GLAMEPS and HarmonEPS developments

Inger-Lise Frogner

and the HIRLAM EPS and predictability team

Toulouse, 2018

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GLAMEPS (version 2, since October 2013)

Operational since 2011

Decision at HIRLAM council 22 June 2017:

- 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

Kai Sattler, Alex Deckmyn, Toon Moene

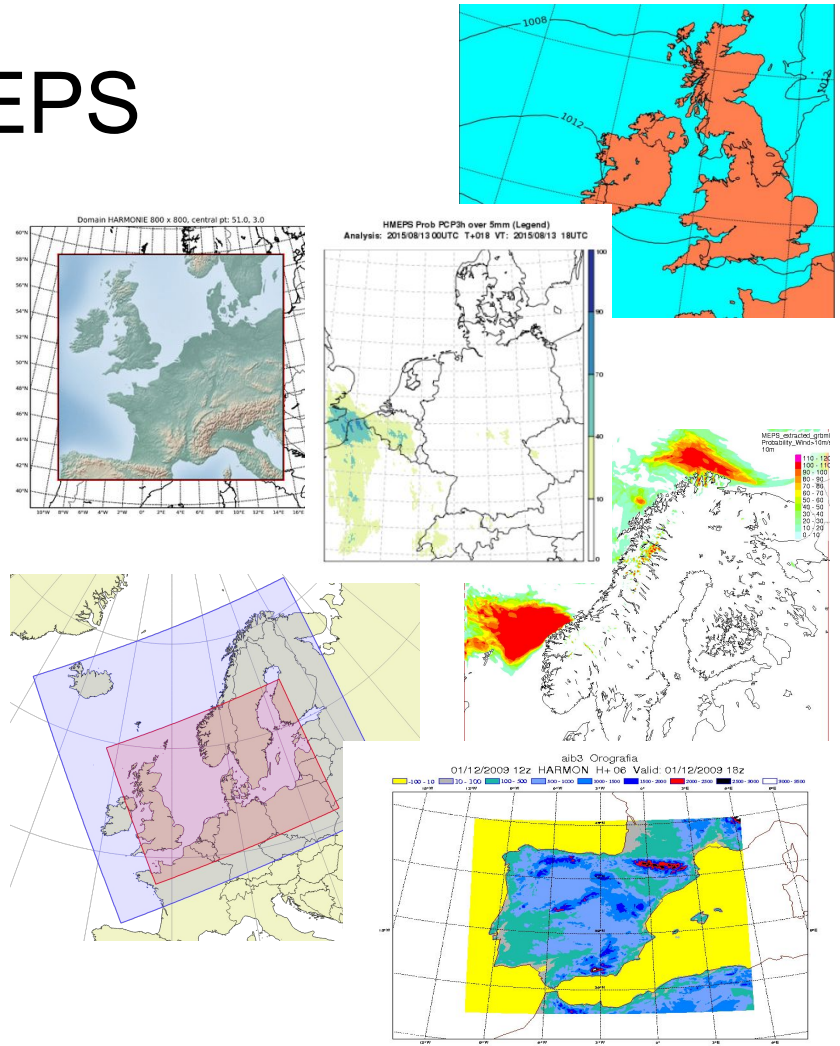
HarmonEPS

HarmonEPS with different configurations operational or being tested at several institutes:

MEPS - COMEPS - ɣSREPS - RMI EPS - KEPS - IREPS

Configurations vary, but typically:

- 10-20 members
- Arome. Alaro now also available in cy40
- 2.5 km
- 3D-Var
- SURFEX
- 2-3 days forecasts



HarmonEPS development

Three topics highlighted this year:

- Lateral boundary condition uncertainties
- Stochastically perturbed parameterizations - SPP
- EDA

Lateral boundary condition uncertainties

Background and motivation

SLAF: Perturbations generated by taking HRES forecasts valid at the same time but with different forecast length and initial times, scaled.

SLAF does the job well, but with some limitations:

- Still some clustering of members due to IFS drift
- It limits the possible number of members
- Earlier comparisons have been done with ENS on lower resolution in time and space

To be fair, there are some pros with SLAF:

- Verifies well
- Easy operational implementation
- Higher resolution perturbations

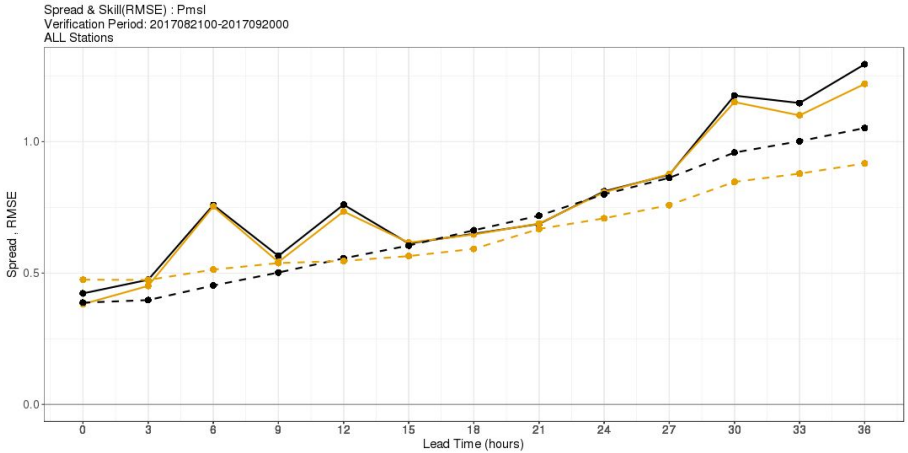
Ulf Andrae, Henrik Feddersen and Björn Stensen

SLAF vs ENS at the boundaries

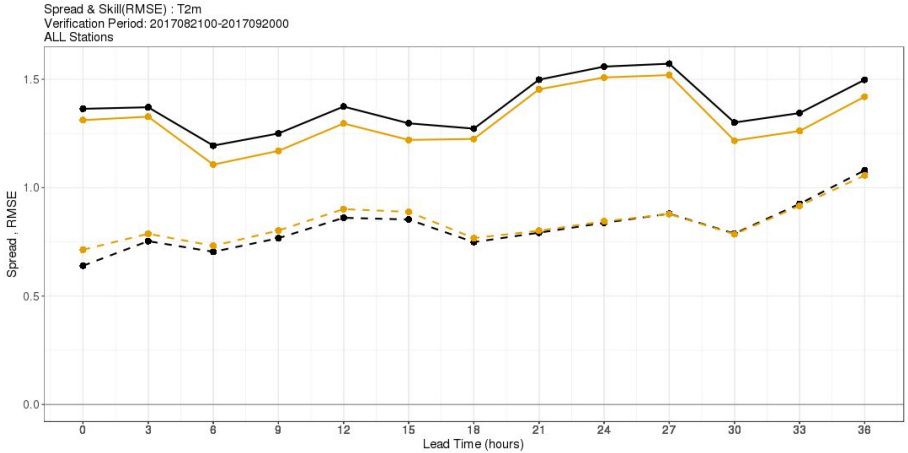
MSLP is reasonable, but T2m doesn't impress...

ENS
SLAF

MSLP



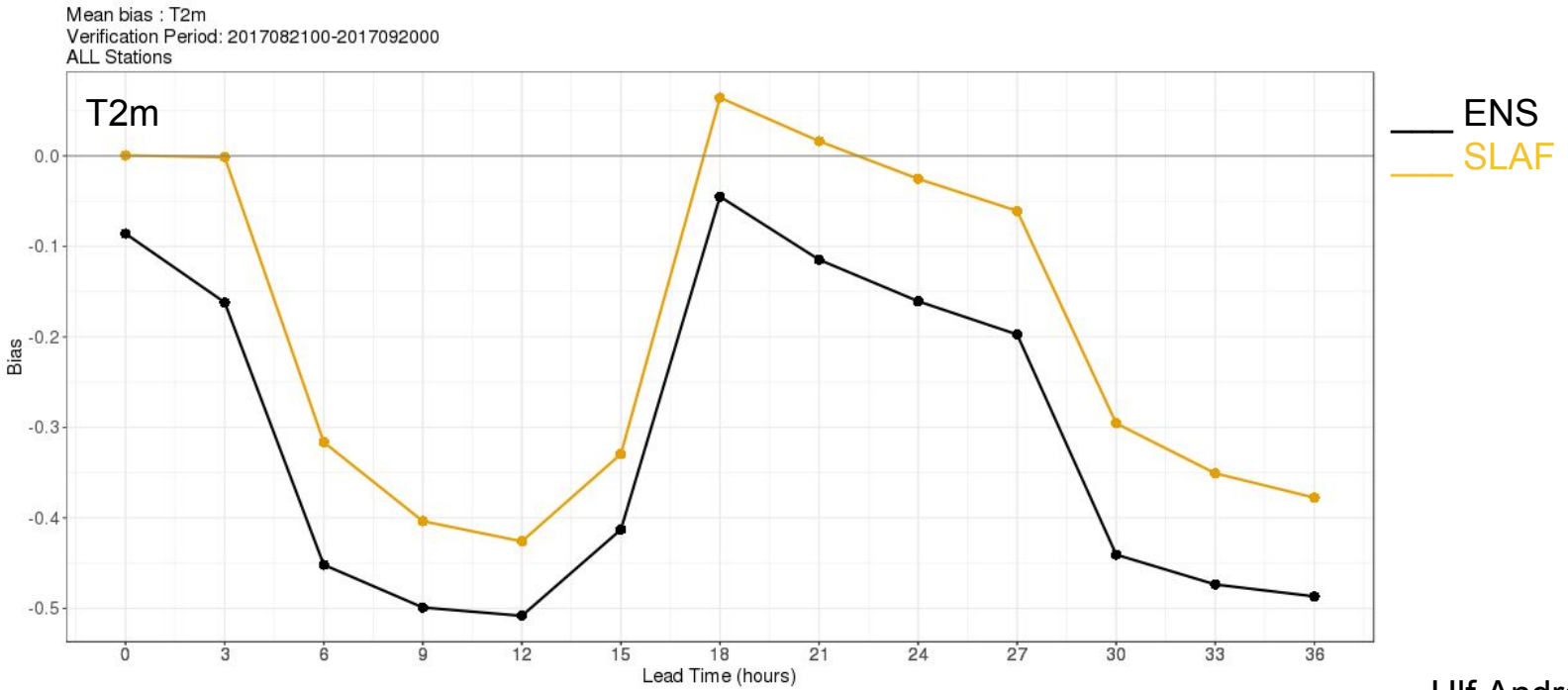
T2m



Ulf Andrae

SLAF vs ENS at the boundaries

We have a clear T2m bias difference. Haven't we seen this before?



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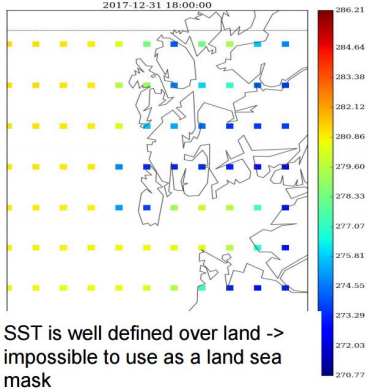
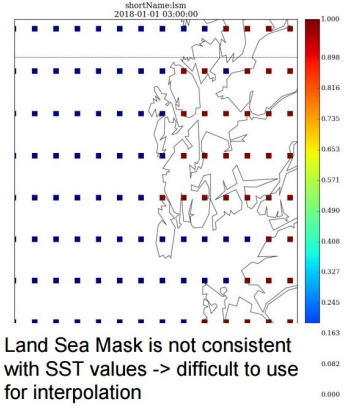
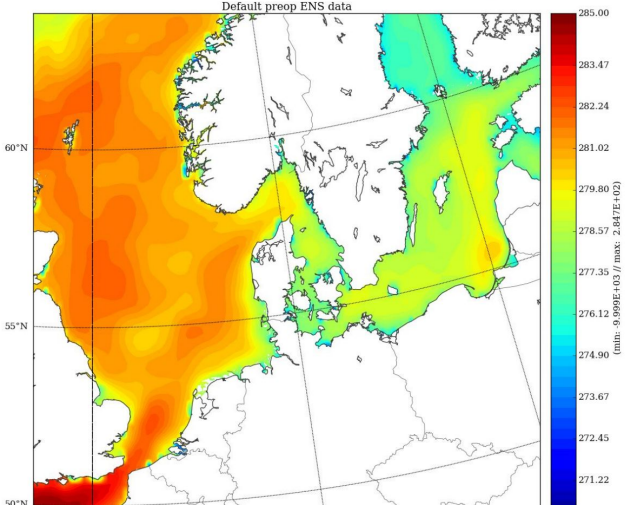
MARS interpolation problems and problems with SST being defined over land



SST is well defined over land -> impossible to use as a land sea mask



Land Sea Mask is not consistent with SST values -> difficult to use for interpolation



Creates erroneous SST along the coast

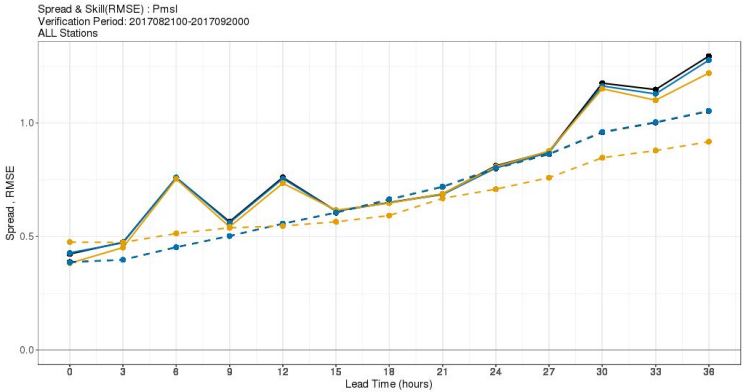
Can be sorted out by some excluding of the points along the coast.

Good news is that MARS with MIR “mars -m” ensures consistency, but properly defined SST would be even better!

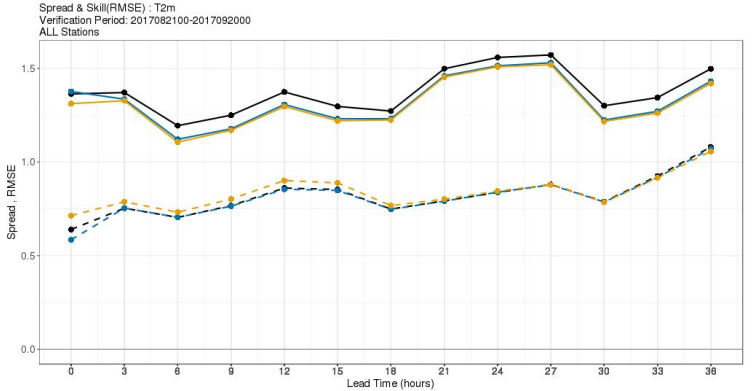
Best solution: USE HRES SST

Ulf Andrae

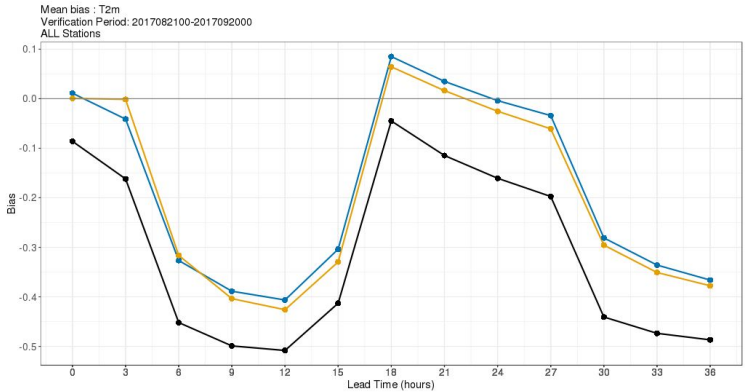
MSLP. Spread growth less good for SLAF



T2m. No real differences left, apart from initial spread



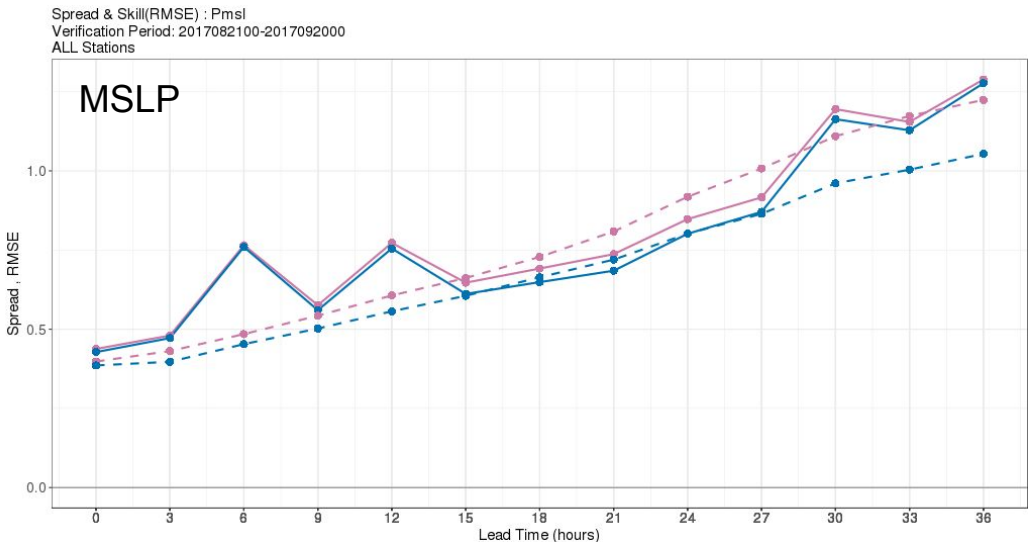
ENS
ENS det. SST
SLAF

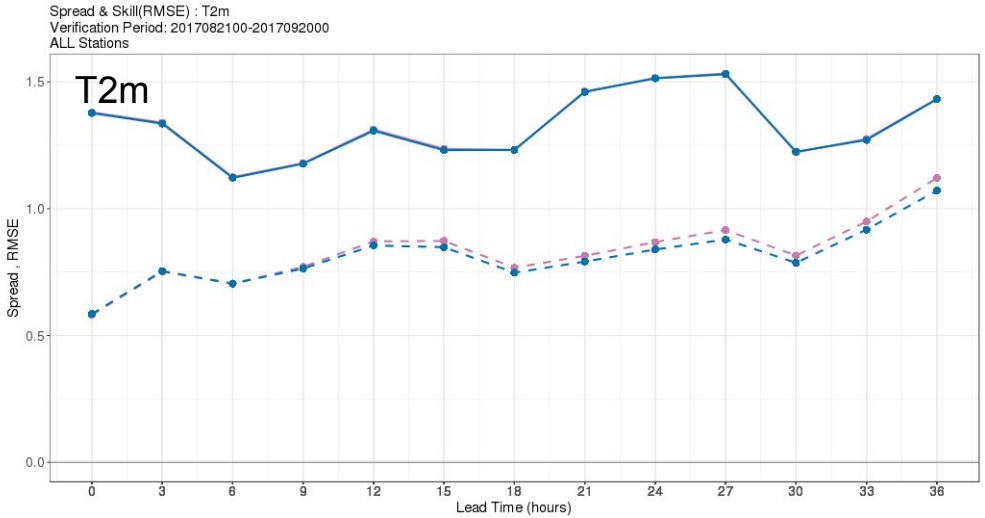


And the T2m bias is similar

With proper definition of SST we achieve as good scores with ENS as with SLAF

Ulf Andrae





A test with clustering at {U,V,T,PS}
@ (850hPa, 925hPa) for +24/+36

Clustering does give some extra spread - gives too much for MSLP - but the overall response is small

Could be important for rare events

___ clustered
___ not clustered

Björn Stensen and Ulf Andrae

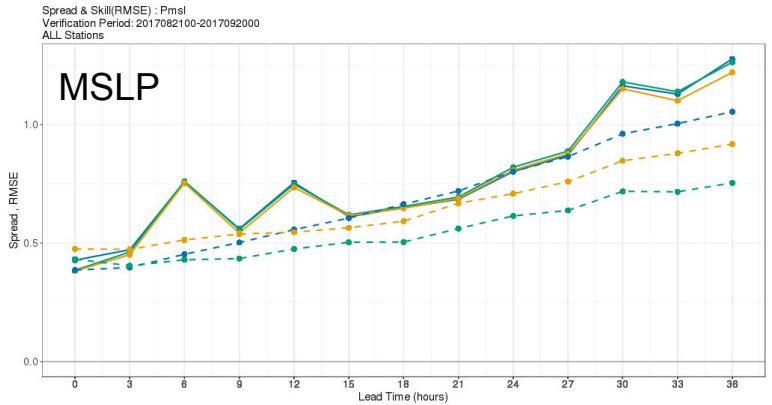
Random field perturbations (RFP)

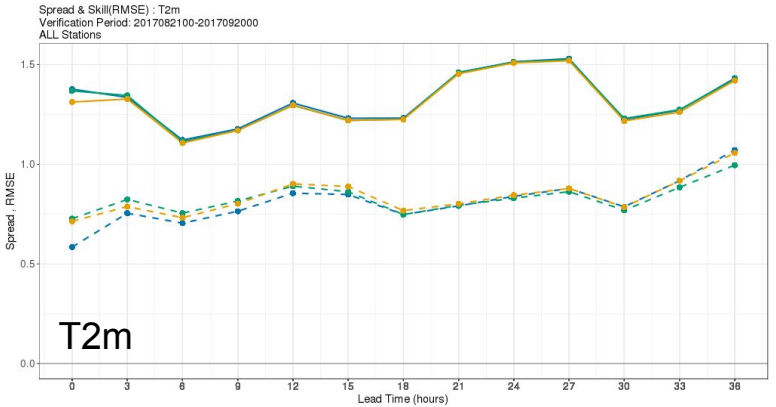
A version of SLAF, but instead of using the latest HRES forecasts for creating the perturbations, one uses old and random forecasts, but where hour and season match.

Based on: Magnusson et al., 2009: “Flow-dependent versus flow-independent initial perturbations for ensemble prediction”

Random field perturbations works well, but spread growth for MSLP less good than SLAF (and ENS).

___ ENS det. SST
___ Random field pert
___ SLAF





Henrik Feddersen and Ulf Andrae

Ensemble Data Assimilation (EDA) in HarmonEPS

Account for the uncertainty in the initial conditions by perturbing the observations.
Observations used: conventional, AMSU-A, AMSU-B and IASI

Boundary nesting: SLAF
Members: 1+10
Area: MetCoOp
All members run their own surface analysis

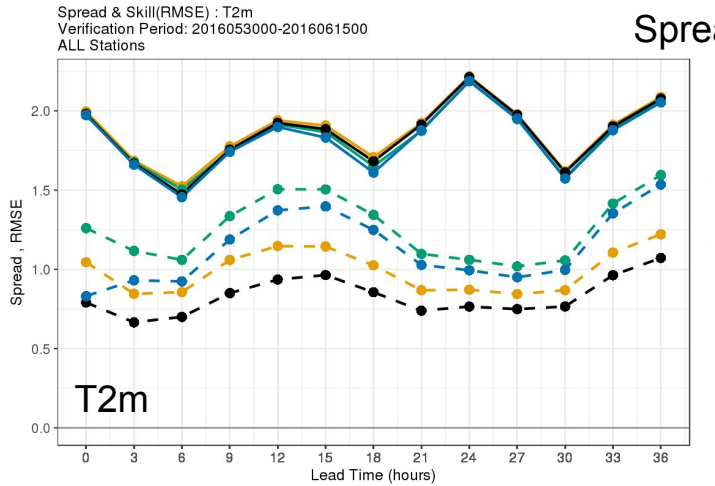
Experiments:

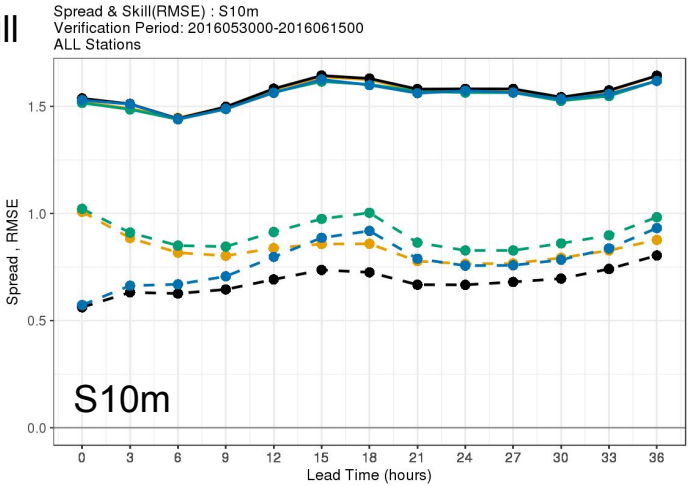
- REF_moreobs3 - reference exp
- EDA_ moreobs3 - As the one above, but with EDA and 3DVar for all members (PERTATMO=CCMA, PERTSUF=ECMA)
- EDA_moreobs3_surfpert - As the one above, but PERTSURF=model (no perturbations of surface observations, instead surface perturbation code is on)
- REF_moreobs3_surfpert - as REF_moreobs3 but surface perturbations switched on

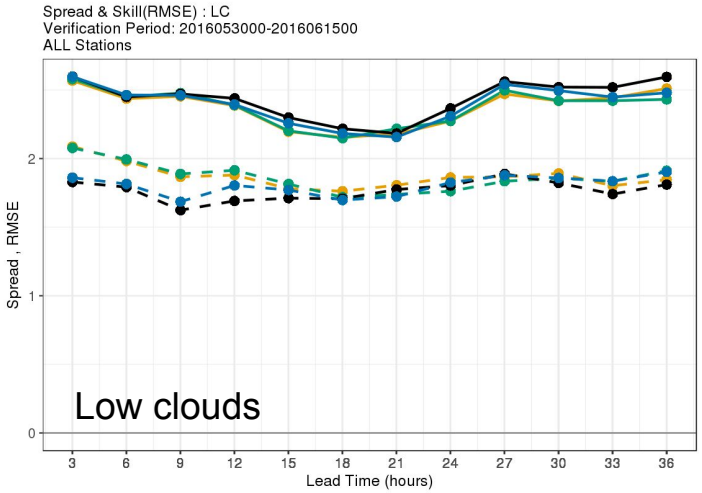
Surface perturbations from Francois Bouttier et al, slightly modified

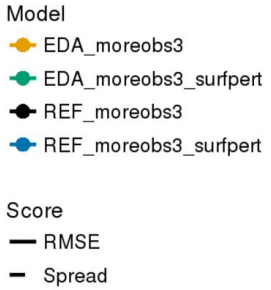
Inger-Lise Frogner and Roger Randriamampianina

Spread and skill







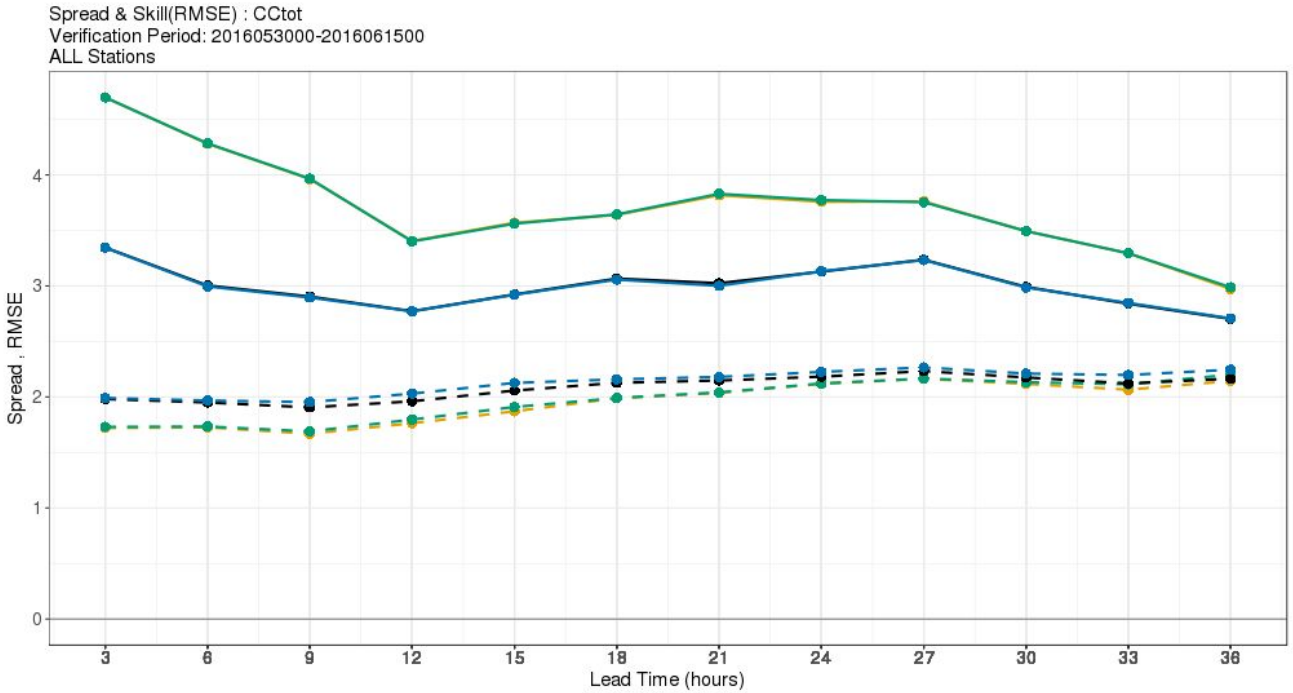


Good overall effect of activating EDA
Increases spread throughout the forecast range,
Particularly for the first ~12 hours.

Surface perturbations scheme gives higher spread than perturbing the surface observations.

Inger-Lise Frogner and Roger Randriamampianina

Spread and skill

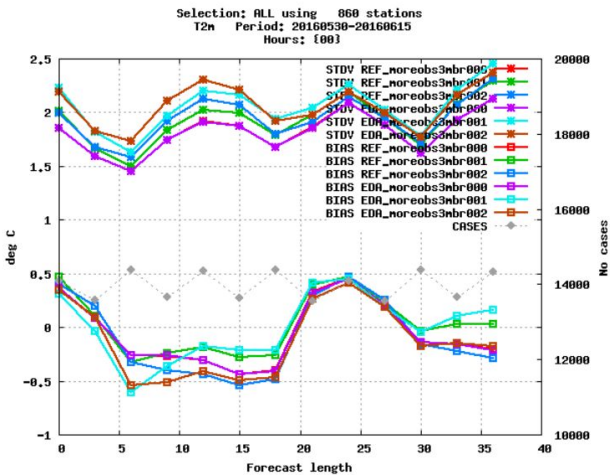


What is wrong with the total cloud cover?

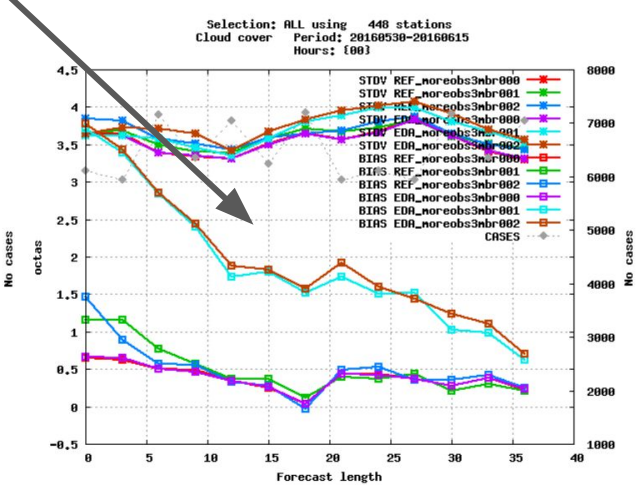
Total cloud cover

Inger-Lise Frogner and Roger Randriamampianina

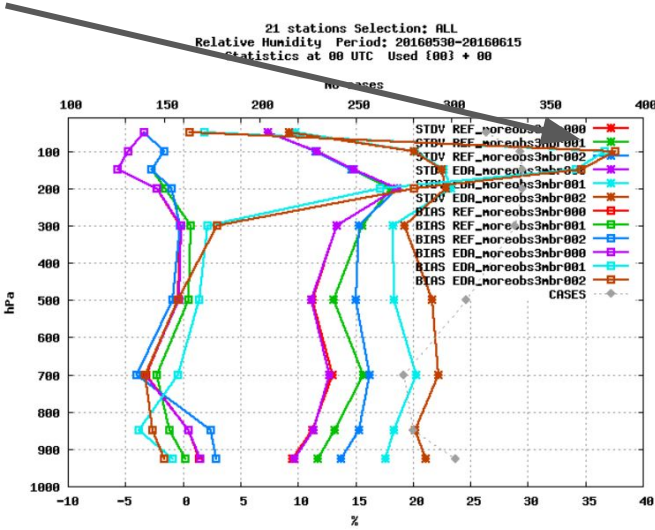
Deterministically comparing control and two members from EDA and REF experiments



T2m



Cloud cover



RH2m

T2m (and other parameters) looks reasonable

control REF
mbr1 REF
mbr2 REF

control EDA
mbr1 EDA
mbr2 EDA

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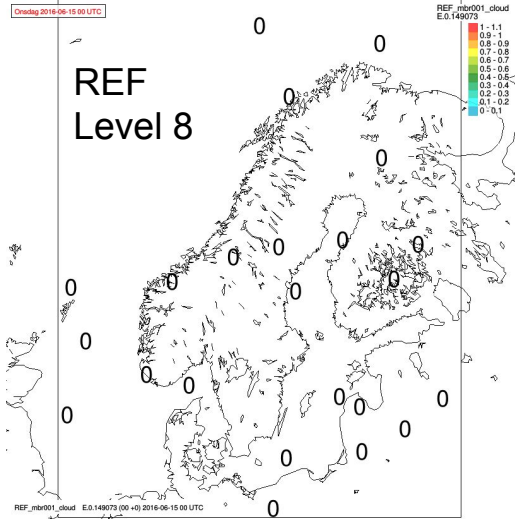
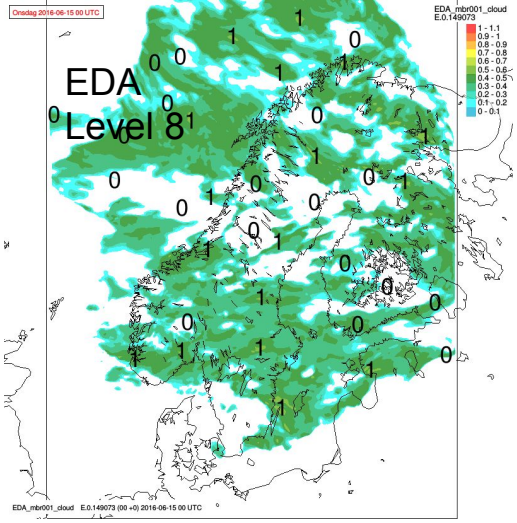
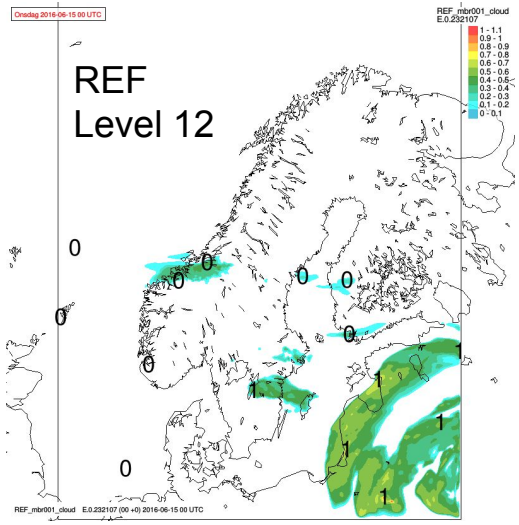
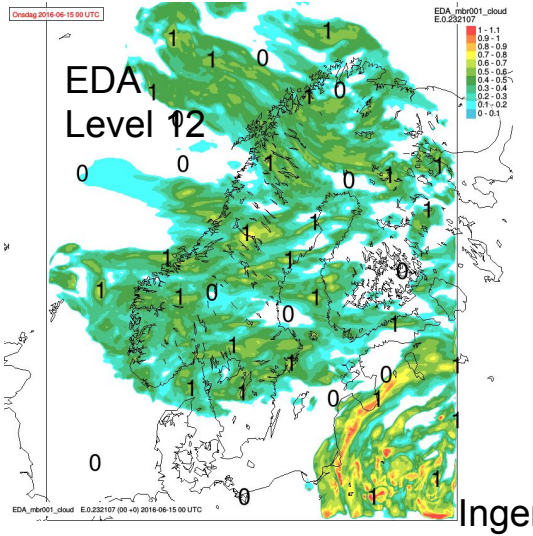
Cloud cover









In EDA we get high level clouds where we should not have clouds

A rerun blacklisting some channels did not help

Investigations to continue

The impact of EDA on surface parameters are probably little affected by this

Inger-Lise Frogner and Roger Randriamampianina

Development work on representing model error:

- **SPPT** is available in HarmonEPS (1 pattern, 3 at ECMWF) - now also with SPG - Stochastic Pattern Generator *(M. Tsyrulnikov and D. Gayfulin. In Arome by Mihaly Szucs, in HarmonEPS by Ole Vignes)*

- **RPP** (Randomly perturbed parameters) - our first attempt at perturbing parameters by stochastically varying the parameter for each member and each cycle, but kept constant in time and space

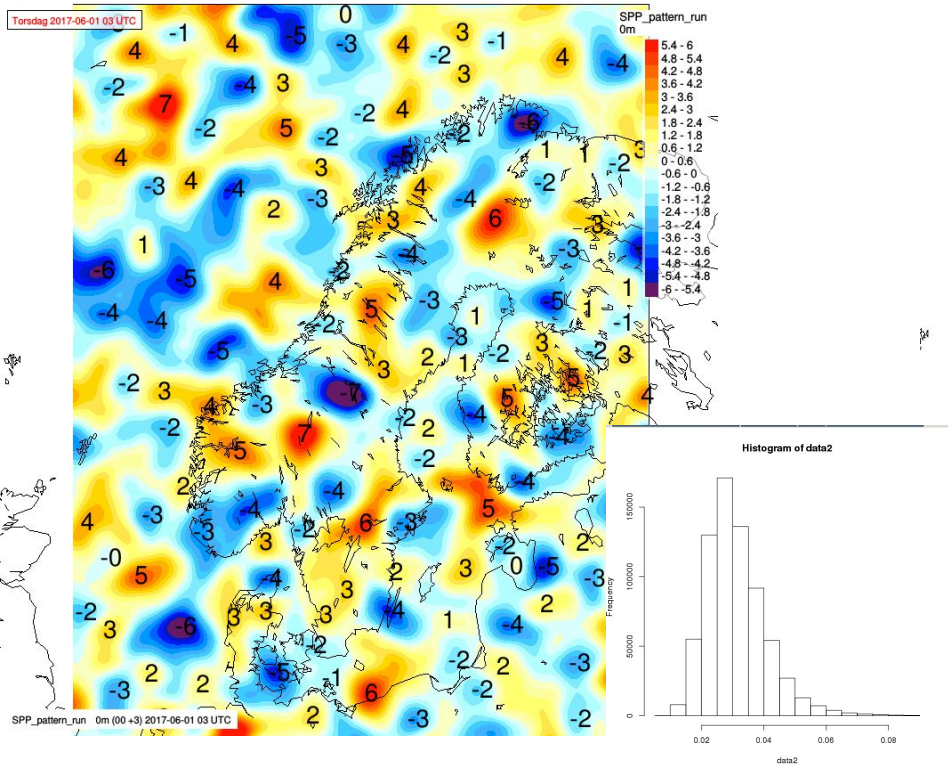
- **SPP** - Stochastically perturbed parameterizations
  - IFS framework for SPP is implemented in HarmonEPS
  - log-normal distribution
  - As RPP - but varying in time and space according to a 2D random pattern

RPP/SPP so far tested for a parameter that allows lower relative humidity for (low) clouds to form (VSIGQSAT).

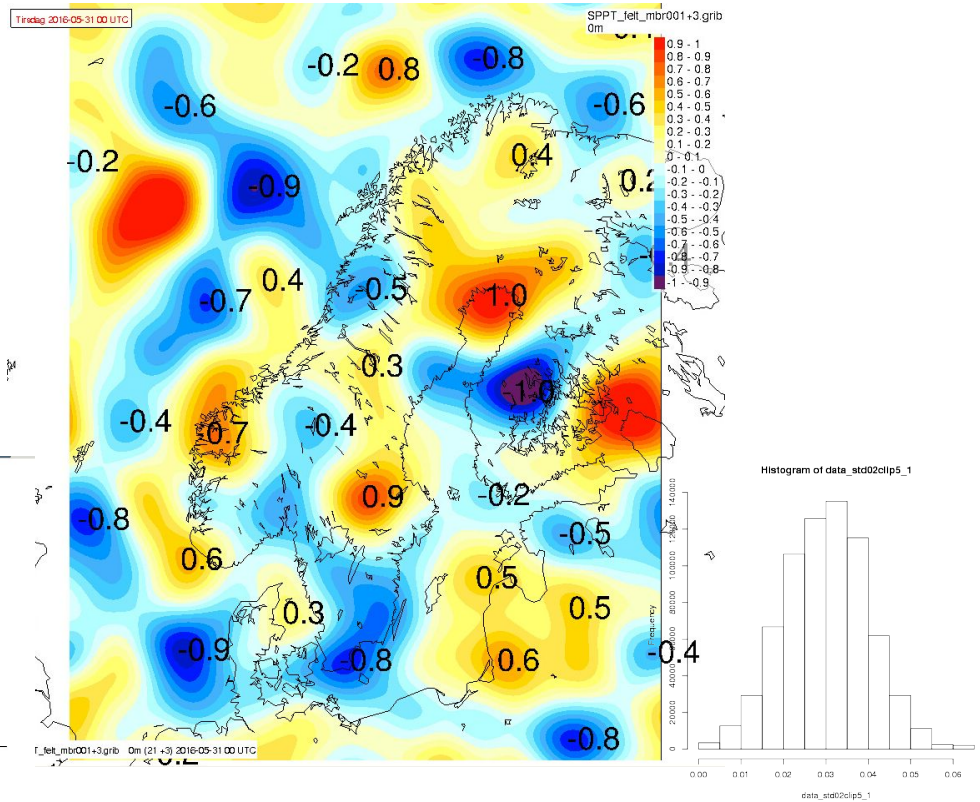
Ulf Andrae, Inger-Lise Frogner and Pirkka Ollinaho

Examples of patterns used:

Temporal scale: 6h, Spatial scale ~100km



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



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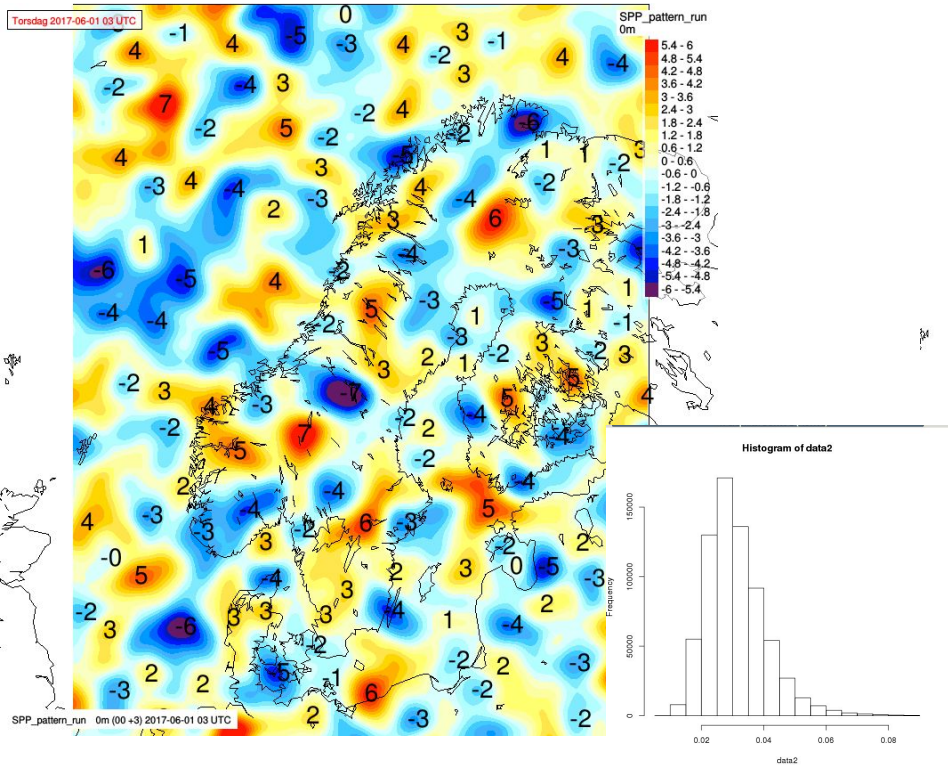
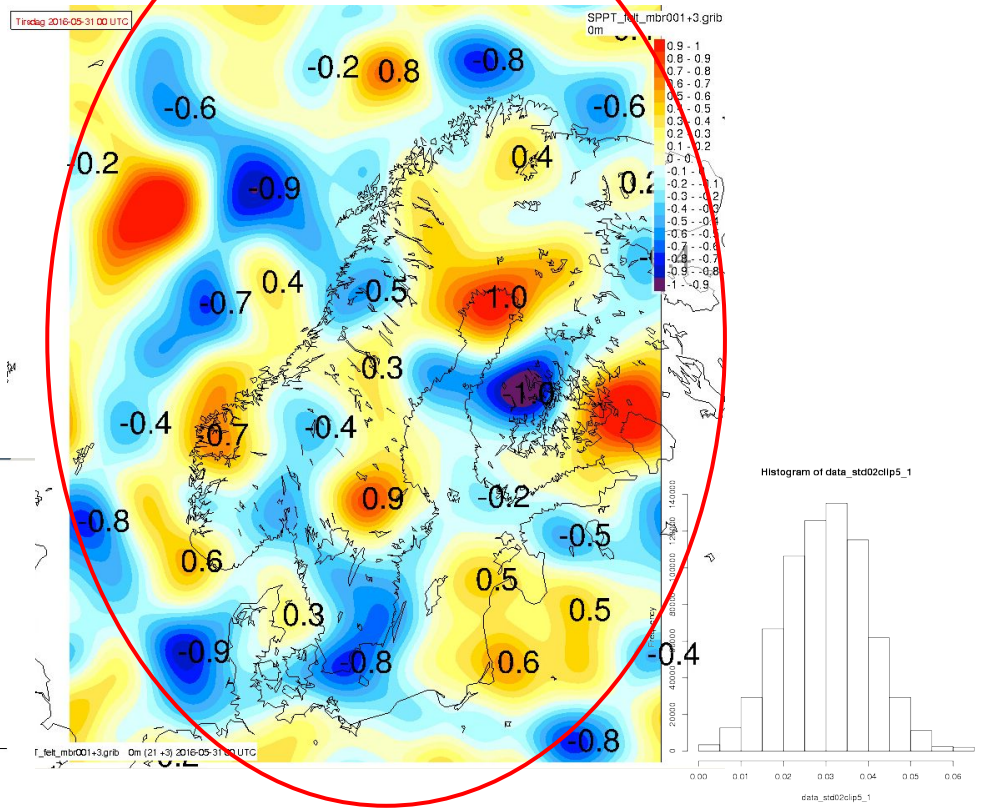


Temporal scale: 8h, Spatial scale: ~200km



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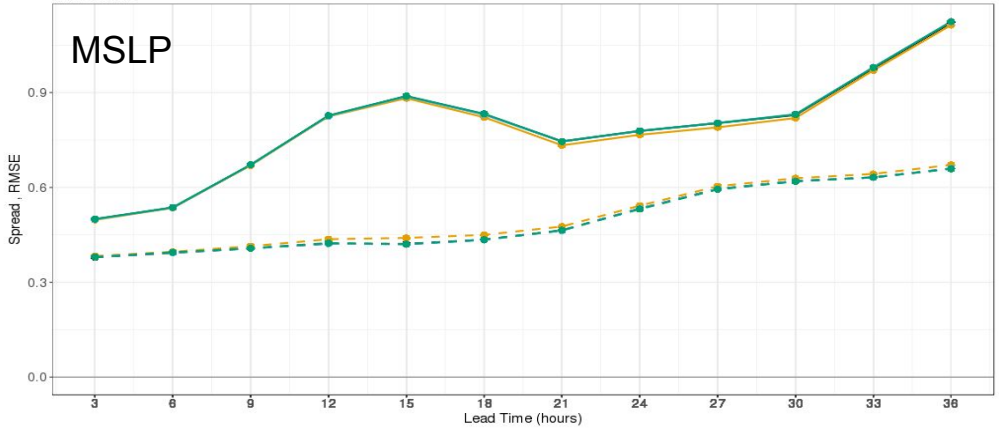
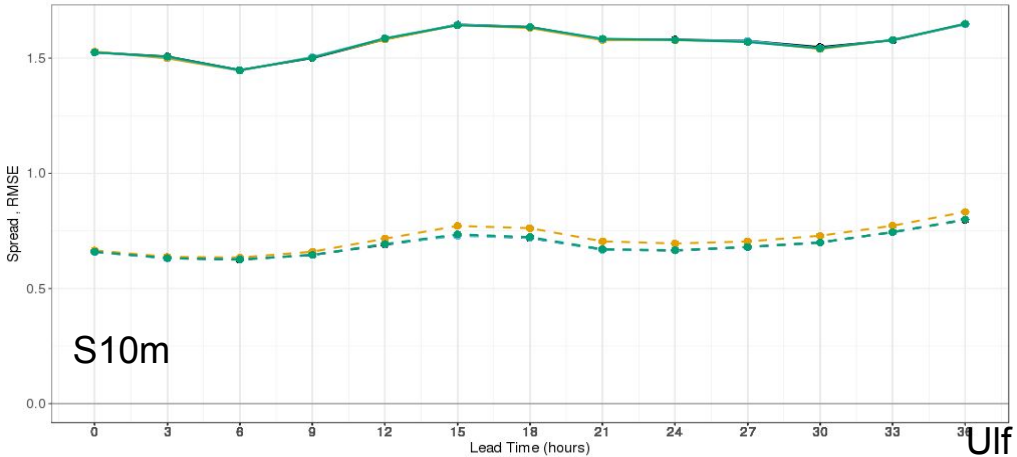
Spread and skill, 2016053000 - 2016061500



REF Varying in time/space (SPP)
SPPT Constant time/space (RPP)

Negligible impact of perturbing VSIGQSAT

Positive, but small, impact on spread from SPPT



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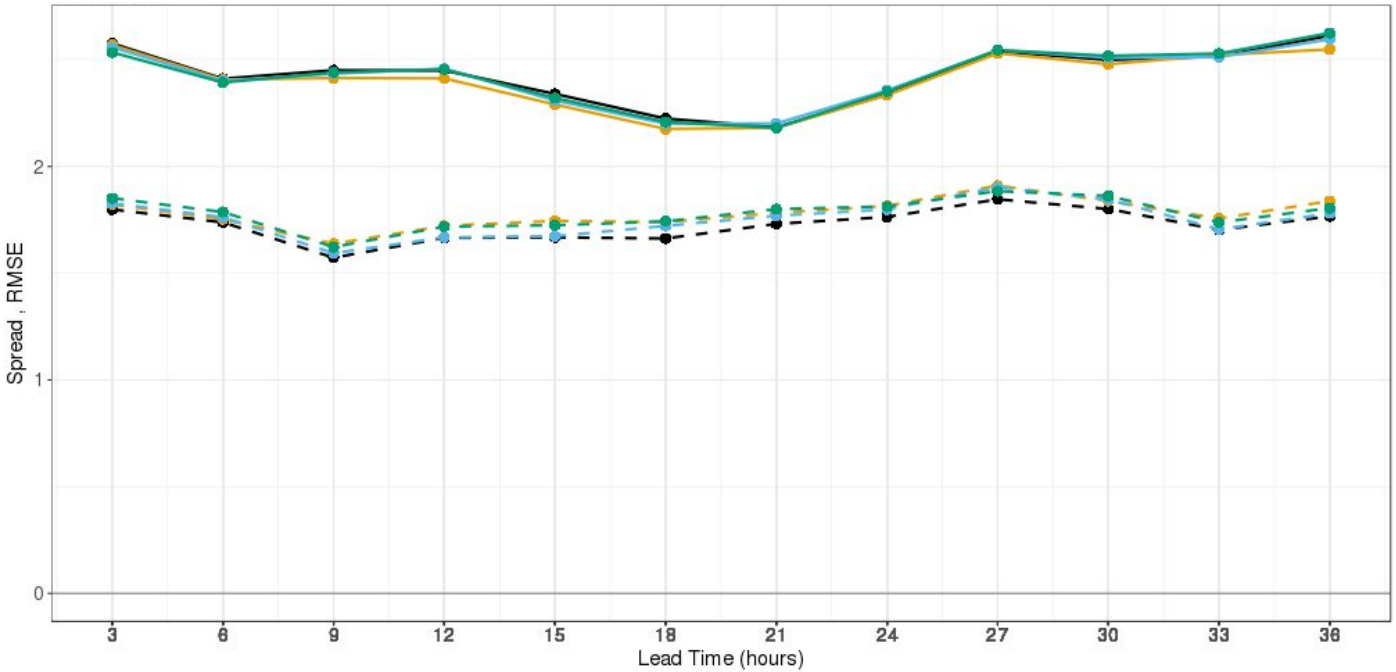
Spread and skill, 2016053000 - 2016061500

Low clouds



REF Varying in time/space (SPP)
SPPT Constant time/space (RPP)

Small positive impact on spread from perturbing VSIGQSAT
~ same as from SPPT

RPP better than SPP

SPPT slightly better RMSE

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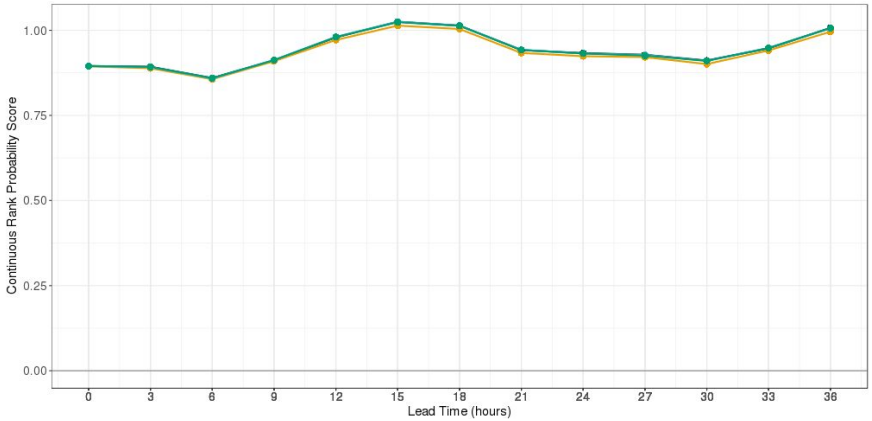
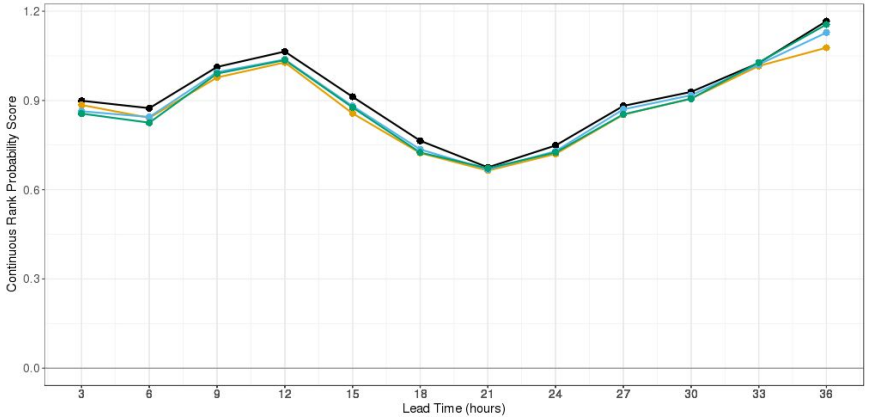
CRPS

S10m



Low clouds



REF — Varying in time/space (SPP)
SPPT — Constant time/space (RPP)

Small, positive impact of SPPT on S10m (and other parameters)

Very little impact of perturbing VSIQSAT except for cloud related parameters where there is a small, but positive, impact of the same order as SPPT

Ulf Andrae, Inger-Lise Frogner and Pirkka Ollinaho

Further work on upper air perturbations in HarmonEPS:

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

Ulf Andrae, Inger-Lise Frogner and Pirkka Ollinaho

Thank you

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)

Potential parameters

8 potential parameters from the parametrizations of micro-physics, cloud processes, convection and radiation to be optimised:

1) ice number concentration (ZZW)
2) the conversion rate from cloud liquid water to rain (ZINHOMFACT)
3) threshold for condensation at sub saturation conditions(VSIGQSAT)
4) threshold cloud thickness for stratocumulus/cumulus transition (ZCLDDEPTH)
5) threshold cloud thickness used in shallow/deep convection decision (ZCLDDEPTHDP)
6) fraction of grid with convection (ZFRACB)
7+8) contribution from graupel and snow to ice in radiation (RADGR+ RADSN)