Skill of 2m temperature seasonal forecasts over Europe in ECMWF and RegCM models

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Outline

○ **Background and motivation**

○ **Experimental design and data**

⇨ **ECMWF global coupled model**

⇨ **RegCM3**

⇨ **verification dataset**

○ **Results**

⇨ **systematic errors**

⇨ **deterministic verification**

⇨ **probabilistic verification**

Background and motivation

○　the impact of ENSO on seasonal climate is transferred to RCM via boundary conditions provided by the driving AOGCM

○　other factors that influence atmospheric seasonal predictability:

⇨　sea ice (Balmaseda et al. 2010, *QJRMS*)

⇨　snow cover (Shongwe et al. 2007, *MWR*)

⇨　soil moisture (Douville and Chauvin 2000, Douville 2010, *Clim. Dyn*)

○　those factors are of regional character – they could bring some improvement in seasonal forecasts produced by a higher resolution RCM

○　RegCM3 was used to dynamically downscale ECMWF experimental seasonal forecasts produced within EU ENSEMBLES project

Experimental design and data

ECMWF global model

○ **atmospheric model:**

⇨ **T_L95 spectral model (approx. 200 km)**

⇨ **40 vertical levels**

○ **ocean model:**

⇨ **1° resolution (0.3° near equator)**

⇨ **29 vertical levels**

○ **soil moisture**

⇨ **defined at four layers (0-255 cm)**

○ **seasonal forecasts initiated in May and November, 1991-2001**

○ **9 ensemble members**
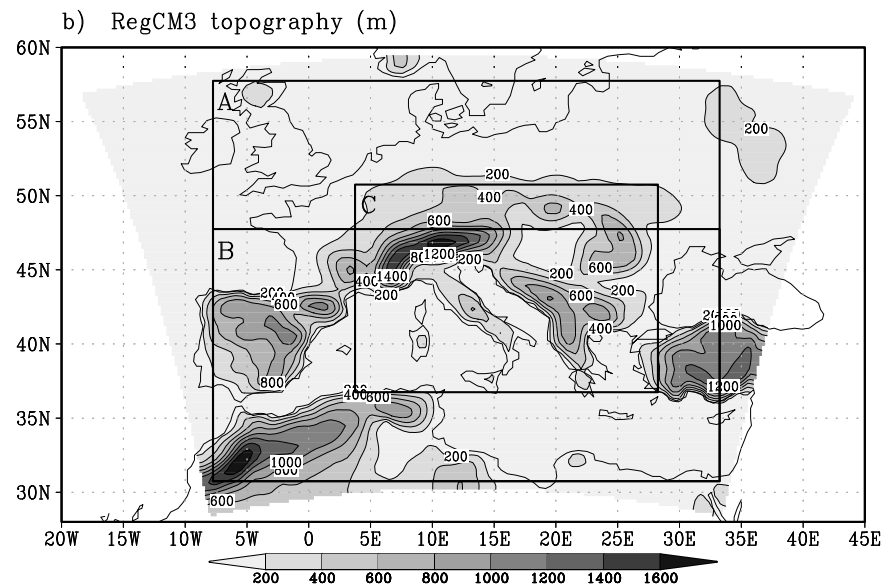
Experimental design and data

Regional model RegCM3

○ **horizontal and vertical resolution:**

⇨ *ds=50 km (80x66 grid points)*

⇨ *18L*

○ **RegCM soil layers (BATS):**

⇨ *first layer: 10 cm thick*

⇨ *second layer: 1 m, 1.5 m or 2 m thick*

⇨ *third layer: 3 m thick*

Topography in global and regional model

ECMWF 200 km

RegCM 50 km

a) ECMWF topography (m)
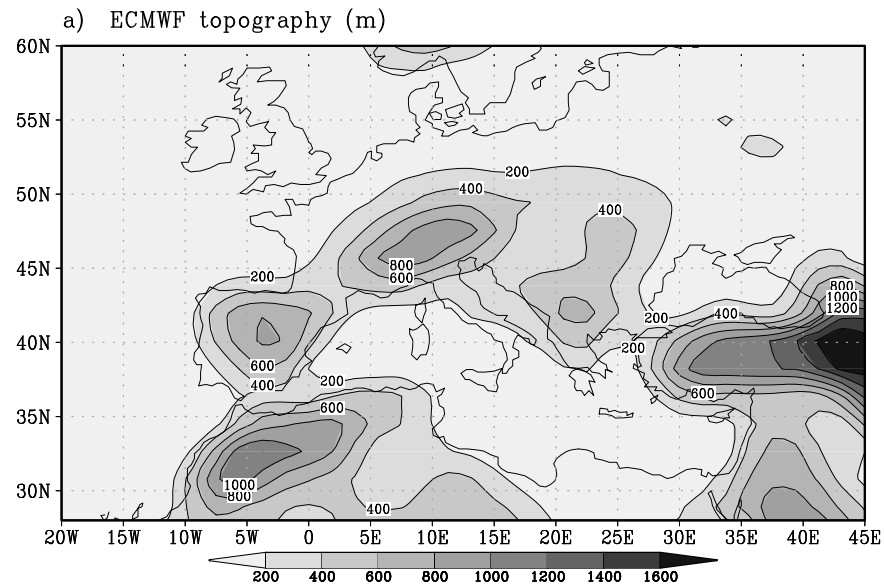
b) RegCM3 topography (m)

Experimental design and data

RegCM simulations

○   downscaling for JFM and JAS seasons, all ensemble members

○   initial soil moisture (SM)

     ⇨ *default RegCM initial SM (RCM_DFSM)*

     ⇨ *SM from ECMWF seasonal forecasts (RCM_ECSM)*

     ⇨ *SM from ERA-Interim driven RegCM simulations (RCM_EISM)*

○   in total 99 integrations for each experiment for JFM and JAS

Verification data
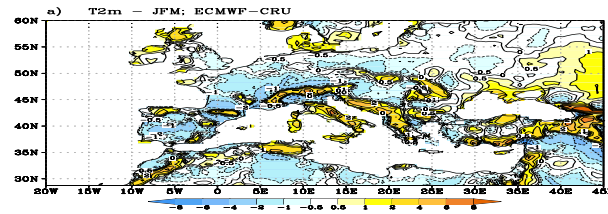
○   gridded 2m temperature (T2m) dataset (0.5 deg) from Climate Research Unit (CRU), University of East Anglia

○   both models outputs interpolated to regular CRU grid

○   forecast quality assessed only for land points
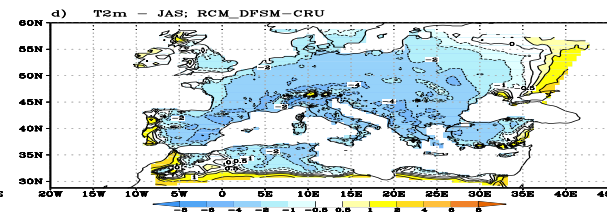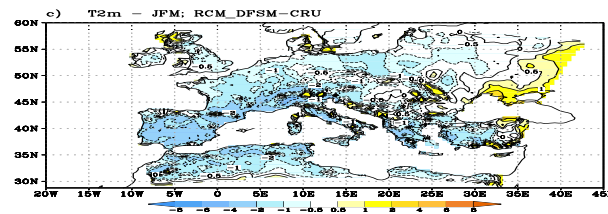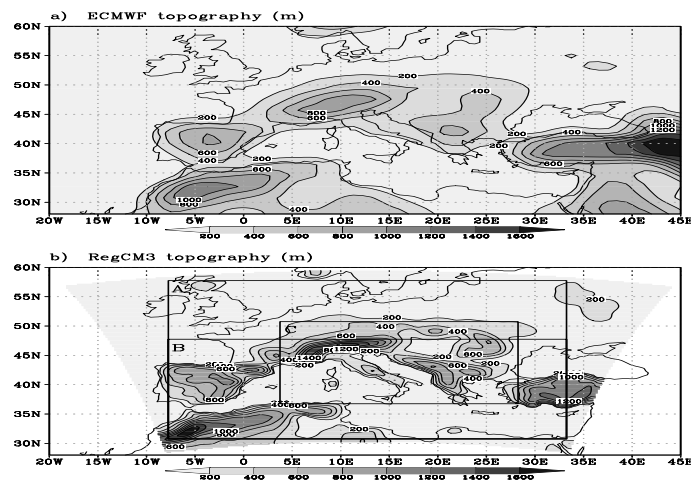
Results – T2m systematic errors
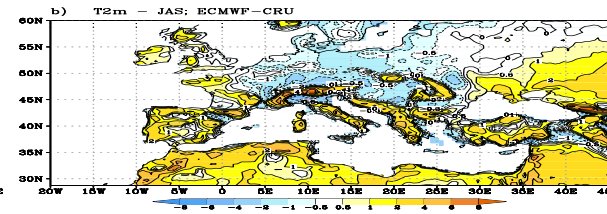
Results – T2m systematic errors

T2m area averaged absolute systematic errors

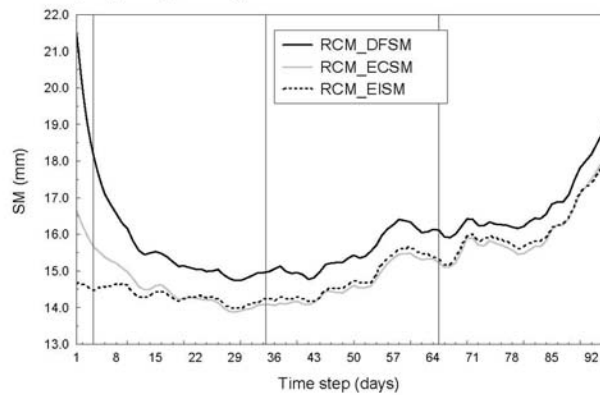|		ECMWF	RCM_DFSM	RCM_ECSM	RCM_EISM
Analysis domain (region A)					
JFM	ave	1.1	1.0	1.1	1.1
JAS	ave	1.5	2.1	(1.6)	2.0
Central part of the domain (region C)					
JFM	ave	1.4	1.1	1.1	1.1
Southern part of the domain (region B)					
JAS	ave	1.8	2.3	(1.6)	1.9

Results – systematic errors and impact of SM initialisation (JAS)

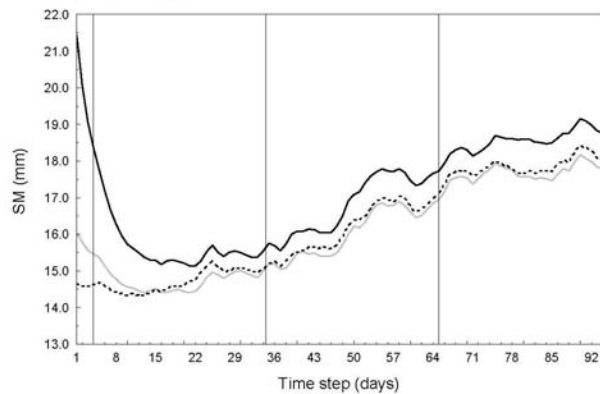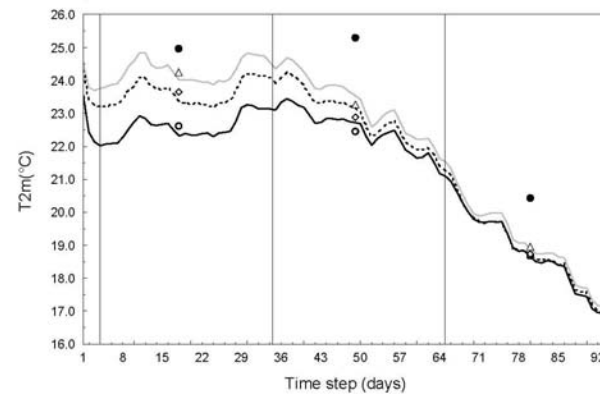**Region B**

upper soil layer SM – 1991   T2m – 1991

dry
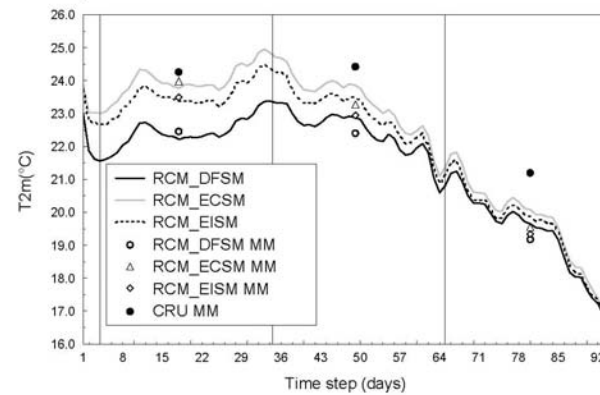
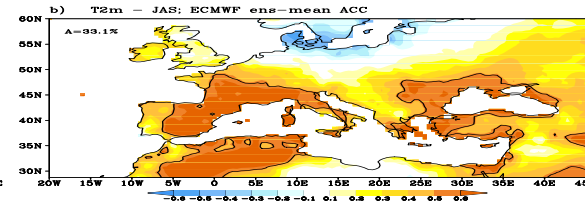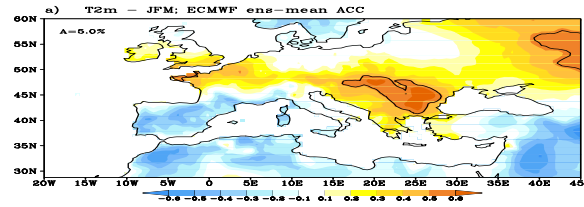upper soil layer SM – 2001   T2m – 2001

wet

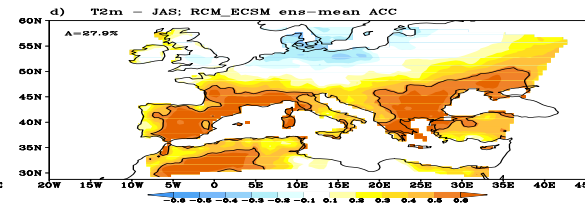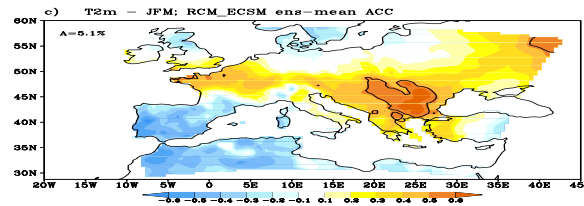# Results – anomaly correlations (ACCs)

JFM

JAS

ECMWF

RCM_ECSM

percentage of the area (relative to the RegCM land points) with statistically significant *ACCs*

	ECMWF	RCM_DFSM	RCM_ECSM	RCM_EISM
JFM	5.0	4.9	5.1	4.6
JAS	33.1	20.9	27.9	17.8

Results – probabilistic verification

Brier score

$$BS = \frac{1}{N} \sum_{i=1}^{N} (p_i - o_i)^2$$

$$BS = \frac{1}{N} \sum_{i=1}^{I} N_i \left(p_i - \overline{o_i}\right)^2 - \frac{1}{N} \sum_{i=1}^{I} N_i \left(\overline{o}_i - \overline{o}\right)^2 + \overline{o}\left(1 - \overline{o}\right)$$

reliability, BS_{rel} resolution, BS_{rel} uncertainty, BS_{cli}
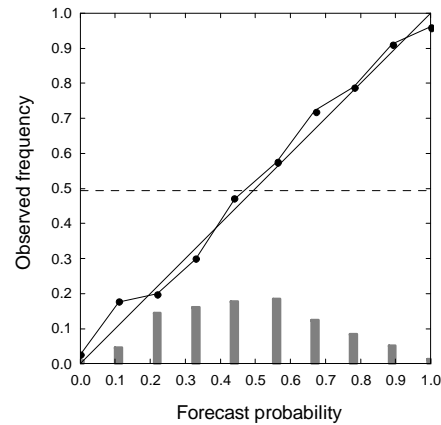
Brier skill score

$$BSS = 1 - \frac{BS}{BS_{cli}}$$

$$B_{rel} = 1 - \frac{BS_{rel}}{BS_{cli}}$$

$$B_{res} = 1 - \frac{BS_{res}}{BS_{cli}}$$

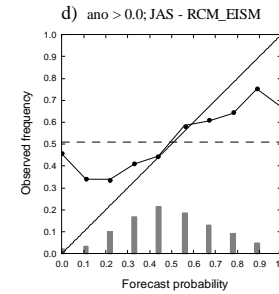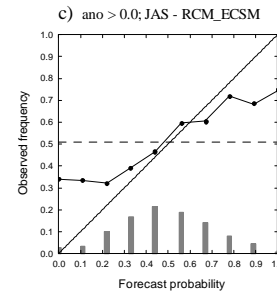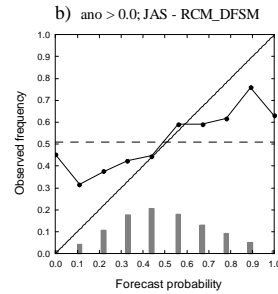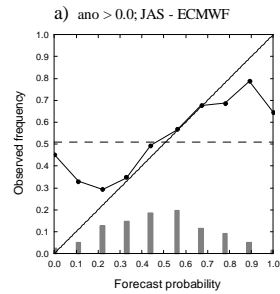# Results – reliability diagrams, JAS

region A

ano > 0.0°C

	ECMWF	RCM_DFSM	RCM_ECSM	RCM_EISM
BSS	0.04	-0.01	0.02	0.00
Brel	0.95	0.94	**0.96**	0.95
Bres	0.09	0.05	0.06	0.05

Results – reliability diagrams

region B, JAS

ano > 0.0°C

ECMWF	RCM_DFSM	RCM_ECSM	RCM_EISM

a) ano > 0.0; JAS - ECMWF   b) ano > 0.0; JAS - RCM_DFSM   c) ano > 0.0; JAS - RCM_ECSM   d) ano > 0.0; JAS - RCM_EISM
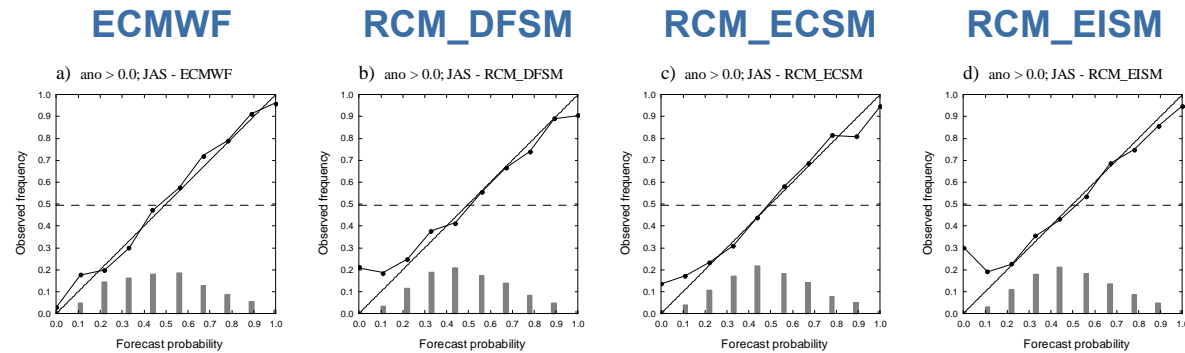
	ECMWF	RCM_DFSM	RCM_ECSM	RCM_EISM
BSS	0.21	0.13	0.16	0.14
Brel	1.00	1.00	1.00	1.00
Bres	0.21	0.13	0.16	0.14

region C, JFM

ano > 0.0°C

	ECMWF	RCM_DFSM	RCM_ECSM	RCM_EISM
BSS	0.06	**0.08**	**0.09**	**0.08**
Brel	0.96	0.97	0.96	0.96
Bres	0.10	**0.11**	**0.13**	**0.12**

Conclusions

○ **Winter**

⇨ *almost no impact of SM initialisation on RegCM systematic errors and skill*

⇨ *errors are reduced in central and eastern Europe when compared to global model*

⇨ *for positive anomalies probabilistic skill in all RegCM experiments is significantly higher than in ECMWF in the central part of the domain*

○ **Summer**

⇨ *RCM_ECSM T2m is closest to the observations among RegCM experiments*

⇨ *errors are reduced in RCM_ECSM in southern part of the domain when compared to global model*

⇨ *skill is increased in southern part of the domain*

⇨ *the best skill is obtained with RCM_ECSM*

Thank you for your attention!

Patarčić, M. and Branković Č., 2012:

Skill of 2m Temperature Seasonal Forecasts over Europe in ECMWF and RegCM Models.

MWR, 140, 1326-1346.