Downscaling of ECMWF seasonal integrations by RegCM

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(Thanks to Paul Dando and Manuel Fuentes for help in data retrieval)

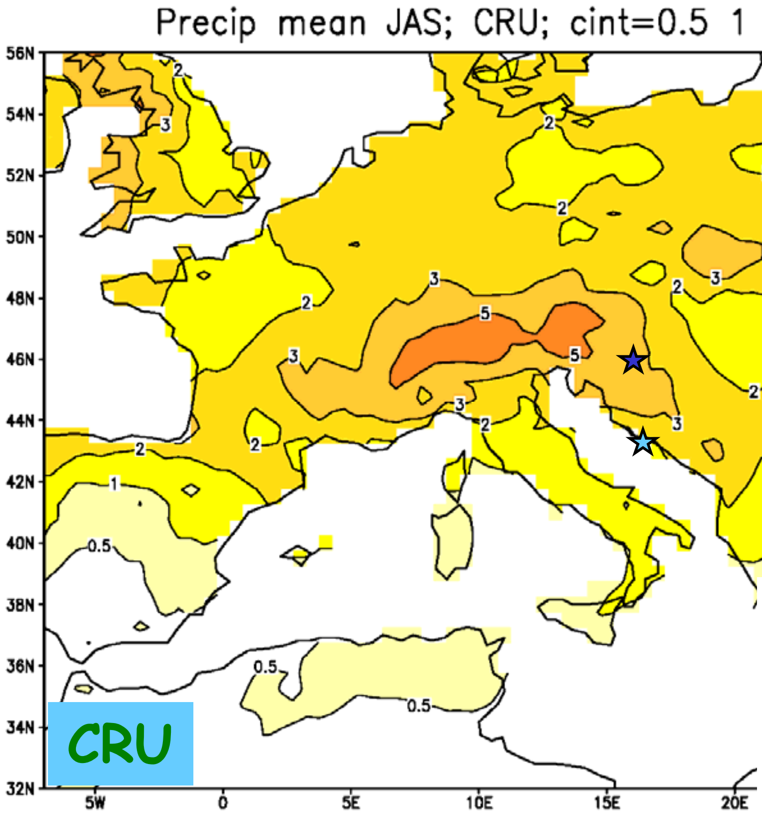
Outline of the talk

1. Introduction

2. Downscaling of ECMWF operational seasonal forecasts (an attempt)

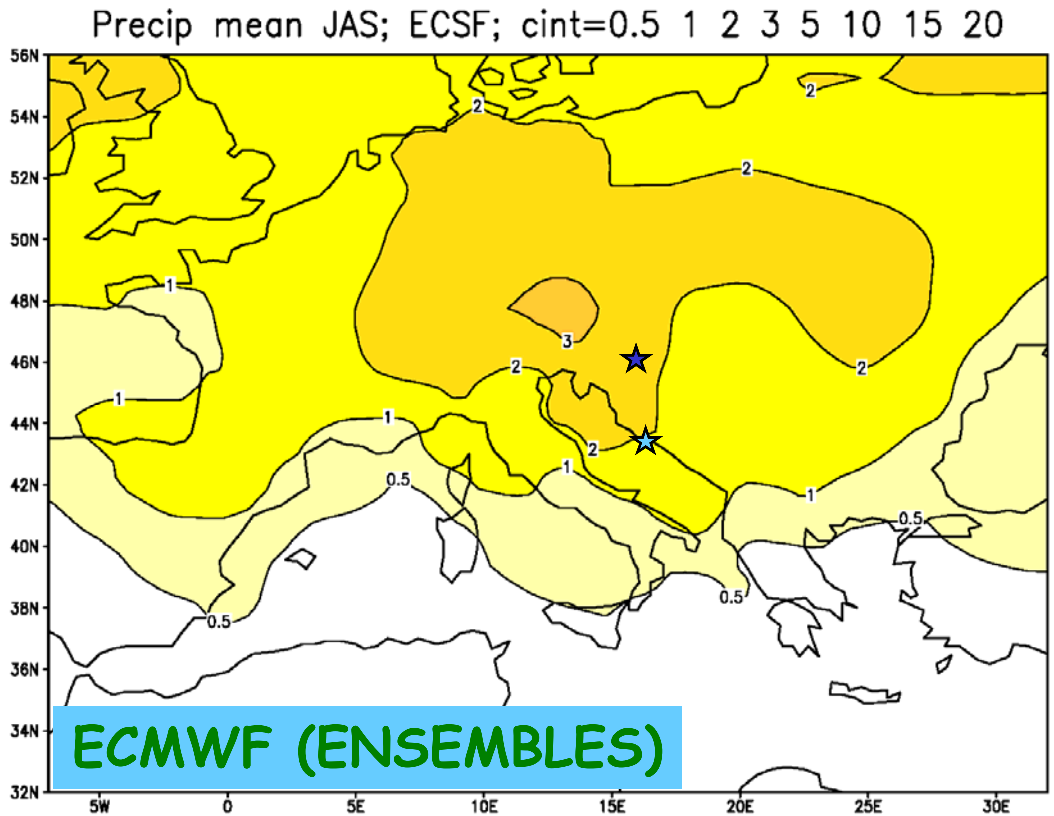
3. Downscaling of ECWMF experimental seasonal forecasts (ENSEMBLES)

4. Some conclusions



Precipitation (mm/day)

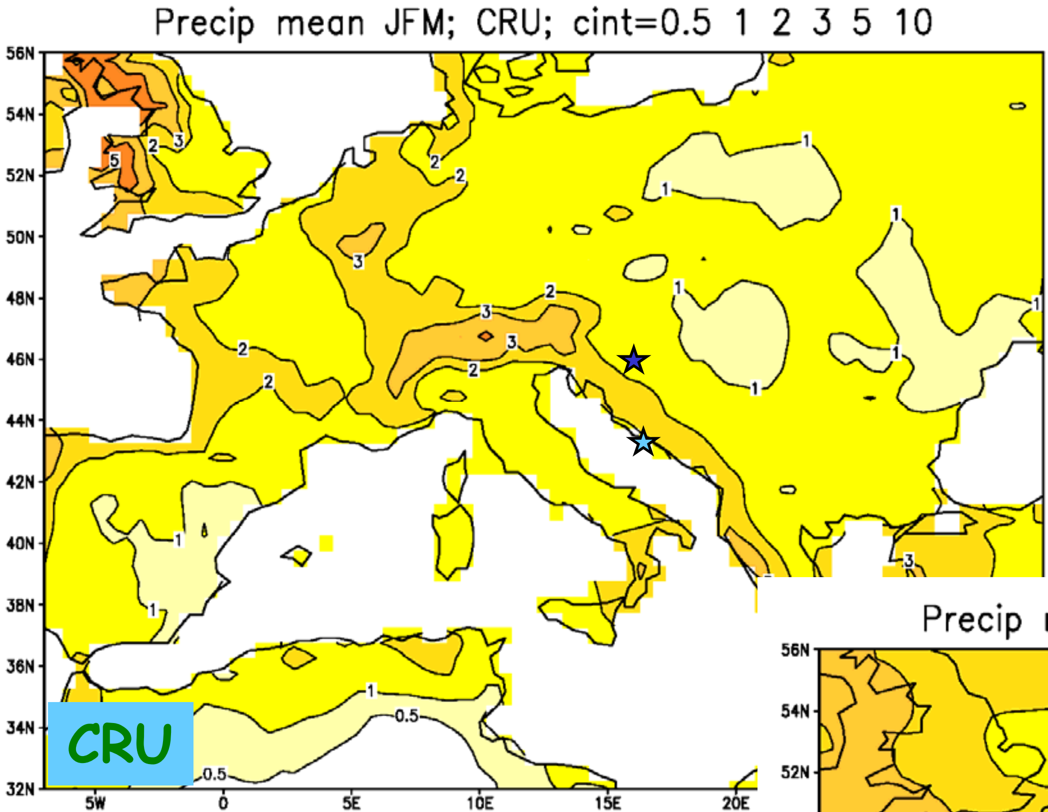
JAS
(mean 1991-2001)



Observed (mm/day)

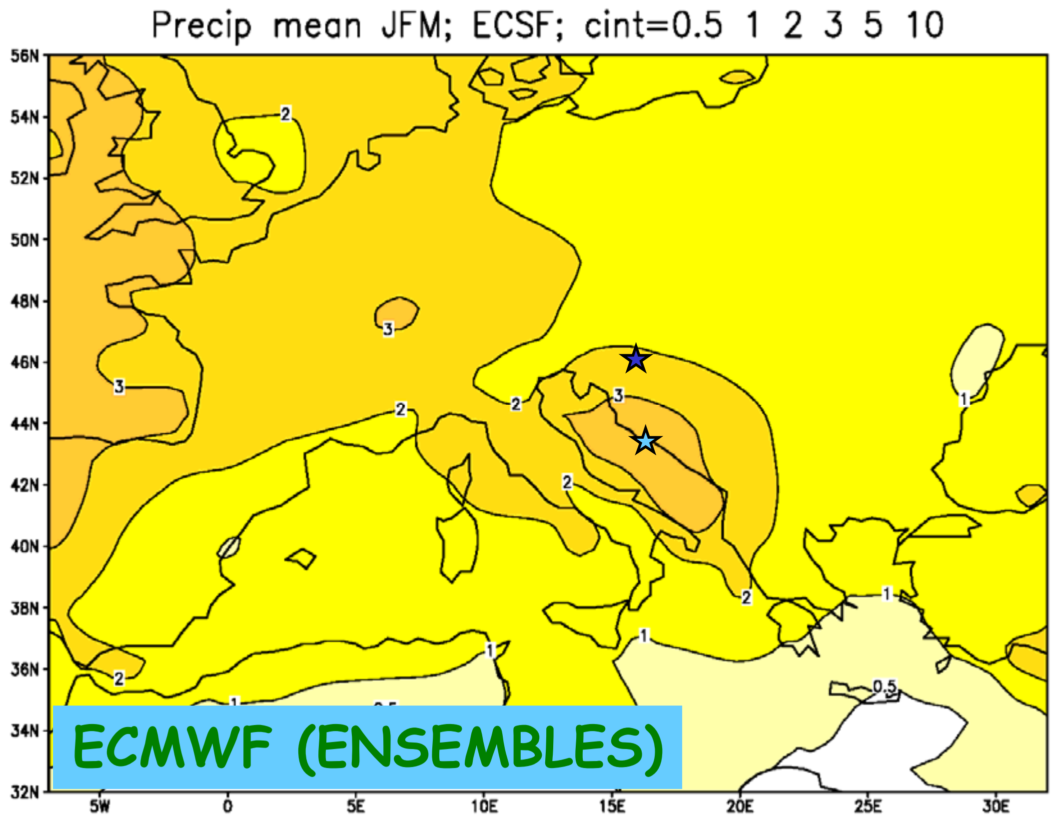
Zagreb 2.9 ★

Split 1.5 ☆



Precipitation (mm/day)

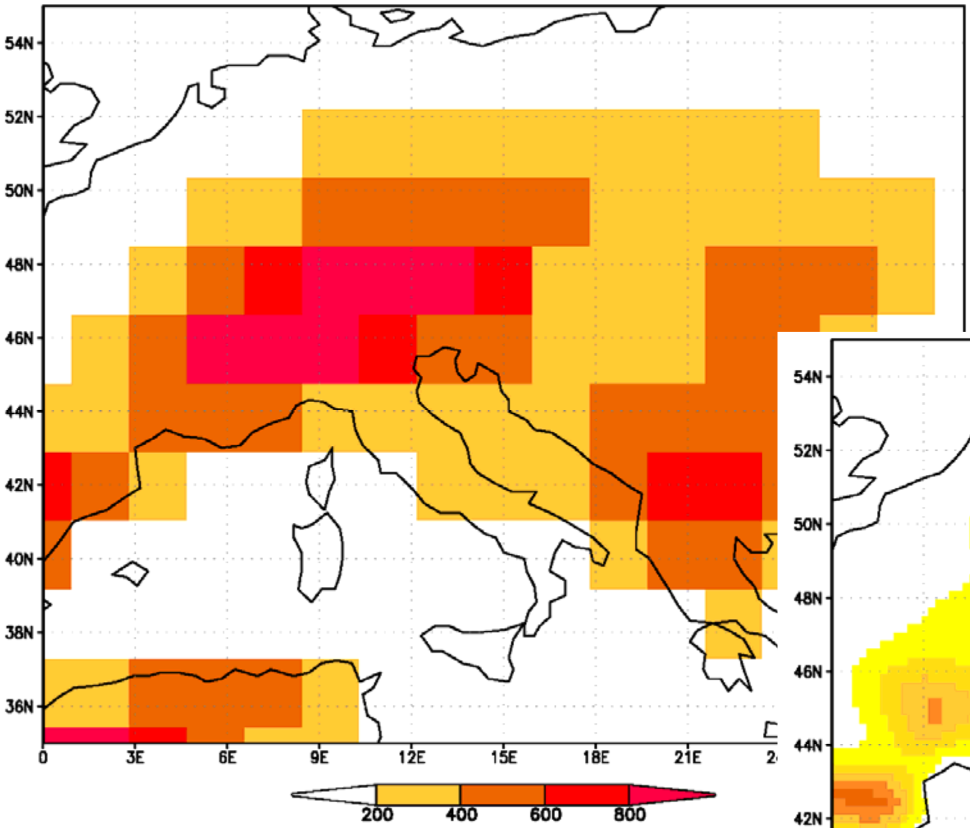
JFM
(mean 1992-2002)



Observed (mm/day)

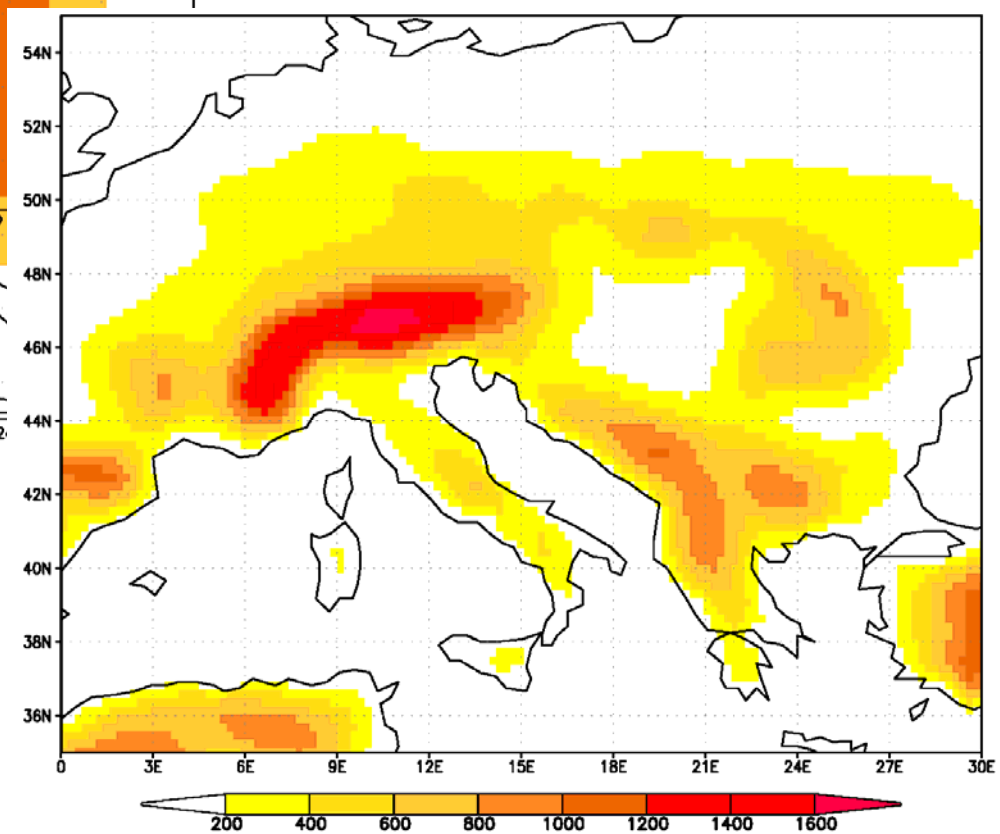
Zagreb 1.3 ★
Split 1.7 ★

Orography in global and limited area models



ECMWF 1.875°

RegCM 50 km



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ECMWF operational seasonal forecasts

* T_L95 global spectral model (1.875°)

* 40 members, JJA 2003 (only one season tested)

* 6 pressure levels (1000, 925, 850, 700, 500, 200)

* Frequency of LBCs every 12 hours

Big ensemble, but poor input for a viable downscaling.

Do we have to downscale the whole ensemble?

RegCM (Giorgi et al. 1993, MWR): 50 km, 14 levels

How to select a sub-ensemble?

* From short- and medium-range forecasting experience:

Objectively select representative members that characterise <u>all</u> possible evolution scenarios of the global model ensemble.

(Molteni et al. 2001 *QJ*, Montani et al. 2001 *Nonlin. Proc. Geophys.*)

* If resources allow, downscale all members and then manipulate

Representative members from a global model may not be representative in a regional model.

(Experiments at CMHS: downscaling of ECMWF EPS by using Aladin-HR; Branković et al. 2007 ECMWF Tech Memo 507)

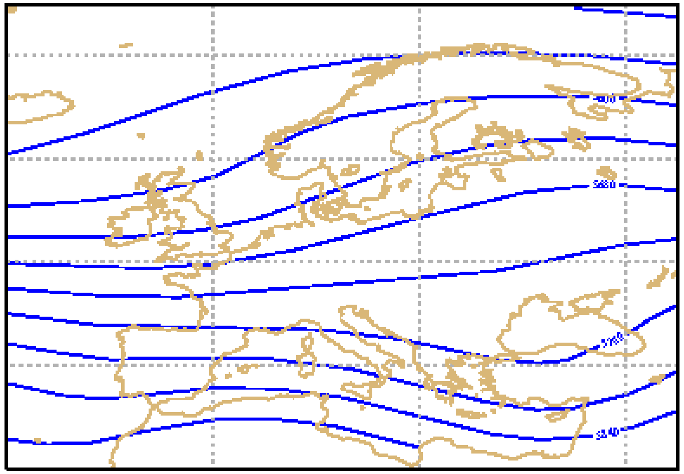
Z500

June 2003 July 2003

Most populated clusters

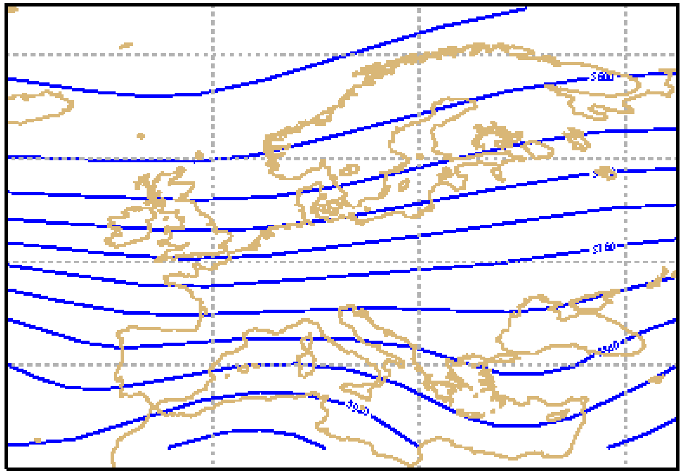
20030501+2 mon z500 cluster 2 - 18 memb
Clustering. area: 75N -20W 30S 45E

a)



20030501+3 mon z500 cluster 1 - 24 memb
Clustering. area: 75N -20W 30S 45E

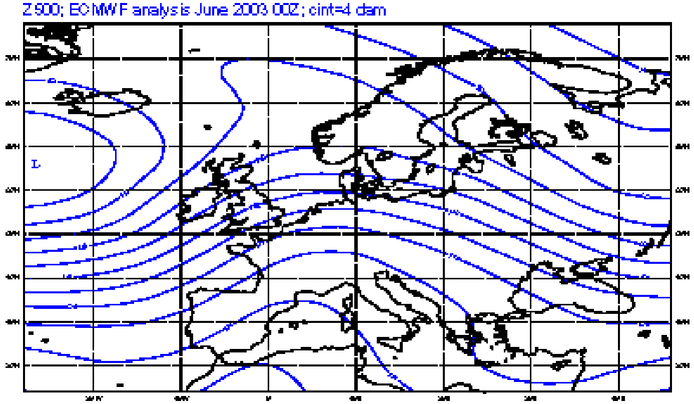
(b)



ECMWF operational analysis

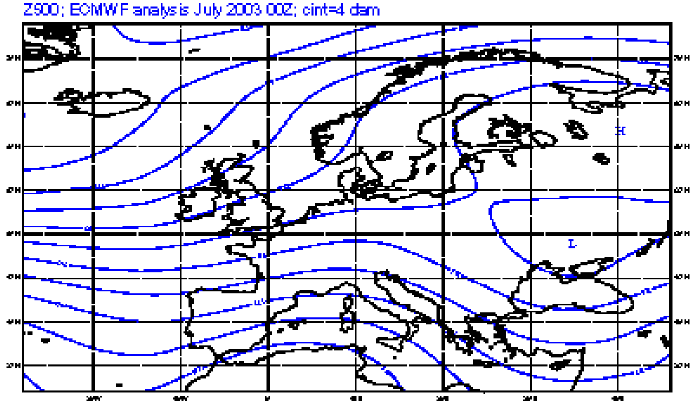
Z500; ECMWF analysis June 2003 00Z; cint=4 dam

c)



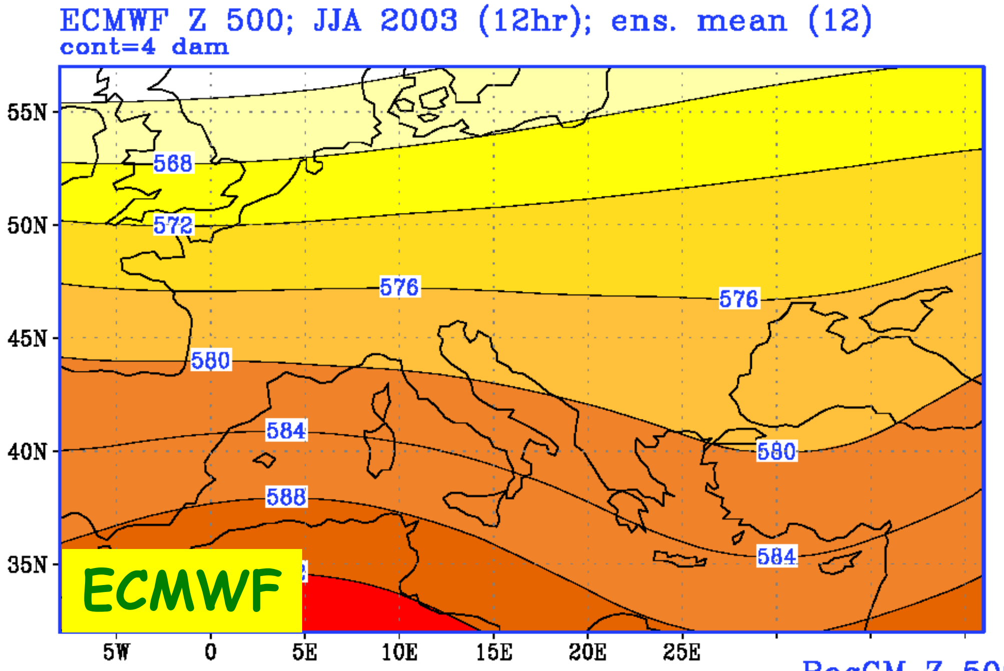
Z500; ECMWF analysis July 2003 00Z; cint=4 dam

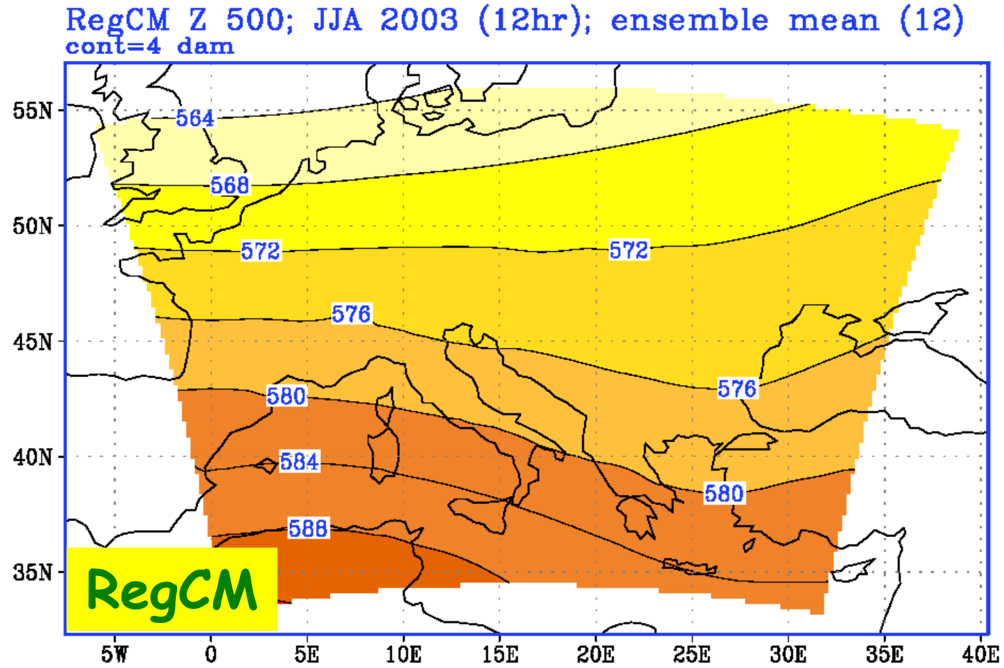
(d)



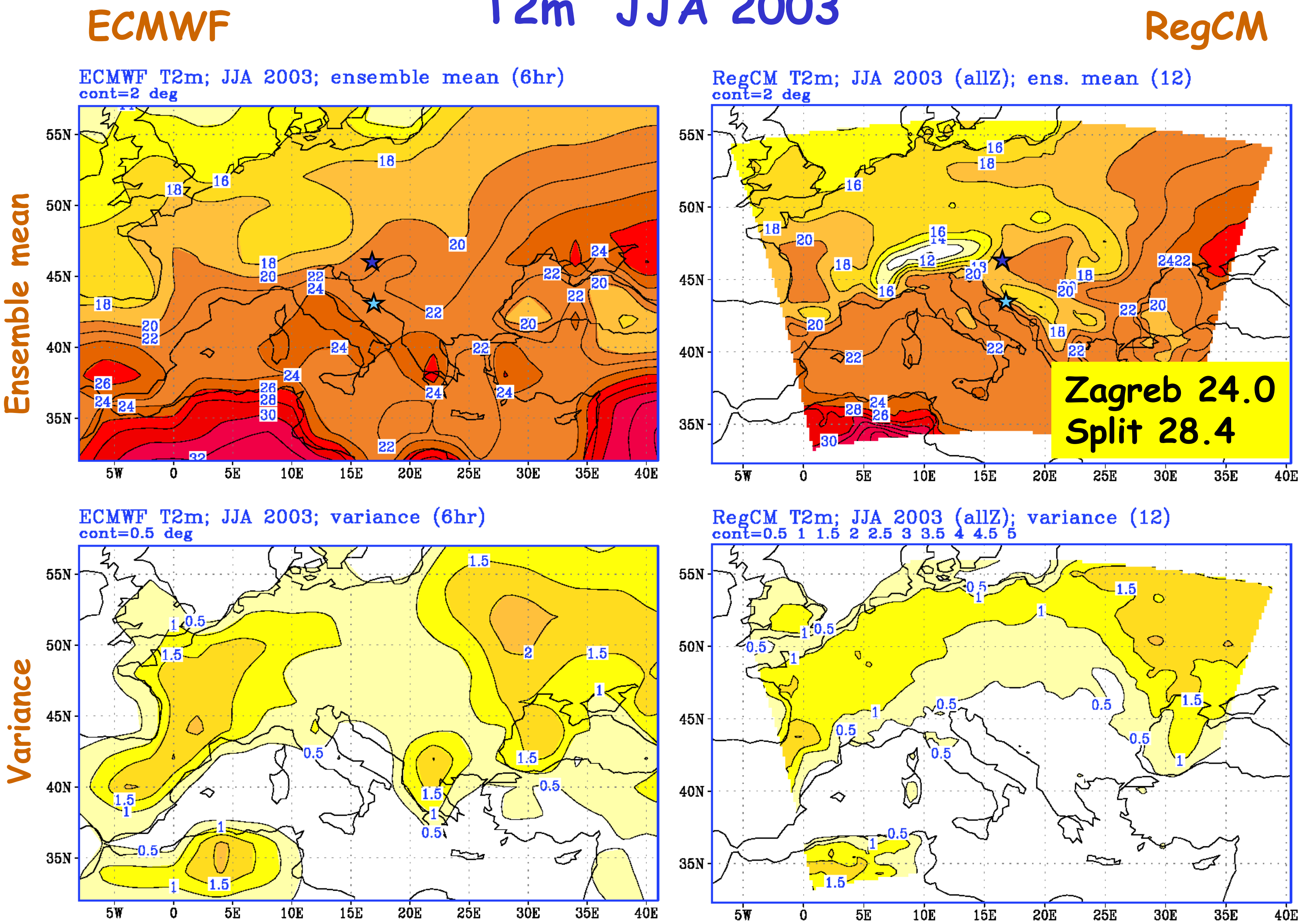
Z500 JJA 2003

Ensemble mean
(12 members)





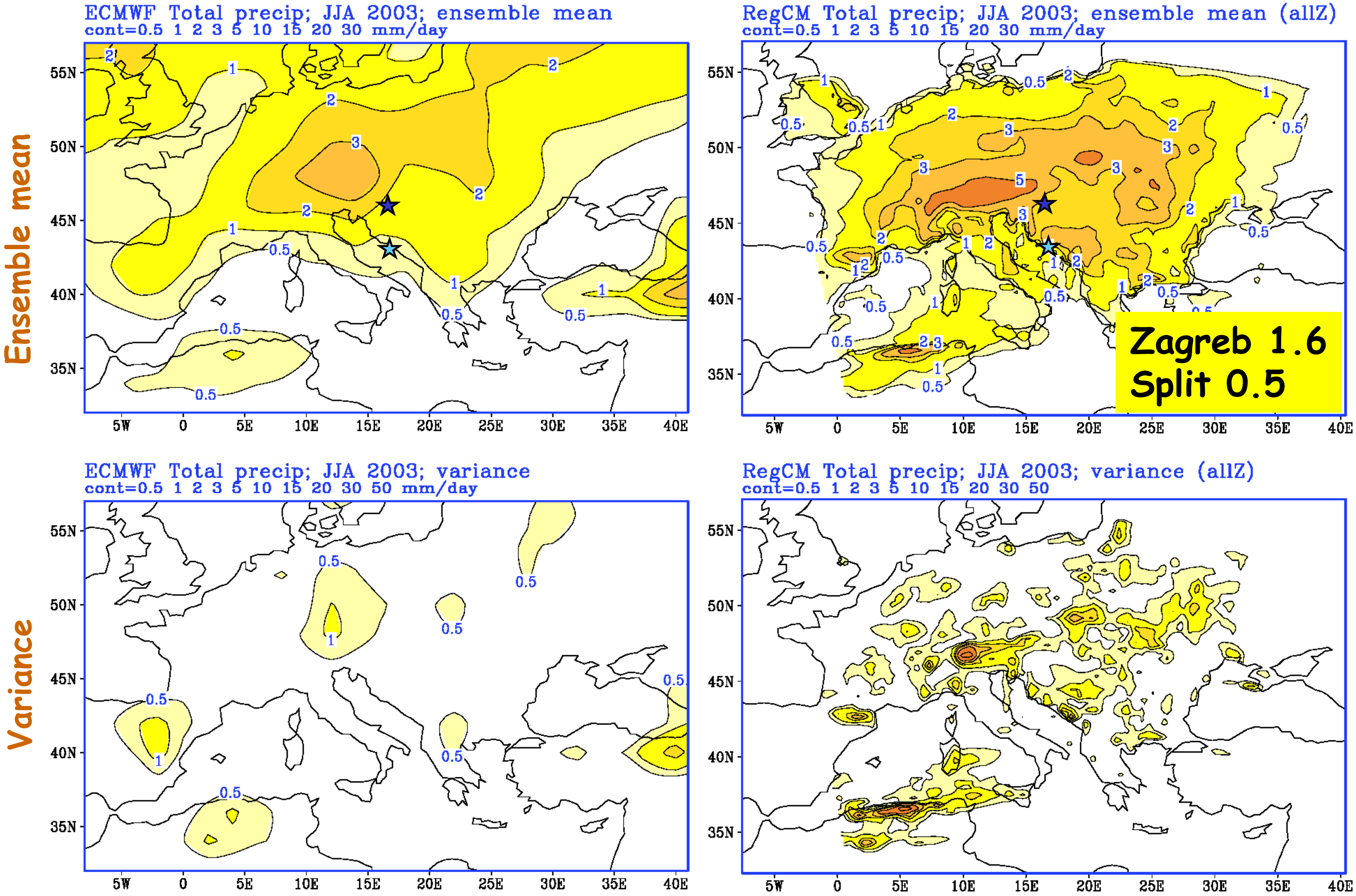
T2m JJA 2003



ECMWF
RegCM
Ensemble mean
Variance
ECMWF T2m; JJA 2003; ensemble mean (6hr)
cont=2 deg
RegCM T2m; JJA 2003 (allZ); ens. mean (12)
cont=2 deg
Zagreb 24.0
Split 28.4
ECMWF T2m; JJA 2003; variance (6hr)
cont=0.5 deg
RegCM T2m; JJA 2003 (allZ); variance (12)
cont=0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
55N
50N
45N
40N
35N
5W
0
5E
10E
15E
20E
25E
30E
35E
40E

Precipitation JJA 2003

ECMWF | RegCM



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ECMWF experimental seasonal forecasts

* Part of ENSEMBLES project

* T_L95 global spectral model (1.875°), 40 model levels

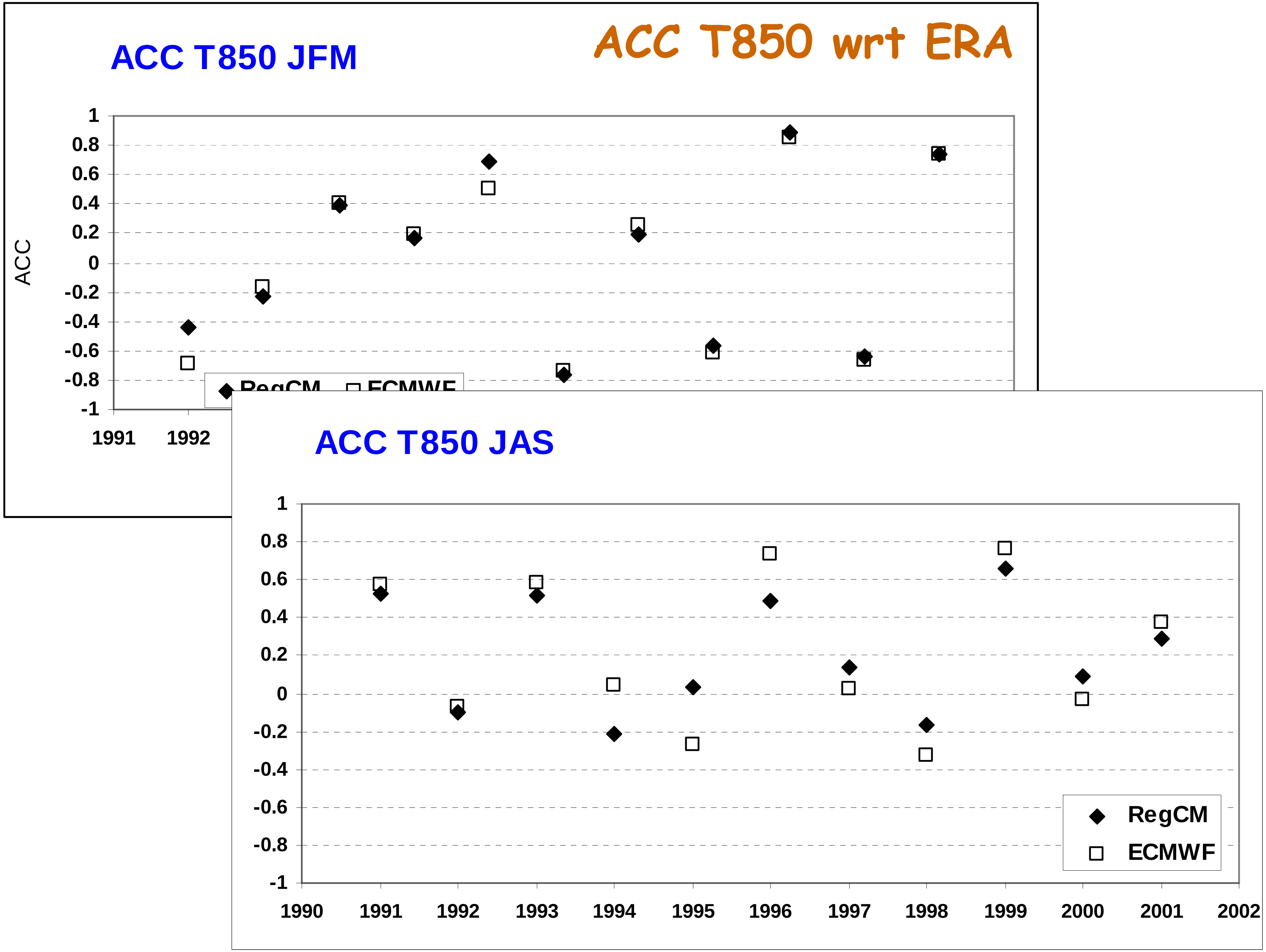
* Frequency of LBCs every 6 hours

* 6-month f/c (May, November), 9 members, 1991-2001

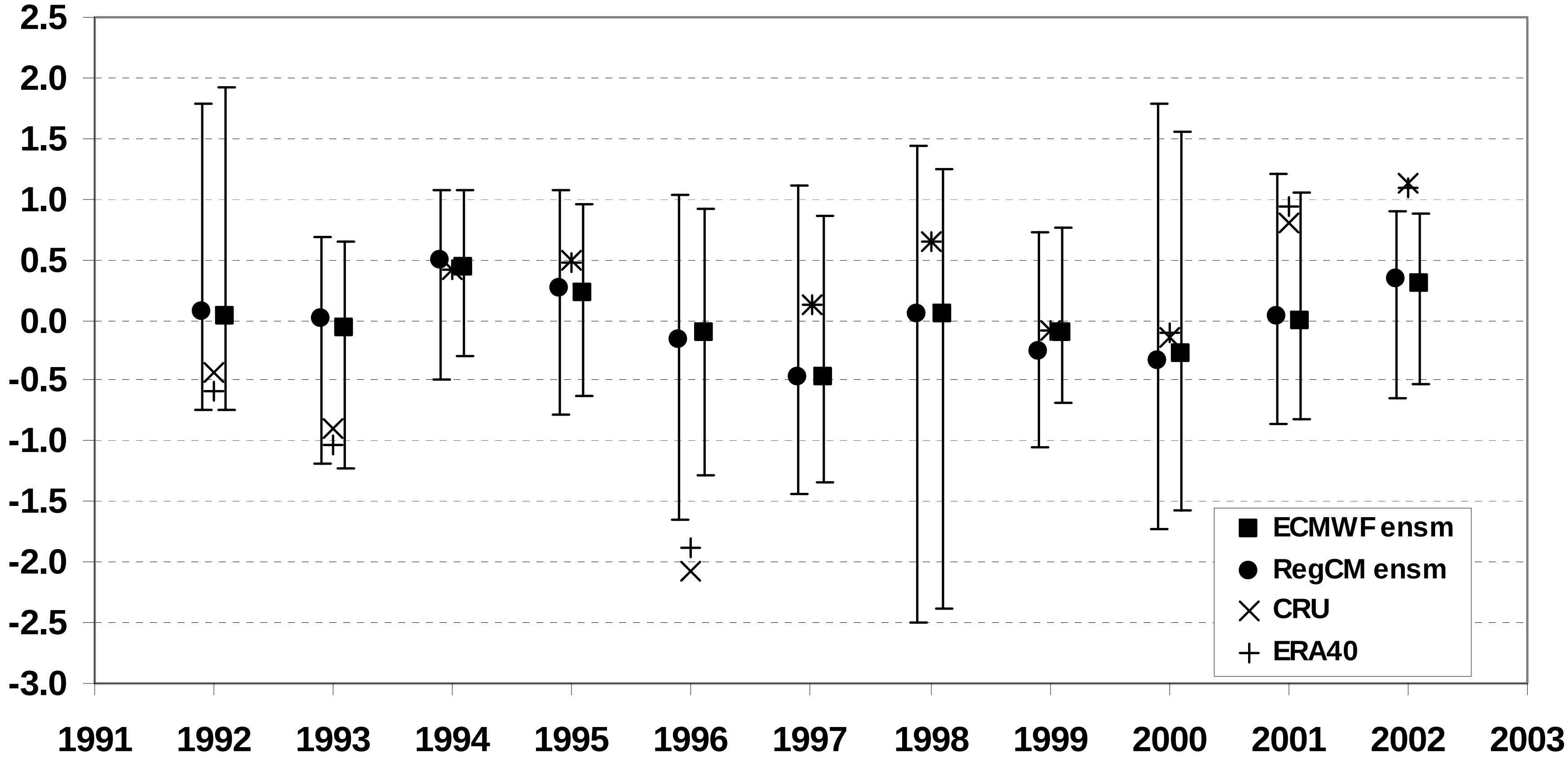
Much better input for downscaling, but smaller ensembles.

No sub-ensembles!

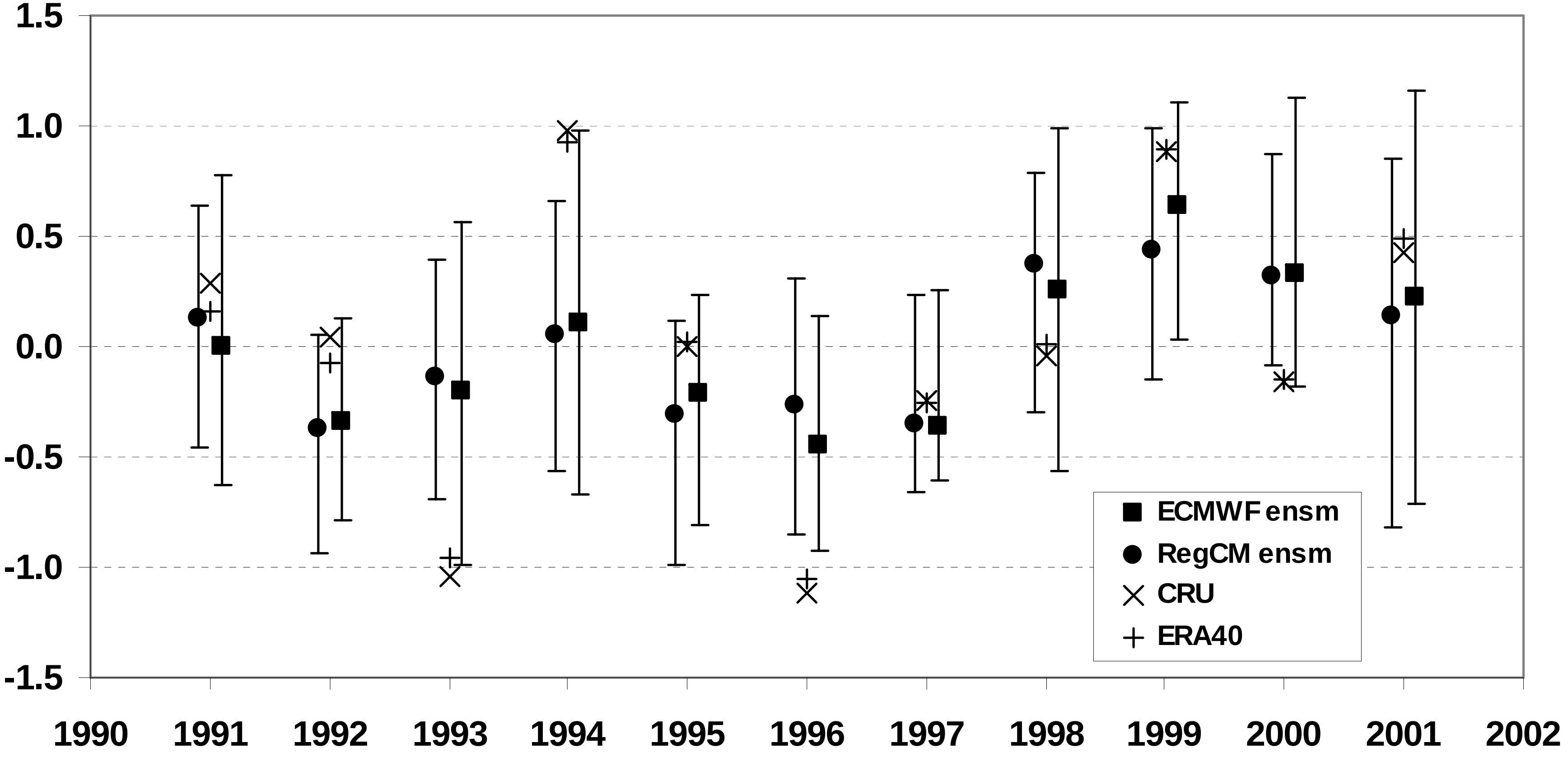
RegCM: 50 km, 18 levels; JAS and JFM seasons


ACC T850 wrt ERA
ACC T850 JFM
ACC
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
1991
1992
RegCM
ECMWF
ACC T850 JAS
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
RegCM
ECMWF

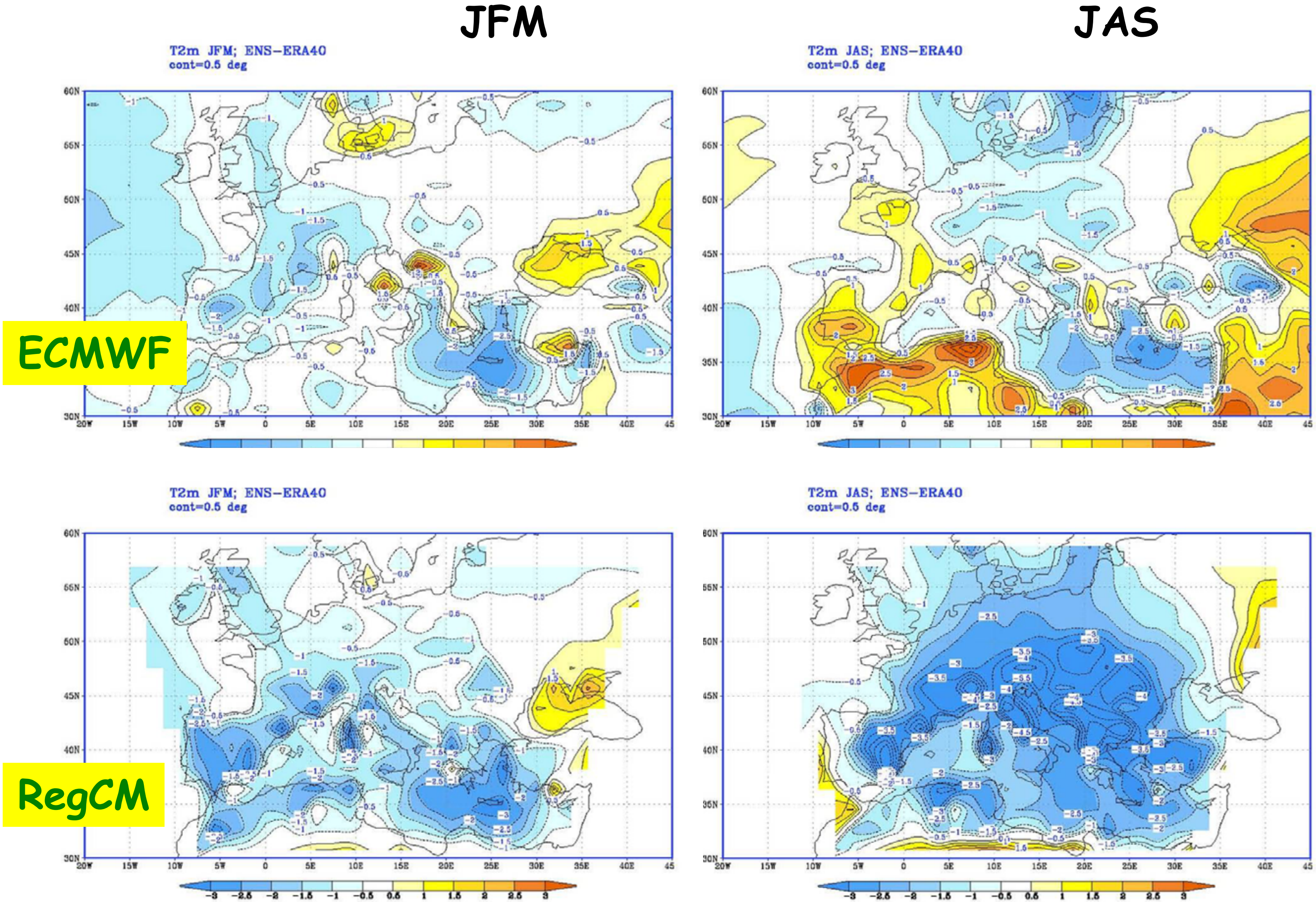
T2m anomaly JFM



T2m anomaly JAS



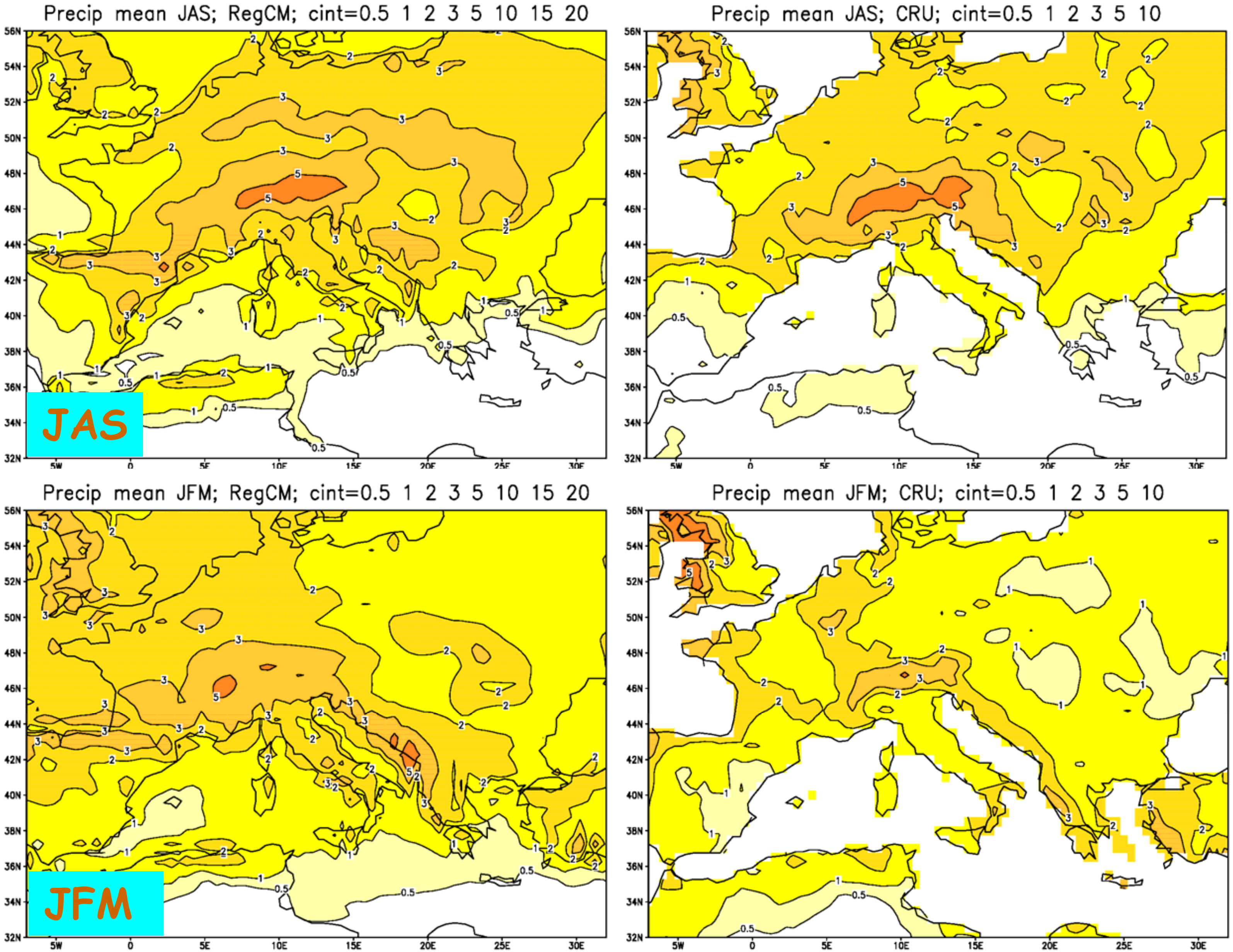
T2m error (11 years)



Precipitation (11 years)

RegCM

CRU verif



Skill scores (accuracy measures)

Contingency tables and quantities (Wilks 1995)

		Observed Y	Observed N
Fcst	Y	a	b
Fcst	N	c	d

$n = a+b+c+d$ total number of fcst/event pairs

Heidke score [1 perfect, 0 random f/c, HSS < 0 worse than random f/c]

$$HSS = \frac{2(ad-bc)}{(a+c)(c+d)+(a+b)(b+d)}$$

$$HR = \frac{a+d}{n}$$ Hit rate [0,1]

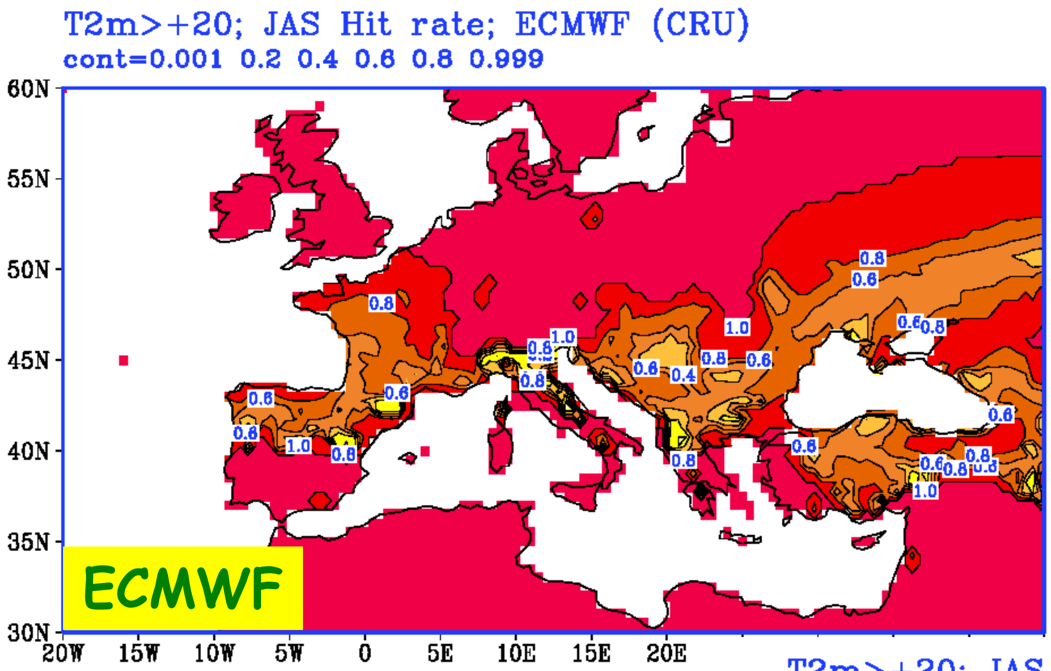
$$FAR = \frac{b}{a+b}$$ False alarm ratio [1,0]

$$TS = \frac{a}{a+b+c}$$ Threat score [0,1]

Kuipers score $$KSS = \frac{ad-bc}{(a+c)(b+d)}$$

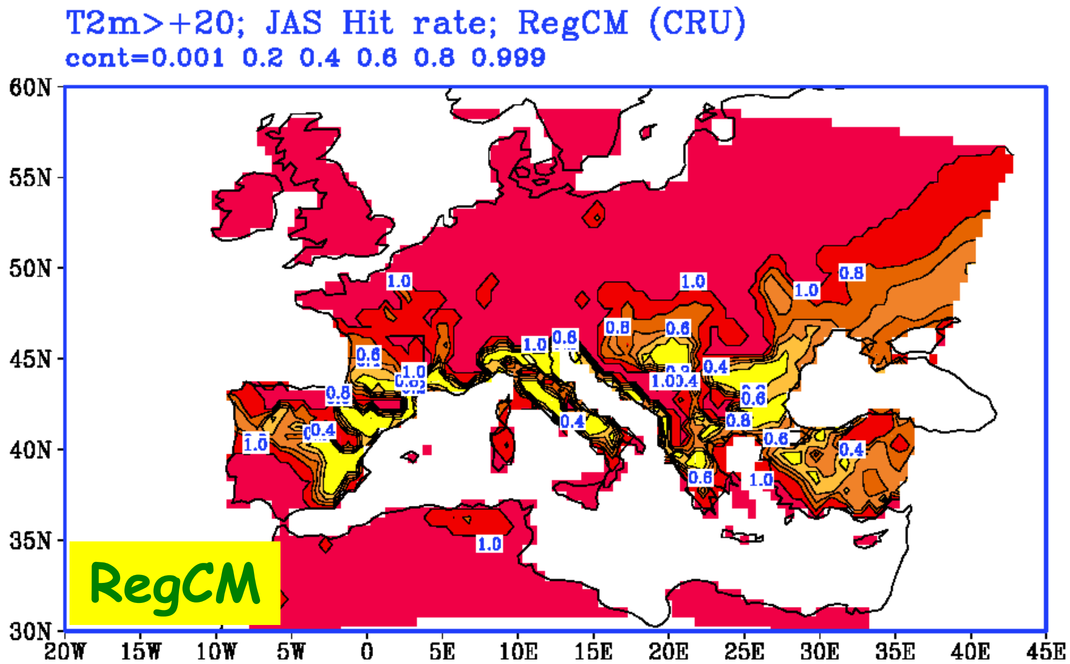
Bias [1 unbiased, B > 1 overforecasting, B < 1 underforecasting]

$$B = \frac{a+b}{a+c}$$



T2m > +20°C
JAS

Hit rate (wrt CRU)

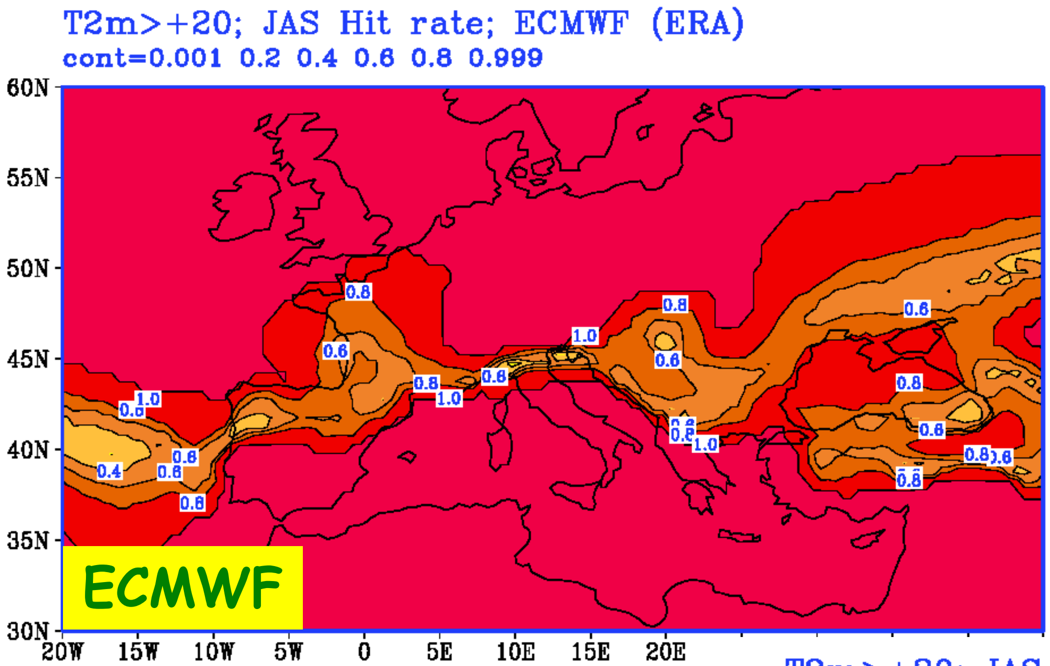


$$HR = \frac{a+d}{n}$$

		Observed	
		Y	N
Fcst	Y	a	b
	N	c	d

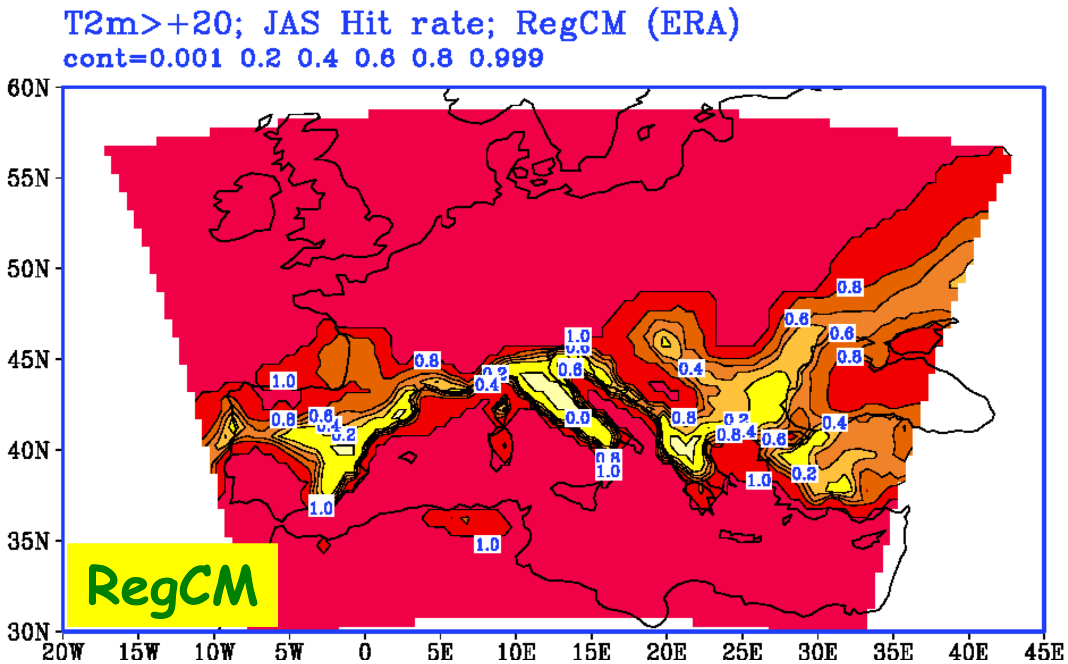
T2m > +20°C
JAS

Hit rate (wrt ERA)



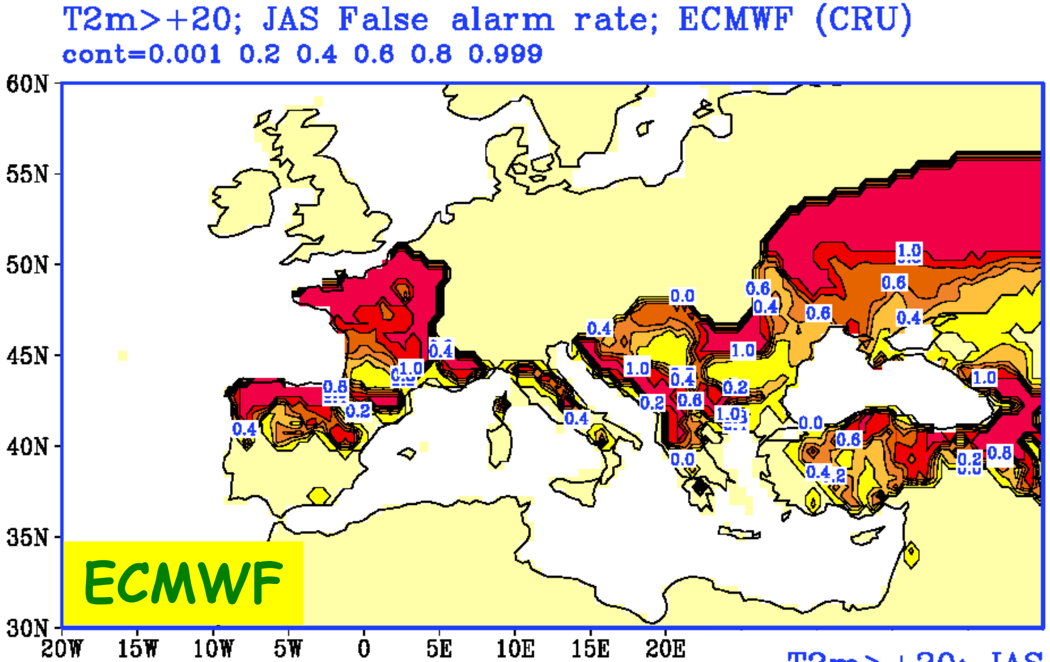
$$HR = \frac{a+d}{n}$$

		Observed	
		Y	N
Fcst	Y	a	b
	N	c	d



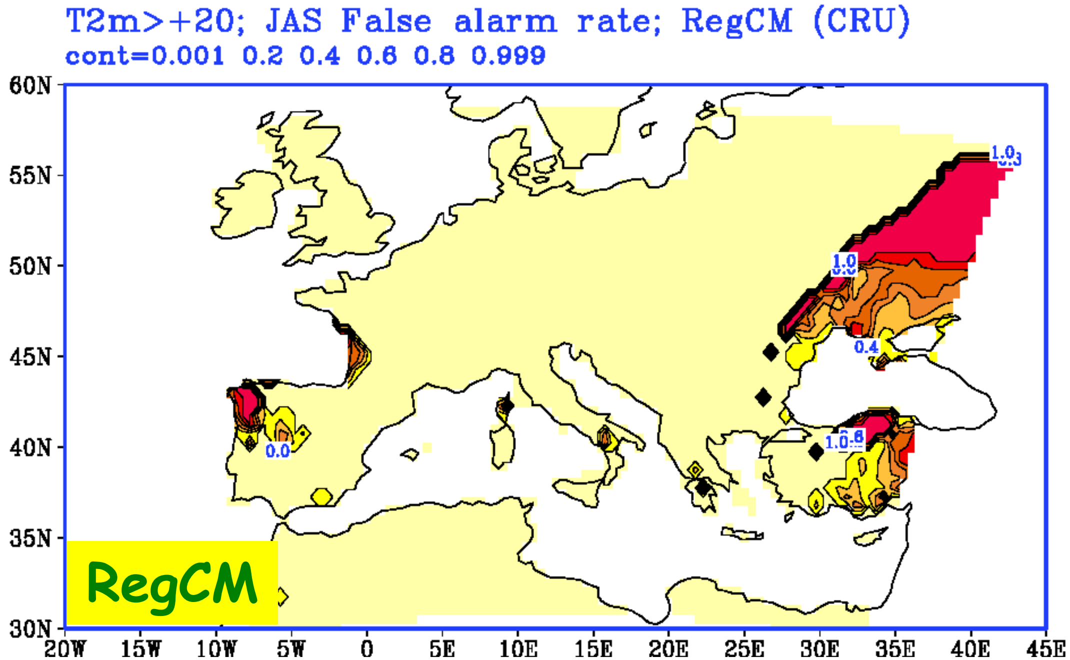
T2m > +20°C
JAS

False alarm ratio



$$FAR = \frac{b}{a+b}$$

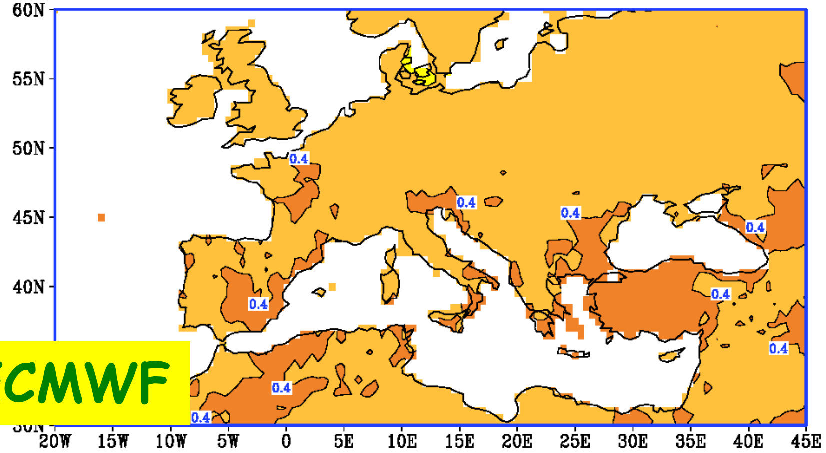
		Observed	
		Y	N
Fcst	Y	a	b
	N	c	d



T2m anom > +0°C **Threat score** $TS = \frac{a}{a+b+c}$

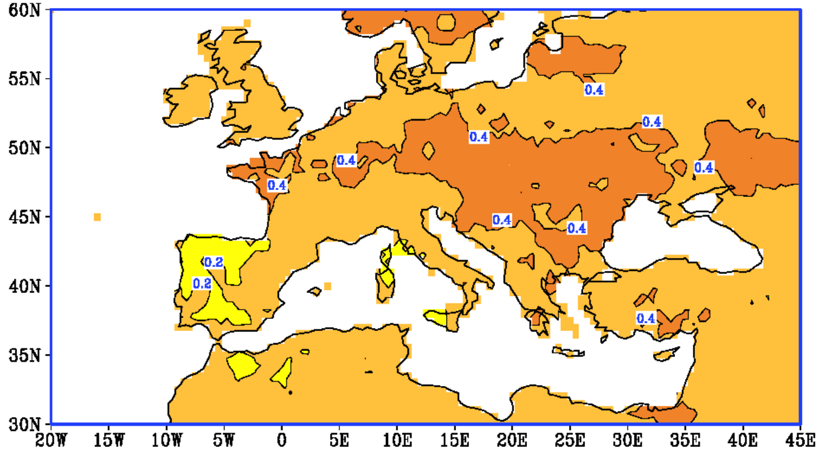
JAS **JFM**

T2m anom>+0; JAS Threat score; ECMWF (CRU)
cont=0.001 0.2 0.4 0.6 0.8 0.999

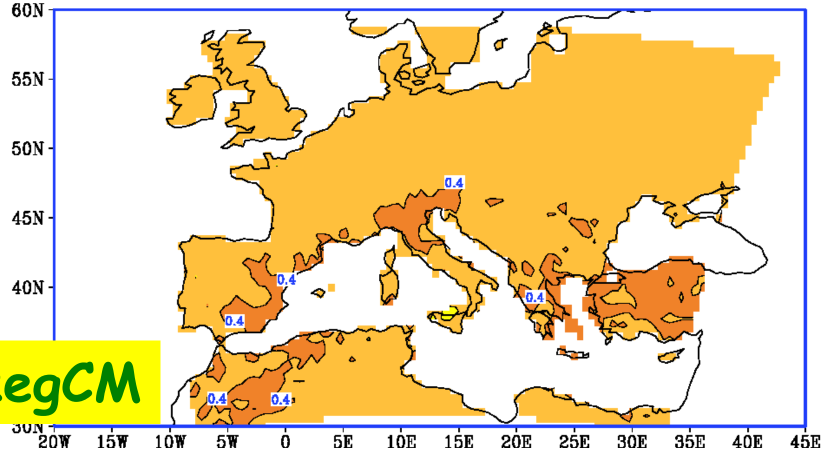


ECMWF

T2m anom>+0; JFM Threat score; ECMWF (CRU)
cont=0.001 0.2 0.4 0.6 0.8 0.999

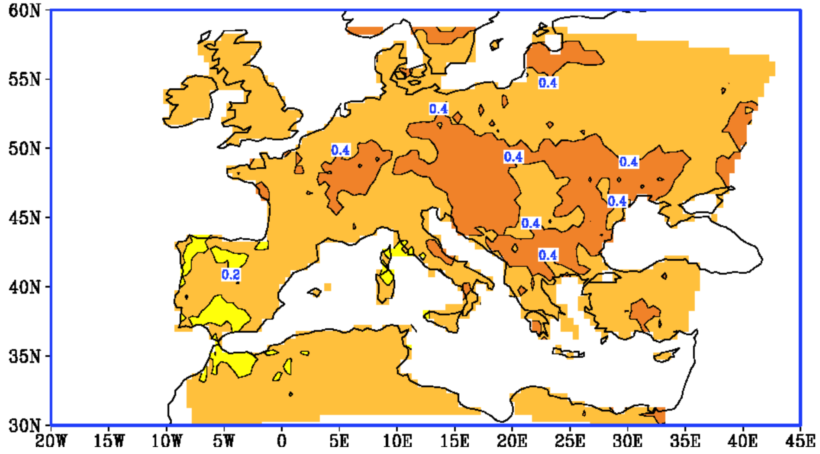


T2m anom>+0; JAS Threat score; RegCM (CRU)
cont=0.001 0.2 0.4 0.6 0.8 0.999



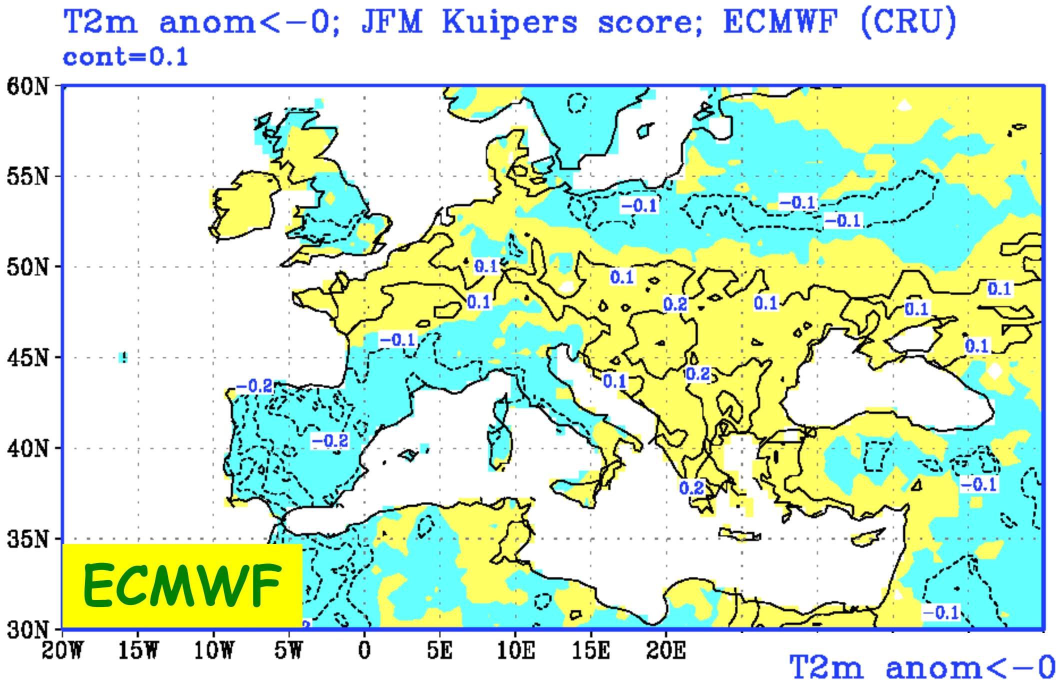
RegCM

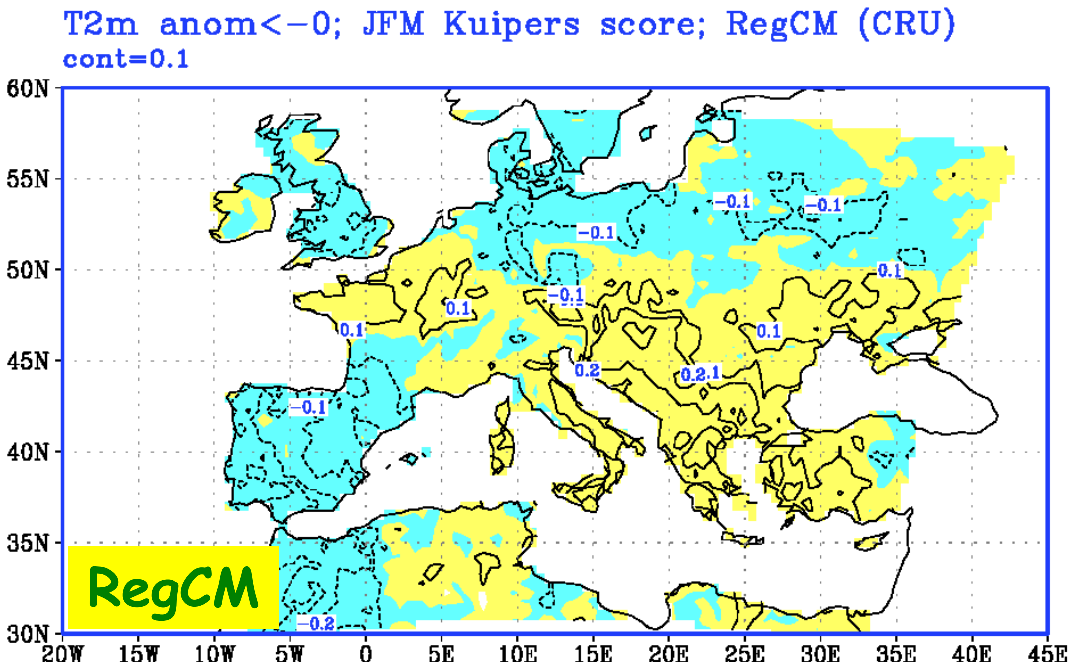
T2m anom>+0; JFM Threat score; RegCM (CRU)
cont=0.001 0.2 0.4 0.6 0.8 0.999



T2m anom < -0°C JFM

Kuipers score

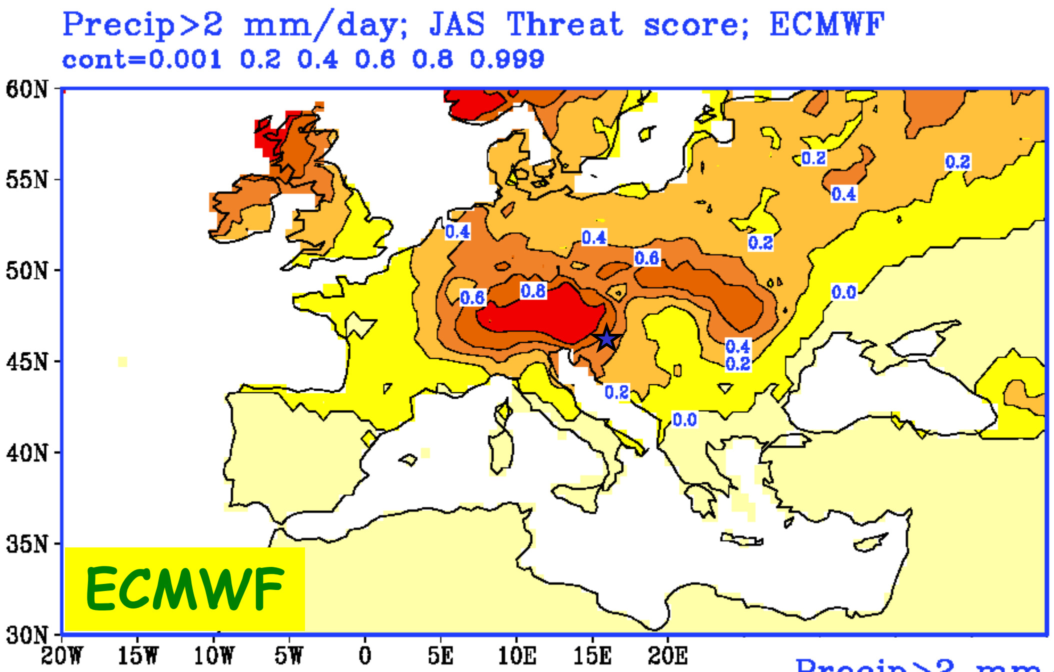




$$KSS = \frac{ad - bc}{(a+c)(b+d)}$$

Observed

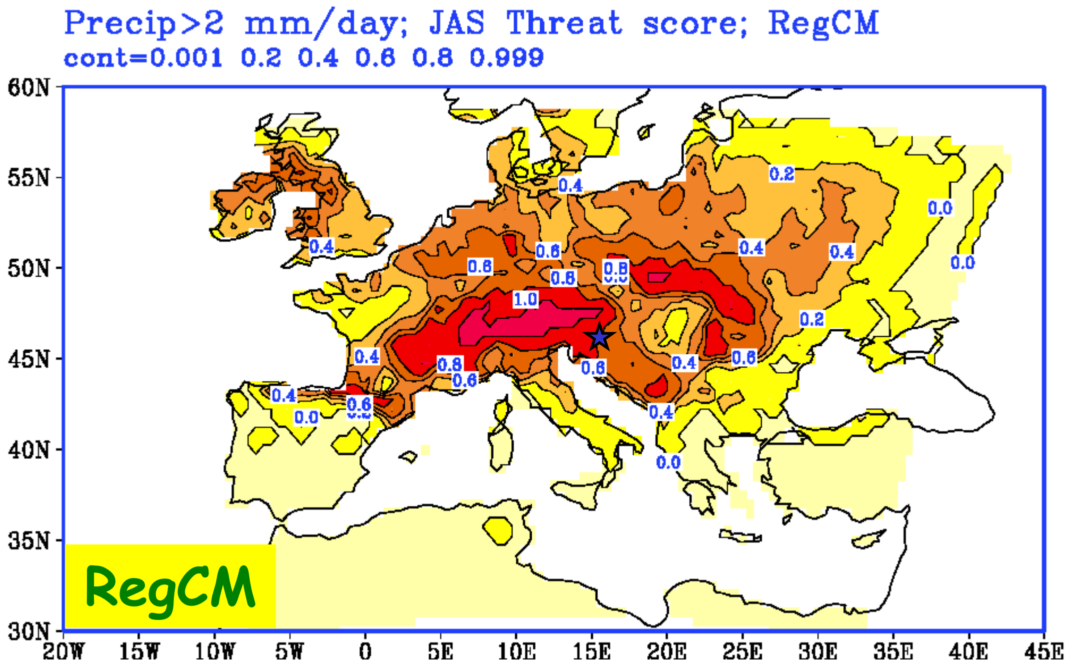
		Y	N
Fcst	Y	a	b
	N	c	d



Precip>2.0 mm/day JAS

Threat score

Average for Zagreb
270 mm

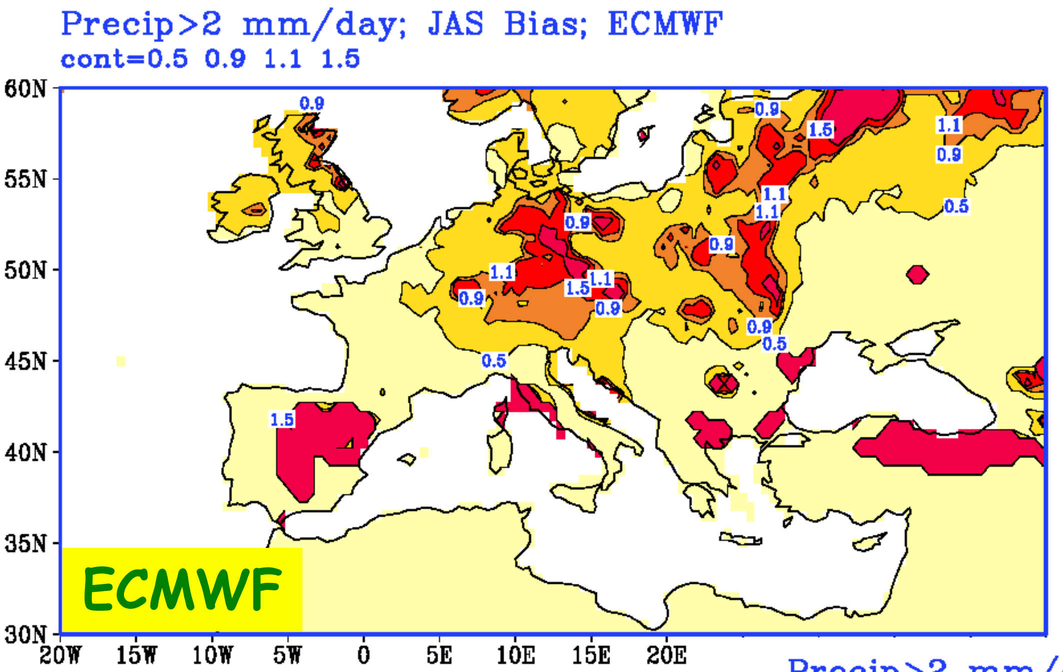


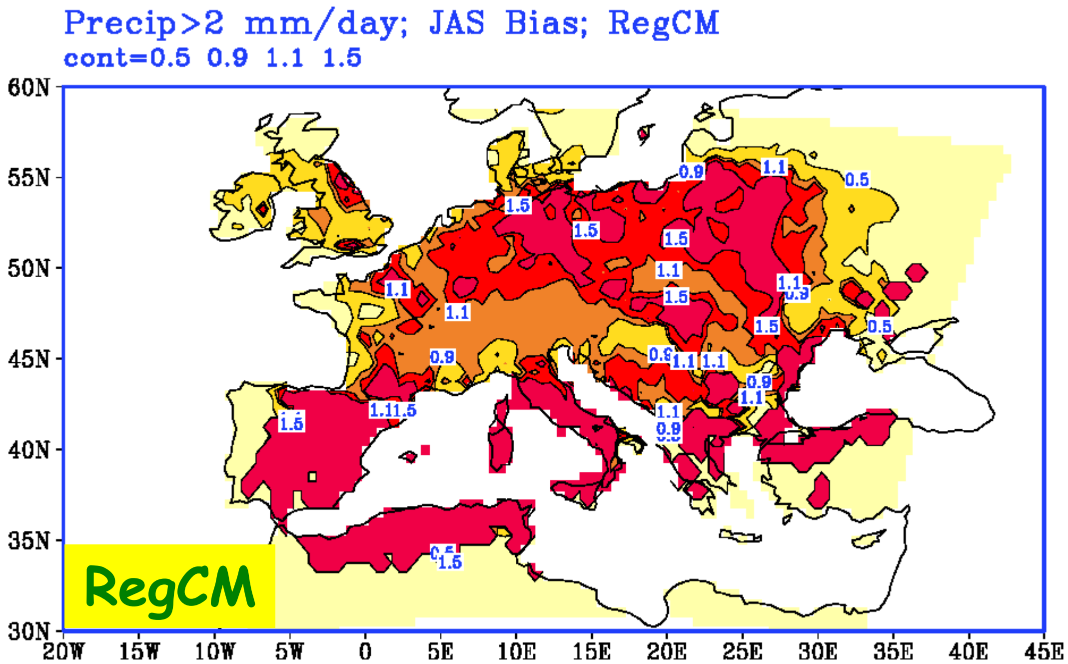
$$TS = \frac{a}{a+b+c}$$

		Observed	
		Y	N
Fcst	Y	a	b
	N	c	d

Precip>2.0 mm/day JAS

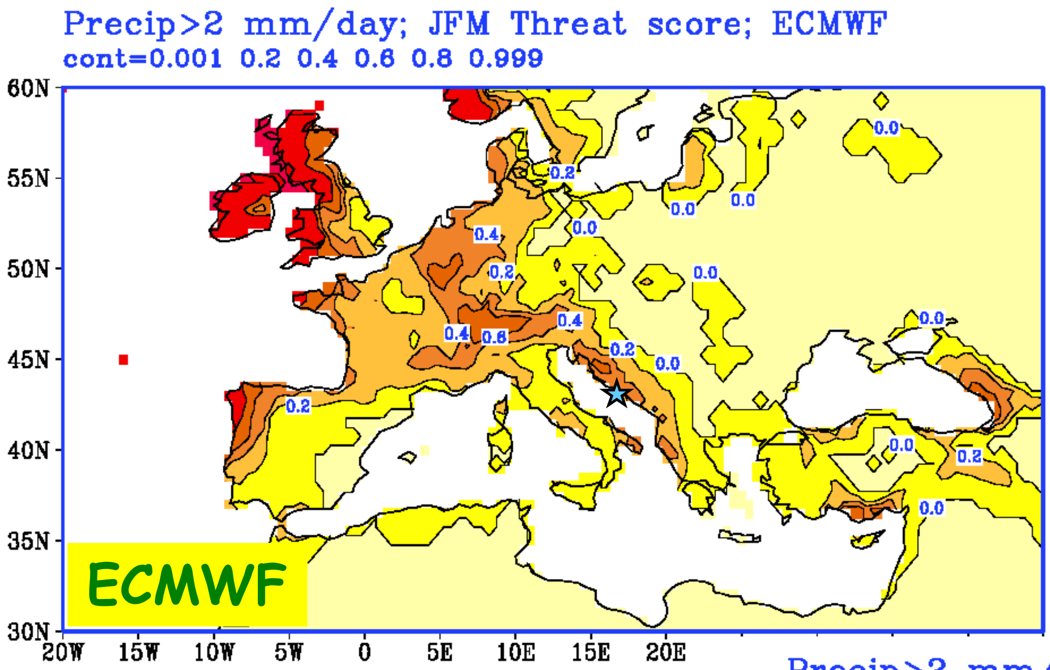
Bias





$$B = \frac{a+b}{a+c}$$

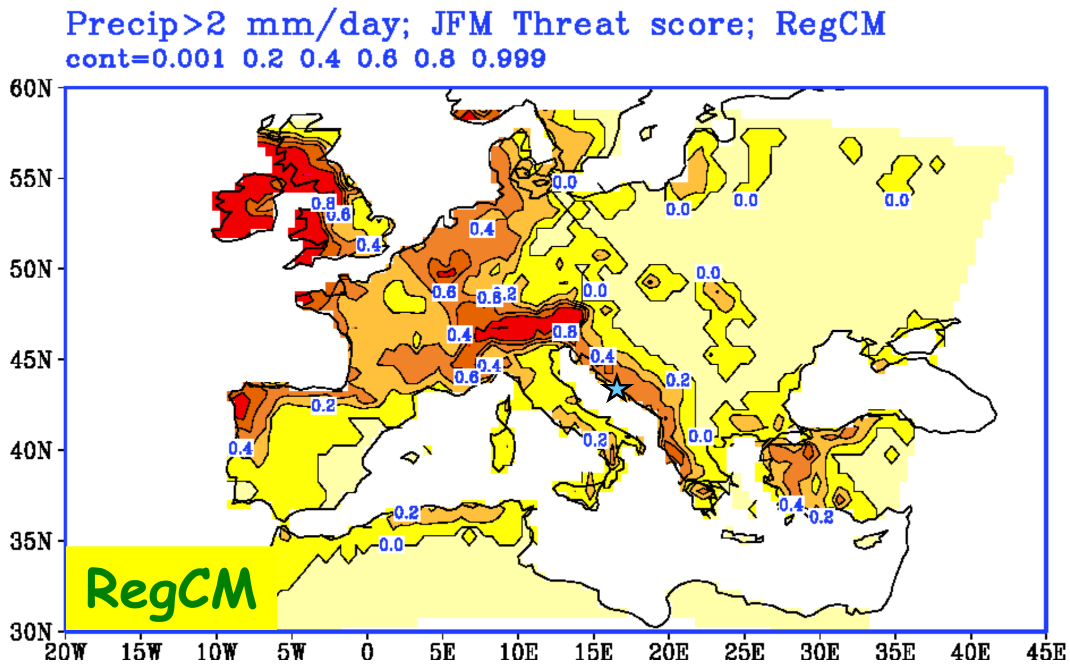
		Observed	
		Y	N
Fcst	Y	a	b
	N	c	d



Precip>2.0 mm/day JFM

Threat score

Average for Split
156 mm



$$TS = \frac{a}{a+b+c}$$

Observed

		Y	N
Fcst	Y	a	b
	N	c	d

Some thoughts on verification statistics:

* No clear overall winner, but RM tends to be better for higher thresholds and over mountains
  (results may improve in favour of RM with a higher resolution)

* Need to know better systematic biases of RM
  ("climate" of 1990's is biased)

* How to best verify results of downscaling ?

... and some thoughts on dynamical downscaling:

* Probably not worth the trouble for upper-air fields (?)

* Improves the structure of surface fields

* If GCM forecast is good, a significant benefit of downscaling
  in orography-related fields
  (need for ever improved orography)

* Won't improve bad global forecast

* It is as good as RM is good