Ensemble developments in the COSMO Consortium

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Outline

- **Operational ensembles:**
  - **COSMO-LEPS**
  - **COSMO-DE-EPS**
  - **COSMO-E**
  - **TLE-MVE (Poland)**
- **Developments**
  - **Improving the spread/skill relation**
  - **Physics perturbation**
  - **Soil/surface perturbation**
  - **Calibration and products**
  - **ICs for the ensembles**

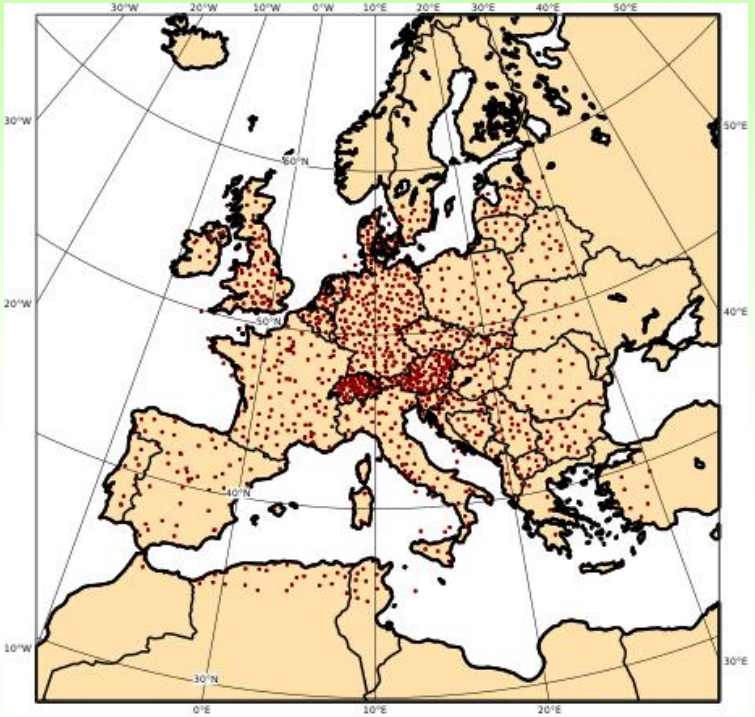
ENSEMBLES:

COSMO-LEPS

Upgrade to 20 members

- COSMO-LEPS **current** configuration:
- 16 members
- COSMO with 7 km hor. res.
- IC and BC from 16 members of ECMWF ENS (clustering)
- parameter perturbation in physics schemes

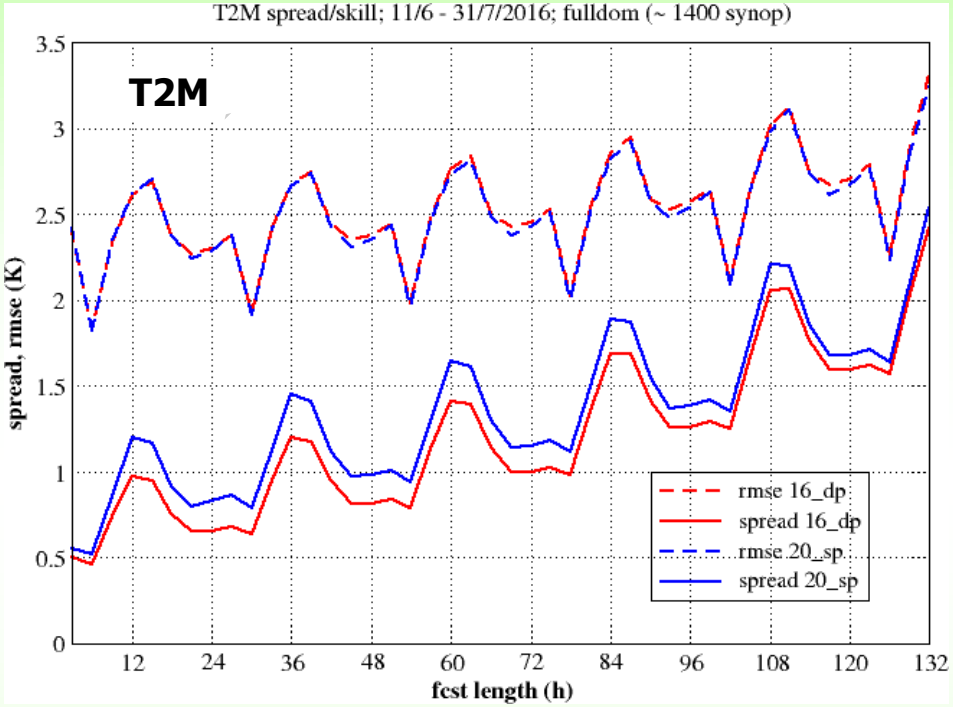
- COSMO-LEPS experimental configuration:
- **20 members**
- **COSMO in single precision** (same hor. res.)
- IC and BC from **20** members of ECMWF ENS (clustering)
- parameter perturbation in physics schemes **+ SPPT**

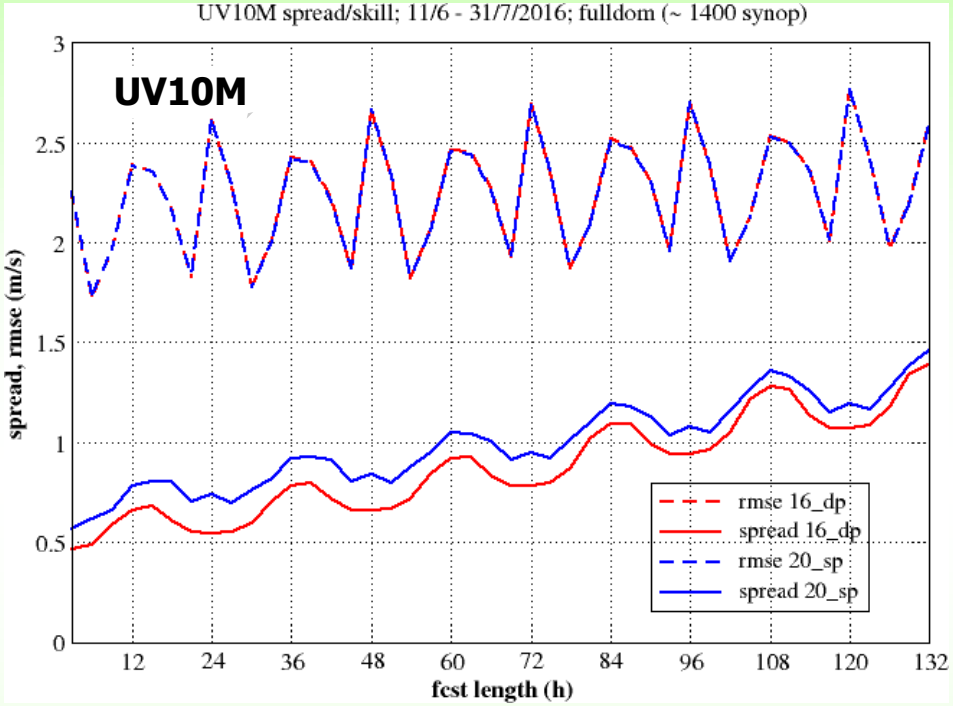


Verification area (~ 1400 synop)

51 days (11/6 - 31/7/2016)

Spread/skill for T2M and UV10M



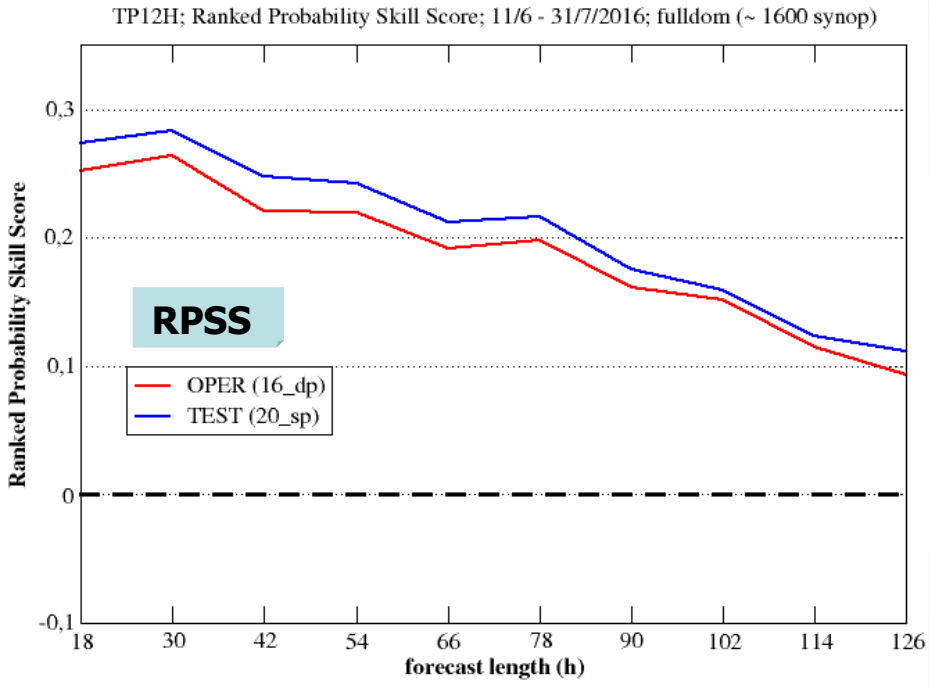


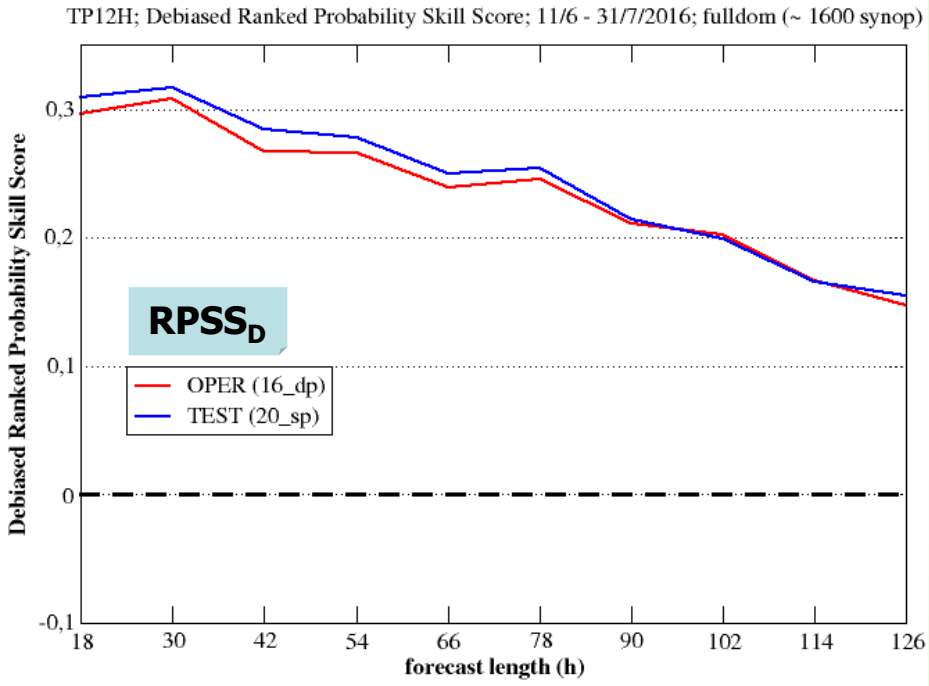
- **Larger spread for 20_sp for both variables**; in either cases, lack of spread in the short range.
- T2M: the daily cycle of the spread follows to a certain extent the cycle of the error.
- **Limited impact** (if any) **on the forecast skill** of the ensemble mean.

Probabilistic prediction of tp: RPSS

Consider debiased RPSS:

$RPSS_D = 1 - (RPS/(RPS_{ref} + RPS_{ref}/N))$





• In either cases (RPSS or $RPSS_D$), better performance of **20_sp** COSMO-LEPS, more evident for short ranges.

ENSEMBLES:

COSMO-DE-EPS

COSMO-DE-EPS operational set-up

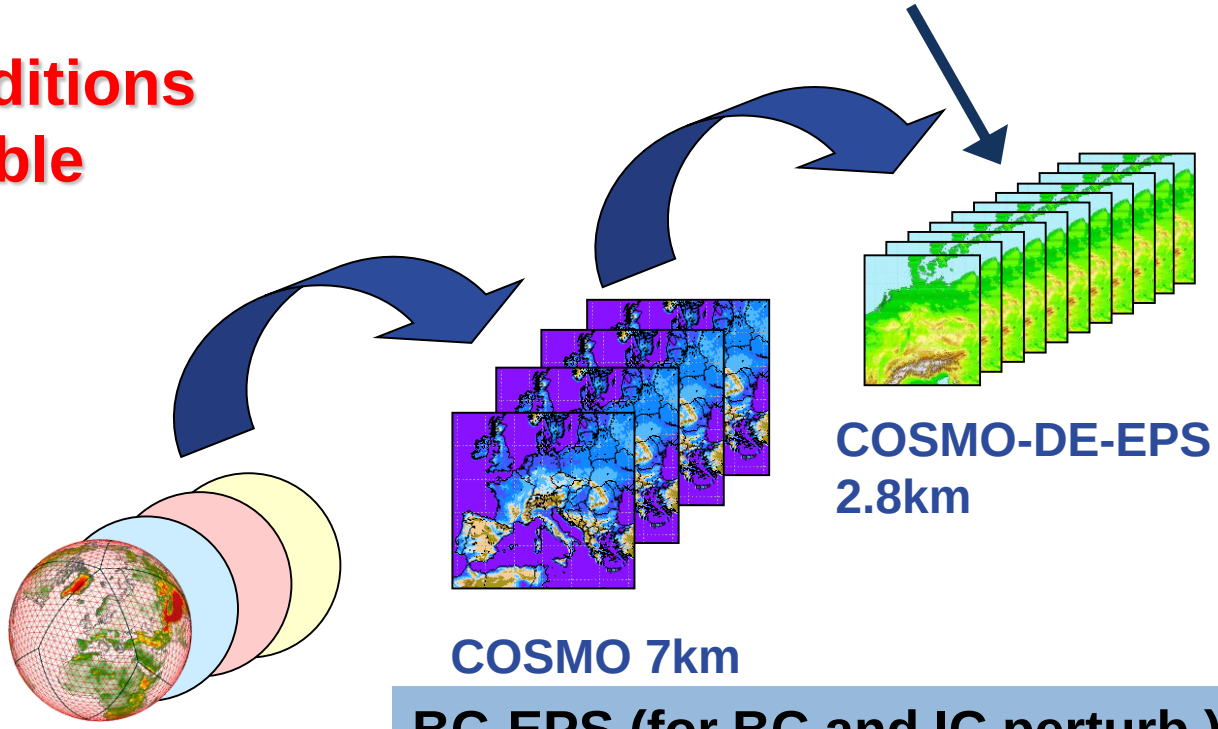
➔20 members, grid size: 2.8 km

➔8 starts per day (00, 03, 06,... UTC)
lead time: 0 - 27 hours
0 - 45 hours for 03 UTC

perturbation of model physics (non-stochastic) and soil moisture

Test: Boundary Conditions from ICON ensemble (pre-operational)

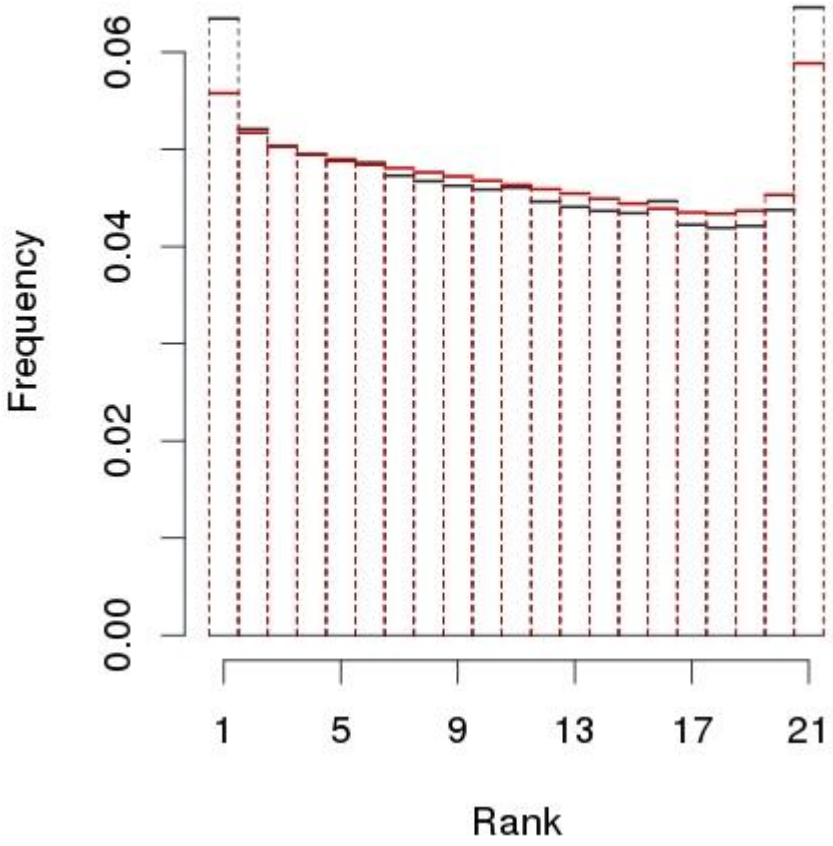
- 40 Member
- Global, 40 km
- ICON-EU Nest, 20 km
- EDA



BC-EPS (for BC and IC perturb.)

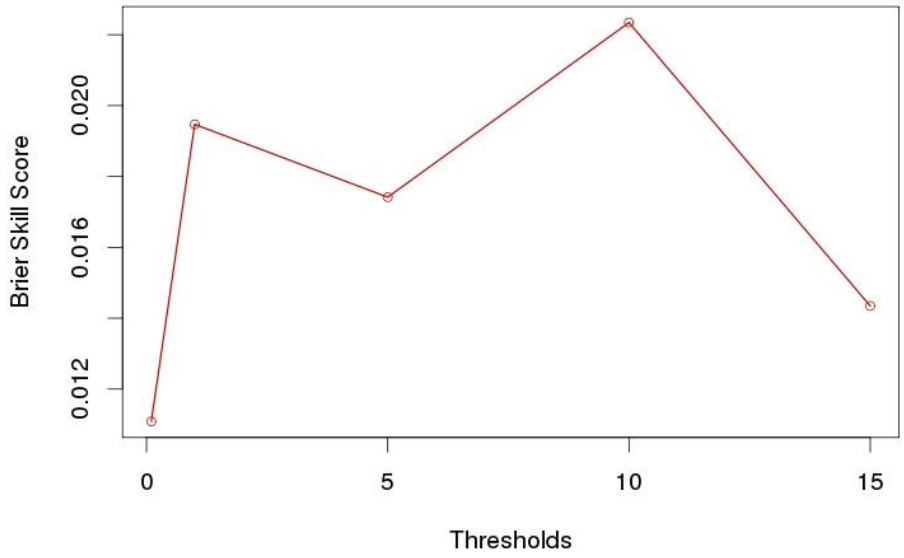
Rank histogram (hourly precipitation)

KENDA + ICON-EPS boundary
KENDA + BCEPS boundary



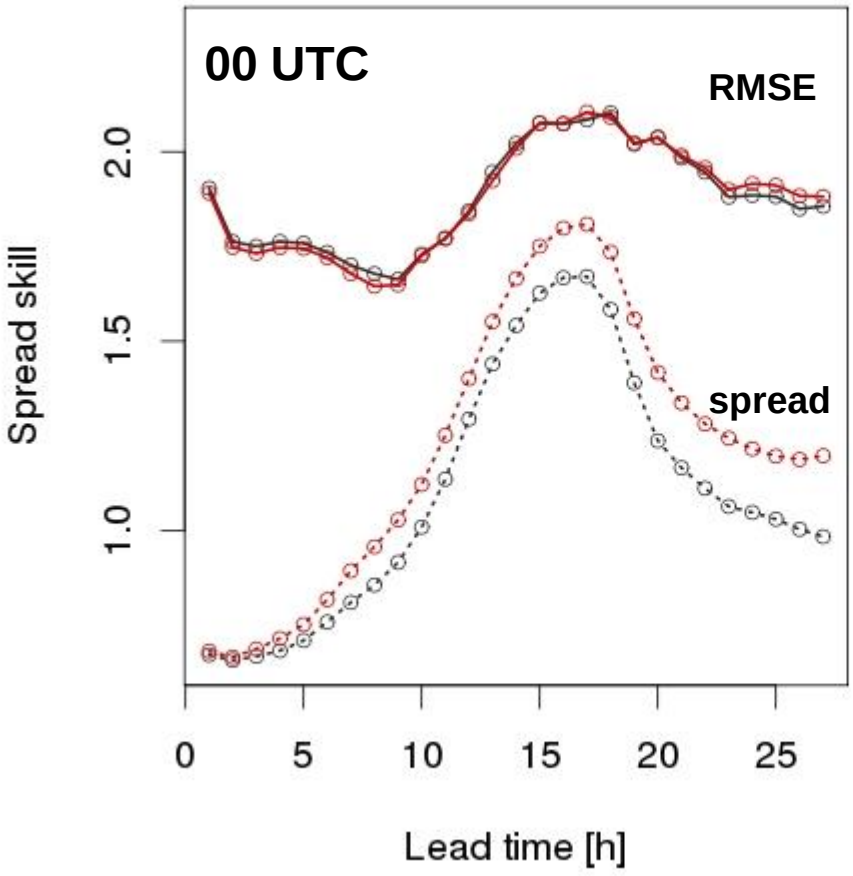
Brier Skill Score (hourly precipitation)

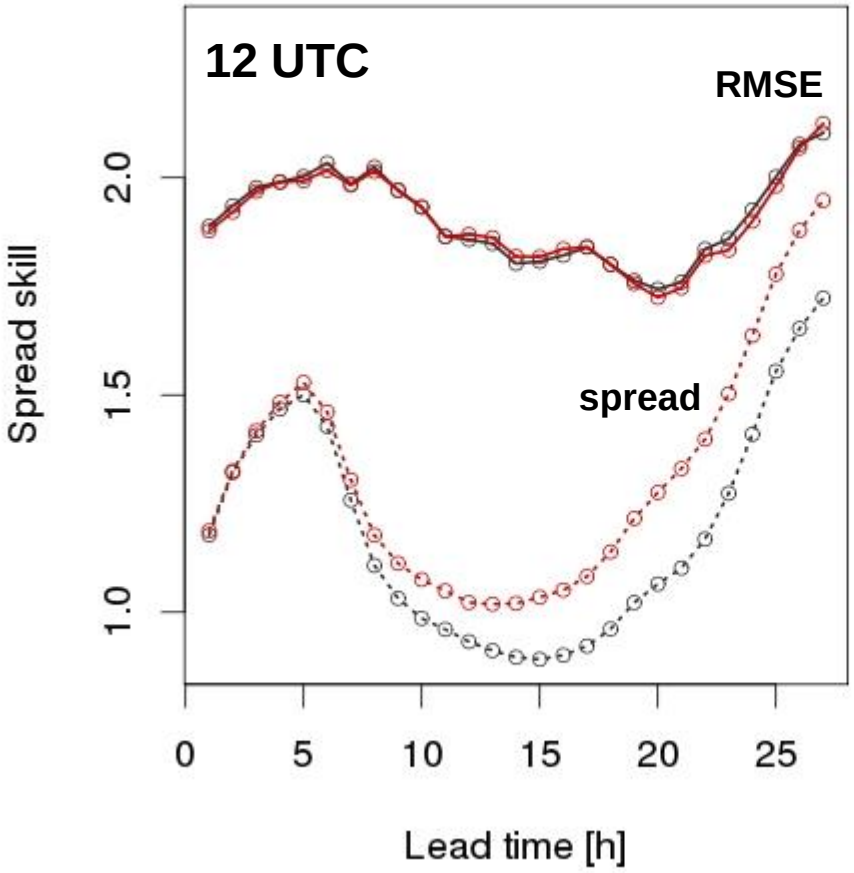
KENDA + ICON-EPS boundary
(vs KENDA + BCEPS boundary)



RMSE & spread (wind gusts)

KENDA + ICON-EPS boundary
KENDA + BCEPS boundary

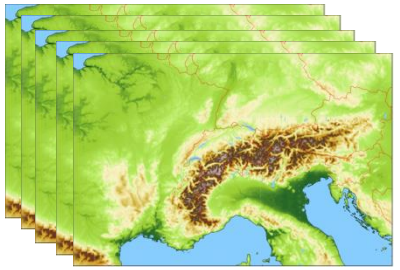




ENSEMBLES:

COSMO-E

COSMO-E operational setup

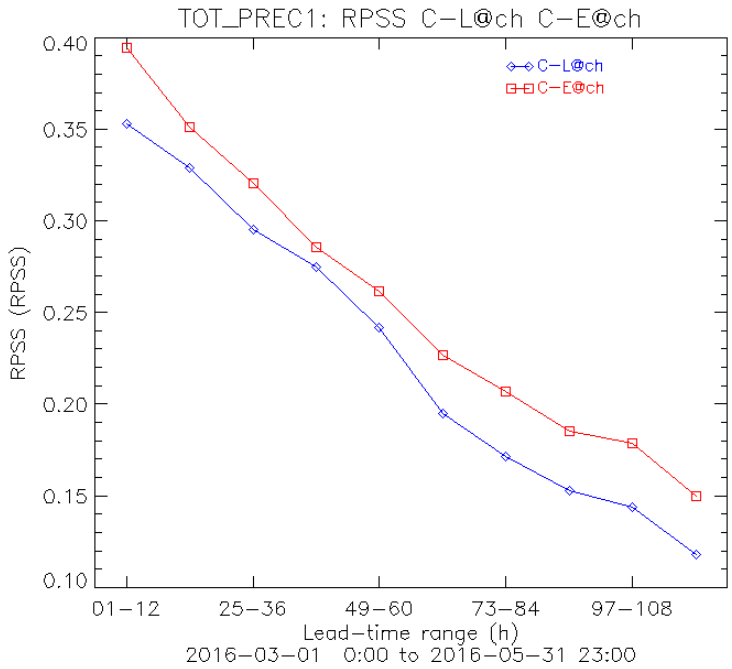


- 21 members (control and 20 perturbed runs)
- 2.2 km mesh-size, 60 levels
- two forecasts per day (00 and 12 UTC) up to +120h
- initial condition (perturbations): KENDA assimilation cycle
  - KENDA ensemble mean for control
  - KENDA members 1-20 (out of 40)
- lateral boundary condition (perturbations): IFS-ENS 18 & 06 UTC (i.e. 6h older LBCs):
  - IFS-ENS control for control
  - IFS-ENS members 1-20 (out of 50)
- model uncertainty: SPPT
- COSMO version 5.0+/GPU, single precision

RPSS, 1h precipitation, MAM 2016

COSMO-E
COSMO-LEPS

Switzerland



Thresholds: 0.1,0.2,0.5,1,2,5,10 mm

- COSMO-E shows skill until end of forecast range
- COSMO-E clearly outperforms COSMO-LEPS

SPRED Priority Project

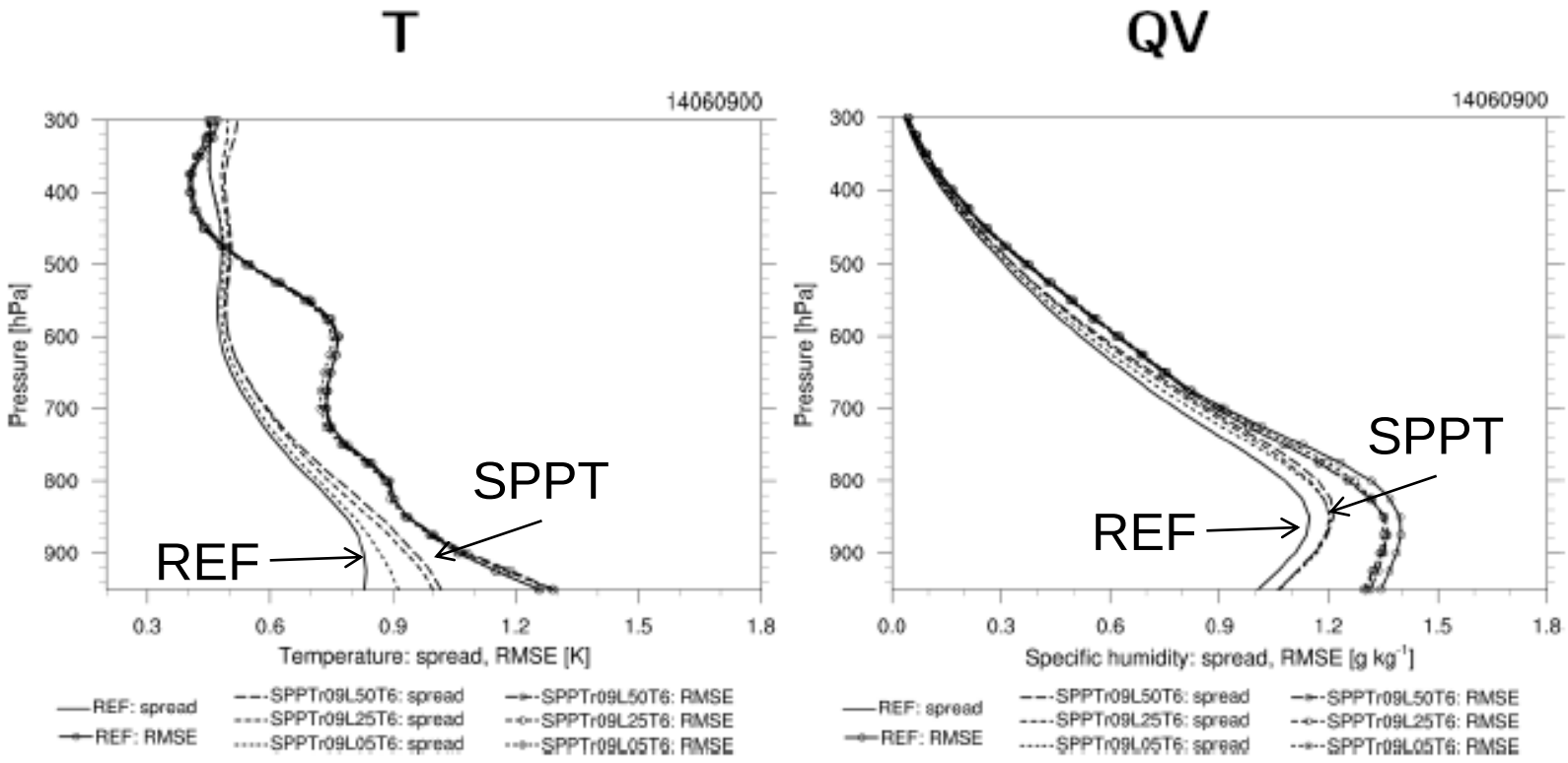
Spread/skill relation SPPT

- METEOSWISS (COSMO-E)
- RHM (COSMO-Ru2-EPS)
- IMGW (TLE-MVE)
- ARPAE (COSMO-IT-EPS)

Vertical profiles of spread & RMSE

Convective case (June 2014)

Impact of SPPT

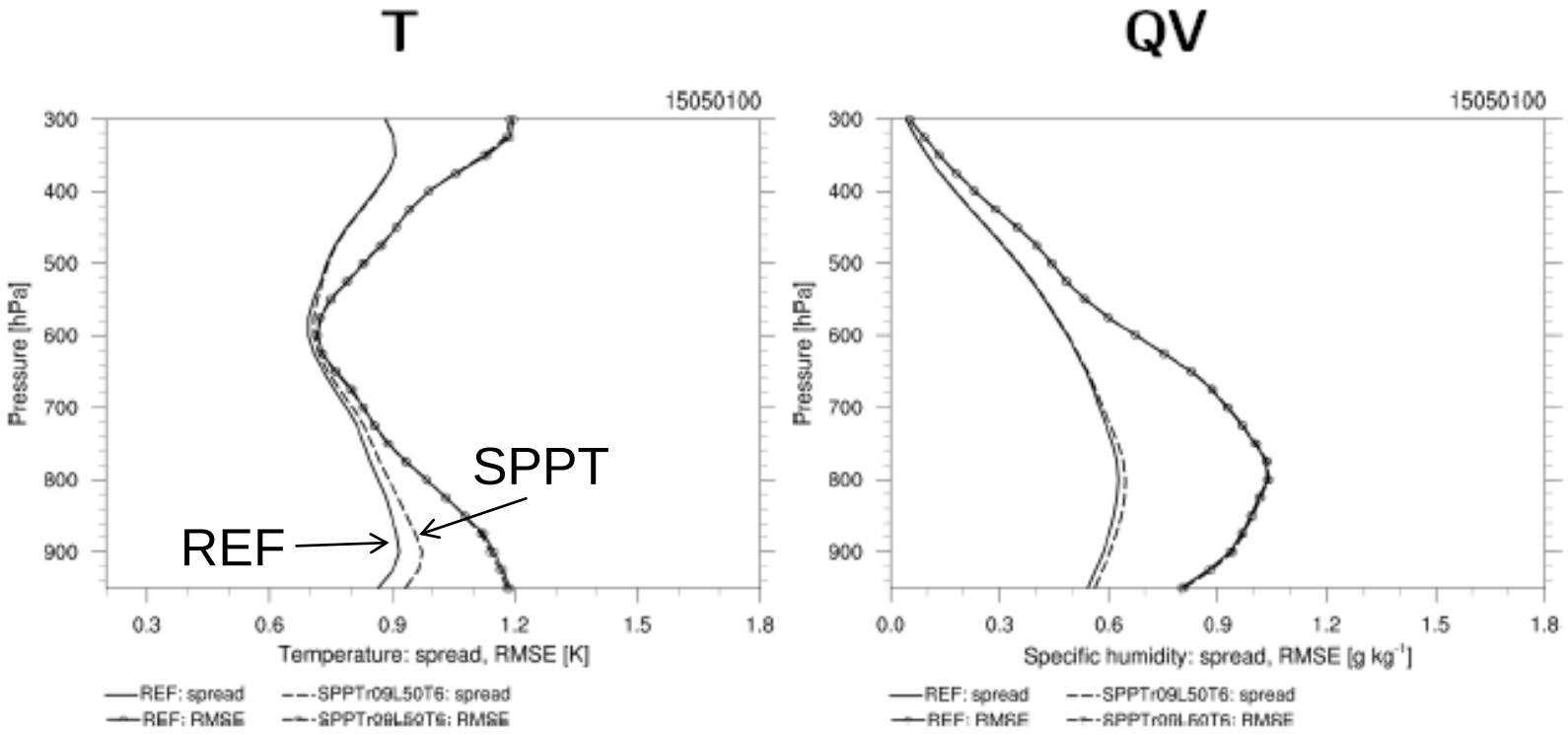


Solid & dashed	Spread
With markers	RMSE of ensemble mean
Experiments	REF and SPPT (5.0°, 2.5°, 0.5°)

Vertical profiles of spread & RMSE

Advective case (May 2015)

Impact of SPPT

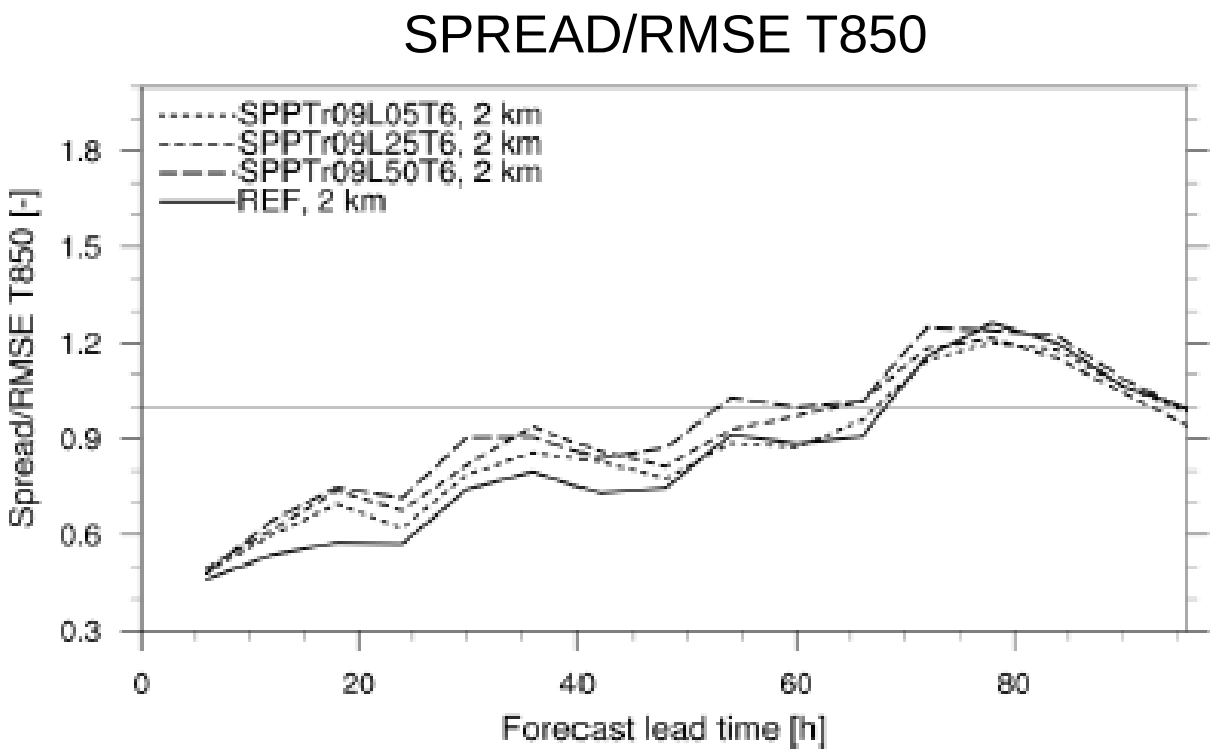


Solid & dashed	Spread
With markers	RMSE of ensemble mean
Experiments	REF and SPPT (5.0°)

Spread & RMSE as function of forecast range

Convective case (June 2014)

Impact of SPPT



C. Klasa, MCH

Evaluation of ensemble spread: SAL

- **Aim: assess the impact of physics perturbations on precipitation**
- **What is the perturbation influencing?**
  - **Precipitation intensity**
  - **Precipitation structure**
  - **Localisation of the precipitation**

⇒ **Use a spatial verification measure: SAL (Wernli et al 2008)**

- **3 independent components:**
  - **Structure**
  - **Amplitude**
  - **Location**
- **Used here not for verification but for evaluating the similarity between fields, only forecasts**

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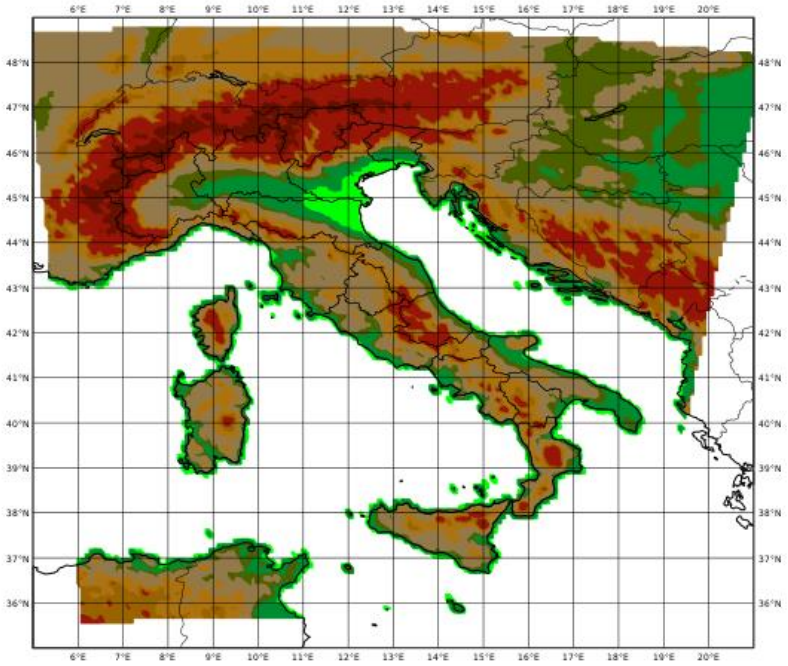
COSMO-IT-EPS



- 2.8 km
- 10 members
- IC/BC from COSMO-ME-EPS
- testing period: October 2015
- 3 set-up for physics perturbations:
  - CTRL: no physics perturbations
  - SPPT: SPPT only
  - SPPT + PP: SPPT + Parameter Perturbation

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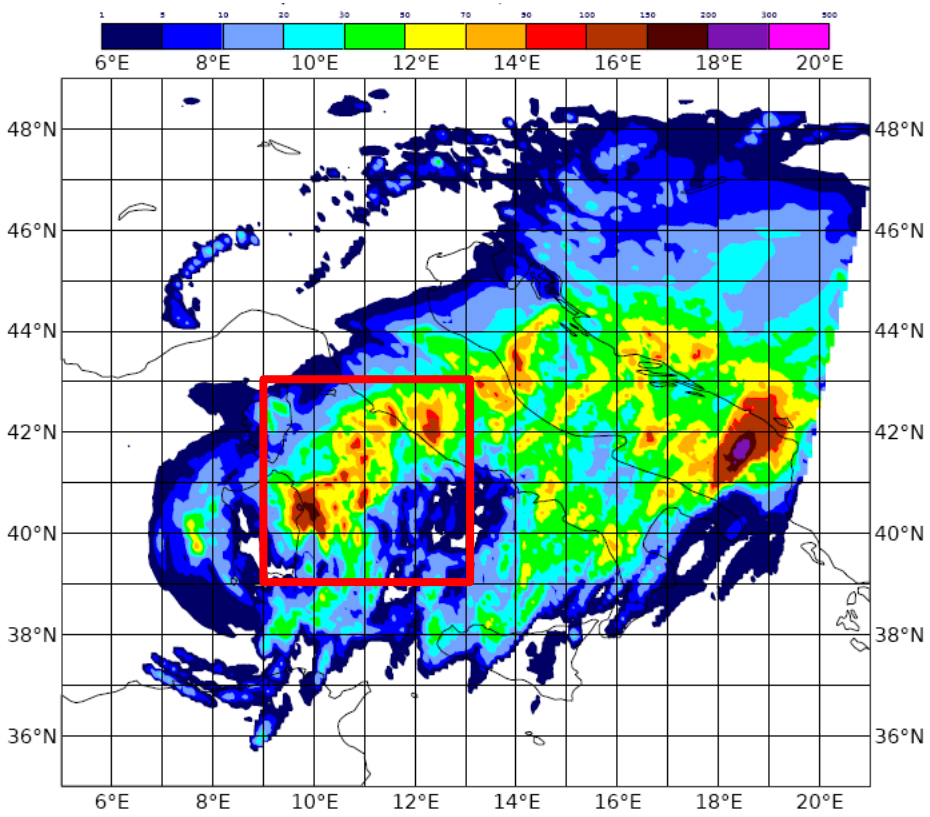
EXAMPLE: INTENSE PRECIPITATION CASE

10/10/15 - 100mm – 125x163



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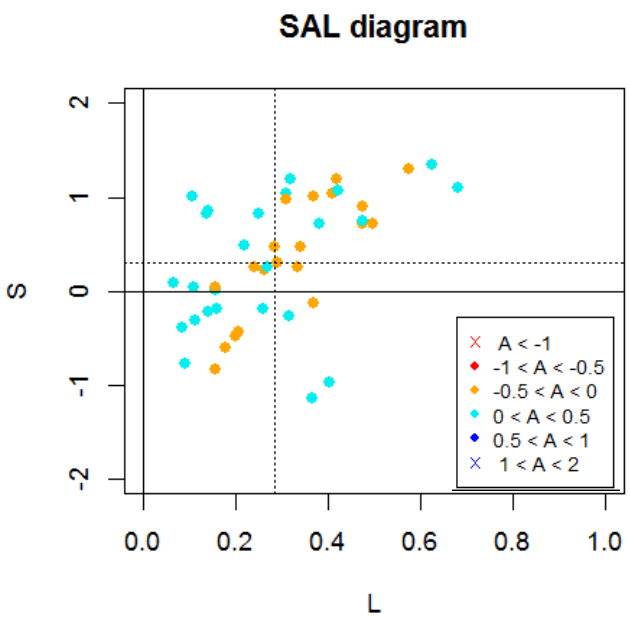
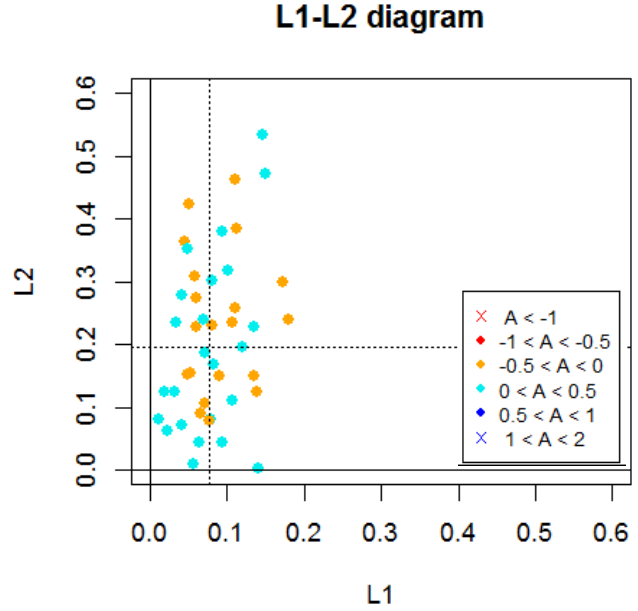
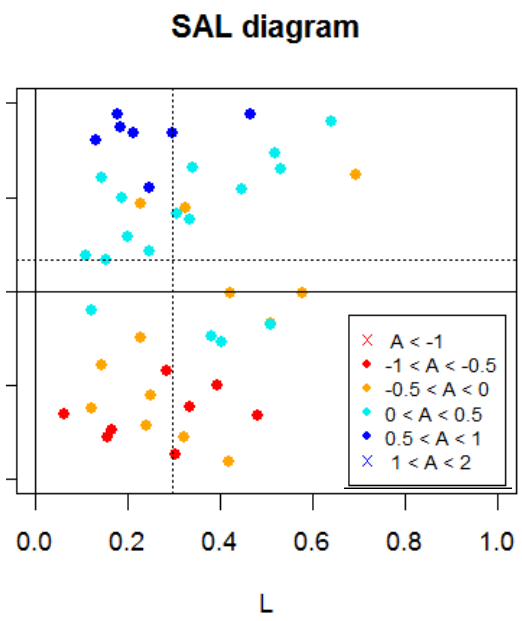
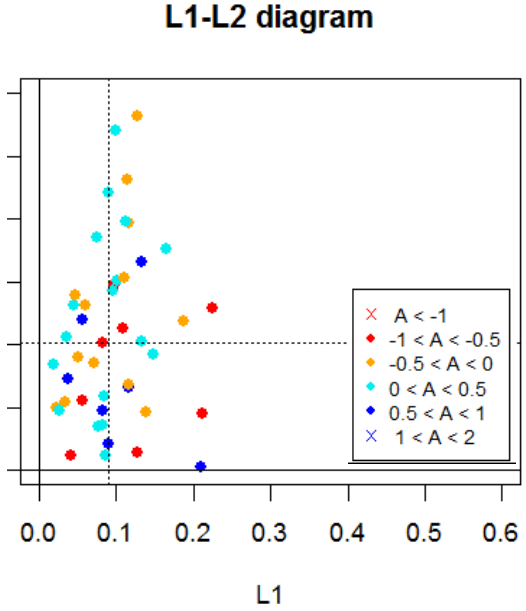
no physics pert



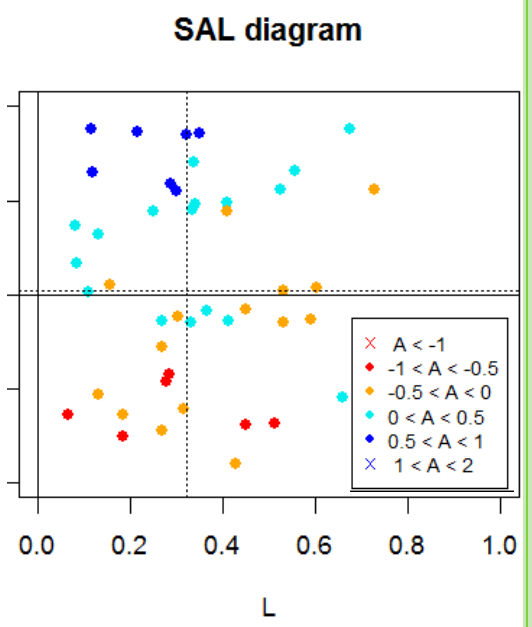


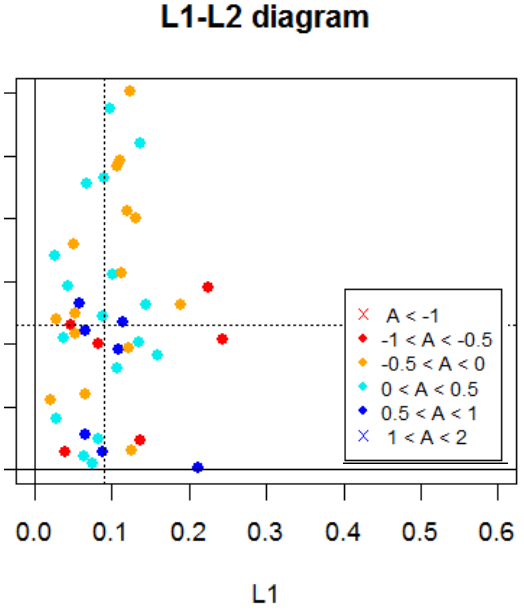
SPPT





SPPT + PP

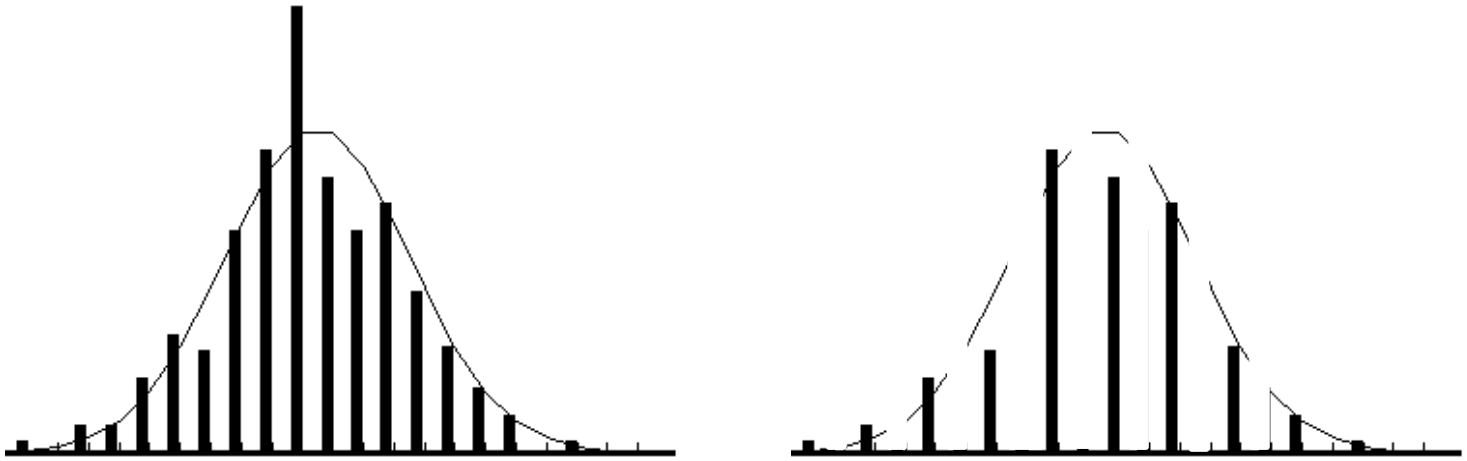




SPRED Priority Project

Member selection for CP ensembles

Goal: Keep the “shape of the PDF”

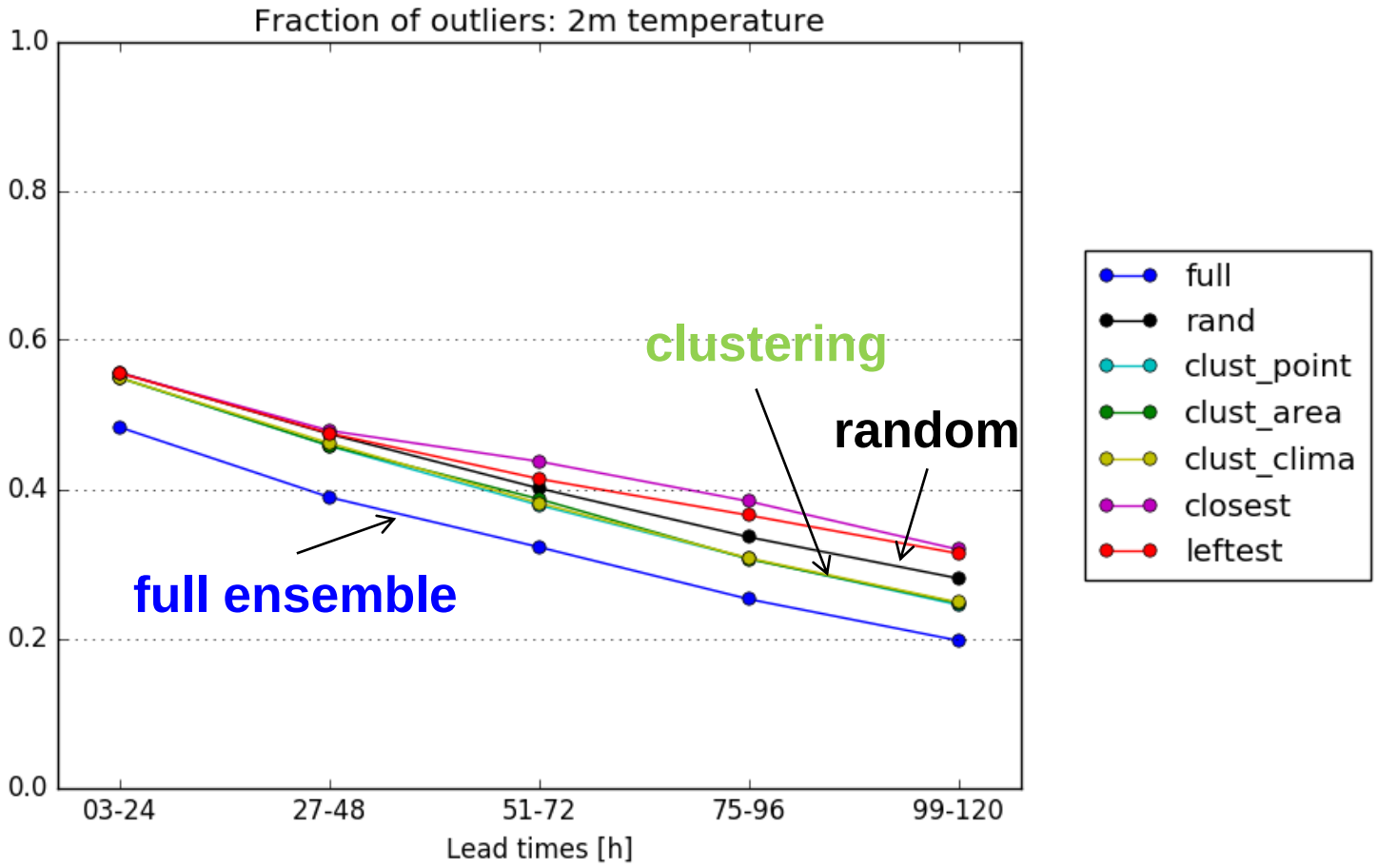


Problem: Multidimensionality (grid-points, variables)

→ reduce phase space and «make» it one-dimensional

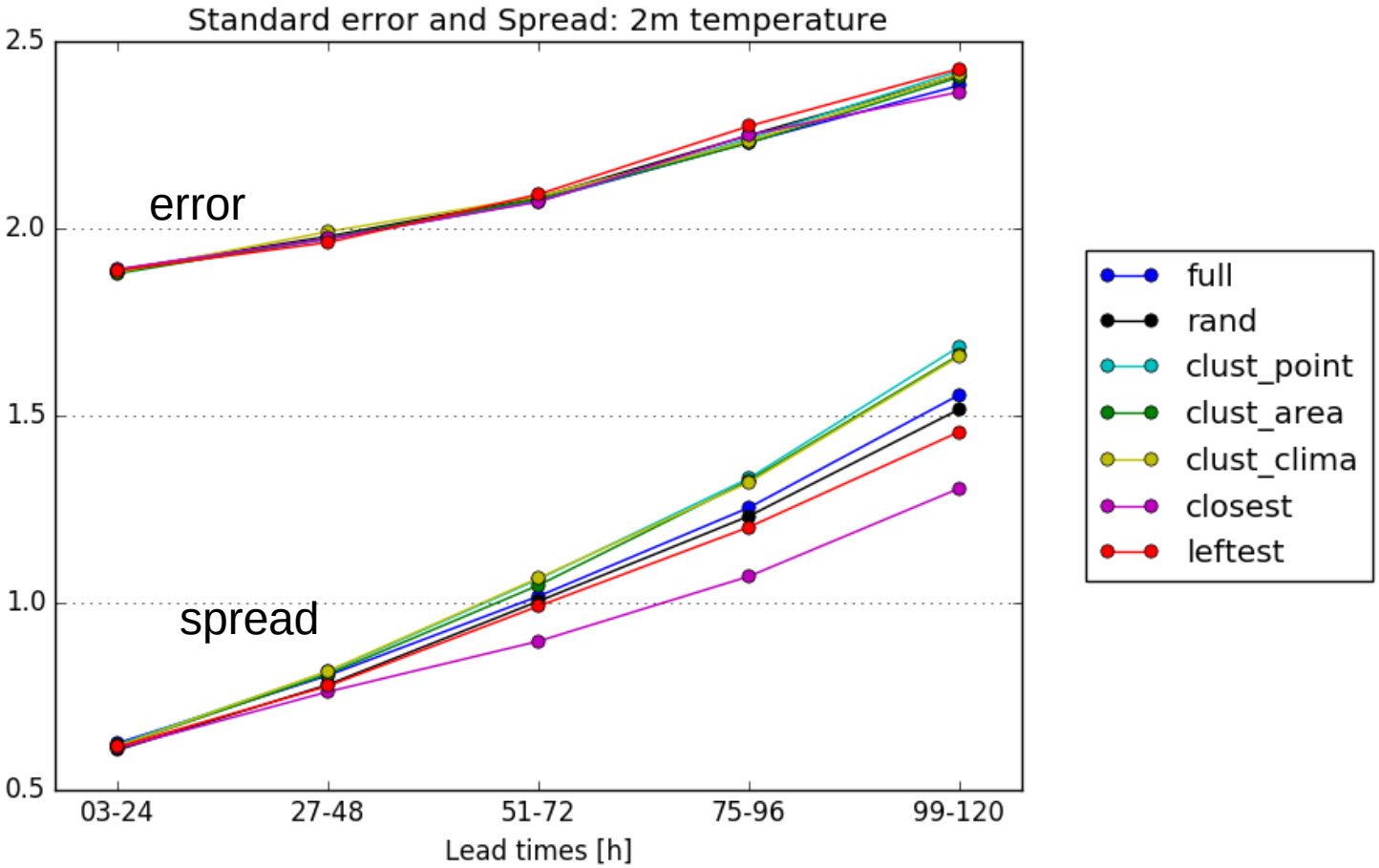
→ similar approach used as in COSMO-LEPS clustering:
3 variables: wind, temperature, humidity on 3 model levels (~850, 700, 500 hPa)

2m temperature, outliers



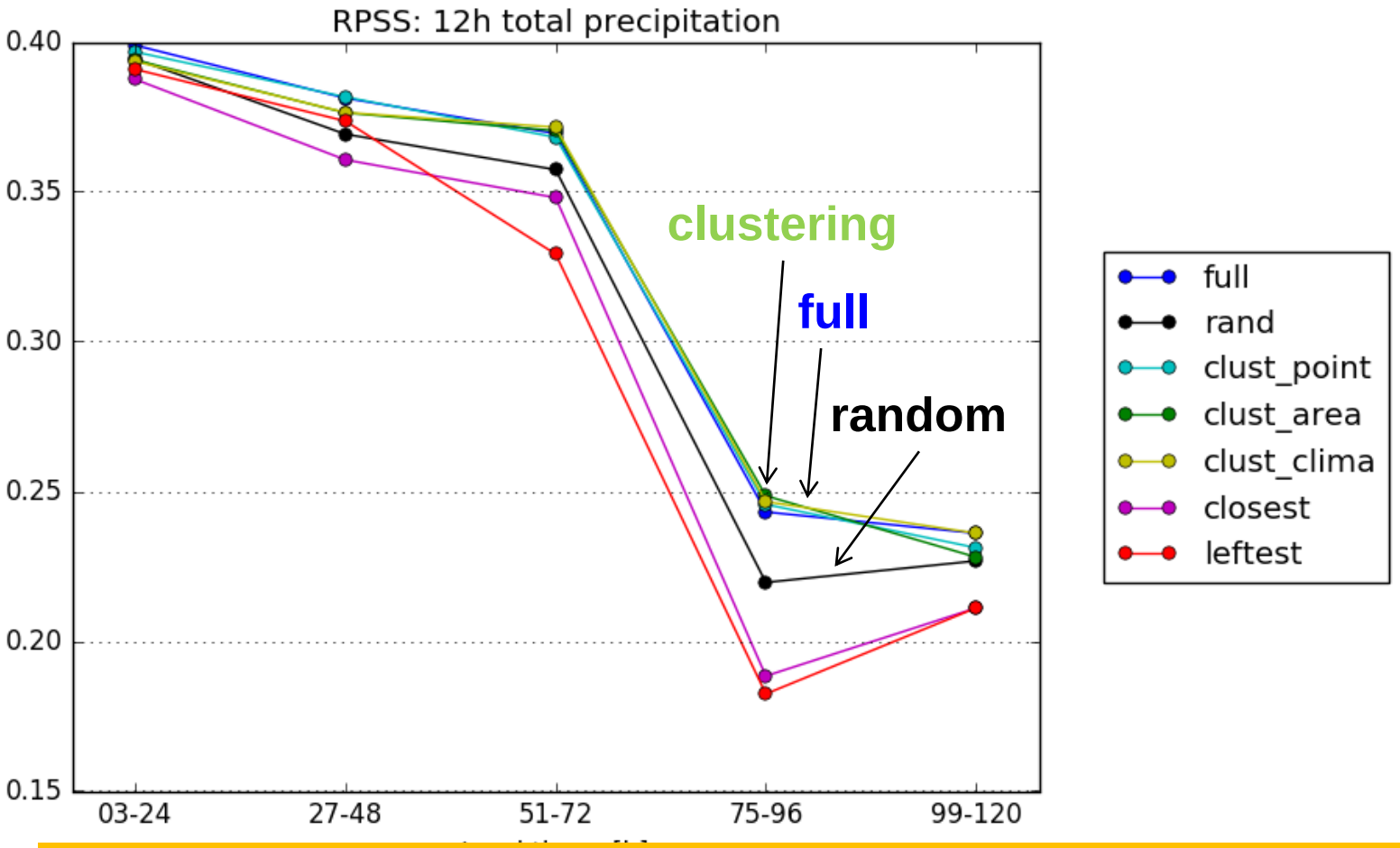
'full' best as expected, 3 clustering setups second and almost identical, than 'rand', 'leftest', 'closest' is worse

2m temperature, spread/error



- ‘clust’ shows larger spread than ‘full’! → tails ‘overpopulated’
- ‘rand’ third, ‘closest’ clearly worst

12h total precipitation, RPSS



similar results, but clustering as good as ‘full’ an ‘leftest’ worst

Concluding remarks

- **CP ensembles well established**
- **More knowledge on SPPT impact**
- **Lower boundary perturbations part of the ensemble set-up**
- **Good result on usefulness of member selection for CP ensemble**
- **A report on the spread/skill assessment will be prepared, to summarise what we know (and what we don't know) about the ensemble spread**

CONSORTIUM FOR SMALL SCALE MODELING

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THANK YOU!