CONSORTIUM FOR SMALL SCALE MODELING

COSMO

LAM-EPS developments in COSMO

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Outline

- consortium ensemble -> COSMO-LEPS
- development of Convection Permitting ensembles
  - KENDA-derived IC perturbations
  - SPPT
  - stochastic physics
  - soil perturbations
- verification
  - benefit of the CP ensembles

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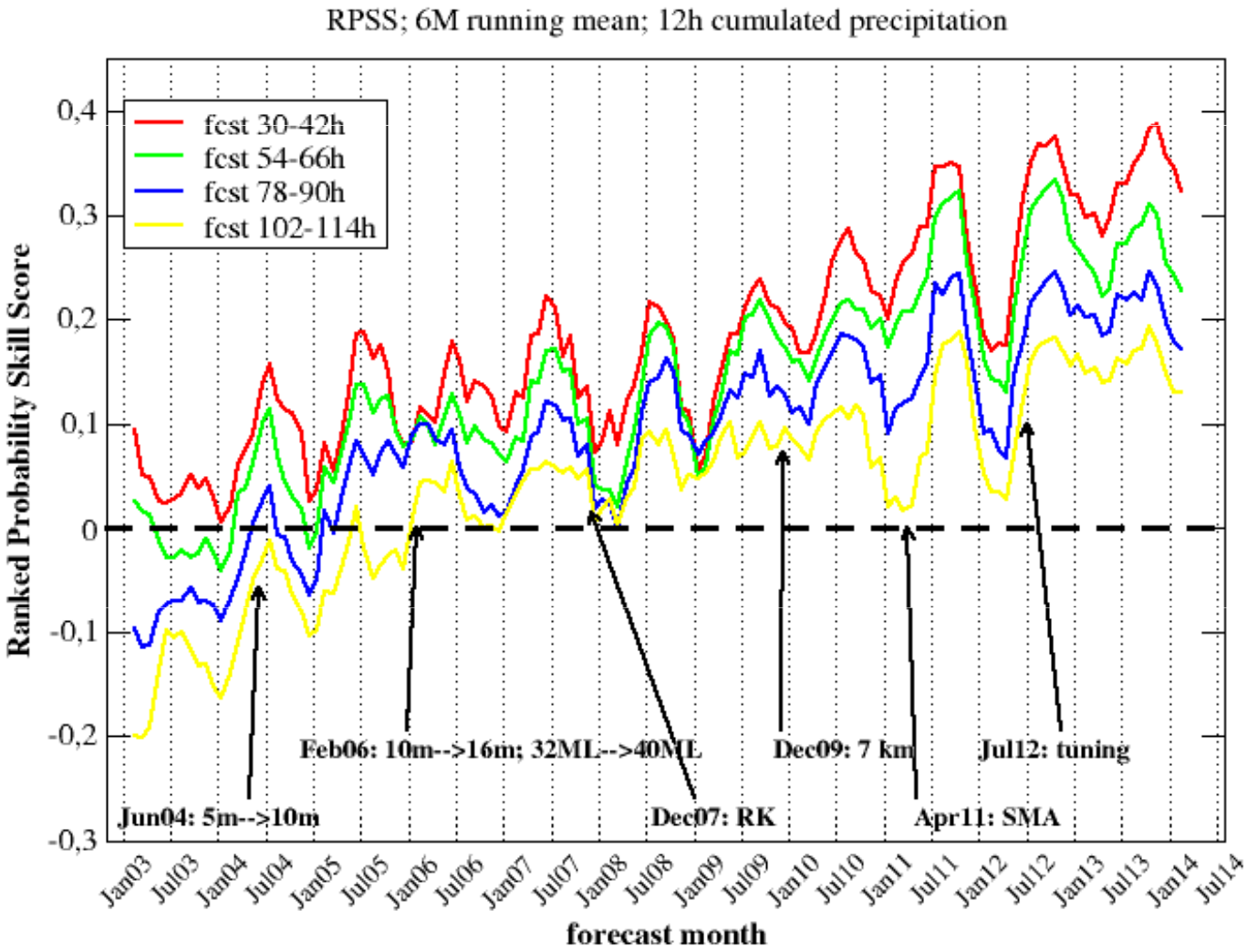
COSMO-LEPS

Ranked Probability Skill Score (RPSS)
12h precipitation - whole domain



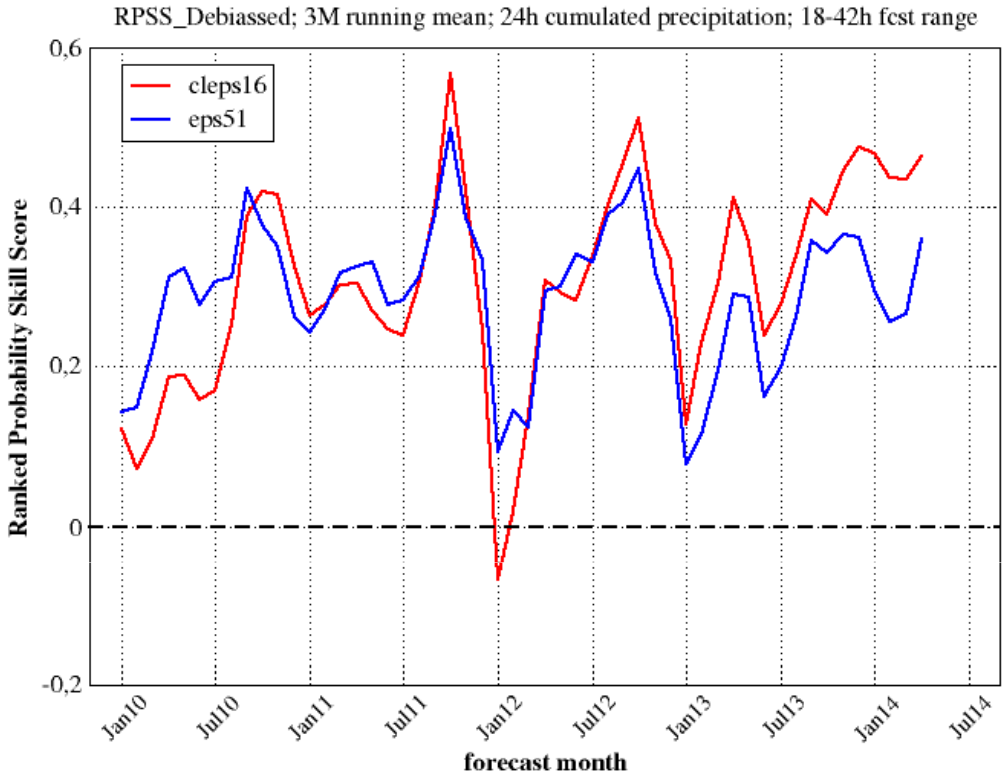
COSMO-LEPS

Time series of Ranked Probability Skill Score maximum values (boxes 1.0 X 1.0) – 18-42h

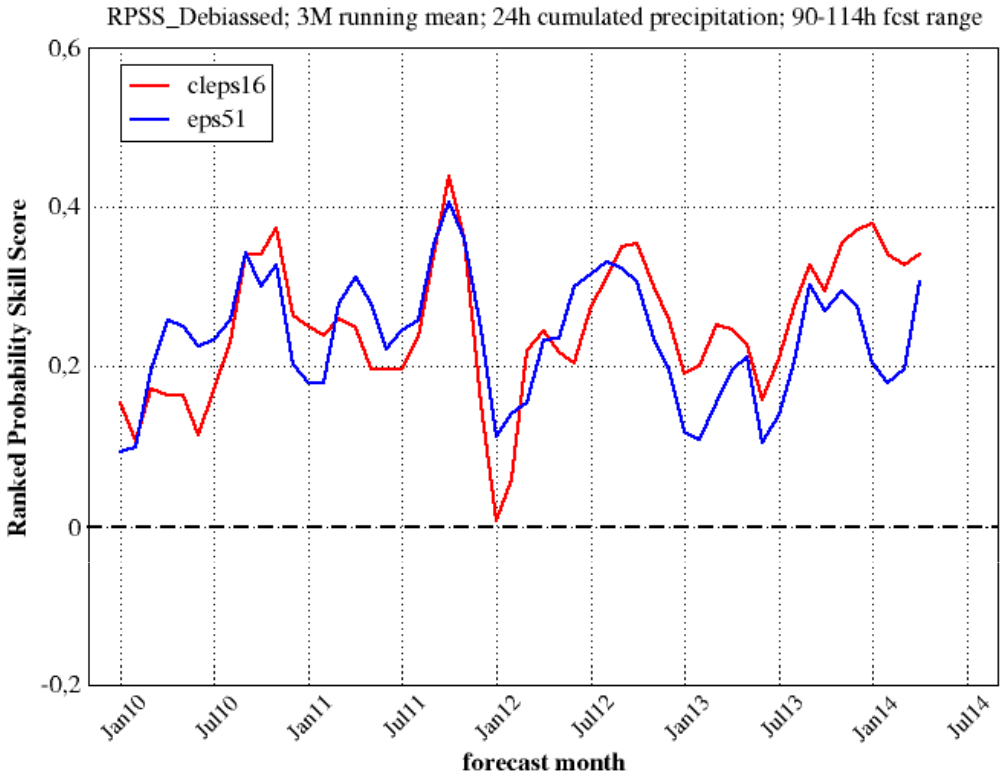
COSMO-LEPS 16 members

ECMWF ENS 51 members

18-42h



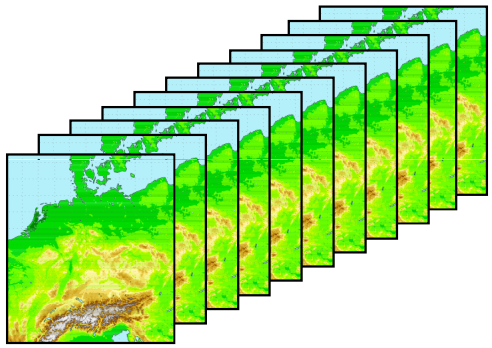
90-114h

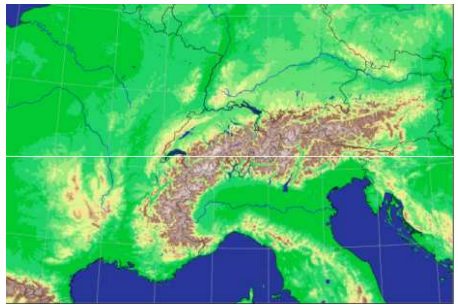


- Seasonal cycles of the scores; worse performance in winters, possibly related to the presence of snow (some stations are not heated).
- ECMWF-EPS had initially higher scores; then, COSMO-LEPS has had higher scores than ECMWF-EPS since 2013 despite the lower ensemble size

Development of CP ensemble systems in COSMO

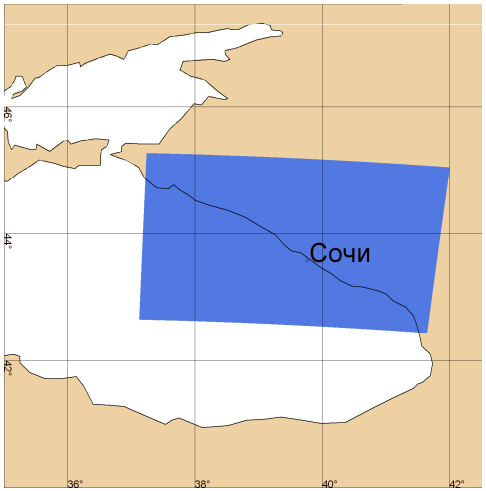
COSMO-DE-EPS, DWD -> operational since 2012

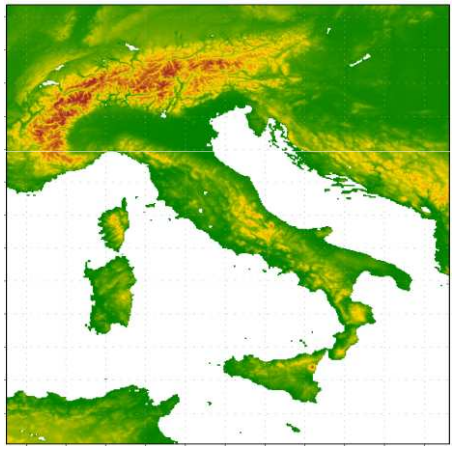




COSMO-E, MCH -> under development

COSMO-RU2-EPS, RHM -> running during the Sochi Olympics





COSMO-IT-EPS, IT -> under development

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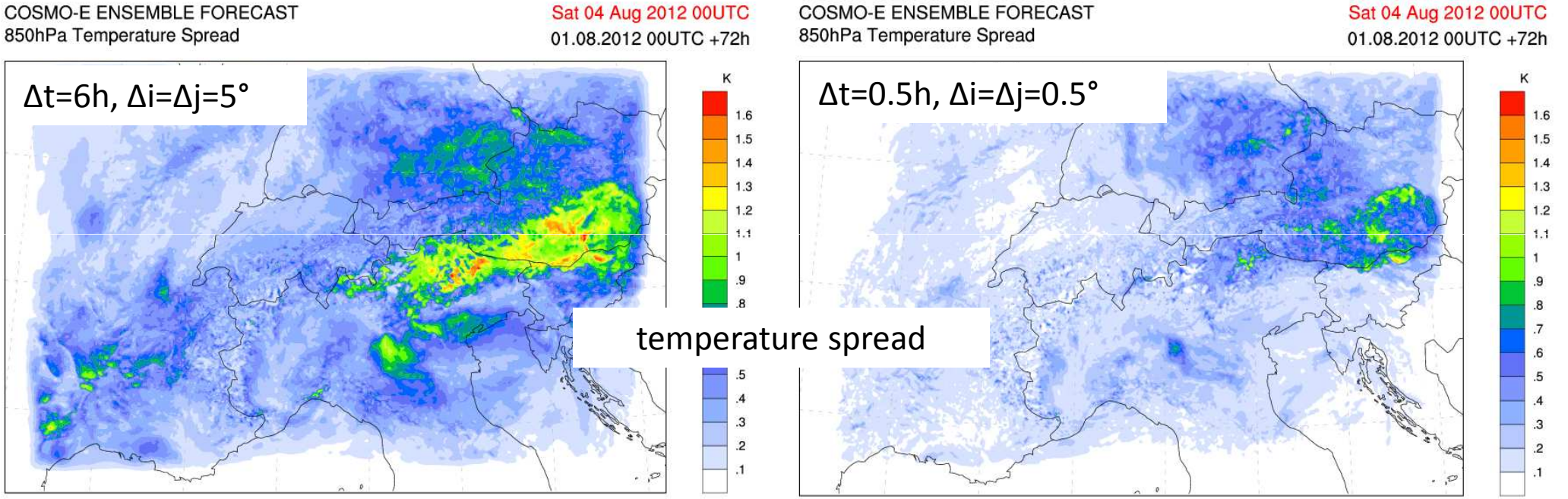
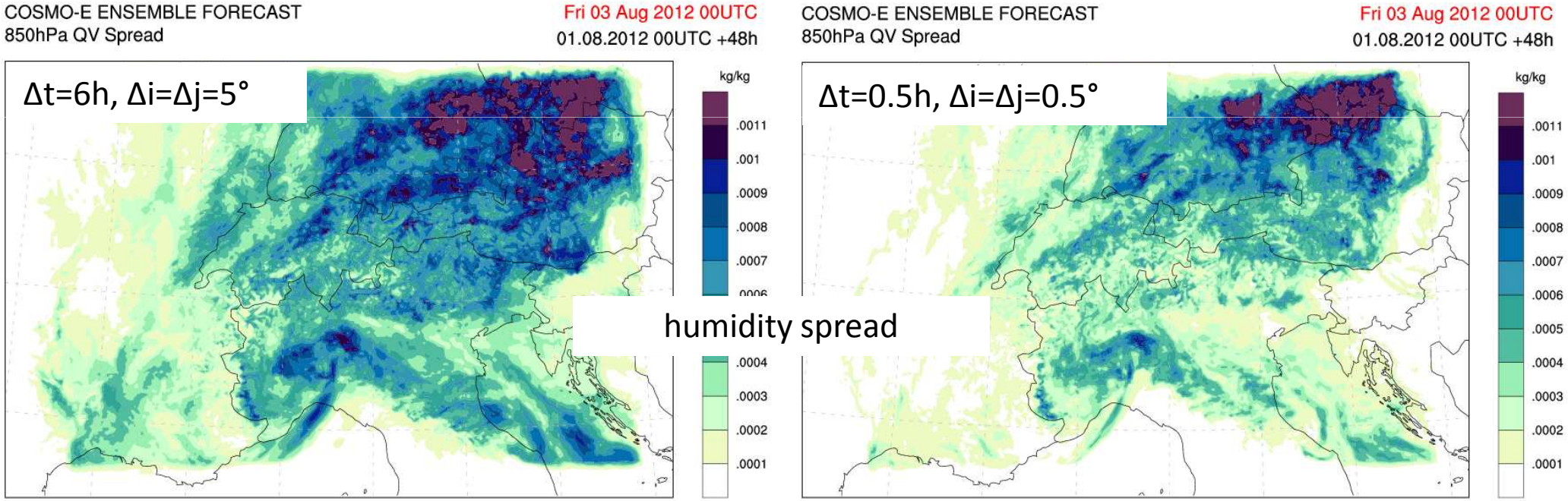
COSMO-E - SPPT Sensitivity

01.08.2012

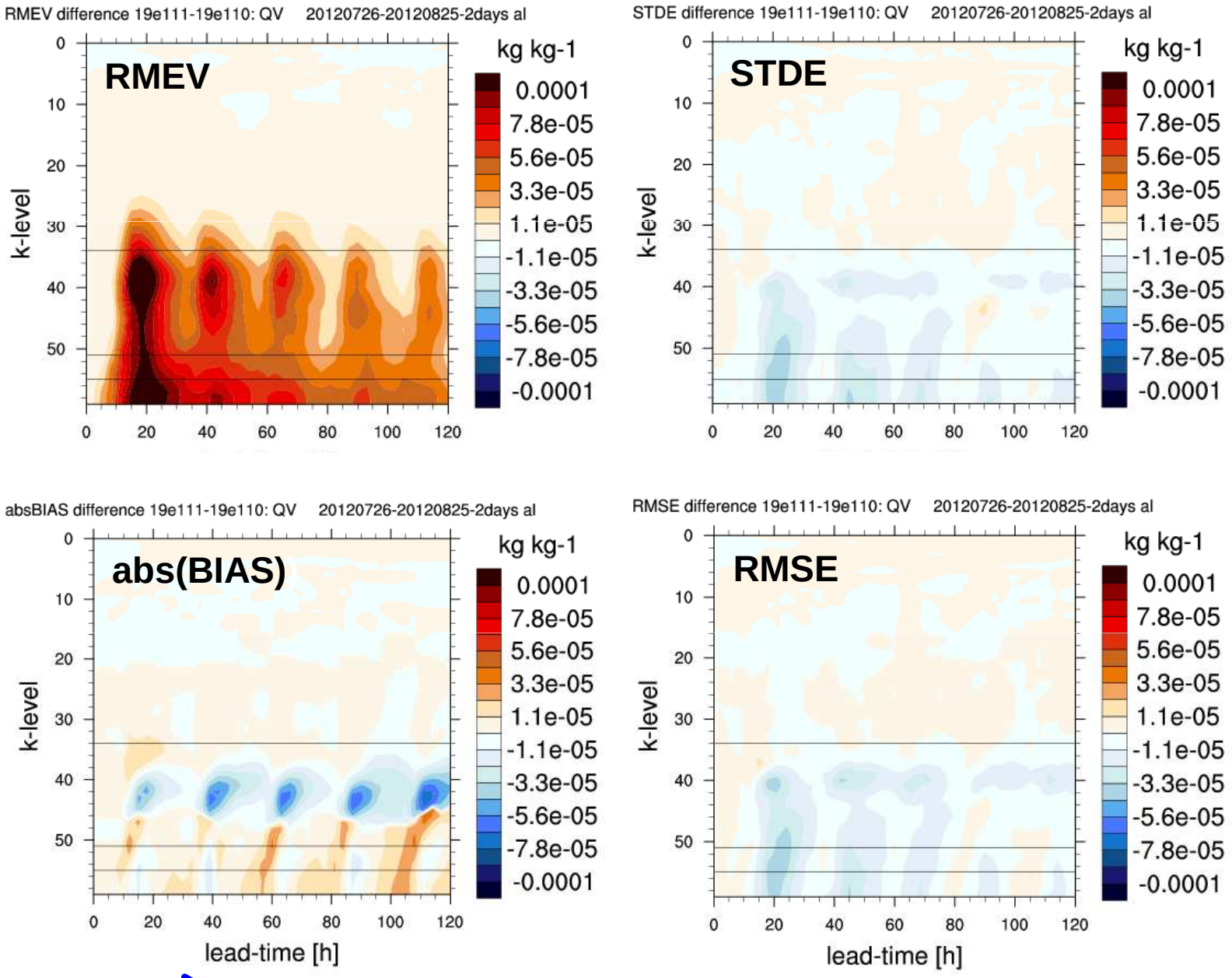


temperature spread



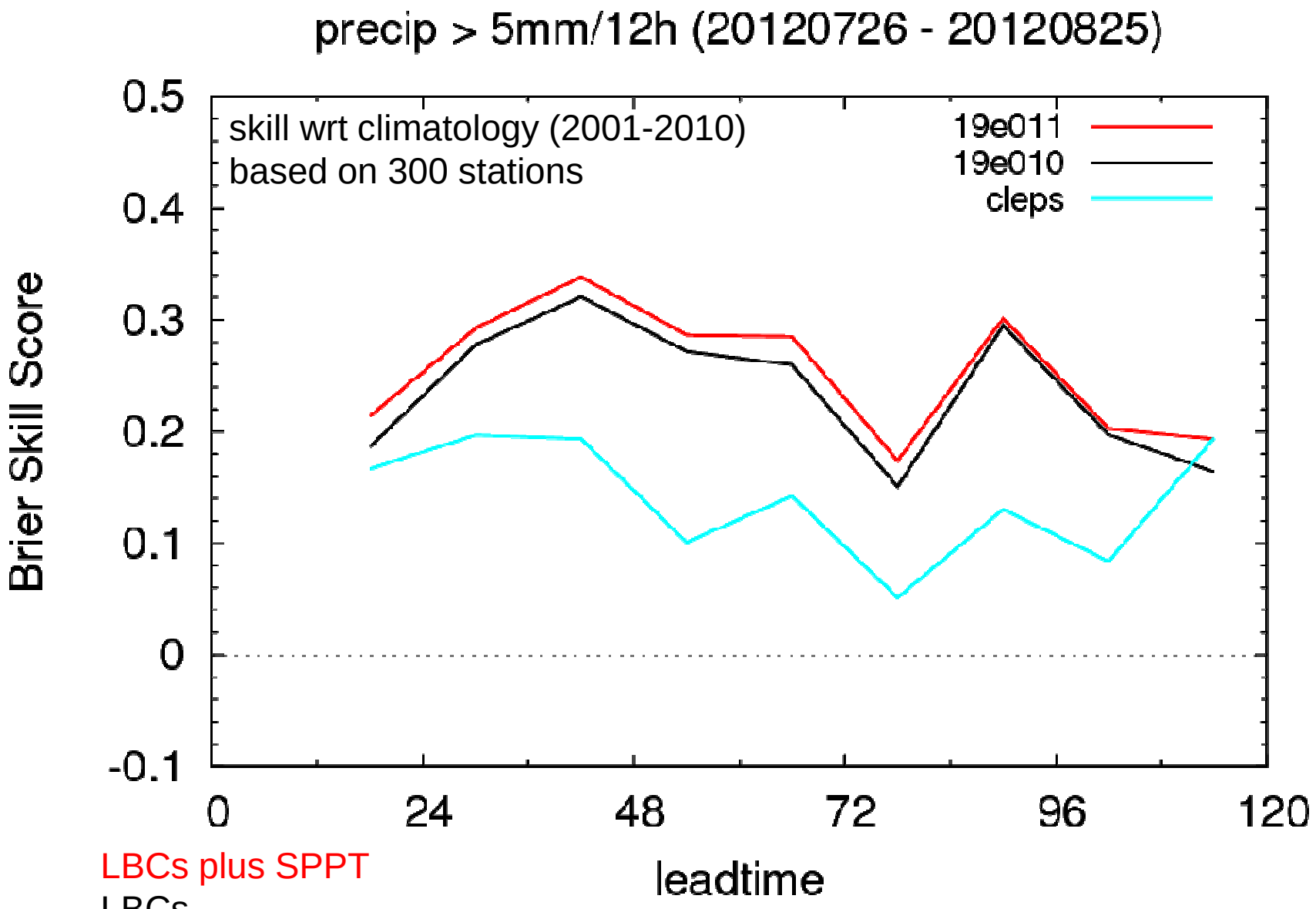
humidity spread

SPPT spread / error: QV, 19e111-19e110



COSMO-E - SPPT

Brier Skill Score for 12h precip, > 5mm/12h, Aug



LBCs plus SPPT

LBCs

COSMO-LEPS

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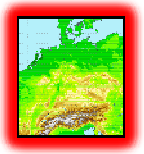
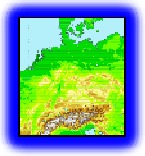
COSMO-DE-EPS

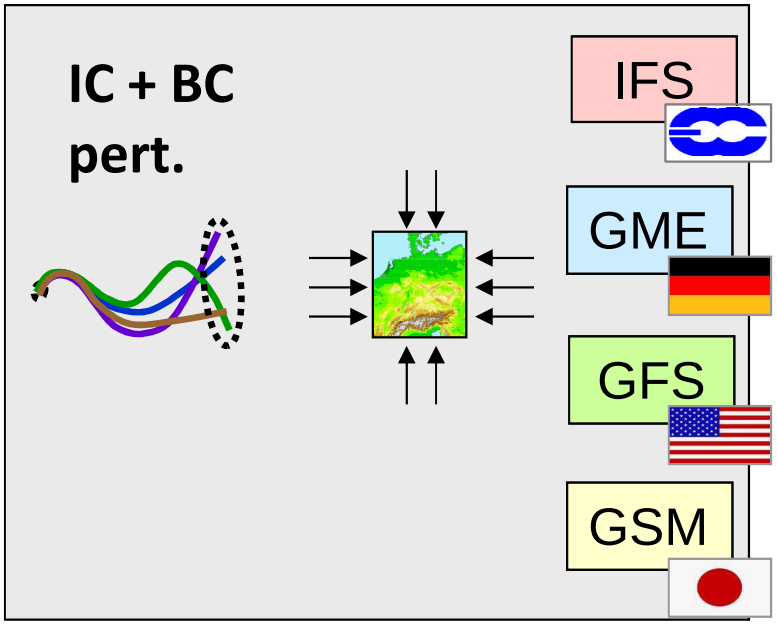
± half the difference between C-EU and C-DE soil moisture in all layers but the lowest

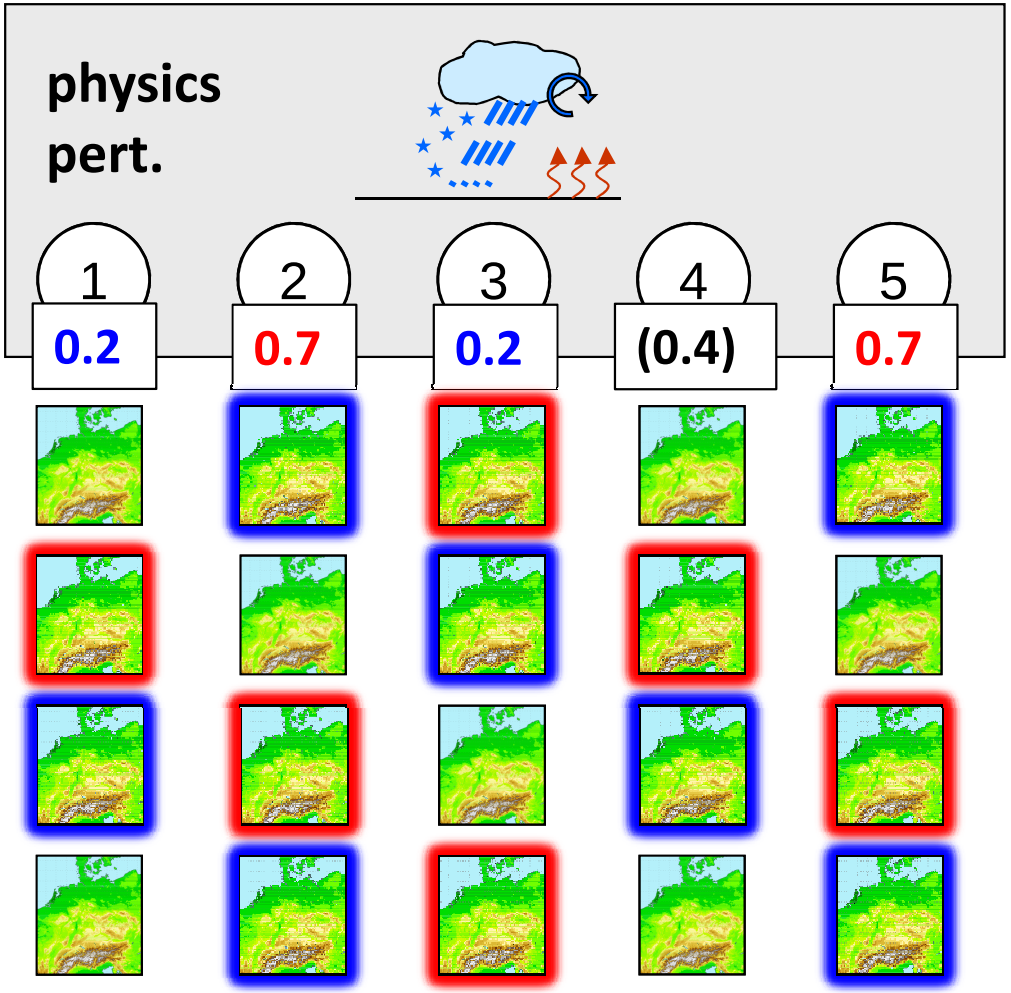


„+“ soil moisture anomaly



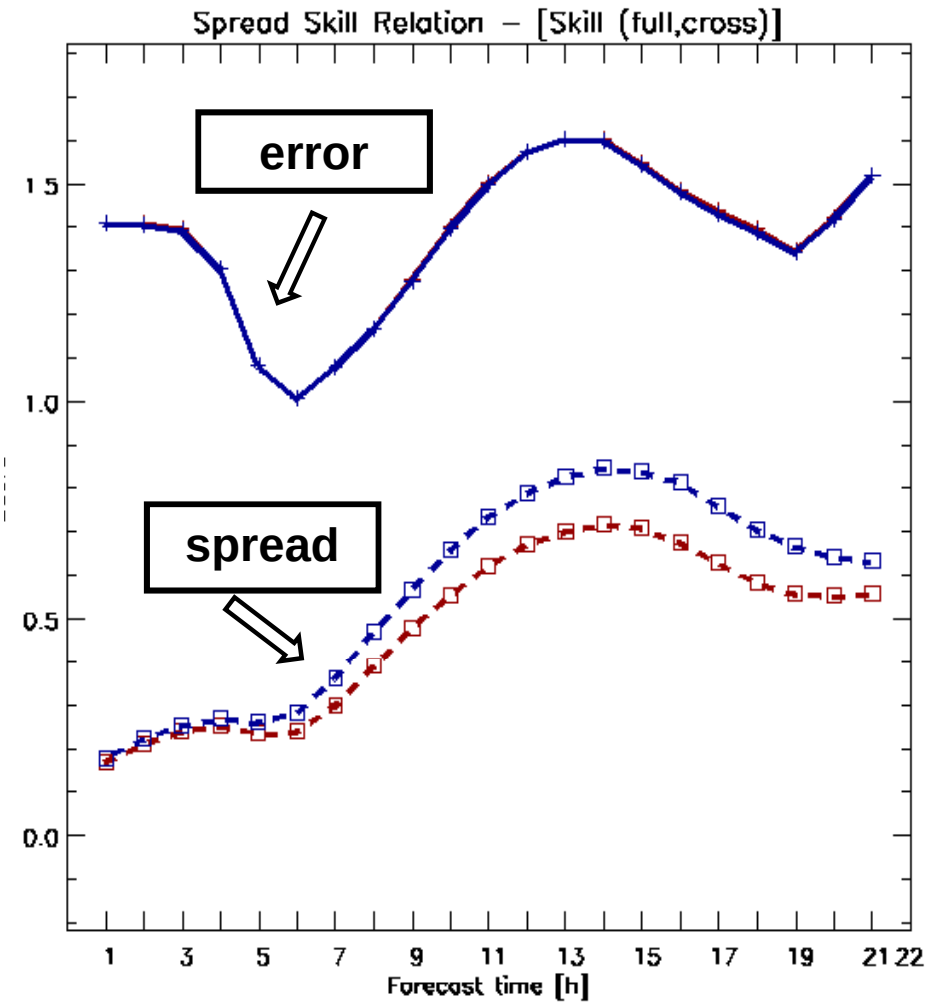
„-“ soil moisture anomaly





COSMO-DE-EPS

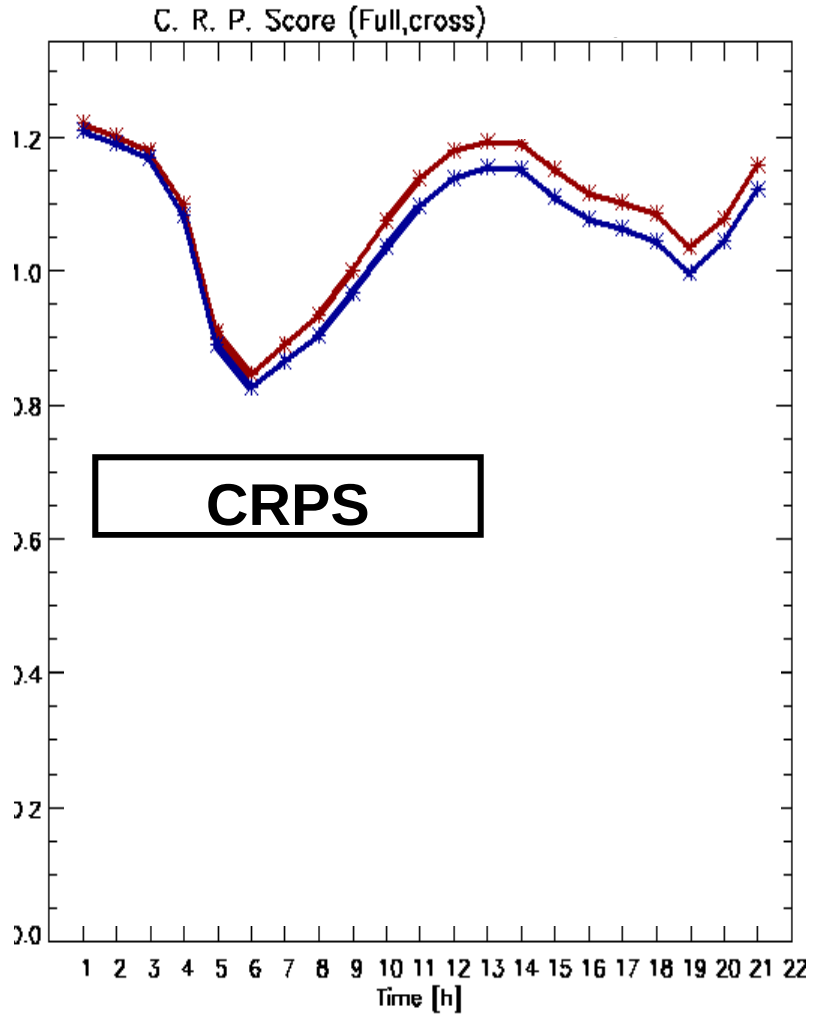
Perturbation of soil moisture

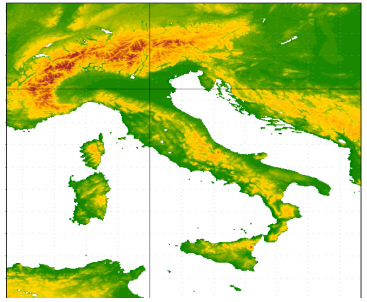


2m temperature

perturbed soil moisture

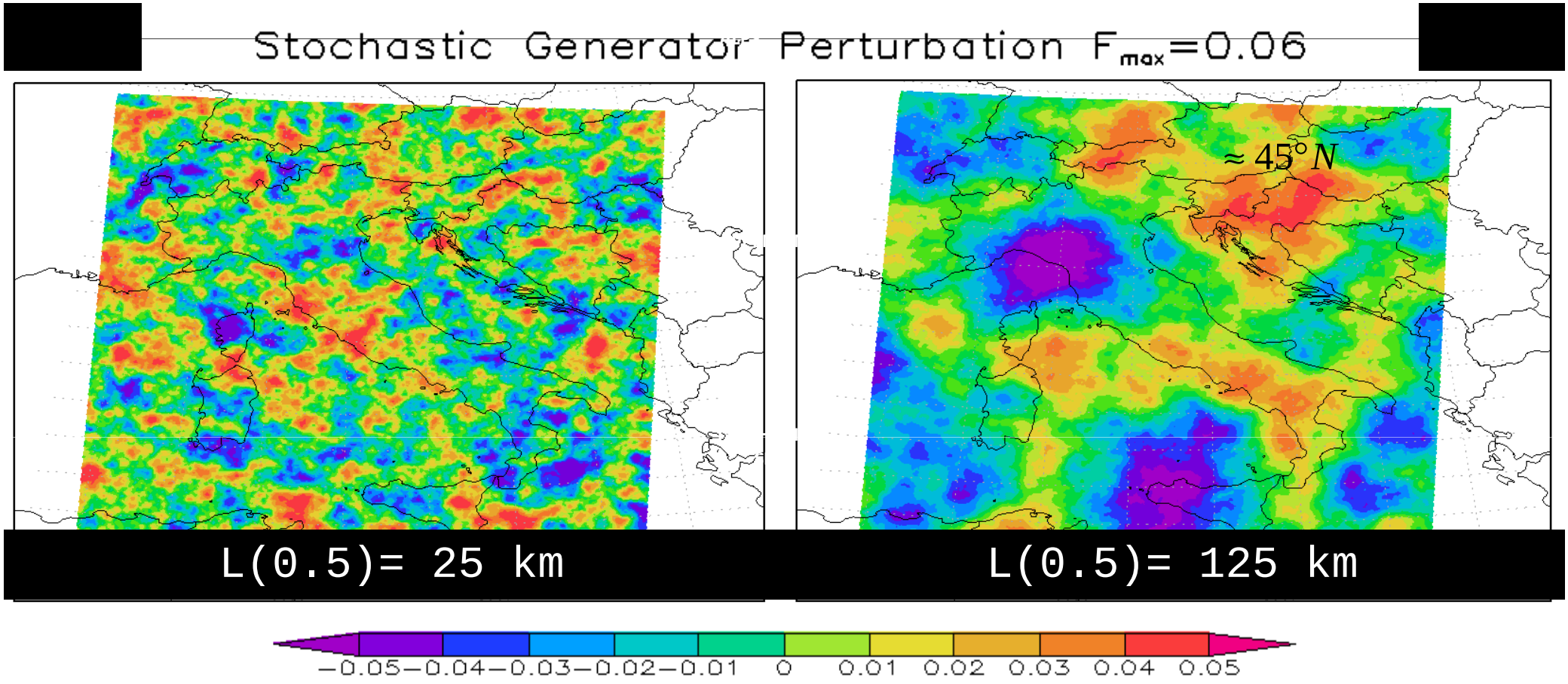
reference





Soil perturbation: pattern generator

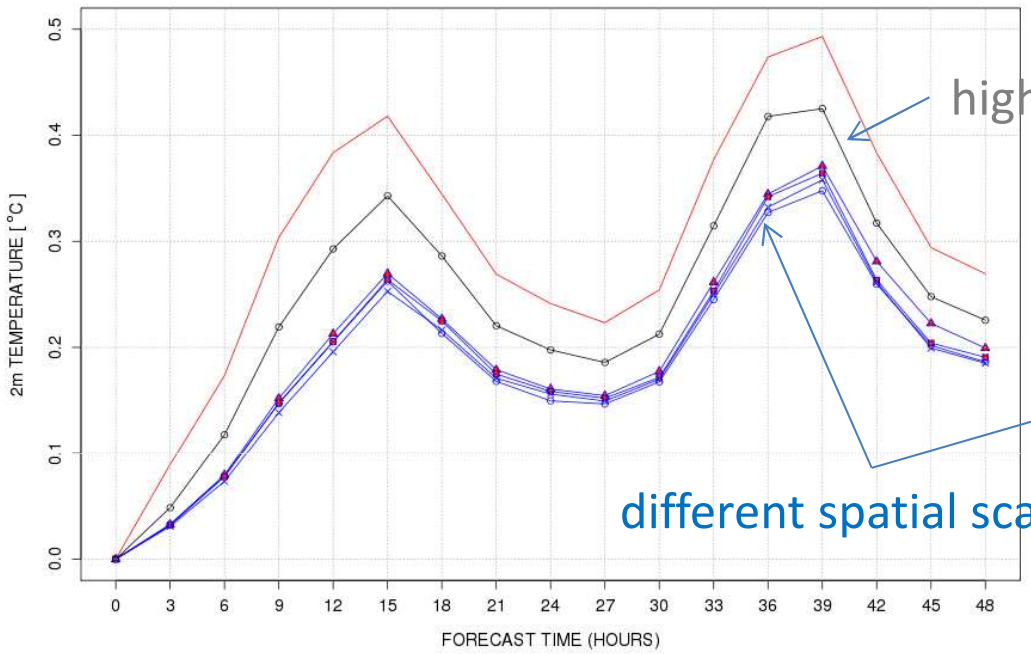
L(0.5) is defined as the distance at which the correlation function falls to 0.5. The value of L(0.5) has to be set in the configuration file to determine λ.



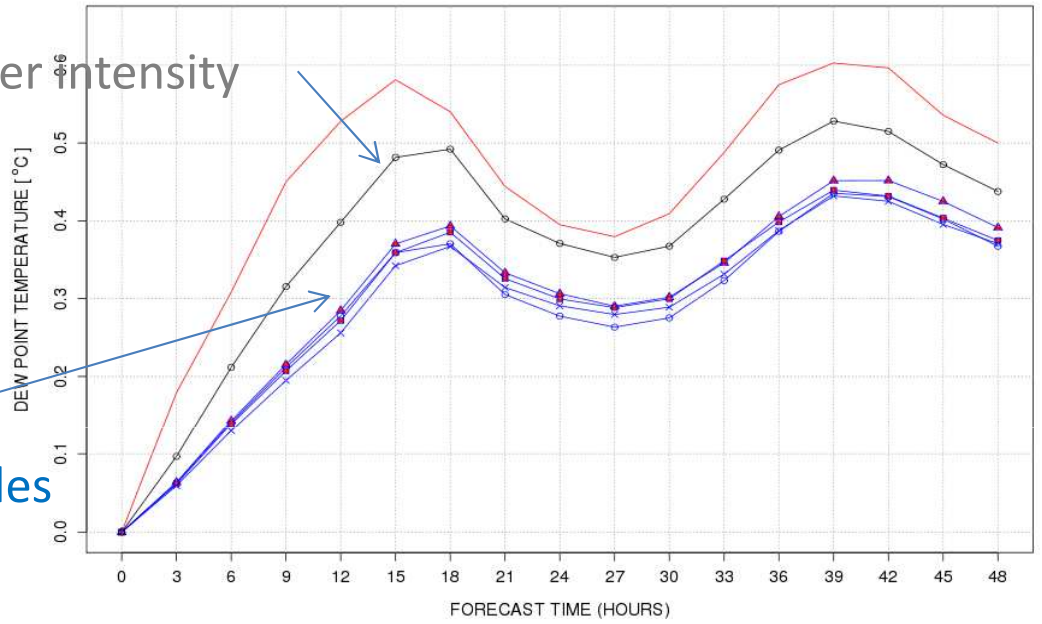
Soil perturbation: sensitivity

case study: 29/06/2011

2m TEMPERATURE [°C]



DEW POINT TEMPERATURE [°C]



higher intensity

different spatial scales

sensitivity test

F_{max} = 0.06, L(0.5) = 25 km

F_{max} = 0.06, L(0.5) = 125 km

F_{max} = 0.06, L(0.5) = 225 km

F_{max} = 0.06, L(0.5) = 425 km

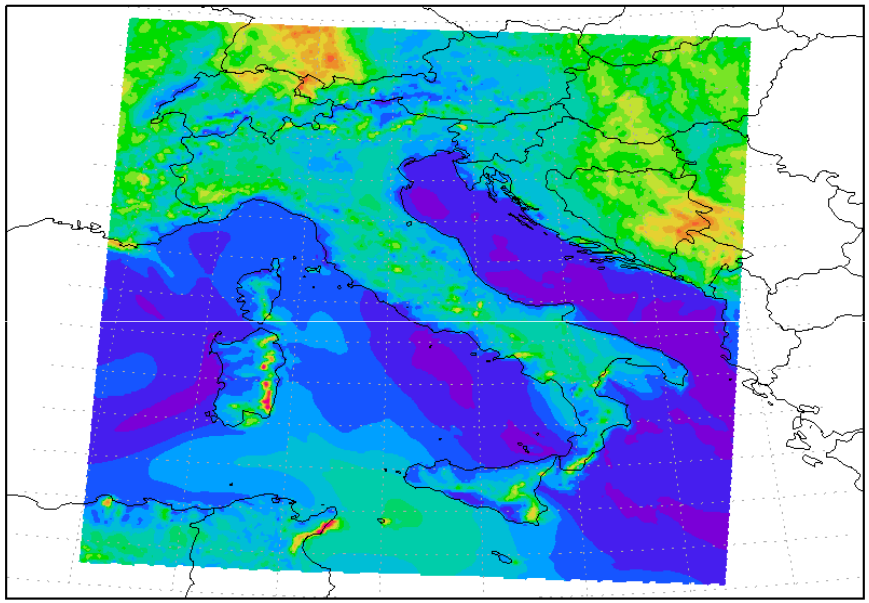
F_{max} = 0.08, L(0.5) = 125 km

PIEMONTE Arpa Agenzia Regionale per la Protezione Ambientale

Spread w.r.t. COSMO-LEPS - 2m Temperature

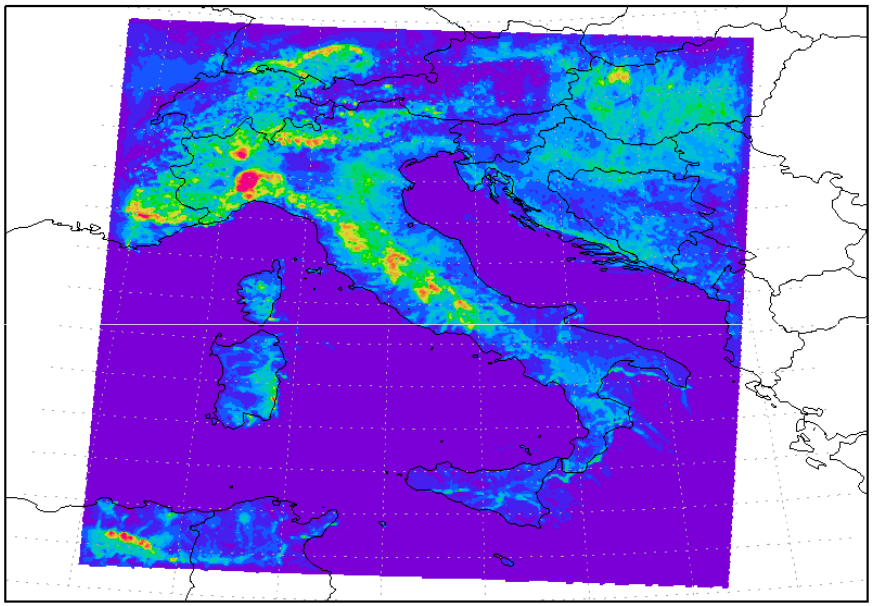
COSMO LEPS – run 28062011 12 UTC

T 2m std [K] 29JUN2011 15UTC

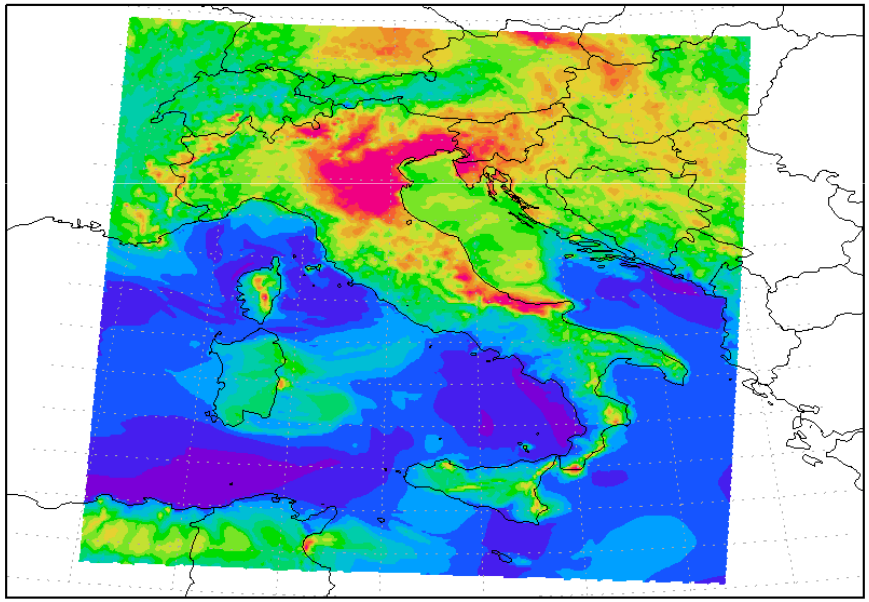


W_SO pert. – $F_{max\ surf}$ = 0.08 $m^3\ m^{-3}$, L(0.5) = 125 km

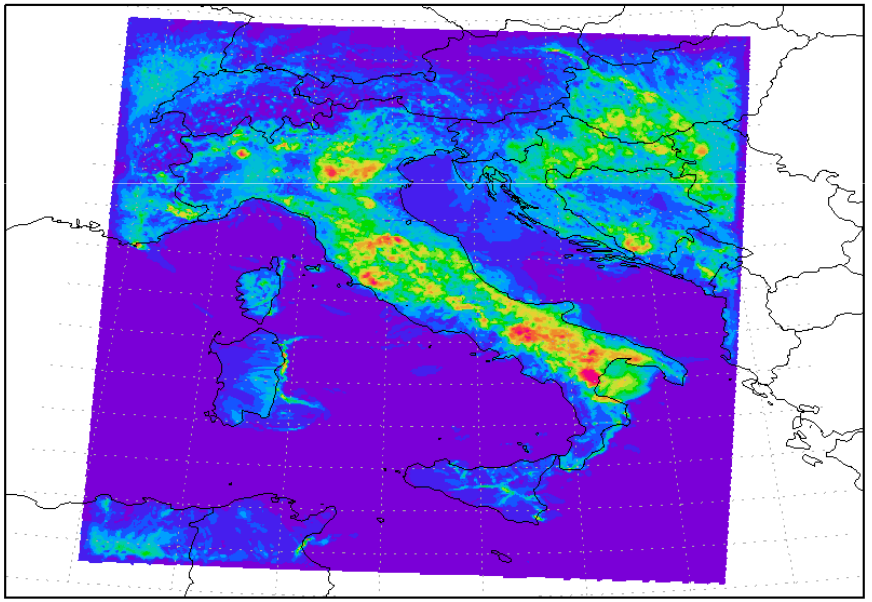
T 2m std [K] 29JUN2011 15UTC

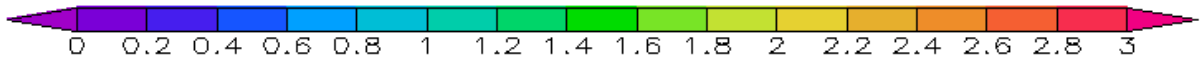


T 2m std [K] 30JUN2011 15UTC



T 2m std [K] 30JUN2011 15UTC





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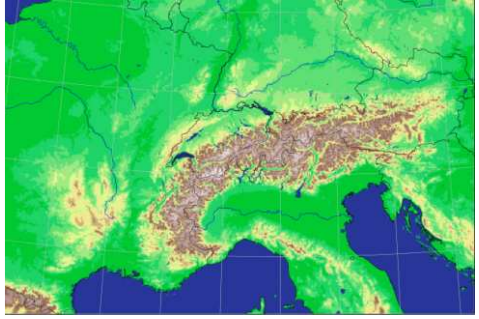
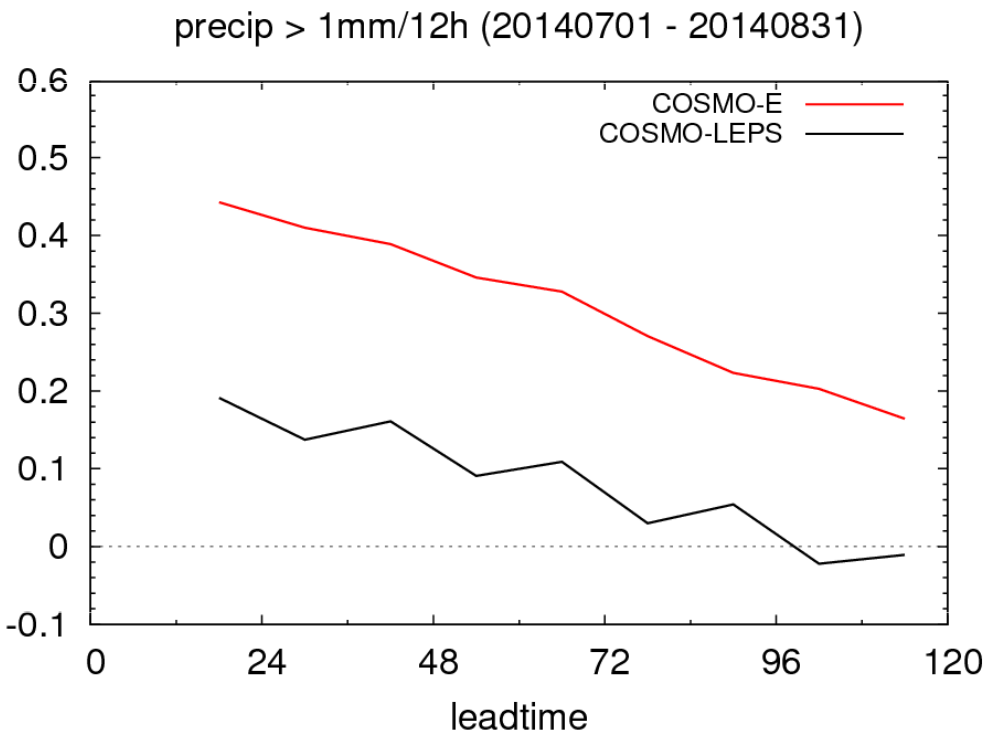
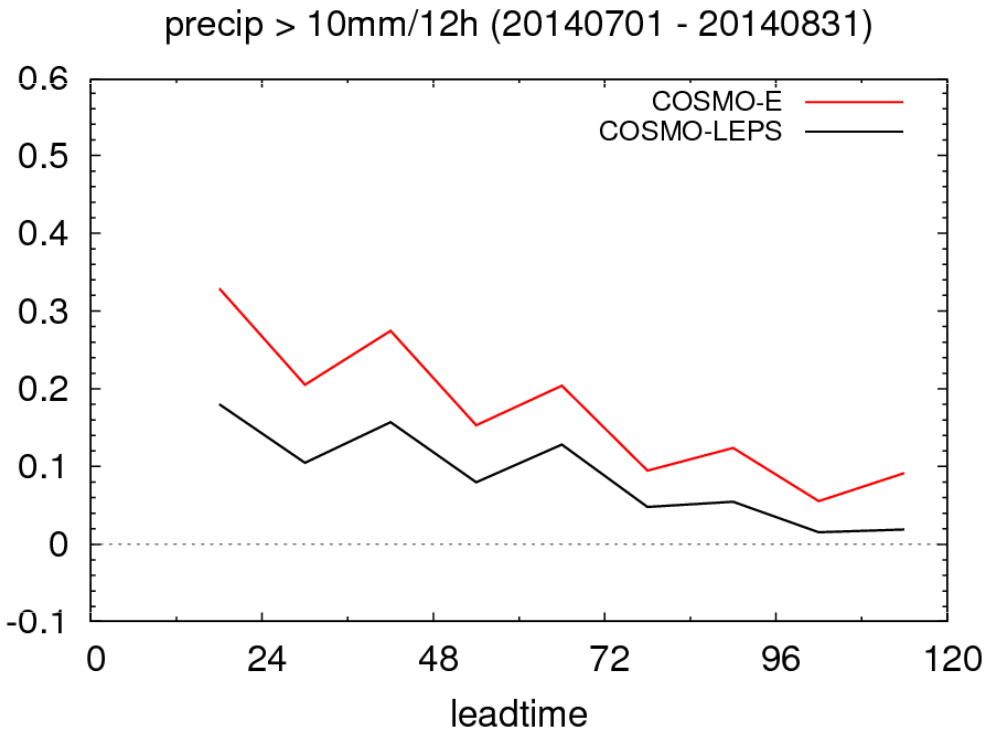


COSMO-E

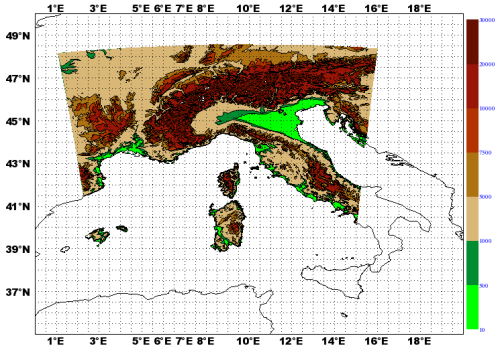
12 precipitation - Brier Skill Score (BSS)

COSMO-E
COSMO-LEPS





- 2.2 km mesh-size, 60 vertical levels
- 21 members, forecasts up to +120h
- LBC: IFS-ENS (members 0-20)
- model errors: Stochastic Perturbation of Physical Tendencies (SPPT)
- 2 months

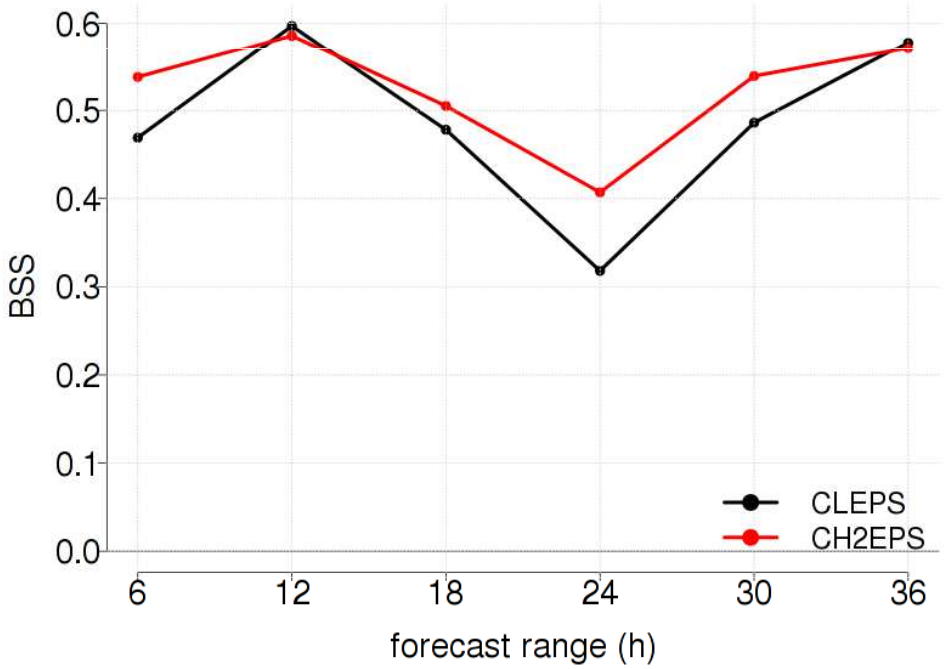


COSMO-H2-EPS

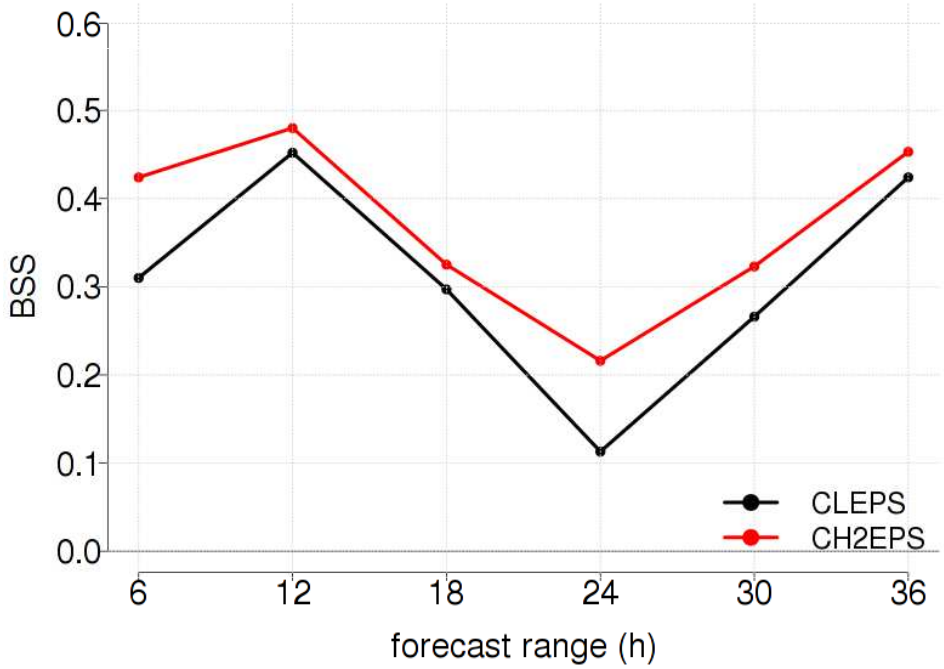
6h precipitation – Brier Skill Score

COSMO-H2-EPS
COSMO-LEPS

1mm/6h



10mm/6h



- 2.8 km mesh-size, 50 vertical levels
- 10 members
- IC/LBC: IFS-ENS
- model errors: perturbed parameters
- 2 months

Role of spatial resolution for ensemble forecasts

COSMO-S14-EPS (7km grid spacing) vs COSMO-RU2-EPS (2.2 km grid spacing)

T2m ensemble mean

Verification Period: 15.1.2014-15.3.2014

Station	BIAS (for 6/12/18hr lead time)		Mean Absolute Error (for 6/12/18hr lead time)	
	COSMO-S14-EPS	COSMO-RU2-EPS	COSMO-S14-EPS	COSMO-RU2-EPS
Sledge (~700m)	-1.3 / -2.0/ -1.4	0.2 / -1.9 / -0.1	1.6 / 2.2 / 1.6	1.4 / 3.5 / 1.7
Freestyle (~1000m)	-2.0 / -1.8 / -1.9	0.3 / -0.7 / 0.0	2.1 / 2.0 / 2.1	1.6 / 2.4 / 1.7
Biathlon Stadium (~1500m)	-1.4 / -1.3 / -1.4	0.9 / 0.0 / 0.5	2.0 / 1.8 / 2.1	2.1 / 2.6 / 2.3
Mountain Skiing(start) (~2000m)	1.6 / 2.2 / 1.6	0.6 / 0.2 / 0.1	2.8 / 3.1 / 2.8	2.1 / 2.2 / 2.6

Green – better for all lead times

- T2m: Some positive effect of downscaling from 7 to 2 km resolution
- Wind Speed: No positive effect of dynamical downscaling was found

Role of spatial resolution

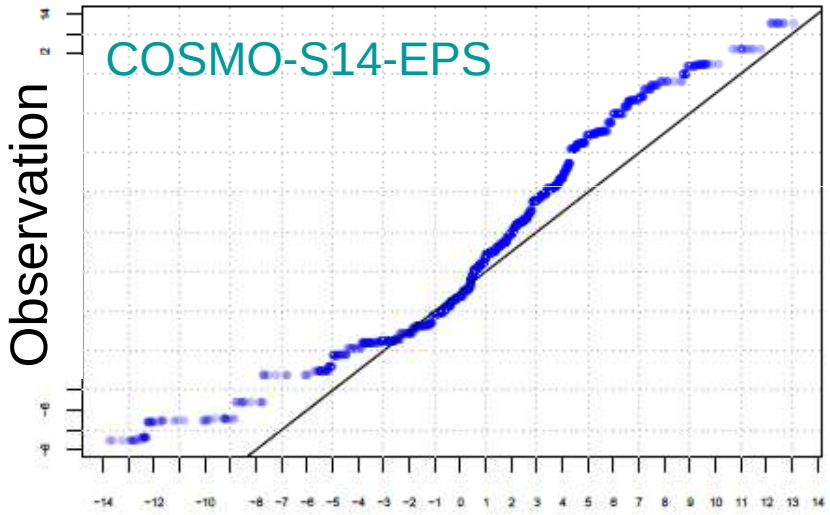
Parameter: T2m, Location: Biathlon Stadium (1455 m) - 15.1.2014-15.3.2014

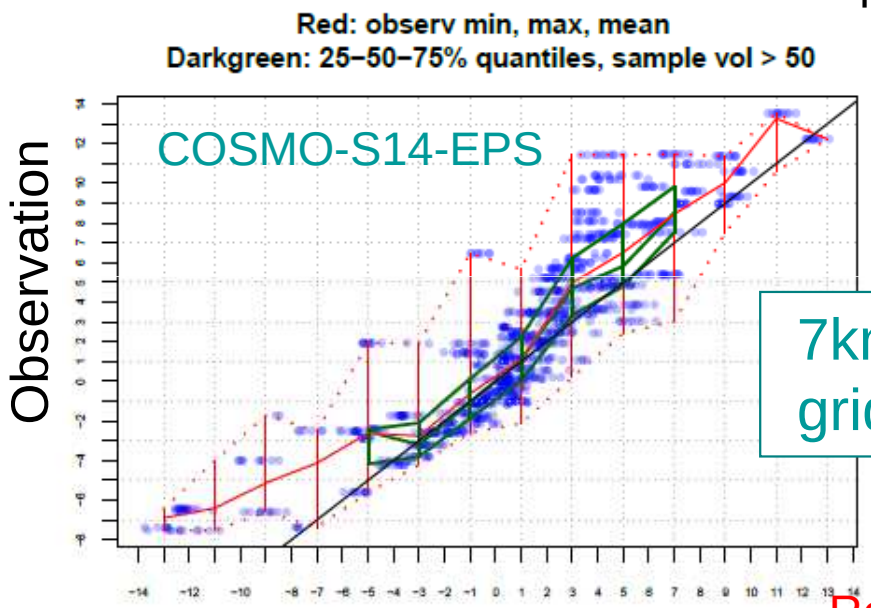
Verification approach: Nearest point

Q-Q plot

Scatter plot

ME=-1.26 MAE=1.83 RMSE= 2.52



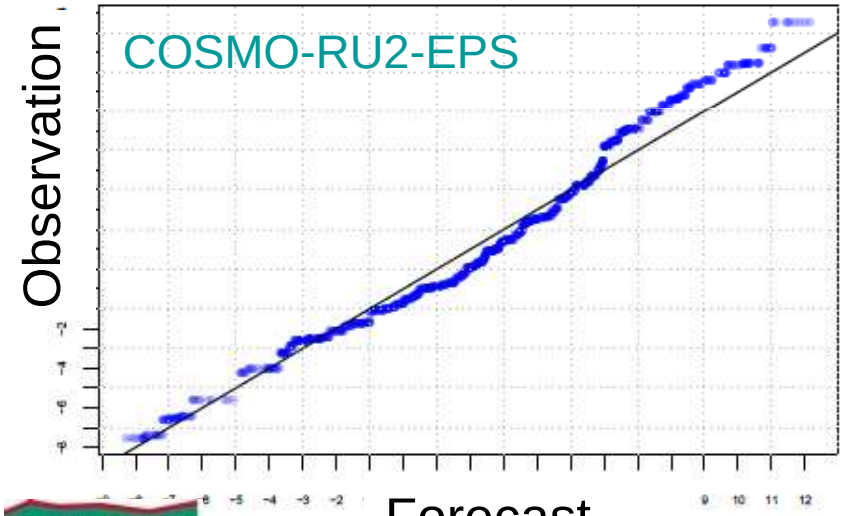


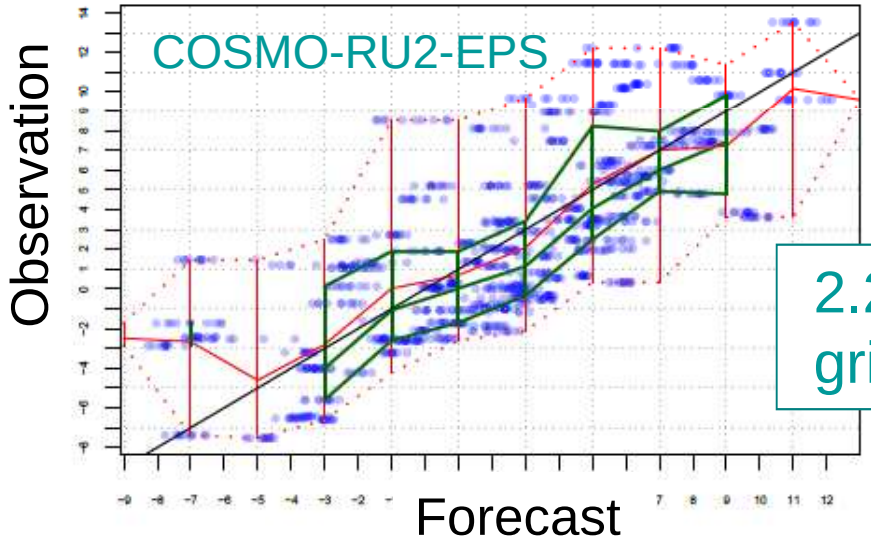
Lead=48

7km
grid spacing

Red:observations
Blue:forecasts

ME=-0.02 MAE=2.61 RMSE= 3.20



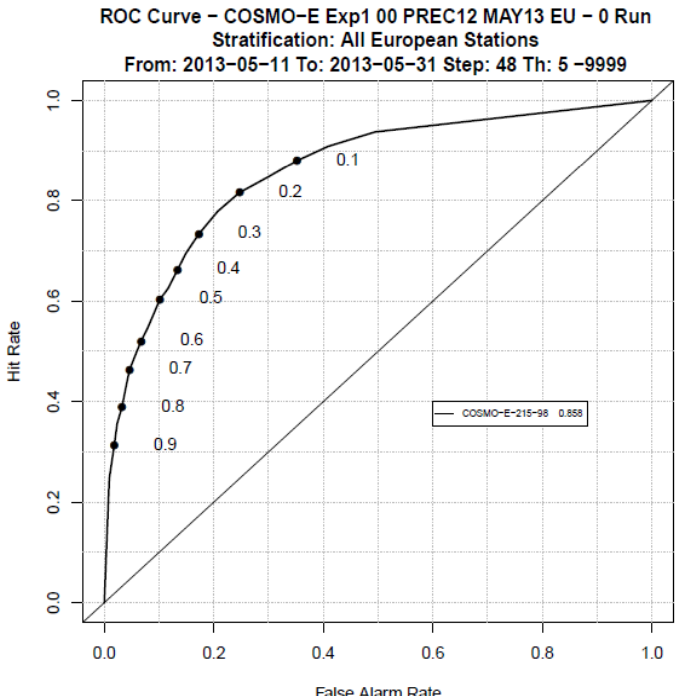


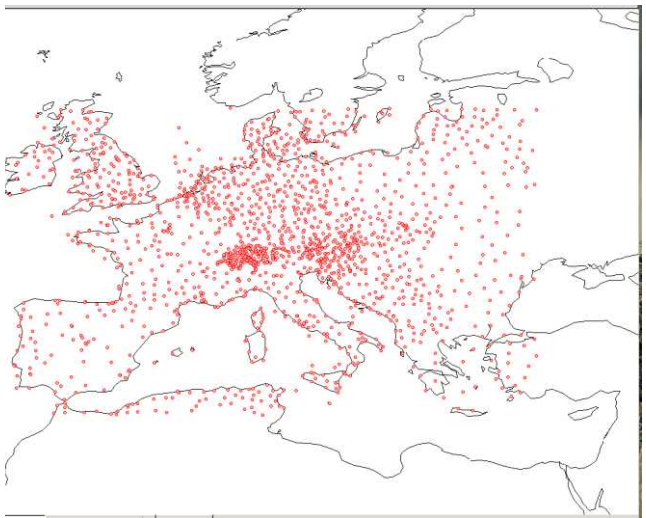
2.2 km
grid spacing

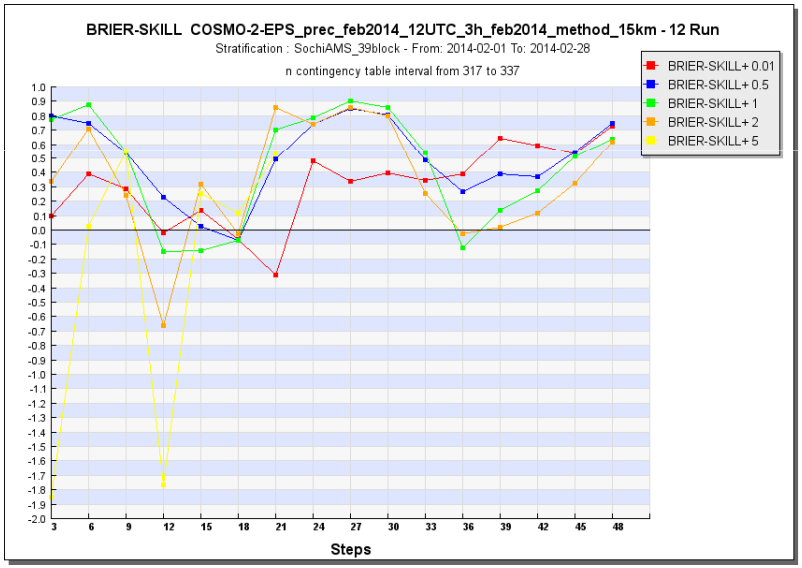
Hi-res ensemble forecasts: better pdfs, higher variability but poorer ensemble mean scores

EPS verification with VERSUS package

- an effort is being made in the Consortium for bringing the EPS verification tool implemented in VERSUS operationally efficient, through coordinated testing and feed-back to the developers
- objective verification of ensemble system(s) is heavy!
  - varying ensemble size
  - large number of stations, O(10^3)
  - several variables
  - intercomparisons







Future work

- maintenance and “light” development of COSMO-LEPS
- test of KENDA-derived IC perturbations
- test soil perturbations in ensemble mode, in combination with IC/BC and physics perturbations
- consolidate EPS (spatial) verification