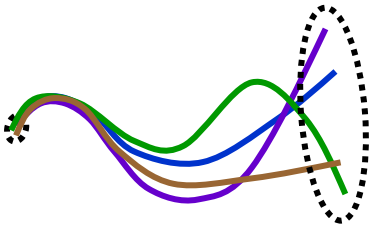
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COSMO-DE-EPS

operational

convection-permitting

ensemble prediction system



Christoph Gebhardt, Susanne Theis,
Zied Ben Bouallègue, Michael Buchhold, Marcus Paulat, Carlos Peralta,
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Deutscher Wetterdienst, DWD

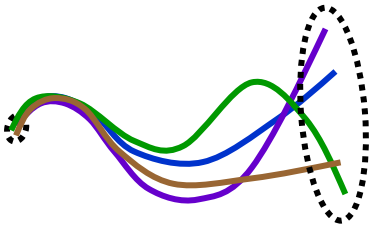
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COSMO-DE-EPS

operational since May 22nd 2012

convection-permitting

ensemble prediction system



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Deutscher Wetterdienst, DWD

Outline

- ➔ operational set-up and member generation of COSMO-DE-EPS
- ➔ case study
- ➔ verification results
- ➔ broad over view of next steps (status and plans, more details in WG 7 parallel session)

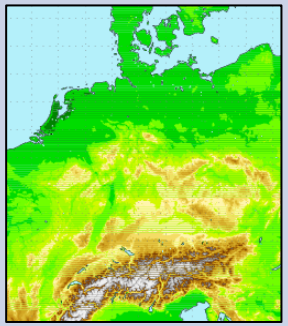
Operational set-up of COSMO-DE-EPS

operational set-up:

- ➔ **20 members**
- ➔ **grid size: 2.8 km**

  convection-permitting
- ➔ **lead time: 0-21 hours,**

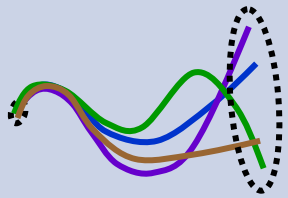
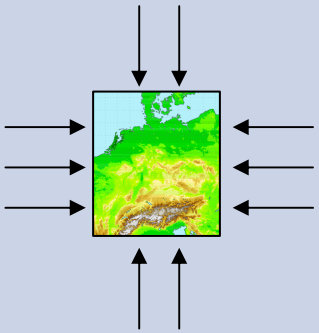
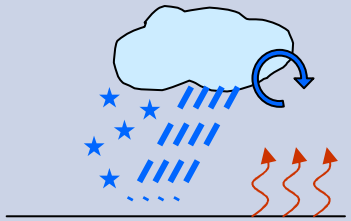
  8 starts per day (00, 03, 06,... UTC)



model domain

Generation of EPS members

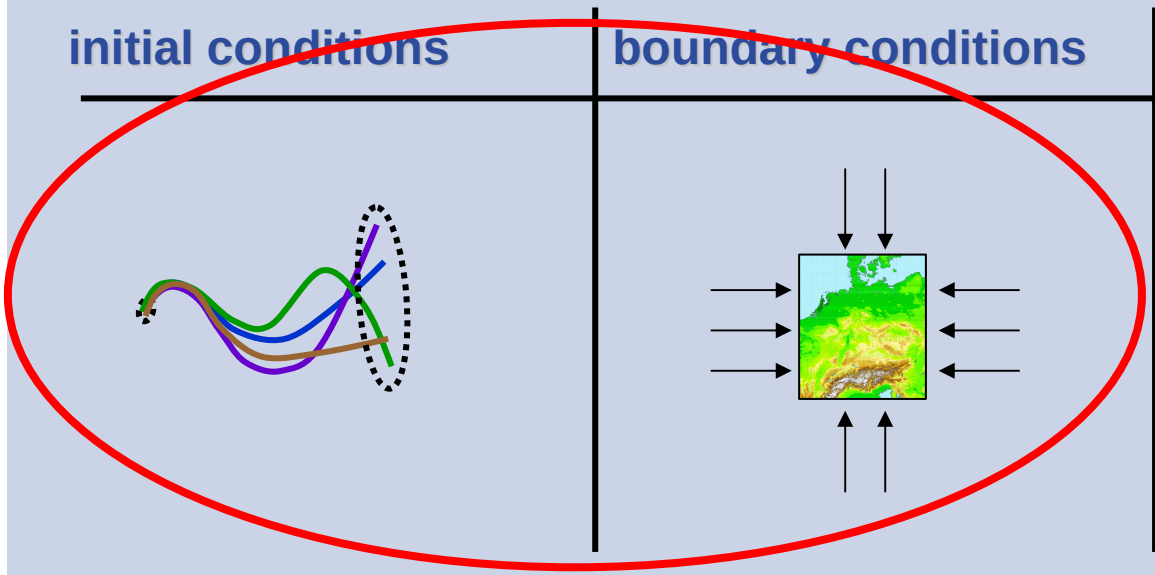
representing uncertainty in

initial conditions	boundary conditions	model physics
		

Generation of EPS members

representing uncertainty in

initial conditions | boundary conditions | model physics



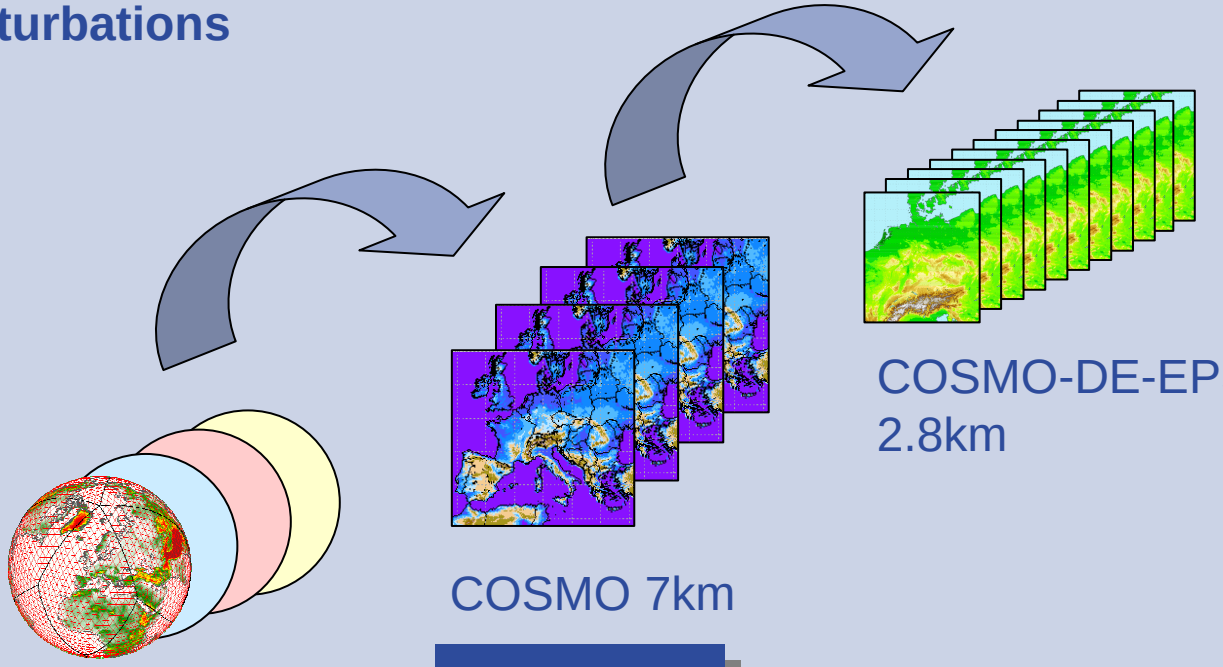
perturbed parameters

„multi-model“

non-stochastic

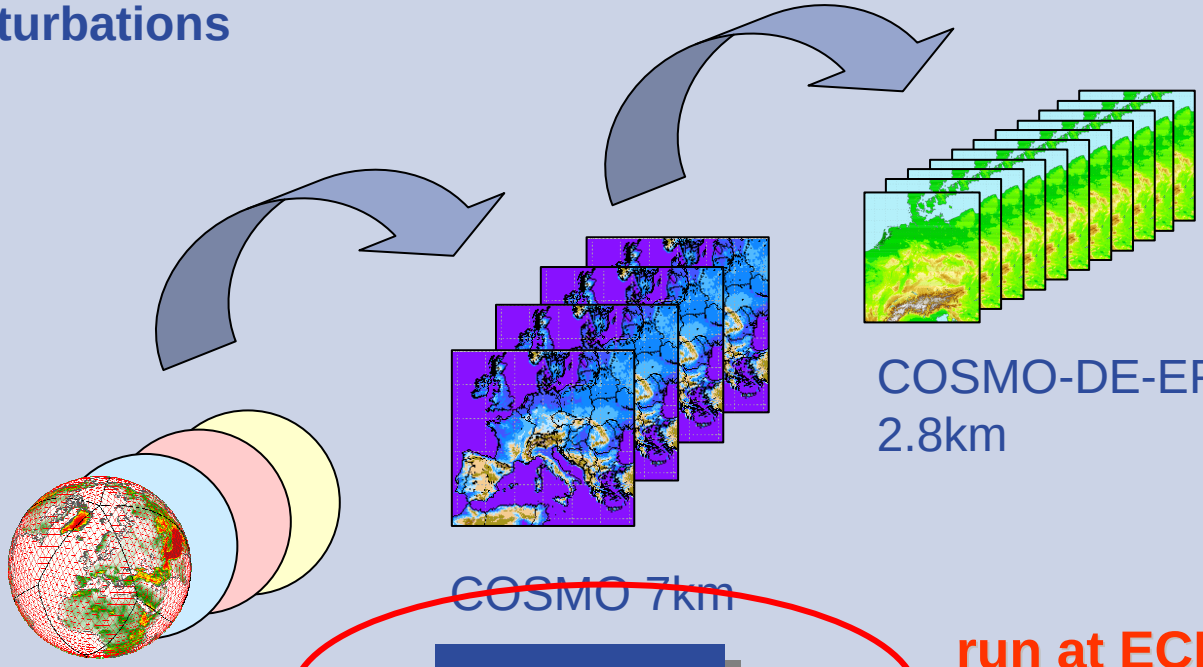
Generation of EPS members

BC-EPS for boundary and initial perturbations



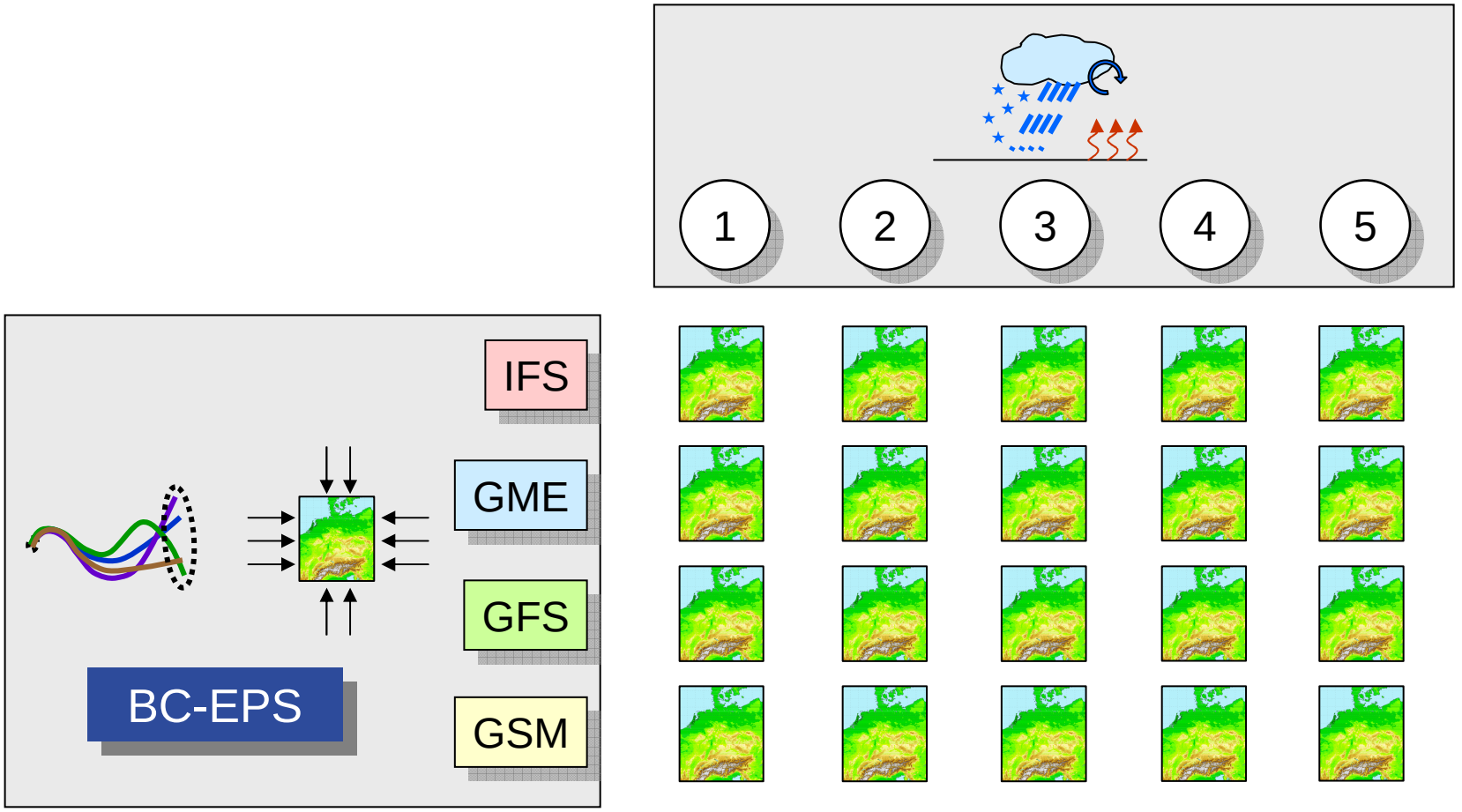
Generation of EPS members

BC-EPS for boundary and initial perturbations



run at ECMWF as time critical application

The 20 members of COSMO-DE-EPS



Generation of Ensemble Members

Perturbation Methods

Peralta, C., Ben Bouallègue, Z., Theis, S.E., Gebhardt, C. and M. Buchhold, 2012: Accounting for **initial condition uncertainties** in COSMO-DE-EPS. Journal of Geophysical Research, VOL. 117, D07108, doi:10.1029/2011JD016581, 2012

Gebhardt, C., Theis, S.E., Paulat, M. and Z. Ben Bouallègue, 2011: Uncertainties in COSMO-DE precipitation forecasts introduced by **model perturbations and variation of lateral boundaries**. Atmospheric Research 100, 168-177. *(contains status of 2009)*

Peralta, C. and M. Buchhold, 2011: **Initial condition perturbations** for the COSMO-DE-EPS, COSMO Newsletter 11, 115–123.

COSMO-DE-EPS Overview COSMO GM 2011

- ➔ start of pre-operational phase / evaluation — **December 2010**
  - ➔ 20 members → probabilities, quantiles, etc
  - ➔ runs at 00 UTC, 03 UTC, 06 UTC,…
- ➔ start of pre-operational phase with **40 ensemble** members — **Q1 2012**
- ➔ reach operational status — **End of 2012**
- ➔ … — **2013**

COSMO-DE-EPS Overview COSMO GM 2011

- start of pre-operational phase / evaluation
  - 20 members → probabilities, quantiles, etc
  - runs at 00 UTC, 03 UTC, 06 UTC,…

- start of pre-operational phase with **40 ensemble** members
- reach operational status
- …

December 2010

Q2 2012

End of 2012

2013

Main results from pre-operational phase (20 members)

- evaluation by forecasters (case studies):
  - additional benefit for precipitation forecasts
  - provides early signals for severe weather
  - most beneficial for convective precipitation in summer
  - drawback: jumpiness between consecutive runs

- probabilistic verification (for periods of several months)
  - probabilities perform better than deterministic “yes/no”
  - particularly for high precipitation thresholds
  - particularly for longer lead times
  - drawback: underdispersiveness (esp. for wind gusts and T_2M)

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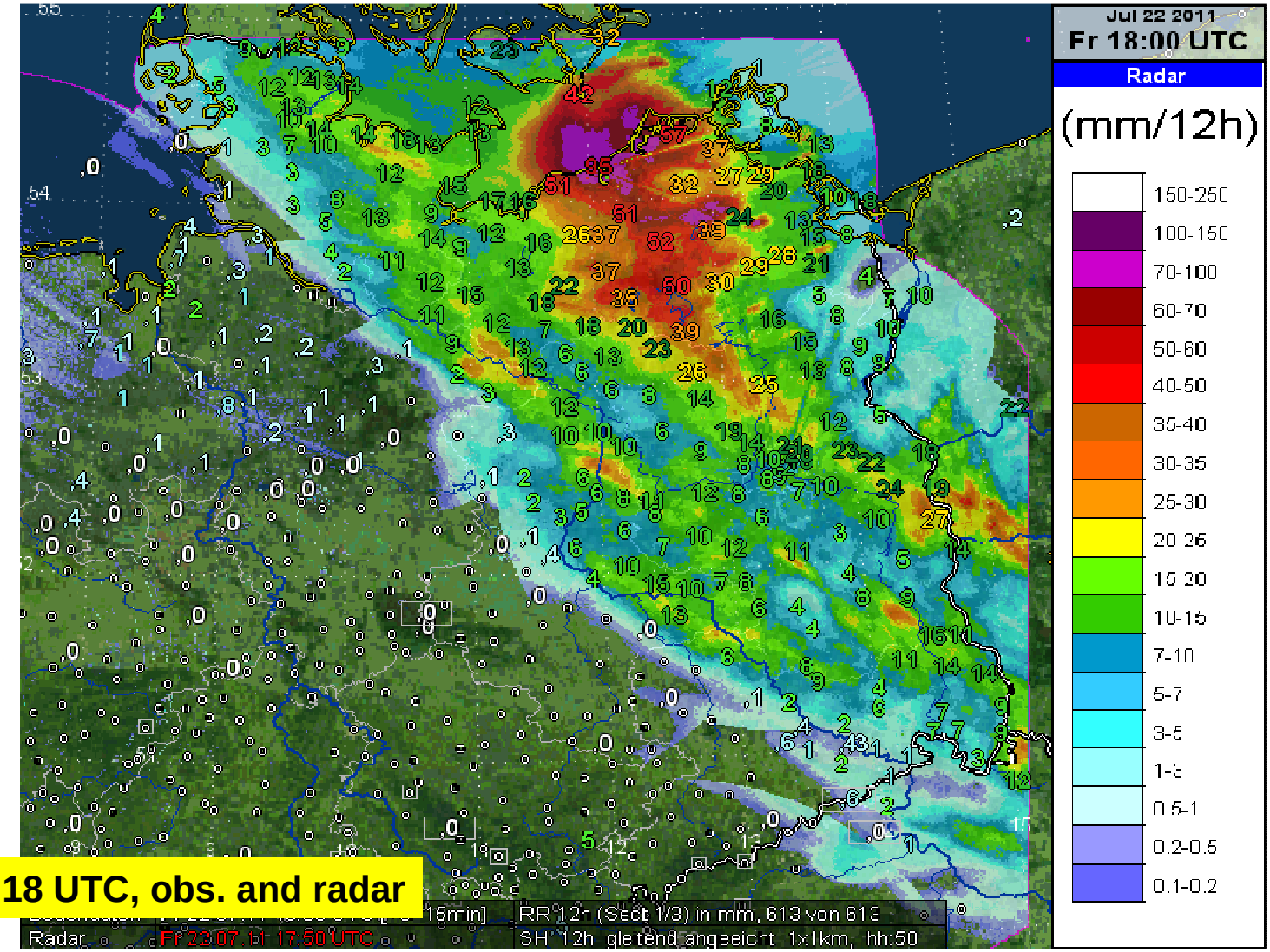
modify time schedule to benefit from EPS in summer 2012

CASE STUDY OF SEVERE WEATHER

Rostock severe weather 22.07.2011

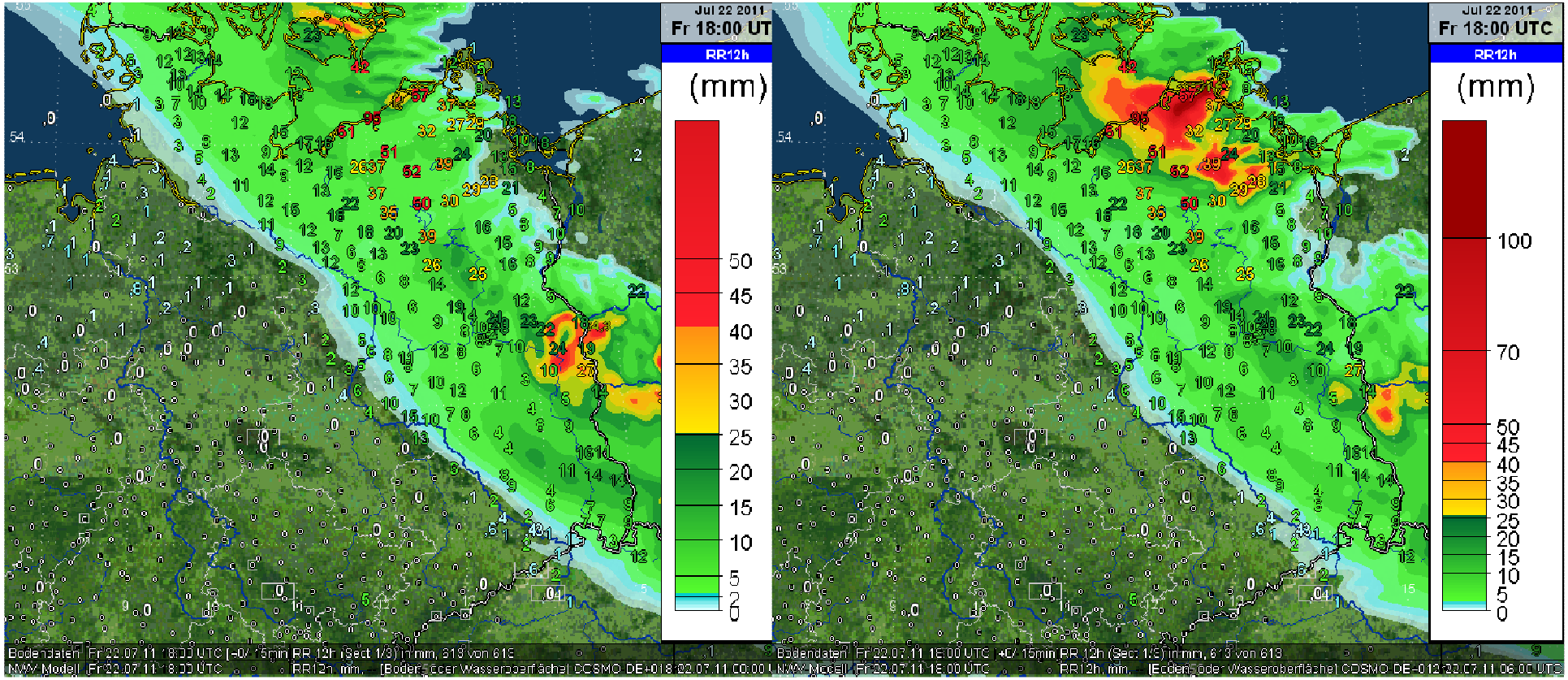
Deutscher Wetterdienst
Wetter und Klima aus einer Hand



12h-RR, 18 UTC, obs. and radar

Rostock severe weather 22.07.2011

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



12h-RR, C-DE+18h
00 UTC run

COSMO-DE

12h-RR, C-DE+12h
06 UTC run

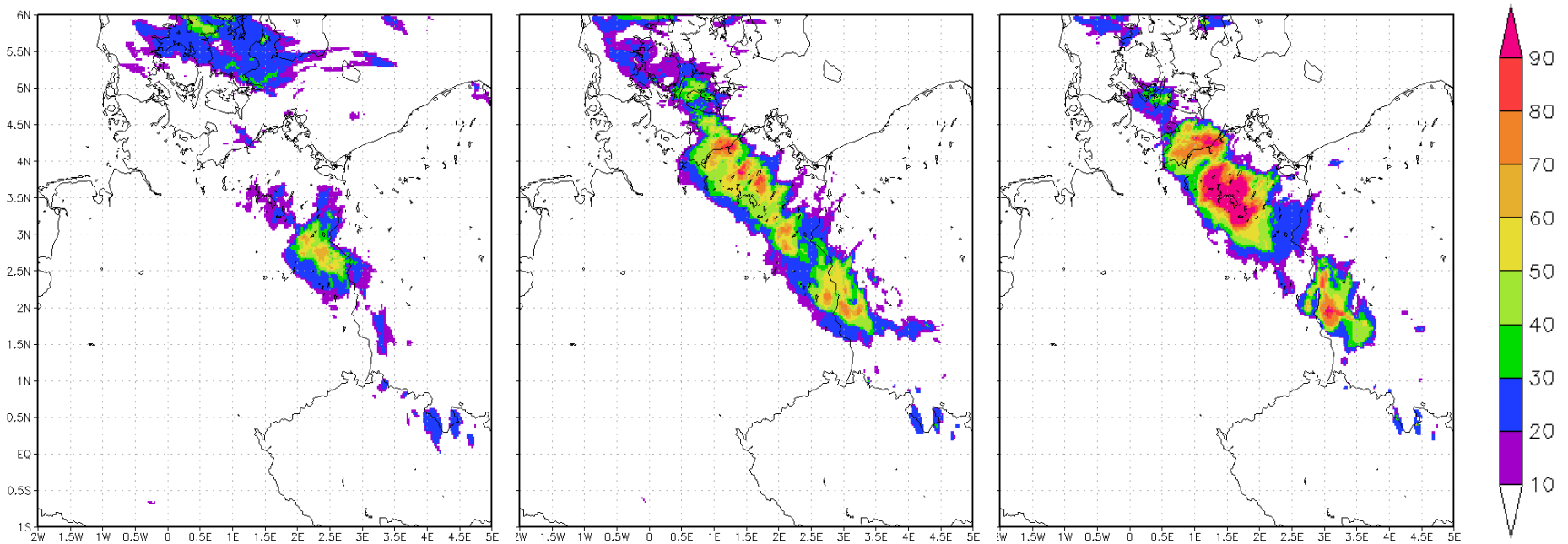
Rostock severe weather 22.07.2011

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COSMO-DE-EPS: Prob > 25 mm, 12h-RR 06-18 UTC

21 UTC run (day before) **00 UTC run** **03 UTC run**

+21h **+18** **+15**



COSMO-DE-EPS

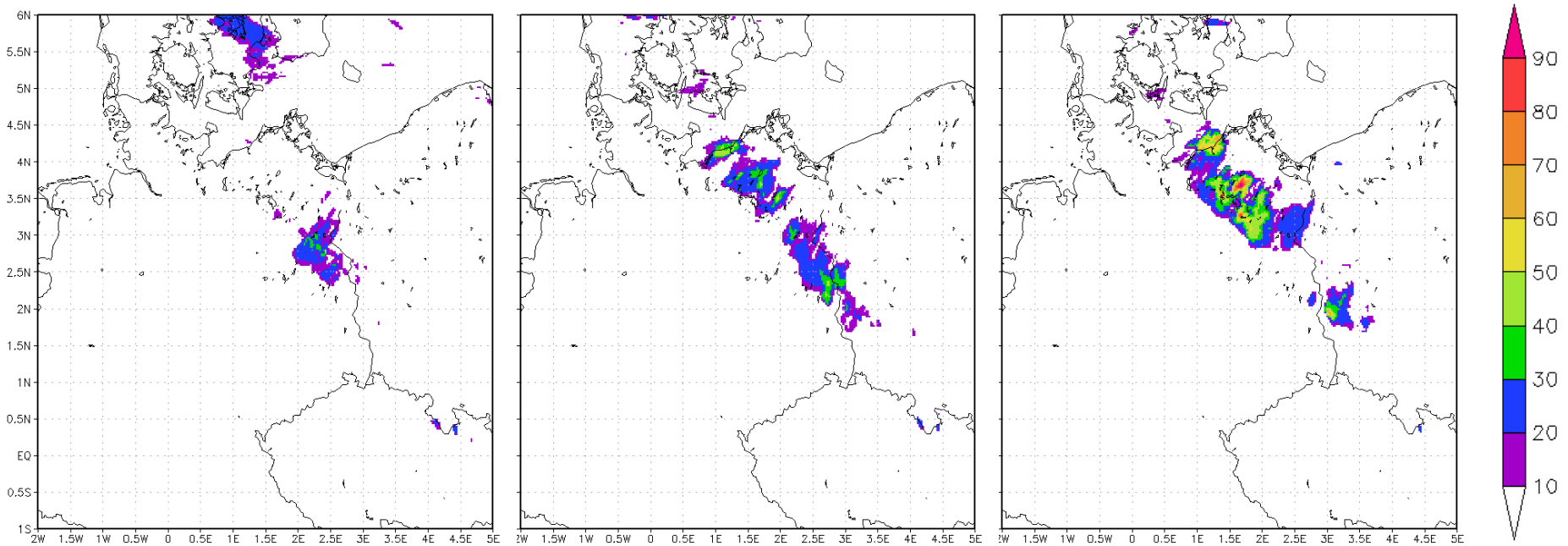
Rostock severe weather 22.07.2011

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

COSMO-DE-EPS: Prob > 40 mm, 12h-RR 06-18 UTC

21 UTC run (day before) **00 UTC run** **03 UTC run**

+21h **+18** **+15**



COSMO-DE-EPS

VERIFICATION OF COSMO-DE-EPS

all results for hourly precipitation

winter 2011/12

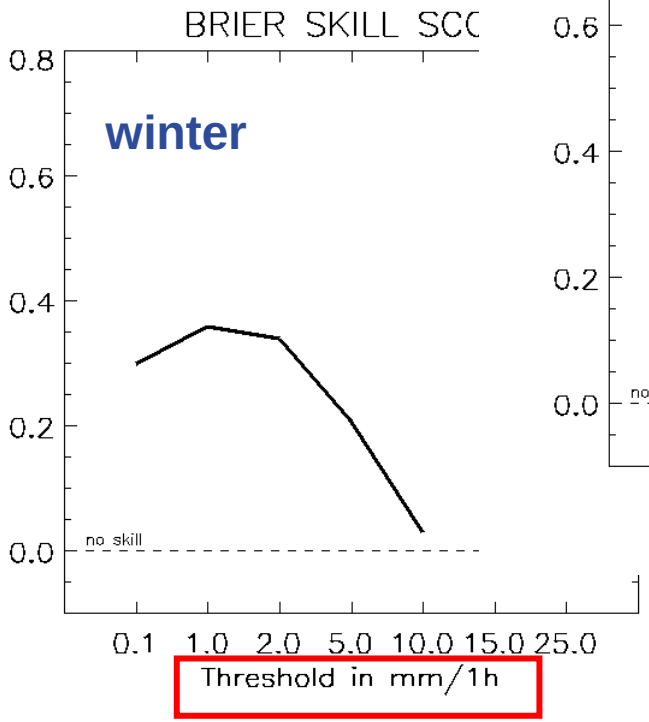
spring 2012

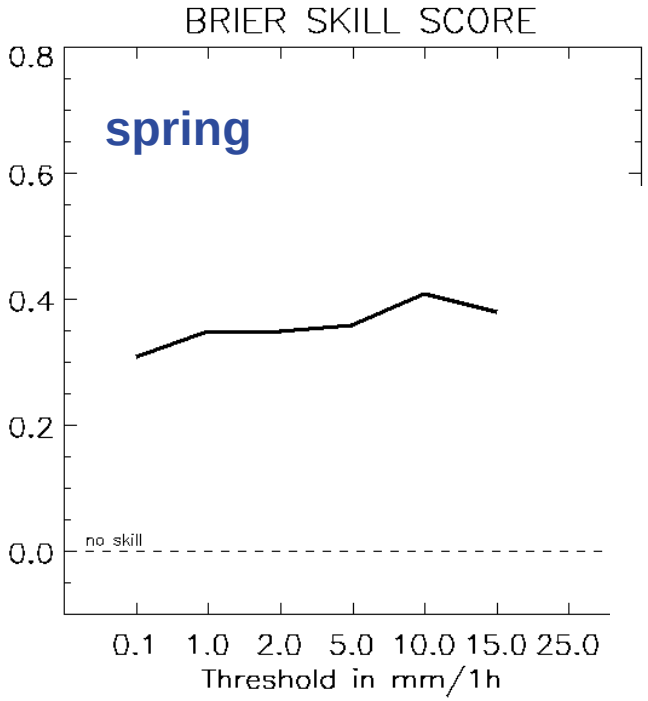
June/July 2012

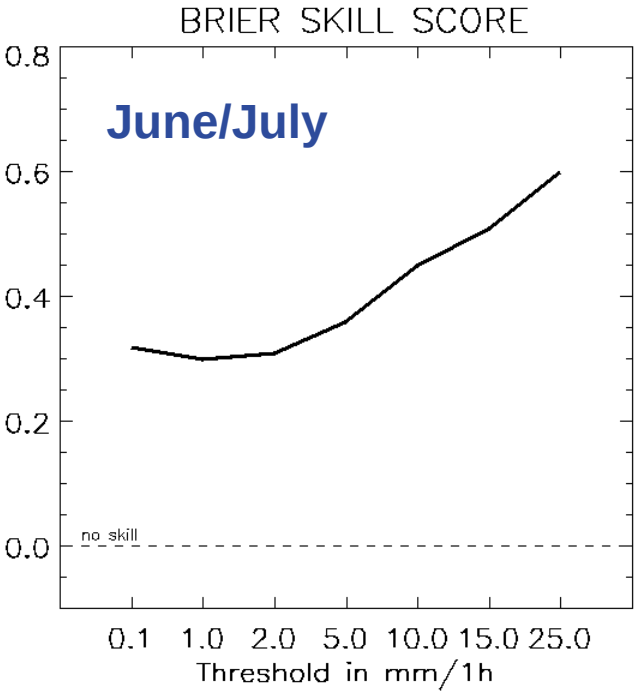
EPS not calibrated or post-processed

observations: rain-gauge adjusted radar

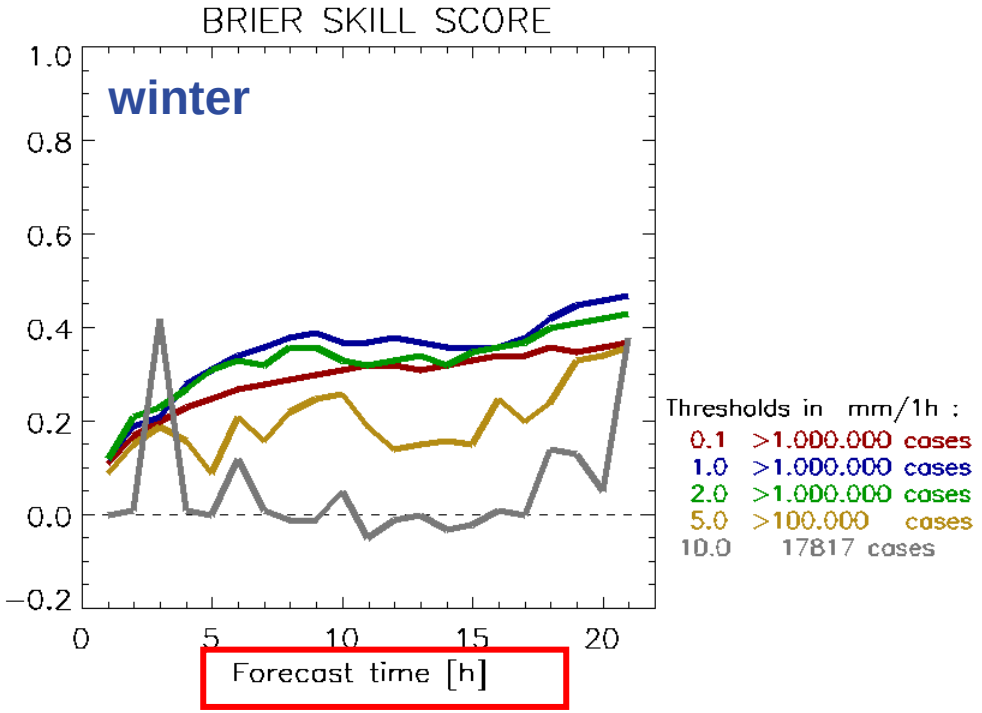
Brier Skill Score (reference: deterministic run of COSMO-DE)

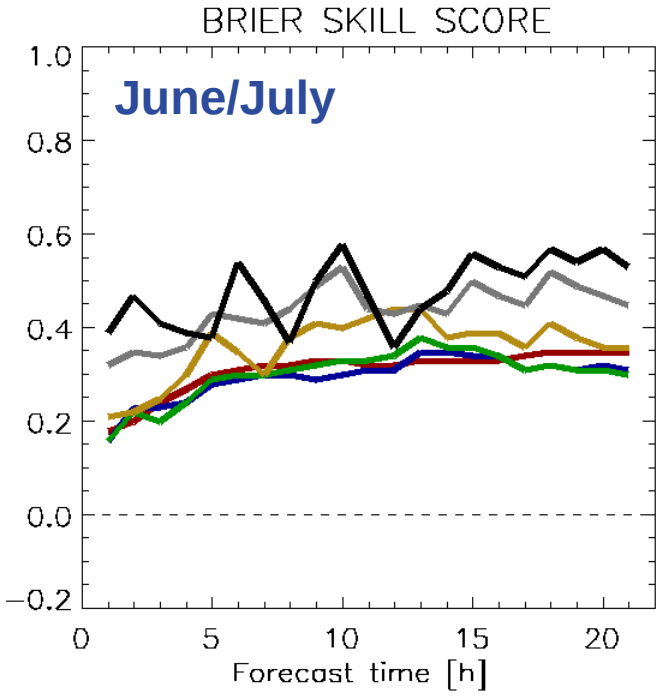




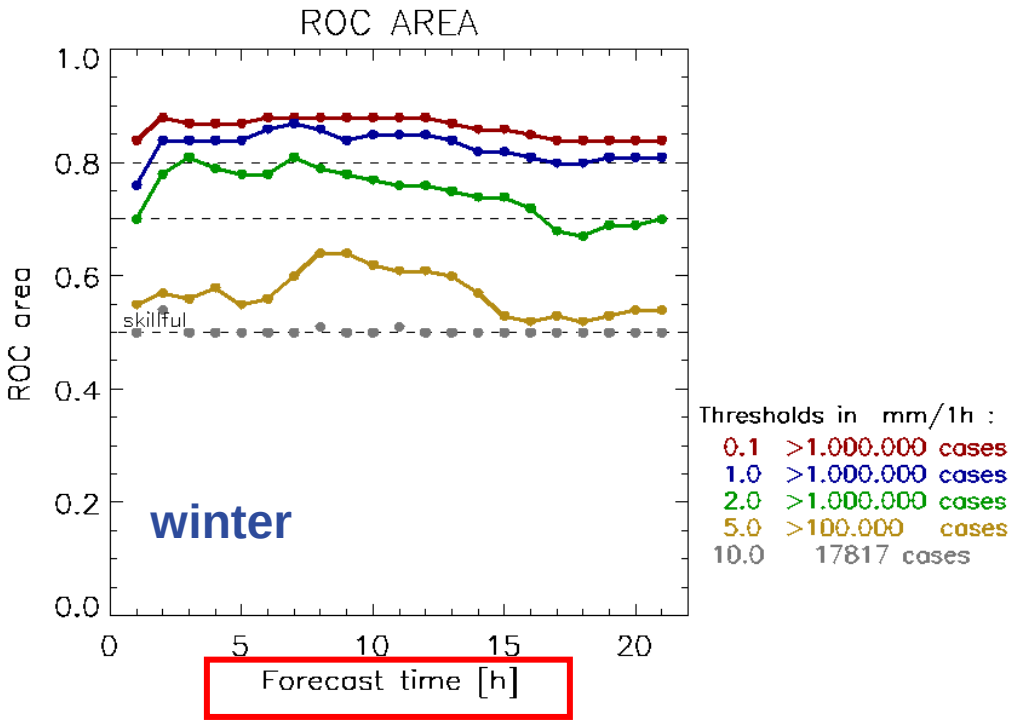


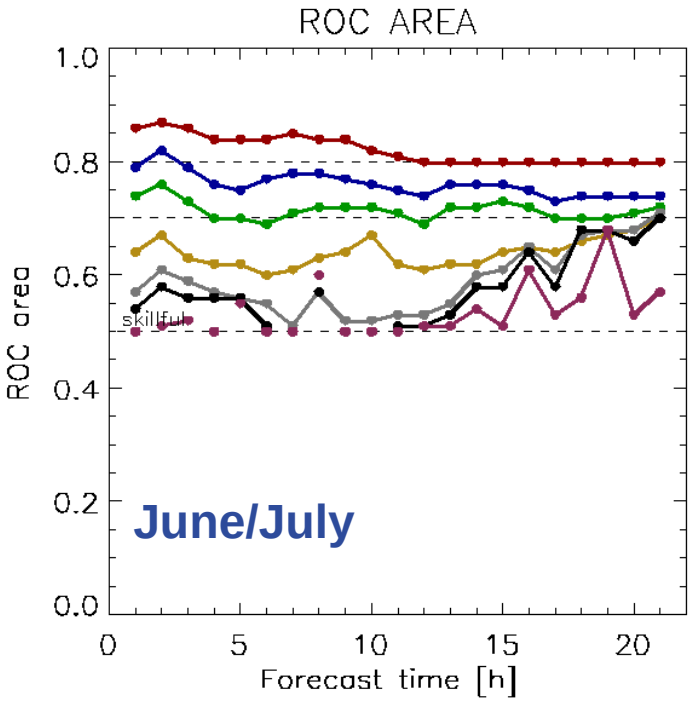
Brier Skill Score (reference: deterministic run of COSMO-DE)





ROC area


ROC AREA
ROC area
1.0
0.8
0.6
0.4
0.2
0.0
skillful
0
5
10
15
20
Forecast time [h]
winter
Thresholds in mm/1h :
0.1 >1.000.000 cases
1.0 >1.000.000 cases
2.0 >1.000.000 cases
5.0 >100.000 cases
10.0 17817 cases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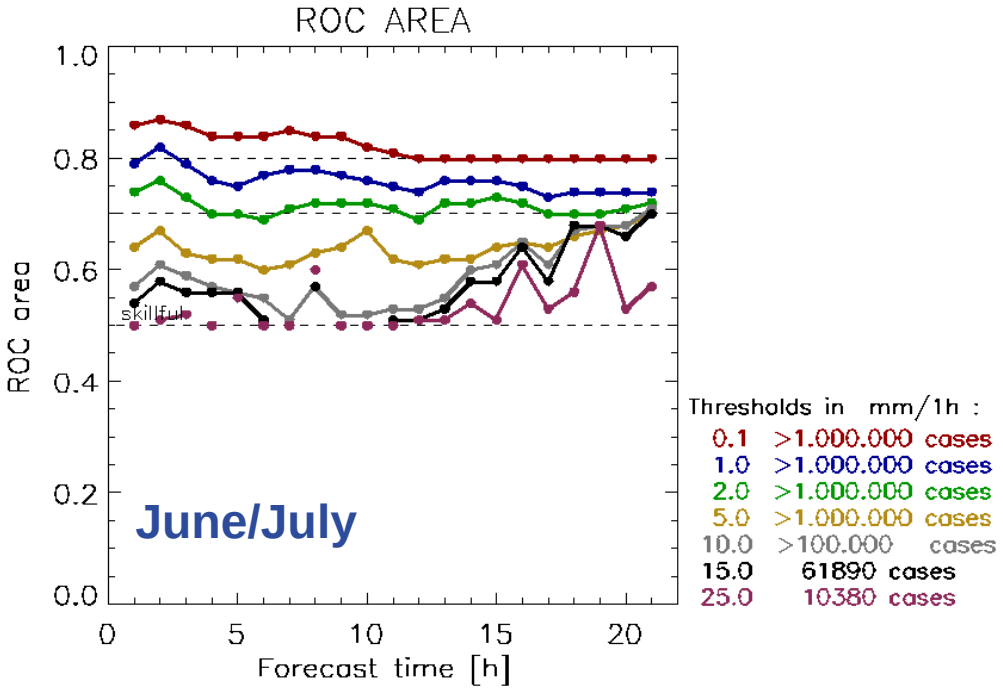
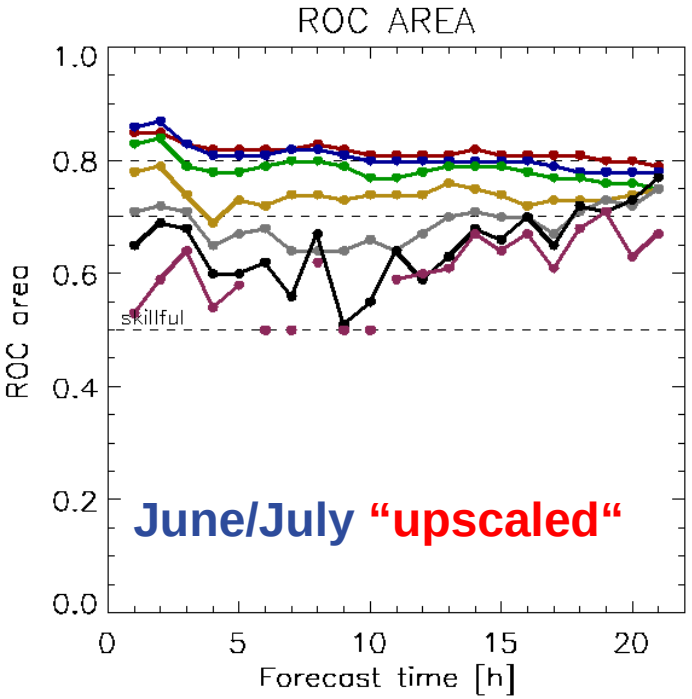
Forecast time [h]
June/July

ROC area

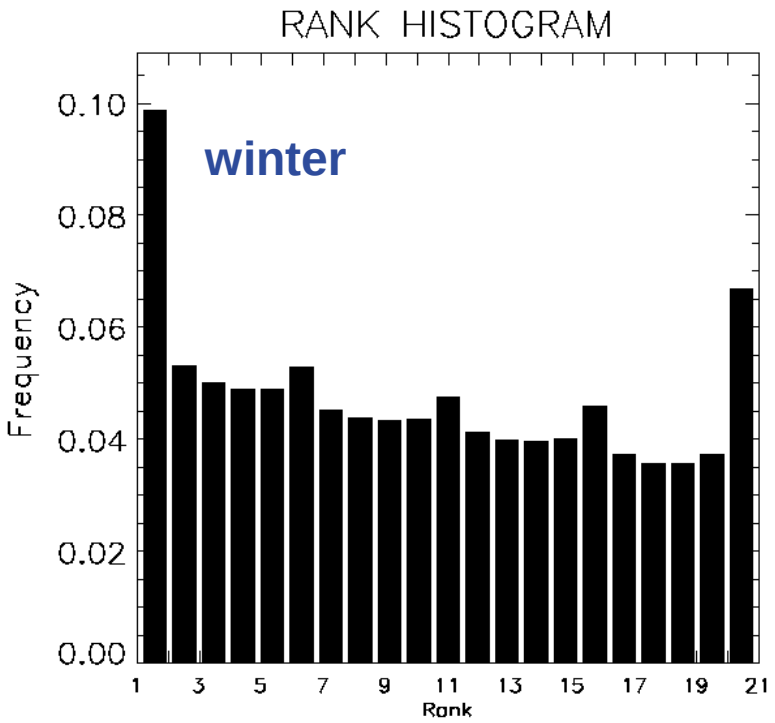


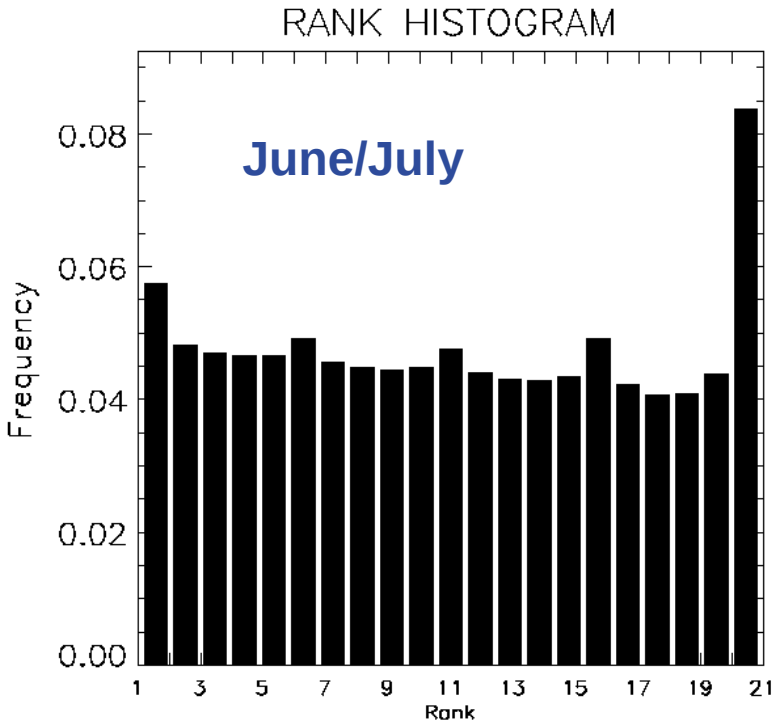


spatially "upscaled" means:

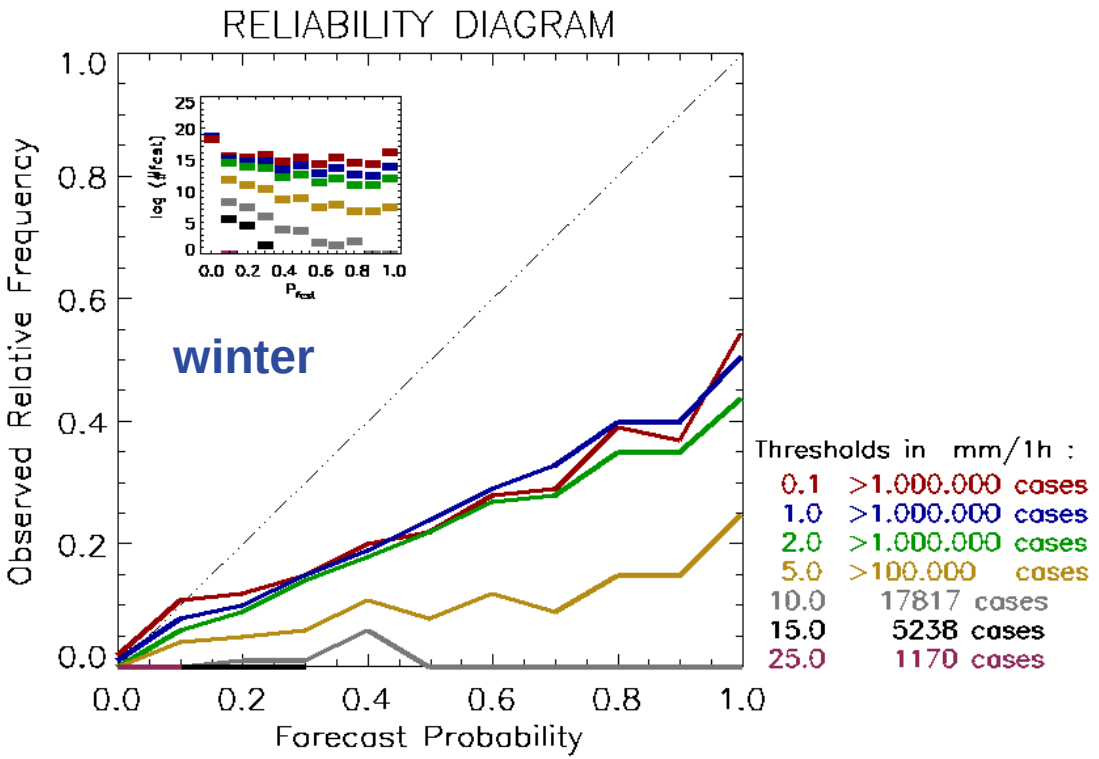
event somewhere within a 10x10 grid points environment

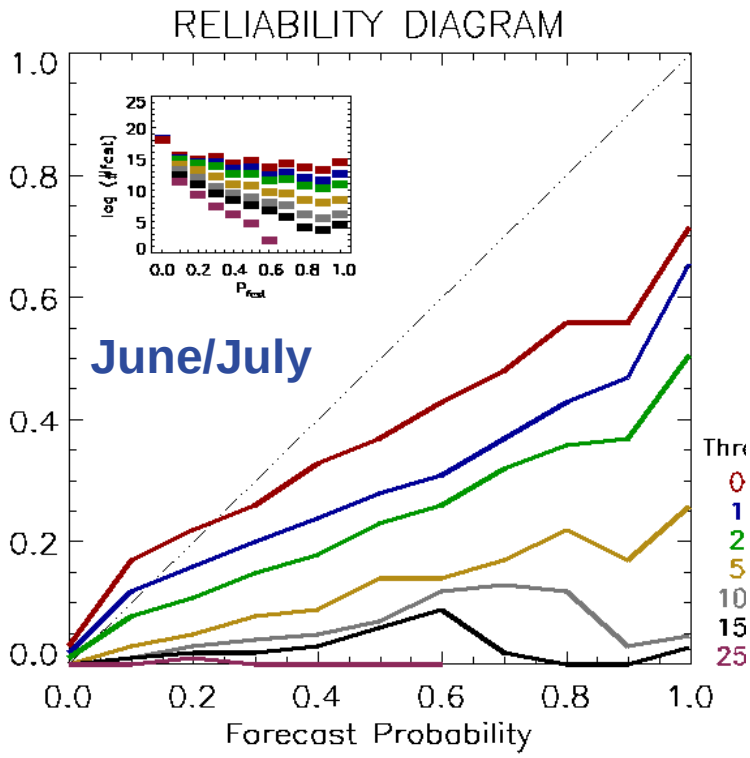
rank histogram





reliability diagram





Deutscher Wetterdienst
Wetter und Klima aus einer Hand

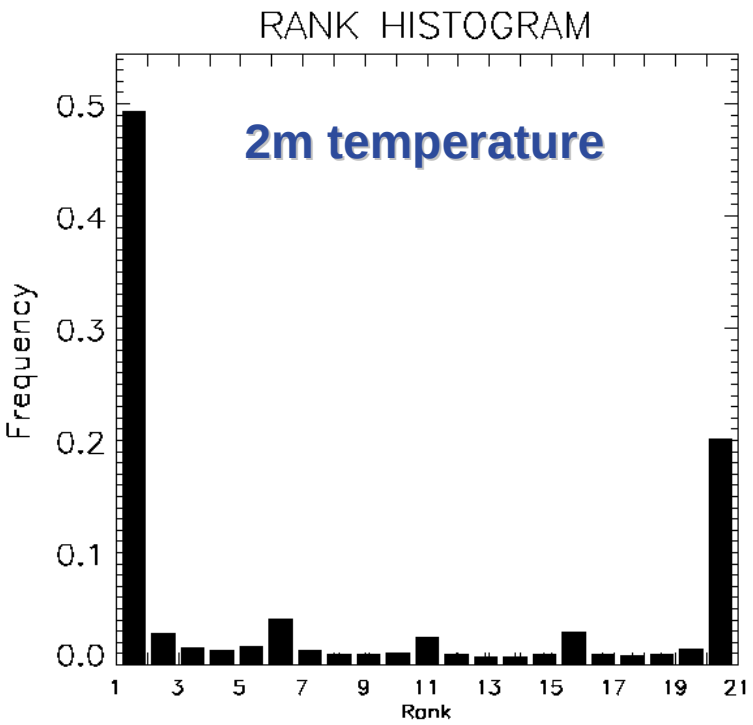
VERIFICATION OF COSMO-DE-EPS

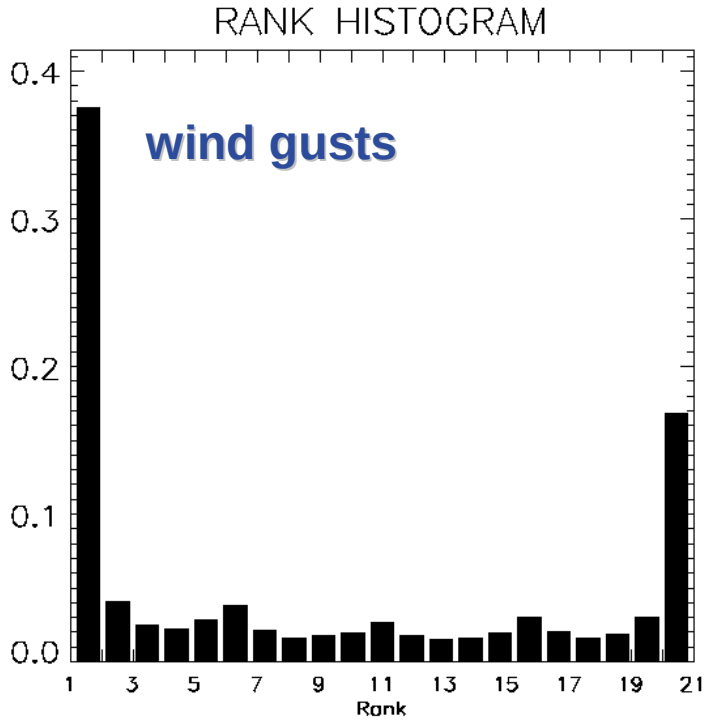
other variables

June/July 2012

observations: SYNOP

rank histogram





COSMO-DE-EPS status and plans

➔ **start of pre-operational mode (9th Dec 2010)**

2010

2011

➔ **undergoing evaluation by forecasters (EPS quality and visualization by NinJo)**

2012

switch to operational mode (22nd May 2012)

➔ **upgrade to 40 members, redesign**

2013 / 14

upgrade to 40 members, redesign

➔ **use of COSMO-LEPS members as boundary conditions (COSMO-LEPS is driven by IFS EPS of ECMWF)**

slight improvements for precip.,
degradation of 2m temperature results

➔ **perturbation of soil moisture**

better results for 2m temperature, slight improvements for precip.

➔ **additional physics perturbations (minimum diffusion, z_0)**

better results for 2m temperature,
slight improvement for wind gusts

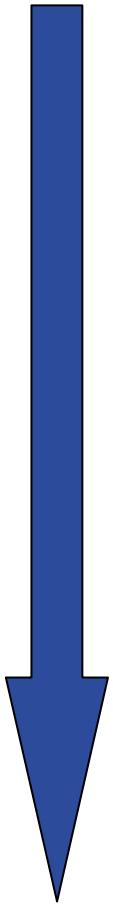
COSMO-DE-EPS status and plans

- ➔ start of pre-operational mode (9th Dec 2010)

- ➔ undergoing evaluation by forecasters
  (EPS quality and visualization by NinJo)

— switch to operational mode —
(22nd May 2012)

- ➔ upgrade to 40 members, redesign
- ➔ statistical postprocessing



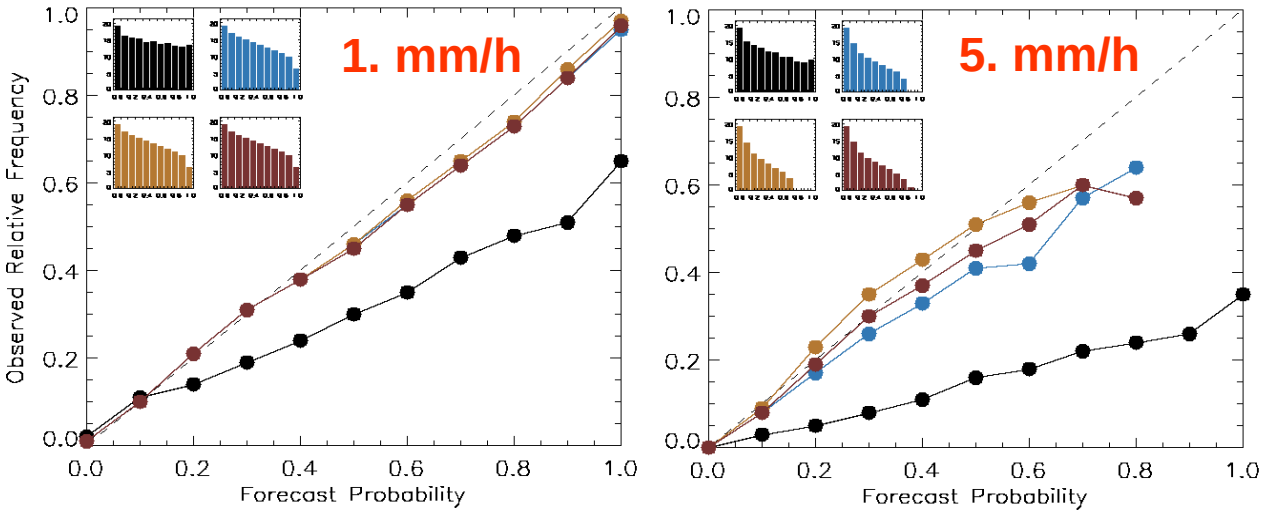
2010

2011

2012

2013 / 14

- **Non calibrated**
- **Calibrated with standard logistic regression**
- **Calibrated with extended logistic regression**
- **Calibrated with extended logistic regression (2nd linearization)**



COSMO-DE-EPS status and plans

- ➔ start of pre-operational mode (9th Dec 2010)

- ➔ undergoing evaluation by forecasters
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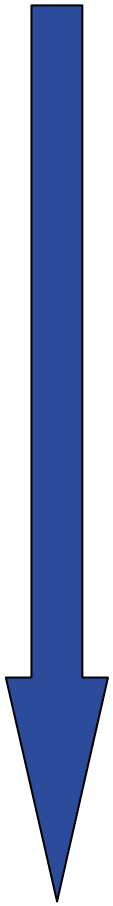
— switch to operational mode —
(22nd May 2012)

- ➔ upgrade to 40 members, redesign
- ➔ statistical postprocessing
- ➔ lagged average forecast



2010

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2012

2013 / 14

COSMO-DE-EPS status and plans

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2010

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  (EPS quality and visualization by NinJo)

2011

2012

switch to operational mode
(22nd May 2012)

- ➔ upgrade to 40 members, redesign
- ➔ statistical postprocessing
- ➔ lagged average forecast
- ➔ initial conditions by LETKF (“KENDA”)
- ➔ lateral boundary conditions by ICON EPS

2013 / 14

Thank you!