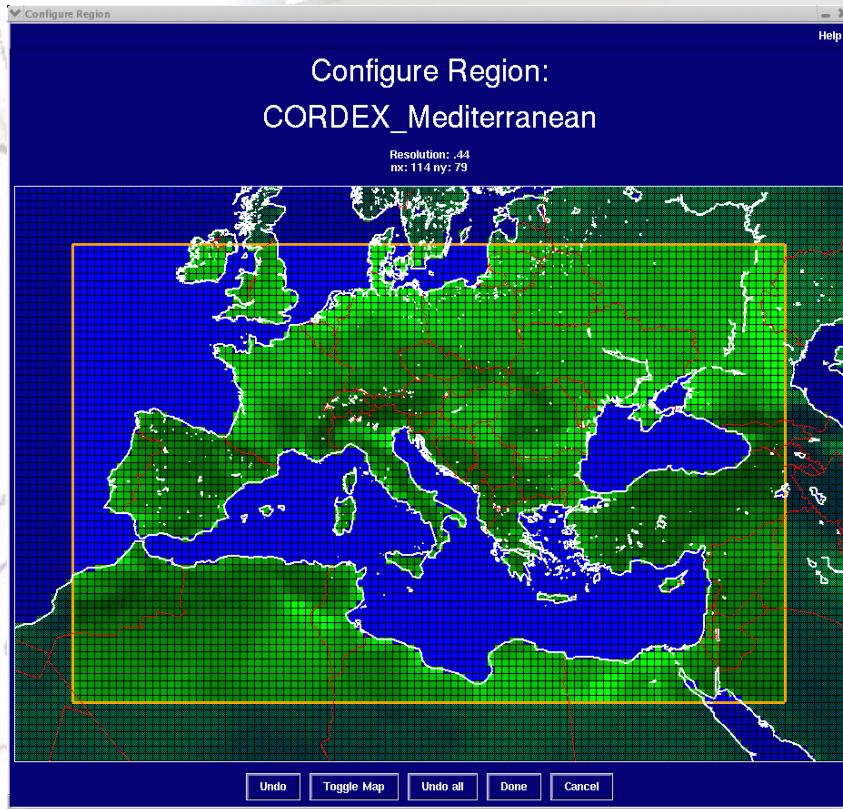
The climate models used for hindcast and scenarios will be run with the same set-up for the **LOP/EOP/SOP** periods



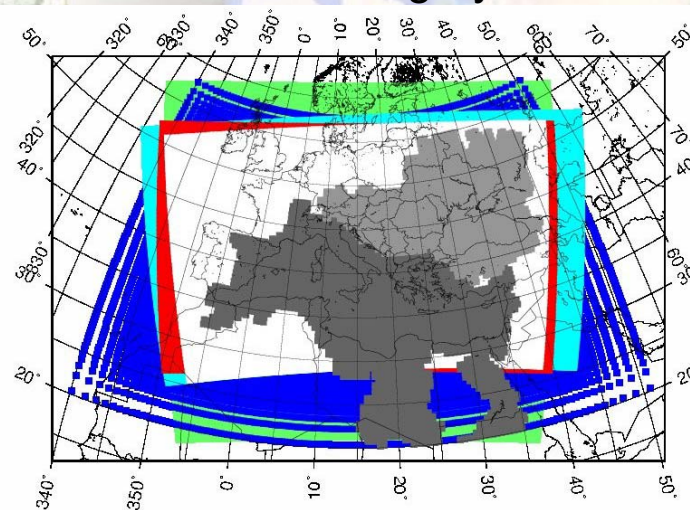


# WCRP-RCM-Mediterranean: a proposal

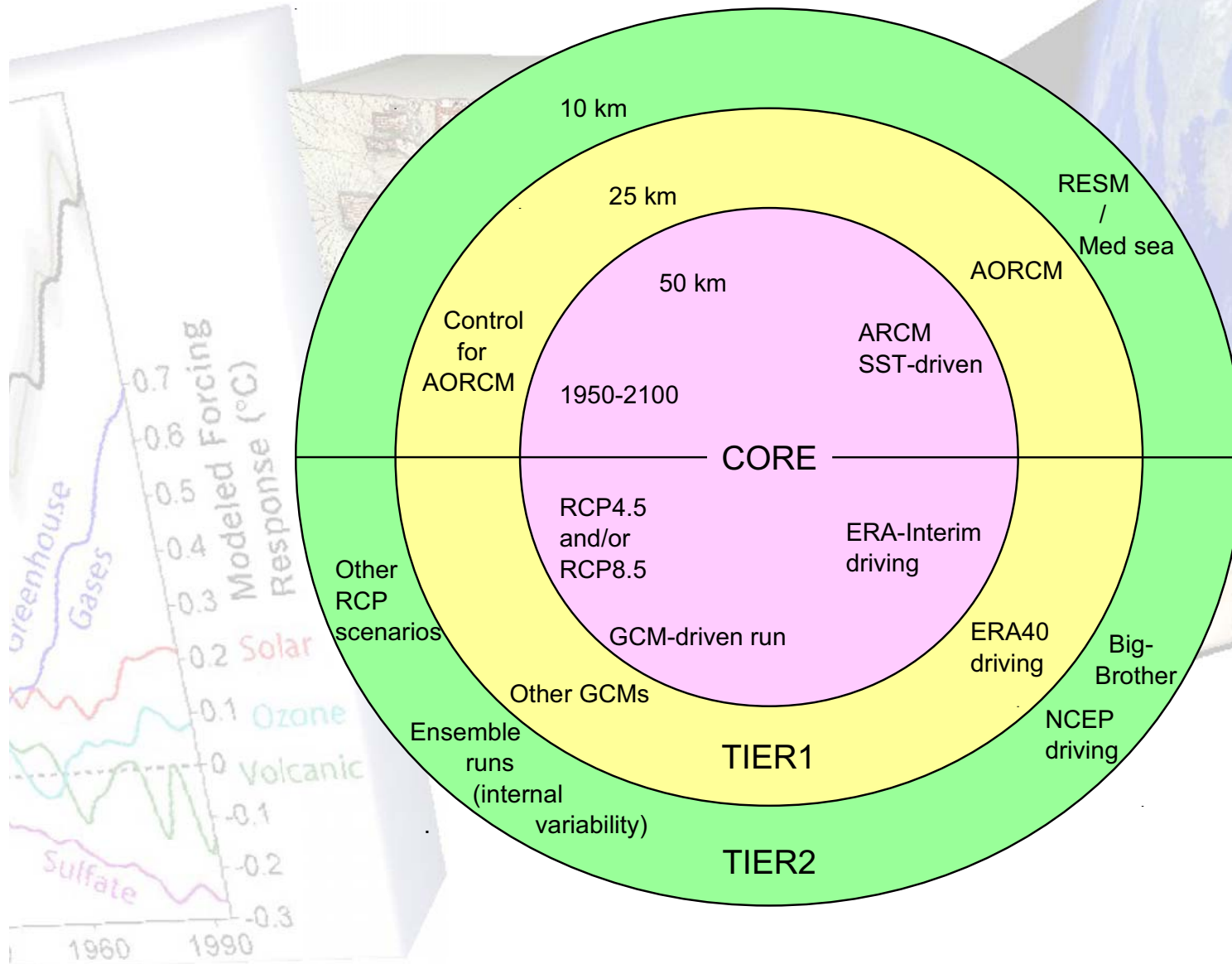
## MedCORDEX minimal domain



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)**

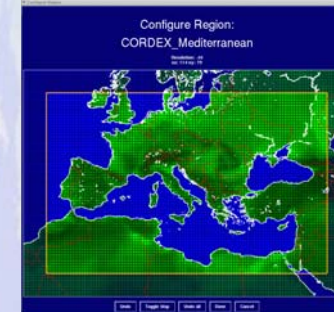
**1989-2008, ERAInterim driven**

**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)**





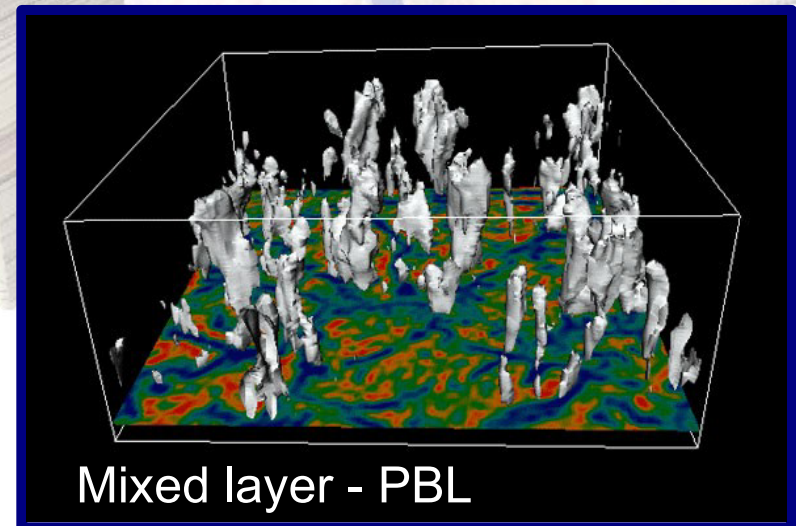
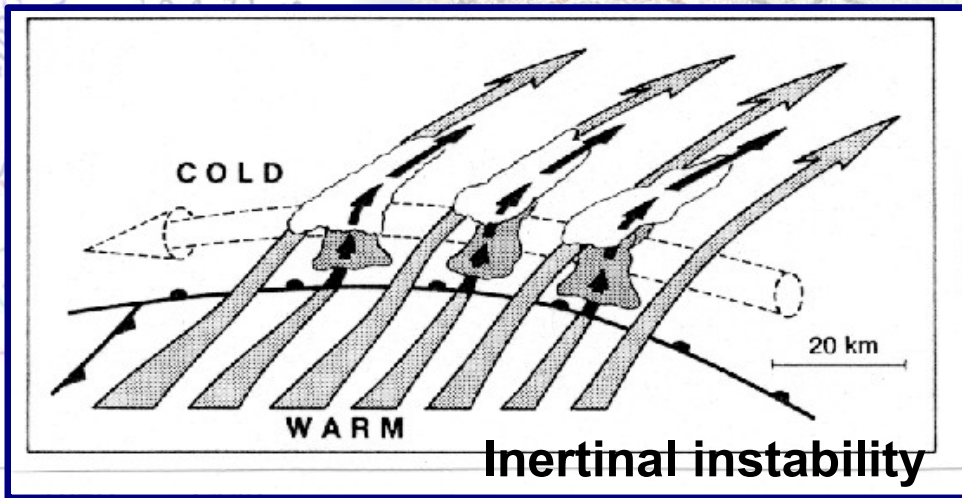
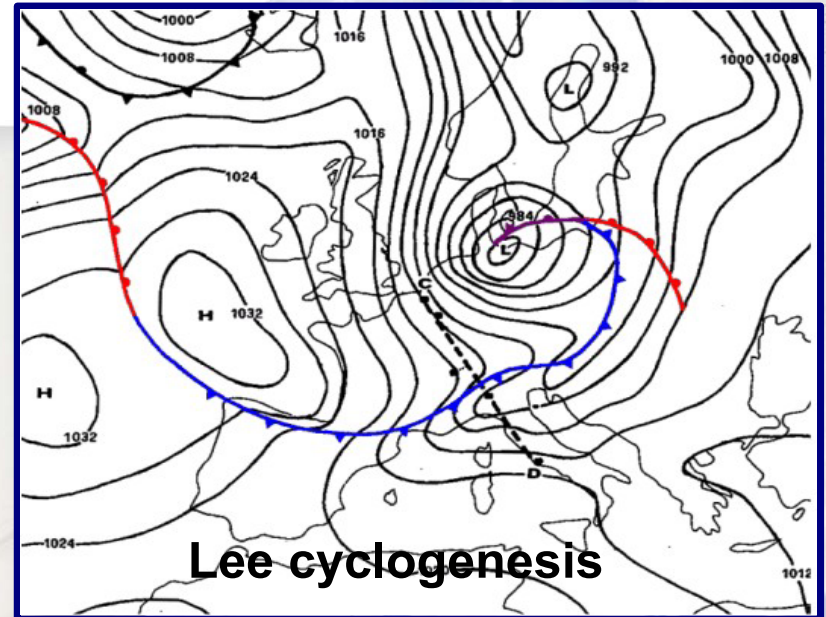
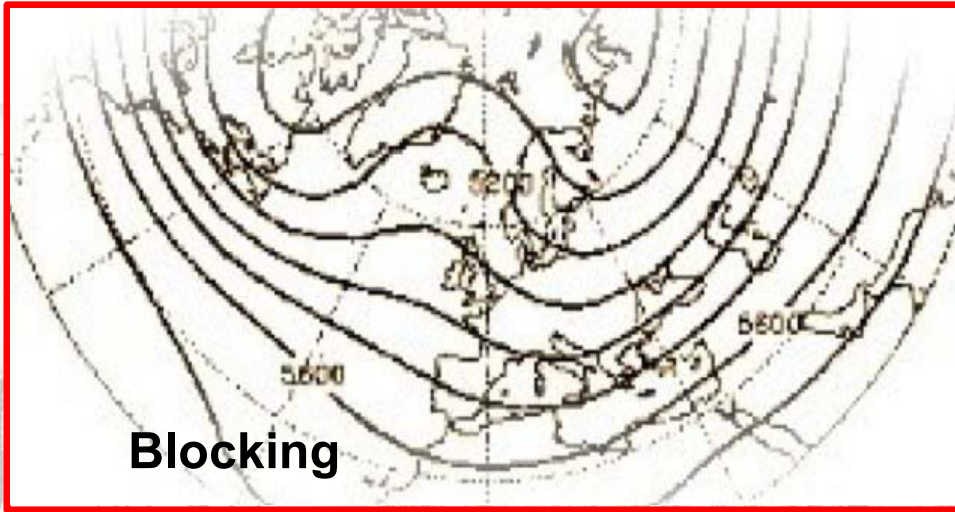


# International Frameworks

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

## Regional processes for regional modeling

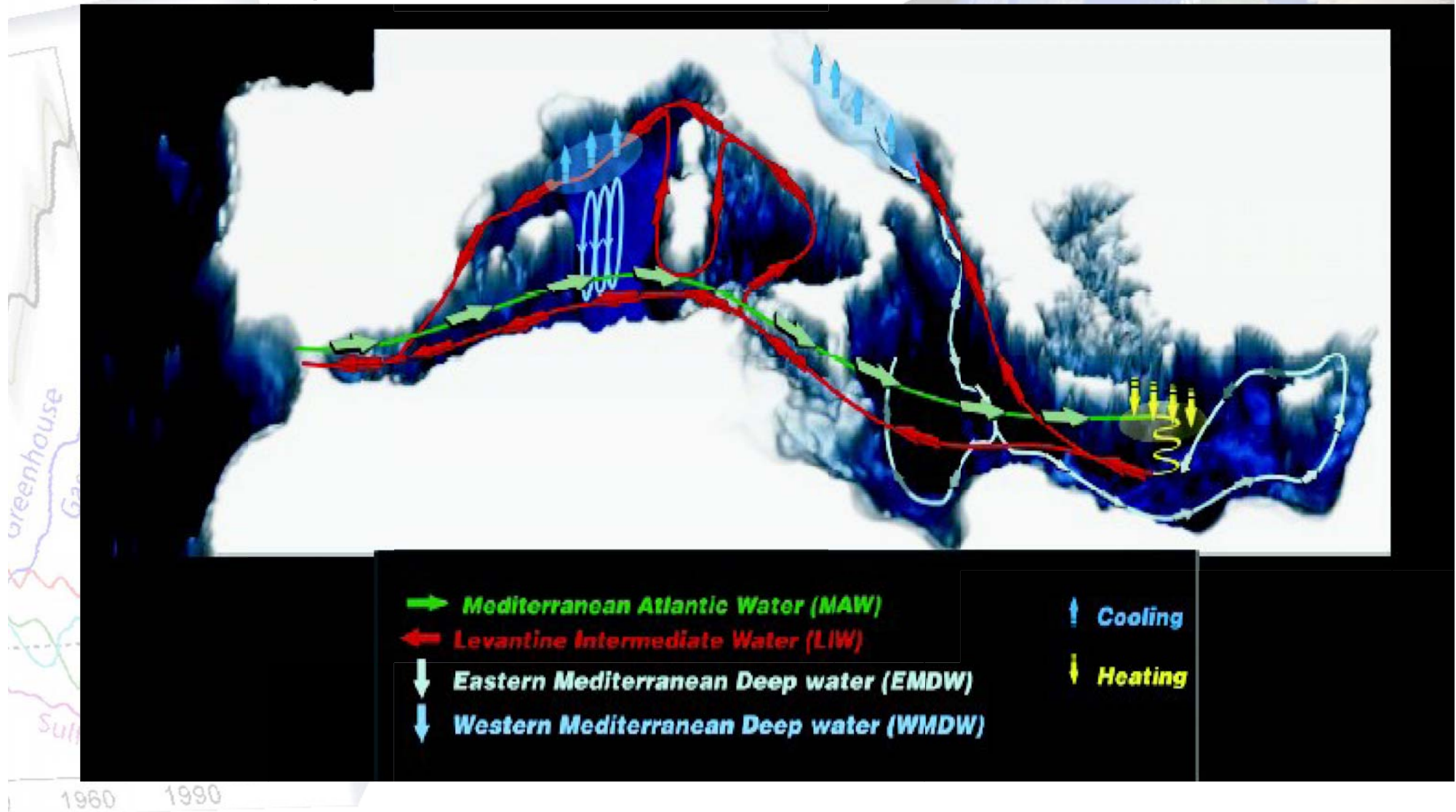
# Why a regional coupled system





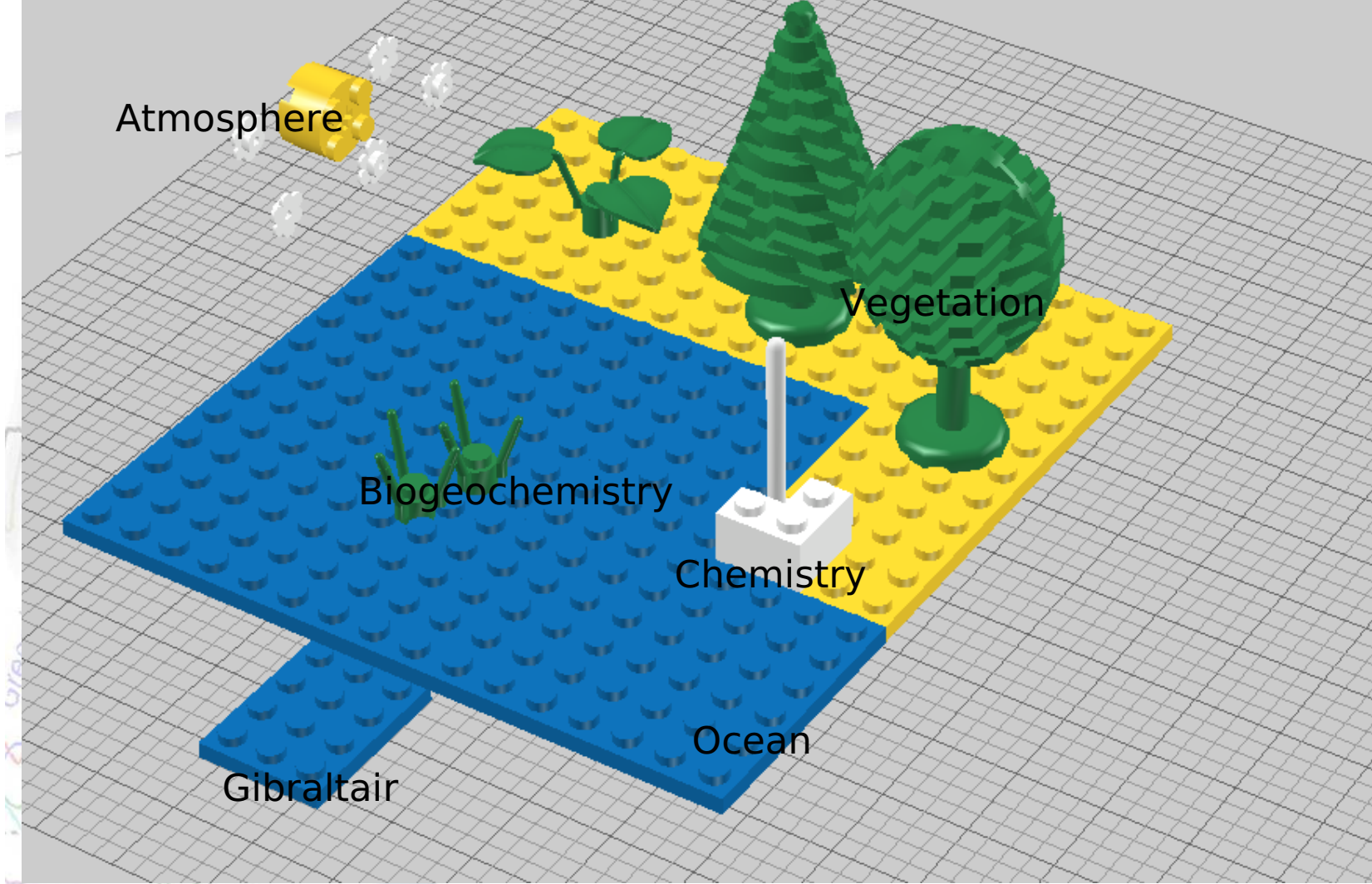
## Why a regional coupled system

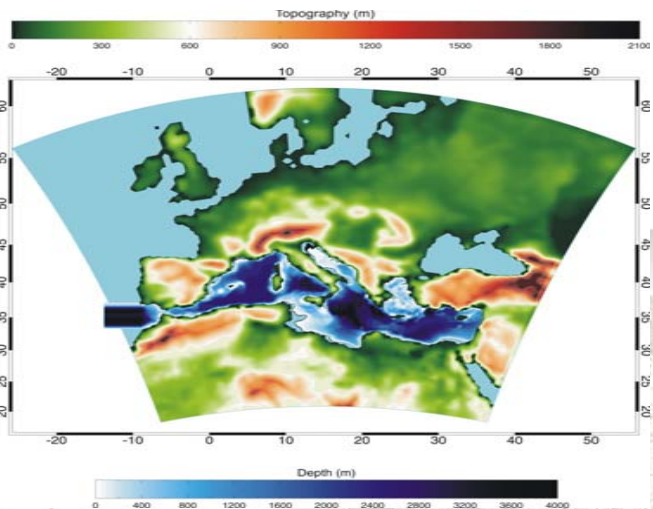
Internal processes and feedbacks



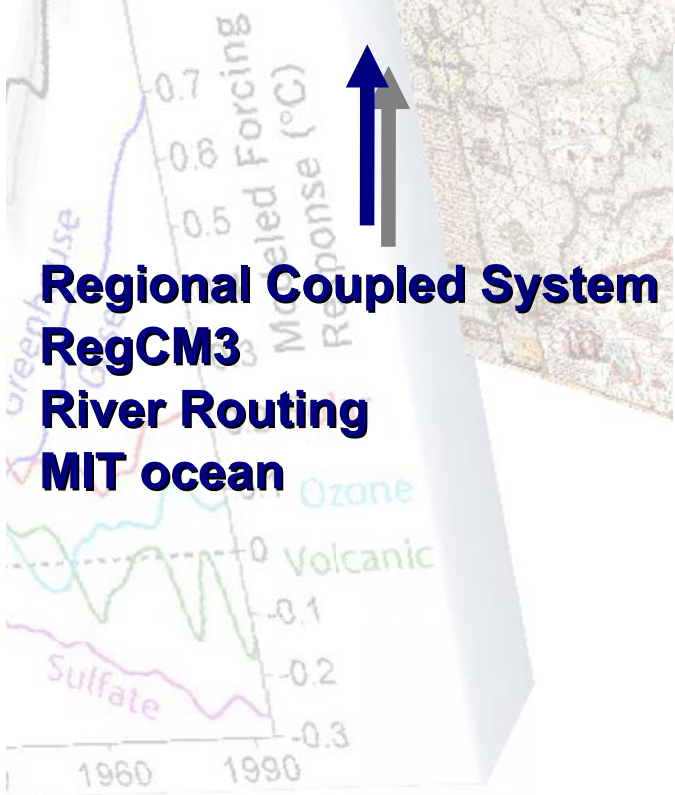


# Present skill of the coupled systems?

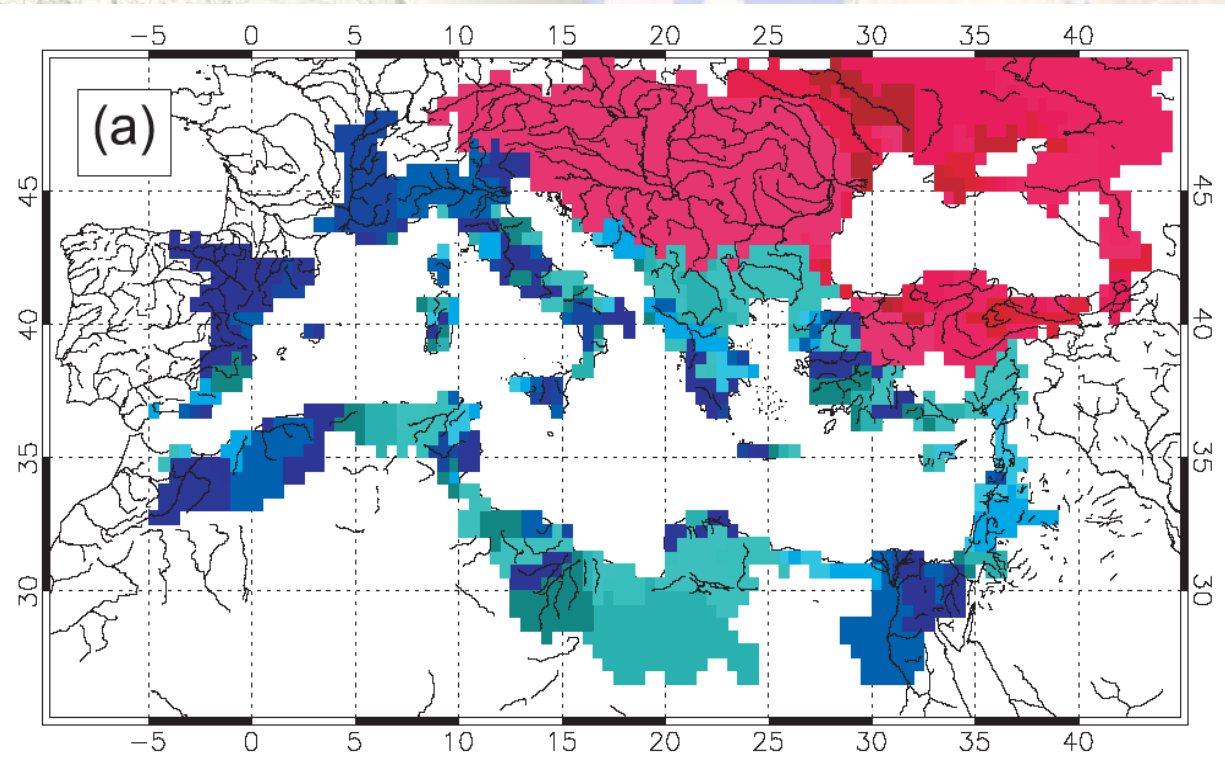




**Integrated water cycle:**  
**S** → land points of the Mediterranean catch.  
**O** → sea points of the Mediterranean basin



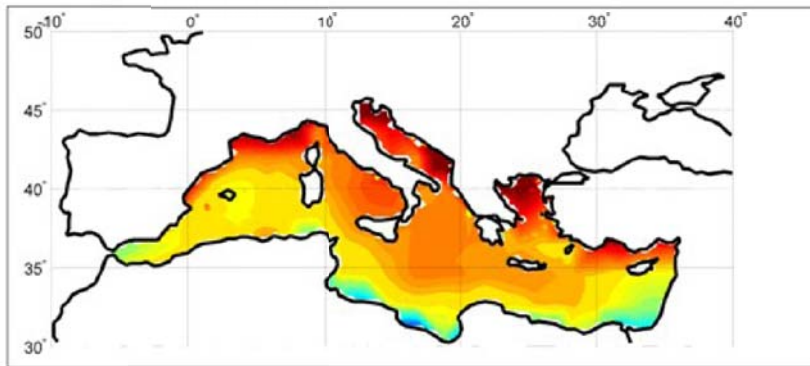
**Regional Coupled System**  
**RegCM3**  
**River Routing**  
**MIT ocean**



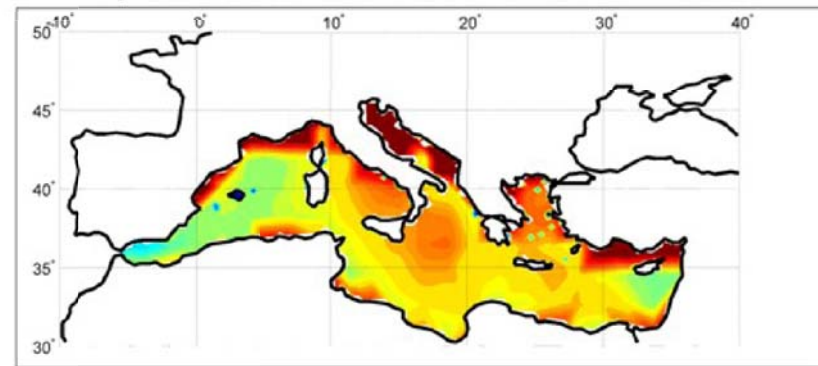


# SST Bias in XX century simulations

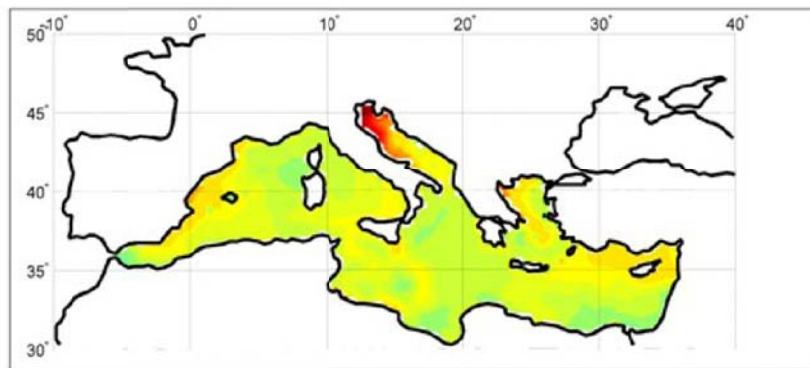
a) GISST-EH5OM 20C3M MAM



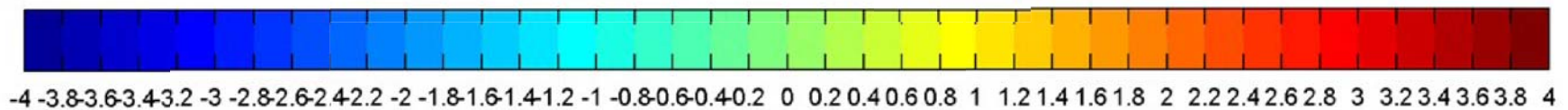
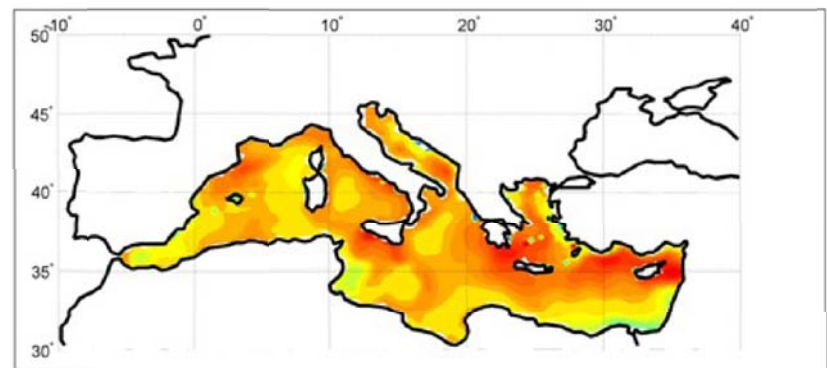
b) GISST-EH5OM 20C3M SON



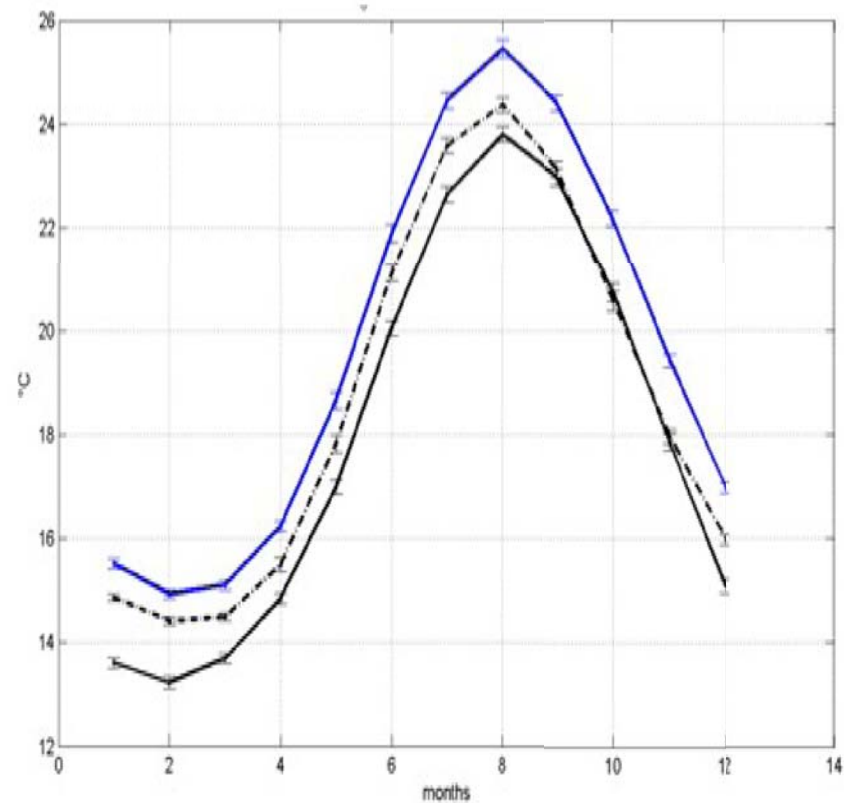
c) GISST-PROTHEUS 20C3M MAM



d) GISST-PROTHEUS 20C3M SON



**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

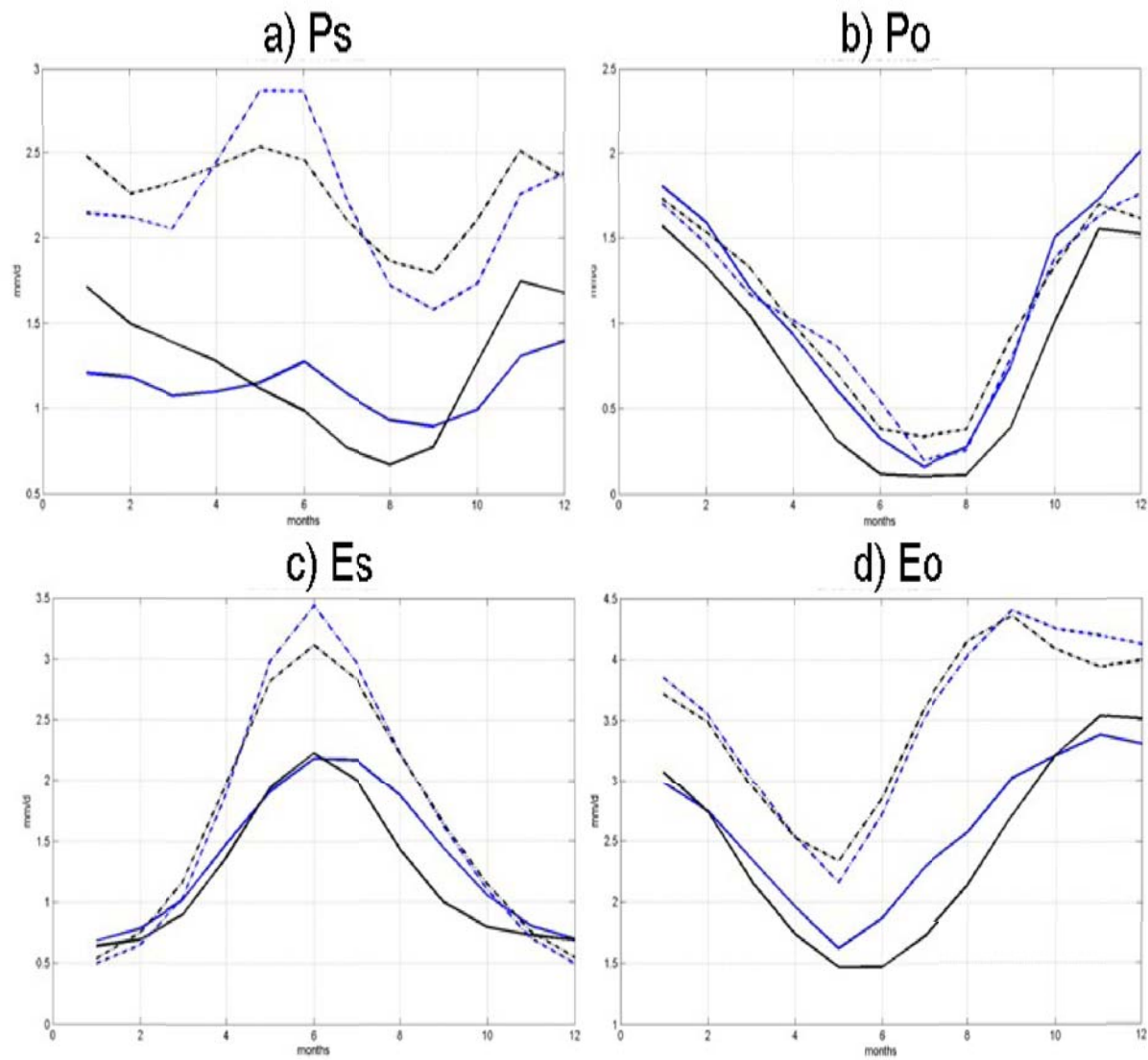
### Color/Line Code

- ERA40
- EH50M 20C3M
- EH50M A1B
- EH50M A1B 2040-2050
- - - PROTHEUS ERA40
- - - PROTHEUS 20C3M
- - - PROTHEUS A1B
- - - PROTHEUS A1B 2040-2050

Global Drivers

Regional Simulations





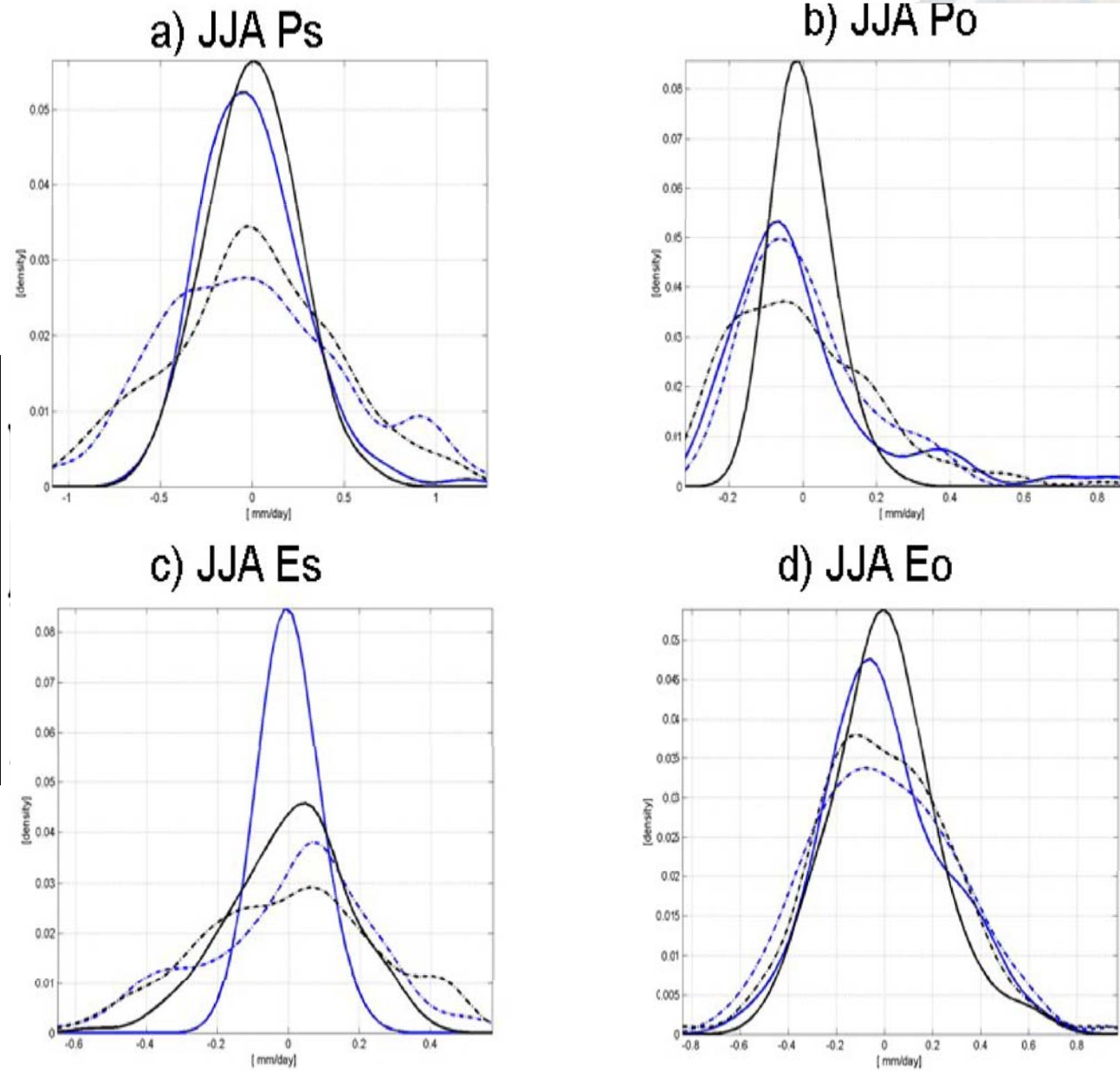
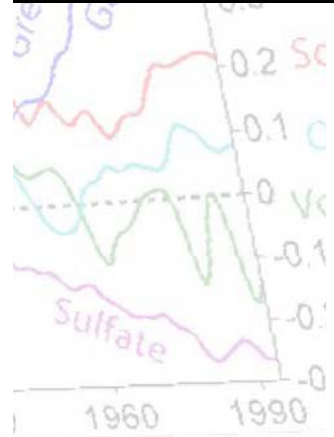
**Color/Line Code**

- ERA40
- EH50M 20C3M
- EH50M A1B
- EH50M A1B 2040-2050
- - - PROTHEUS ERA40
- - - PROTHEUS 20C3M
- - - PROTHEUS A1B
- - - PROTHEUS A1B 2040-2050

**Fig. 3** Seasonal cycle of main components of hydrological budget over the MED basin

### Color/Line Code

- ERA40
- EH50M 20C3M
- EH50M A1B
- EH50M A1B 2040-2050
- - - PROTHEUS ERA40
- - - PROTHEUS 20C3M
- . - . PROTHEUS A1B
- . - . PROTHEUS A1B 2040-2050



**Fig. 4** PDF of JJA values (seasonal cycle removed) of main components of hydrological budget over the MED basin



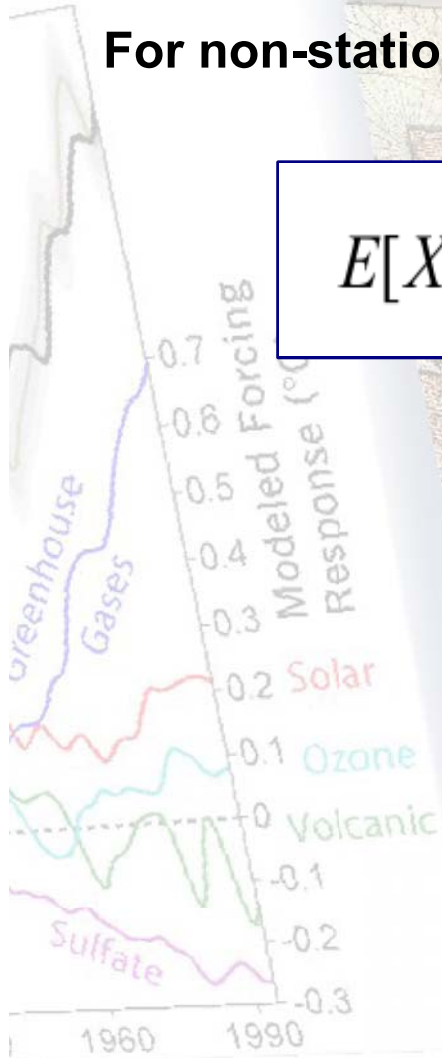
# Coupling and memory

For non-stationary stochastic processes with stationary increments

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

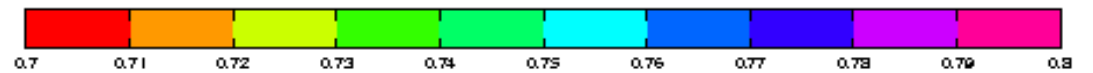
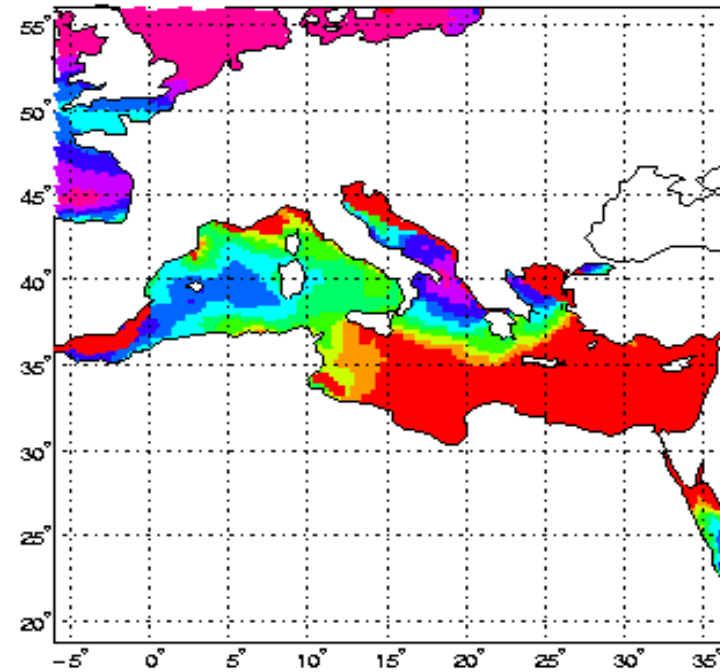
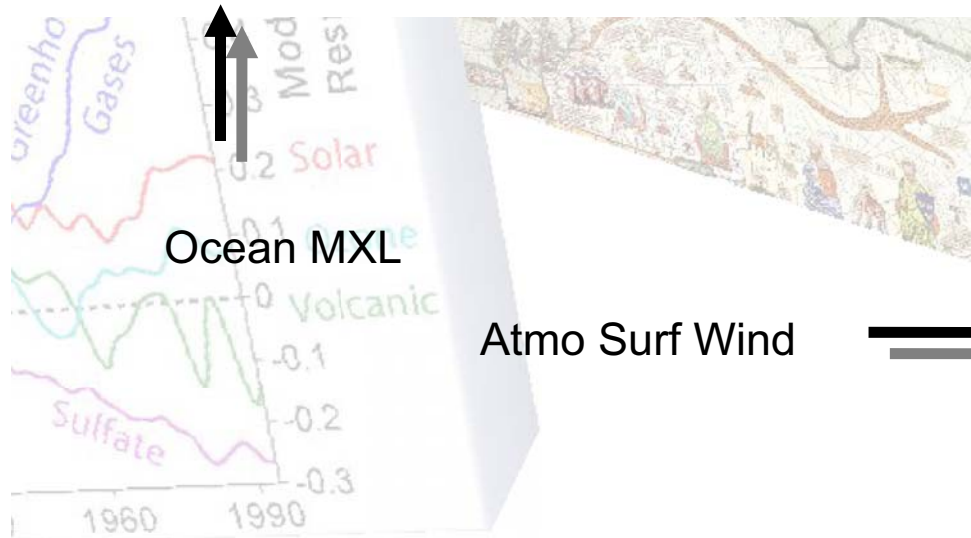
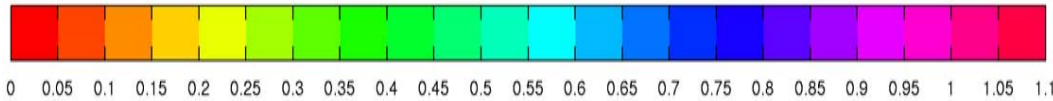
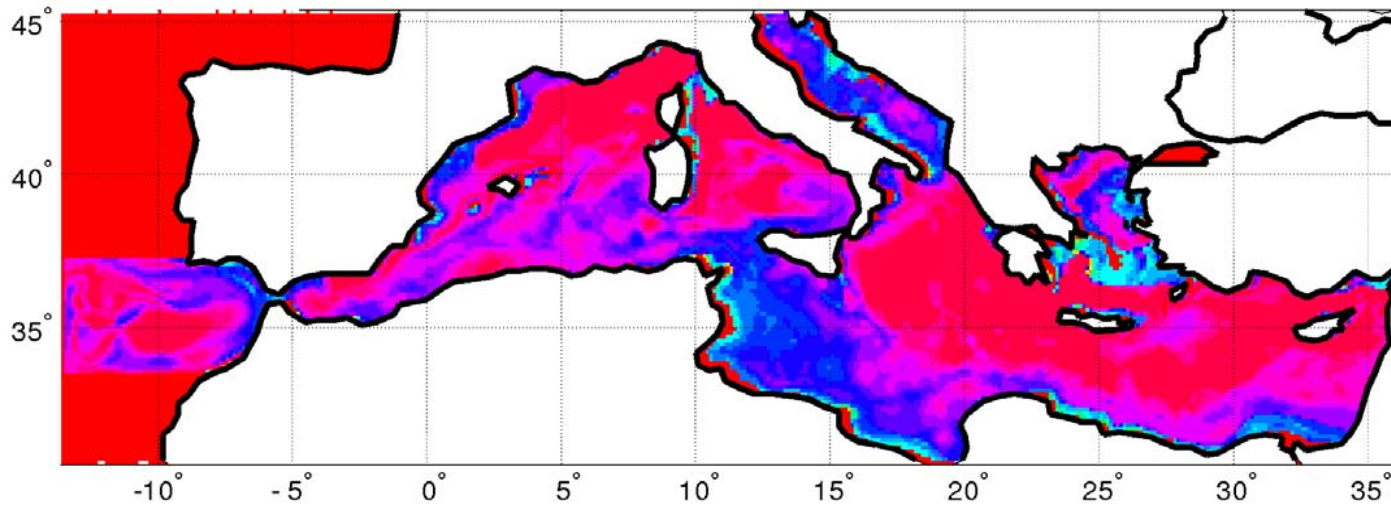
$0 < H < 0.5$ , short memory

$0.5 < H < 1$ , long memory



# Ocean Mixed Layer – PBL and wind

Feb-Mar





# 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!!!

