LAMEPS – Limited area ensemble forecasting in Norway, using targeted EPS

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Limited area ensemble forecasting in Norway - outline

- Ensembles using Norway's operational version of the HIRLAM model – LAMEPS
- Perturbing initial state and lateral boundary conditions with a dedicated version of EPS from ECMWF - TEPS
- Combining these two systems gives NORLAMEPS
- Main focus is precipitation, especially extreme precipitation events
- Running storm surge from EPS,TEPS and LAMEPS

TEPS

- A dedicated version of EPS, differences are
  - 20 + 1 ensemble members, as opposed to 50 +1 for EPS
  - Target area Northern Europe and adjacent sea areas, as opposed to NH north of 30°N(*)
  - Run to +96h, as opposed to +240h for EPS
- Running at 12 UTC every day
- Running at ECMWF for ¾ year
- Operational since 5 April 2005
- ~80 km, 40 vertical levels

LAMEPS

- HIRLAM in ensemble set-up
- Resolution: 20km, 40 levels in the vertical
- +60h
- 20 + 1 members
- Running at 18UTC every day
- Quasi-operational at met.no since 14 February 2005

NORLAMEPS

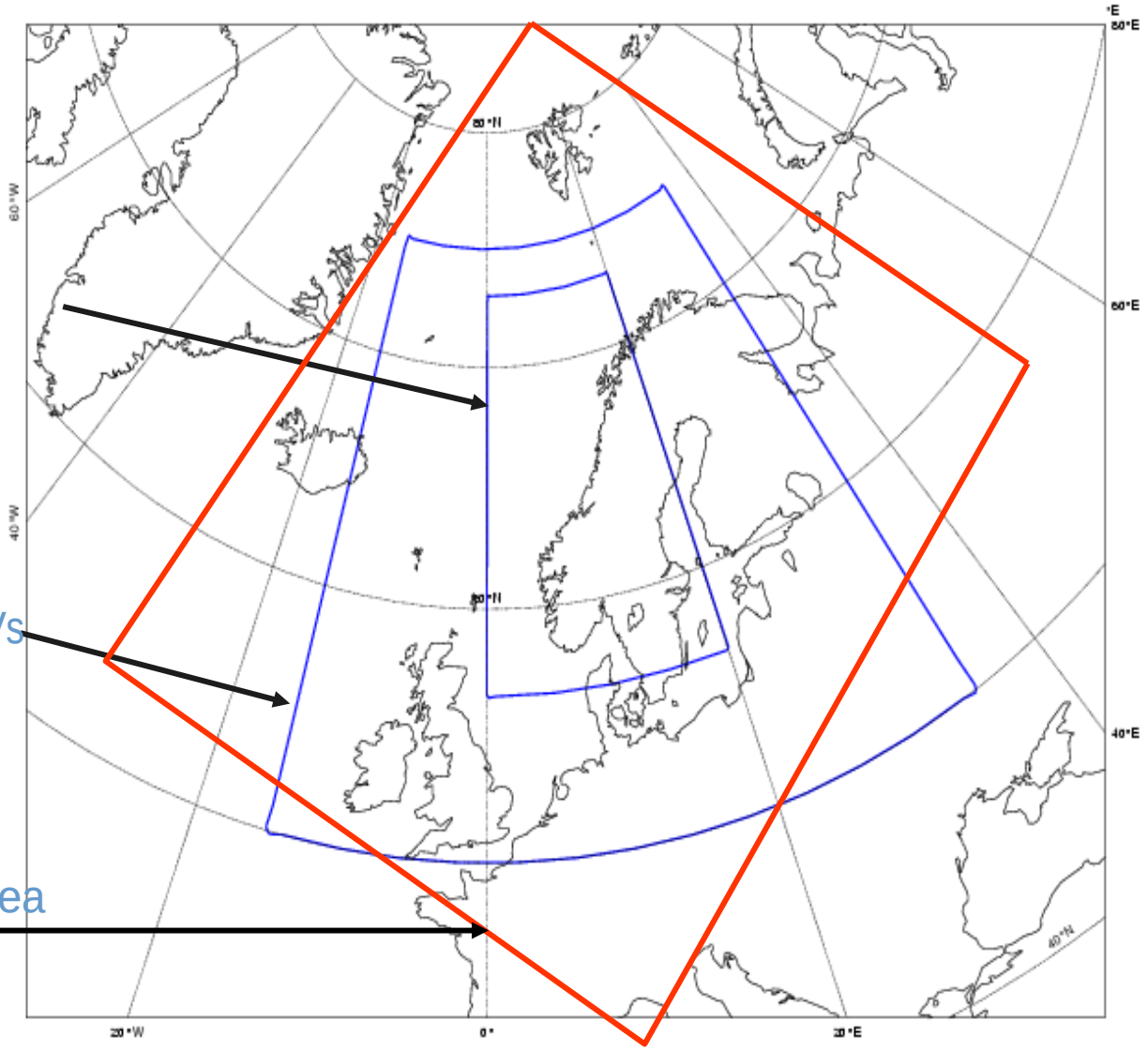
- An ensemble prediction system using IFS and HIRLAM
  - A simple combination of TEPS and EPS
- NORLAMEPS is a supplement to EPS from ECMWF:
  - NORLAMEPS includes two different models (model uncertainty)
  - NORLAMEPS has better resolution than EPS
  - NORLAMEPS is designed for our area of interest
  - For day 1 – 3

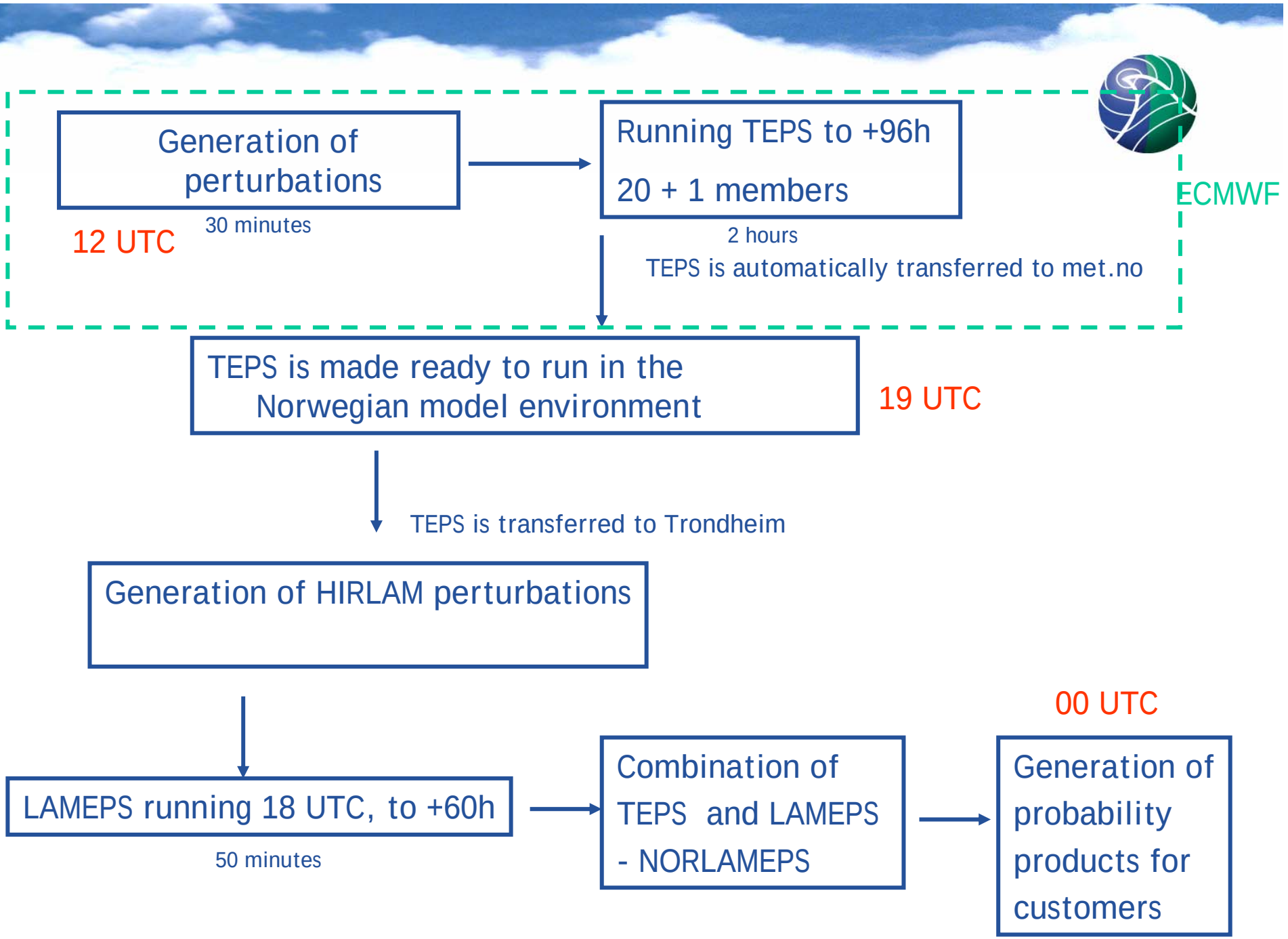
AREAS USED

Verification area

Target area SVs

Integration area HIRLAM




Generation of perturbations
30 minutes
12 UTC
Running TEPS to +96h
20 + 1 members
2 hours
ECMWF
TEPS is automatically transferred to met.no
TEPS is made ready to run in the Norwegian model environment
19 UTC
TEPS is transferred to Trondheim
Generation of HIRLAM perturbations
LAMEPS running 18 UTC, to +60h
50 minutes
Combination of TEPS and LAMEPS - NORLAMEPS
00 UTC
Generation of probability products for customers

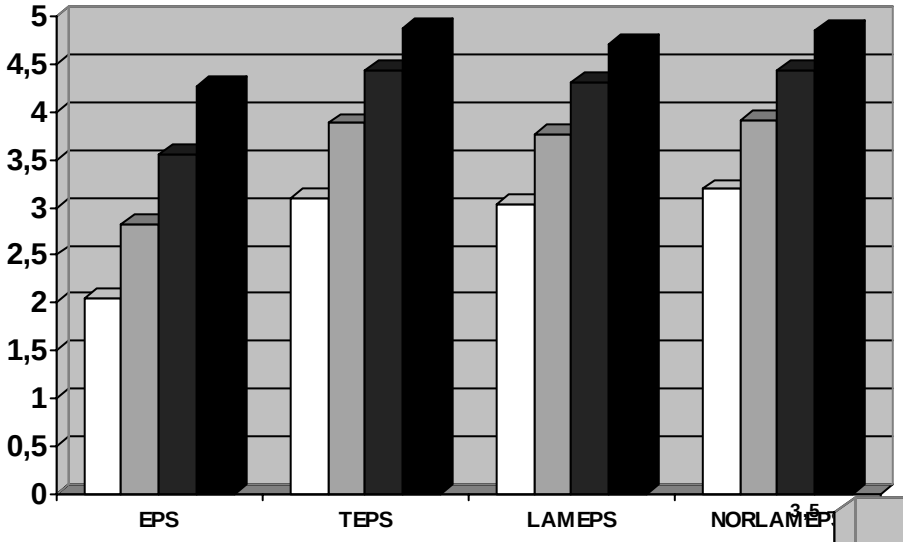
Verification methodology - 1

- Verify precipitation against “super-observations”. (Ghelli and Lalaurette).
- All precipitation stations in Norway inside the verification area are aggregated using the method of Kriging (Ripley 1981)
- Total precipitation (stratiform and convective) from LAMEPS, TEPS, EPS and NORLAMEPS are compared to these super-observations

Verification methodology – 2

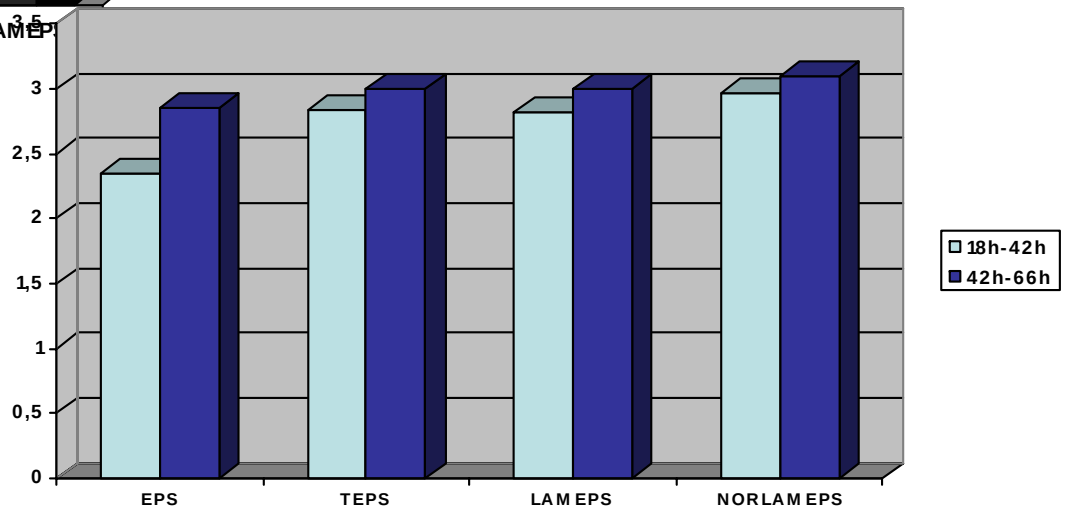
- Agglomerations of samples spanning locations and times with different climatological frequencies can lead to spurious skill (Hamill, 2005).
- Distribution of precipitation in Norway is dominated by sharp gradients (*)
- We verify sub regions with grossly different precipitation climatology separately.
- Averages are calculated using weights reflecting the area of the sub regions

Spread around ensemble mean for a test-run (45 cases)

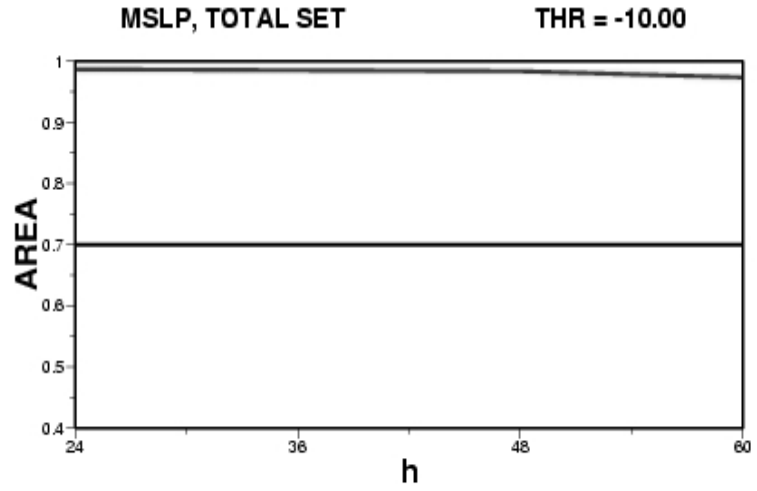


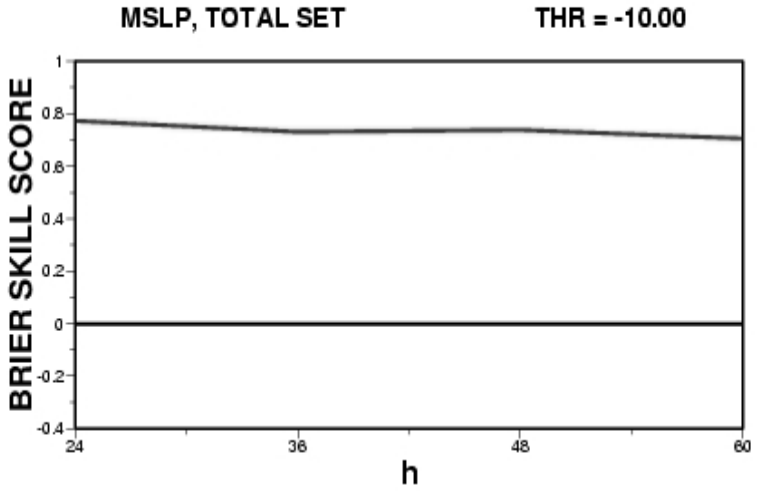
MSLP

PRECIP.



LAMEPS MSLP – test cases

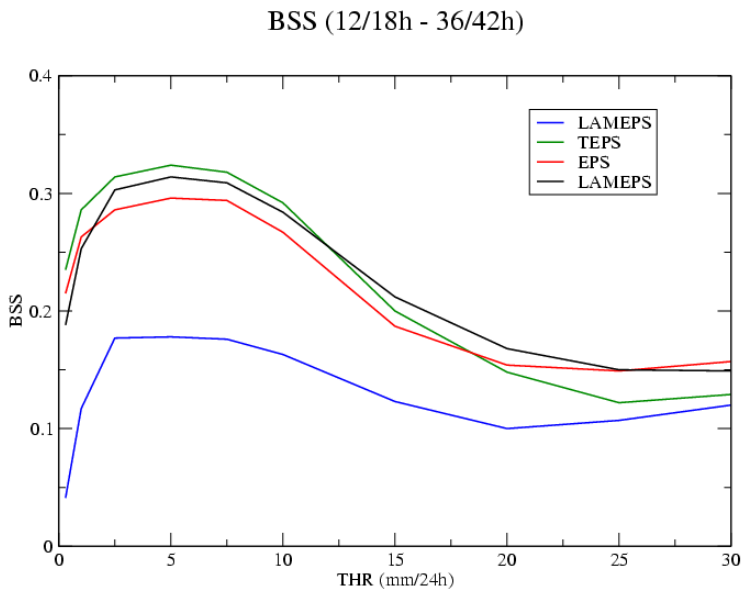


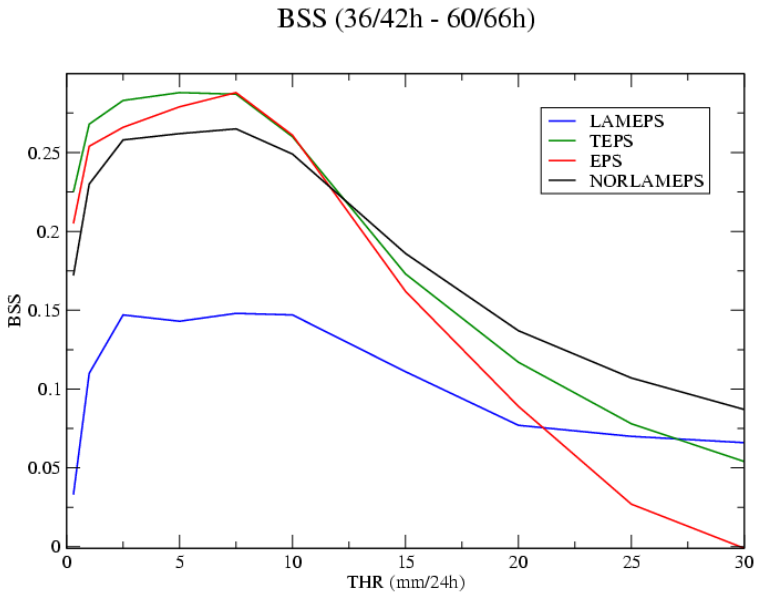


RESULTS FROM QUASI-OPERATIONAL RUNS

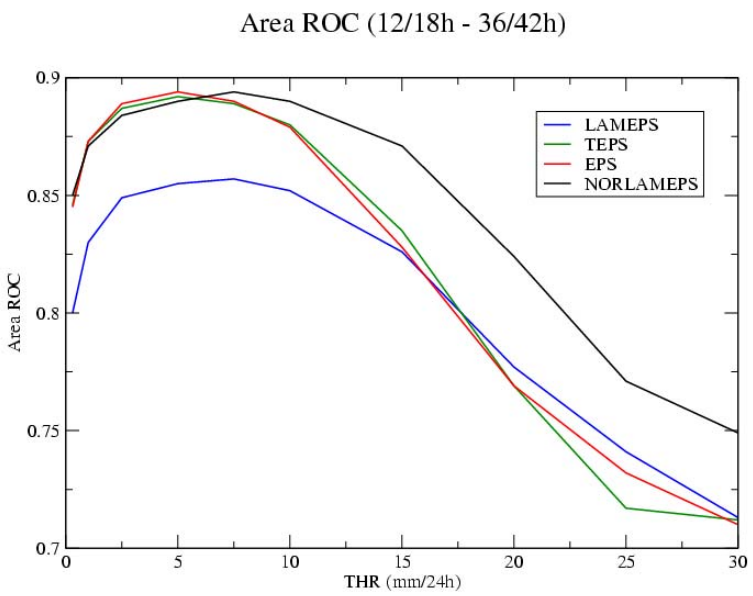
- Verification since 14 February 2005 until 24 July 2005 = 161 days
- Mean over the three verification areas based on precipitation climatology
- Important: verification is done for
  - LAMEPS 20 + 1 members
  - TEPS 20 + 1 members
  - EPS 50 + 1 members
  - NORLAMEPS 41 + 1 members
- Parameter: 24 hours precipitation (from 06 to 06 UTC)
- Forecast lengths
  LAMEPS: +36 and +60 hours
  TEPS : +42 and +66 hours
  EPS : +42 and +66 hours

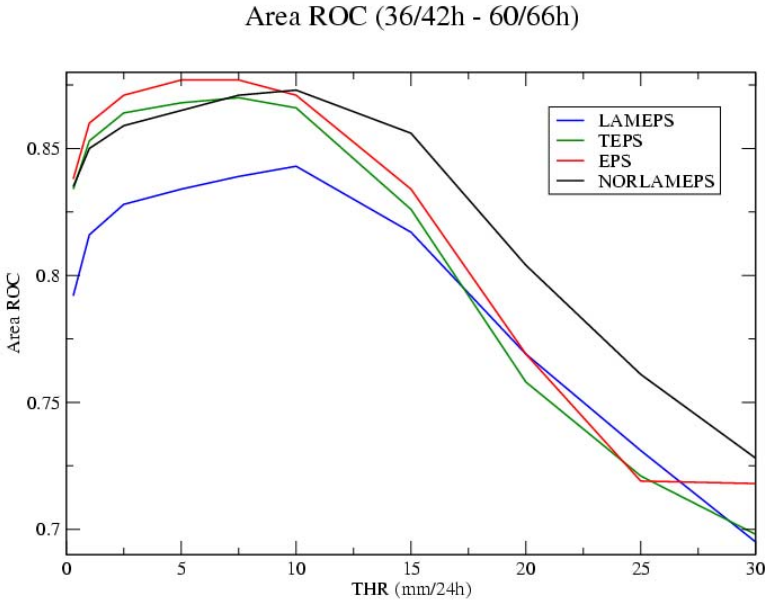
BRIER SKILL SCORE



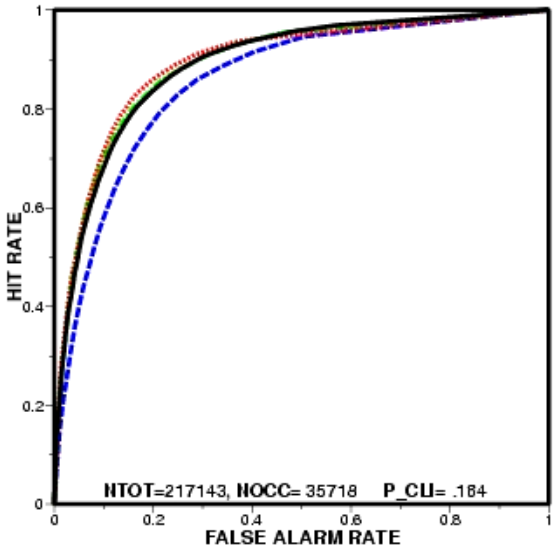


Area under ROC-curve

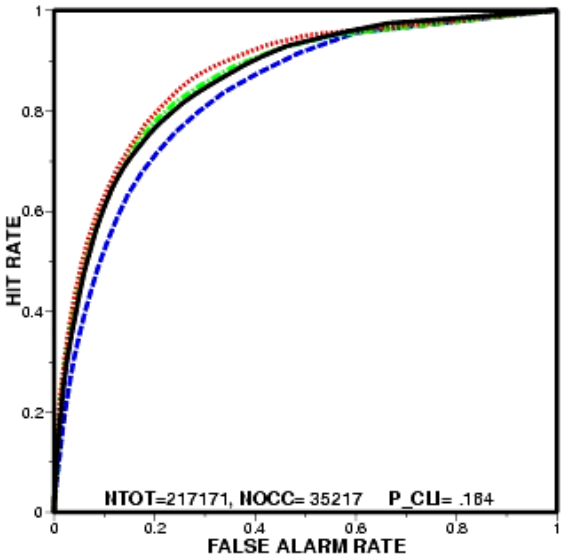




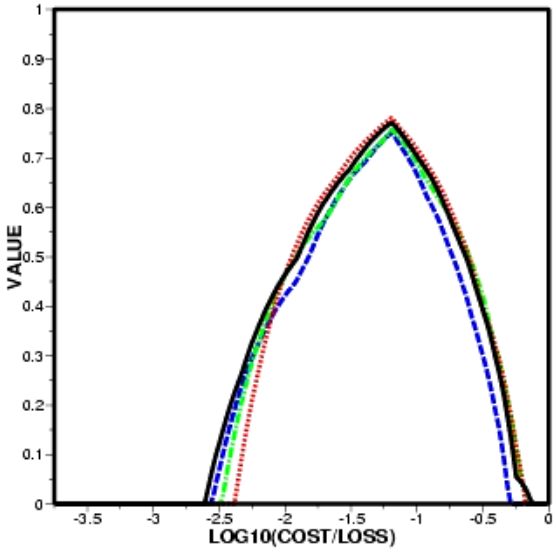
SMALL THRESHOLD: 5 mm/24h

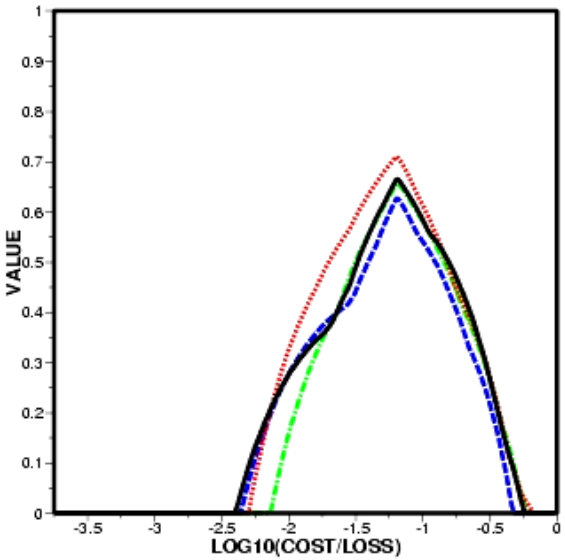


PRECIP, + 42h, THR = 5.00



PRECIP, + 66h, THR = 5.00





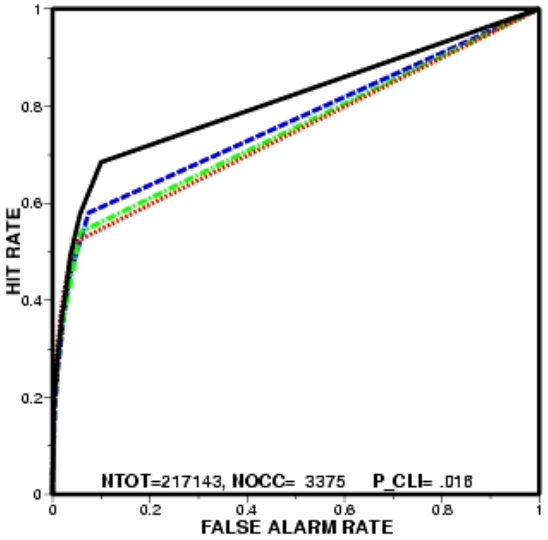
LAMEPS

TEPS

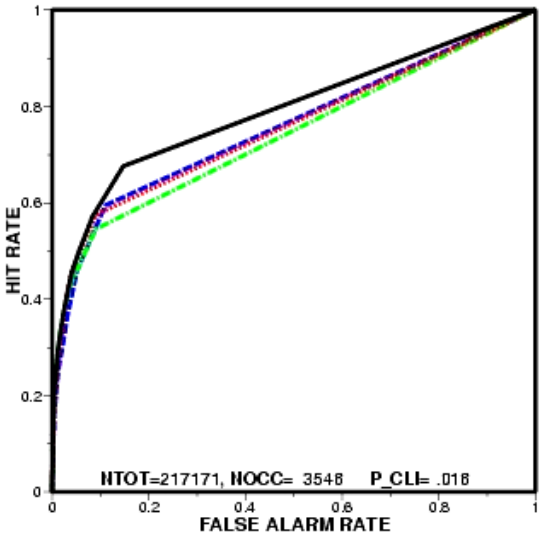
EPS

NORLAMEPS

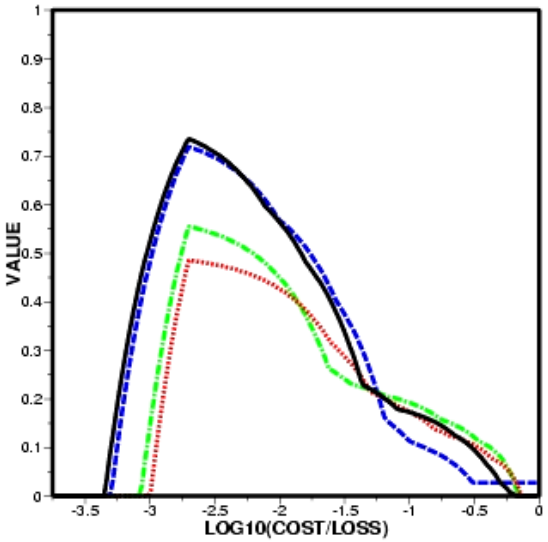
Large threshold: 20 mm/24h

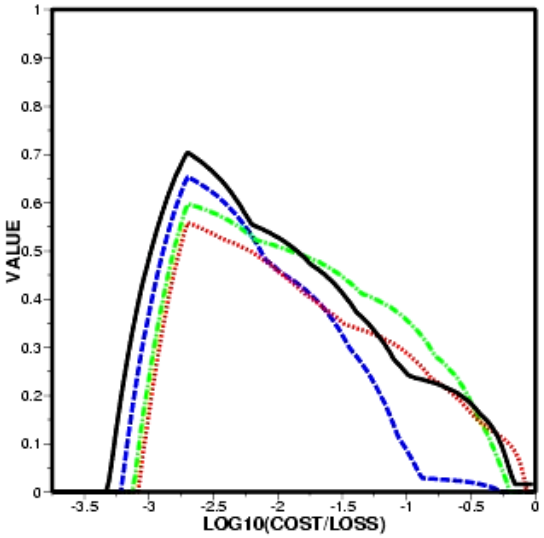


PRECIP, + 42h, THR = 20.00



PRECIP, + 66h, THR = 20.00





LAMEPS

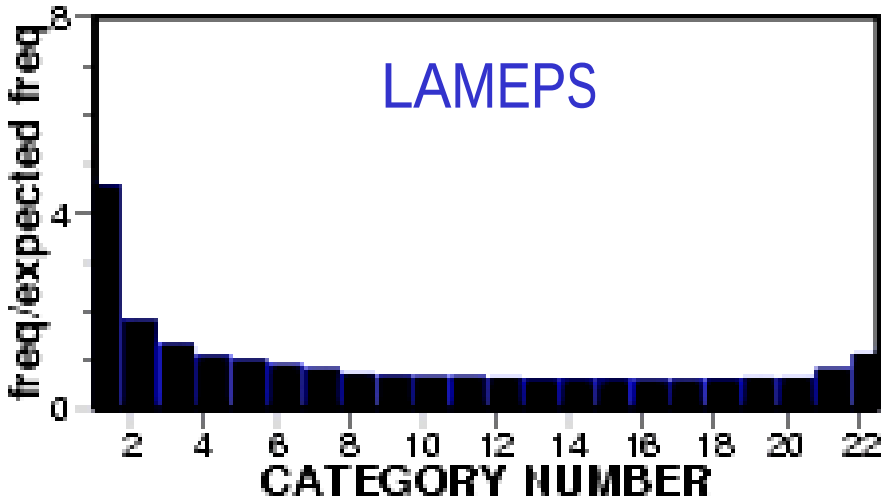
TEPS

EPS

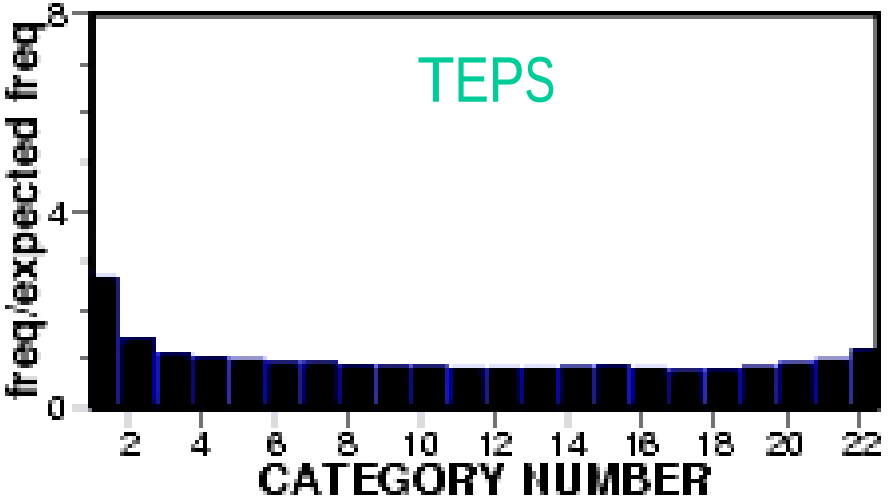
NORLAMEPS

Rank histograms

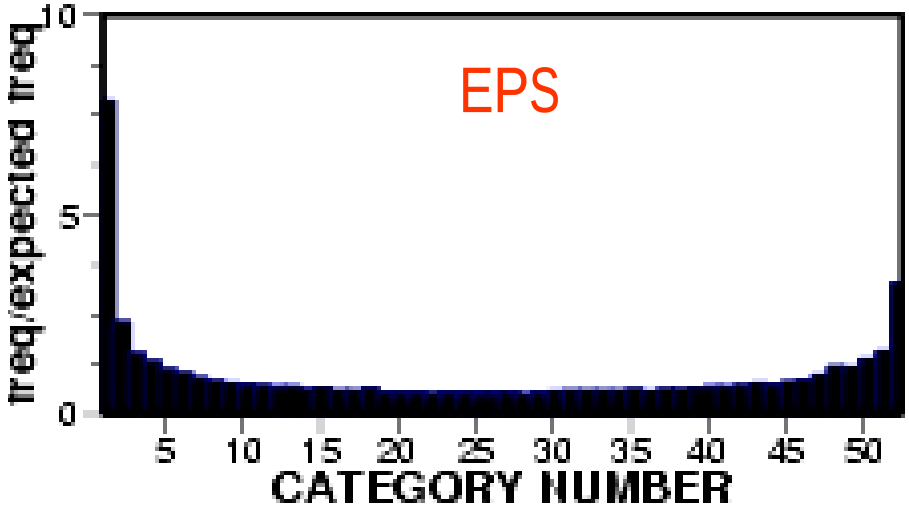
+60



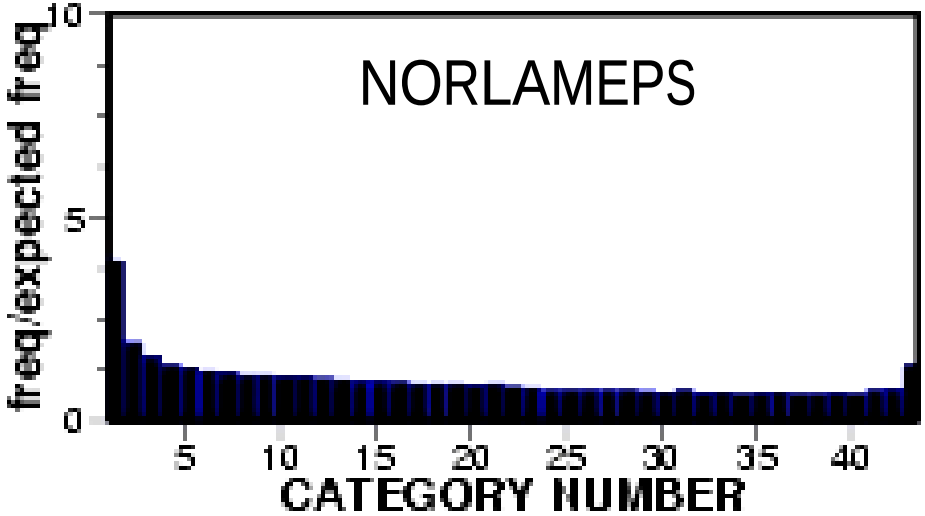
+66



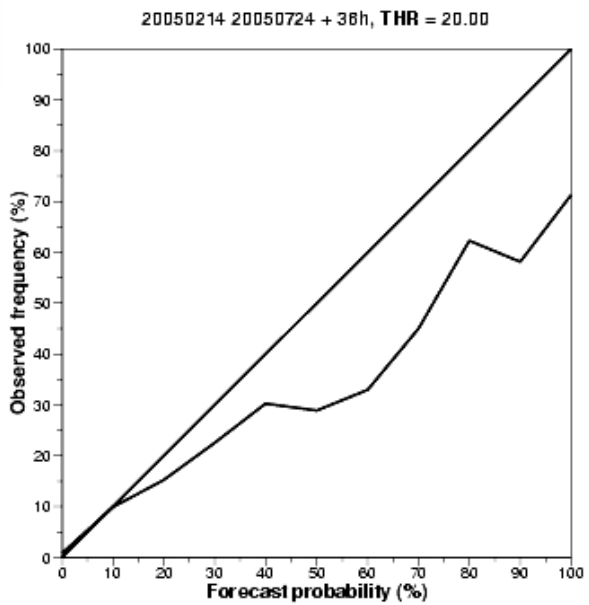
+66



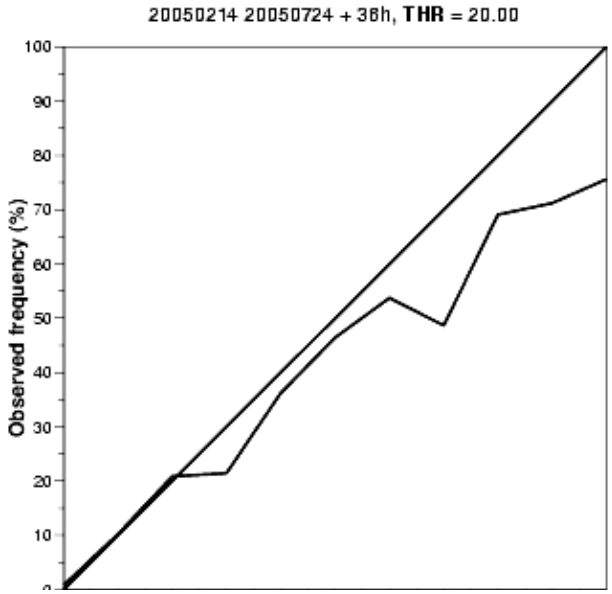
+66



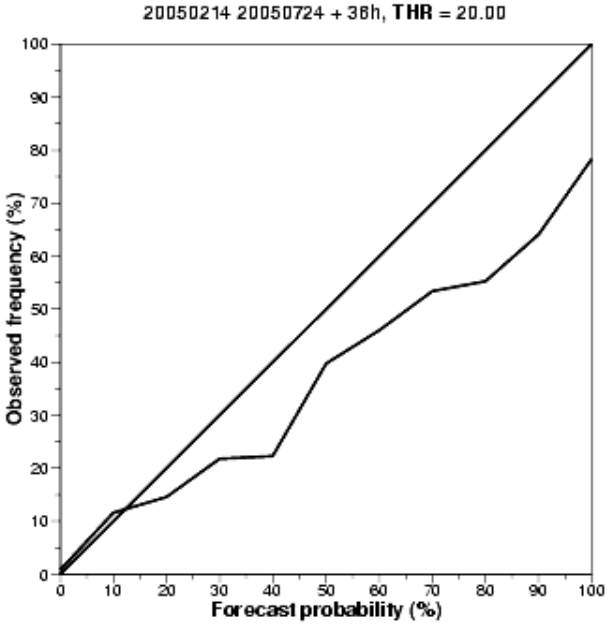
Reliability diagrams



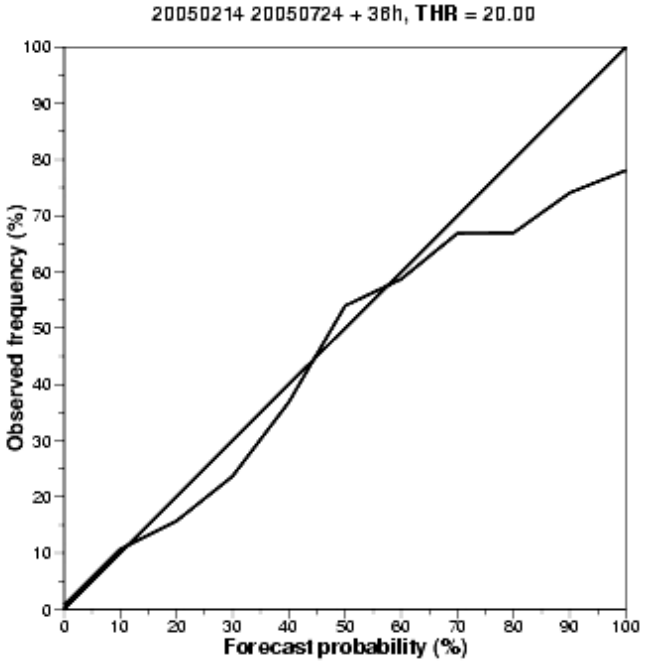
LAMEPS



TEPS



EPS



NORLAMEPS

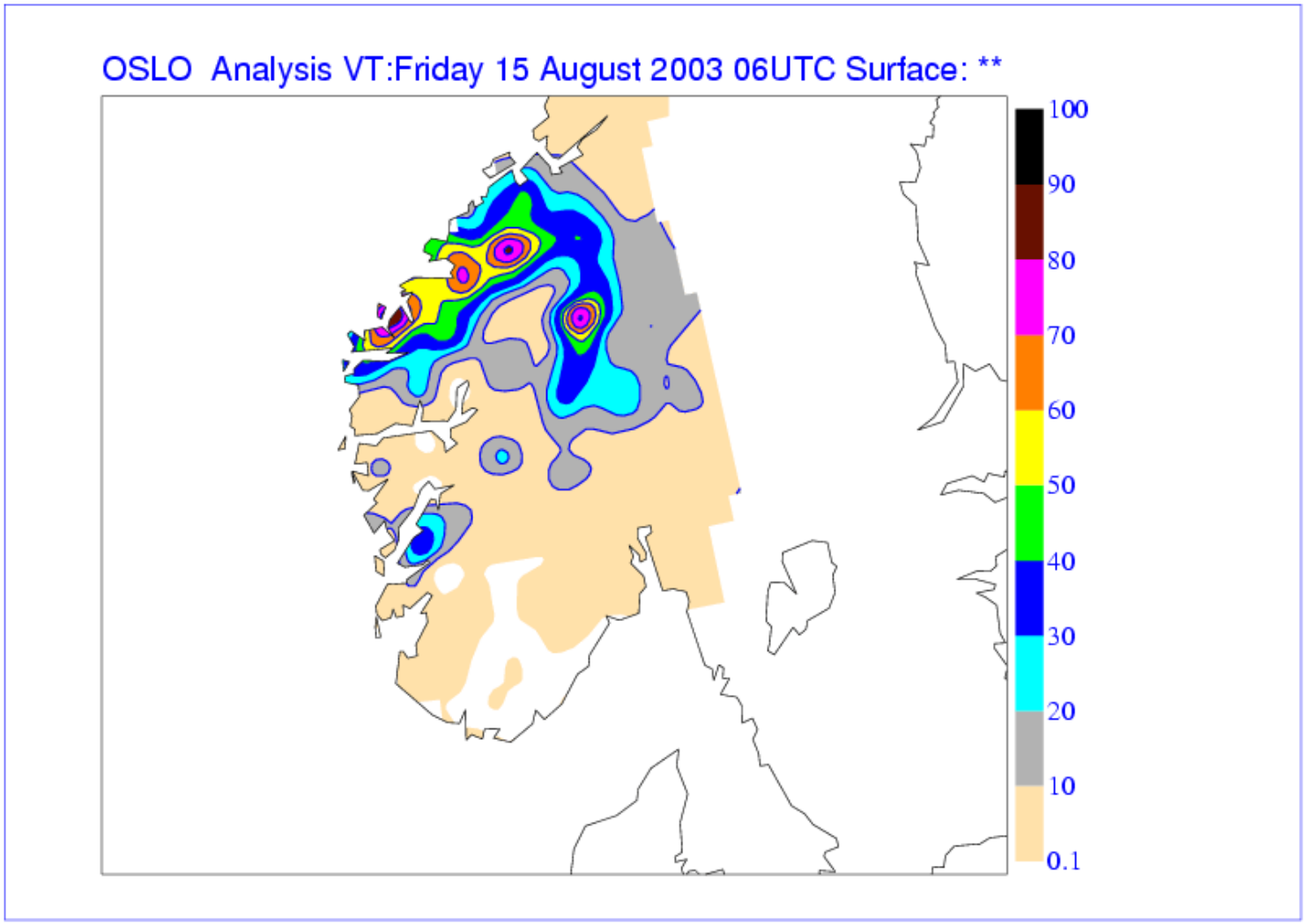
Case study: “100 year precipitation” in the middle part of Norway in August 2003

- 14. – 15. August 2003
- Atnadalen:

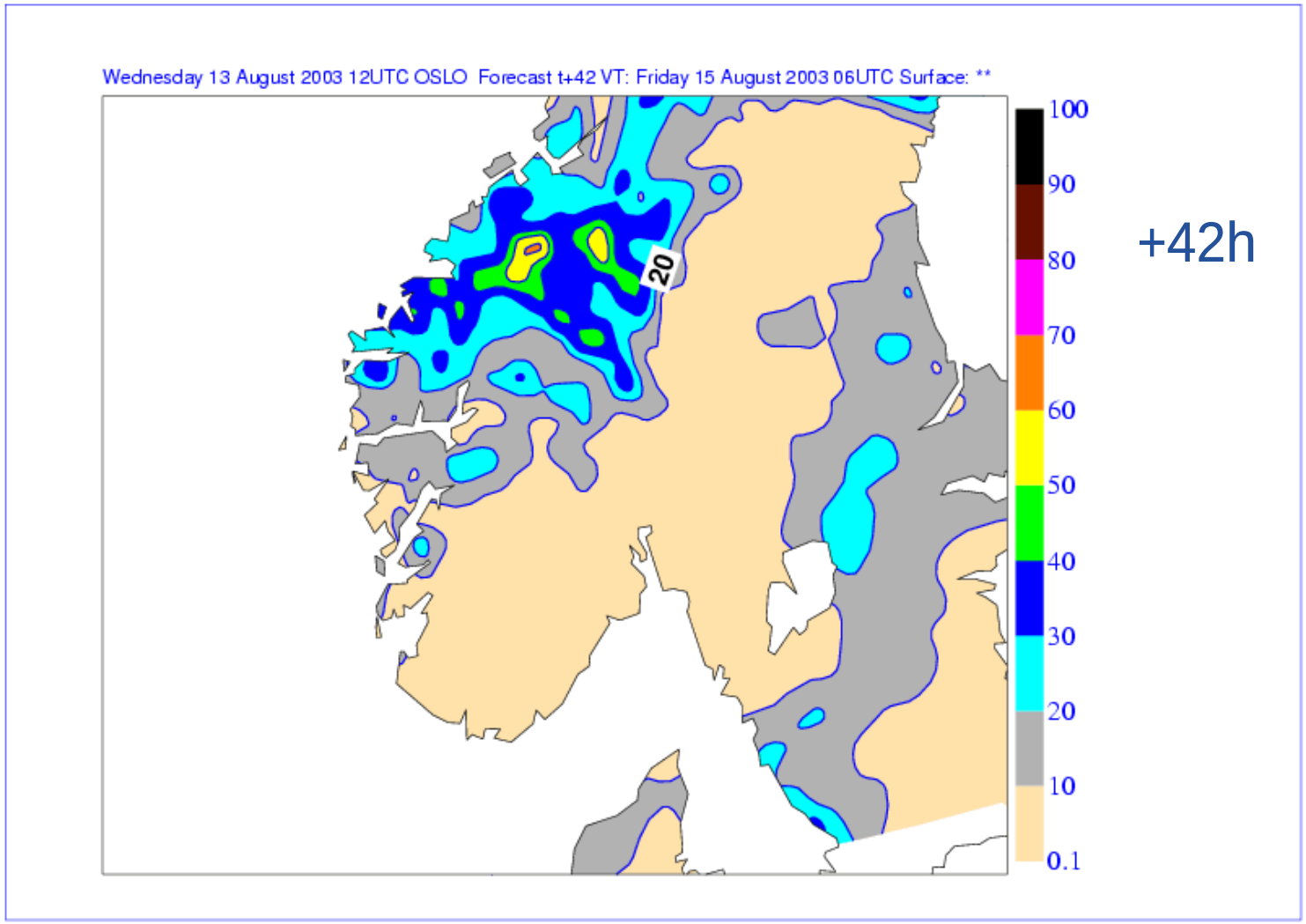
  116,5 mm/24h, 156,2 mm/48h
- Sunndalsøra:

  102,5 mm/24h, 171,9 mm/48h

14. Aug. 06UTC - 15. Aug. 06UTC



Observed



Operational HIRLAM 20 km

ECMWF
TEPS
ensemble

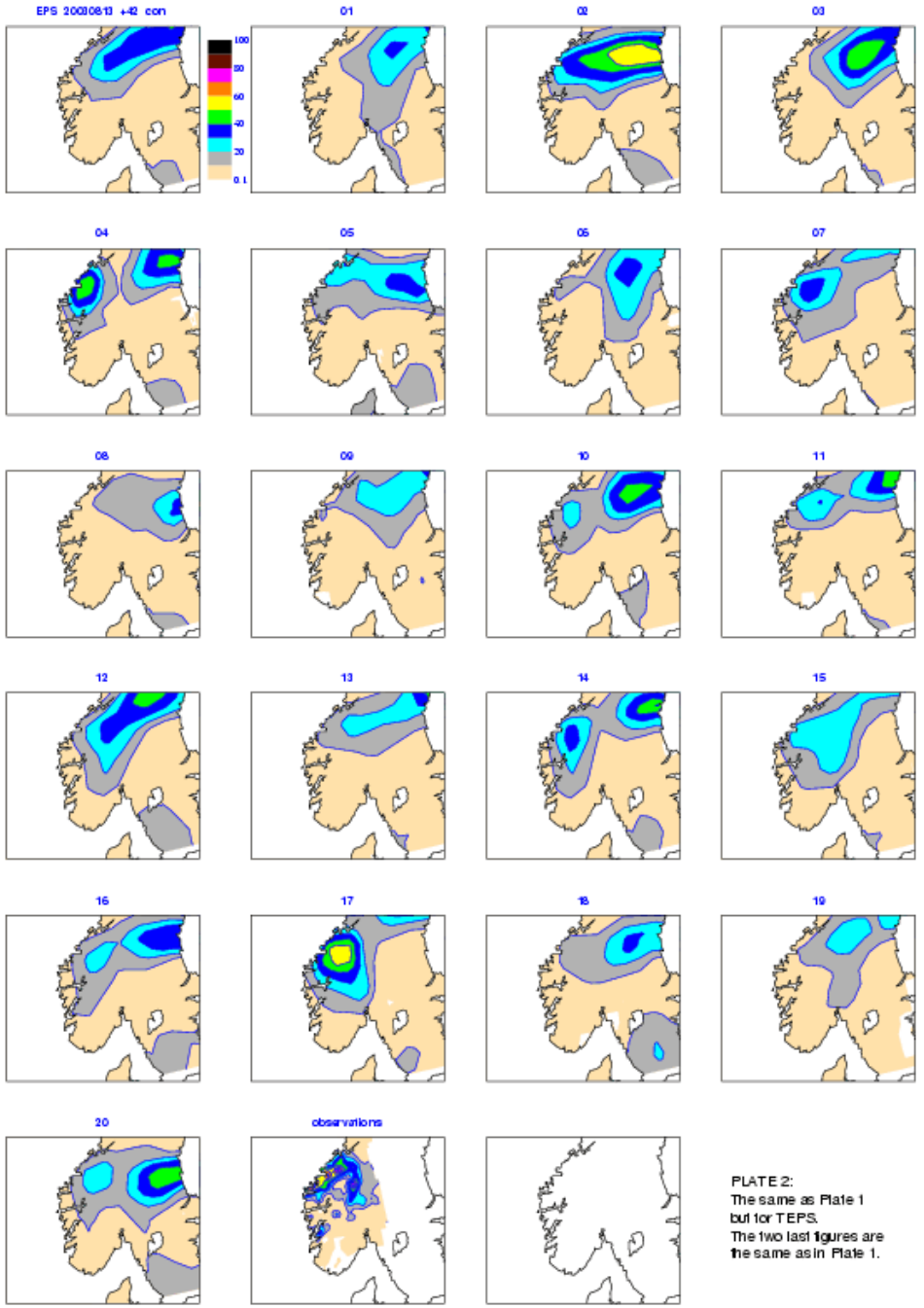


PLATE 2:
The same as Plate 1
but for TEPS.
The two last figures are
the same as in Plate 1.

+42h

LAMEPS ensemble

+42h

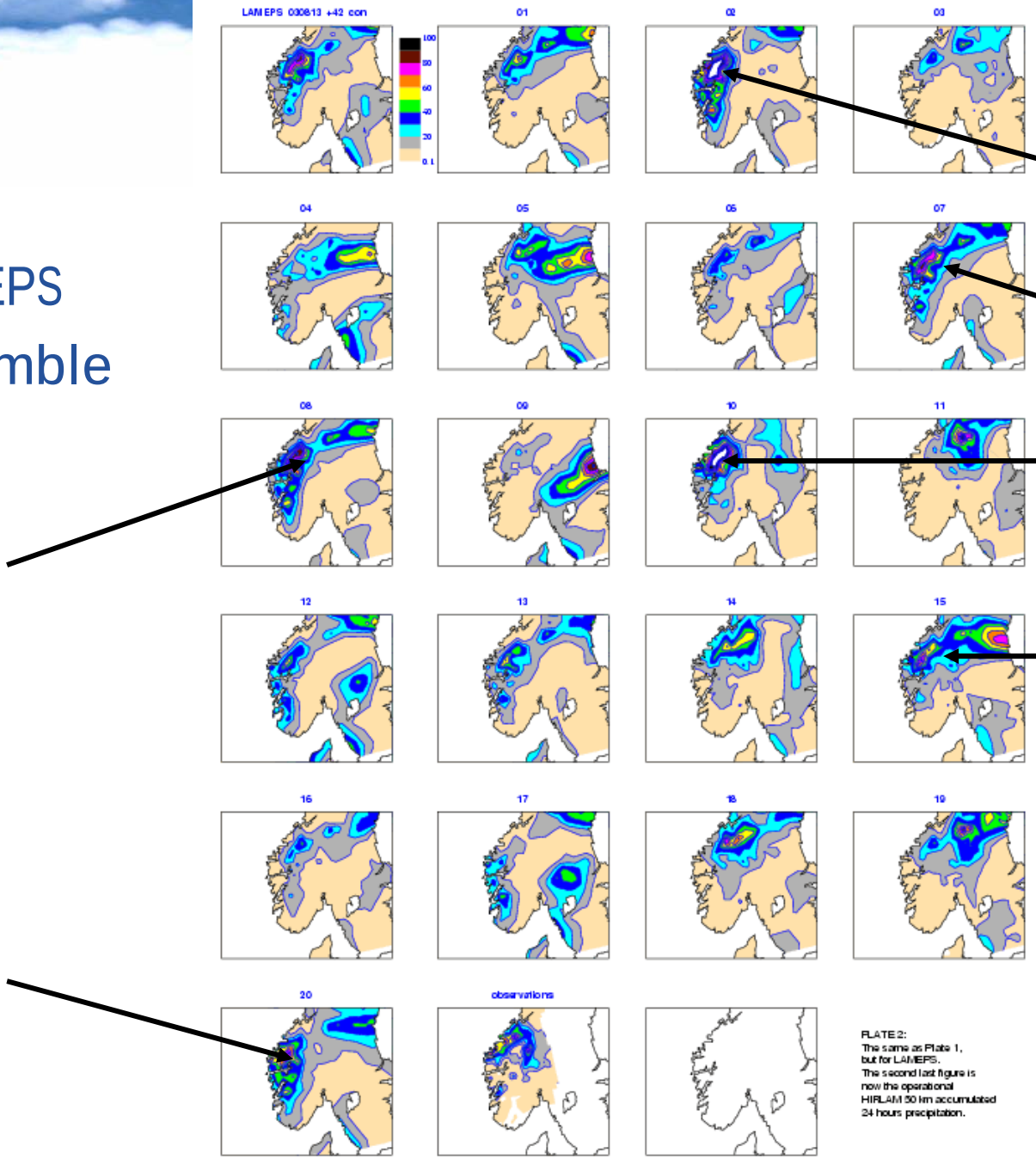


PLATE 2:
The same as Plate 1, but for LAMEPS. The second last figure is now the operational HIRLAM 50 km accumulated 24 hours precipitation.

Use of LAMEPS

- Forecasting (*)
- EU-project Eurorisk – further downscaling
- Storm-surge LAMEPS (*)
- Input to hydrological models (*)

Future developments

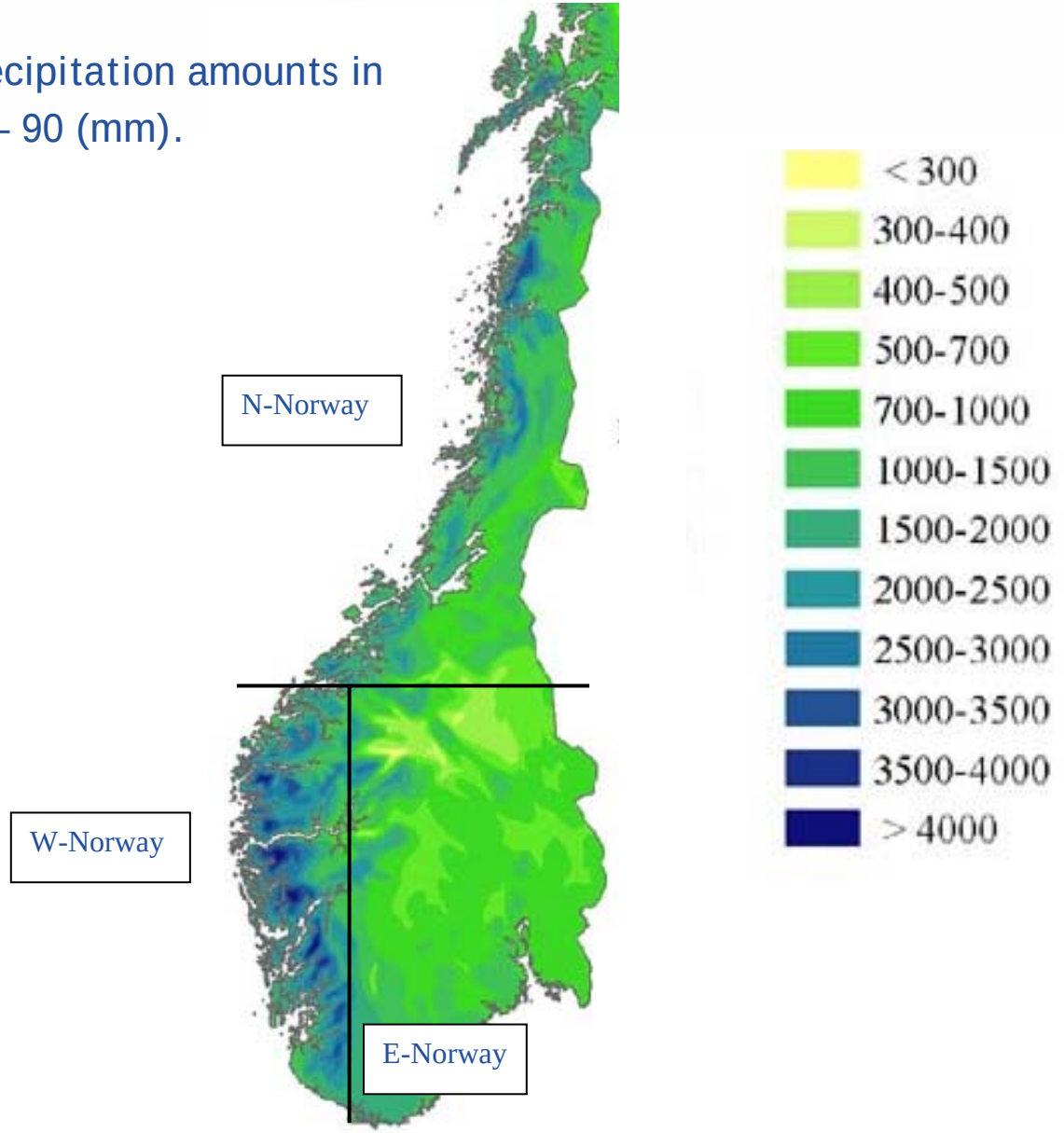
- Include perturbing of the model physics in LAMEPS
- Increase the time resolution of the boundary fields (now every 6 hour)
- Expand system to more parameters: temperature, wind, ….
- Develop more probability products
- Compute SVs within HIRLAM
- Move to higher resolution
- Further downscaling

Test LAMEPS on a new configuration for TEPS

- A system that combines targeted SVs and hemispheric SVs (Martin Leutbecher, ECMWF)
  - 10 leading targeted singular vectors
  - 40 leading hemispheric singular vectors computed in the subspace orthogonal to the targeted singular vectors
  - Ensemble size 20 + 1
  - Initial perturbations constructed with (revised) Gaussian sampling
- Results in increased spread for TEPS after day 2, without increasing the error of the ensemble mean
- We wish to test LAMEPS on this revised TEPS system

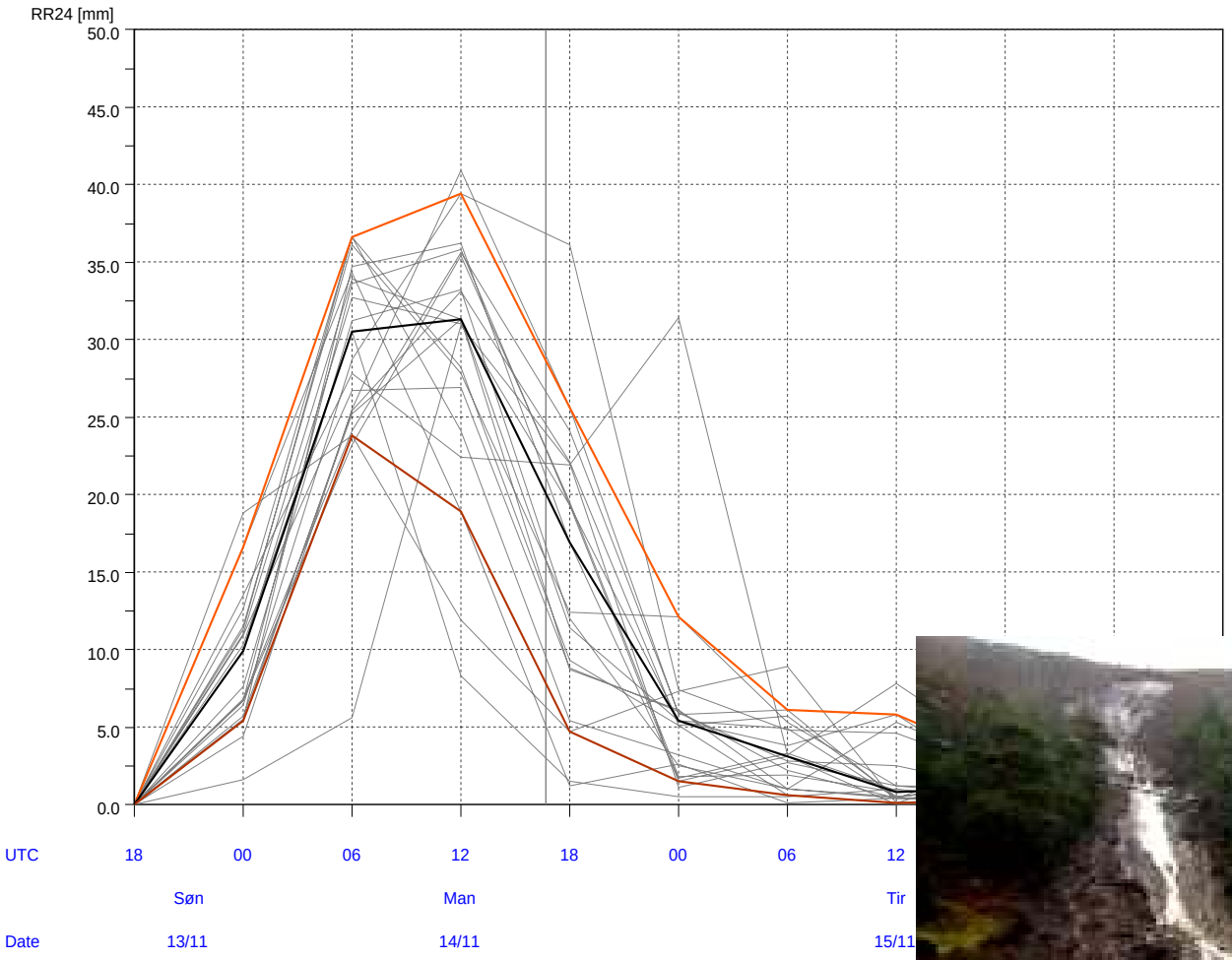
Thank you for your attention

Average annual precipitation amounts in Norway from 1961 – 90 (mm).



BERGEN

P10 P50 P90 LAMEPS−ensemble



Input to hydrological models

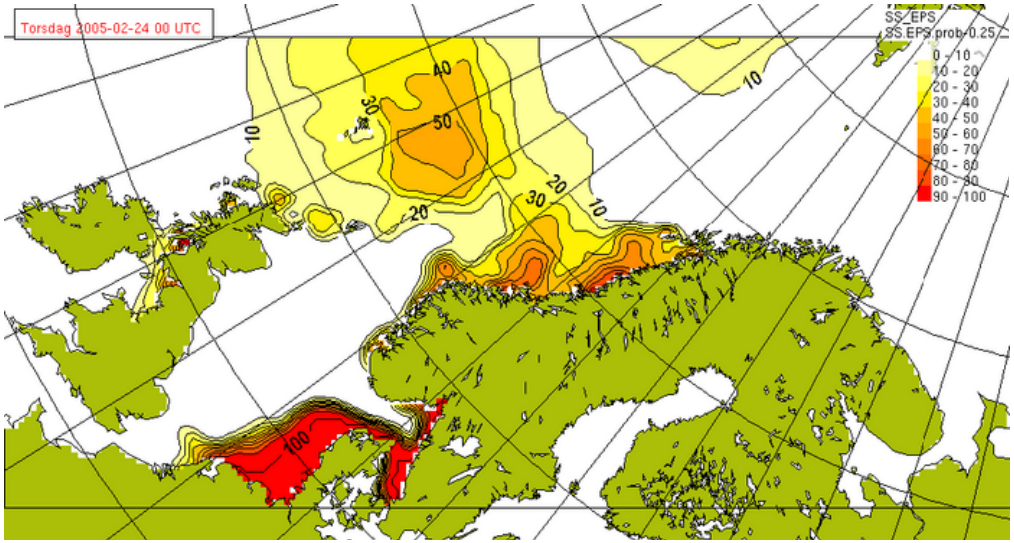
- Ensemble of hydrological models –
  one time series for each ensemble member as input to the hydrological models (customers)

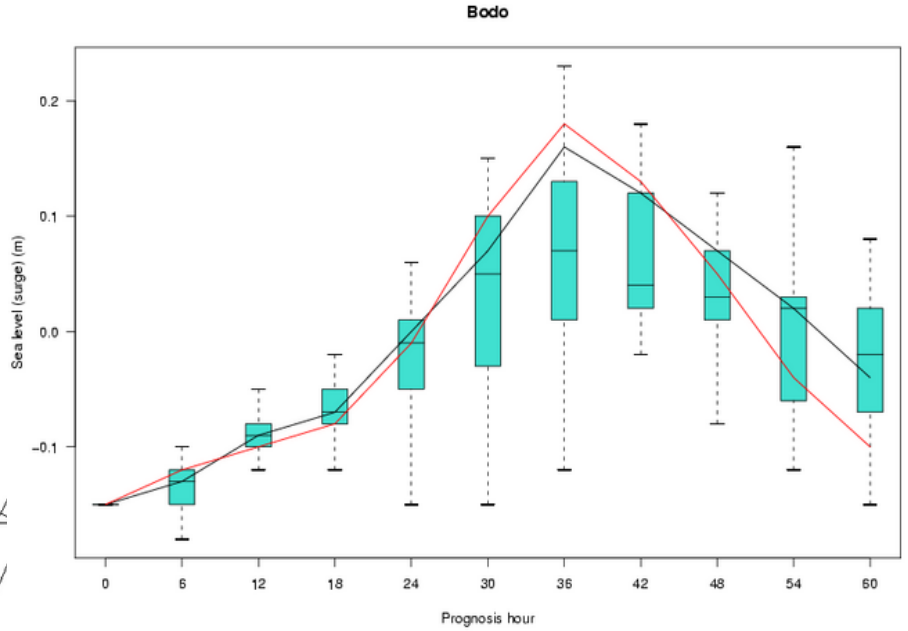
(*)

Area: Selbusjøen 615m

Time	T2m	dT/dz	R6
18+ 0	7.4	-1.3	0.0
18+ 6	1.0	-0.7	0.0
18+12	1.7	-0.8	1.5
…			
…			
18+54	3.3	-0.6	1.5
18+60	5.1	-0.7	0.3

Storm-surge LAMEPS





Something else….
EPS storm-surge Katarina