Role of air-sea coupling in the simulation of moisture sources over the Mediterranean Basin

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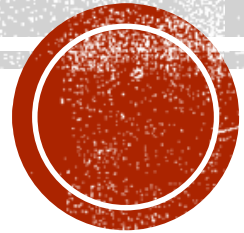

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CONTENTS

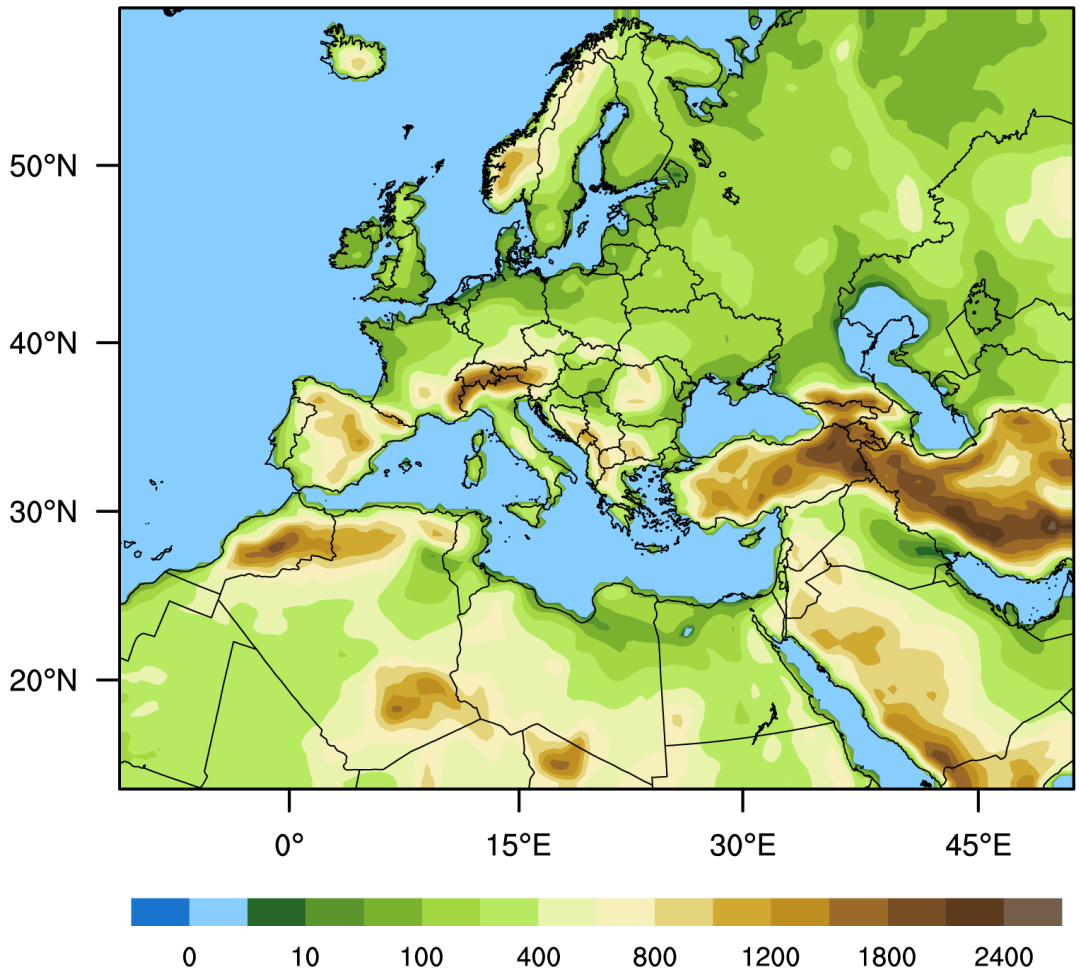
- RegESM (Model System & Experimental Design)
- Winter Analysis
- Moisture Source Analysis
- Ongoing work

Key Points

- This study aims to understand and investigate the role of air-sea interaction in the simulation of key processes that govern precipitation variability over the Mediterranean basin.

- Additionally, to establish an improved understanding of dynamic and thermodynamic drivers of both large-scale mesoscale patterns and fine-scale coastal processes in the Mediterranean basin that are associated with hydro climate extremes in the historic climate through the application of advanced analytical and modeling techniques, and develop robust methods to understand their impacts on natural and human systems.

Model Domain



Experimental Design

- The list of the simulations that are performed by using standalone and coupled model

Run Id	Resolution	ICBC	Active Models	Details
R50E	ATM, 50km	ERA-Interim ERSST	ATM (RegCM4)	Standalone
C50E	ATM, 50km OCN, 1/12 (active only Med. Sea)	ERA-Interim ERSST	ATM (RegCM4) OCN (ROMS 3.6)	Exchange heat, freshwater fluxes, surface pressure, wind components and SST
The river discharge of major rivers are prescribed using GRDC dataset				
The coupling time step is set as 3 hours				

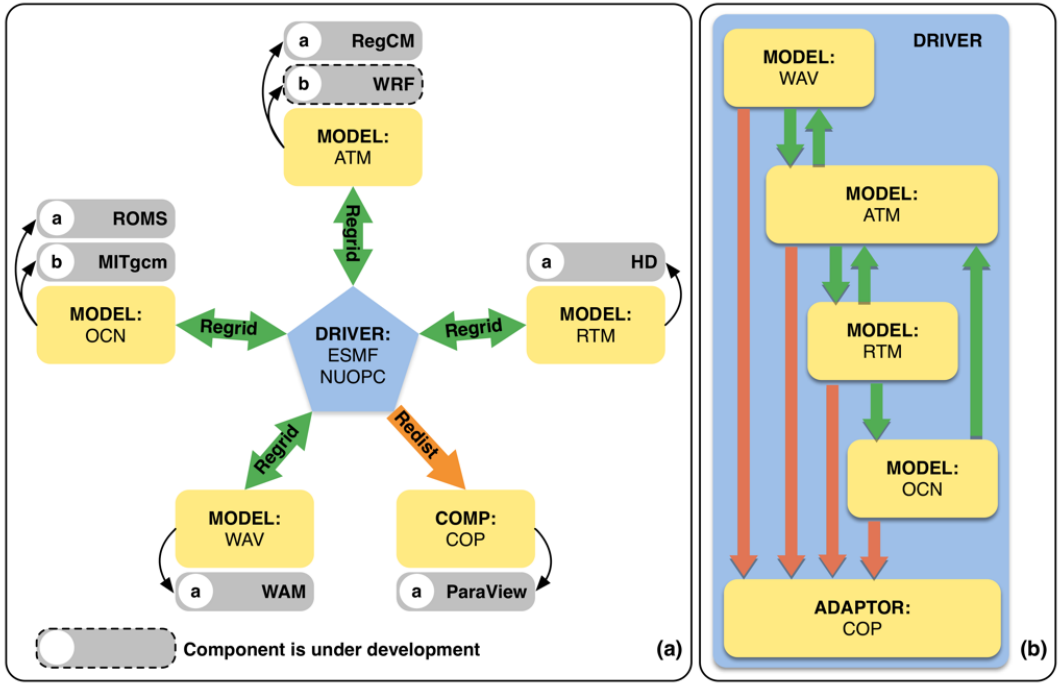
Turuncoglu et al. (2016)

Model Domain	MED50 (50km)
Region Sizes (x/y)	118x144
Center Lat/Lon	45.5, 20.0
Initial/Boundary Conditions (Atmoaphere/SST)	ERA-Interim, ERA-SST
Planetary Boundary Condition	Holstag PBL
Radiation Model	CCSM
Cumulus Convection	Emanuel
Moisture Scheme	SUBEX
Ocean Flux Scheme	Zeng

Turuncoglu et al. (2016)

RegESM (Regional Earth System Model)

- Figure1. Design of the RegESM coupled modelling system. Model components include co-processing component, their interactions (orange arrows represent the redistribution and green arrows shows re-gridding), (Turuncoglu et al., 2016).
- The state-of-art driver that is responsible for the orchestration of the overall modeling system resides in the middle and acts as a translator among model components.



Analysis and Their Contributions

1- Winter Season Analysis

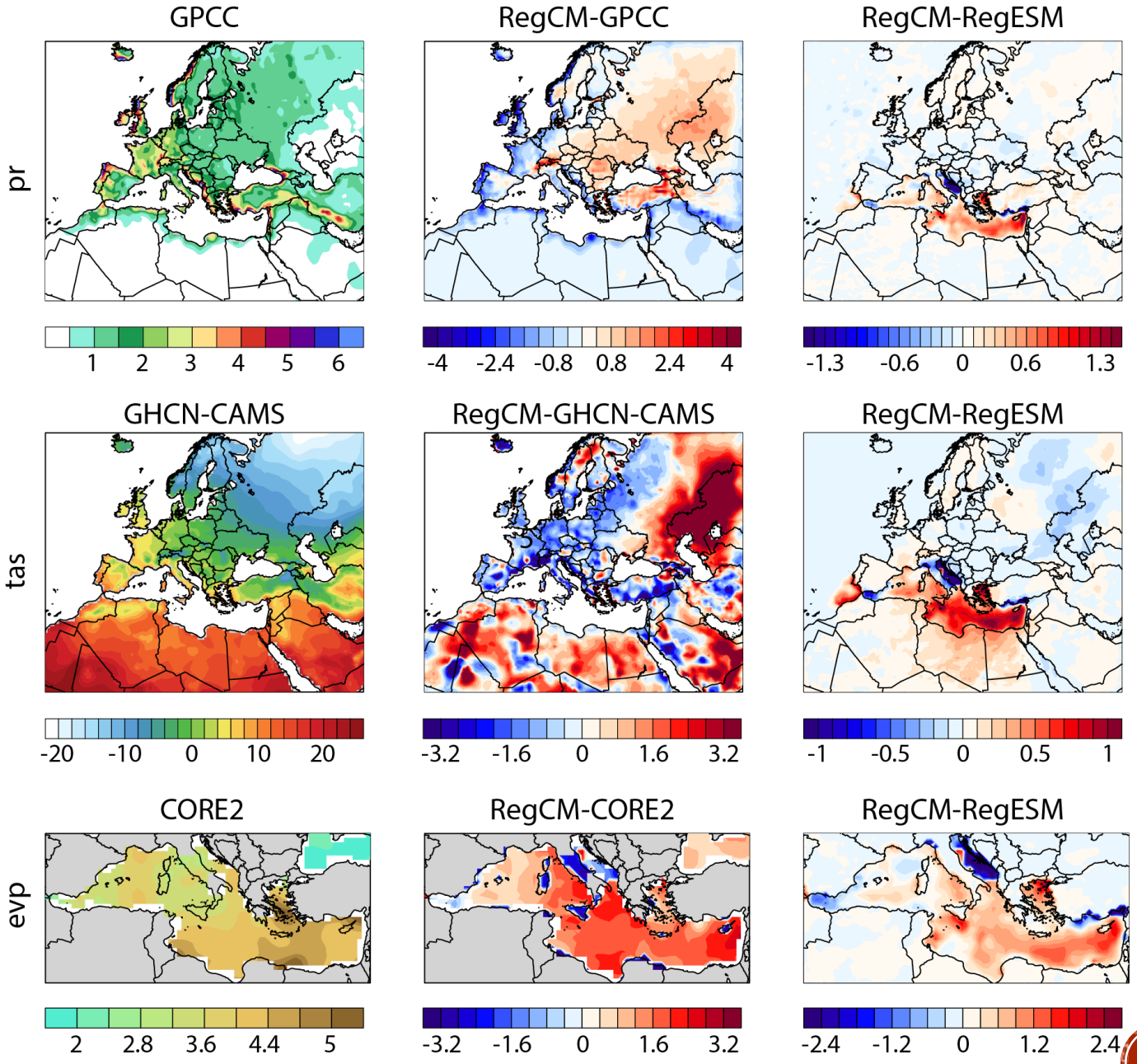
- Winter temperature, precipitation and evaporation analyses

2- Moisture Sourcing over the Mediterranean

- Lagrangian approach (Lagrangian moisture tracking method)

Winter

- Uncoupled model generally exhibits a cold temperature bias throughout the domain and dryer than normal conditions along the coastal areas.
- Additionally, it overestimates evaporation over the Mediterranean Sea.
- Coupled model improves the cold bias over south and western parts of the domain, as well as the overestimation of evaporation over the Mediterranean Sea.



Lagrangian Moisture Tracking Method

The Lagrangian moisture tracking method is an extension of the Dynamic Recycling Model (DRM) developed in Dominguez et al. (2006).

- $R(\chi, \xi, \tau) = 1 - \exp[-\int_0^{\tau} \frac{\varepsilon(\chi,\xi,\tau)}{\omega(\chi,\xi,\tau)}]$

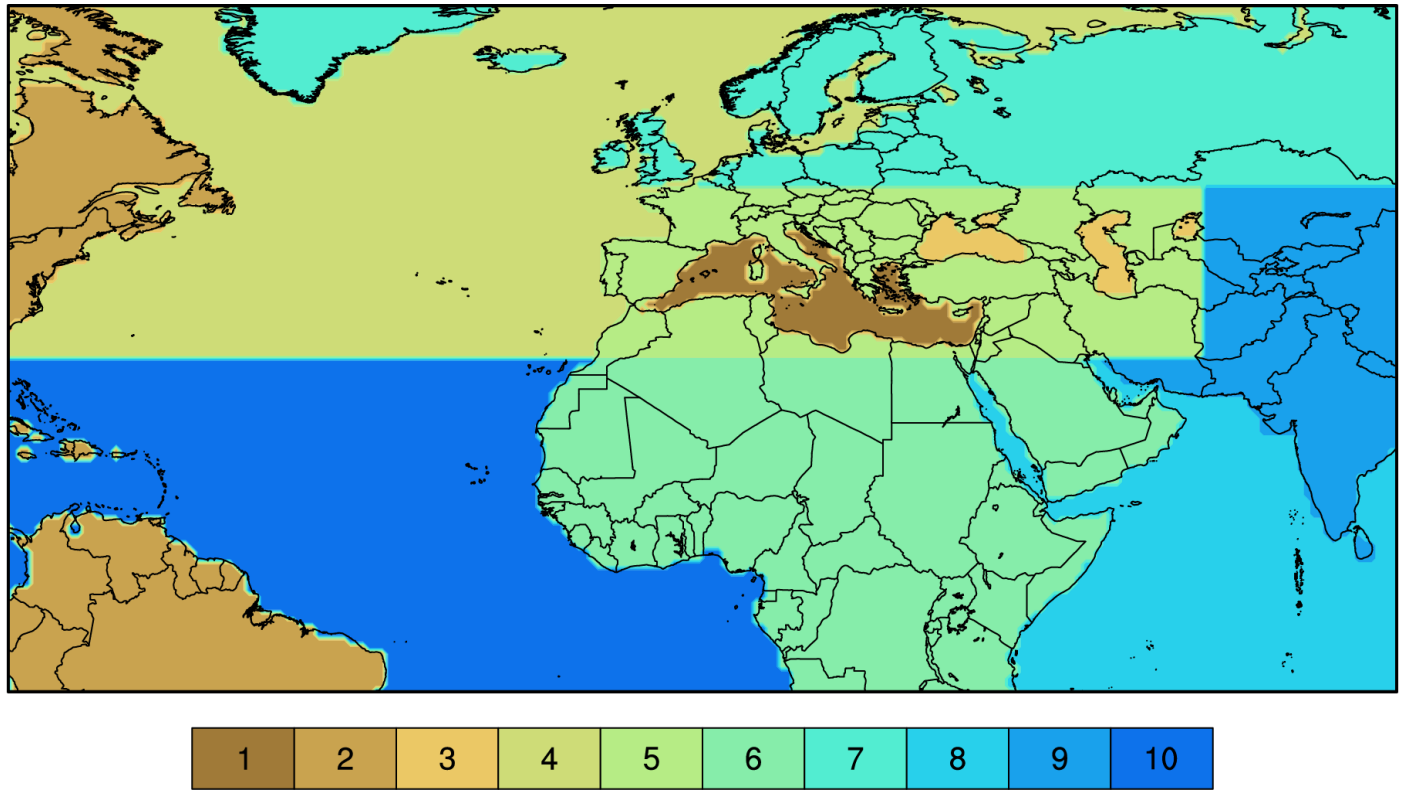
- $R(\chi, \xi, \tau, m)|(\tau 1 - dt) = R(\chi, \xi, \tau, m)|(\tau 1) - \exp\left[-\int_{\tau 1-dt}^{\tau} \frac{\varepsilon(\chi,\xi,\tau)}{\omega(\chi,\xi,\tau)}\right] + \exp\left[-\int_{\tau 1}^{\tau} \frac{\varepsilon(\chi,\xi,\tau)}{\omega(\chi,\xi,\tau)}\right]$

Lagrangian coordinate system (χ,ξ,τ);
X: dimension in space (west-east)
ξ: dimension in space (north-south)
τ: time

Lagrangian Moisture Tracking Method

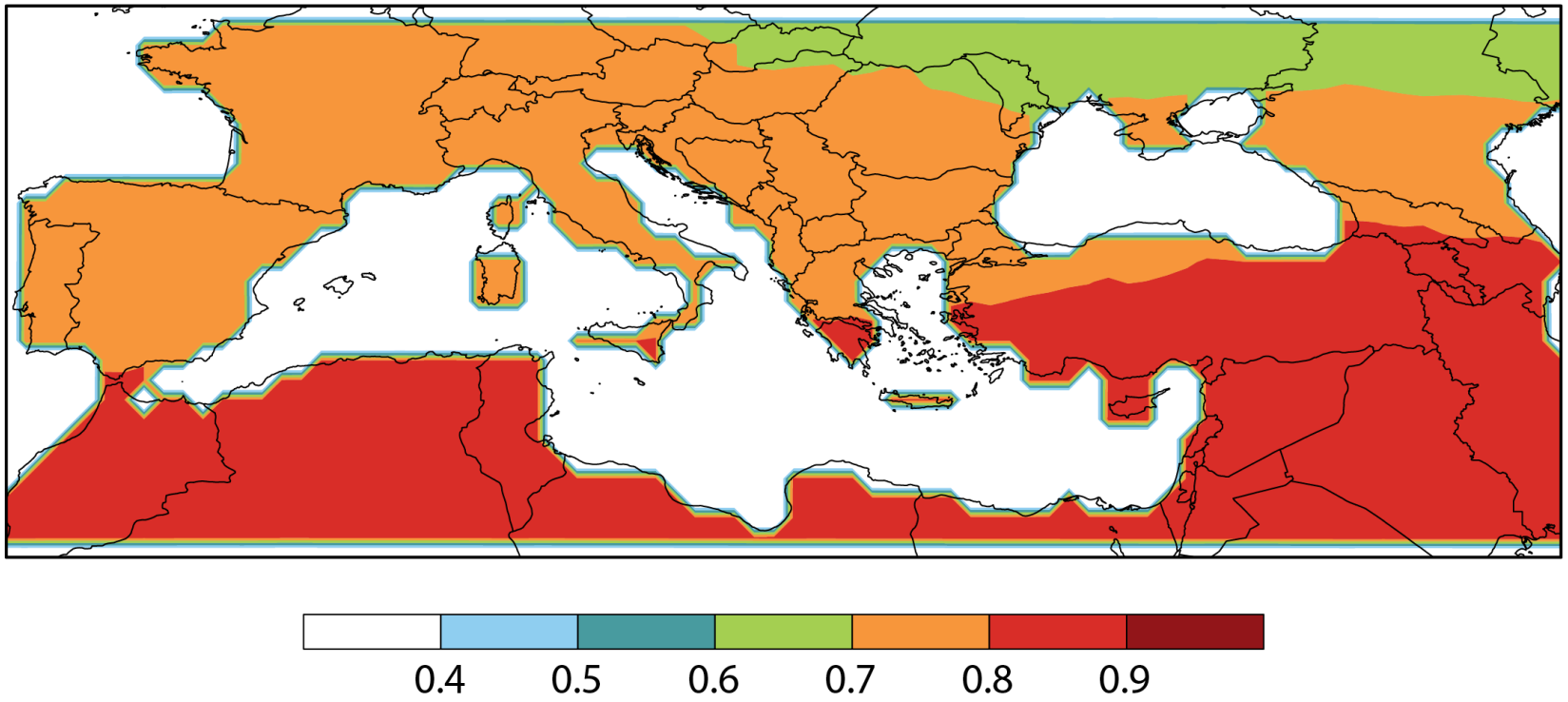
- Precipitation Recycling: is the contribution of evaporation within a region to precipitation in that same region.

- Precipitation Recycling Ratio: precipitation at a certain location and time which is contributed by evaporation within the basin.



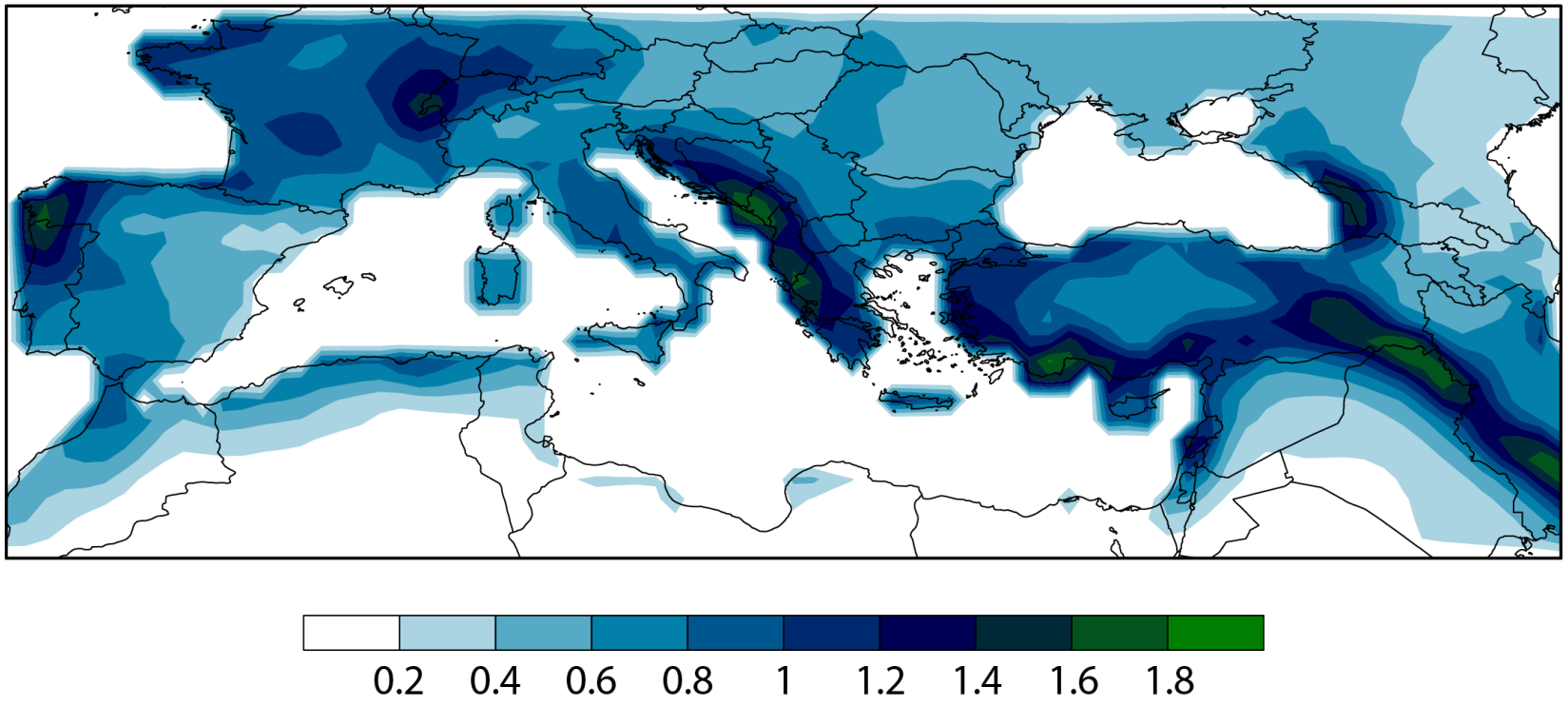
Lagrangian Moisture Tracking Method

- Recycling ratio of ERA-Interim Reanalysis data
- It only accounts for up to 80% of the moisture sources during the DJF season.



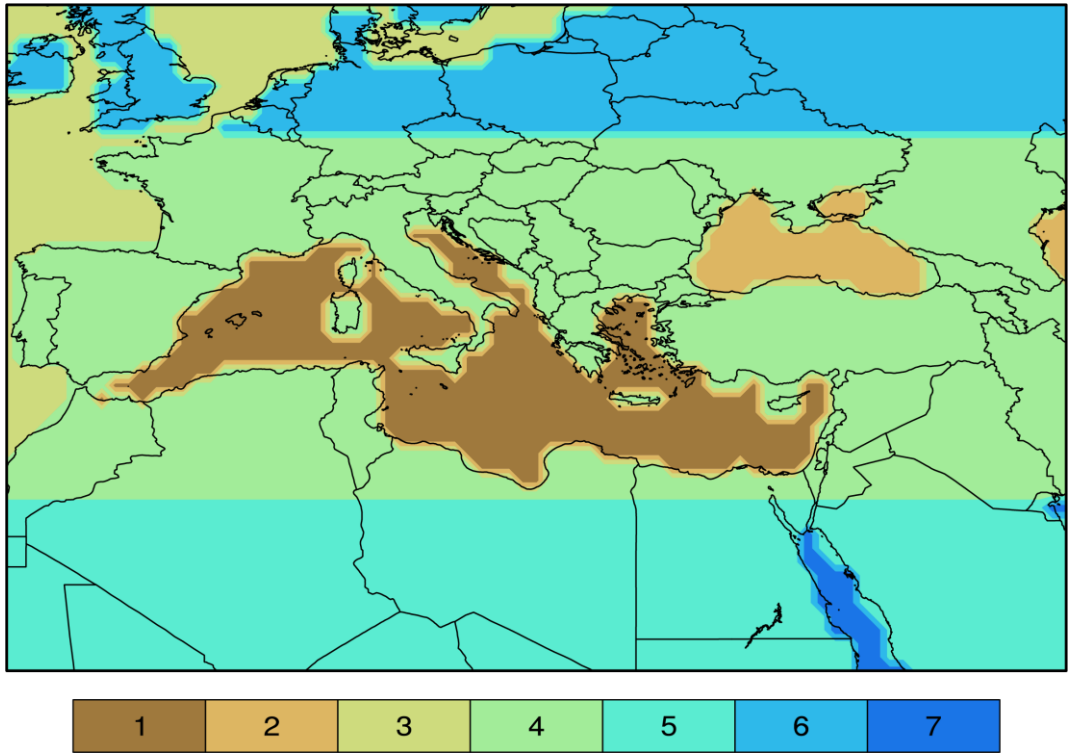
Lagrangian Moisture Tracking Method

- Precipitation contribution calculated with ERA-Interim Reanalysis data.
- It accounts for up to 1.8 mm/day of the precipitation during the DJF season.



Lagrangian Moisture Tracking Method

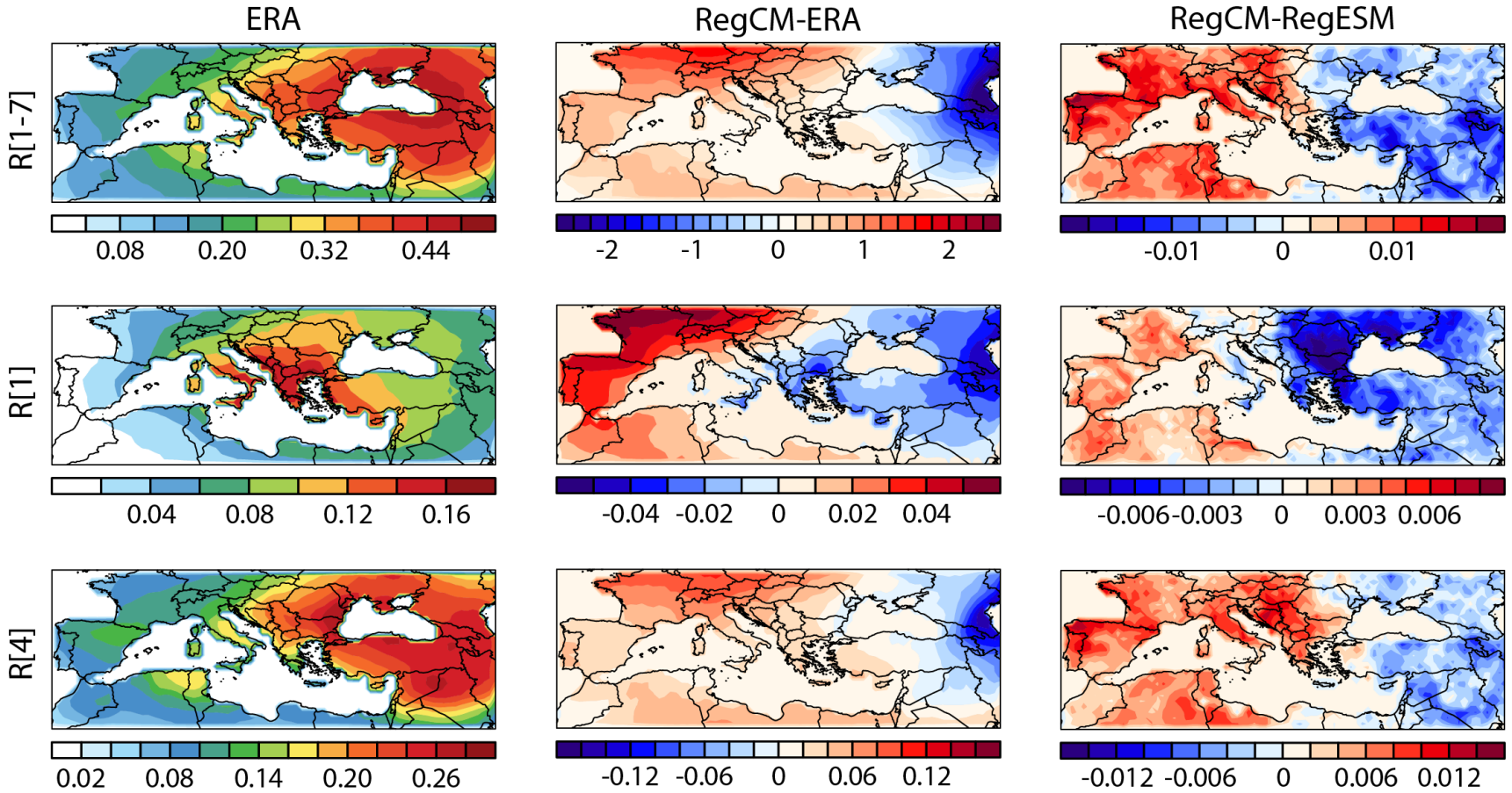
- Mediterranean Sea #1
- Mediterranean Land Region #4



- Defined regions for the Lagrangian moisture source analysis

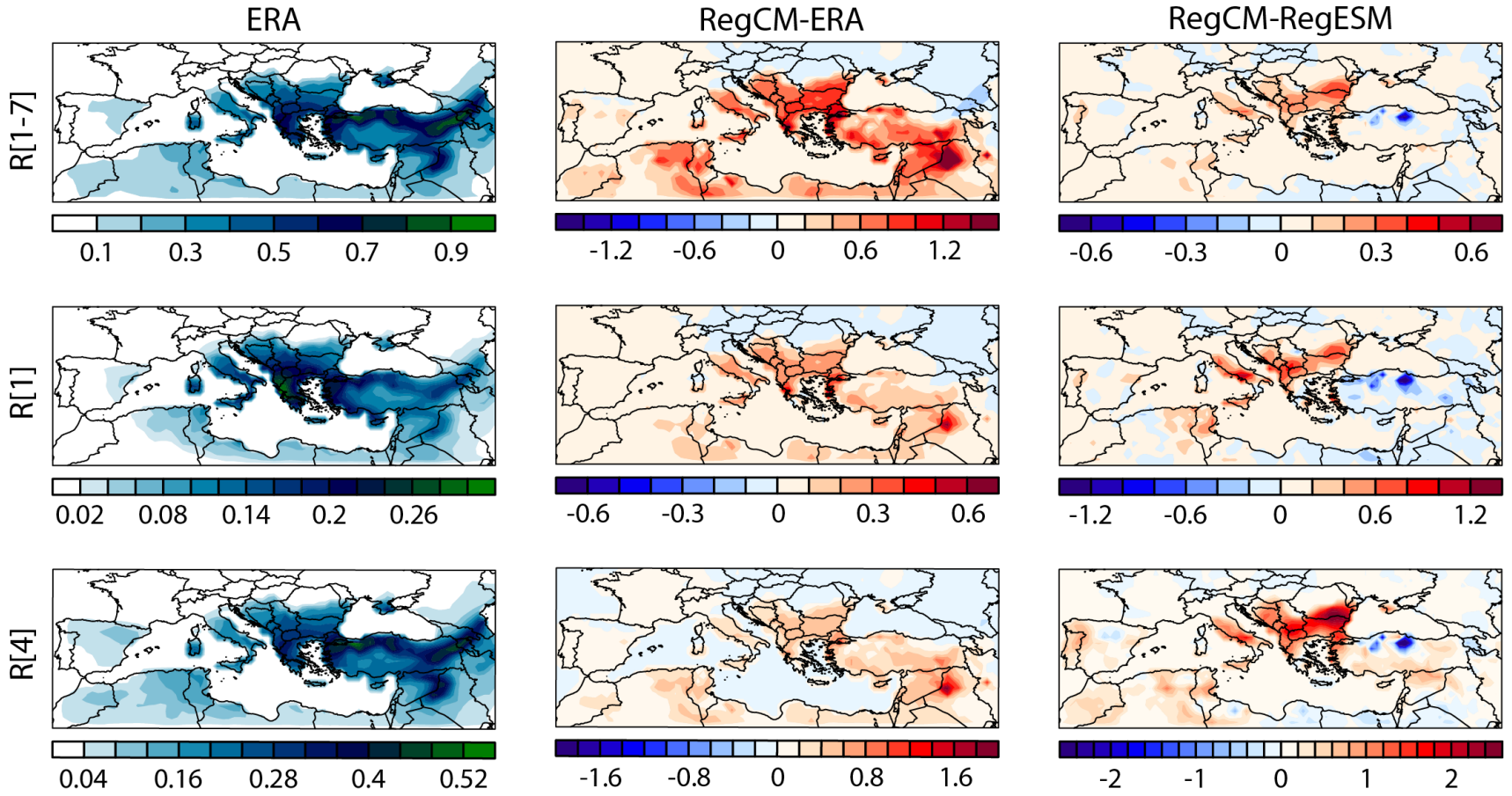
Lagrangian Moisture Tracking Method

- Uncoupled model exhibits a dipolar bias in the total recycling ratio with higher (lower) than ERA-interim recycling ratio in the west (east). This dipolar bias is mainly driven by the similar pattern of bias over Region # 1 (local Mediterranean land).
- Stronger recycling ratio drives stronger contribution to precipitation in the coupled model from Mediterranean Sea and local Mediterranean land. Both of these biases seem to improve in the coupled model simulation.



Lagrangian Moisture Tracking Method

- It only accounts for up to 50% of the moisture sources during the DJF season.
- Within the simulation domain, two major moisture sources include Mediterranean Sea and Mediterranean land (local recycling).
- Figure shows the precipitation for which moisture is sourced back to its origin.



Ongoing work

1- Standalone Model Simulation (RegESM)

- 1979-2012 historical period.
- 12 km horizontal resolution
- Validation for Mediterranean

2- Coupled Model Simulation (RegESM)

- 1979-2012 historical period.
- 12 km horizontal resolution
- Wave model will be activated.
- Open-boundary ocean model to define the interaction with the Atlantic Ocean through the Strait of Gibratlar

EVALUATION OF OCEAN SYNTHESES

COST Action ES1402

http://www.eos-cost.eu

A COST Action to improve the coordination of European efforts in the evaluation of ocean syntheses:

- better understanding of the value and use of ocean syntheses
- promote the use of ocean syntheses

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Thank You!