Climate Change Scenarios for the Agricultural and Hydrological Impact Studies

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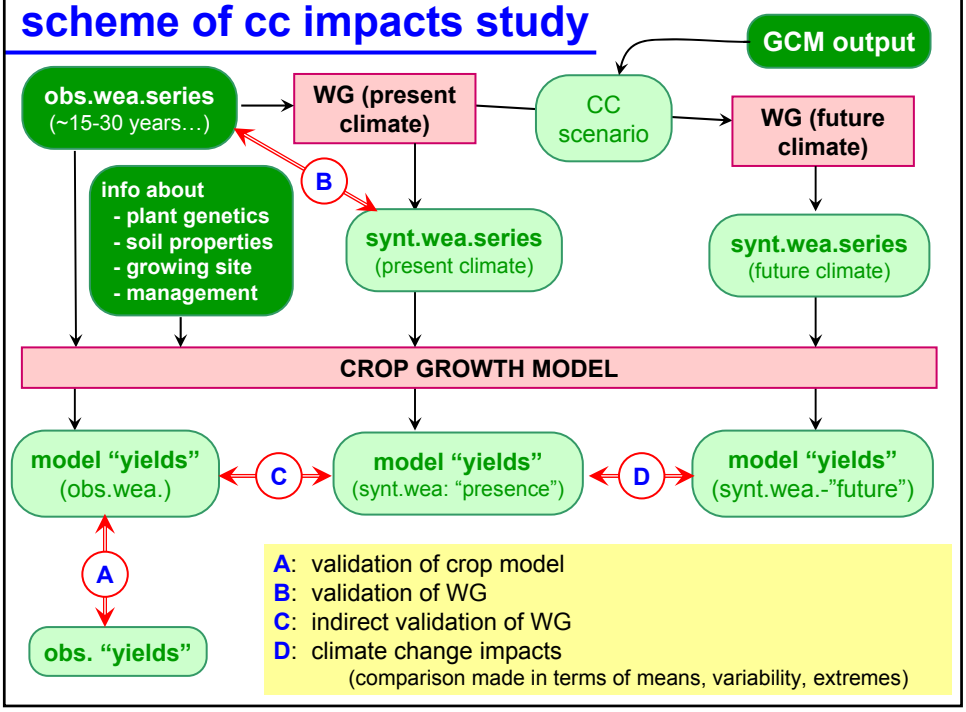
(WP 3, 5, 6)

hotel Mendi, Halkidiki, Greece ***** 10-12. June 2009

scheme of cc impacts study

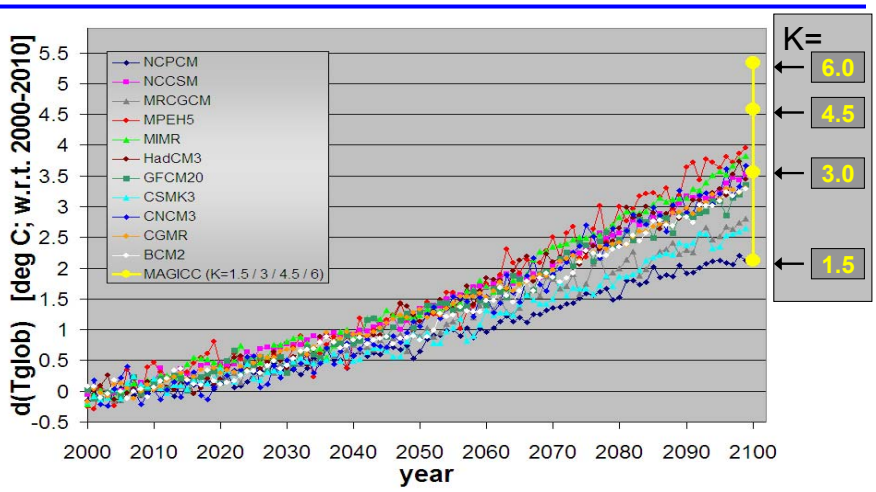


in our climate change impact studies we want to account for the uncertainties…

- between GCMs (or in RCMs if we would have more of them)
- in emission scenarios
- in climate sensitivity

Global temperature (at SRES-A2)

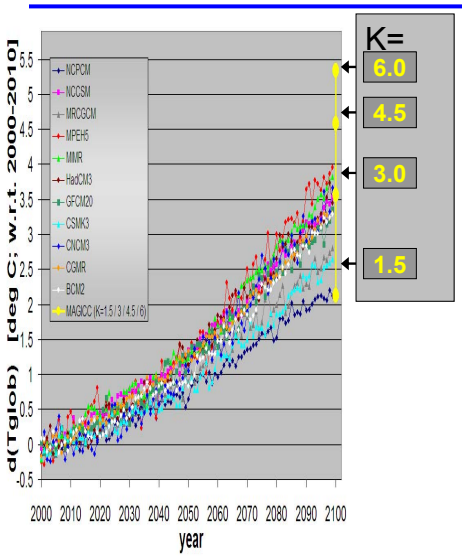
11 GCMs (colour time series) *vs* **MAGICC** model (run at various climate sensitivities; yellow bar on the right)

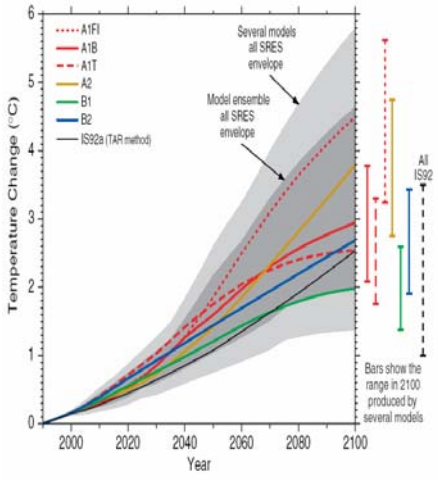


! ***range of ΔT_{glob}*** *simulated by a set of GCMs is not representative for the uncertainty in climate sensitivity* → ***pattern scaling helps*** !

Global temperature at SRES-A2

11 GCMs + MAGICC **IPCC figure**





pattern scaling technique

assumption: pattern (spatial and temporal /annual cycle/) is constant, only magnitude changes proportionally to the change in global mean temperature:

$$\Delta X(t) = \Delta X_S \times \Delta T_G(t)$$

where ΔX_S = ***standardised scenario (= scenario related to ΔT_G = 1 °C)***

a) $\Delta X_S = \Delta X_{[tA\text{-}tB]} / \Delta T_{G\,[tA\text{-}tB]}$

b) linear regression [$x = \Delta T_G$; $y = \Delta X$] going through zero

ΔT_G = ***change in global mean temperature***

!! ΔT_G *may be estimated by other means than GCMs* !!
(e.g. simple climate models /~ MAGICC/)

between GCM uncertainties

combining information from 18 / 14 GCMs

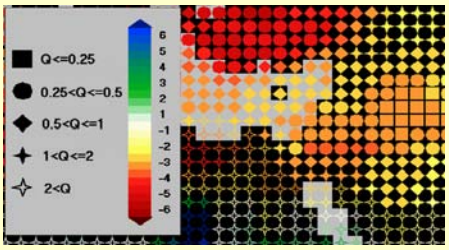
motivation: to show the multi-model mean/median + uncertainty in a single map

step1: **results** obtained with each of 7 GCMs are **re-gridded** into **0.5x0.5º grid (~CRU data)**

step2: **median** [med(X)] and **std [**std(X)**]** from the 18/14 values in each grid box are derived

step3 (map): the median is represented by a colour, the shape of the symbol represents value of **uncertainty factor Q**:

$$Q = \frac{\text{std}(X)}{\text{med}(X)}$$

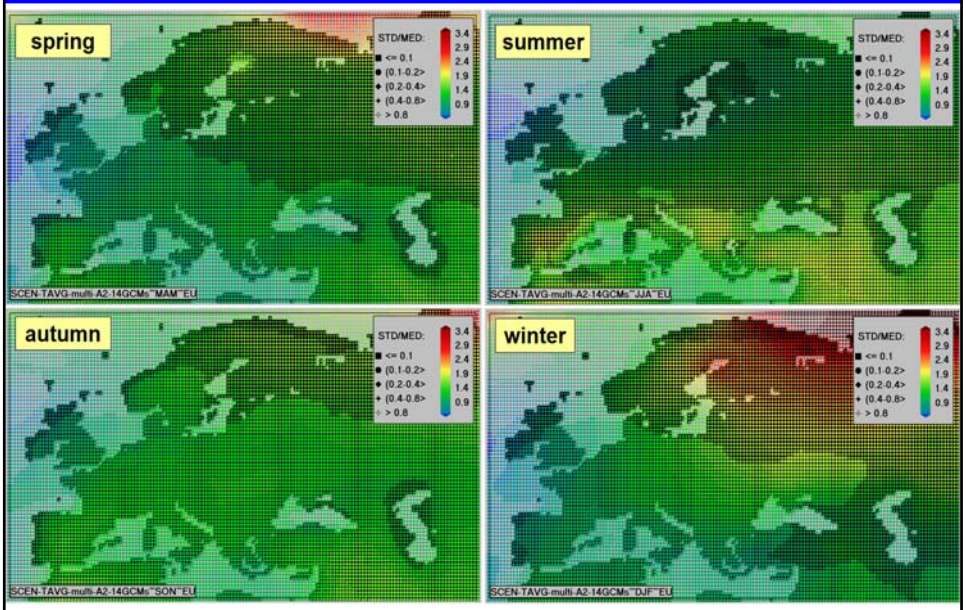


interpreting the uncertainty:

- **squares and circles** [std(X) ≤ 0.5 * median(X)] indicate that med(X) differs from 0 at **significance level higher than 95%** (roughly)
- **4-point stars** indicate **high uncertainty** [std(X) > med(X)]

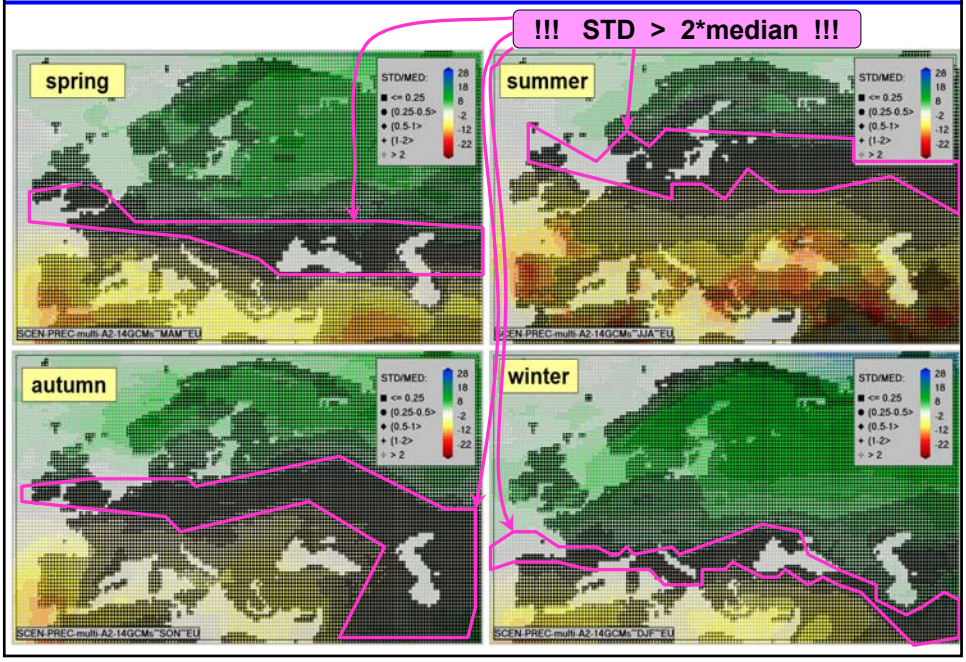
or: the greater is the proportion of grey (over sea) or black (over land) colour, the lower is the significance, with which the median value differs from 0

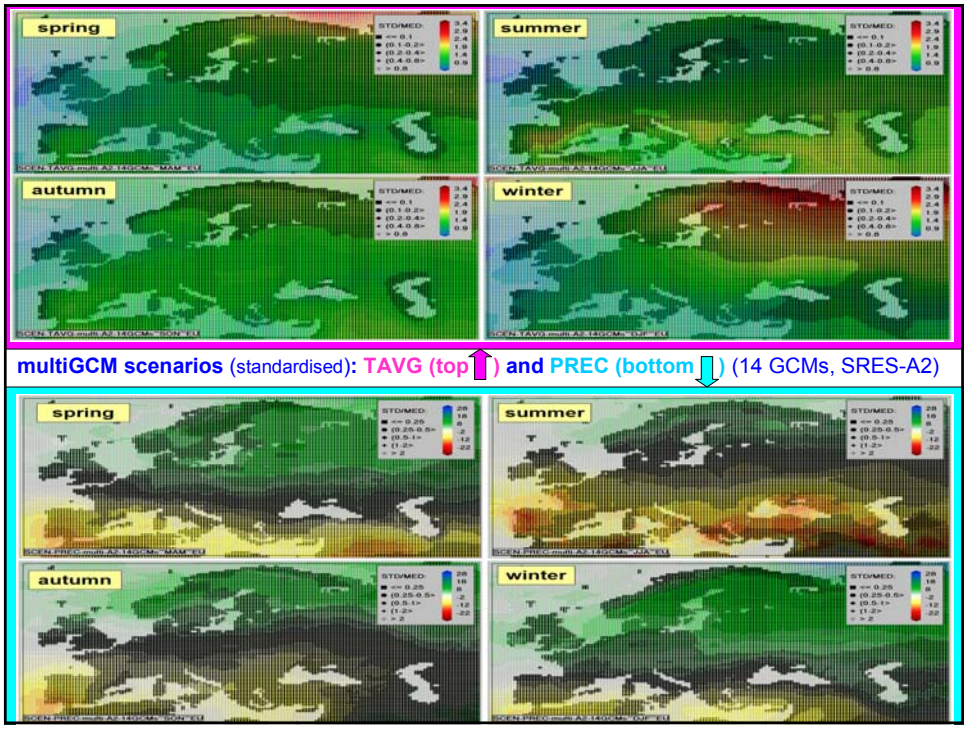
multiGCM scenarios (standardised) :: **TAVG** (14 GCMs, SRES-A2)



nearly whole Europe: STD(ΔT) < 0.4 * median(ΔT)

multiGCM scenarios (standardised) :: **PREC** (14 GCMs, SRES-A2)

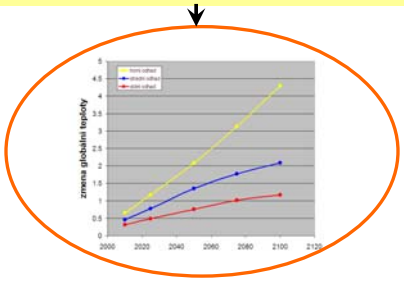




to reflect above uncertainties, we typically use combination of 3 ΔT_G x 3 GCMs:

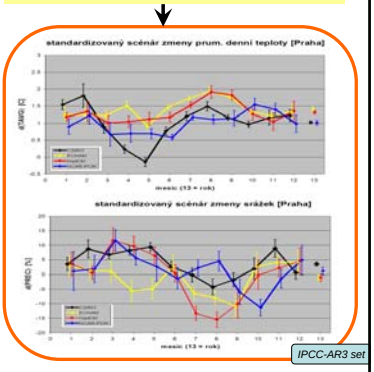
- **uncertainty in ΔT_G (modelled by MAGICC):**

	emissions	clim.sensitivity
high scenario:	SRES-A2	4.5 K
low scenario:	SRES-B1	1.5 K
middle scen.:	middle	2.5 K



X

- **uncertainty in pattern:** set of GCMs



preferred GCMs:
- HadCM3
- NCAR-PCM
- ECHAM5

…… + Arpege

+ natural variability (day-to-day, year-to-year) **is modelled by WG**

…. now we have outputs from RCM.
Q: How to implement it in our impact studies?

A. direct output from RCM run at given emission scenario? ... NO.

- **It does not reproduce real-climate weather characteristics** (annual cycle, temporal structure, …)
- **we do not have enough RCM simulations to account for uncertainties** (in emissions, in climate sensitivity, between GCMs)

B. using our methodology but with RCM instead of OBS …results: Friday

- **present climate:** WG calibrated with RCM output (driven by ERA-40 reanalysis)
- **future climate:** WG is modified according to GCM-based scenario

problem:

- RCM does not have a satisfactory statistical structure (next slides)

RCM vs. OBServations (station data)

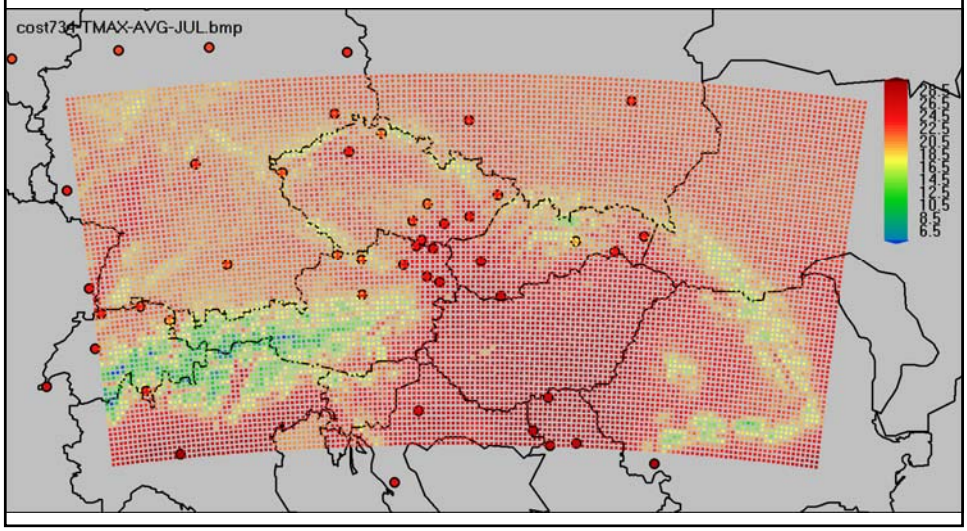
(via WG parameters)

Acknowledgement: European station data for RCM validation were provided by the COST734 project

RCM vs OBS: TMAX(July)

- **RCM:** Aladin driven by ERA-40
- **observations:** COST-734 database

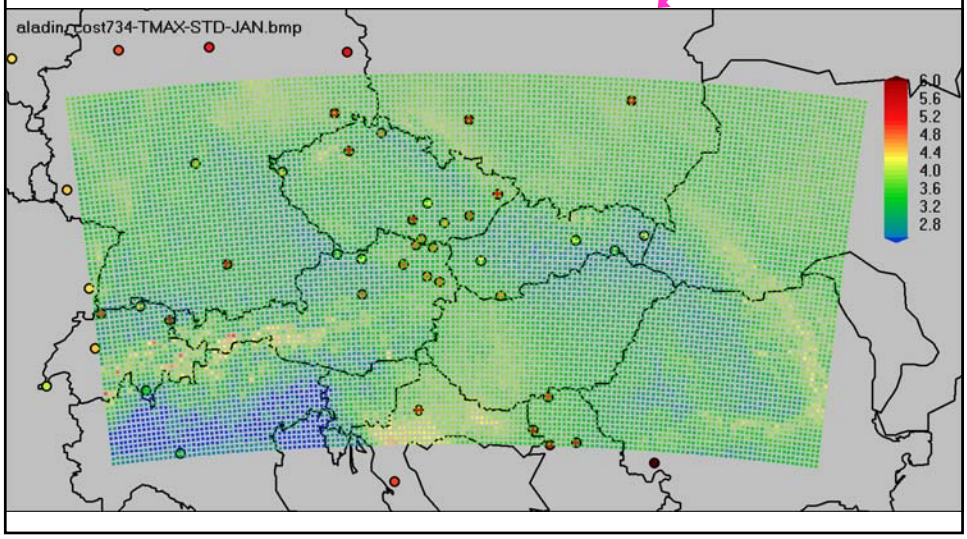
RCM ~ OBS



RCM vs OBS: std(TMAX) [JAN]

- **RCM:** Aladin driven by Reanalysis
- **observations:** COST-734 database

RCM < OBS



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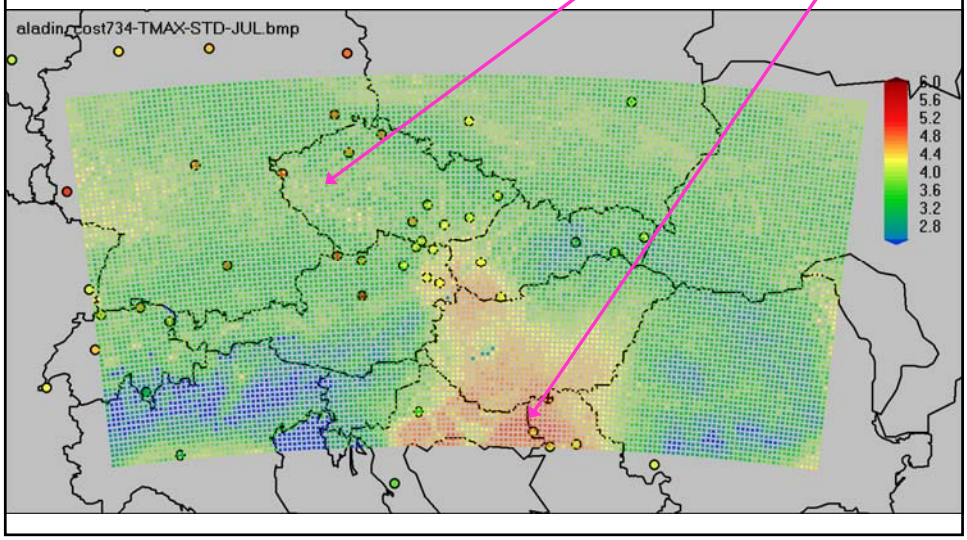
RCM < OBS … RCM > OBS



RCM vs OBS: PREC(avg.daily sum) [JUL]

- **RCM:** Aladin driven by ERA-40
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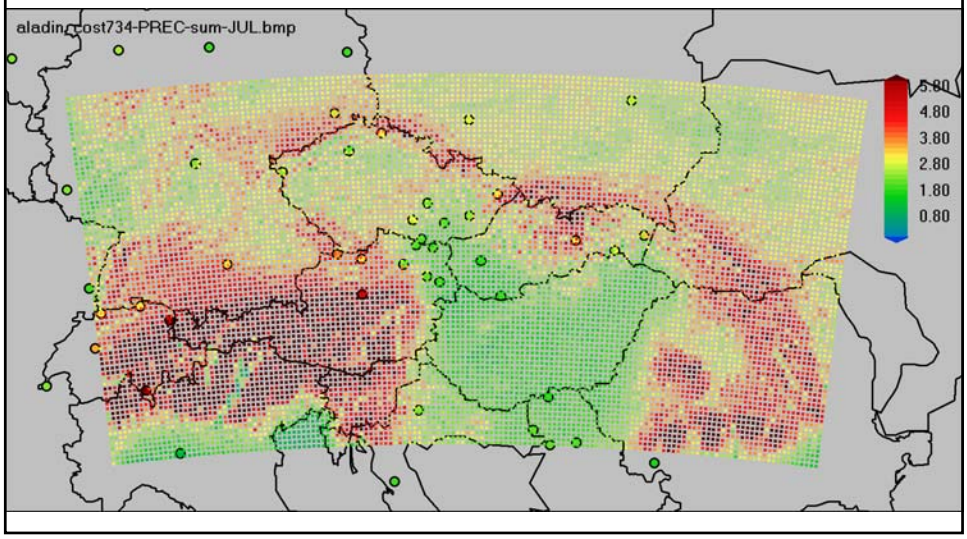
RCM ~ OBS



RCM vs OBS: prob(PREC>0) [JUL]

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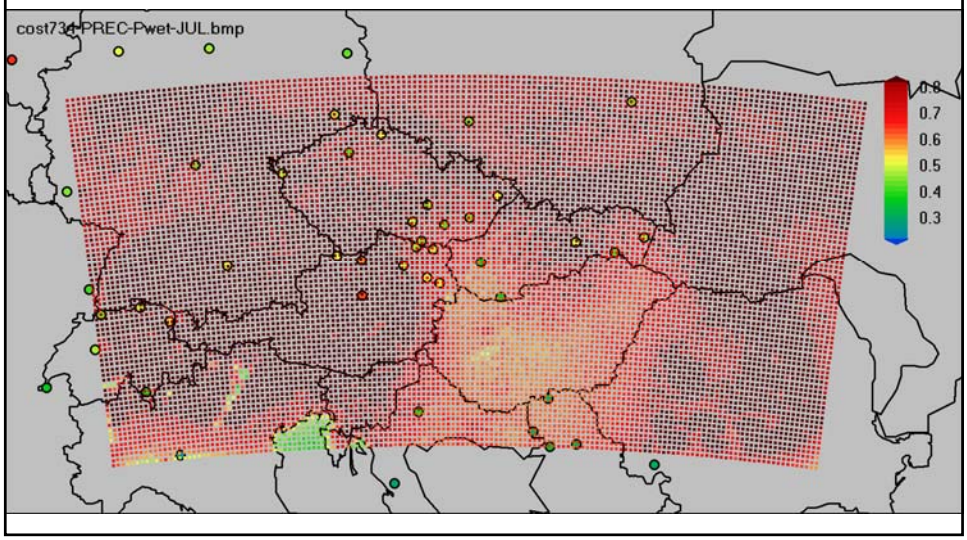
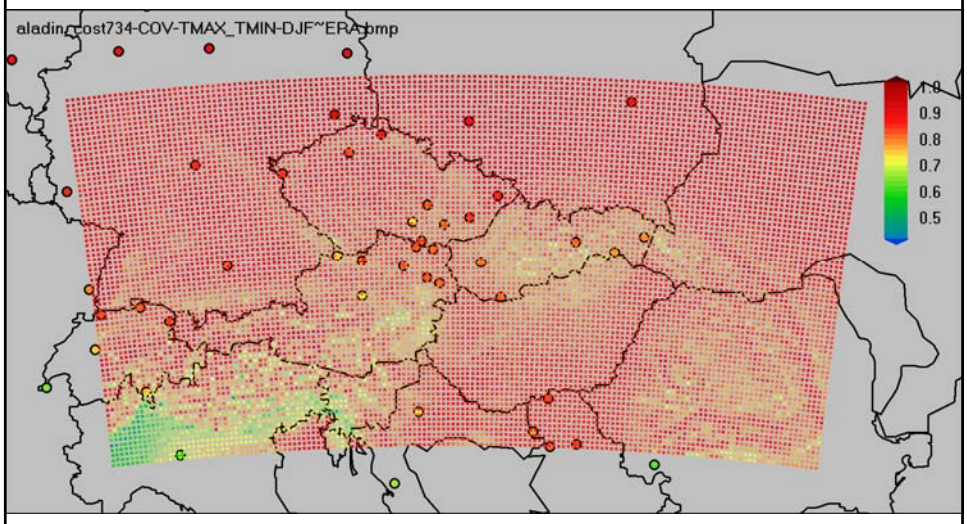
RCM >> OBS !



RCM vs OBS: cor(TMAX,TMIN) [JAN]

- **RCM:** Aladin driven by Reanalysis
- **observations:** COST-734 database

RCM ~ OBS



RCM vs OBS: cor(TMAX,TMIN) [JUL]

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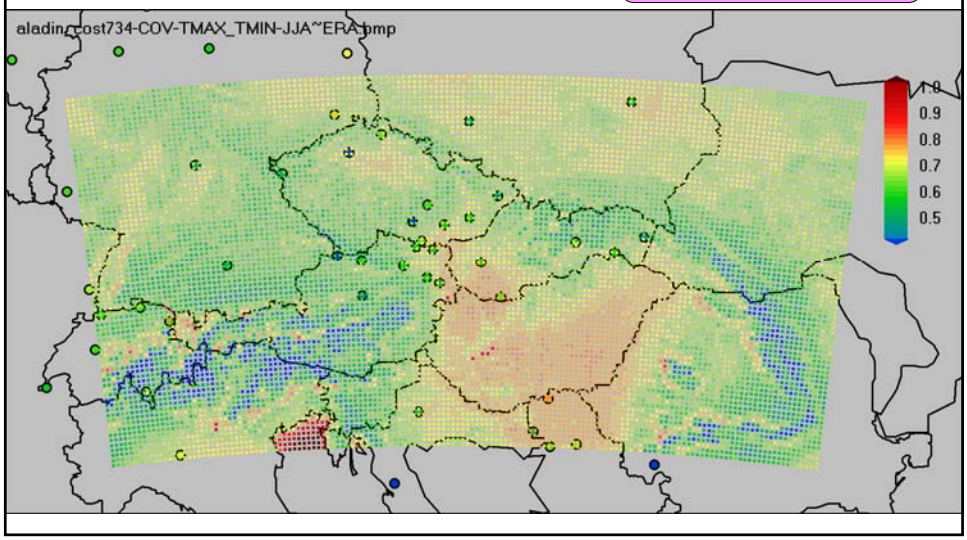
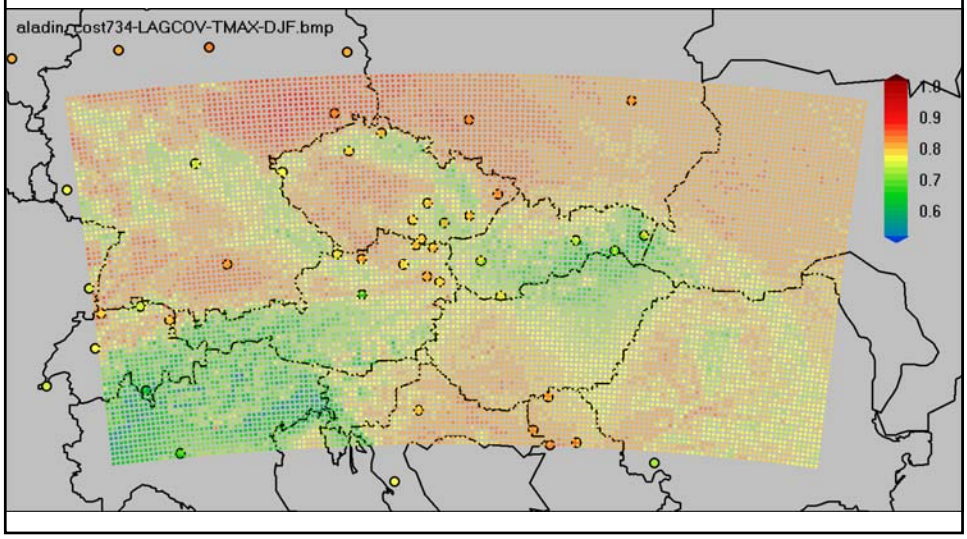
RCM > OBS
(RCM overestimates cor(Tx,Tn))



RCM vs OBS: autocor(lag=1day) (TMAX) [JAN]

- **RCM:** Aladin driven by Reanalysis
- **observations:** COST-734 database

RCM < OBS (in most stations)



RCM vs OBS: autocor(lag=1day) (TMAX) [JUL]

- **RCM:** Aladin driven by Reanalysis
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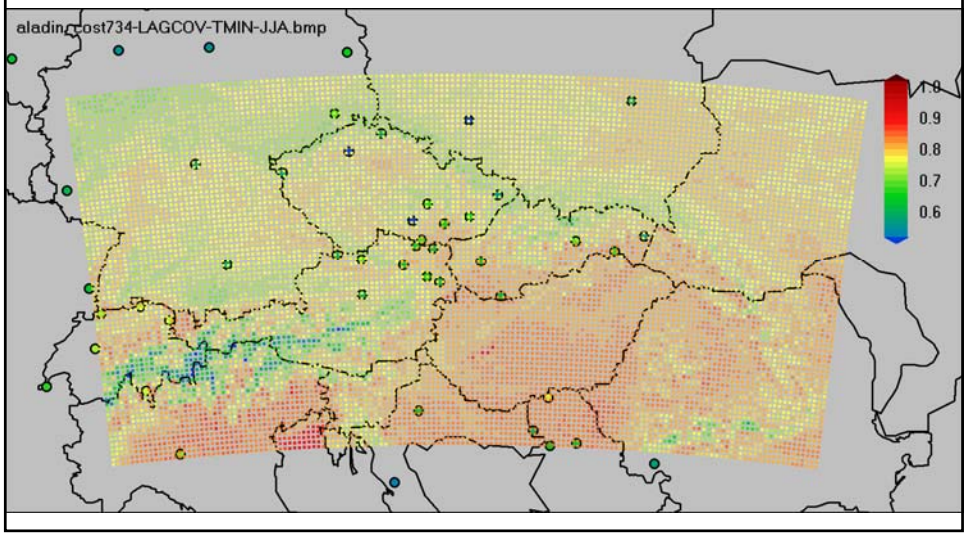
RCM > OBS
(RCM overestimates lag-1-cor(Tx))



RCM vs OBS: autocor(lag=1day) (TMIN) [JAN]

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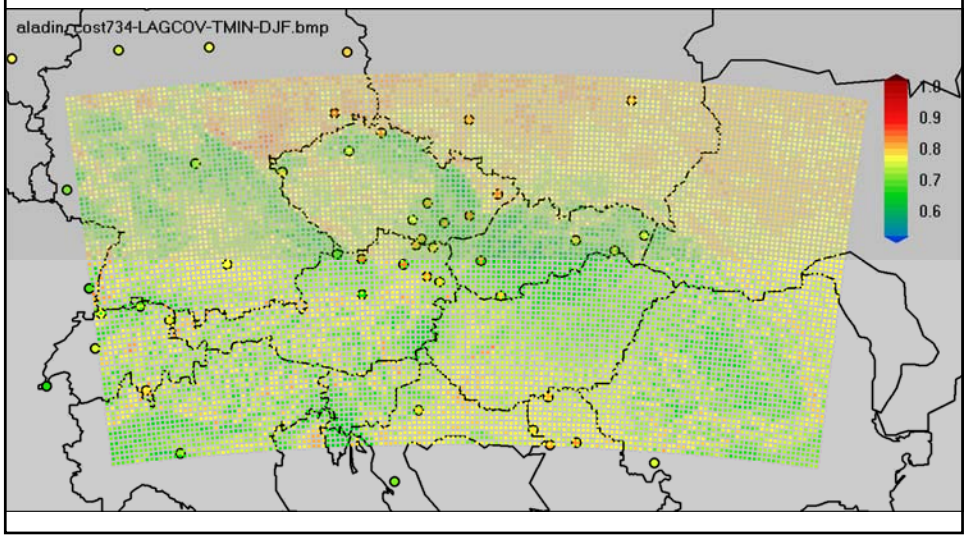
RCM < OBS



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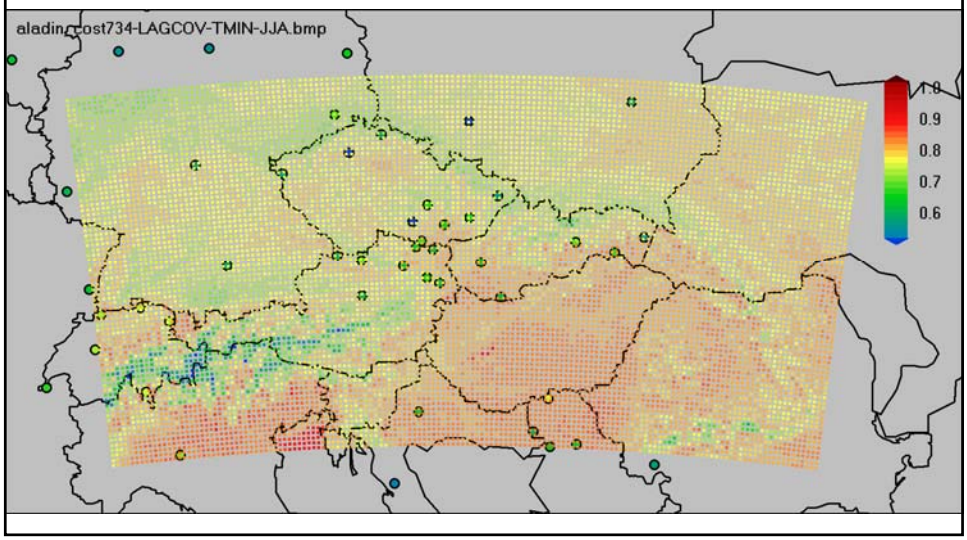

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C. the methodology under development:
- **to correct systematic errors in RCM output:** WG parameters calibrated from RCM is corrected with (OBS-RCM) bias (RCM = dynamical interpolator WG)
- **to account for the sub-GCM-grid information on scenario from RCM:** adding RCM-GCM increment to GCM-based scenarios (interpolated to RCM grid)

conclusion

results (using WG calibrated with RCM + GCM-based scenarios)**:**

..... **tomorrow (?)**

testing the new methodology (RCM-calibrated WG + [OBS-RCM] correction):

..... **future**

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