The MED-CORDEX ensemble of future climate projections for the Mediterranean Sea: Impacts of the high resolution and ocean-atmosphere coupling

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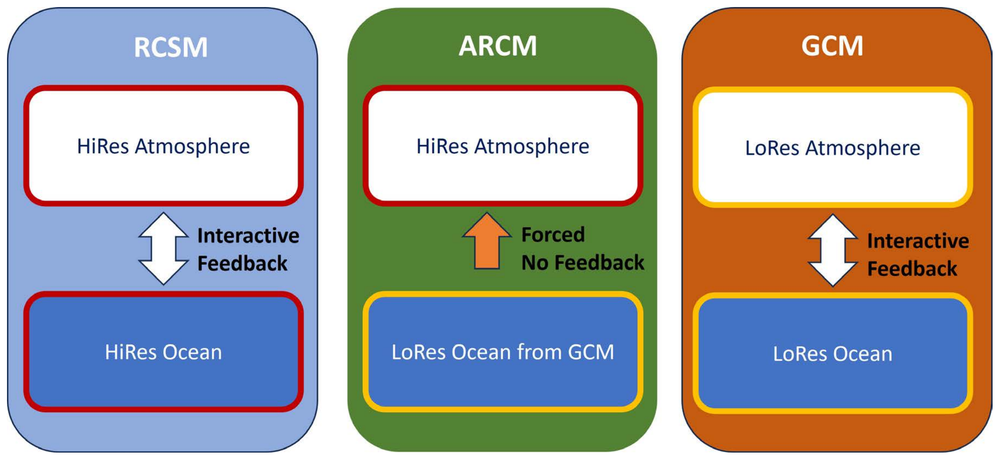
Med-CORDEX is an international initiative that aims at developing fully coupled high resolution Regional Climate System Models (RCSMs) for the Mediterranean basin. After 11 years of work an ensemble of more than **25 multi-model and multi–scenario climatic simulations** is now available.

In this study, we use the **MedCORDEX** ensemble to address the following questions:

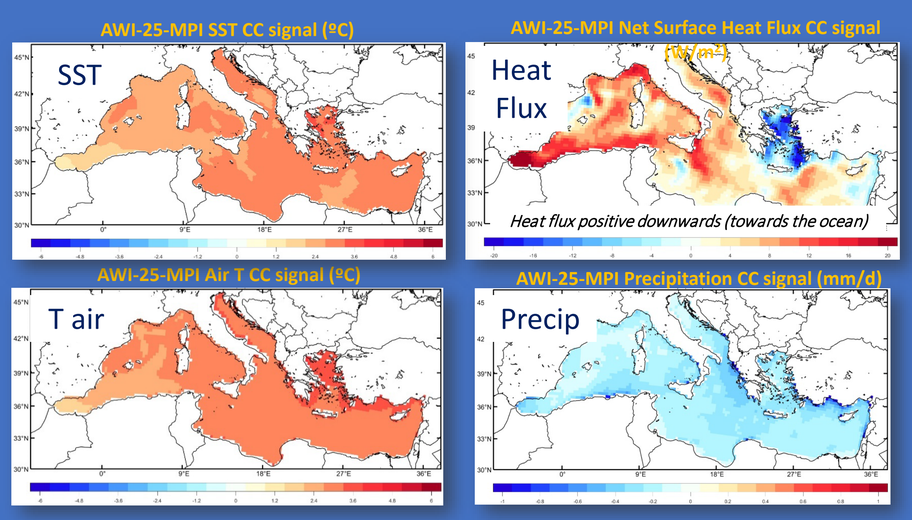
- Is the **climate change signal consistent** in all the models?
- Is there a significant impact in the **climate change signal** because of the **higher resolution** in the RCMs?
- Is there a significant impact in the **climate change signal** because of the **ocean-atmosphere** coupling?

- 14 (10 RCM, 4 ARCM) historical and RCP 8.5 scenario runs + corresponding GCMs
- Analysis of the climate change signal of SST and atmospheric variables at the surface level
- *Climate Change (CC) signal*
  = average(2070-2100) – average(1976-2005)
- *dCC = Difference in the CC signal between models*



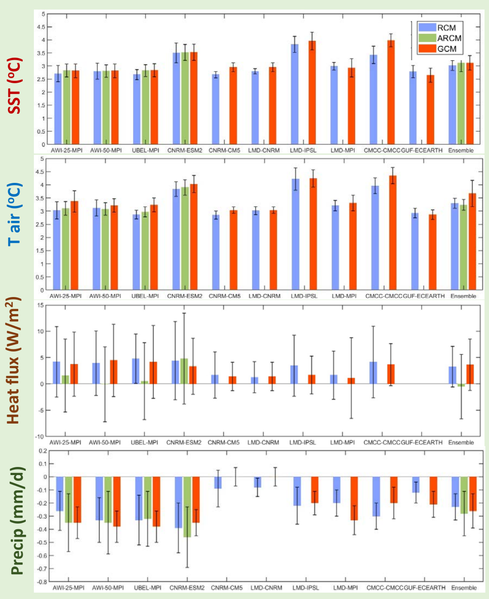
Institution	RCSM (8)	ARCM (4)	GCM (7)	Scenario	Short Name
CNRM	CNRM-RCSM4		CNRM-CM5	RCP 8.5	CNRM-CM5
	CNRM-RCSM6	CNRM-ALADIN63	CNRM-ESM2-1	SSP5-85	CNRM-ESM2
GERICS-AWI	GERICS-AWI-ROM25	REMO25	MPI-ESM-LR	RCP 8.5	AWI-25-MPI
	GERICS-AWI-ROM50	REMO50	MPI-ESM-LR	RCP 8.5	AWI-50-MPI
LMD	LMD-LMDZNEMOMED8		IPSL-CM5A-MR	RCP 8.5	LMD-IPSL
			MPI-ESM-MR	RCP 8.5	LMD-MPI
			CNRM-CM5	RCP 8.5	LMD-CNRM
U. Belgrade	EBU-POM2	EBU	MPI-ESM-LR	RCP 8.5	UBEL-MPI
CMCC	CMCC-CCLM4		CMCC-CM	RCP 8.5	CMCC-CMCC
GUF	CLMcom-GUF-CCLM5		EC-EARTH	RCP 8.5	GUF-ECEARTH

RCSM Climate Change response

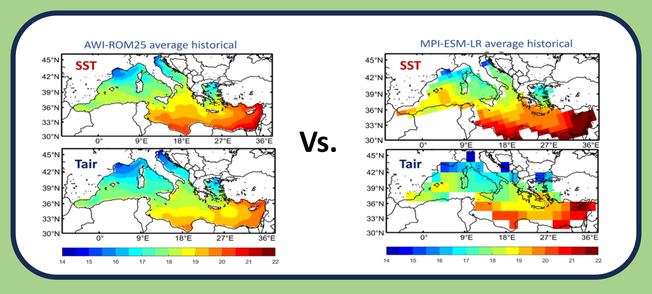


- **SST warming** between 2.5 and 4 ºC on average.
- The **Air Temperature** increase is ~ 30% higher than the SST.
- **Decrease in the net heat loss**
  (average 0.2 – 4.3 W/m²)
  → the atmosphere is cooling less the sea
- **Precipitation decreases** in all RCMs
  (average -0.1 to -0.4 mm/d).

CC signal averaged over the basin for each model

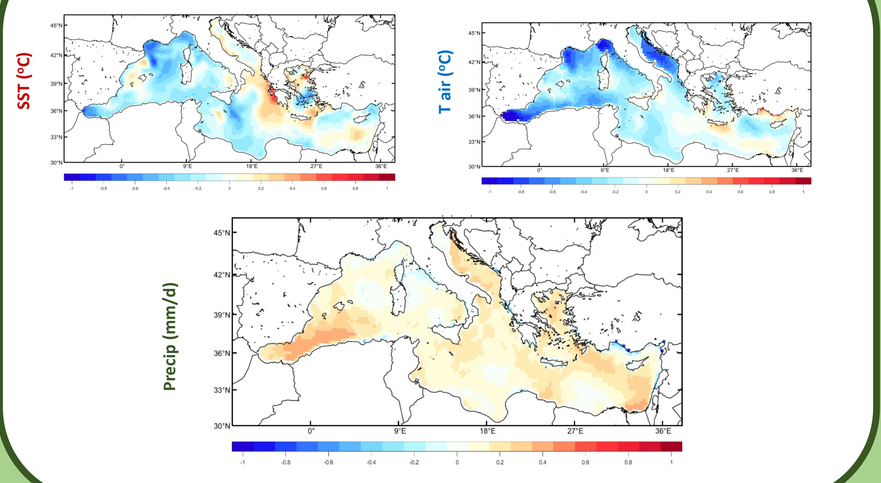


Impact of the spatial resolution : dCC between RCSM and GCM



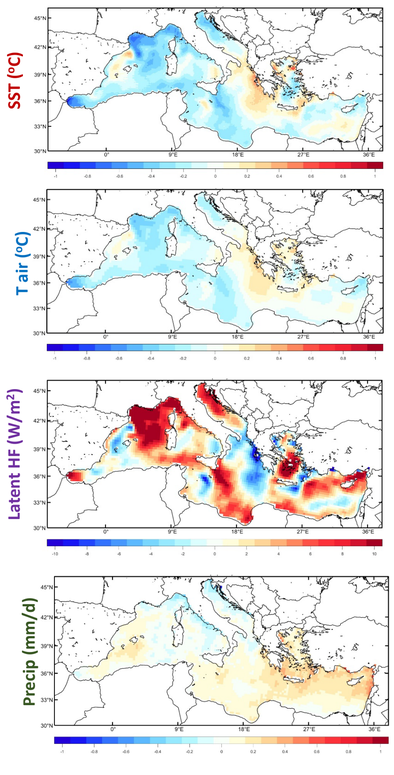
- The SST CC signal is stronger in the GCMs
  (+ 0.2 ºC , ~10%).
- The air T CC signal is stronger in the GCMs
  (+ 0.4 ºC, ~15%).
- dCC can be up to 40% in specific regions.
- In GCMs : higher SST & Tair → increase in the heat gain → higher reduction of the precipitation (up to 30%, model dependent)

AWI-ROM25 vs MPI-ESM-LR dCC signals

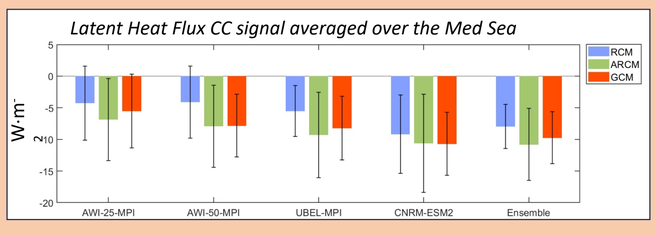


Impact of the ocean coupling : dCC between RCSM and ARM

AWI-ROM25 vs REMO25 dCC signals



- Larger dCC in SST as expected, but dCC in Tair are smaller wrt to the GCM.
- Significant changes in the spatial structures.
- ARCMs show stronger latent HF signals
  → *more evaporation to compensate the higher SST increase from the GCMs boundary condition at the sea surface.*
- Also higher humidity increase and latent heat flux differences in the ARCMs.



In general, **higher resolution coupled simulations** project a **lower increase in the SST** than lower resolution runs. This translates in a **smaller input of heat and humidity** to the atmosphere that, in turn, **affect the cloud cover and precipitation** over the basin and the adjacent continental areas.

These changes are the result of a **better representation of the Mediterranean Sea functioning** in the Med-CORDEX RCSMs. In particular, they resolve better the mesoscale processes of the basin, which are partly responsible of the heat transport from the surface to deeper layers, and the ocean-atmosphere feedback that regulates the heat exchange.