Developments in GLAMEPS and HarmonEPS

Inger-Lise Frogner

and the HIRLAM EPS and predictability team, and
RMI for GLAMEPS

Lisbon, 2016

GLAMEPS (version 2, since October 2013)

Operational since 2011

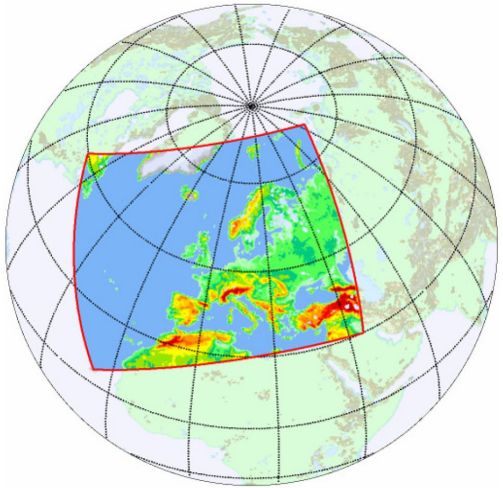
Multi-model, pan-European EPS

48 + 4 ensemble members; lagged
4 sub-ensembles:
- Two HIRLAM ensembles with 3D-Var for controls
- Two Alaro ensembles (downscaling) with SURFEX or ISBA for surface

Nested in IFS ENS

- Forecast range: 54h
- Four times a day (00, 06, 12 and 18 UTC)
  All members their own surface assimilation cycles
- Stochastic physics in HIRLAM
- Perturbed surface observations in HIRLAM
- ~8 km resolution

Runs as Time-Critical Facility at ECMWF



GLAMEPS

ALADIN

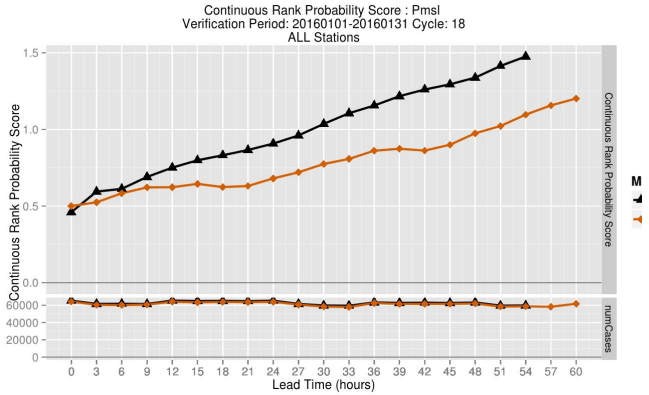
HIRLAM

Kai Sattler, Alex Deckmyn, Xiaohua

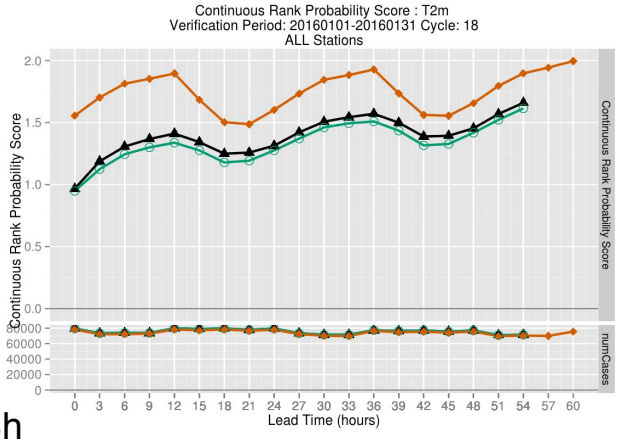
GLAMEPS (version 2)

CRPS

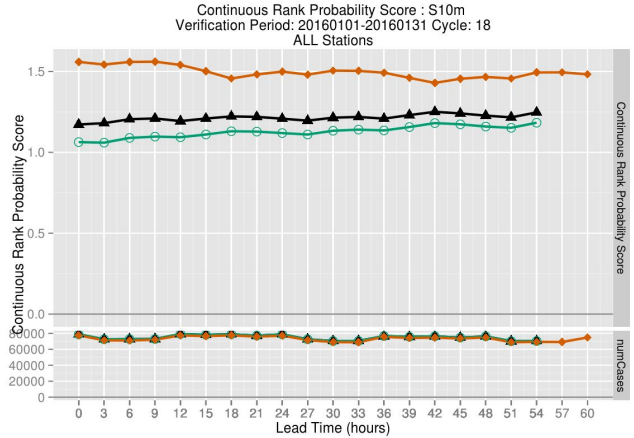
Pmsl



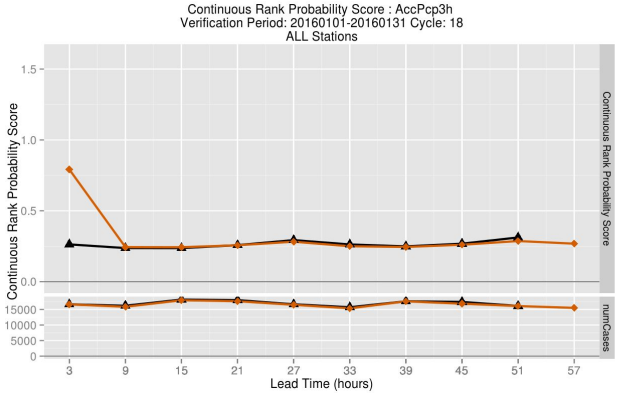
T2m



S10m



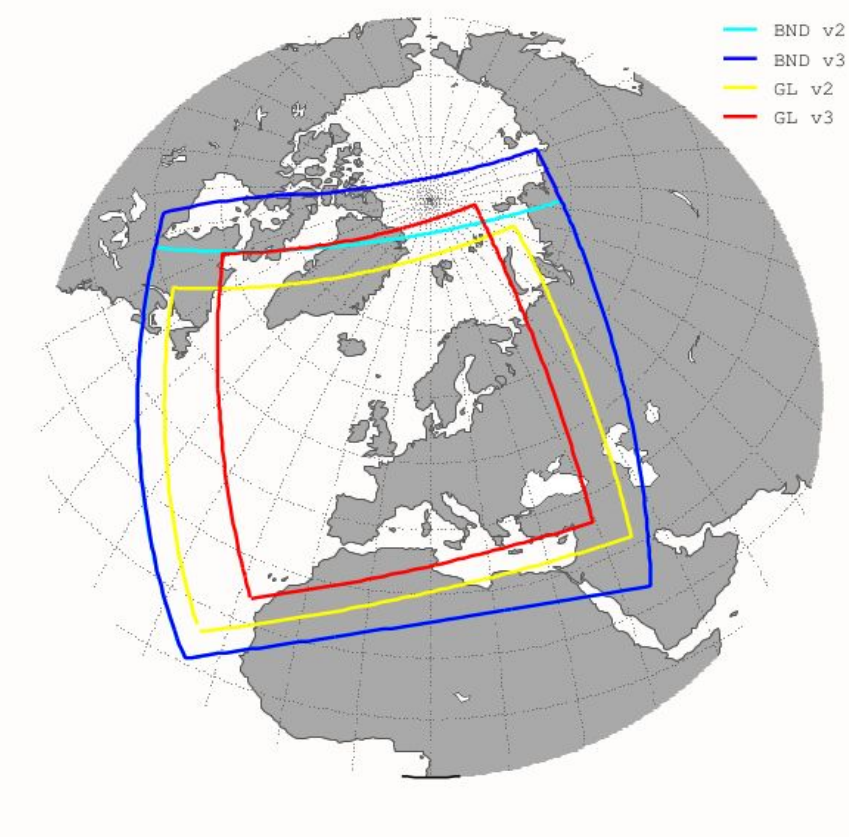
AccPcp3h



IFS ENS
GLAMEPS raw
GLAMEPS cal.

GLAMEPS (version 3, tests ongoing)

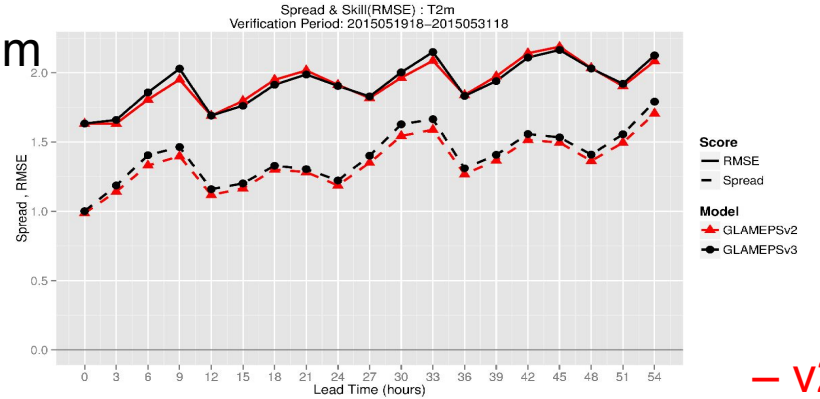
- Hourly output
- Increased resolution - 0.05 deg. (Hirlam) / 6 km Alaro
- Reduced area
- 36 members (4+1)
- Inflation of the initial perturbations coming from IFS ENS
- Include CAPE SVs in Hirlam
- Changes for ALARO:
  - Upgrade from cy37 to cy38
  - Perturb observations
  - CA?
  - Implement perturbation in horizontal diffusion?
  - Adding inflation factor to ALARO boundary?
- Parallel run ~ May. Aim: replace v2 ~ August



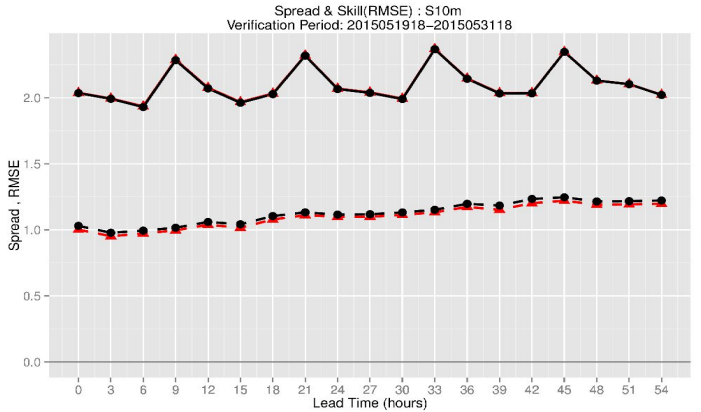
Kai Sattler, Alex Deckmyn, Xiaohua

Inflation of initial perturbations in HIRLAM sub-ensembles – spread/skill

T2m



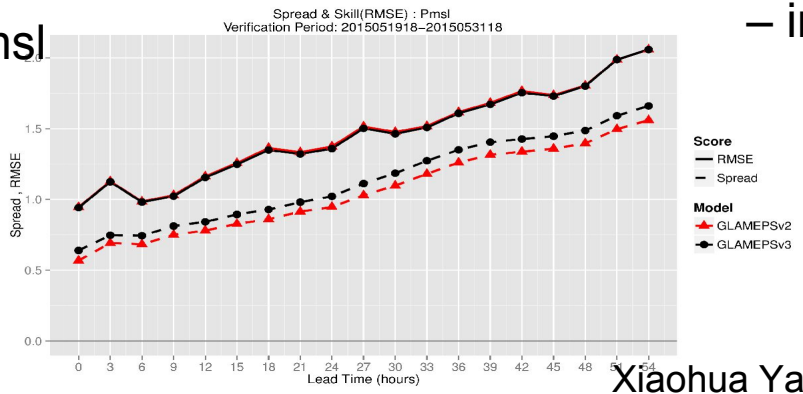
S10m



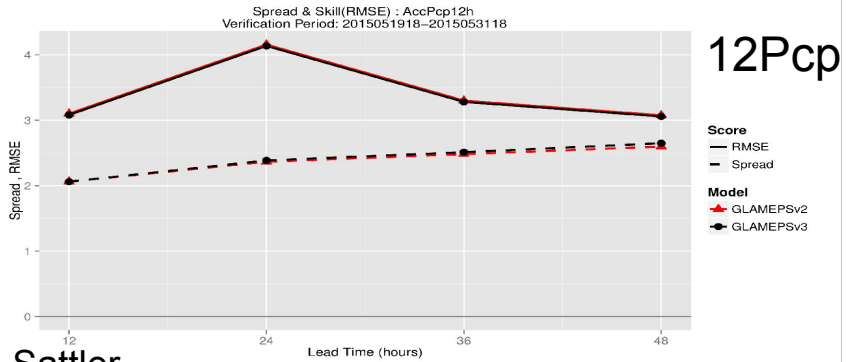
– v2

– inflated

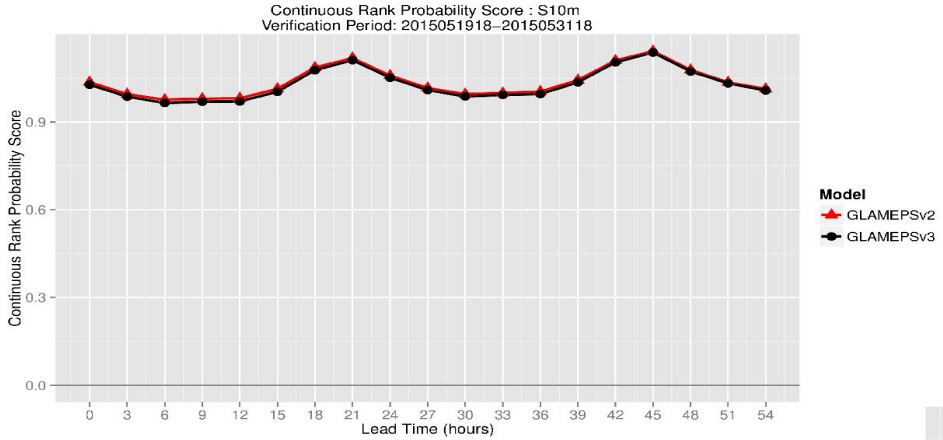
Pmsl

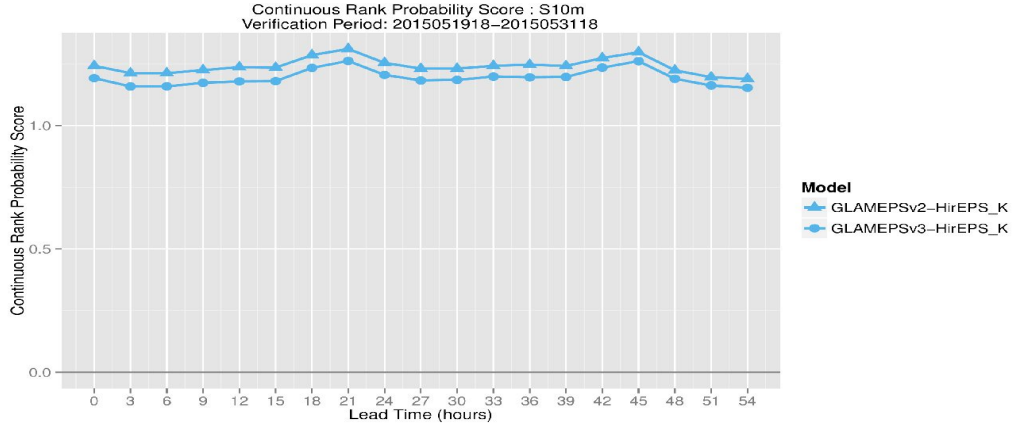


12Pcp



Inflation of initial perturbations in HIRLAM sub-ensembles – CRPS





– v2
– inflated
^^ HirS v2
. . HirS inflated

Xiaohua Yang and Kai Sattler

Calibrating GLAMEPS

Aim: Make well-calibrated forecasts at all model grid points based on (recent) historical data of

- synop measurements
- forecasts
- orographic and (model) climate information

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

Operational system:

T2m

Gaussian distribution with parameters:

- **mean**: ensemble mean + model elevation
- log(**standard deviation**): log(ensemble standard deviation) + log(model elevation})

S10m

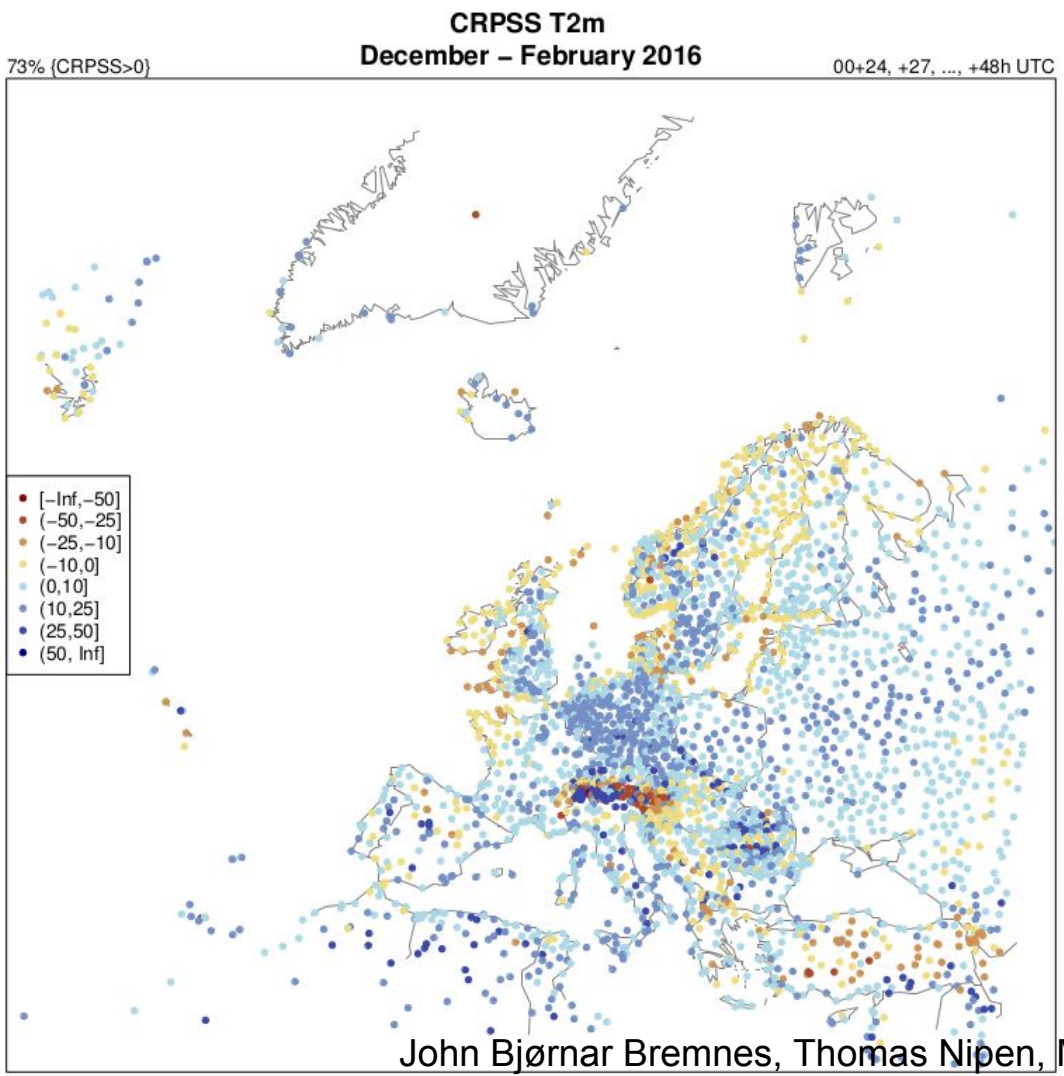
Box-Cox t-distribution with parameters

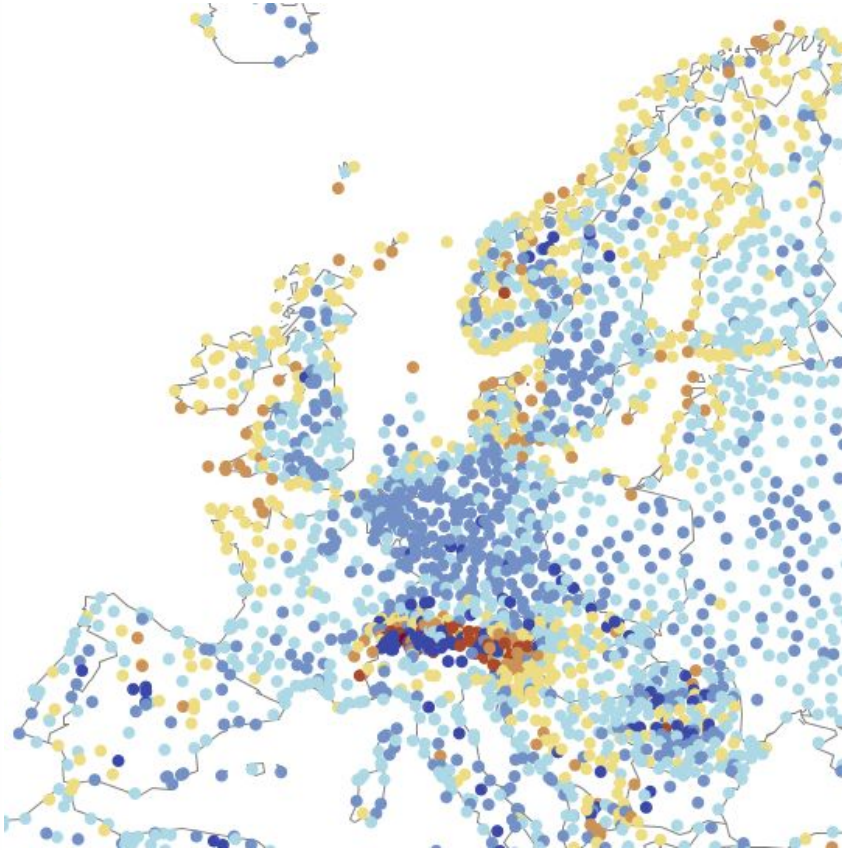
- **mean**: ensemble mean + model elevation
- log(**sigma**): log(ensemble standard deviation) + log(max{1,model elevation})
- **nu**: ensemble mean
- log(**tau**): constant

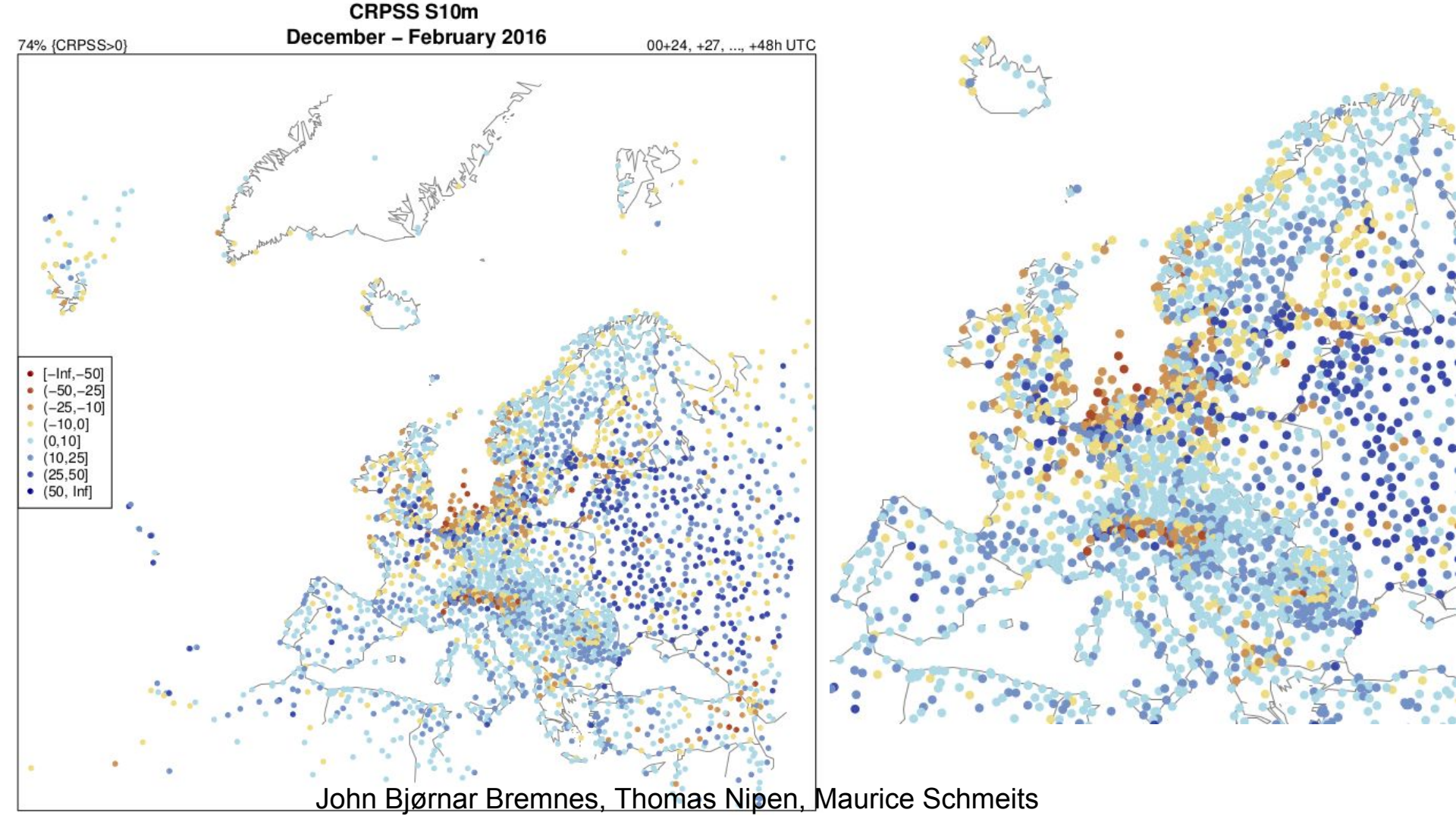
Training

- separate models for each forecast hour and lead time
- models updated every Thursday at approx. 05 UTC
- estimation time about 2 hours (T2m) and 5.5 hours (S10m)
- training period of 42 days (max. 20000 cases)
- no lagging

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

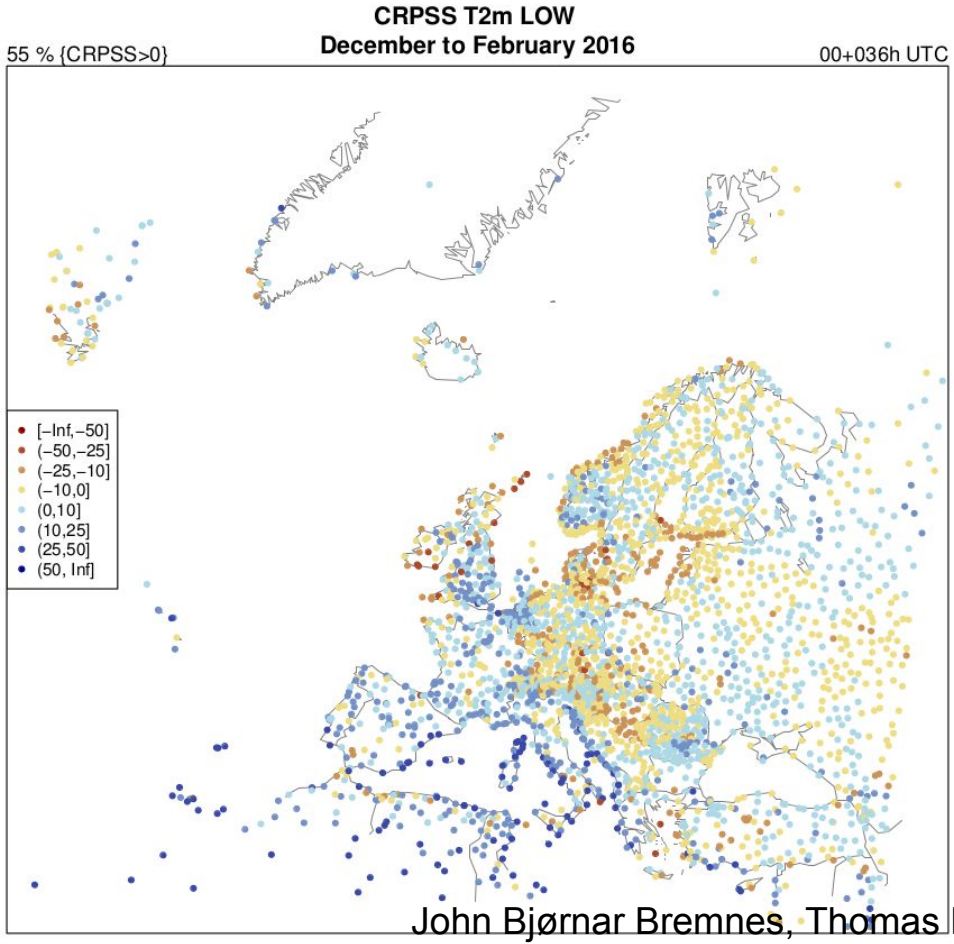

CRPSS T2m
December – February 2016
73% {CRPSS>0}
00+24, +27, ..., +48h UTC
[−Inf,−50]
(−50,−25]
(−25,−10]
(−10,0]
(0,10]
(10,25]
(25,50]
(50, Inf]

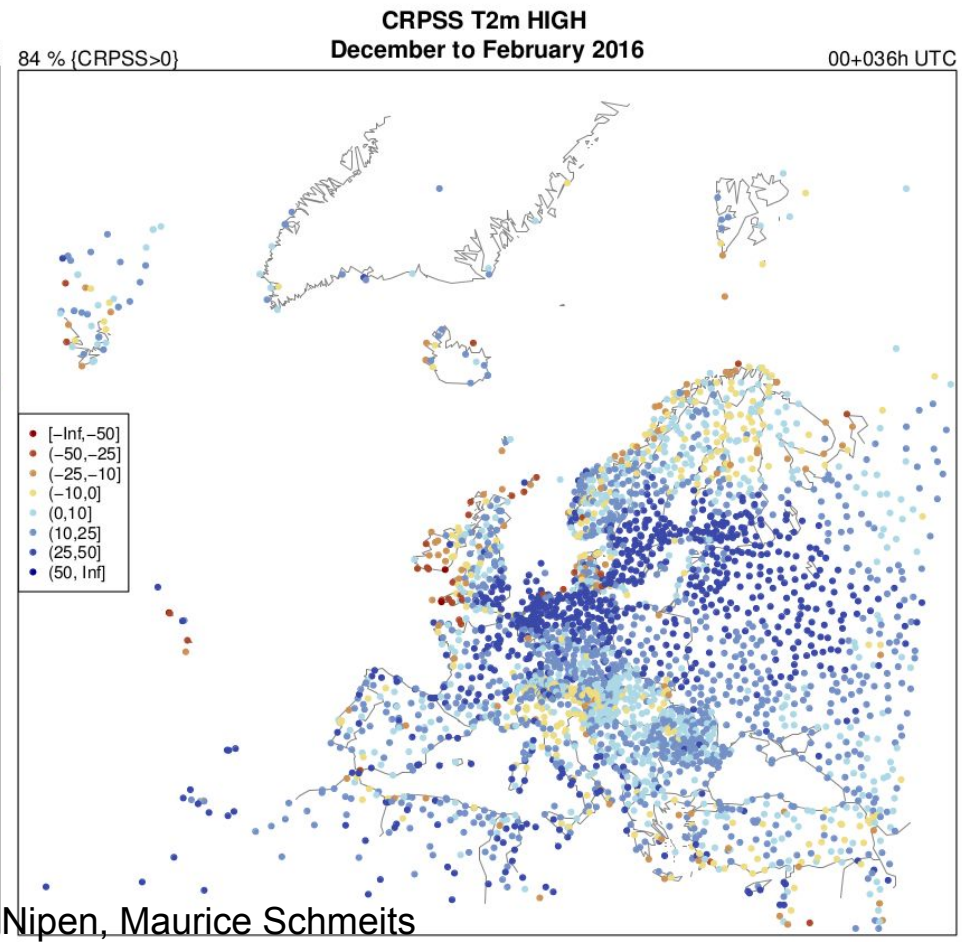




John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

CRPSS when ensemble mean is ...





Current work

- better modeling of spatial variations:
    a. Use flexible regression methods to predict spatial bias using training sample errors, orography and climate information
    b. use output from a) as input to the "probabilistic" regression model
- precipitation calibration

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

Zero-adjusted Gamma distribution

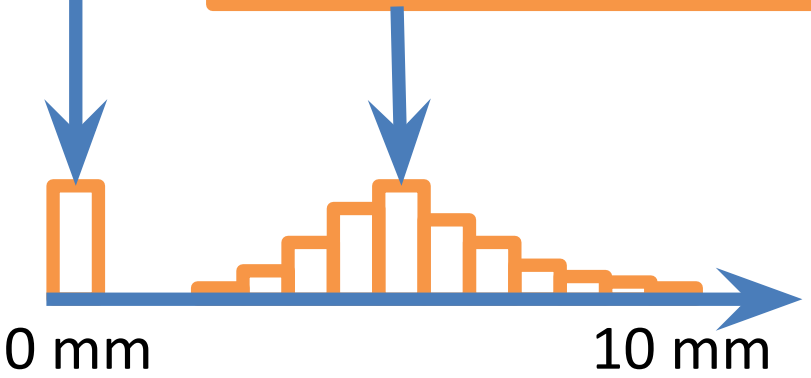
Logistic regression

$$P[X=0]=\frac{1}{1+\exp\left(a+bM+c\sqrt[3]{M}+dF\right)}$$

Gamma distribution

$$\mu=\exp\left(a+b\sqrt[3]{M}\right)$$

$$\sigma=\exp\left(a+bM\right)$$

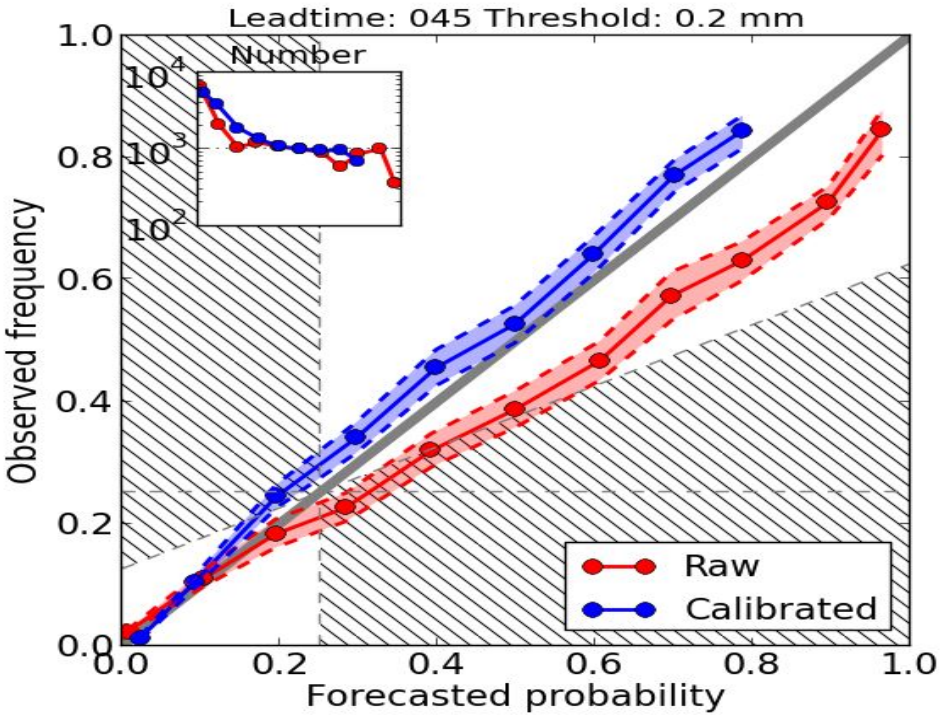


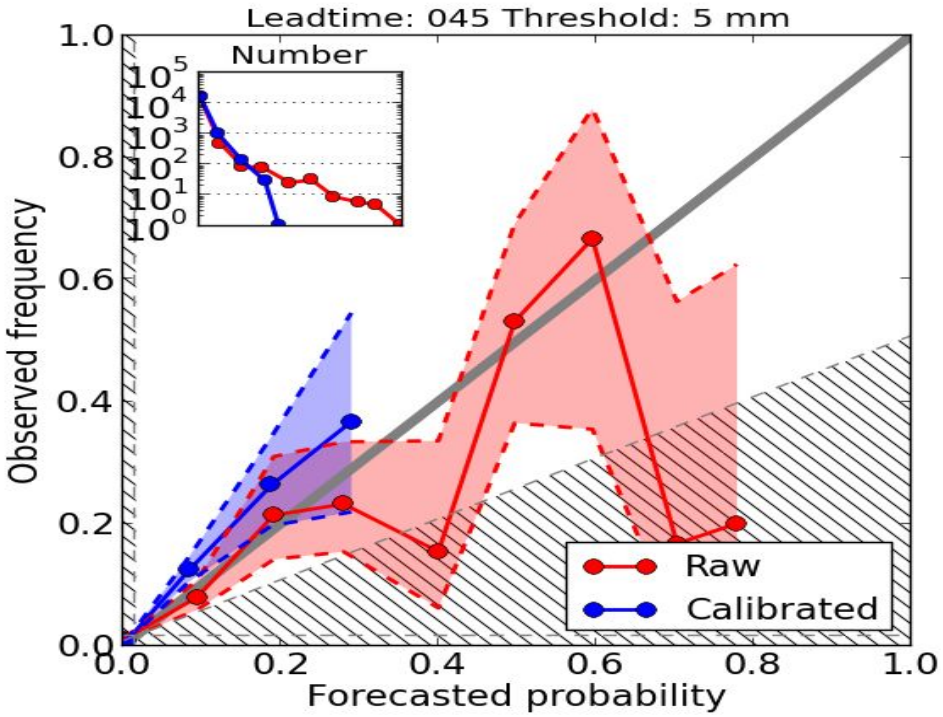
Predictors:

Ensemble mean (M)

% members with precip (F)

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits





John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits

HarmonEPS

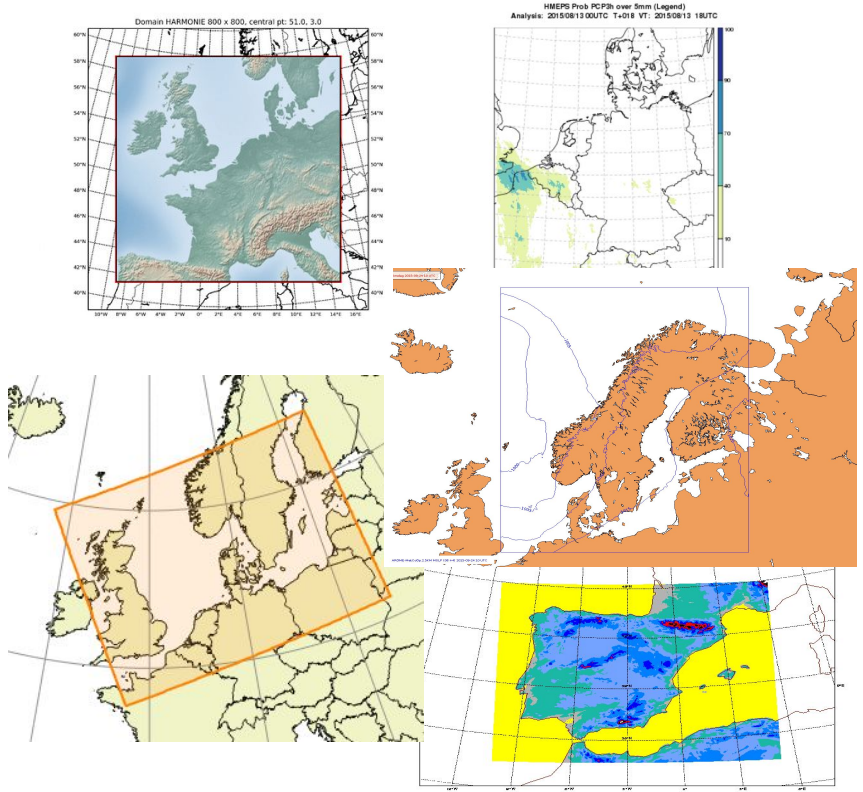
Experimental – first operational version expected in 2016

For European areas

- Configurations vary, but typically between 10+1 and 20+1 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.



HarmonEPS

Experimental – first operational version expected in 2016

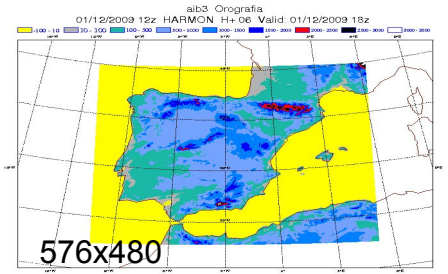
For European areas

- Configurations vary, but typically between 10+1 and 20+1 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.

ɣSREPS: talk by José A. Garcia-Moya



HarmonEPS

Experimental – first operational version expected in 2016

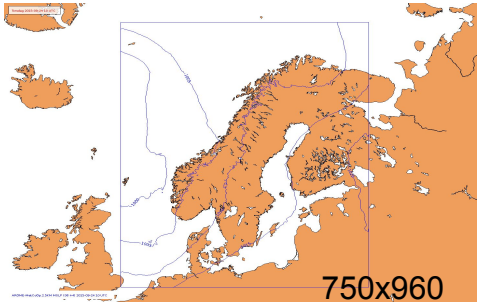
For European areas

- Configurations vary, but typically between 10+1 and 20+1 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.

MEPS: see poster by Ulf Andrae



HarmonEPS

Experimental – first operational version expected in 2016

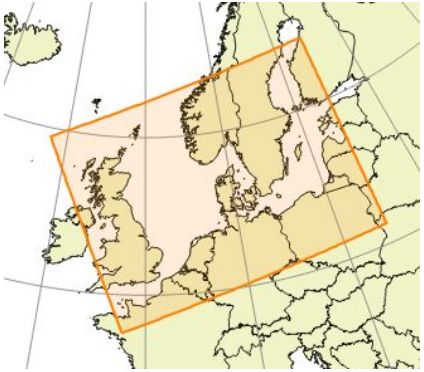
For European areas

- Configurations vary, but typically between 10+1 and 20+1 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.

COMEPS: see talk by Xigohua Yang



HarmonEPS

Experimental – first operational version expected in 2016

For European areas

- Configurations vary, but typically between 10+1 and 20+1 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.

Netherlands: ask Jan Barkmeijer for details

HarmonEPS

Experimental – first operational version expected in 2016

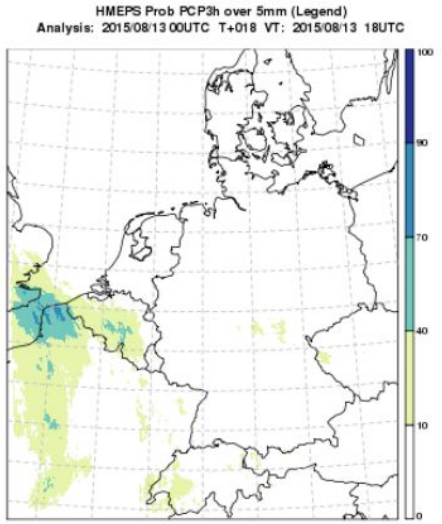
For European areas

- Configurations vary, but typically between 10+1 and 20+1 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

Nested in IFS ENS or IFS high res.

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.

HMEPS: running in test mode, RMI
Geert Smet



HarmonEPS

LBC

Experiments with different flavours of using IFS ENS and SLAF -

see presentation by Andrew Singleton

HarmonEPS

Initial perturbations

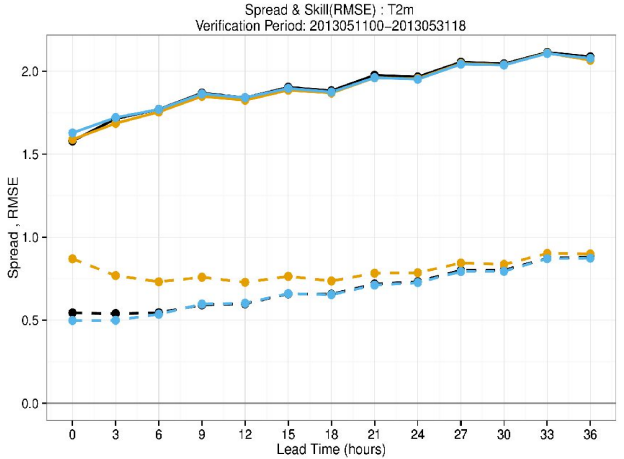
- Default is to use perturbations from IFS ENS/SLAF
- EDA with 3D-Var tested
- LETKF under development
  - Tested perturbations based on first guess

HarmonEPS

EDA

10 + 1 member Arome EPS, 21 days in May 2013

- HarmonEPS-Arome: default setup with 3D-Var for control and large scale perturbations from IFS ENS added to this analysis for each member
- EDANOECPERT: Each member running their own analysis, with perturbed observations
- EDAWITHECPERT: same as above, but also added large scale perturbations from IFS ENS



HarmonEPS-Arome
EDANOECPERT
EDAWITHECPERT

Spread and skill T2m

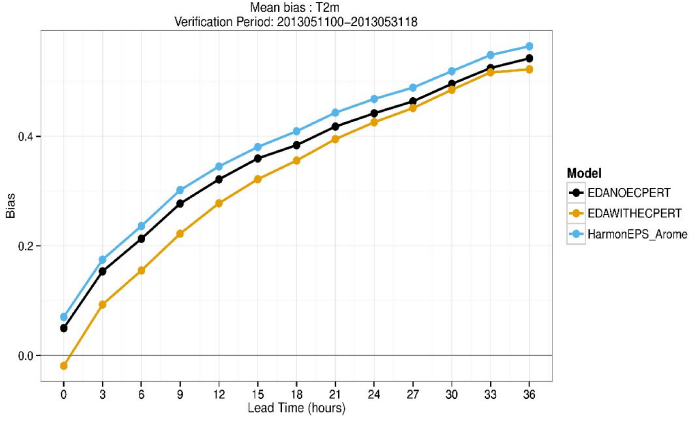
Inger-Lise Frogner

HarmonEPS

EDA

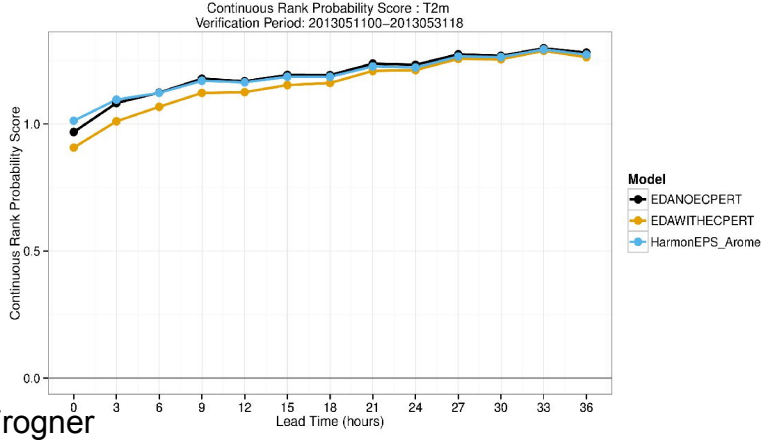
T2m

HarmonEPS-Arome
EDANOECPERT
EDAWITHECPERT



Mean bias

CRPS

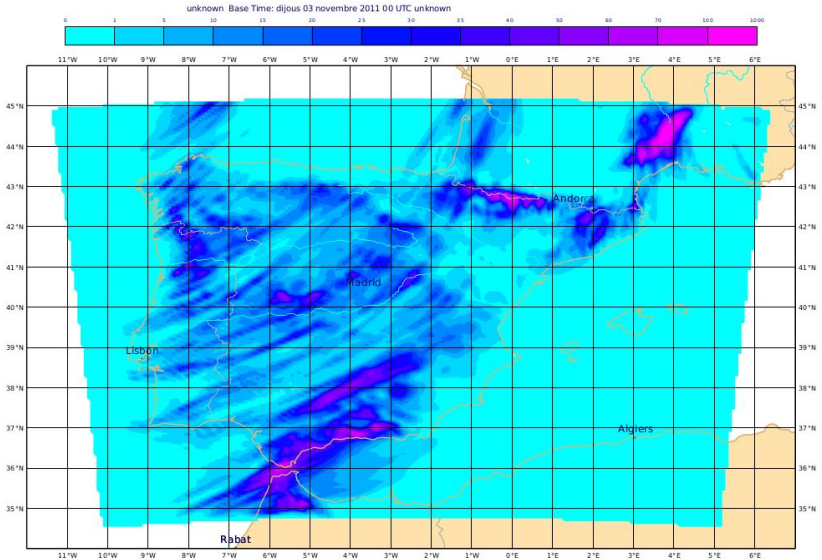


HarmonEPS

LETKF versus 3DVAR

- Period of study: 2011102800 – 2011110300 = 7 days, 7 EPS Runs, started at 00 UTC every 24 hours up to H+24 over IBERIAN peninsula.

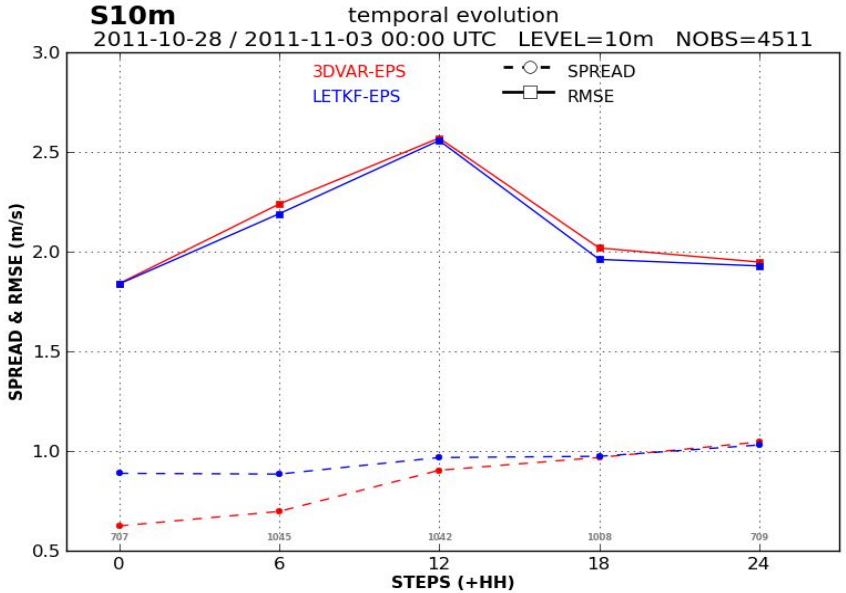
Model domain. Accumulated precipitation field showing the strong synoptically driven convection

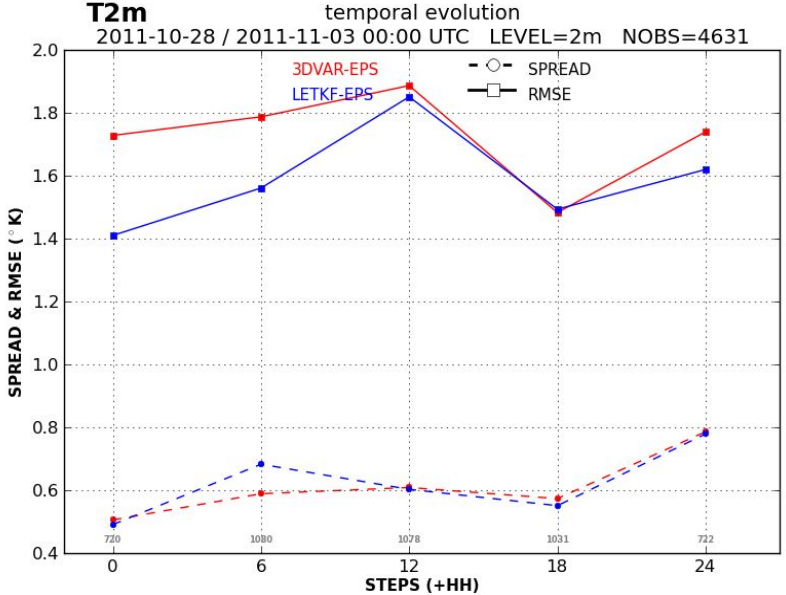


Pau Escribà

Temporal Evolution of SPREAD and RMSE for sfc params

LETKF versus 3DVAR





Pau Escribà

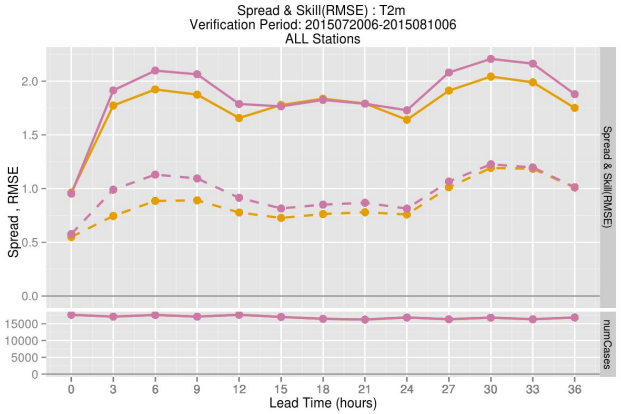
HarmonEPS

Perturbations based on first guess

Perturbation of initial state according to:
IN = AN_c + k *(FG_c - FG_m)
with the hope to retain the small scale information from the members

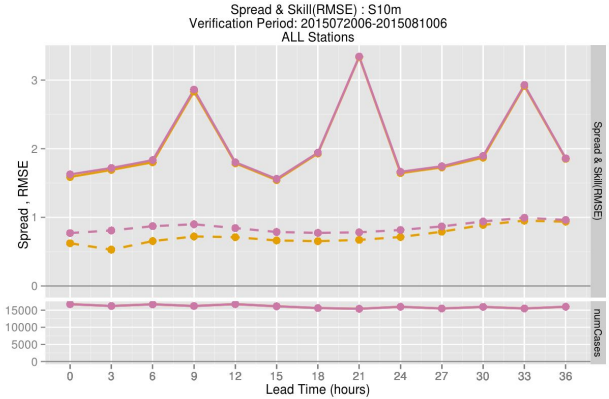
Spread and skill

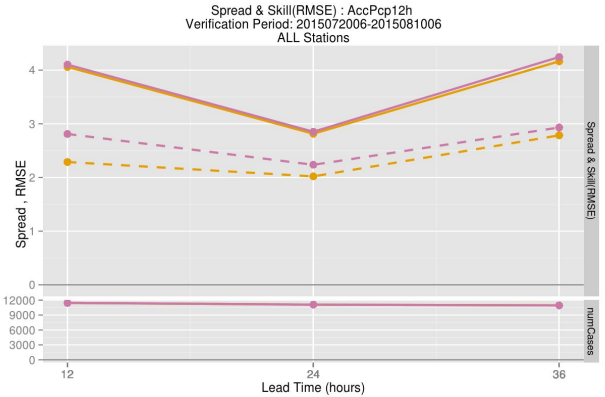
Pert: First guess
Pert: IFS ENS



T2m

S10m





AccPcp12h

Ulf Andrae

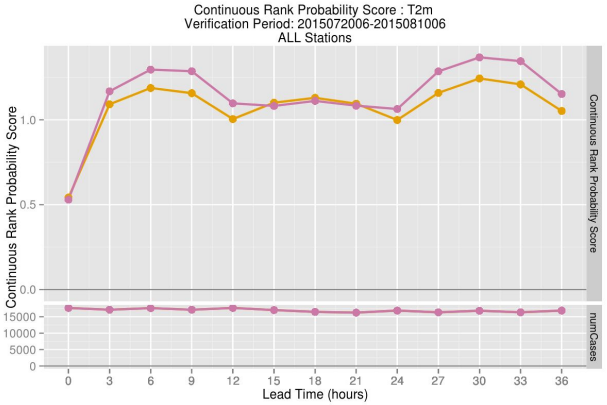
HarmonEPS

Perturbations based on first guess

Perturbation of initial state according to:
IN = AN_c + k *(FG_c - FG_m)
with the hope to retain the small scale information from the members

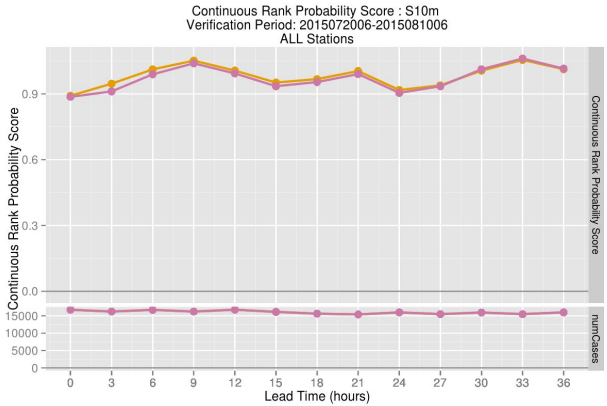
CRPS

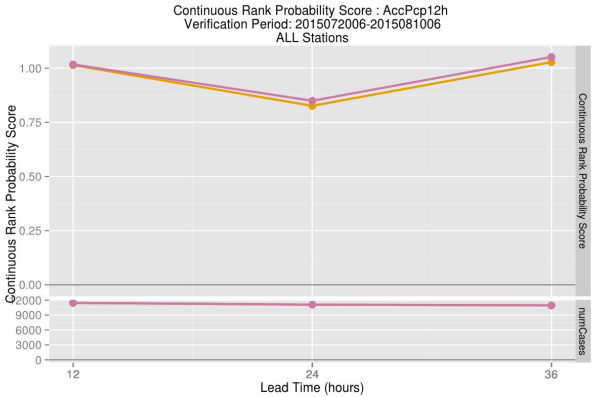
Pert: First guess
Pert: IFS ENS



T2m

S10m





AccPcp12h

Ulf Andrae

HarmonEPS

Model error

- Default is to use multi-physics with Arome and Alaro
- SPPT (Alfons Callado, implementation ongoing)
- Multi-physics the “LAEF-way” - see poster by **Björn Stensen**
- Cellular Automata (CA) (Lisa Bengtsson, presented last year)
- Stochastic perturbations in parameterizations / processes (Sibbo van der Veen)
- Humidity perturbations and MSG cloud mask (Sibbo van der Veen, presented last year)

HarmonEPS

Surface uncertainty

- Thanks to MF and F. Bouttier for providing surface perturbation code -> implemented in HarmonEPS (Ole Vignes)

- Perturb surface parameters, like soil moisture, albedo, SST, … (Work ongoing, Andrew Singleton and Björn Stensen)

- Perturb surface physics: study perturbations in momentum, heat and moisture flux parameterizations. (Work ongoing, Andrew Singleton)

HarmonEPS

Post-processing and HARP EPS developments

HARP:

- Tagging of HARP v1.2 and v2.0
- Work on new formulation of spread/skill and deeper understanding of the practice of centering the ensemble round control (see presentation by **Åke Johansson**)

Post processing:

- Calibration (Thomas Nipen)
- Neighborhood methods (Andrew Singleton)

Thank you