

# Simulation of extremely hot events in Croatia with RegCM4



Lidija Srnec, Ksenija Cindrić, Ivan Güttler and Čedo Branković

Meteorological and Hydrological Service of Croatia, HR-10 000 Zagreb, Grič 3

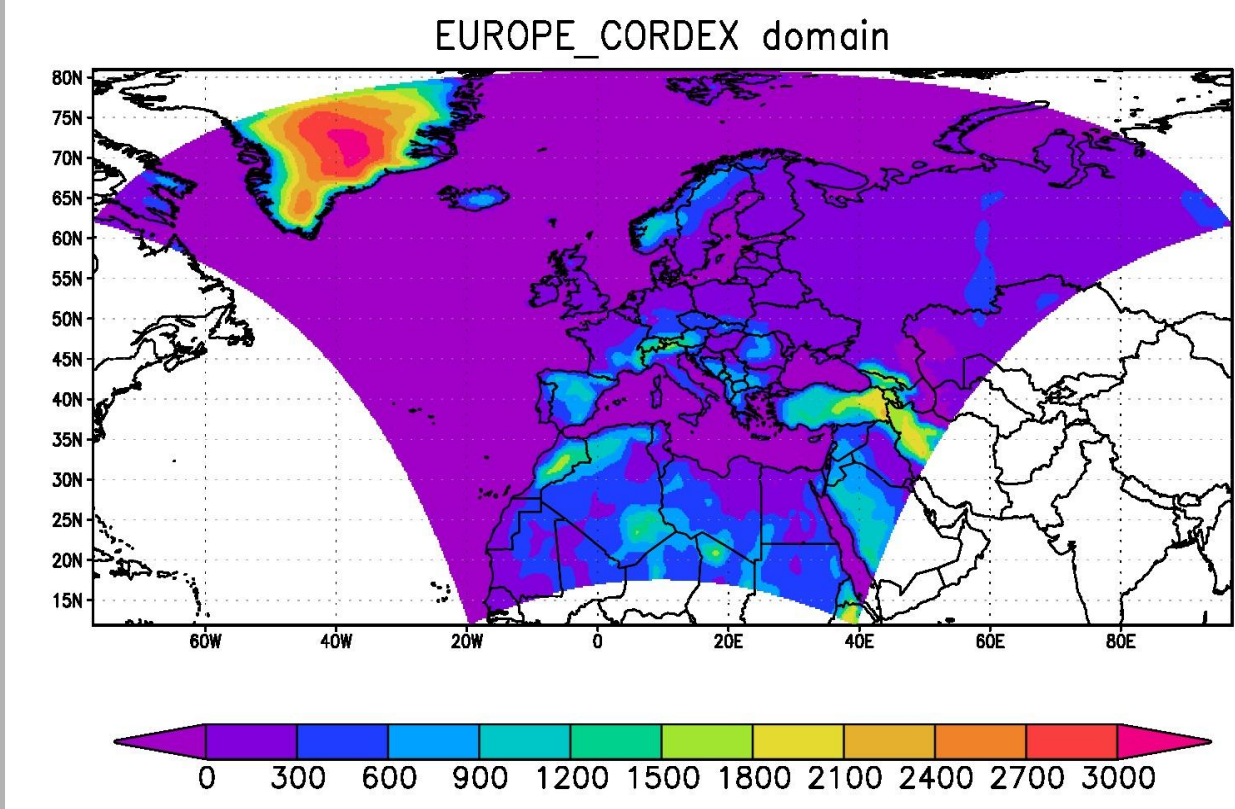
e-mail: srnec@cirus.dhz.hr



## INTRODUCTION

The characteristics of summertime hot events in Croatia are examined by using the regional climate model RegCM4. Climate indices based on summer (JJA) daily minimum and maximum air temperature in the period 1989-2008 are calculated from two model experiments that differ in horizontal resolution. They are compared with EOBS data and observational data from Croatian meteorological stations. The main purpose of this study is to test model ability to simulate indices that describe hot events in Croatia and how they depend on the model horizontal resolution.

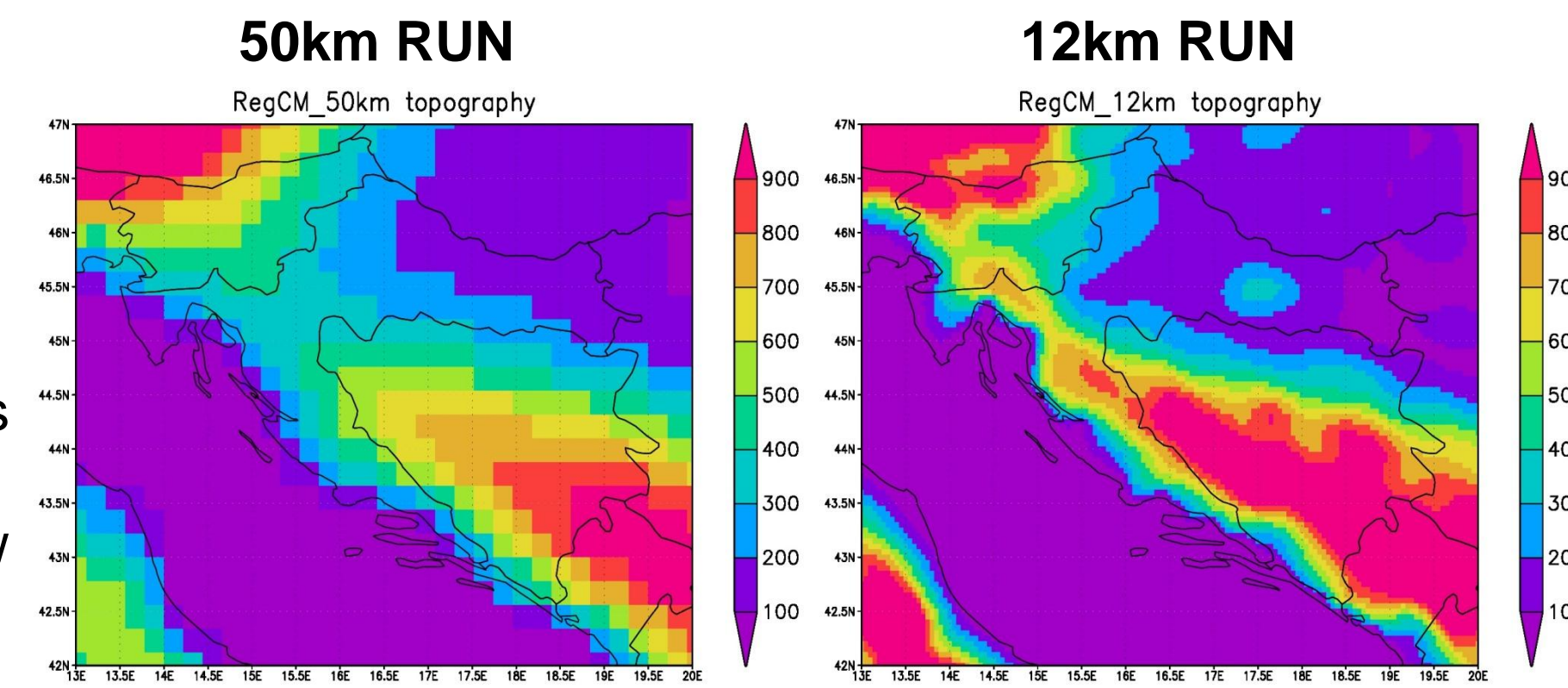
## MODEL – RegCM4



- RegCM4 model (Giorgi et al., 2012) was run over EUROPE-CORDEX domain for the 1989-2008 period
- Forced by ERA-Interim reanalysis
- Two different horizontal resolutions:
  - 50km with 144x144 grid cells
  - 12.5km with 576x576 grid cells
- 23 vertical  $\sigma$ -levels with the model top at 50 hPa
- Emanuel (1991) convection scheme
- Holtslag et al. (1993) PBL scheme
- BATS LSM
- CCM3 radiation package

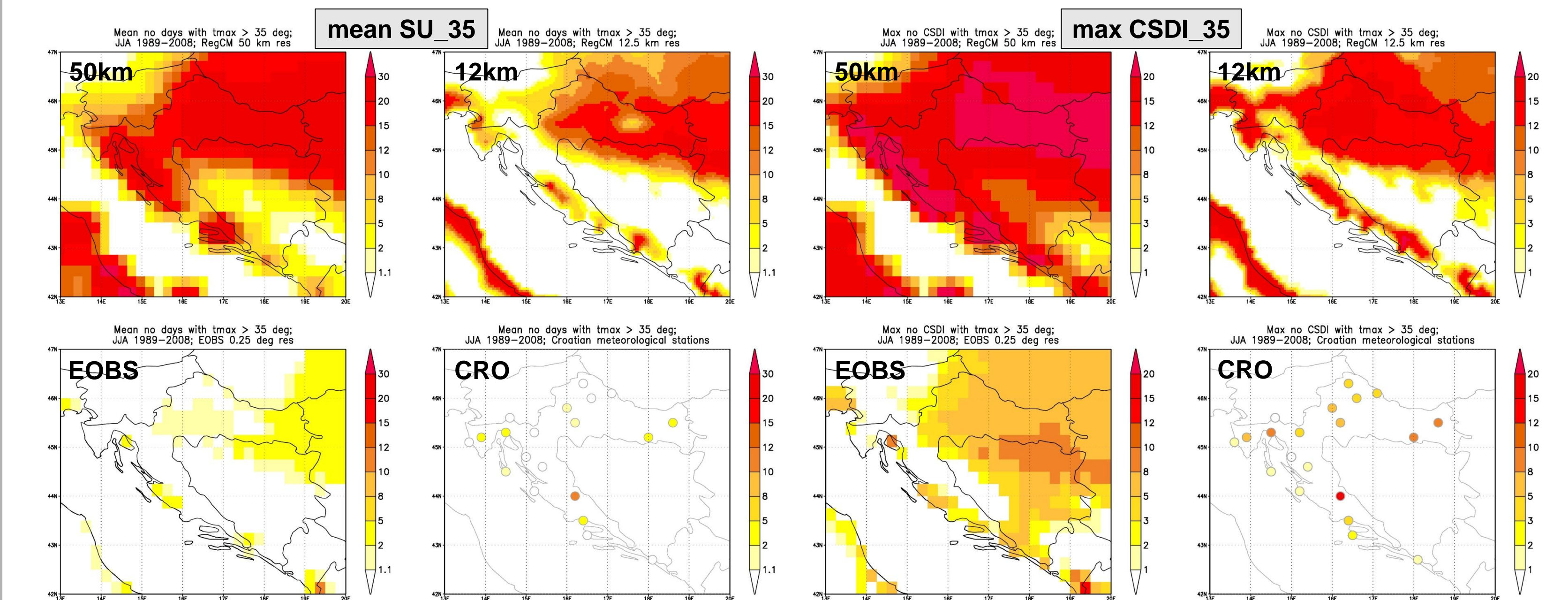
## Experiments

Croatia has a complex orography along the Adriatic coast and therefore two main climate regimes (continental and maritime). The representation of orography is improved with the resolution increase and here we test how this change in resolution influences temperature indices.

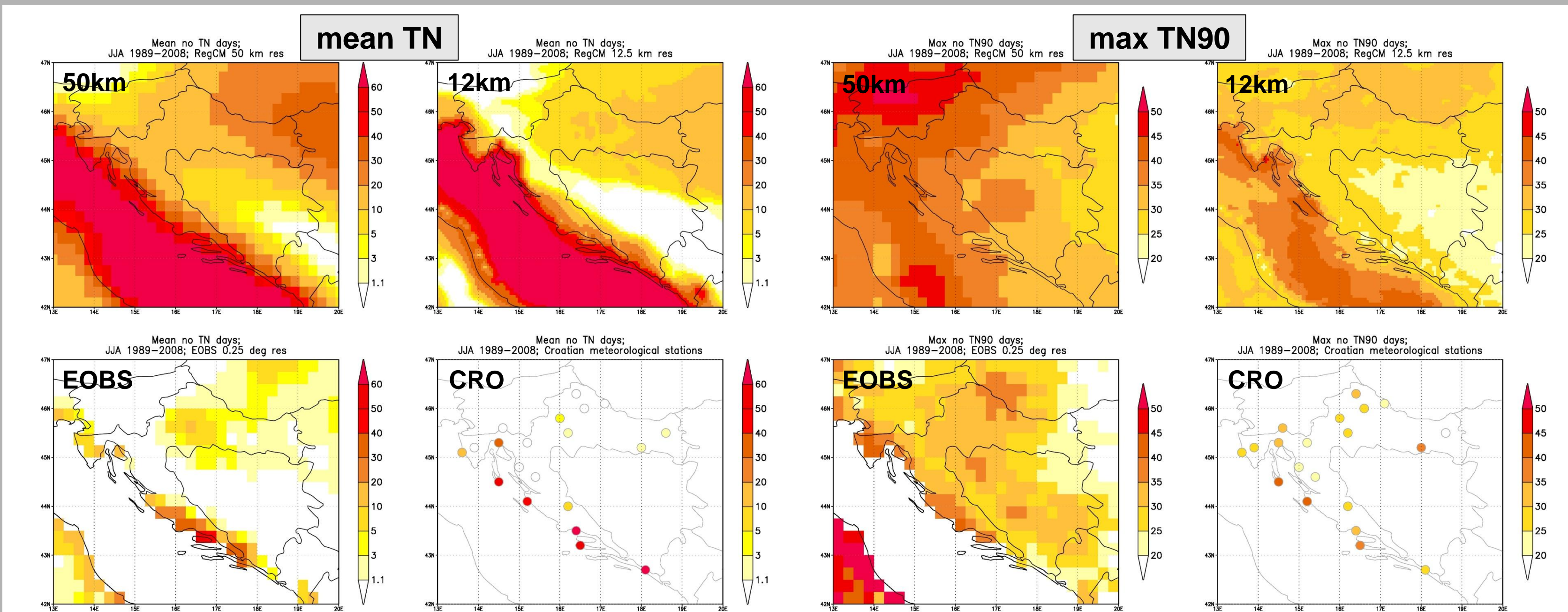


## Indices (Klein Tank et al. 2009):

- Summer days (SU\_35): number of days with daily maximum temperature  $> 35^{\circ}\text{C}$
- Consecutive summer days (CSDI\_35): number of days with the largest number of consecutive days with  $t_{\text{max}} > 35^{\circ}\text{C}$
- Tropical nights (TN): number of days with daily minimum temperature  $> 20^{\circ}\text{C}$
- Warm days (TX90): number of days with  $t_{\text{max}} > 90^{\text{th}}$  percentile of daily  $t_{\text{max}}$
- Warm nights (TN90): number of days with  $t_{\text{min}} > 90^{\text{th}}$  percentile of daily  $t_{\text{min}}$
- Warm spell duration (WSDI): number of days where, in intervals of at least 6 consecutive days,  $t_{\text{max}} > 90^{\text{th}}$  percentile of  $t_{\text{max}}$
- Heat wave duration (HWDI): number of days where, in intervals of at least 6 consecutive days,  $t_{\text{max}} > \text{TXnormal} + 5^{\circ}\text{C}$



Observed summer days over  $35^{\circ}\text{C}$  (CRO) are more frequent on the coast and its hinterland than in the mainland. In the lowlands they occur frequently in the eastern and central parts. Both experiments overestimates SU\_35 (EOBS and CRO) significantly but the 12-km experiment reproduces better observed horizontal distribution of SU\_35 days. The observed maximum number of CSDI\_35 is between 4 and 9 days in the lowlands, 2-4 days in the mountainous parts (with no such days at higher elevations) and up to 16 days in the coastal hinterland. While the 50-km experiment makes no difference in the horizontal distribution of CSDI\_35 days over Croatia, in the 12-km experiment there is a difference in the frequency of those days in the area with more developed orography and along the coast. Again, the absolute values are overestimated.



There are almost no tropical nights in the continental Croatia, while at the coast there are 17 to 64 warm nights per summer, increasing from north to the south. Whereas in the 50-km experiment this distribution is not seen, in the 12-km it is well represented but overestimated for up to two classes. Similar is for maximum number of warm nights in the 1989-2008 period. Although the observed values at the Croatian stations are not reproduced exactly in the 12-km experiment, the range of maximum TN number in summer is almost the same.

## CONCLUSIONS

Several temperature indices are calculated for summer 1989-2008 in Croatia from the two different experiments with regional climate model RegCM4. Experiments were done for two different horizontal resolutions (50 and 12km) and compared with observed gridded EOBS data set and observations from 20 meteorological stations in Croatia. The higher horizontal distribution resolves better topography and reduces biases in daily minimum and maximum temperature. For all indices, except HWDI, the increase from 50 to 12 km gives a better spatial distribution, although the simulated values are overestimated. Of all analysed indices, the indices at the 12-km resolution based on percentile are the closest to the observed ones.

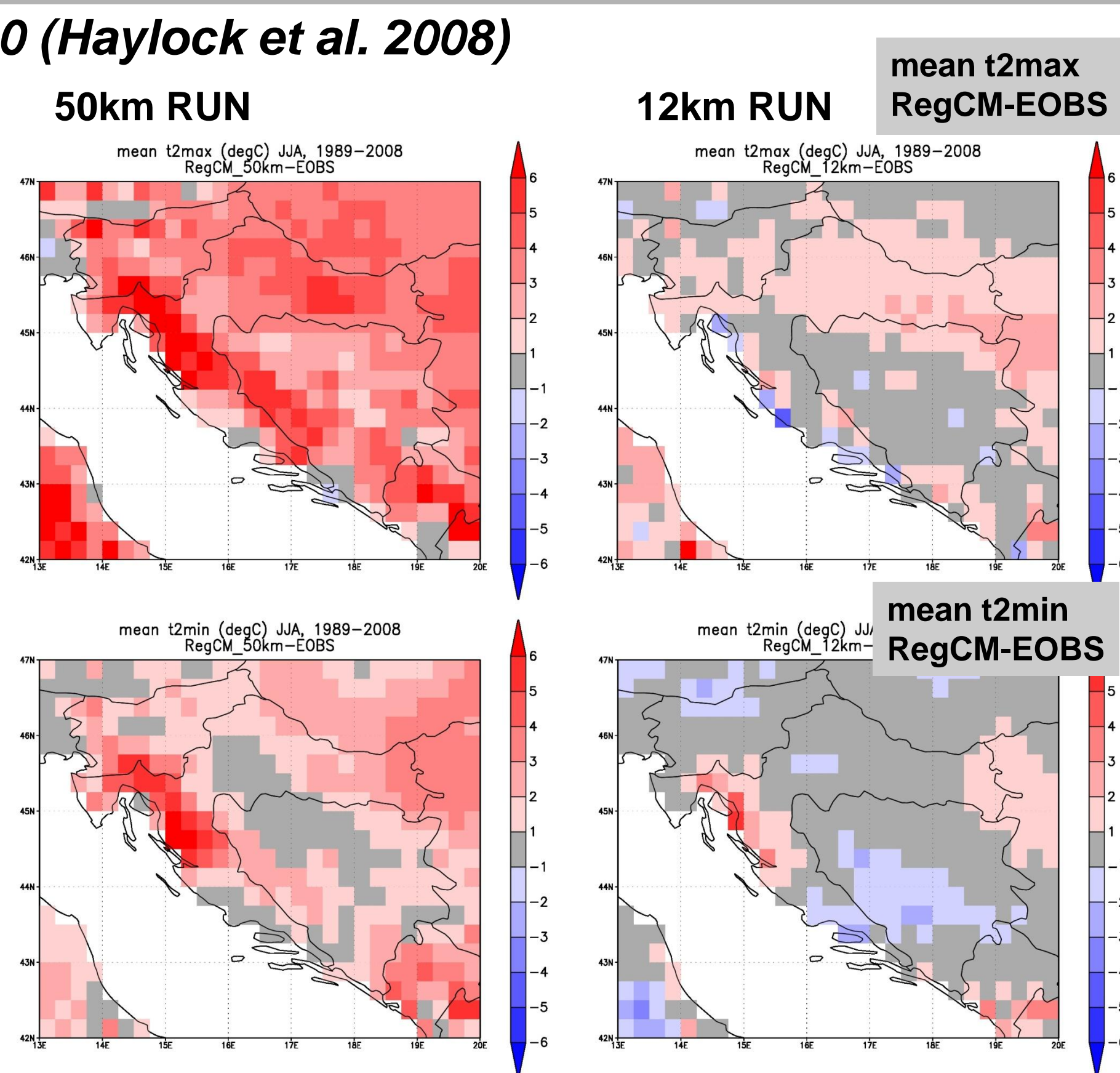
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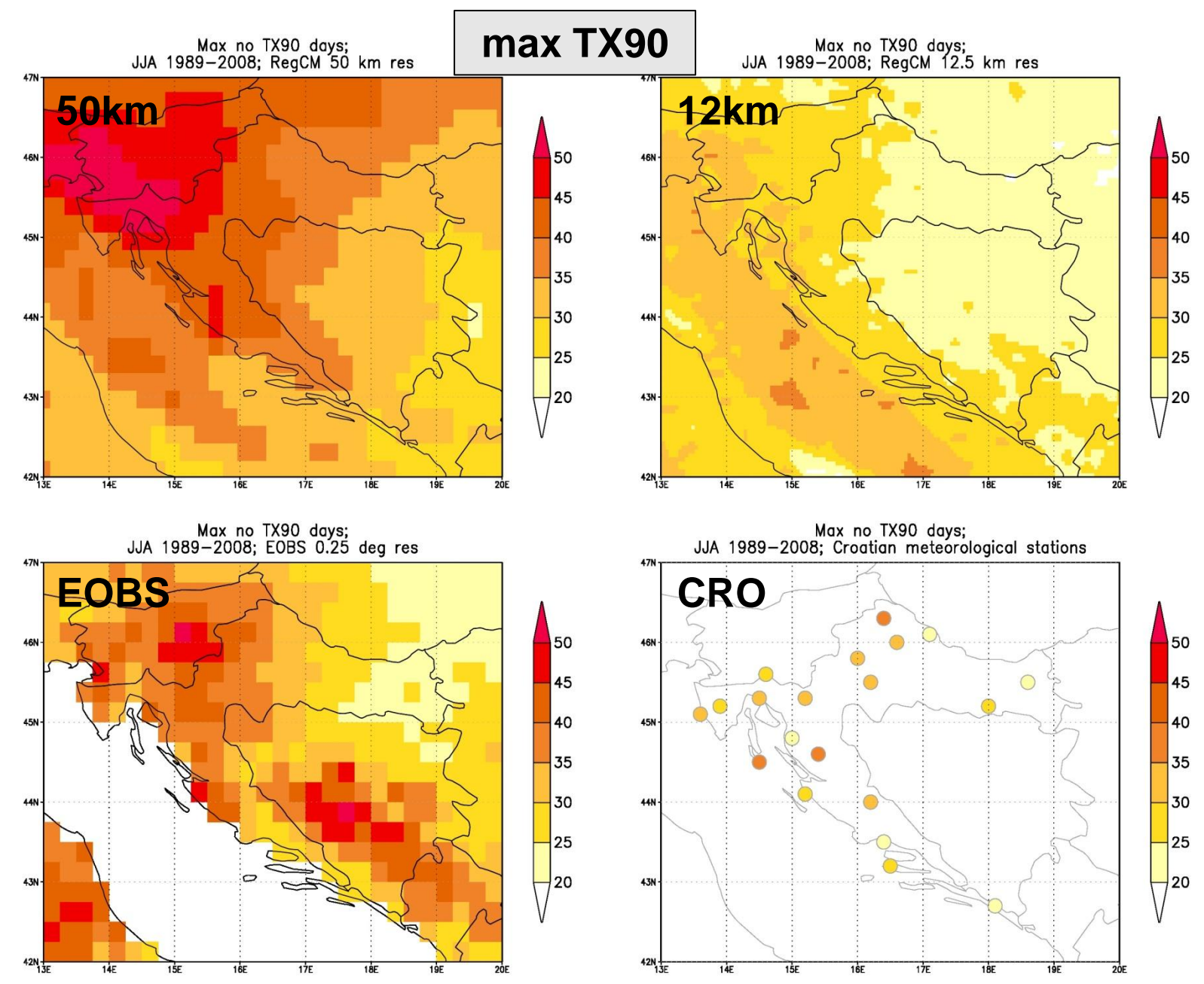
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## Model vs. EOBS9.0 (Haylock et al. 2008)

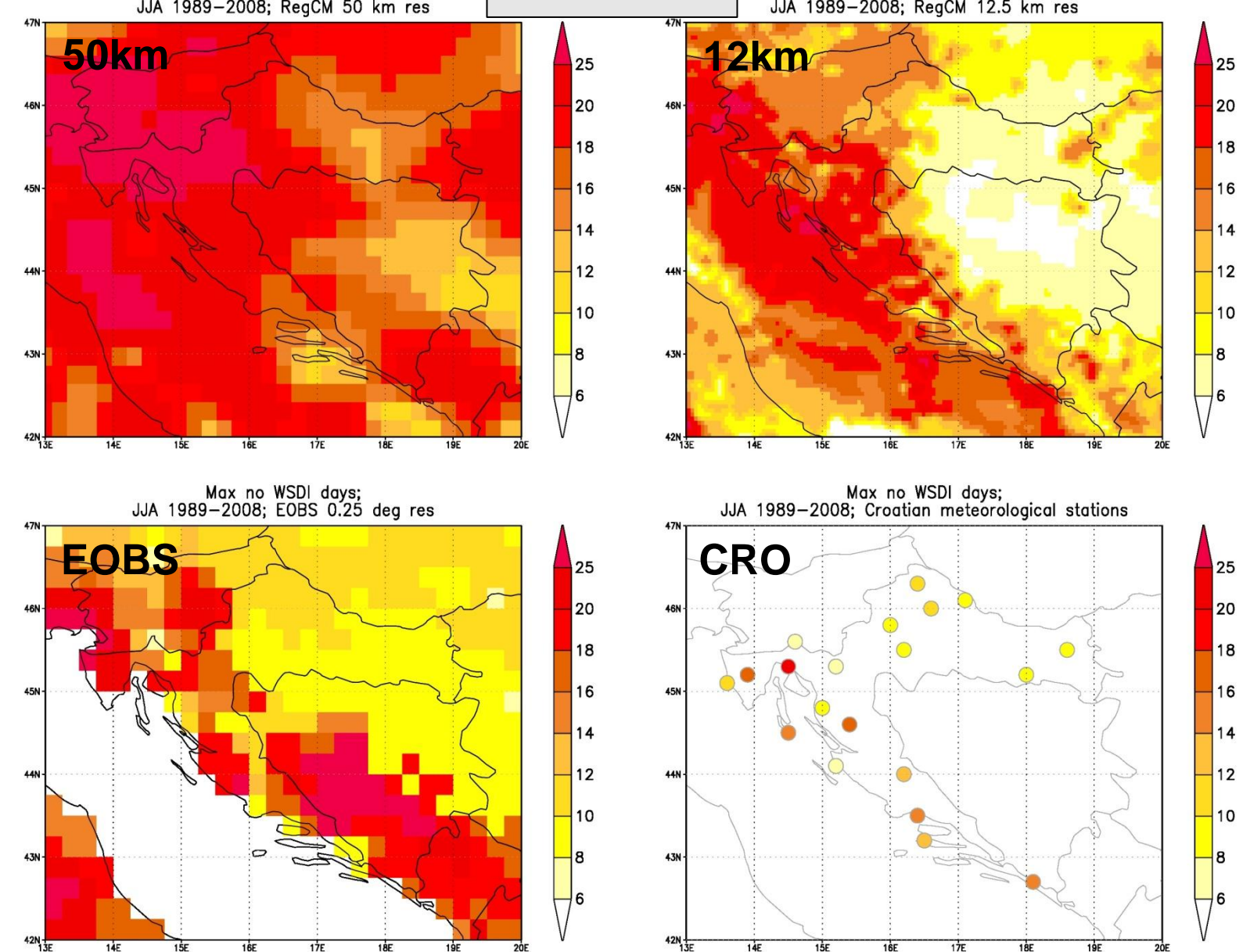
The difference between simulated and EOBS temperatures indicate model systematic errors. Model is generally warmer than observations. The increase of resolution effects a decrease of systematic errors for both,  $t_{\text{max}}$  and  $t_{\text{min}}$ .  $t_{\text{min}}$  compared to  $t_{\text{max}}$  has smaller bias, particularly in the continental Croatia.



During summer in Croatia, there is average 8-9 TX90 days (not shown). The maximum number TX90 days in 1989-2008 period is between 24 to 40. The 12-km experiment simulates quite well the TX90 days as well as its spatial distribution (higher values in the western part of Croatia and along the coast).



The maximum WSDI in Croatia occurred in 2003 or in 2007. It ranges between 7 to 21 days. The range of simulated max WSDI days in the 12-km run is the same as in observed values, but the frequency of higher values is overestimated especially at the coast and in the mountainous area.



In the 1989-2008 period there were up to seven years in Croatia with observed heat wave. There were one or two episodes and mostly it was in 2003. Both simulations overestimates the observed HWDI substantially and the 12-km experiment does not make an improvement as in other indices.

