Workshop on advances in meso- and micro-meteorology
3–4 November 2014, Jezerčica Thermae,Donja Stubica, Croatia

Evaluating regional climate models over complex topography

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Outline

1.Introduction

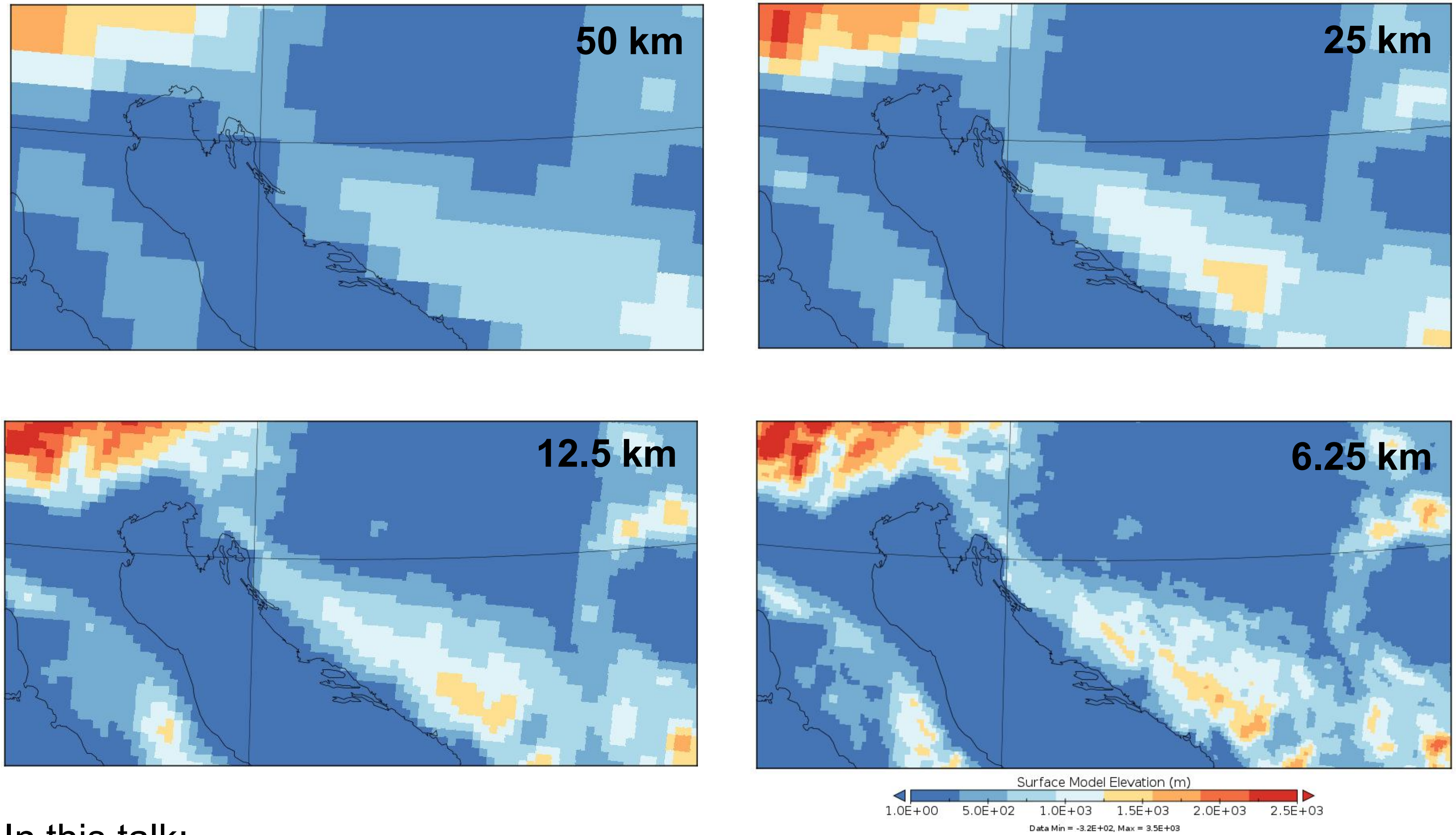
2. RCM *T2m* systematic errors and *T2m* projections

3. RCM total precipitation errors and the impact of horizontal resolution

4. Linking *T2m*, total cloud cover and surface radiation errors

5. Summary

DHMZ



In this talk:

FP6-ENSEMBLES regional climate models (RCMs): 25 km horizontal resolution

SMHI RCA3 experiments: 50 km, 25 km, 12.5 km, 6.25 km

DHMZ CORDEX experiments: 50 km and 12.5 km

Table 1 Geographical and geophysical data for the Croatian coast climatological stations

No.	Station	Latitude N	Longitude E	Altitude (m)	LSF (%)	Type
1	Rovinj	45°6′	13°38′	20	46	Coastal
2	Rijeka	45°20′	14°27′	120	57	Coastal
3	Crikvenica	45°10′	14°42′	2	67	Coastal
4	Senj	45°0′	14°54′	26	57	Coastal
5	Cres	44°57′	14°25′	5	45	Island
6	Mali Lošinj	44°32′	14°29′	53	15	Island
7	Zadar	44°8′	15°13′	5	60	Coastal
8	Šibenik	43°44′	15°55′	77	72	Coastal
9	Split-Marjan	43°31′	16°26′	122	46	Coastal
10	Hvar	43°10′	16°27′	20	18	Island
11	Vela Luka	42°58′	16°43′	5	25	Island
12	Lastovo	42°46′	16°54′	186	12	Island
13	Dubrovnik	42°39′	18°5′	52	46	Coastal

Station locations with corresponding numbers are shown in Fig. 1a

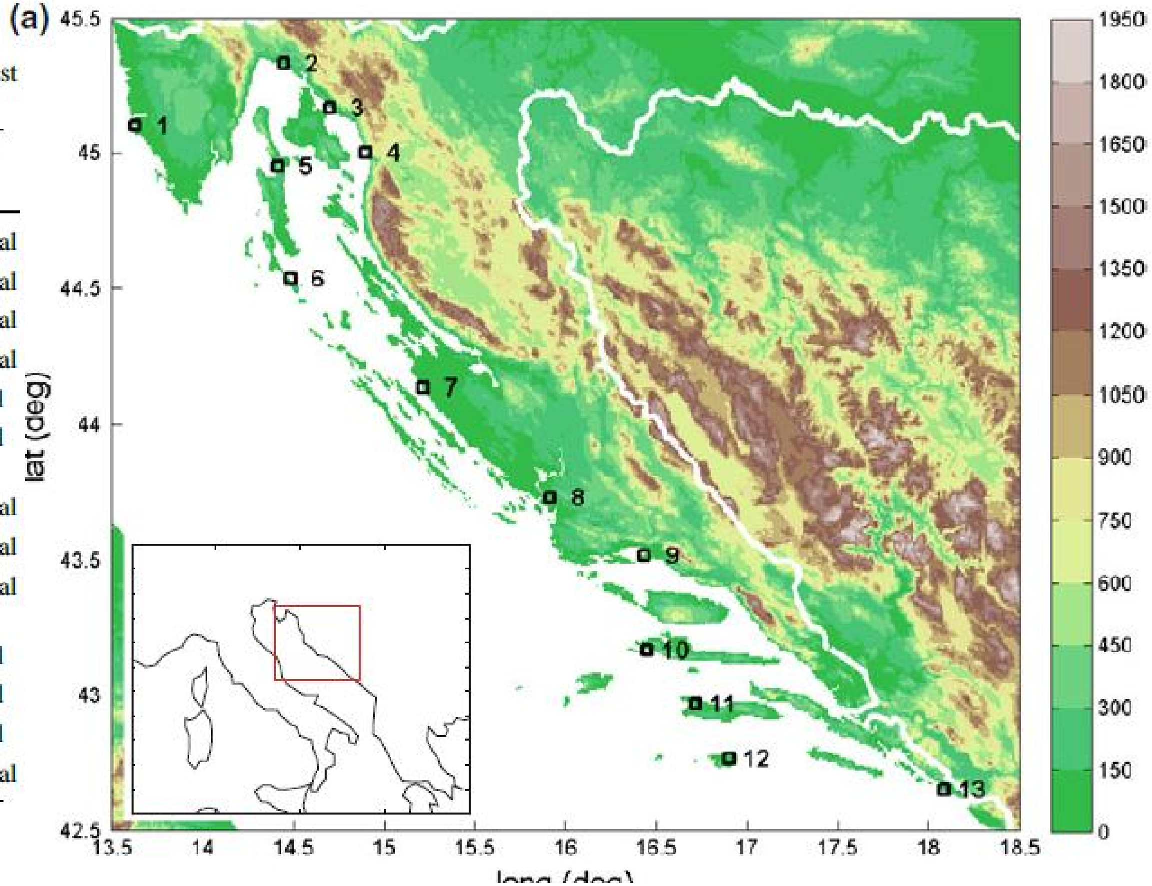


Table 2 Regional climate models used in this study

Model	Acronym	Reference	Vertical levels	Land surface scheme
DMI—HIRHAM5	HIRHAM	Christensen et al. (2007b)	19	Based on ECHAM4 land surface scheme (Roeckner et al. 1996)
KNMI—RACMO2	RACMO	van Meijgaard et al. (2008)	40	Based on ECMWF land surface scheme (Van den Hurk et al. 2000)
SMHI—RCA3	RCA	Kjellström et al. (2005)	24	Samuelsson et al. (2006)
ICTP—RegCM3	RegCM	Pal et al. (2007)	19	Dickinson et al. (1993)
MPI—REMO	REMO	Jacob et al. (2001)	27	Based on ECHAM4 land surface scheme (Roeckner et al. 1996)

Branković et al. (2013) *Clim. Dyn.*

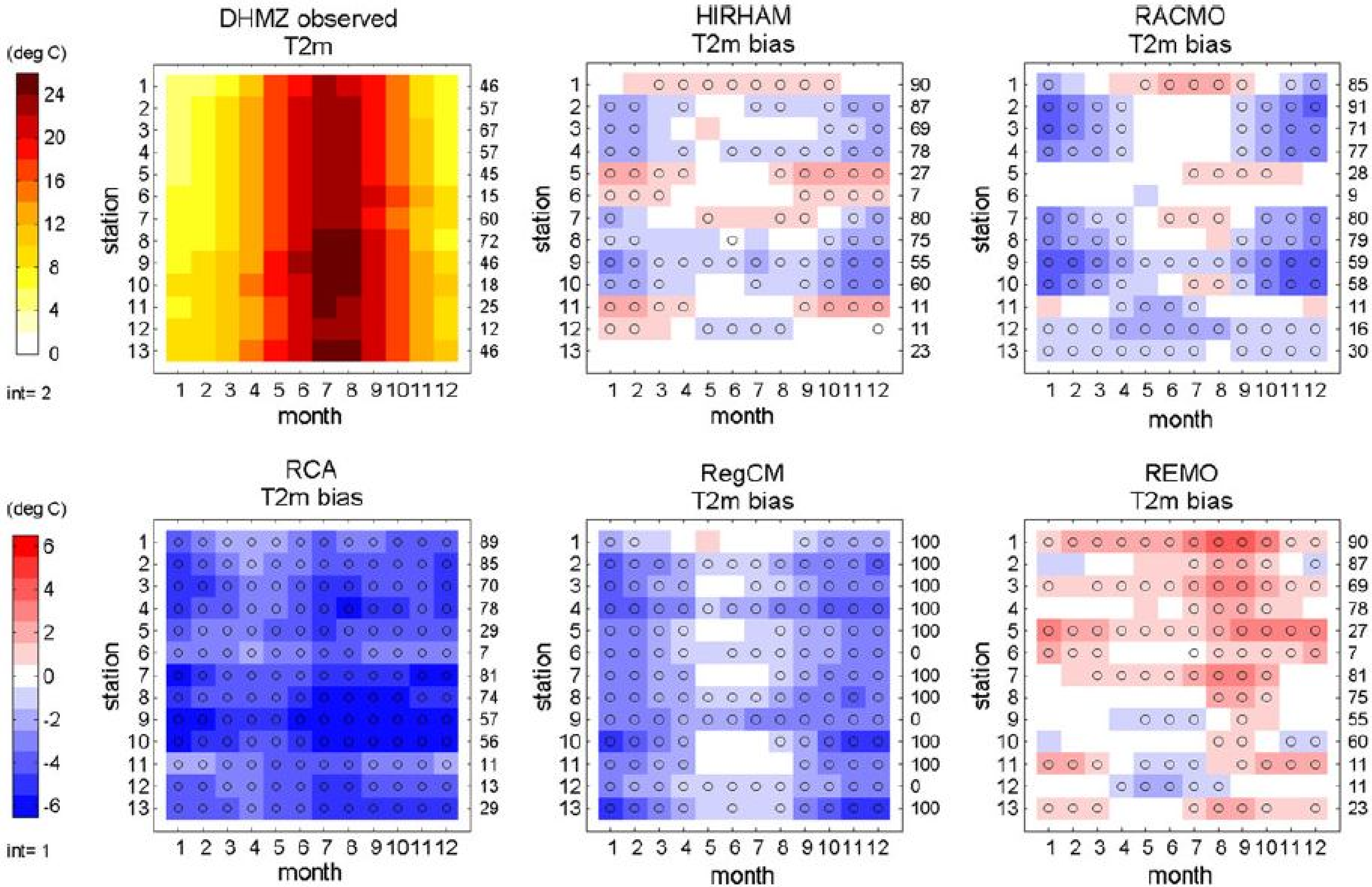
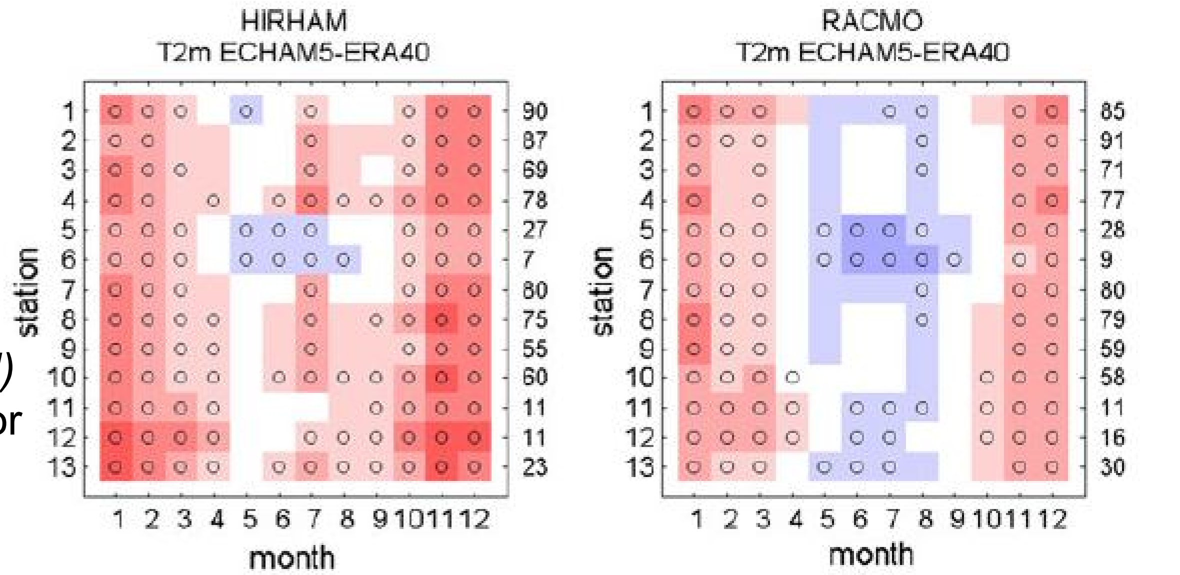


Fig. 3 Annual cycle (*left* to *right* in each panel) of observed (DHMZ) monthly mean T2m (*top left panel*; in °C) and RCM monthly mean T2m biases (in °C) for all stations (*top* to *bottom* in each panel) in the period 1961–1990 when RCMs were forced by ERA-40 boundary conditions. Biases significant at the 95 % confidence level are denoted by *open circles*. Station locations are indicated in Fig. 1a. Land-sea fraction (LSF) for stations and in models is on the *right-hand* side of each panel

RCM+reanalysis (e.g. ERA40)
Total Error ≈ RCM Error

RCM+GCM (e.g. ECHAM5/MPI-OM)
Total Error ≈ RCM Error + GCM Error



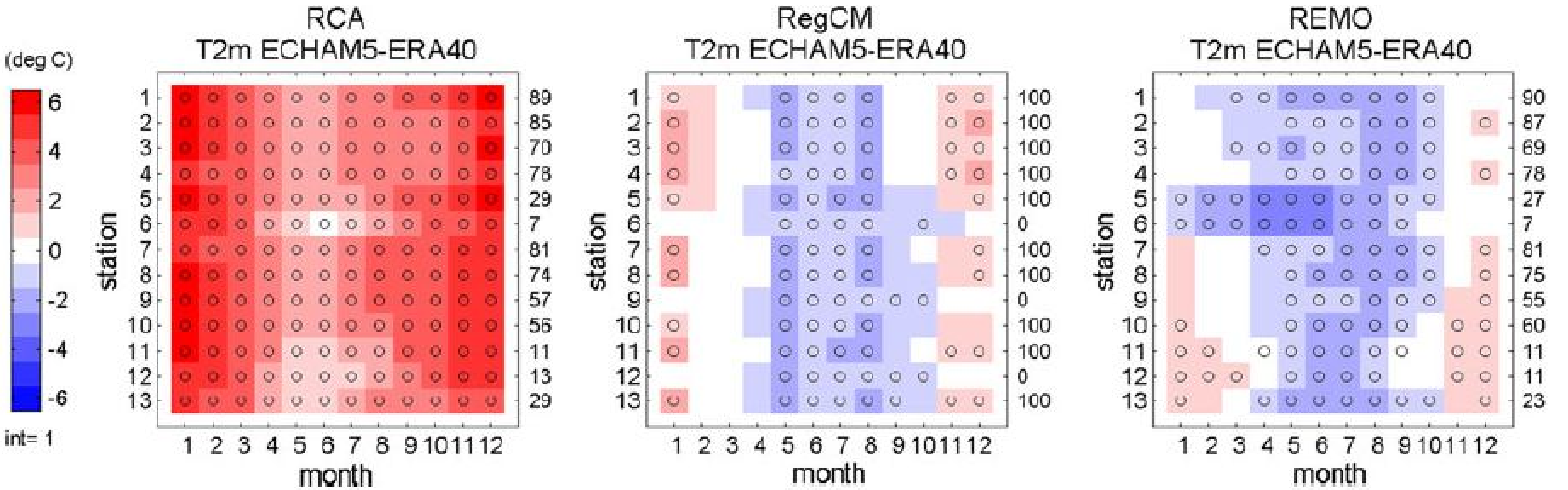


Fig. 8 Annual cycle (*left* to *right* in each panel) of RCM T2m monthly mean differences (in °C) between simulations forced by ECHAM5/MPI-OM and simulations forced by ERA-40 in the period 1961–1990. Differences significant at the 95 % confidence level are denoted by *open circles*

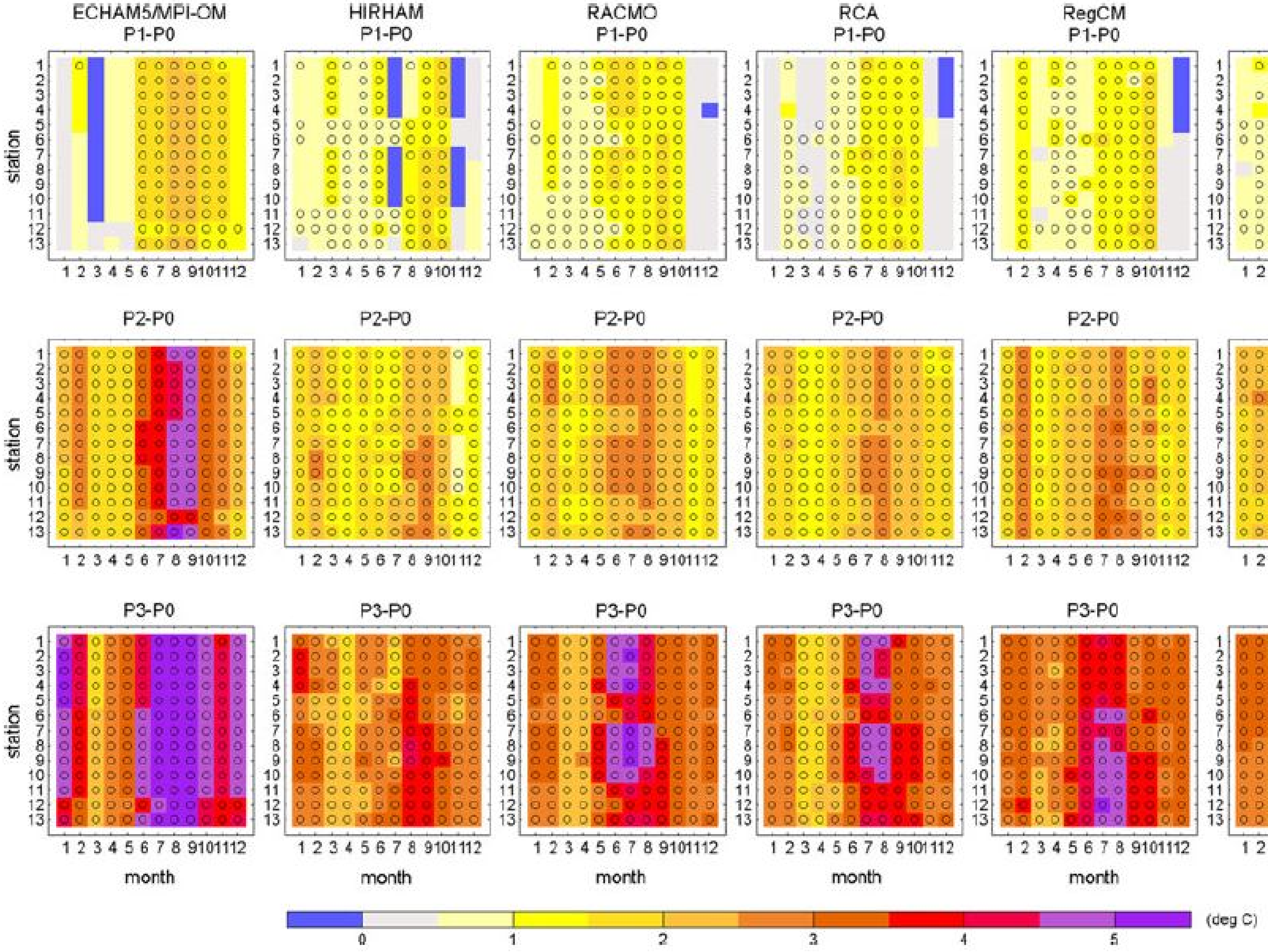
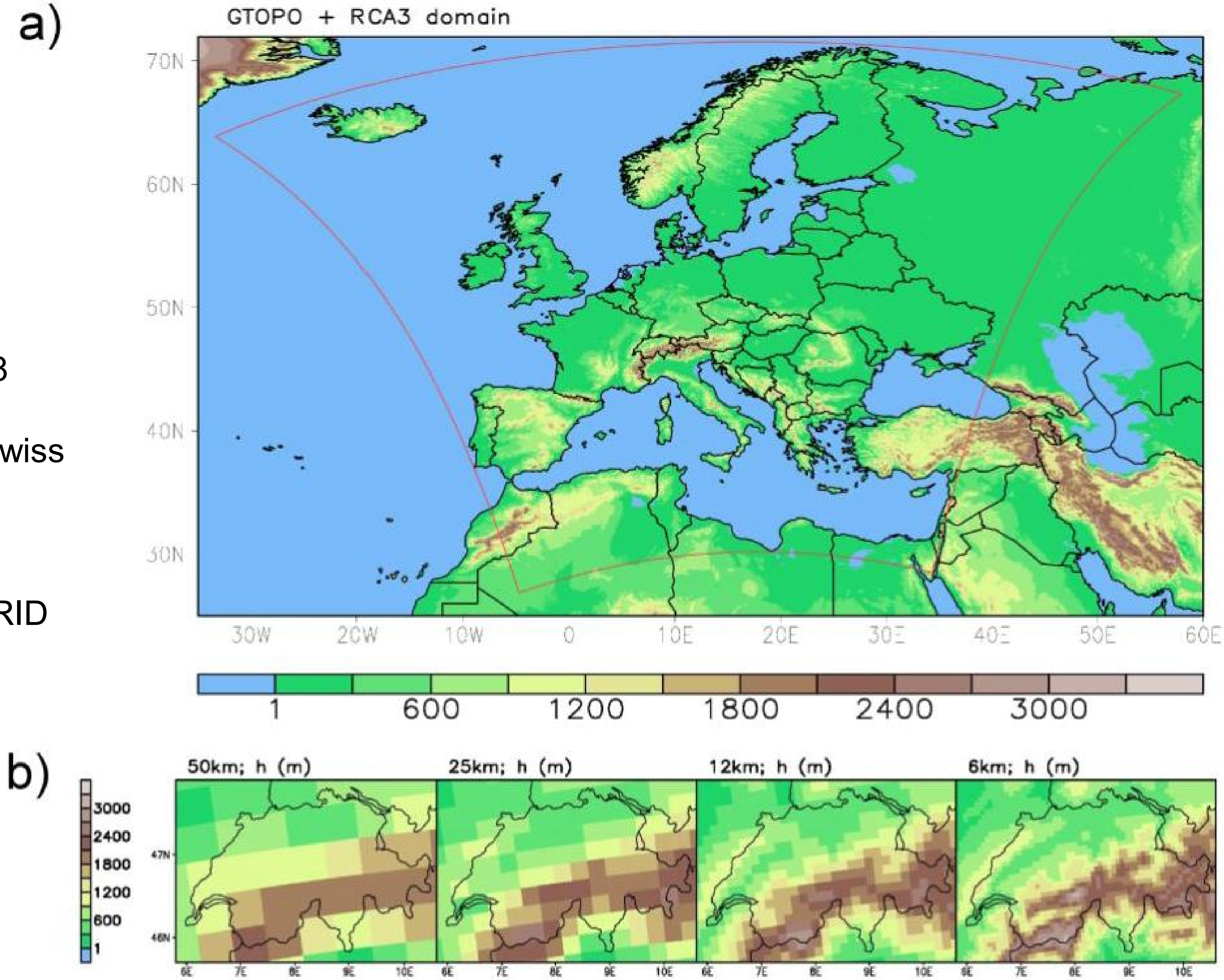


Fig. 10 Annual cycle (*left* to *right* in each panel) of T2m monthly mean climate change (in °C) in the periods: 2011–2040 (*top*), 2041–2070 (*middle*) and 2071–2100 (*bottom*). Changes significant at the 95 % confidence level are denoted by *open circles*. Note that warming in P3 in ECHAM5/MPI-OM (*bottom left*) exceeds the maximum given by *colour bar* (see text)

RCA3+(ERA40, ECMWF analysis)

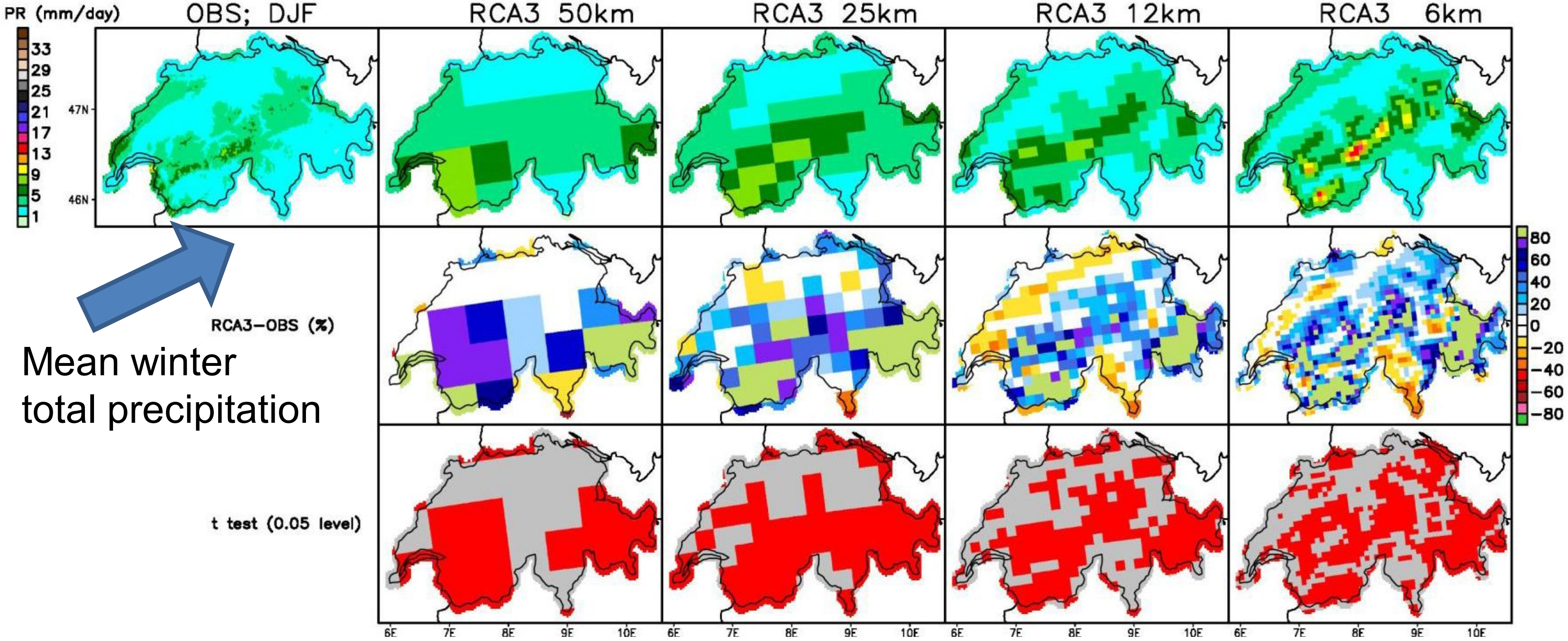
Period: 1987-2008

RCA3 vs. MeteoSwiss RhiresD over **Switzerland** and METNO KLIMAGRID over **Norway**

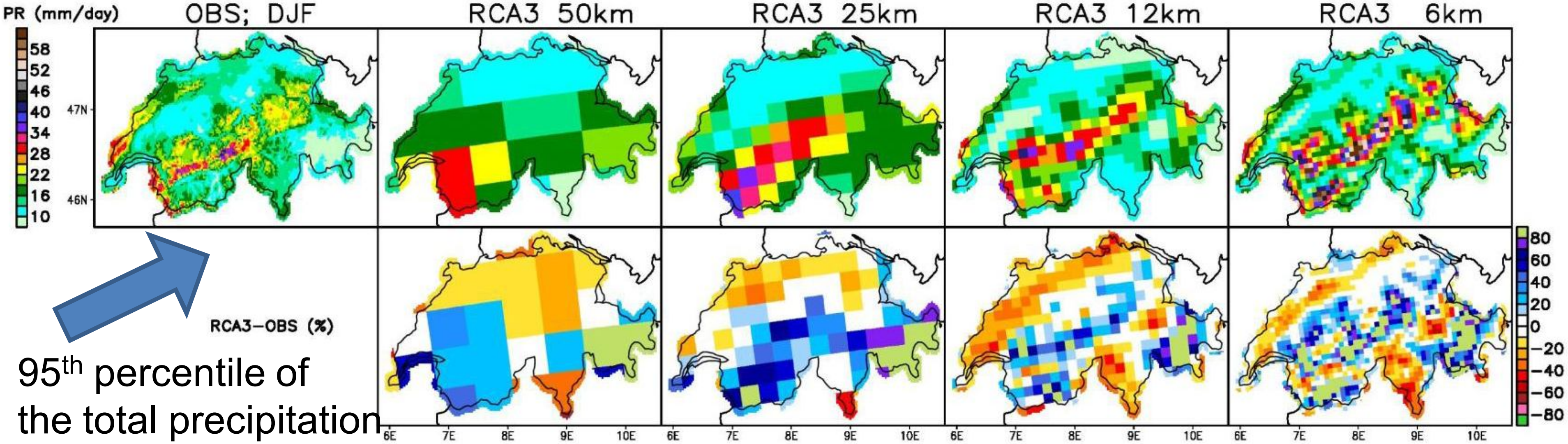


Güttler et al., *submitted*

RCM total precipitation errors and the impact of horizontal resolution: Switzerland



Mean winter total precipitation



95th percentile of the total precipitation

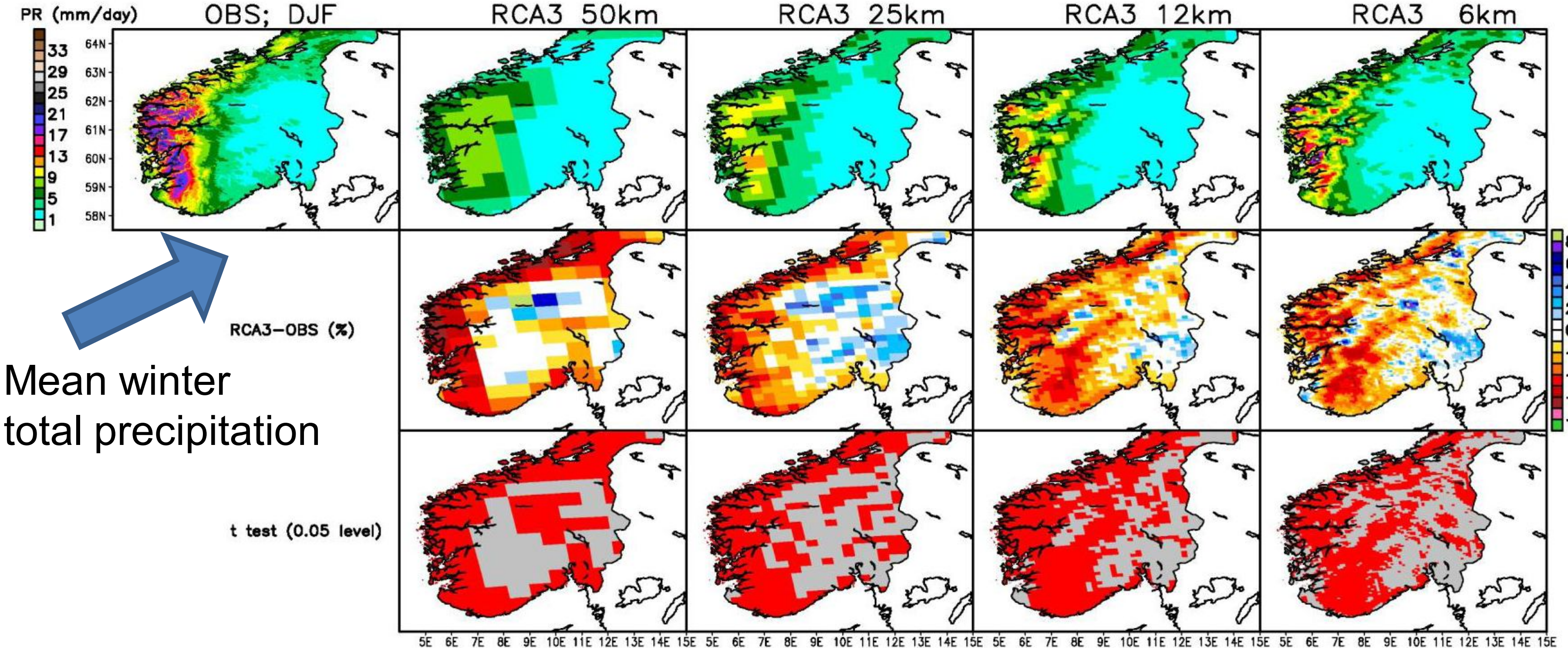
Table 2: Fraction of the area where relative differences between mean seasonal simulated and observed precipitation is ≥ 10%, and ≤ -10%.

	a) Switzerland			
	DJF		JJA	
Model resolution	diff ≥ 10%	diff ≤ -10%	diff ≥ 10%	diff ≤ -10%
50 km	59.9%	6.1%	38.6%	47.7%
25 km	72.2%	7.7%	37.5%	48.0%
12 km	54.6%	19.6%	39.9%	31.3%
6 km	63.1%	13.8%	54.2%	18.8%

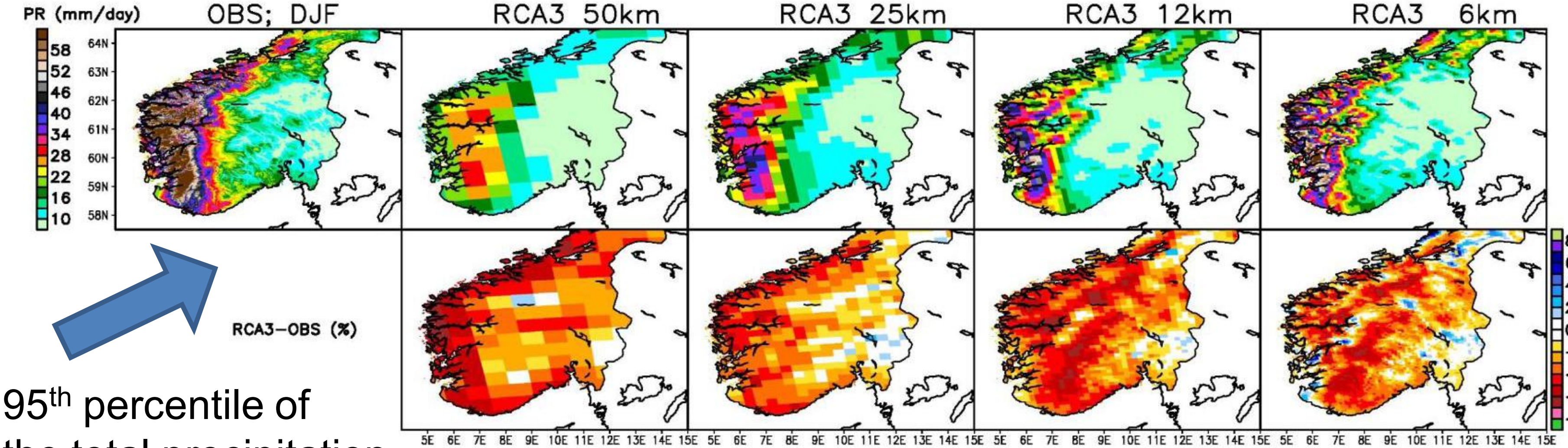
	a) Switzerland	
Model resolution	DJF	JJA
50 km	0.34	0.11
25 km	0.53	0.17
12 km	0.64	0.49
6 km	0.62	0.62

Table 3: Spatial correlation coefficient between mean seasonal precipitation simulated by RCA3 and mean seasonal precipitation from observations remapped to specific model grid.

RCM total precipitation errors and the impact of horizontal resolution: Norway



Mean winter
total precipitation



95th percentile of
the total precipitation

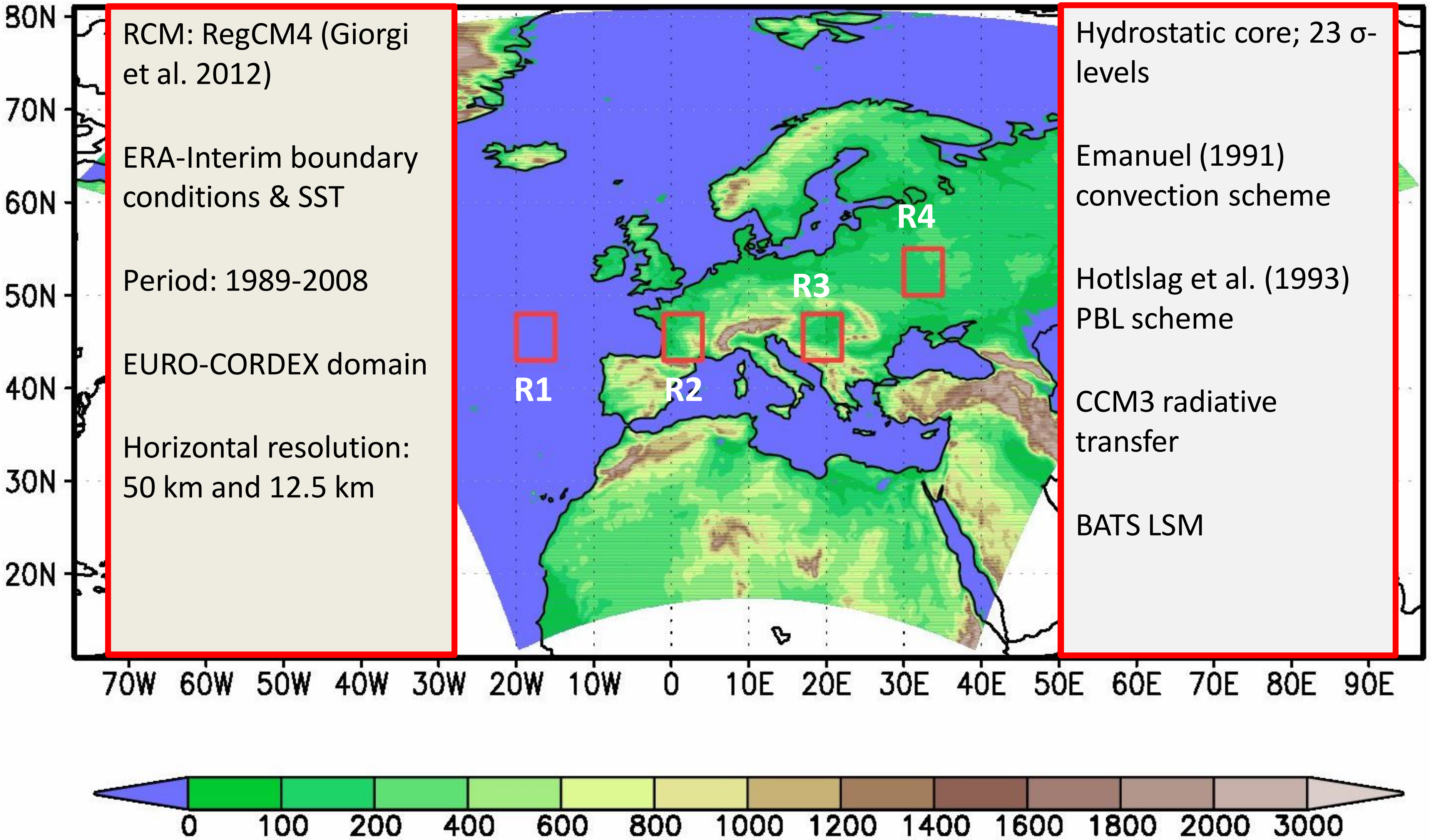
RCM: RegCM4 (Giorgi et al. 2012)

ERA-Interim boundary conditions & SST

Period: 1989-2008

EURO-CORDEX domain

Horizontal resolution: 50 km and 12.5 km



Hydrostatic core; 23 σ-levels

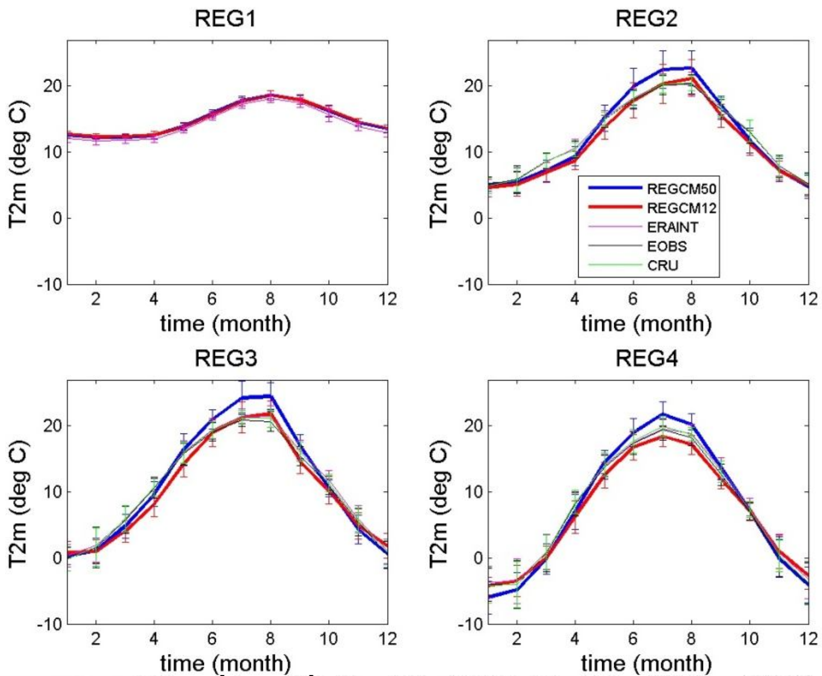
Emanuel (1991) convection scheme

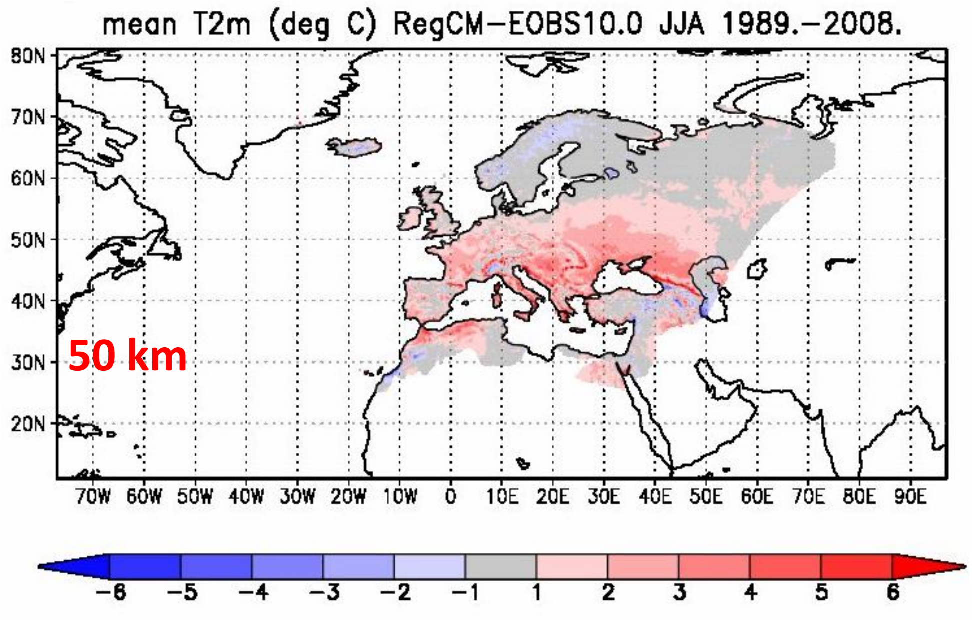
Hotlslag et al. (1993) PBL scheme

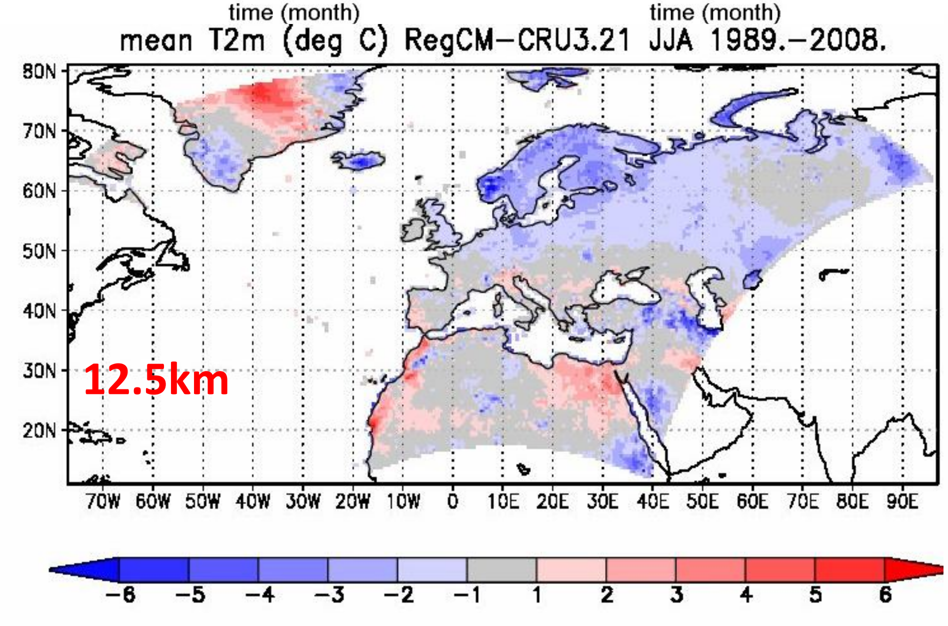
CCM3 radiative transfer

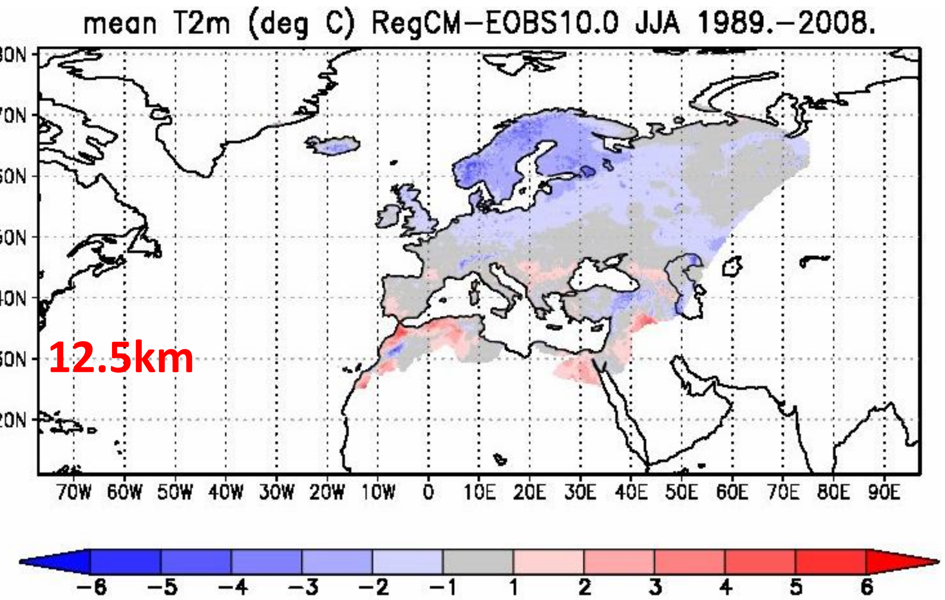
BATS LSM

Linking *T2m*, total cloud cover and surface radiation errors

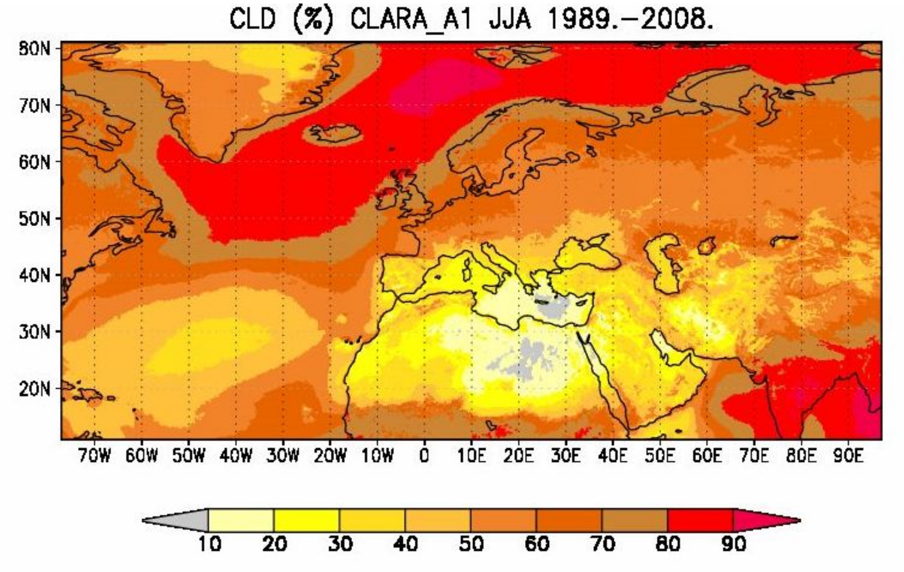


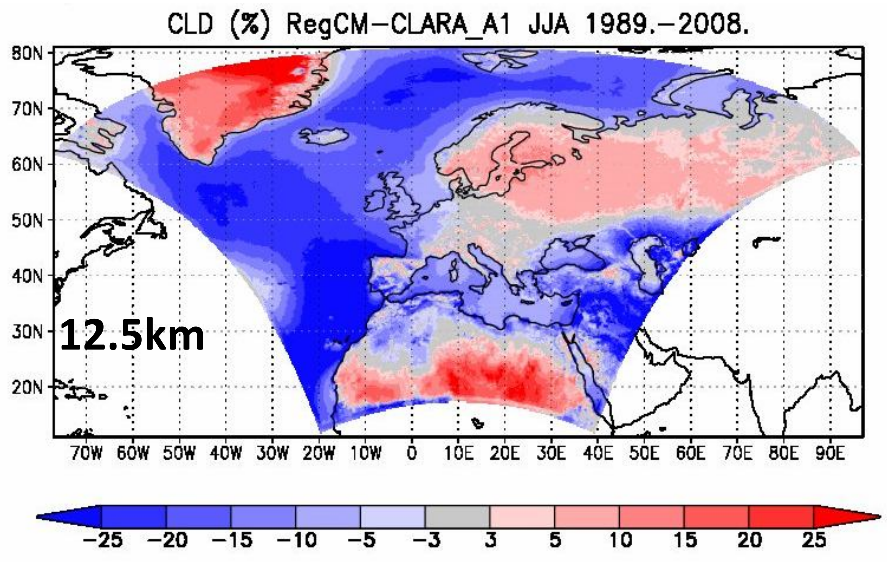


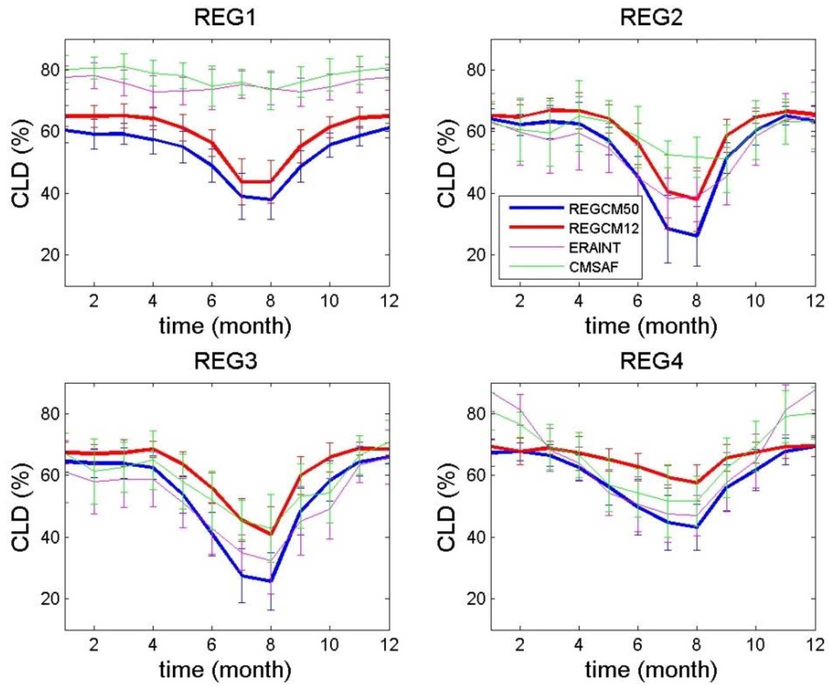


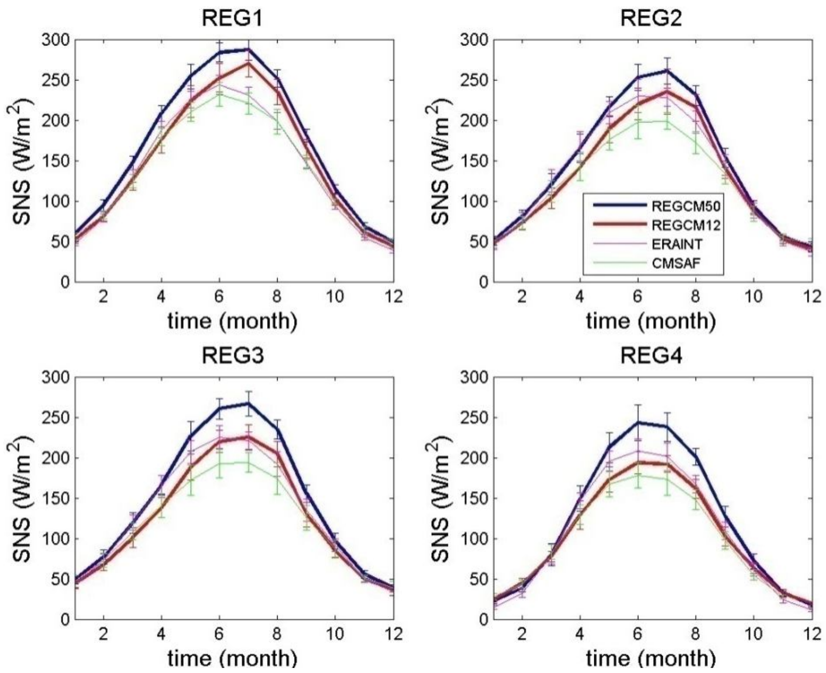


Linking *T2m*, total cloud cover and surface radiation errors

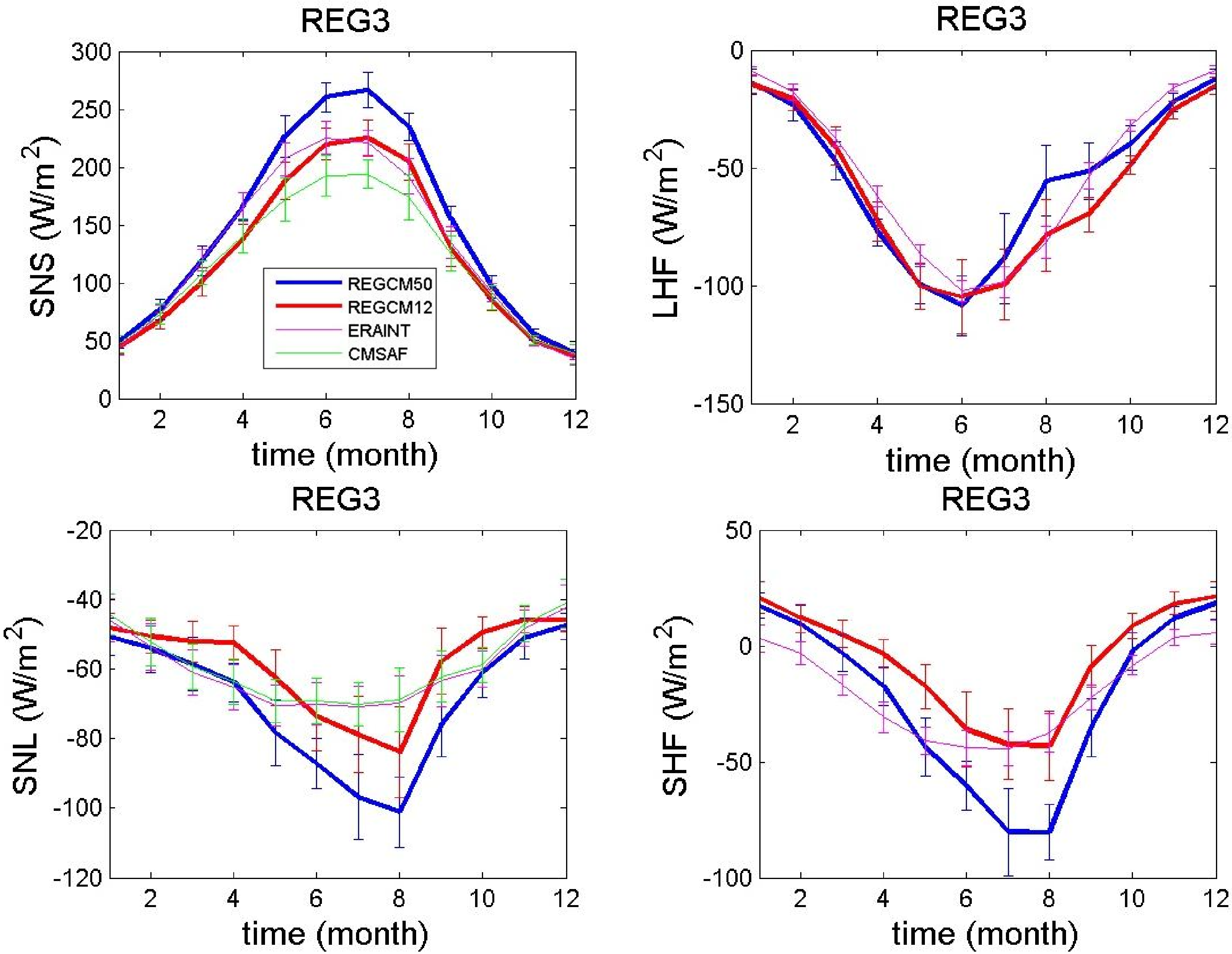








Linking *T2m*, total cloud cover and surface radiation errors: surface energy budget



SNS: surface net SW flux; **SHF**: sensible heat flux
SNL: surface net LW flux; **LHF**: latent heat flux

Summary

1. The amplitude of the **systematic errors** on the local scales can be substaintal. However, in some cases the **climate change signal** is not strongly sensitive to the systematic errors.

2. The increase in the horizontal resolution **is not sufficient** for the error reduction. Total precipitation is expected to benefit the most from the horizontal resolution increase.

3.Many satellite-based climatology datasets are emerging. Often not fit for the trend detection but very usefull **model evaluation**.

Thank you for attention!