

Evaluation of very high resolution ERA-Interim driven COSMO-CLM simulation for CORDEX FPS and EUCP

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Overview

Simulations with the RCM COSMO-CLM and urban parametrization

- EUCP project
- The experiments over Greater Alpine Region and South-West Europe

Evaluation of the simulations against the finest available observational datasets

- Seasonal values of 2m temperature and total precipitation
- Spatial seasonal Taylor diagram

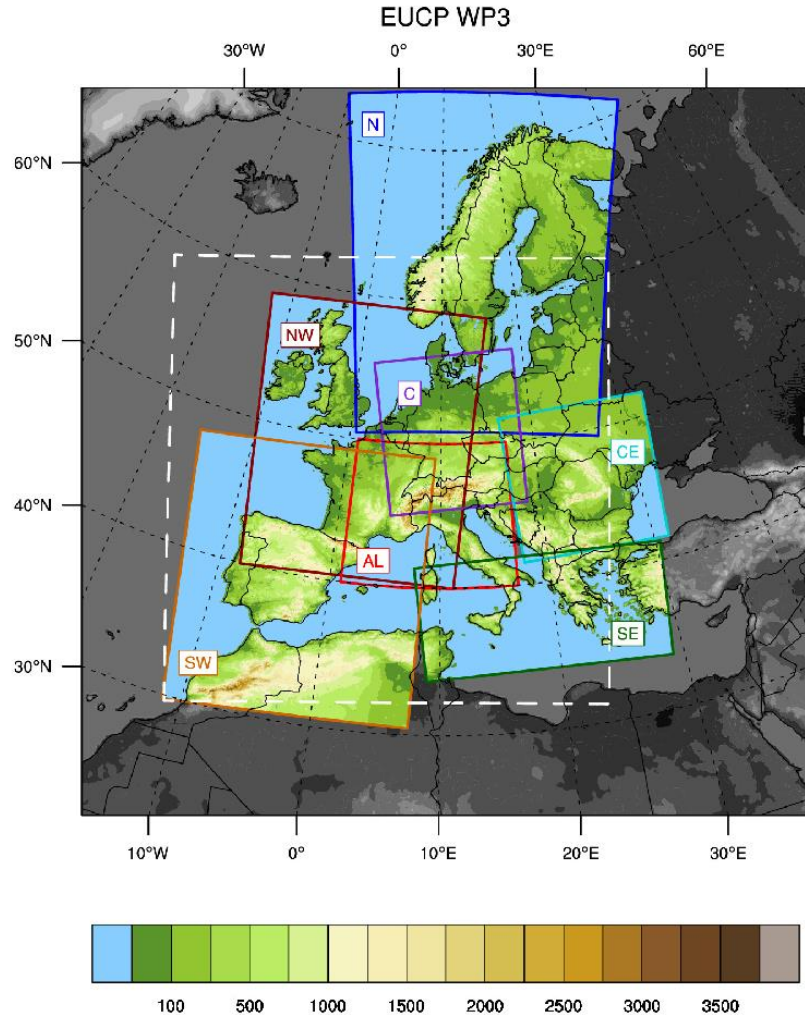
Comparison between very-high (3 km) and high (12 km) resolution simulation over GAR

Conclusions



EUCP project

The overarching **objective** of the **European Climate Prediction (EUCP)** system is to develop an innovative European regional ensemble climate prediction system based on a **new generation of improved and higher-resolution climate models**, covering timescales from seasons to decades, and designed to support taking practical and strategic climate adaptation and mitigation decisions on local, national and global scales.



GROUP	MODEL
CMCC	CCLM
CNRM	AROME41t1
DMI/SMHI	HCLIM38-AROME
SMHI	HCLIM38-AROME
KNMI	HCLIM38-AROME
ETHZ	CCLM-GPU
GERICS	REMO
ICTP	RegCM4
IPSL	WRF
UKMO	UM

#1 Experimental setup – GAR Domain

RCM version

- **COSMO-CLM v 5.00 clm9** with urban parametrization **TERRA-URB 2.2**

Computational Domain

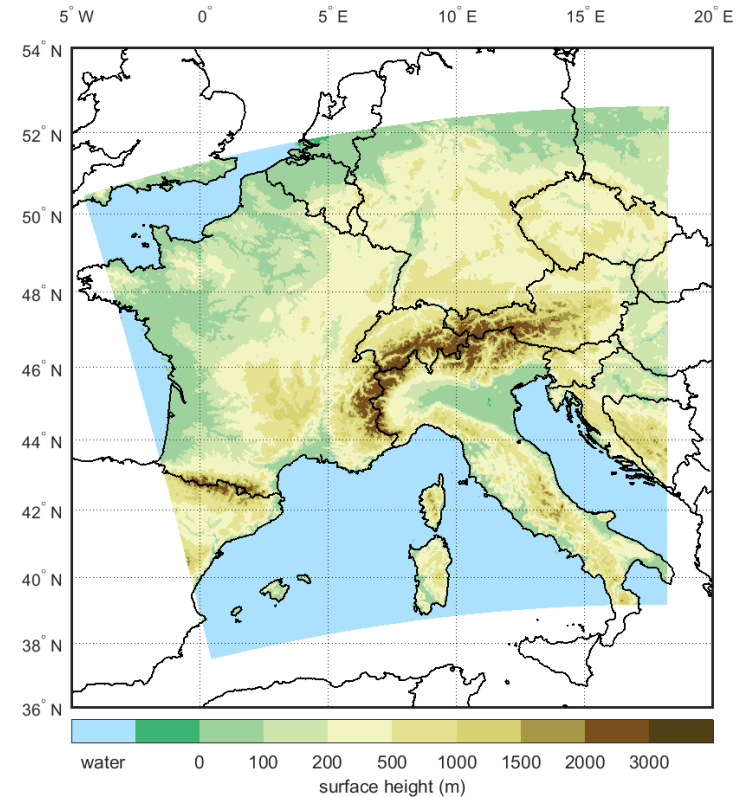
- Extended Alpine Region
5°W - 18°E, 38°N - 53°N
- Nx=522, Ny=490, Nz = 50
- Resolution 0.0275°, ~3 km
- Sponge zone: 23 grid points

Forcing data:

- CCLM 0.11° over EURO-CORDEX domain

Experiments

Simulation type	Period	Status
Evaluation run (ERA-Interim)	2000-2009 (1999 spin up)	Completed
Historical run (EC-EARTH)	1996-2005 (1995)	In progress
Near future run (EC-EARTH, RCP8.5)	2041-2050 (2040)	Not Started



#2 Experimental setup – SW Domain

RCM version

- **COSMO-CLM v 5.00 clm9** with urban parametrization **TERRA-URB 2.3.1**

Computational Domain

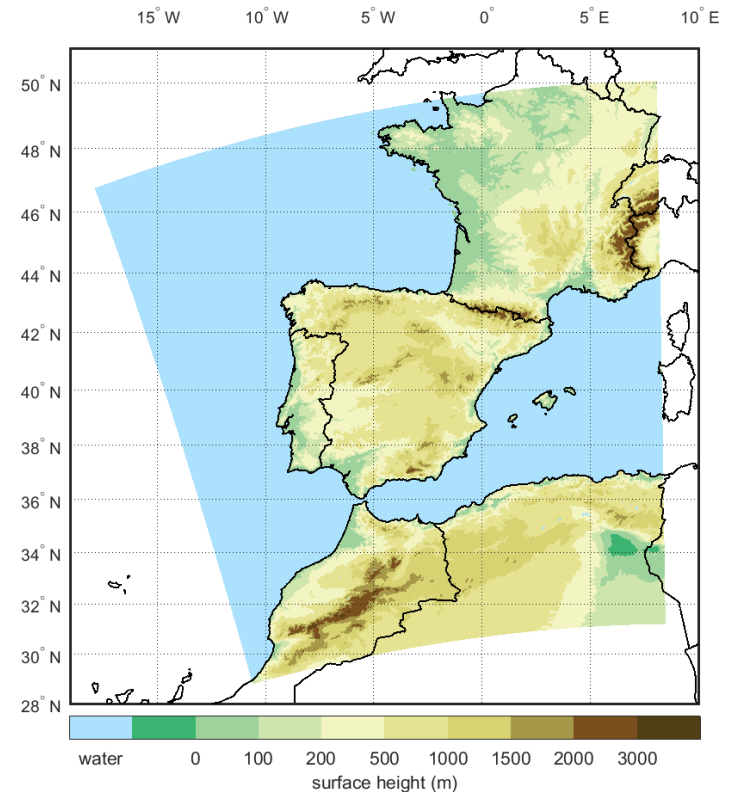
- South West Europe
18°W - 8°E, 29°N - 50°N
- Nx=636, Ny=686, Nz = 50
- Resolution 0.0275°, ~3 km
- Sponge zone: 23 grid points

Forcing data:

- CCLM 0.11° over EURO-CORDEX domain

Experiments

Simulation type	Period	Status
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Historical run (EC-EARTH)	1996-2005 (1995)	In progress
Near future run (EC-EARTH, RCP8.5)	2041-2050 (2040)	Not Started



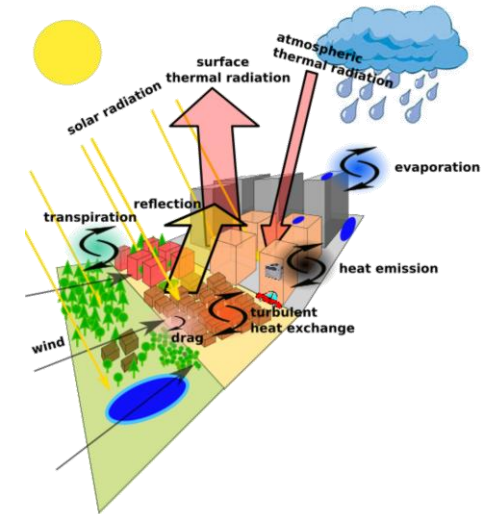
Urban parametrization TERRA-URB

Regional climate model COSMO-CLM is used with the urban-canopy land-surface scheme TERRA URB (Wouters et al., 2016).

TERRA-URB implements the Semi-empirical Urban canopy parameterization (SURY) that translates urban-canopy thermal parameters into bulk parameters:

Input → Anthropogenic heat flux (**AHF**) and Impervious surface area (**ISA**)

Output → bulk parameters: albedo, emissivity, heat capacity and heat conductivity and aerodynamic roughness length



```
INT2LM
&CONTRL
    l_isa = .TRUE.
    l_ahf = .TRUE.
...
```

```
COSMO
dt = 25
&PHYCTL
...
    lterra urb = TRUE
    itype_canopy = 1
    itype_albedo = 2
    itype_aerosol = 2
...
```

See “*TERRA URB user documentation*” by Wouters and “*Implementing TERRA URB in COSMO-Model Version 5.04g*” by Ulrich Schattler for advanced settings.



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Observational datasets and evaluation

Dataset	Spatial resolution	Variable	Period	Temporal resolution	Reference
EURO4M	5 km	Tot prec	1979-2008	daily	Isotta et al., 2014
SAFRAN	8 km	T2m	1958-2014	hourly	Vidal et al. 2010
HYRAS REGNIE	1 km	Tot prec	1931-2014	daily	Rauthe et al. 2013
IBERIA01	11 km	T2m, Tot prec	1971-2015	daily	Herrera et al. 2019

- EUCP_GAR vs EURO4M

- Total precipitation



- EUCP_GAR vs SAFRAN

- T2m



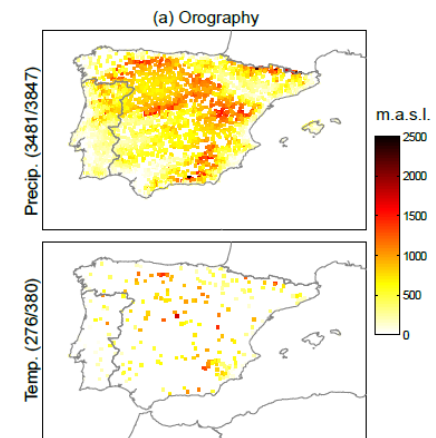
- EUCP_GAR vs HYRAS REGNIE

- Total precipitation



- EUCP_SW vs IBERIA01

- T2m and total precipitation



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- **Spatial seasonal Taylor diagram**



Comparison between very-high (3 km) and high (12 km) resolution simulation over GAR

Conclusions



Evaluation TOT_PREC: GAR vs EURO4M

Period 2000-2008

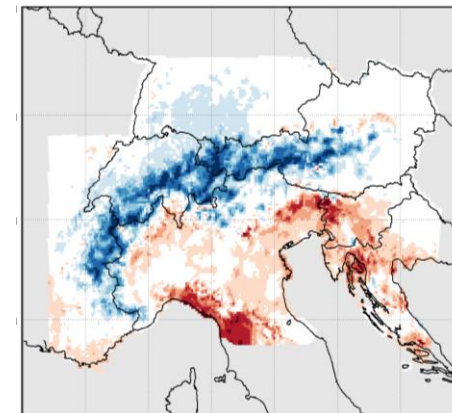
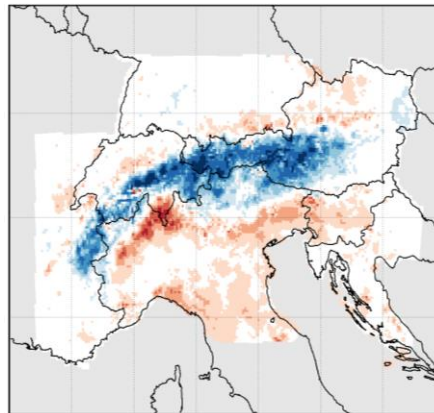
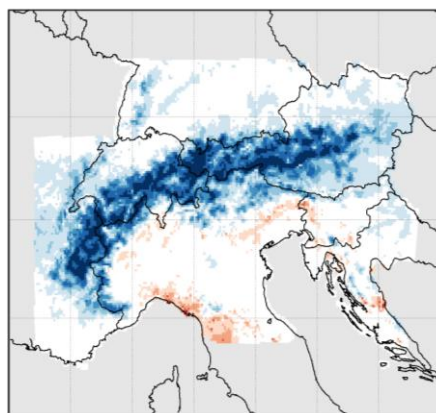
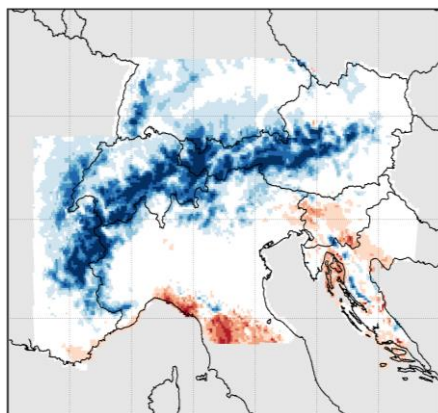


DJF

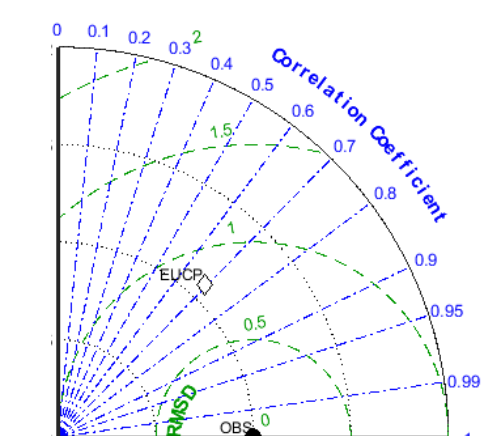
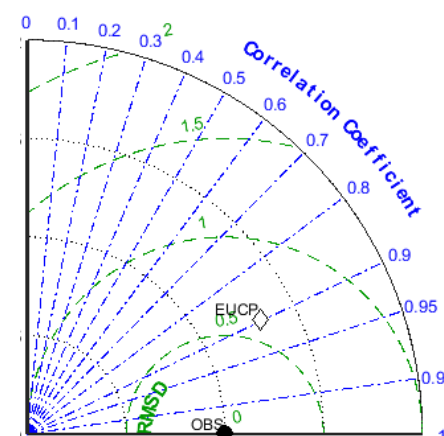
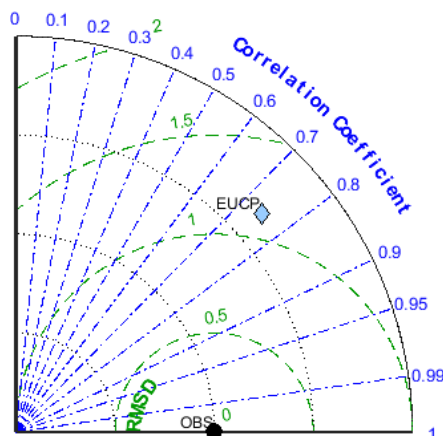
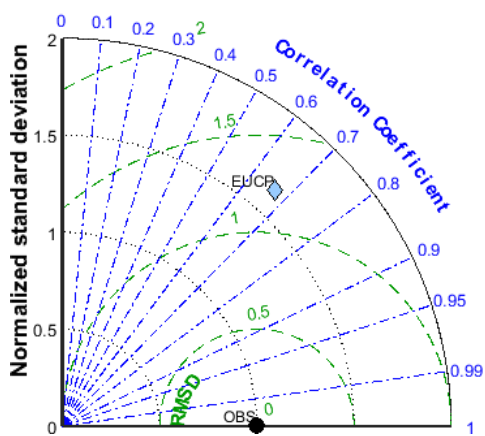
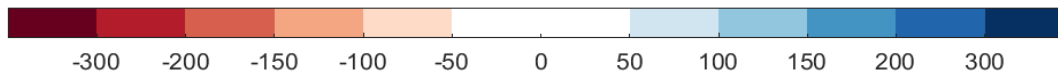
MAM

JJA

SON



Bias of Total precipitation
(mm/season)



Mean bias of Total Precipitation (mm/season)

	DJF	MAM	JJA	SON
GAR vs EURO4M	58,5	66,7	1,5	8,7



Evaluation TOT_PREC: GAR vs HYRAS REGNIE

Period 2000-2010

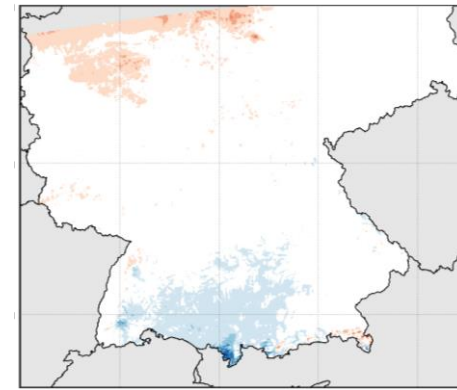
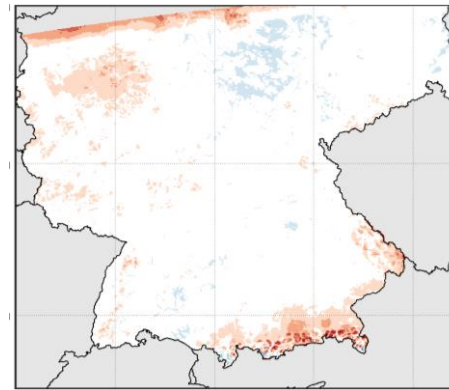
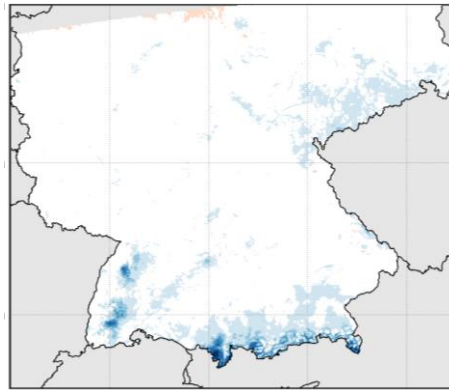
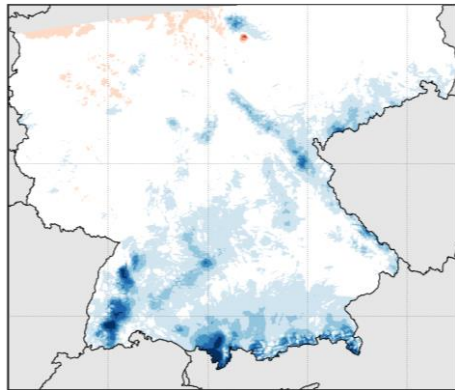


DJF

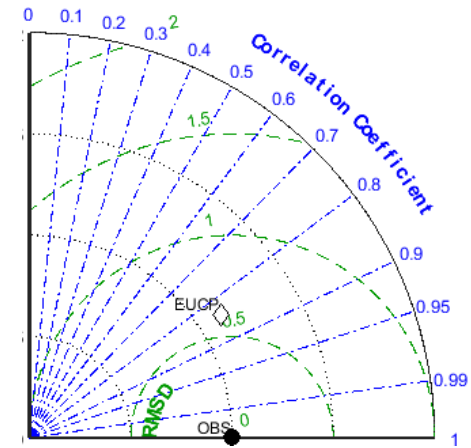
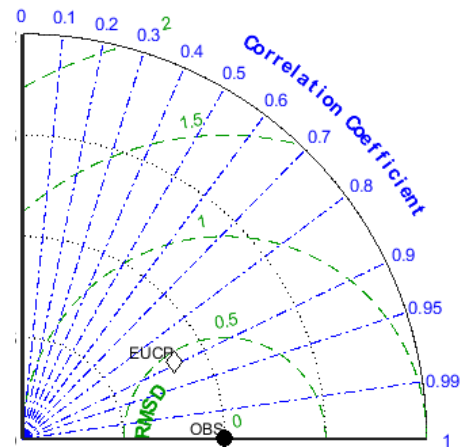
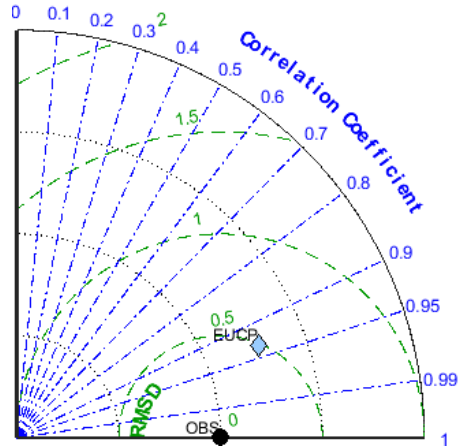
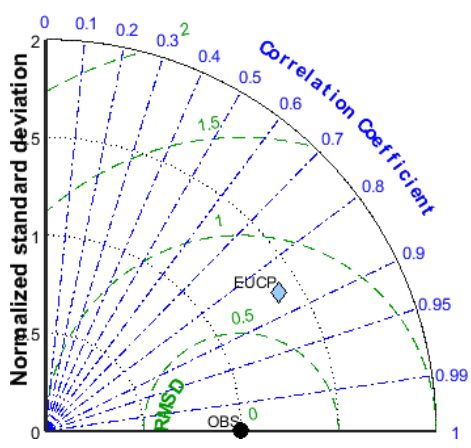
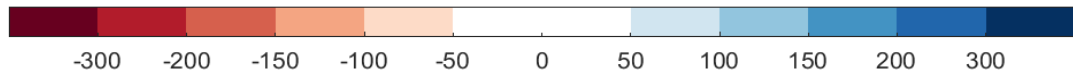
MAM

JJA

SON



Bias of Total precipitation
(mm/season)



	Mean bias of Total Precipitation (mm/season)			
	DJF	MAM	JJA	SON
GAR vs HYRAS REGNI	35,6	25,3	-9,0	1,9



Evaluation TOT_PREC: SW EUROPE vs IBERIA01

Period 2000-2009

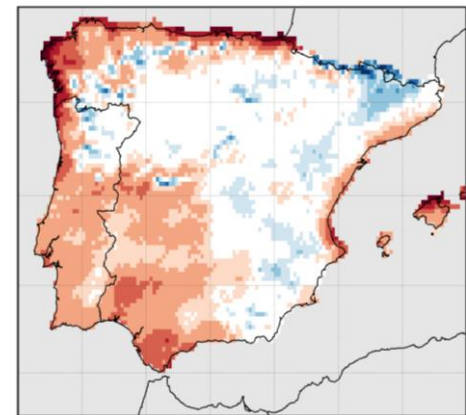
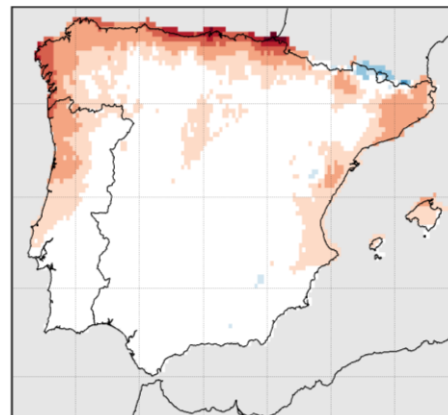
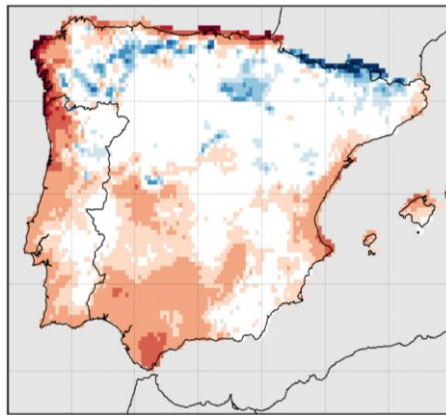
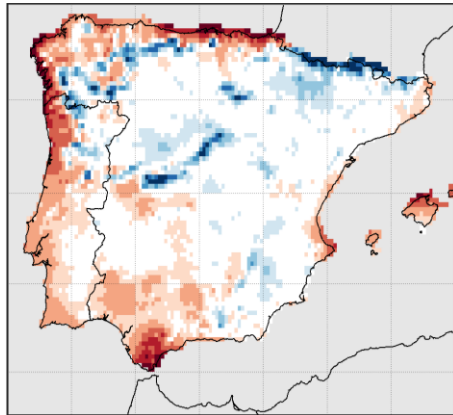


DJF

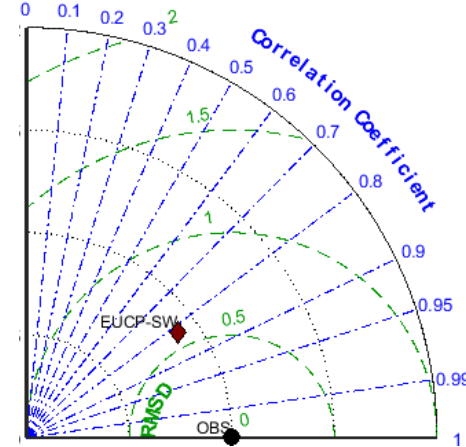
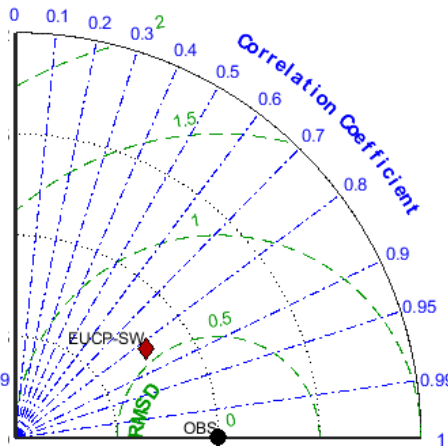
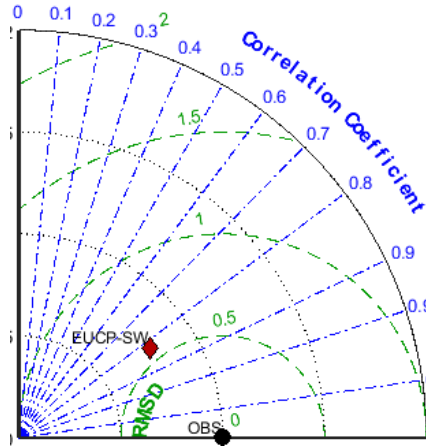
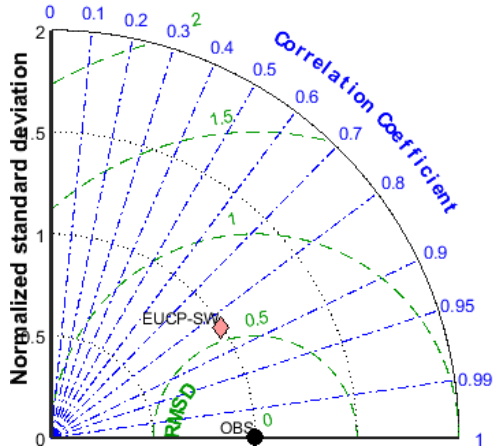
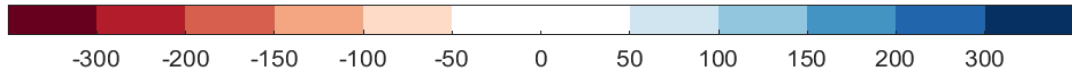
MAM

JJA

SON



Bias of Total precipitation
(mm/season)



Mean bias of Total Precipitation (mm/season)

	DJF	MAM	JJA	SON
EUROPE SW vs IBERIA01	-10,8	-23,1	-23,5	-30



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- **Spatial seasonal Taylor diagram**



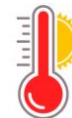
Comparison between very-high (3 km) and high (12 km) resolution simulation over GAR

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Evaluation T_2M: GAR vs SAFRAN

Period 2000-2010

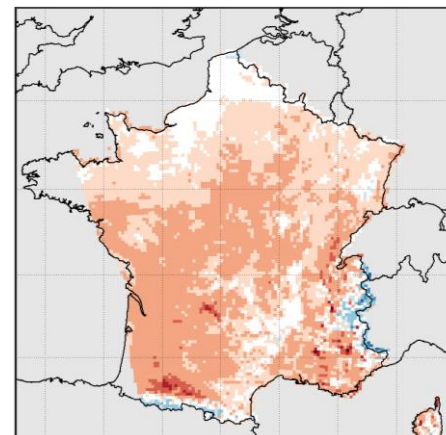
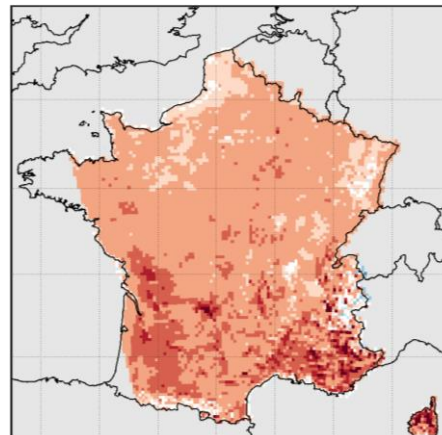
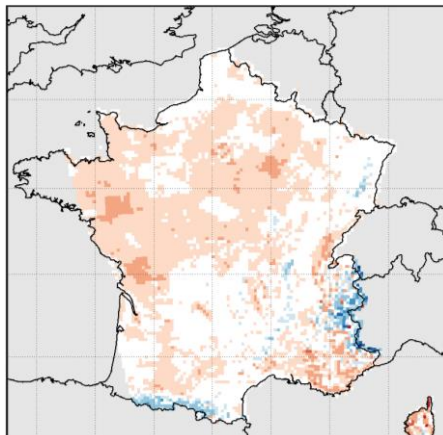
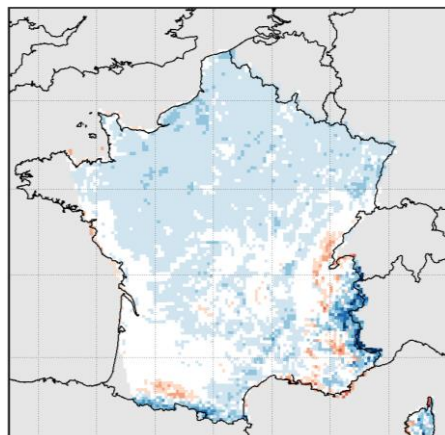


DJF

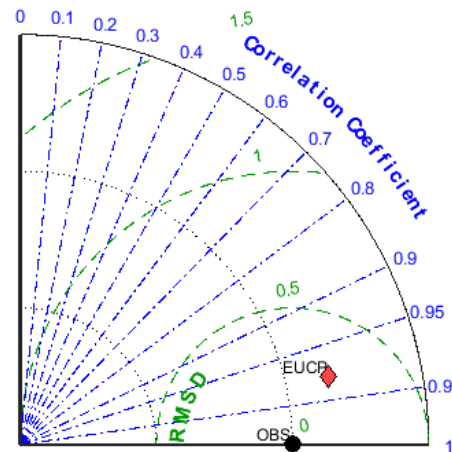
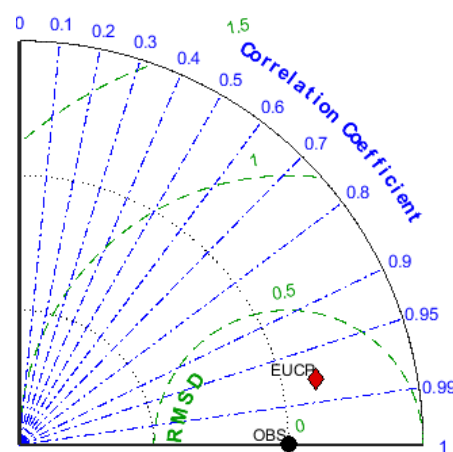
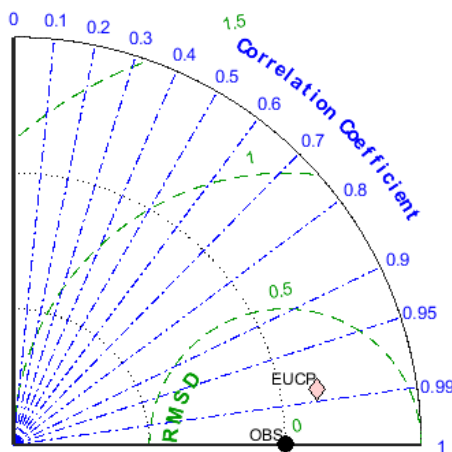
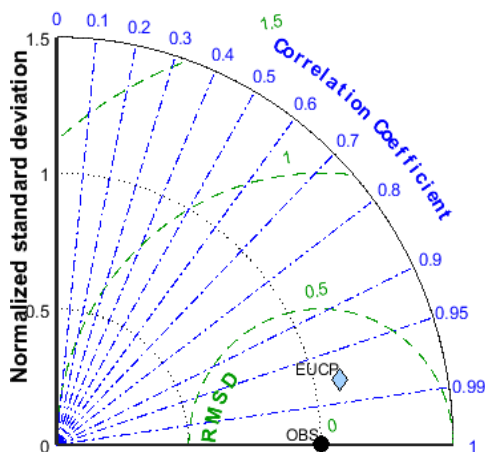
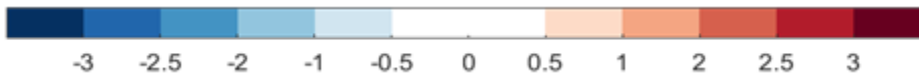
MAM

JJA

SON



Bias of 2m temperature (K)



Mean bias of 2m temperature (K)

	DJF	MAM	JJA	SON
GAR vs SAFRAN	-0,5	0,3	1,5	0,9



Evaluation T_2M: EUROPE SW vs IBERIA01

Period 2000-2009

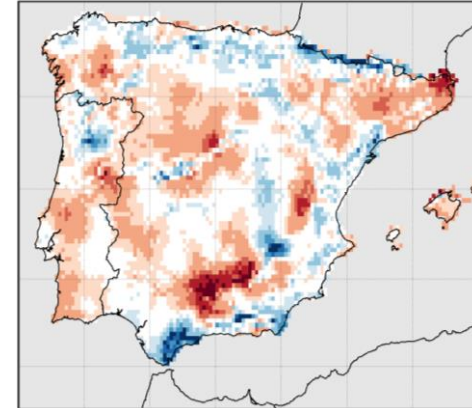
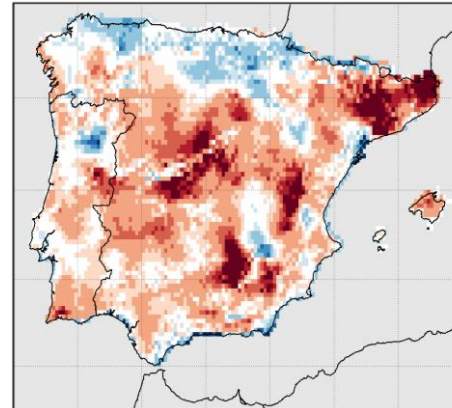
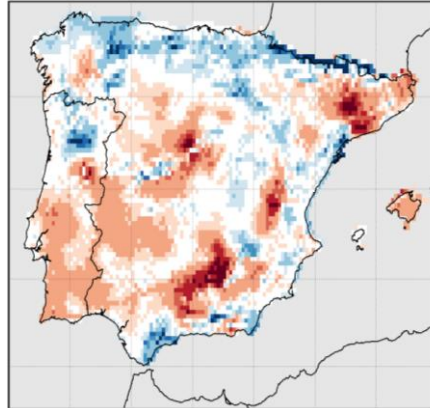
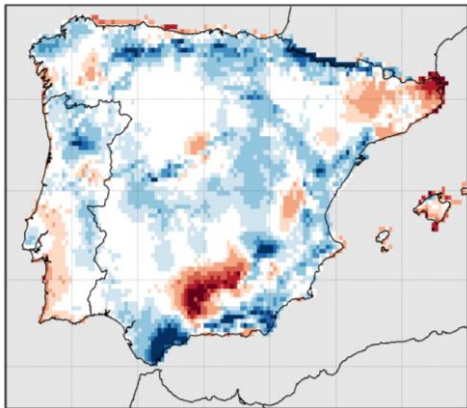


DJF

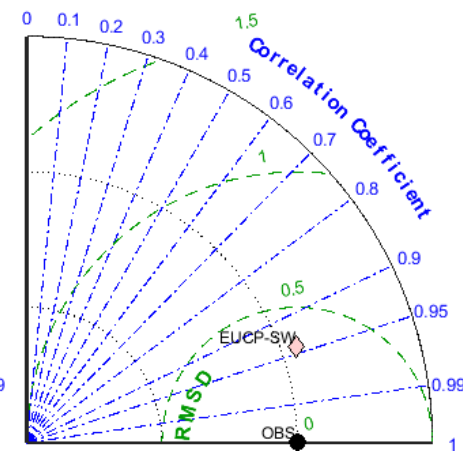
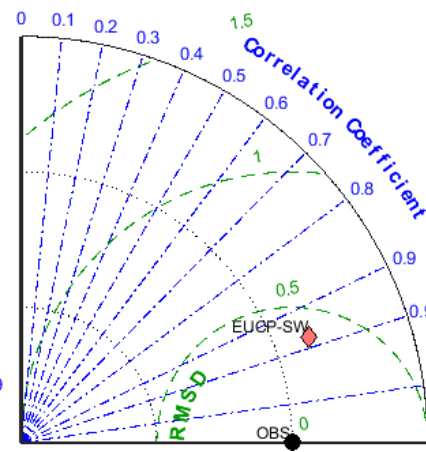
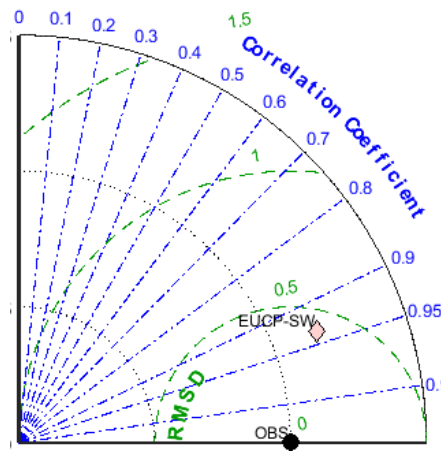
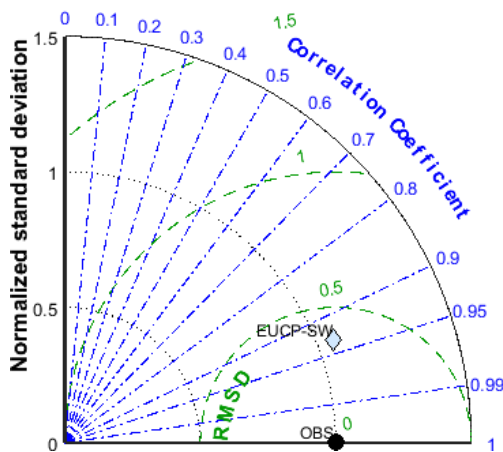
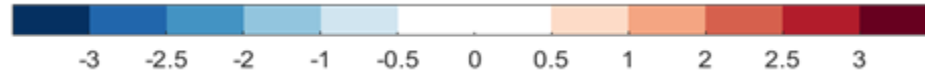
MAM

JJA

SON



Bias of 2m temperature (K)



Mean bias of 2m temperature (K)

	DJF	MAM	JJA	SON
EUROPE SW vs IBERIA01	-0,4	0,3	0,8	0,3



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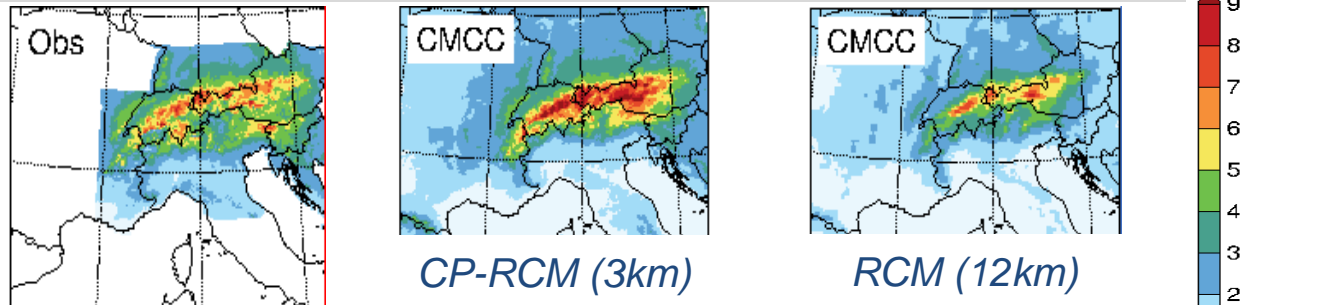
Comparison between **very-high (3 km)** and **high (12 km) resolution** simulation over GAR (First deliverable of EUCP)

Conclusions

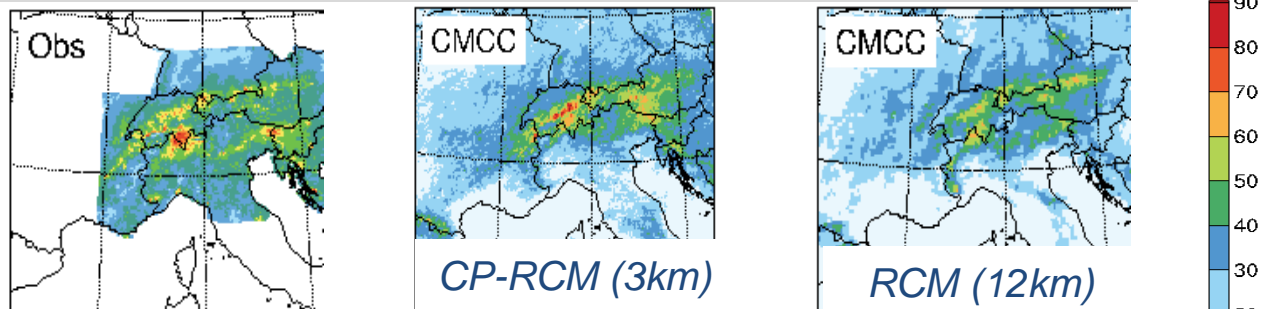


Comparison between very-high (3 km) and high resolution (12 km) simulation over GAR

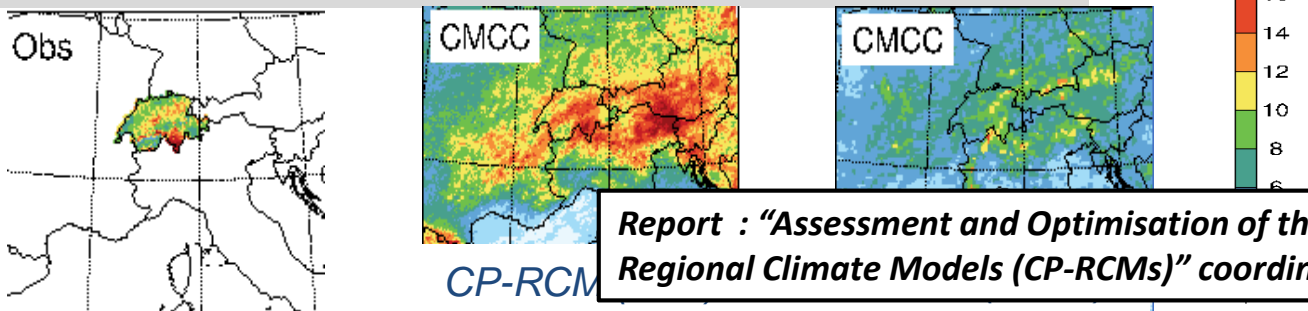
Daily summer precipitation



Heavy (99th percentile) daily summer precipitation



Heavy (99.9th percentile) hourly summer precipitation



- Mean daily summer precipitation is well reproduced both by CP – RCM (3km) and RCM driving (12 km) simulation.
- The differences between CP-RCM and its driving coarse-resolution RCM are much larger for heavy precipitation, especially at hourly frequency: the coarse-resolution RCM produces too light precipitation compared to the observations, while CP-RCM tends to reduce this bias.

Report : "Assessment and Optimisation of the Convection-Permitting Regional Climate Models (CP-RCMs)" coordinated by ETH



Conclusions

This work is a **summary of the evaluation** of two ERA-Interim-driven climate simulations at very high resolution (3 km) for EUCP project: **GAR** and **South-West Europe experiments**

The evaluation is performed using the finest observational datasets over Europe (HYRAS, SAFRAN, EURO4M, IBERIA01)

MAIN RESULTS

- Generally, the lowest bias of Total Precipitation occurs over Germany; Alps region is a critical domain, the CCLM model tends to overestimate the seasonal precipitation;
- Temperatures are overestimated in both experiments (on France and Iberian peninsula), especially in JJA, but the bias values are very low.
- Taylor diagrams confirm a good agreement in terms of temperature; for precipitation, the correlation is higher than 0.8 (except over Alps). Two experiments show higher variability with respect to the observations (except over Iberian peninsula).

TERRA-URB remarks

- The **urban-canopy land-surface scheme TERRA URB** gives generally positive feedback on temperature and precipitation also in not urban areas.

(see results on the dedicated poster *"The effect of the urban parametrization scheme into a very high resolution ERA-Interim driven COSMO-CLM simulation"*, Adinolfi et al.)

- Furtherly investigation on the sensitivity of TERRA-URB will be performed also in agreement with **PT_AEVUS** and in **WG-SOILVEG** .



Thanks

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Paestum, Italy
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