EPS activities in HIRLAM

Inger-Lise Frogner

and the HIRLAM EPS and predictability team

Reading, 2017

GLAMEPS (version 2, since October 2013)

Operational since 2011

Decision at HIRLAM council 22 June:

- No further development of GLAMEPS - no version 3
- Keep running version 2 for maximum of two years

As a consequence of lack of resources (mainly personnel) and limited use and more focus on HarmonEPS

HarmonEPS

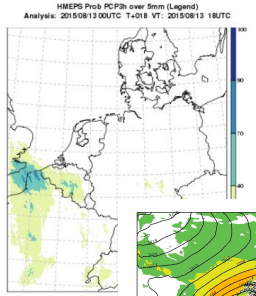
Operational systems:

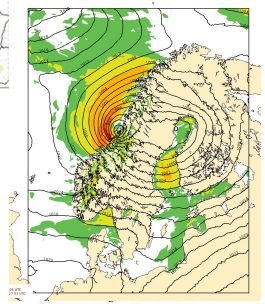
- MEPS (MetCoOp EPS, see poster by Ulf Andrae)
- COMEPS (DMI, see poster by Xiaohua Yang)

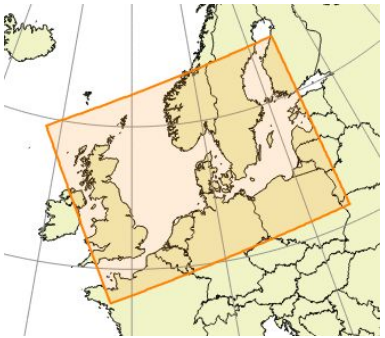
Configurations vary, but typically between

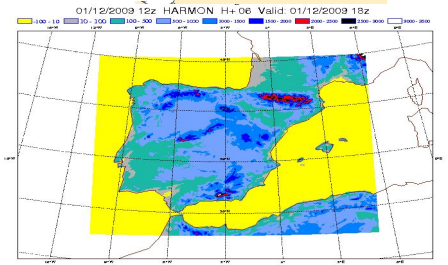
- 10 - 20 members
- Arome
- 2.5 km
- 3D-Var
- SURFEX
- ~54h
- With or without lagging

Nested in IFS ENS or IFS high res (SLAF).
Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing.









Outline

- LETKF
- Perturbations of the control vector
- Surface perturbations
- Parameter perturbations and SPPT

Outline

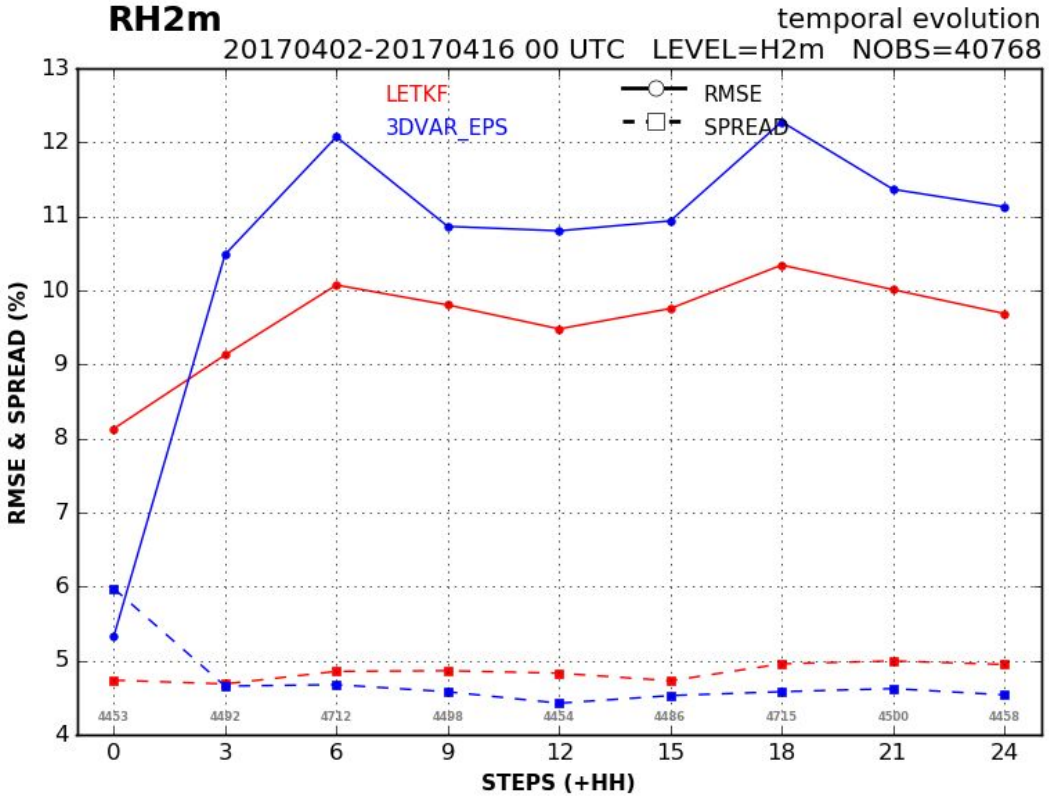
- LETKF
- Perturbations of the control vector
- Surface perturbations
- Parameter perturbations and SPPT

Technical implementation

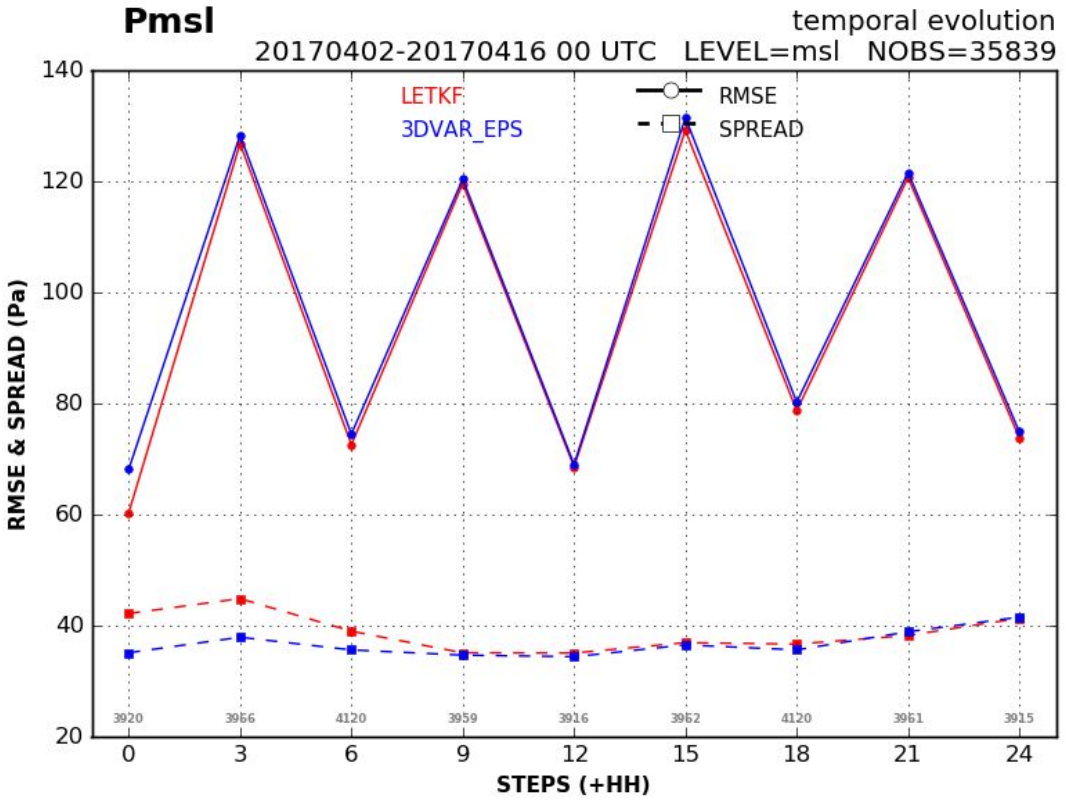
- LETKF implemented in HARMONIE 40h11
- Results from IBERIA_2.5 domain
- Main characteristics of experiments:
  - 2.5 km horizontal resolution
  - 65 vertical levels
  - 10 ensemble members
  - 3 hour analysis cycle
  - 2 hour assimilation window
  - Conventional observations assimilation

Pau Escribà

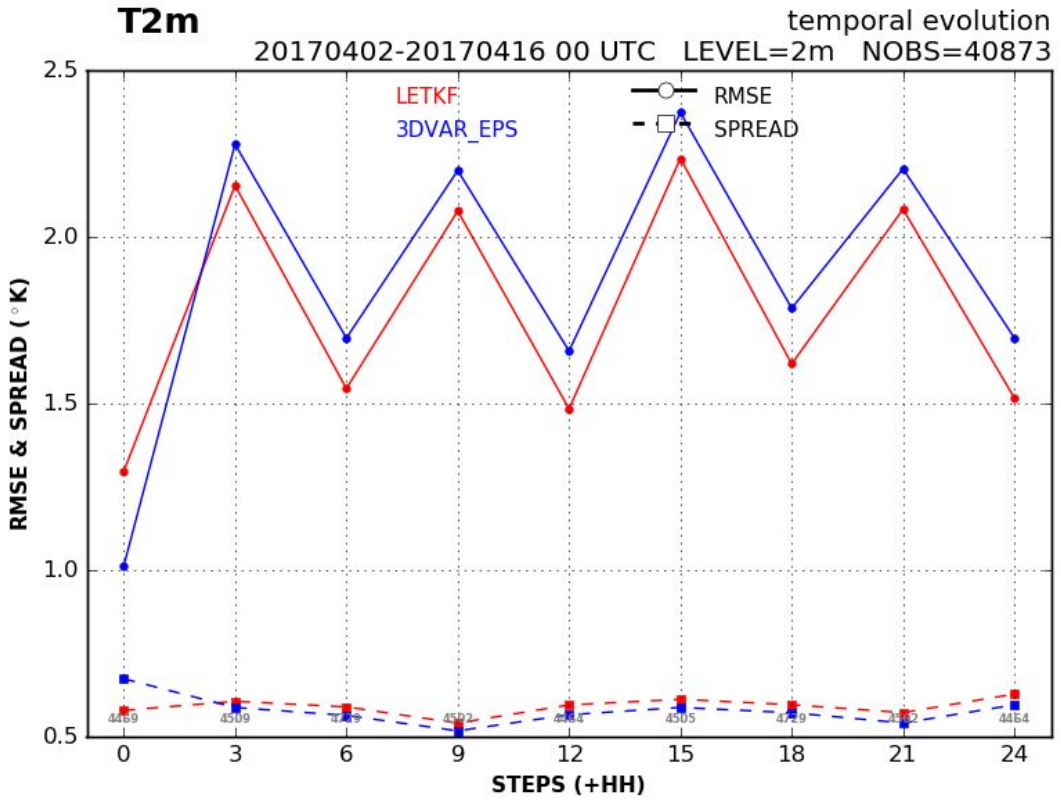
Probabilistic verification. Surface.



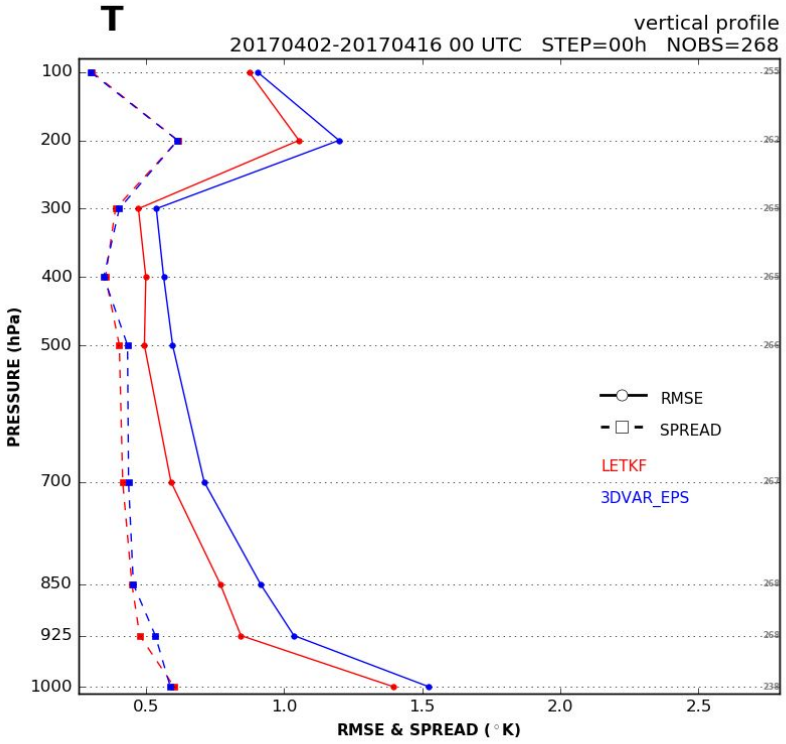
Probabilistic verification. Surface.



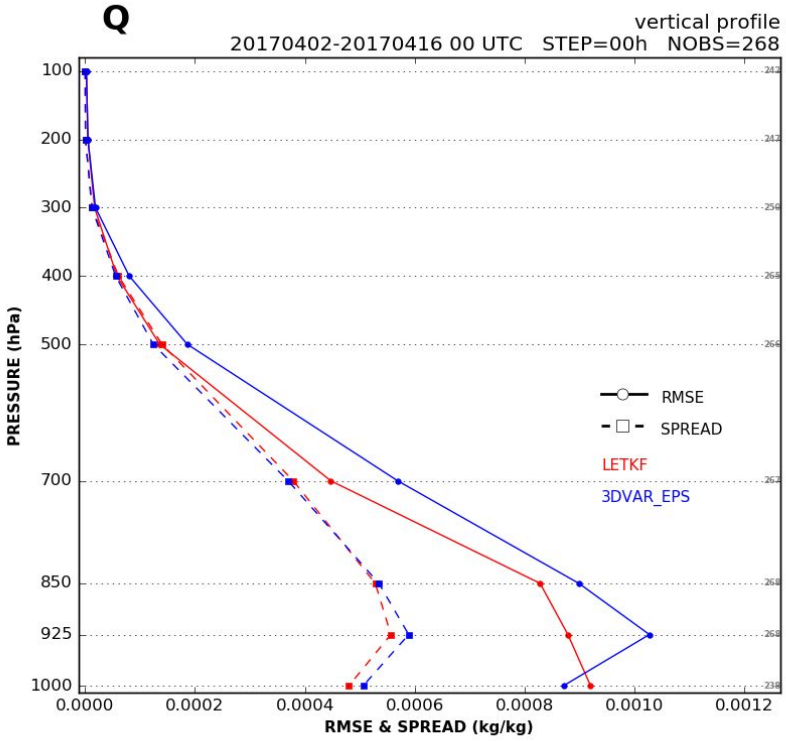
Probabilistic verification. Surface.



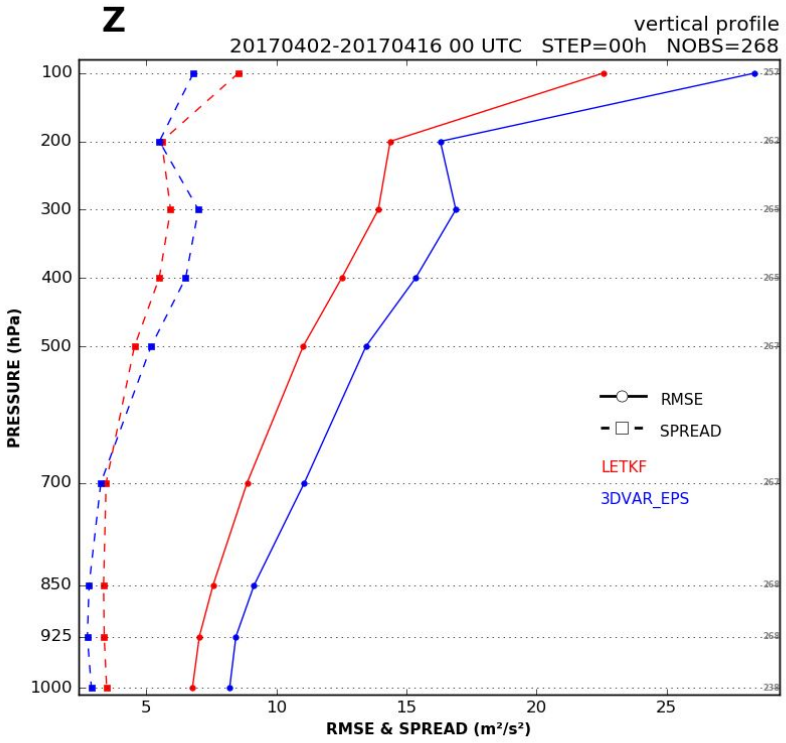
Probabilistic verification. Vertical.



Probabilistic verification. Vertical.



Probabilistic verification. Vertical.



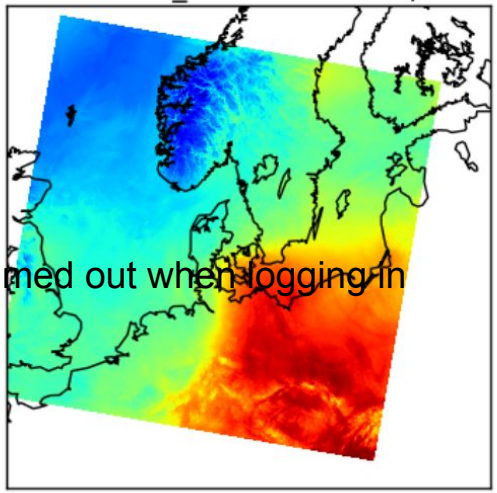
Summary

- LETKF is implemented in HARMONE 40h11 and can be used in any HARMONIE domain either in deterministic or probabilistic mode
- LETKF seems to improve 3DVAR performance specially for Surface mass fields (T2m, Td2m, RH2m, Q2m)
- LETKF has more spread with respect to 3DVAR-EPS
- Using more members in LETKF improves deterministic forecast
- LETKF is much more expensive than 3DVAR in computational cost (in the order of 4DVAR)

Outline

- LETKF
- Perturbations of the control vector
- Surface perturbations
- SPPT and SPP

20120618_15 control temp 47



270 273 276 279 282 285 288 291 294

Timed out when logging in

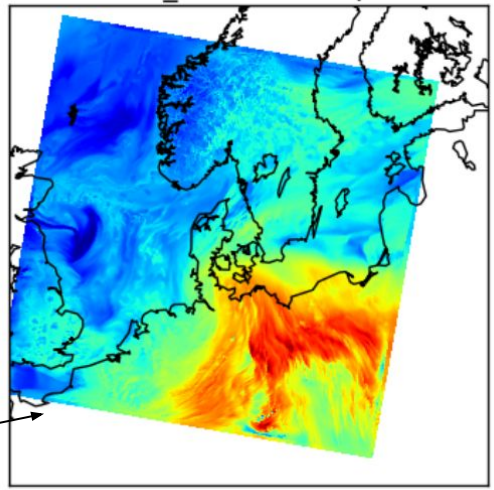
The weather situation:

Strong front (around 850pHA): warm and wet air meets cold and dry air.

Temperature

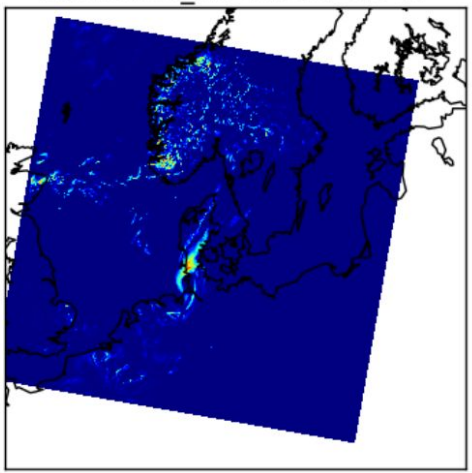
Specific humidity

20120618_15 control sphum 47



0.0030 0.0045 0.0060 0.0075 0.0090 0.0105 0.0120 0.0135

20120618_15 control cw 47



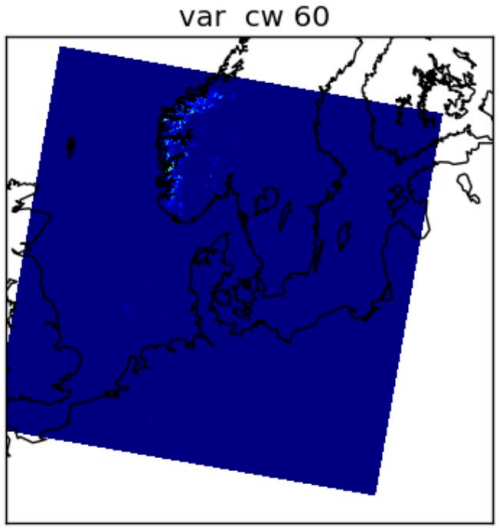
BRAND ens

We impose perturbations for control variables around this control member : Temperature, humidity, u- and v- winds components, surface pressure

Cloud Water around 850hPa

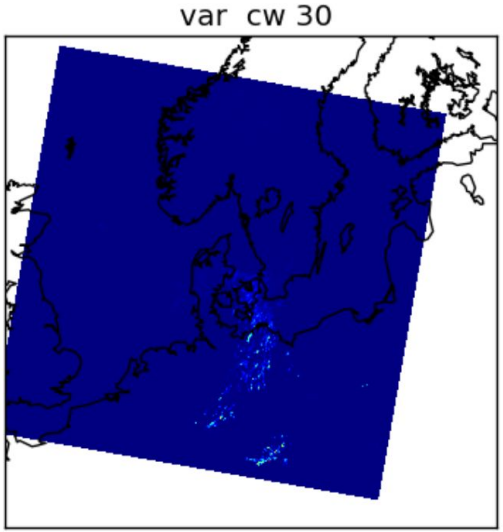
Cloud water is small scales field which depends on spatial derivatives of temperature and humidity

Jelena Bojarova

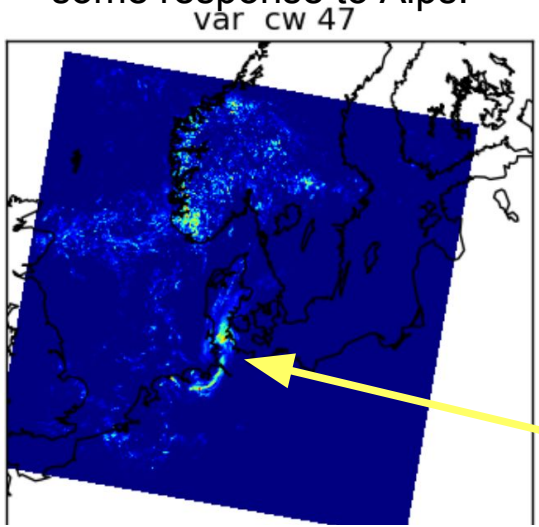


Variance of cloud water (10 members +03h)

The variability of the cloud water at level 30 depends the location of the strong temperature/humidity gradients and includes some response to Alps.

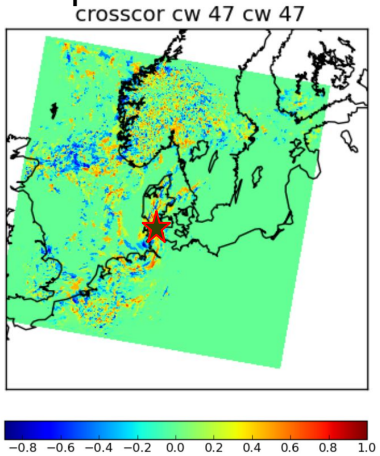


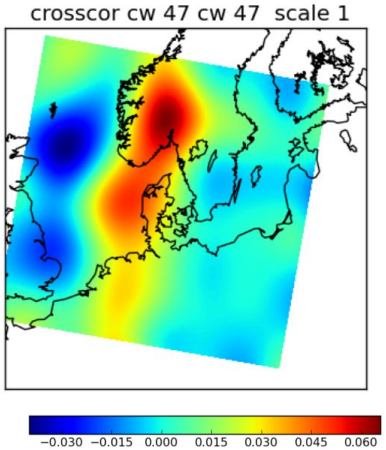
The variability of cloud water on model level 60 clearly shows response to orography (Norwegian Fjords)



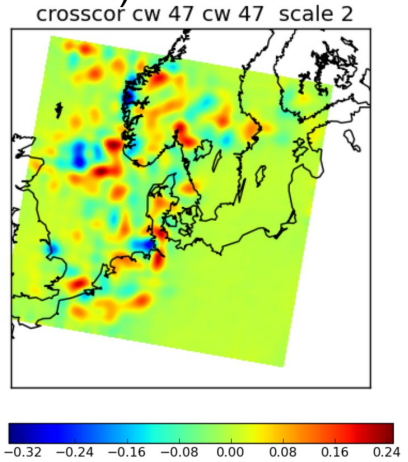
The variability of the cloud water on level 47 is more dramatic and depends on the location of front

The field of cloud water auto-correlation at model level 47 (from the star location) and its decomposition on different scales

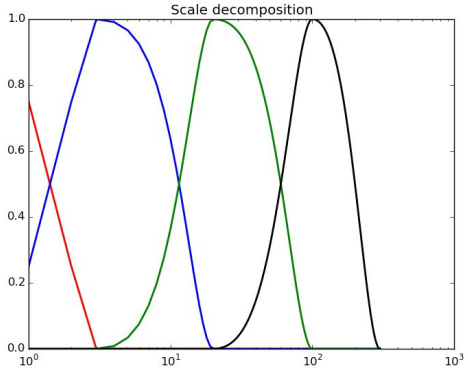


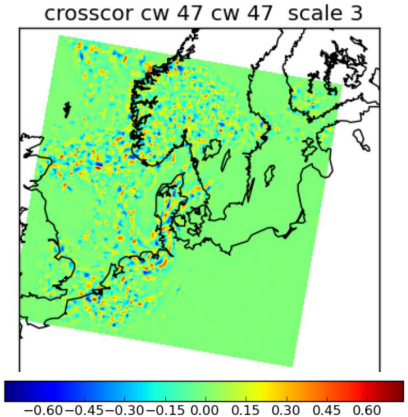


Scale 1

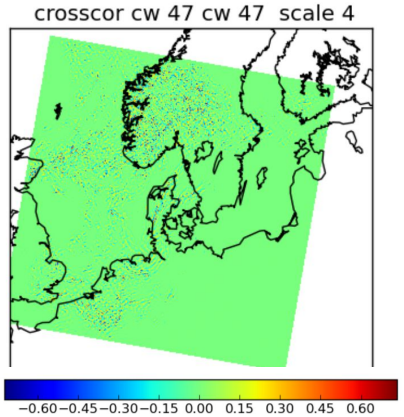


Scale 2





Scale 3



Scale 4

BRAND 10 ens. members
(+03h HARMONIE AROME 2.5)

Outline

- LETKF
- Perturbations of the control vector
- Surface perturbations
- Parameter perturbations and SPPT

What is perturbed at the surface?

A selection of surface fields are perturbed in the surface analysis file from SURFEX - both prognostic and physiographic:

- Surface temperature (SST and top 2 soil layers)
- Surface moisture (top 2 soil layers)
- Vegetation fraction
- Leaf Area Index
- Soil thermal coefficient
- Roughness length over land + fluxes over the sea
- Albedo
- Snow depth

Andrew Singleton (MET Norway)
Björn Stensen (SMHI)

Ulf Andrae (SMHI), Ole Vignes (MET Norway), Inger-Lise Frogner (MET Norway)

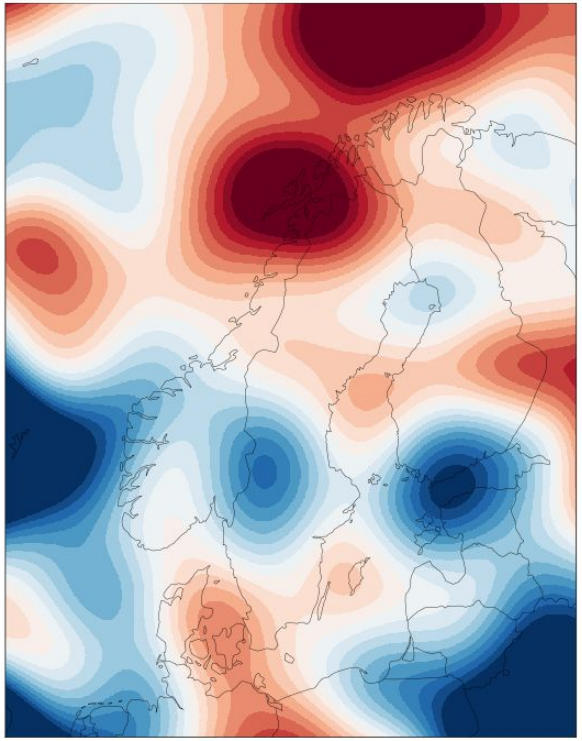
Francois Bouttier (Meteo France)

Sensitivity to correlation length scale

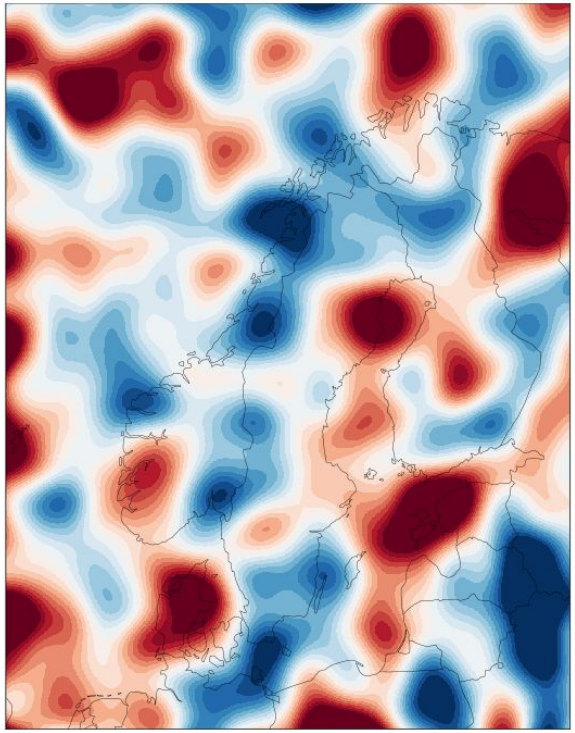
- Original surface perturbation experiments were done with a correlation length scale of approx 300km in the random perturbation fields.
- What happens if we half the correlation length scale, effectively adding perturbation energy with smaller spatial scales?

Halving the correlation length scale of the perturbation fields

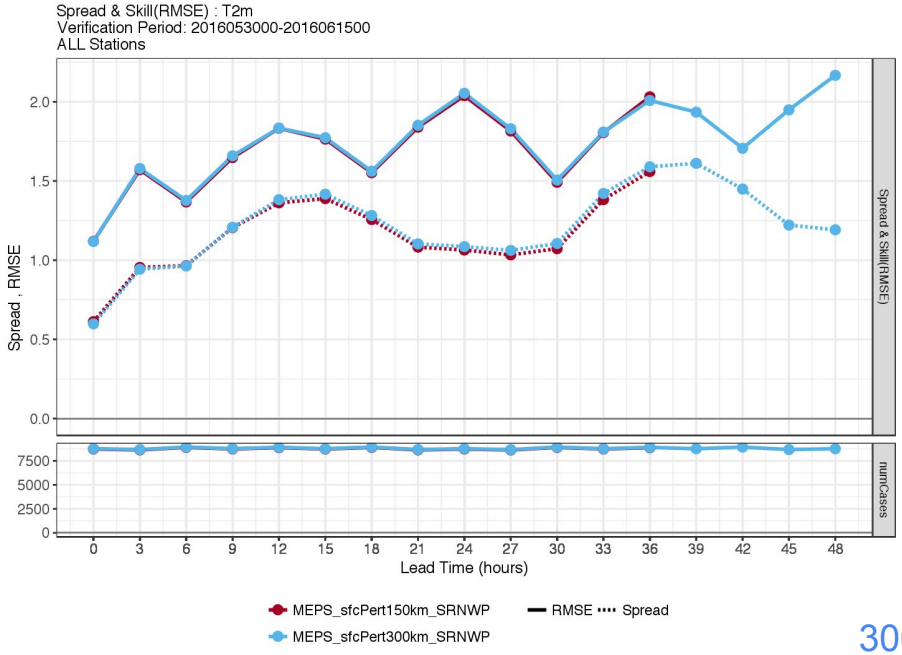
300km

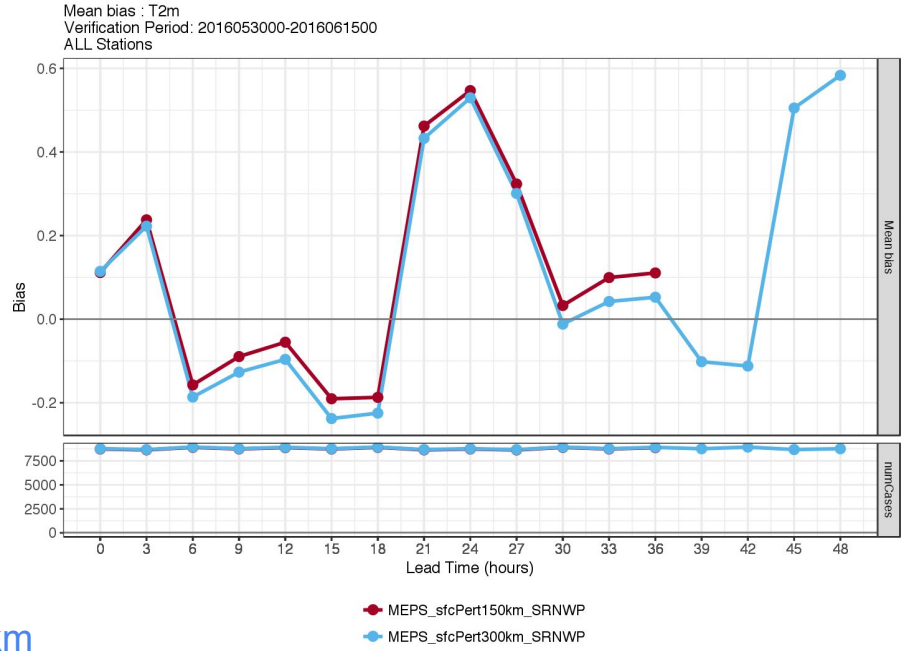


150km



T2m

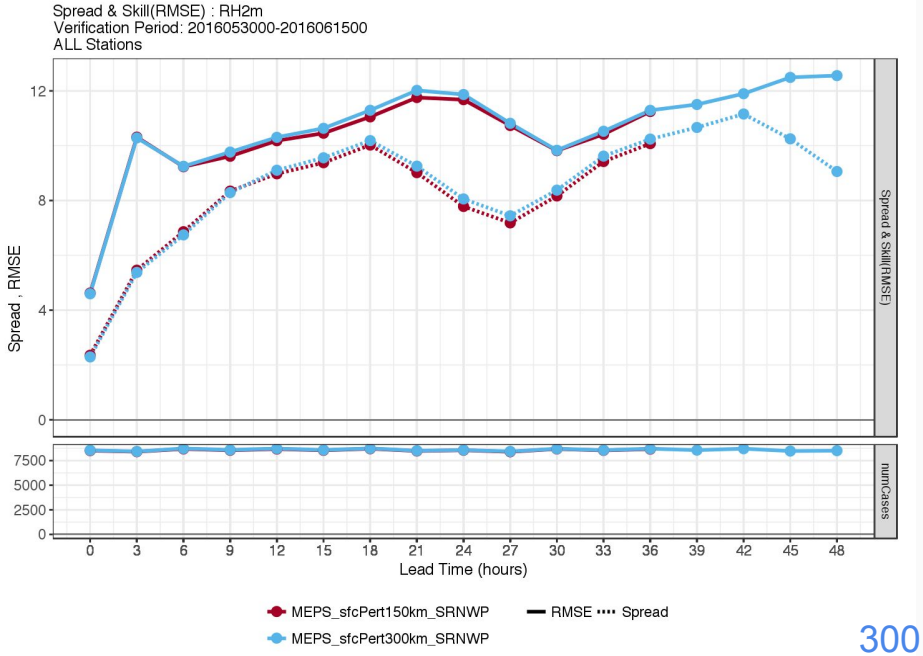


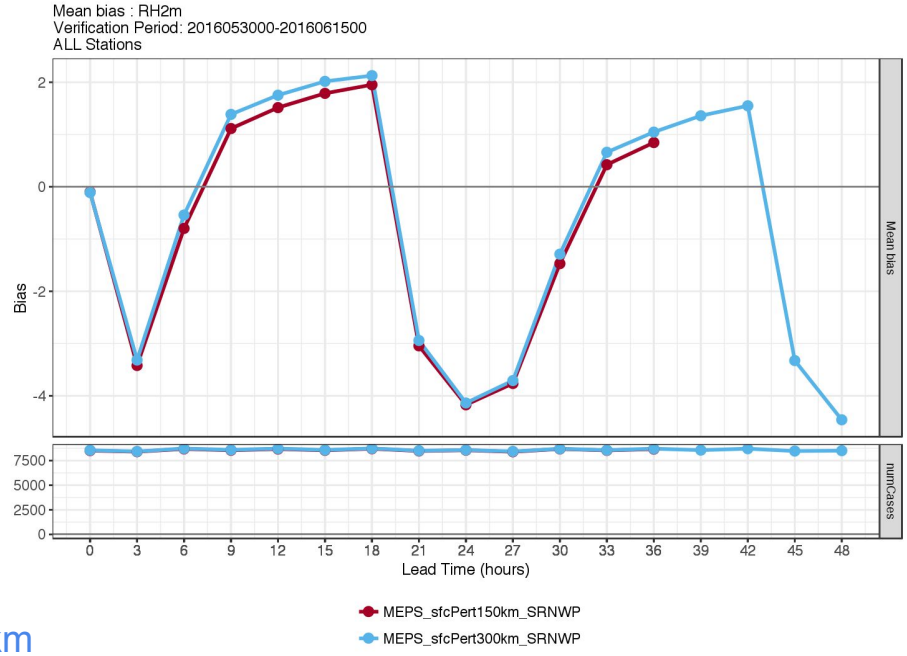


300 km

150 km

RH2m

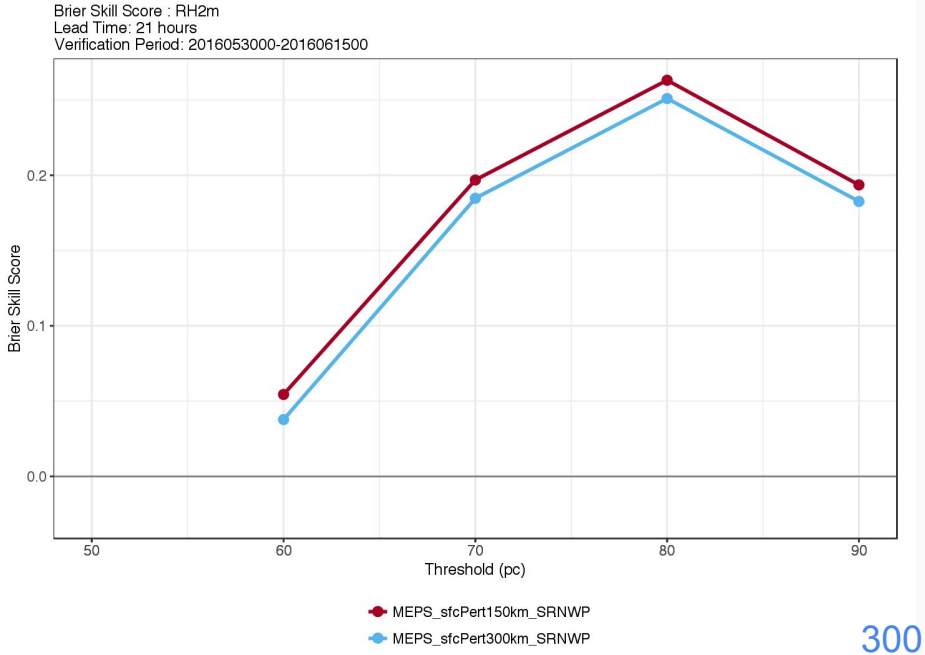


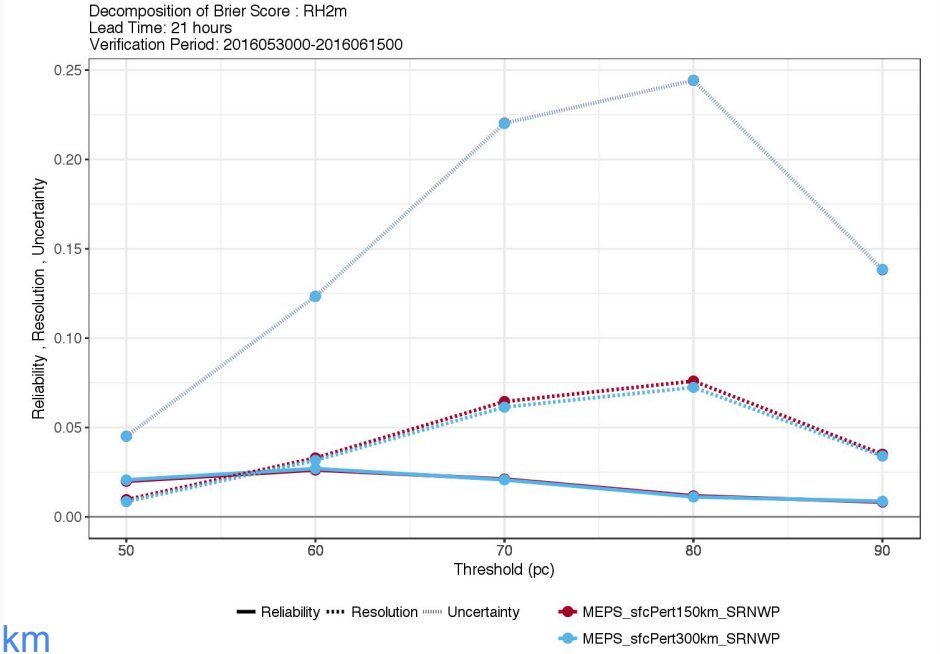


300 km

150 km

RH2m (night-time)





300 km

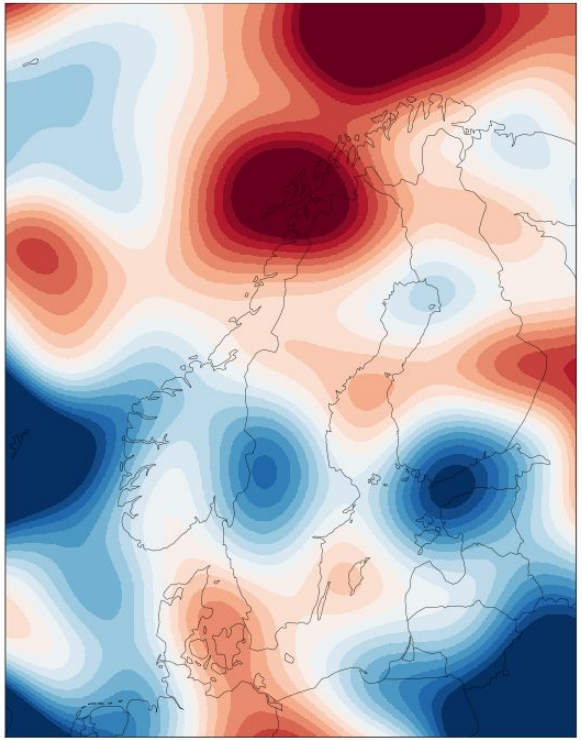
150 km

Effects of halving correlation length scale

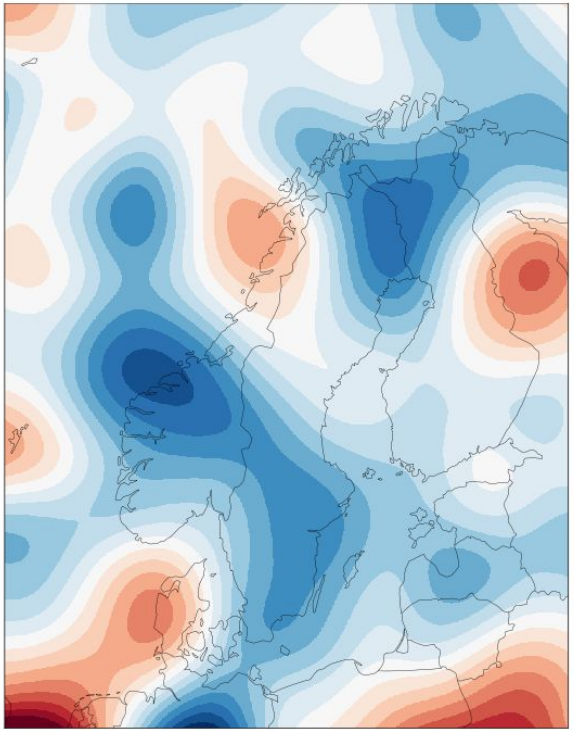
- Negligible impact on T2m
  - Slight improvement of day-time bias for day 1
- Small impact on RH2m
  - Slightly reduced RMSE in first 24 hours
  - Improved day-time bias
  - Improved BSS for all thresholds in first part of night - resolution is improved

Increasing clipping of random fields to ±4 with parameter standard deviations halved

Clipping at ±2

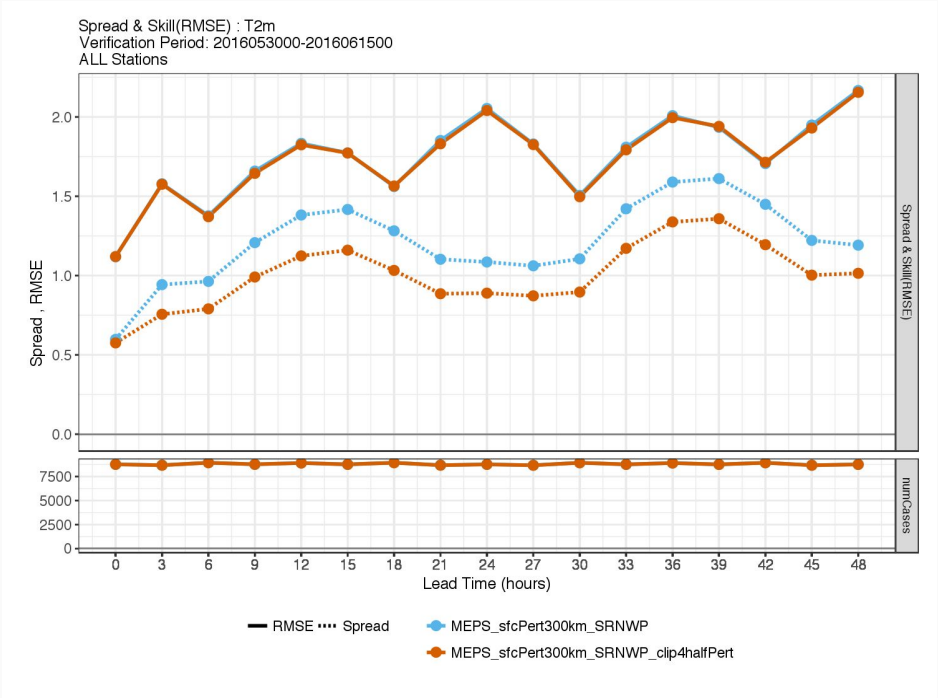


Clipping at ±4 perturbations halved



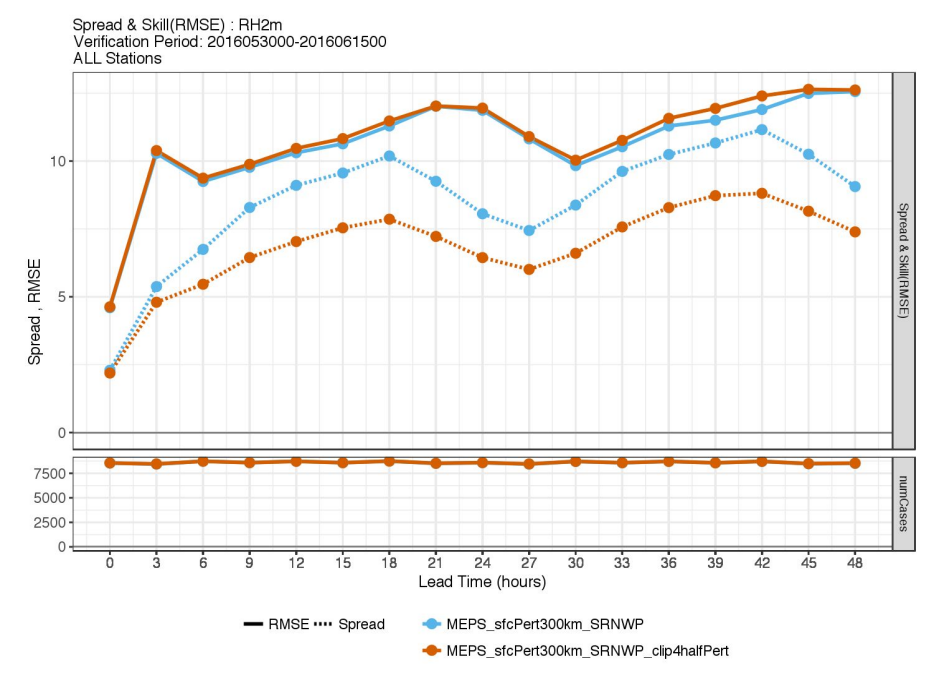
T2m

___ REF
___ clipping4, std halved

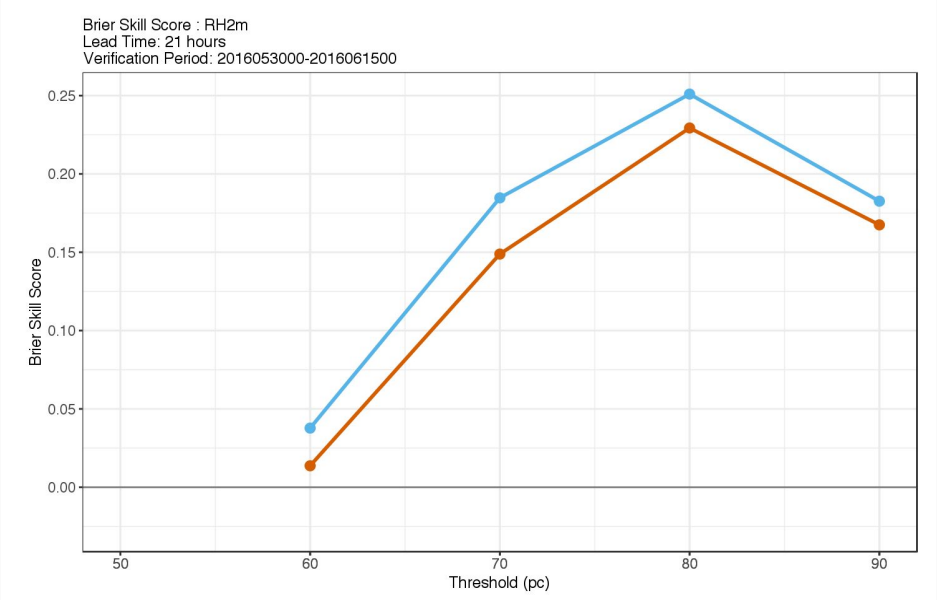


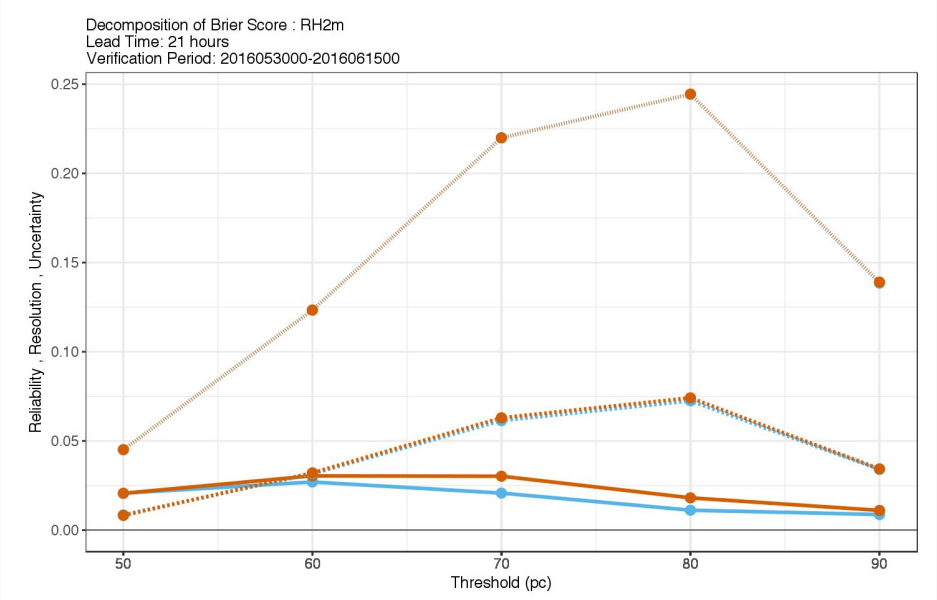
RH2m

___ REF
___ clipping4, std halved



RH2m (night-time)





___ REF

___ clipping4, std halved

Effects of increasing clipping and halving perturbations

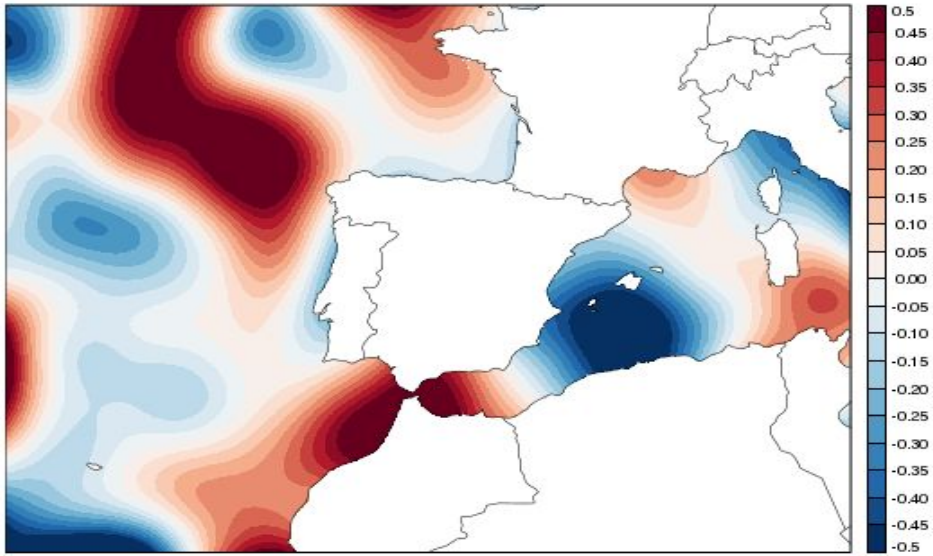
- Reduced spread for T2m and RH2m
    - Perturbation magnitudes too small?
- Worse night-time BSS due to loss of reliability

Surface Perturbation in HarmonEPS over the Iberian Peninsula

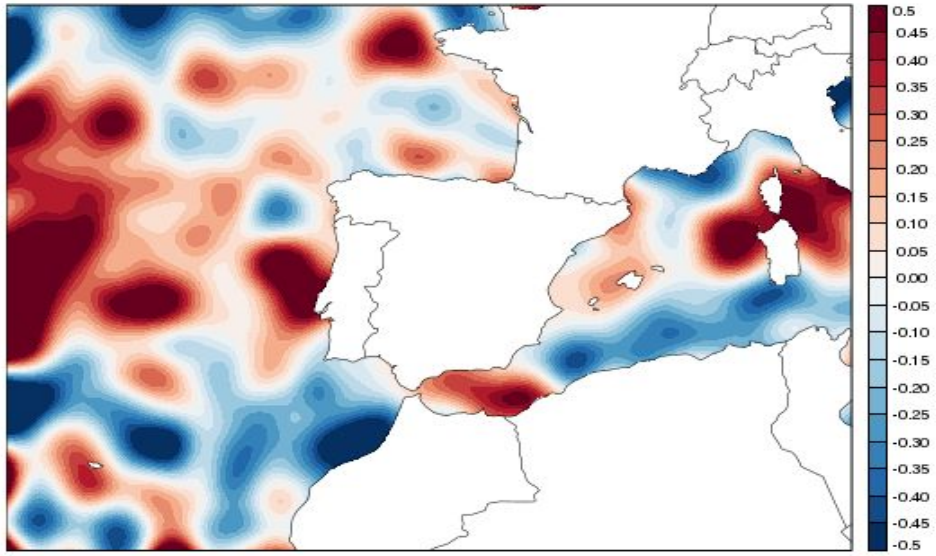
Sensitivity to correlation length scale:

Alberto Martín García

300 km



150 km



Outline

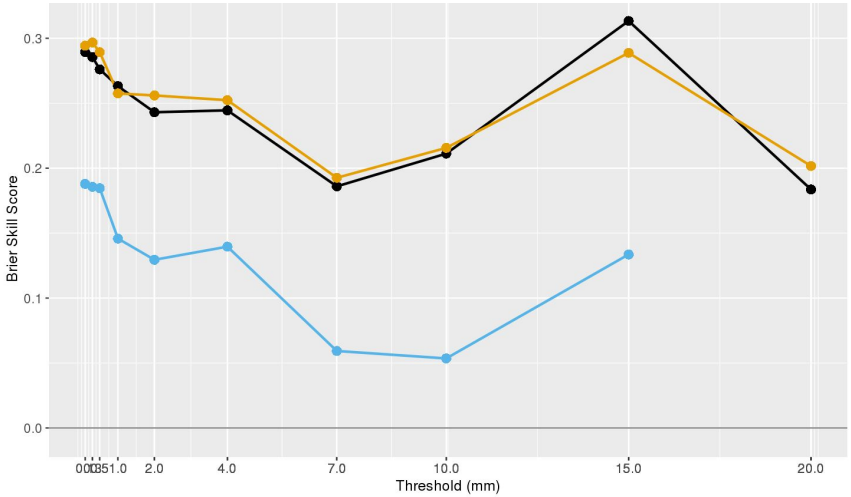
- LETKF
- Perturbations of the control vector
- Surface perturbations
- Parameter perturbations and SPPT

Perturbing parameters in HarmonEPS:

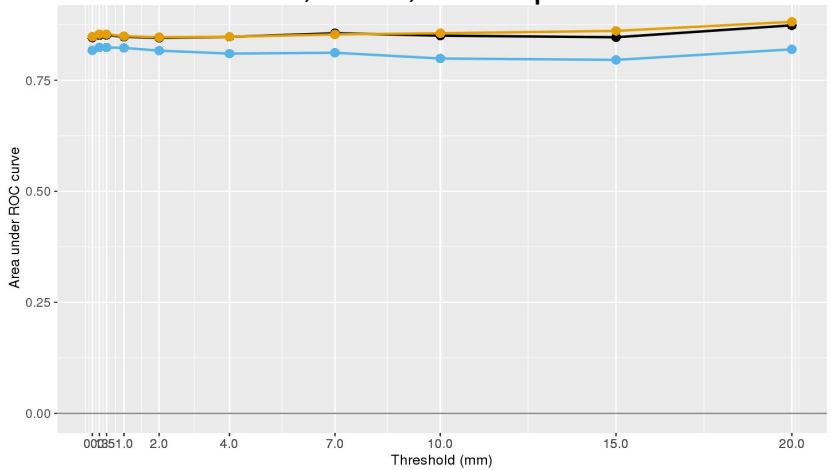
- Experiment for the Netherlands 11-18 June 2016
- 10 + 1 members
  - Stochastically perturbing, but perturbation kept constant in time and space
  - Critical cloud water content above which raindrop formation will start - *rlcrit*
    - Reference, no perturbations of rlcrit
    - As reference, but stochastically perturbing rlcrit
    - No perturbations of initial or boundaries, stochastically perturbing rlcrit

Sibbo van der Veen

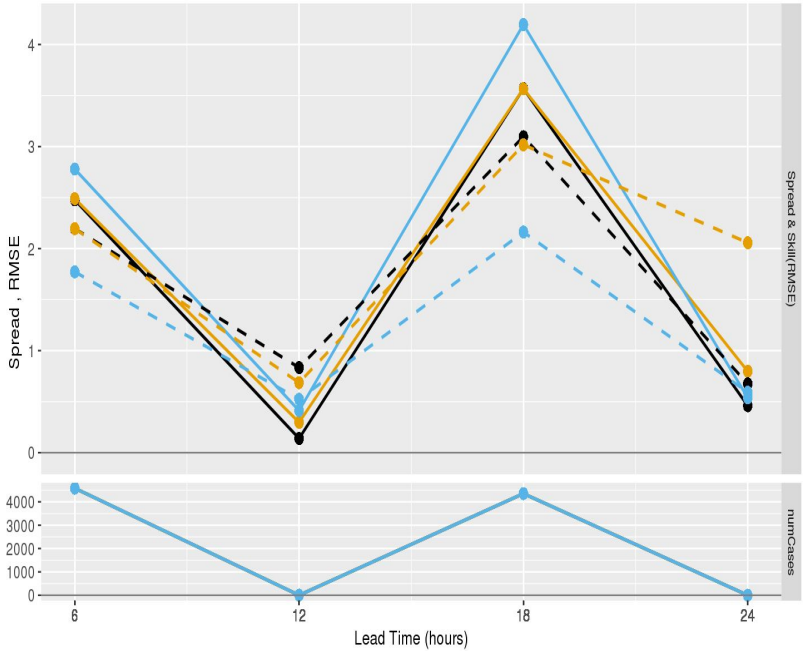
BSS +18h AccPcp6h



Area ROC, +24h, AccPcp12h



Spread and skill AccPcp6h



REF

REF + pert. rlcrit

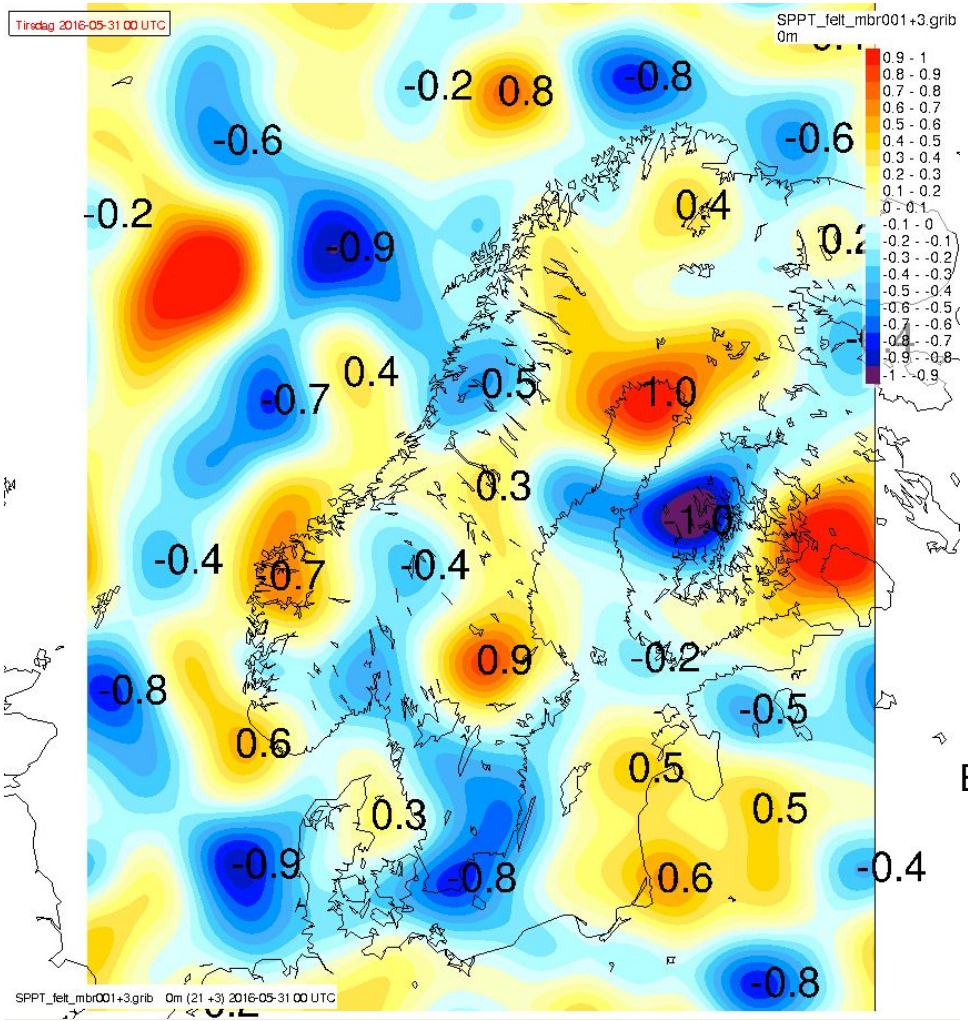
Pert. rlcrit, no ini or LBC pert.

SPPT and parameter perturbations (towards SPP):

- SPPT is now (finally) working in HarmonEPS cy40
- SPP - Stochastically perturbed parameterizations (or parameters) is being developed in HarmonEPS
  - Test with a parameter that allows lower relative humidity for (low) clouds to form - VSIGQSAT
    - Stochastically varying, but kept constant in time and space
    - Coupled to the SPPT-pattern generator to allow for spatio-temporal correlations
    - Compared to a reference with no perturbation of VSIGQSAT
    - Compared to SPPT

Experiment period:
2016053000 -
2016061500

10+1 members, 2.5 km

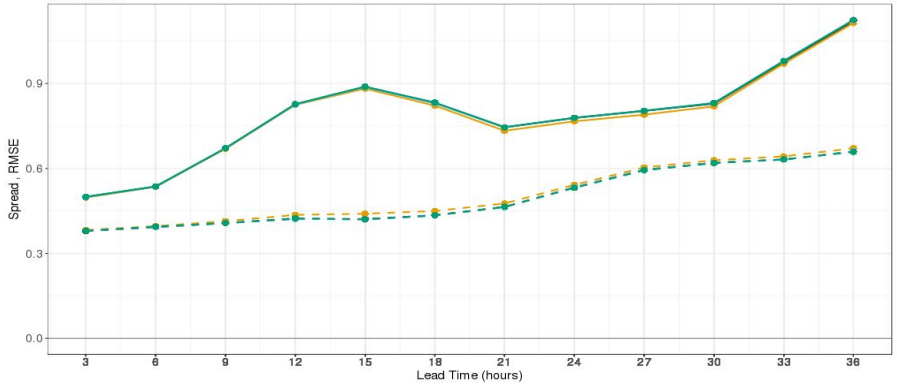


Example of pattern used:

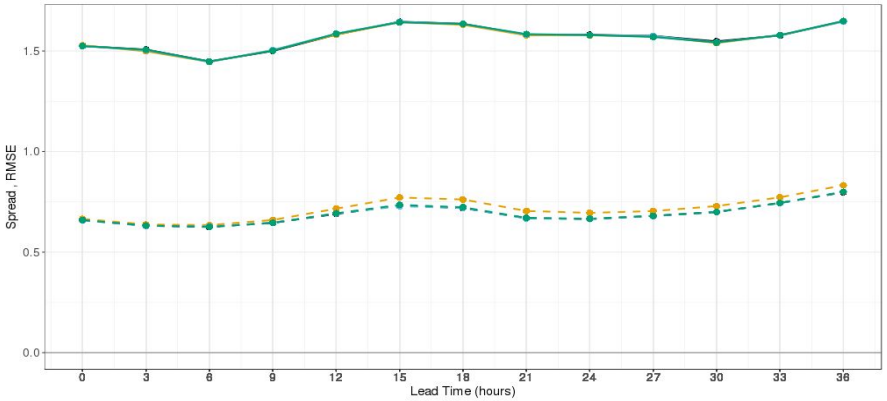
- Temporal scale: 8h
- Spatial scale: ~200km

Spread and skill

Pmsl

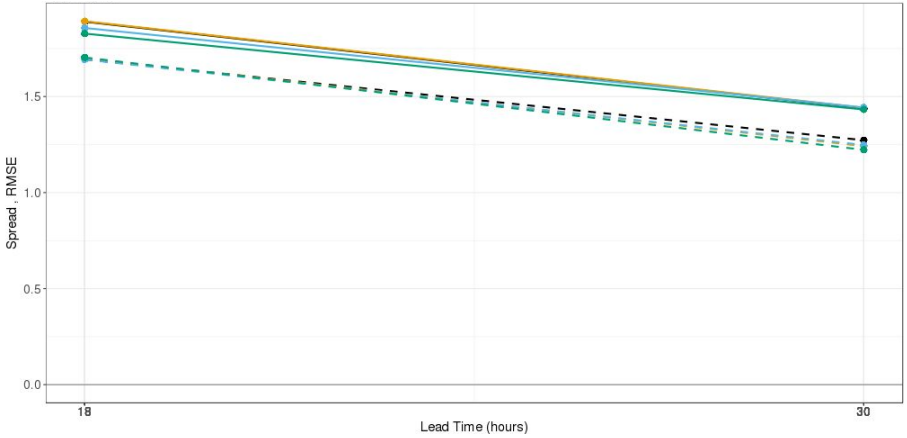


S10m

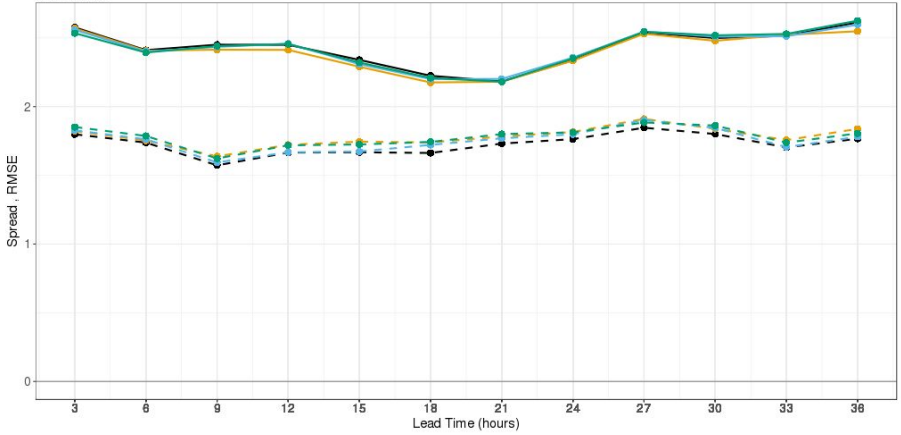


REF Varying in time/space
SPPT Constant time/space

AccPcp12h

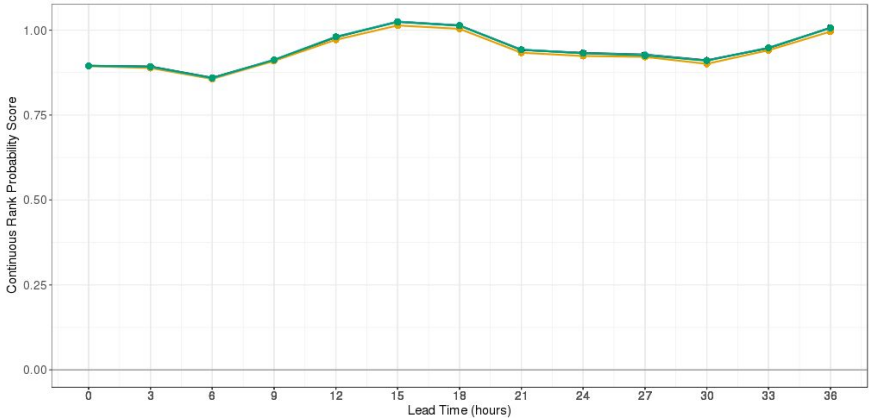


Low clouds

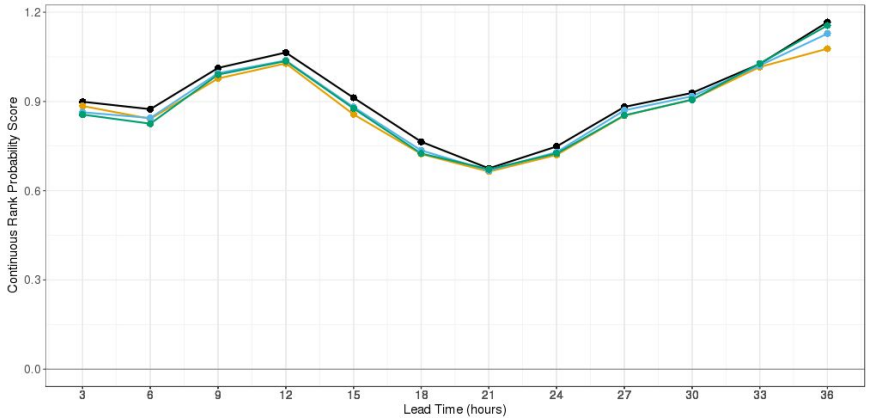


CRPS

S10m



Low clouds



REF Varying in time/space
SPPT Constant time/space

Further work on Stochastic parameter perturbations in HarmonEPS

- Study closer the effect of the perturbations, looking into spatial and temporal scales of the pattern, comparing SPP with SPPT
- Include more parameters
- Estimate uncertain parameter values, and pdf's, in Harmonie-Arome by use of **EPPES (Ensemble Prediction and Parameter Estimation System) in HarmonEPS**

Thank you

GLAMEPS (version 2, since October 2013)

Operational since 2011

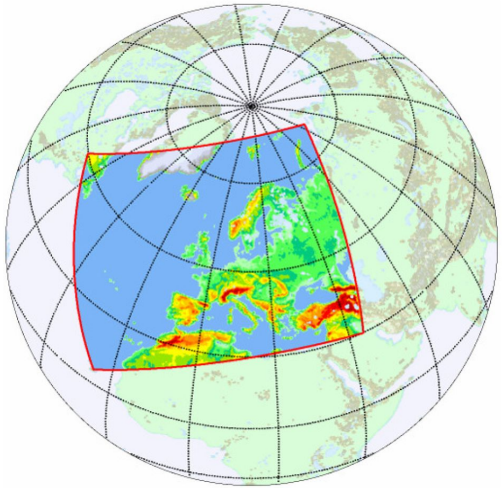
Multi-model, pan-European EPS

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



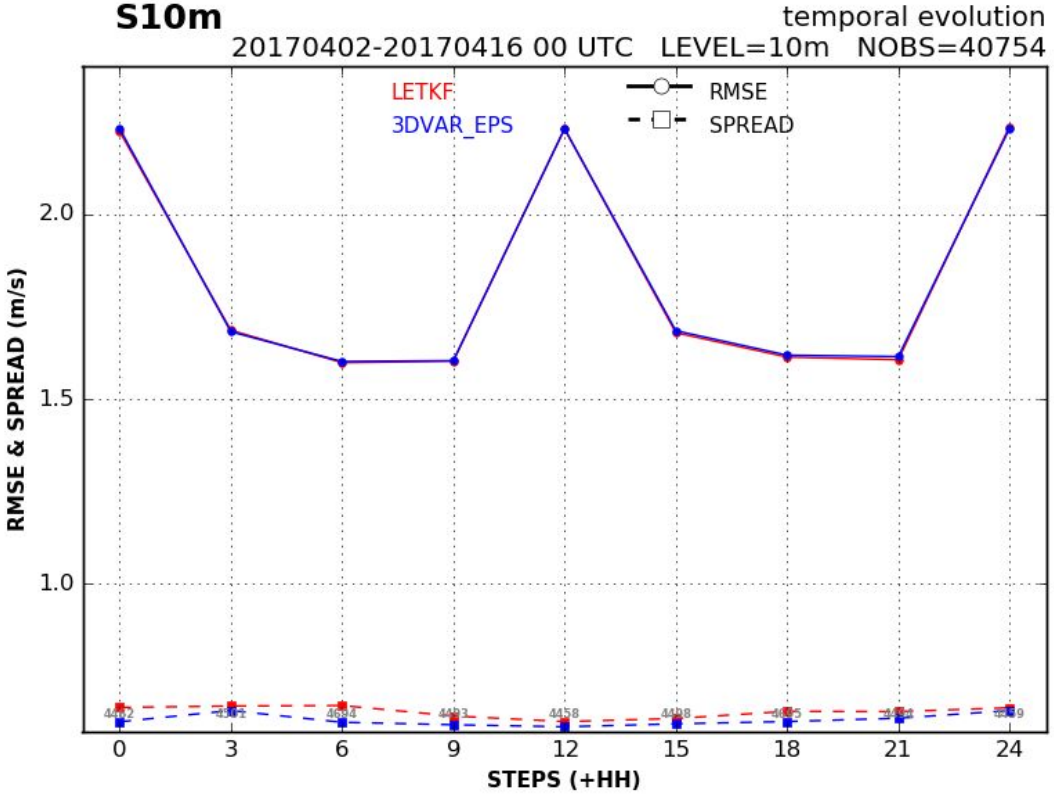
Experiments

- Reference (MEPS_sfcPert300km_SRNWP)
  - SLAF IC and BC perturbations : 10 + 1 members
  - 3DVAR upper air data assimilation on control member with 3h cycling
  - OI surface data assimilation for all members with 6h cycling
  - Surface perturbations with 300km correlation length scale
- MEPS_sfcPert150km_SRNWP
  - As reference, but surface perturbations with 150km correlation length scale

How the perturbation pattern is generated

- Model grid is filled with white noise
- Spatially smoothed by repeated application of a recursive low pass filter in both grid directions until a pre-defined correlation length scale is achieved (default ~300km, 10 iterations).
  - After smoothing, pattern is clipped to have max / min value of ± specified clipping value
- Perturbation fields are rescaled and clipped with spatially constant values that are "tuned" for each parameter: the perturbation std. deviations are roughly consistent with the precision at which the surface parameters are known, and perturbed values are clipped to constrain them to realistic values.

Probabilistic verification. Surface.



Probabilistic verification. Vertical.