GLAMEPS and HarmonEPS developments

Inger-Lise Frogner

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

Helsinki, 2017

GLAMEPS (version 2, since October 2013)

Operational since 2011

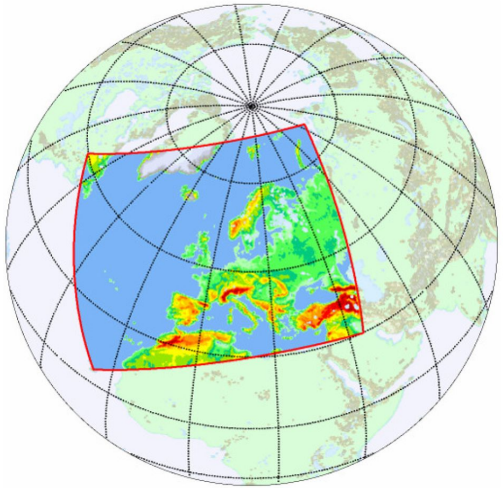
Multi-model, pan-European EPS

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

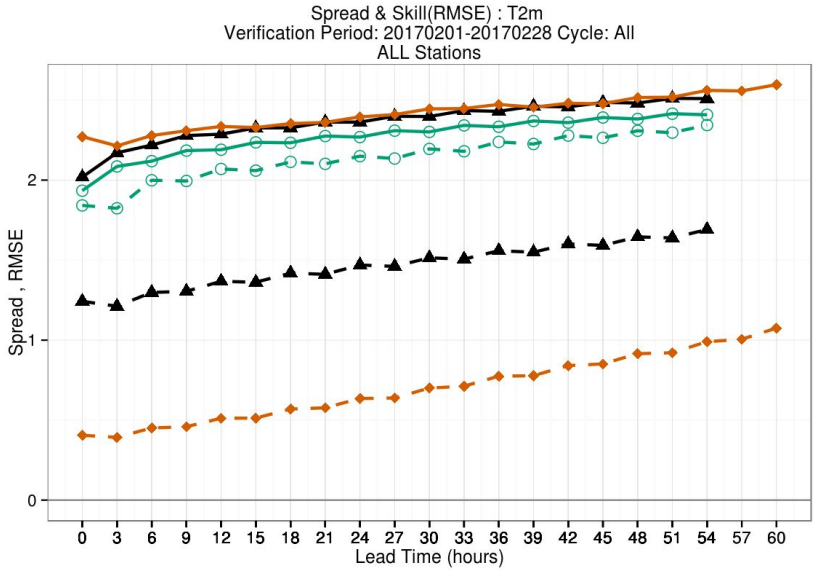
ALADIN

HIRLAM

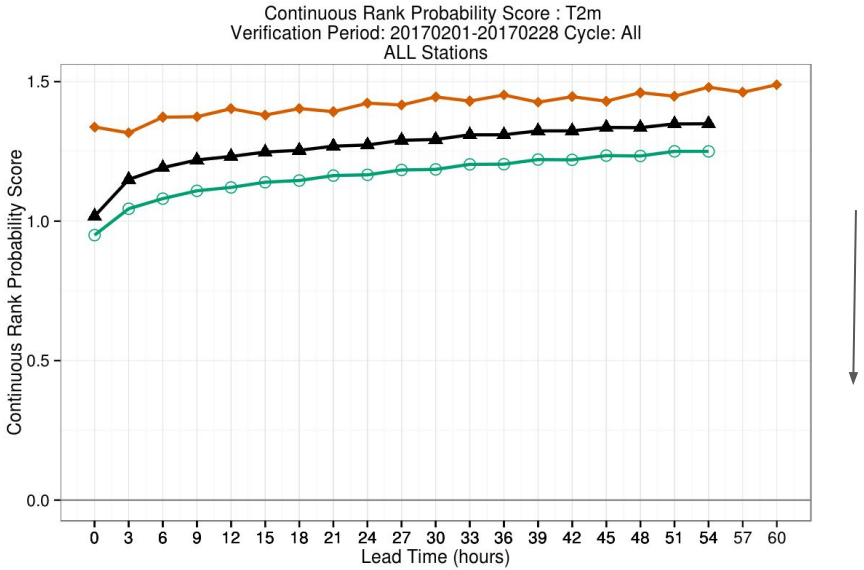
Kai Sattler, Alex Deckmyn, Xiaohua Yang

GLAMEPS vs. EC ENS - February 2017

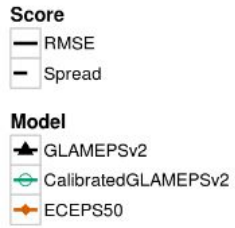
T2m



Spread and skill



CRPS



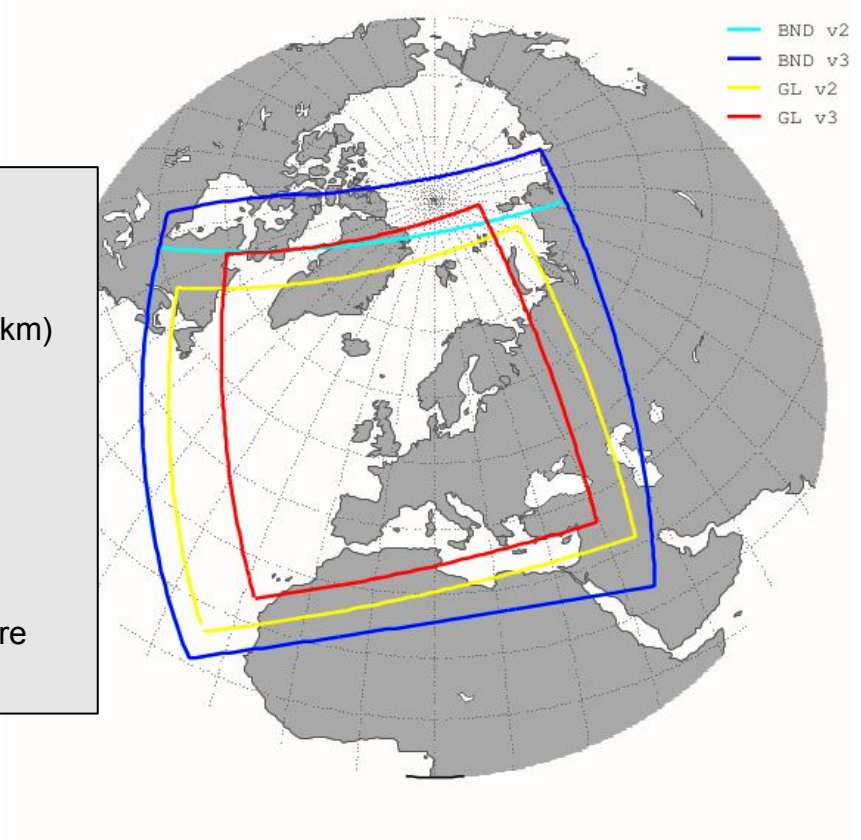
GLAMEPS version 3, running in parallel

What is new?

- Hourly output (was 3 hourly)
- Increased resolution - 0.05 deg. (Hirlam) / 6 km Alaro (was ~8km)
- Reduced area
- 36 members (was 52)

- Inflation of the initial perturbations coming from IFS ENS
- Includs CAPE SVs in Hirlam
- Newer version of Alaro

- Calibration of precipitation (in addition to two meter temperature and 10 m wind speed)



Kai Sattler, Alex Deckmyn, Xiaohua Yang, Toon Moene

HarmonEPS

Operationalization ongoing in several institutes

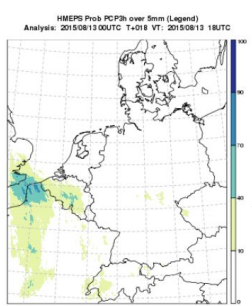
MEPS (MetCoOp EPS) was operational on 8. November 2016 - see presentation by U. Andrae

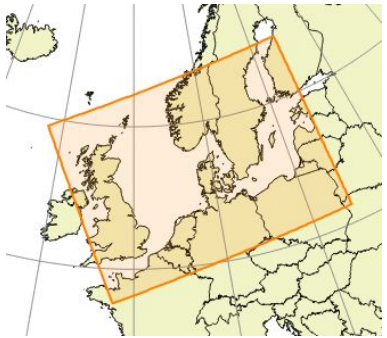
Configurations vary, but typically between 10+1 and 20+1 members

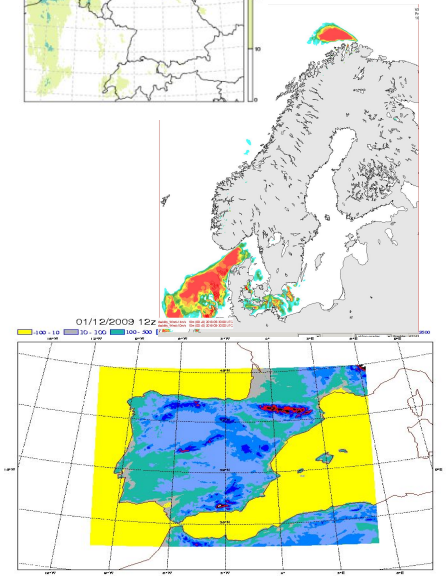
- Arome (Alaro, not available cy40 with SURFEX)
- 2.5 km
- 3D-Var
- SURFEX
- ~48h

Nested in IFS ENS or IFS high res (SLAF).

Experiments with perturbations in initial conditions, lateral boundary conditions, model physics and surface ongoing (see talk by A. Singleton).







Model error representation in HarmonEPS

.Multi-physics - utilising different parameterization schemes that are available in the system

.Cellular Automata (CA) - Investigate coupling CA module to shallow convection in Arome (EDMFm) to describe uncertainty in convective cells (Lisa Bengtsson)

.SPPT (Alfons Callado, implementation ongoing)

.Stochastic parameter perturbations (Sibbo van der Veen, Ulf Andrae, Inger-Lise Frogner)

Model error representation in HarmonEPS

- Multi-physics - utilising different parameterization schemes that are available in the system
- SPPT (Alfons Callado, implementation ongoing)
- Stochastic parameter perturbations (Sibbo van der Veen, Ulf Andrae, Inger-Lise Frogner)
- Cellular Automata (CA) - Investigate coupling CA module to shallow convection in Arome (EDMFm) to describe uncertainty in convective cells (Lisa Bengtsson)

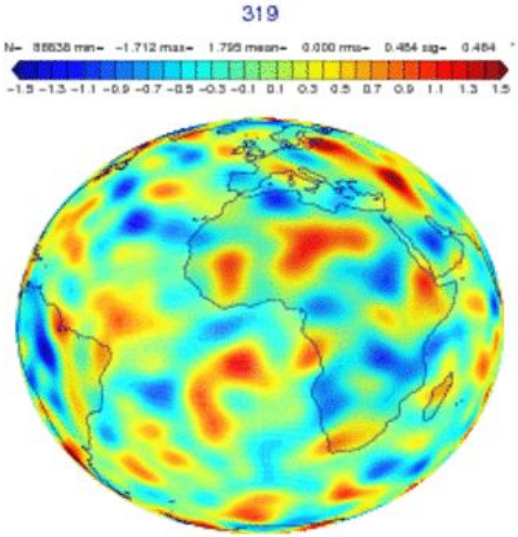
SPPT: basic concepts

- SPPT or Stochastic Perturbed Parameterisation Tendencies (Buizza *et al.*,1999):
  - **Multiplicative noise** applied to each variable parameterized tendency:

$$\frac{\partial X}{\partial t} = D_X + K_X + P_X + \delta P_X$$

$$\delta P_X = r P_X$$

- Spectral **spatial and time correlations**
- Applied to medium levels

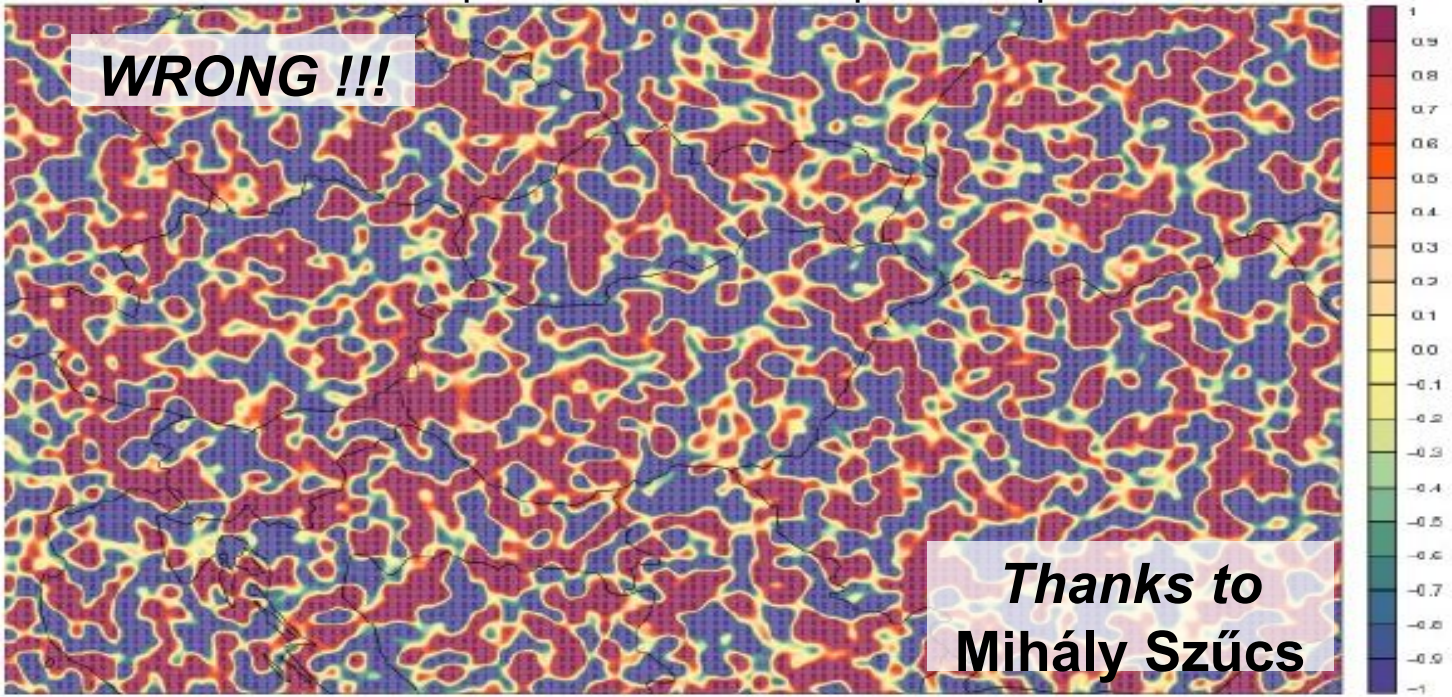


ECMWF

HARMONIE-AROME
SPPT in HarmonEPS

r (perturbation number)

500 km spatial correlation in spherical space



HARMONIE-AROME
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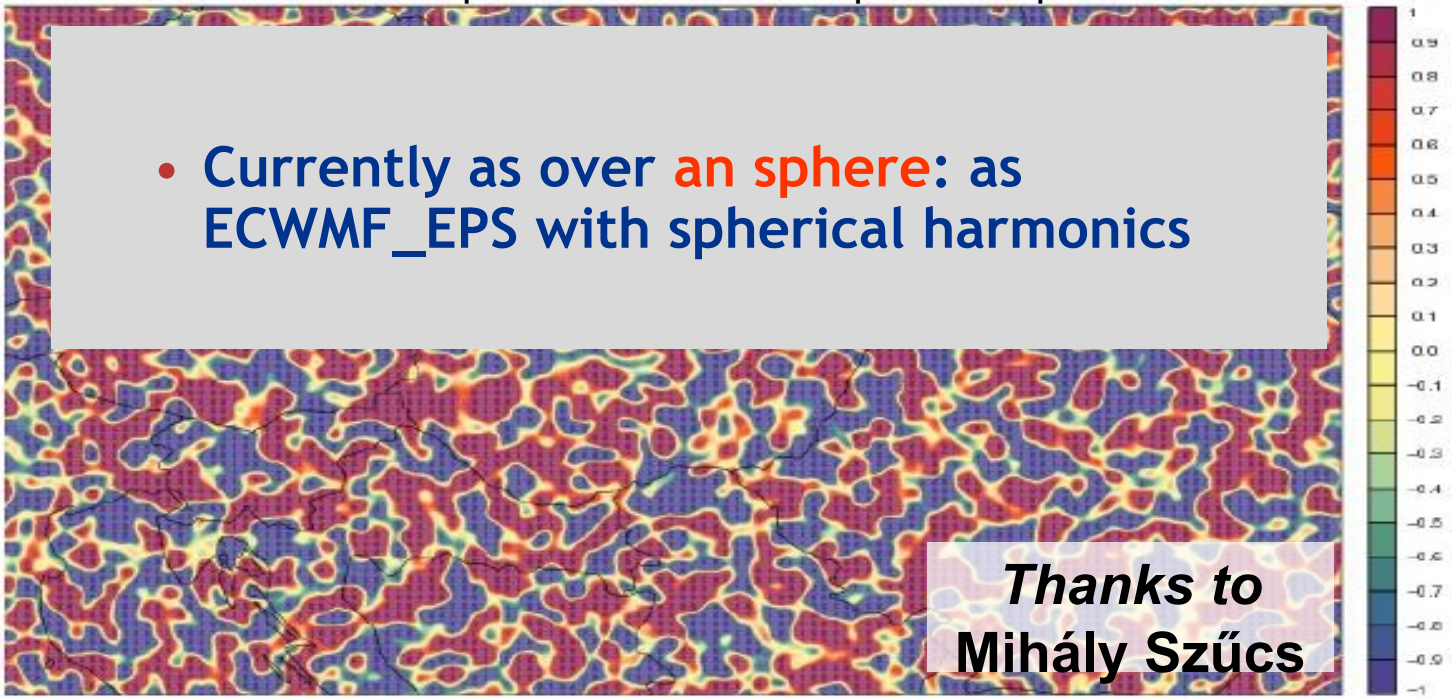


- **Currently as over an sphere: as ECWMF_EPS with spherical harmonics**

Thanks to
Mihály Szűcs

HARMONIE-AROME
SPPT in HarmonEPS

r (perturbation number)

500 km spatial correlation in spherical space

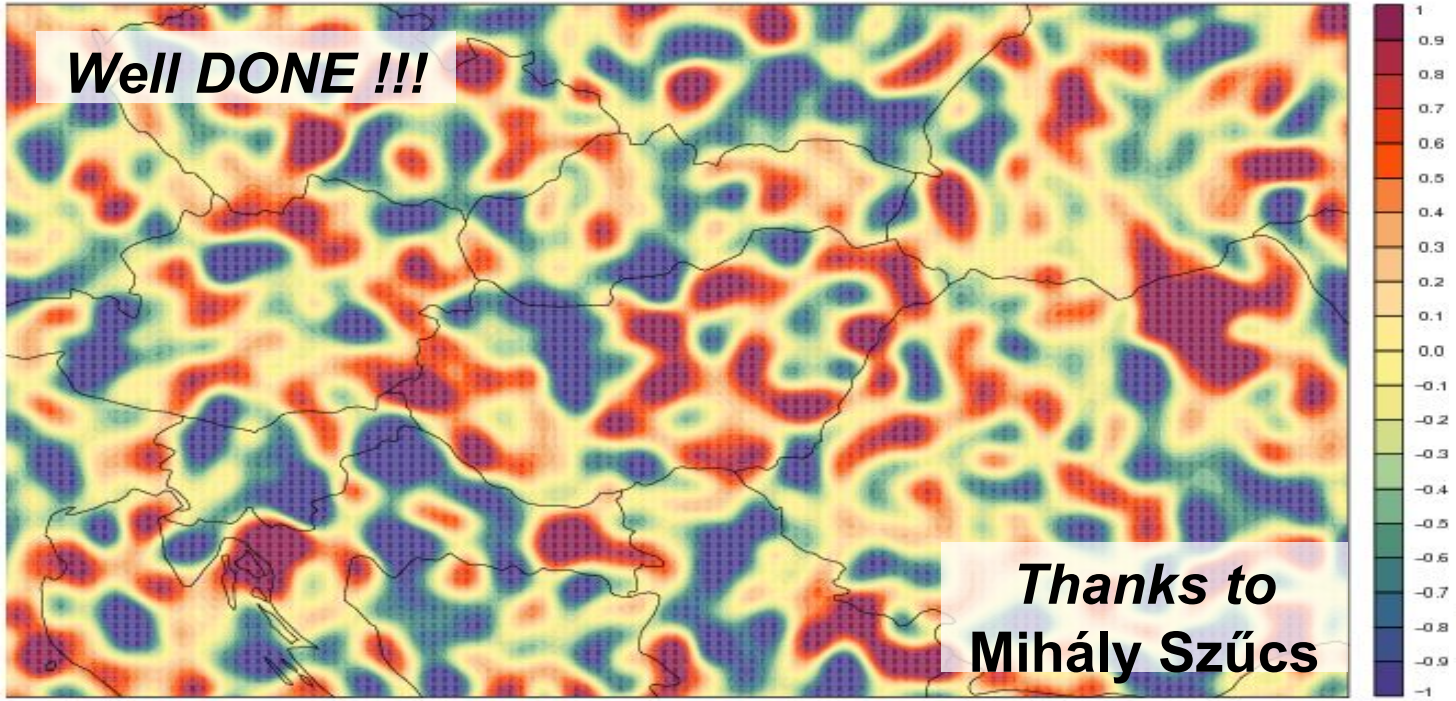
- **Better over a plane on a bi-Fourier space (A.Callado, work in progress)**

Thanks to Mihály Szűcs

HARMONIE-AROME
SPPT in HarmonEPS

r (perturbation number)

25 km spatial correlation in bi-Fourier space



Model error representation in HarmonEPS

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.SPPT (Alfons Callado, implementation ongoing)

.Stochastic parameter perturbations (Sibbo van der Veen, Ulf Andrae, Inger-Lise Frogner)

Stochastic parameter perturbations in HarmonEPS

- Motivation: improve spread, and hopefully other scores, for clouds and precipitation

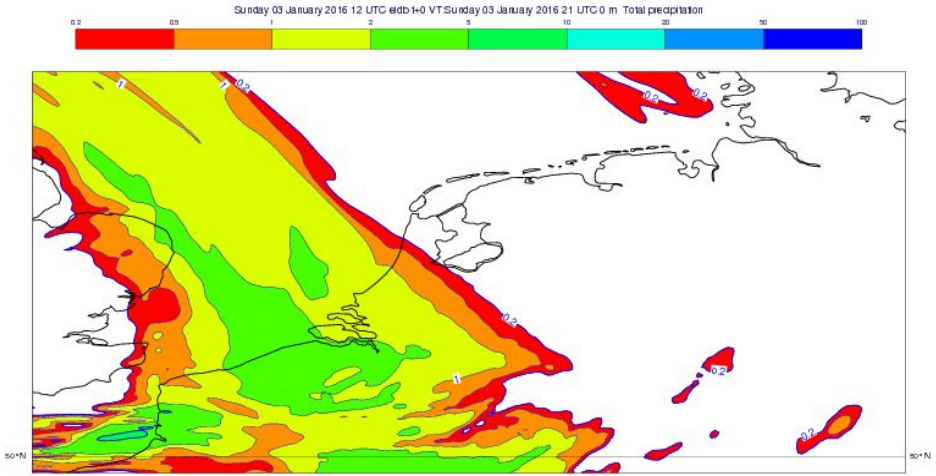
- A general setup for perturbing stochastically parameters in HarmonEPS is implemented - *Ulf Andrae*
  - *In first trial one random value (with bounds) for each member for each cycle*

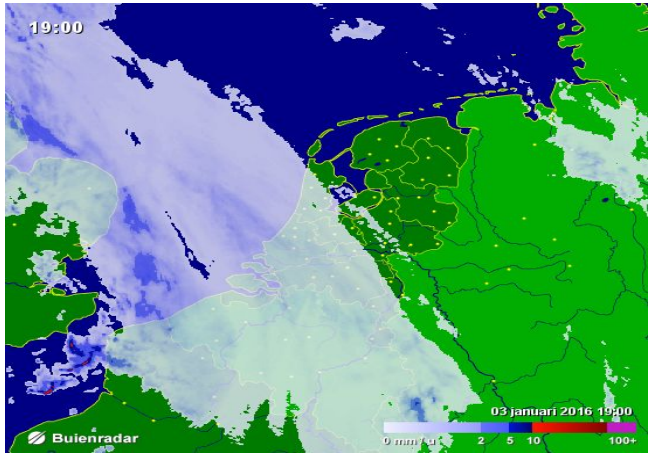
Stochastic parameter perturbations in HarmonEPS

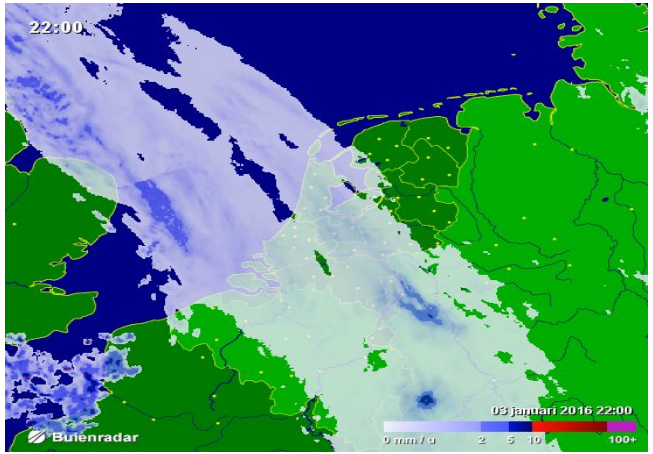
Sensitivity study of changing the critical cloud water content above which the conversion from cloud water to rain drops starts (autoconversion) -qcrit

Sibbo van der Veen

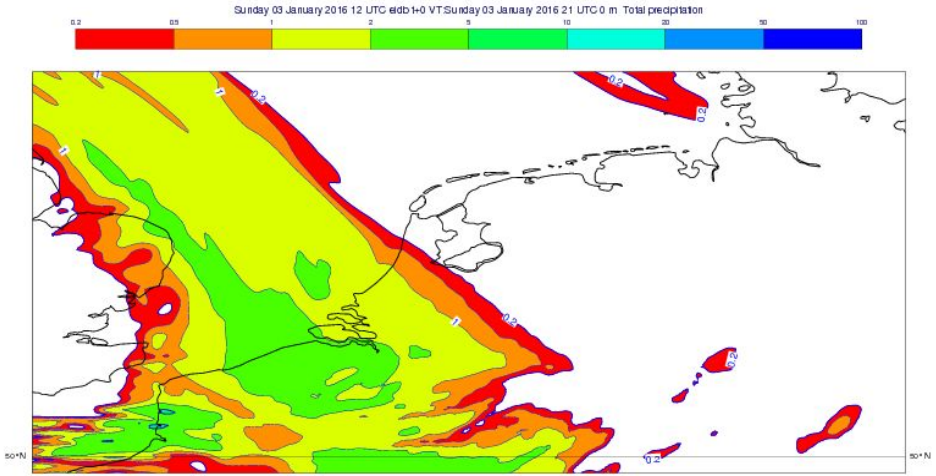
0.25E-3
3 January 2016
12 utc + 9h - 12utc +6h

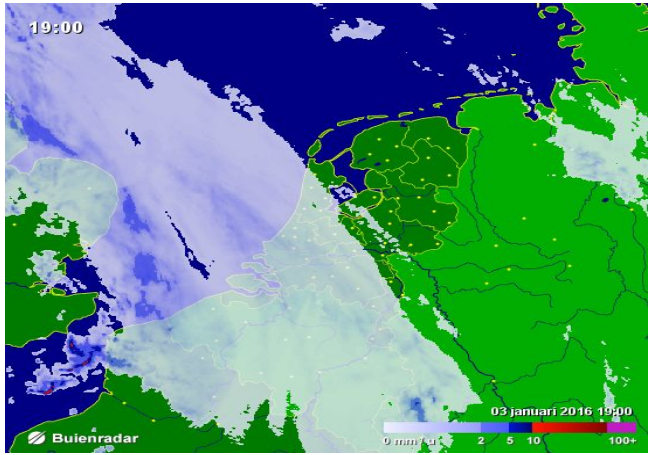


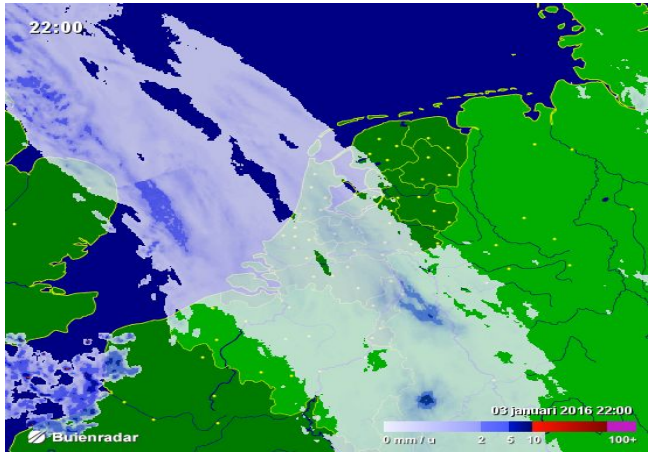




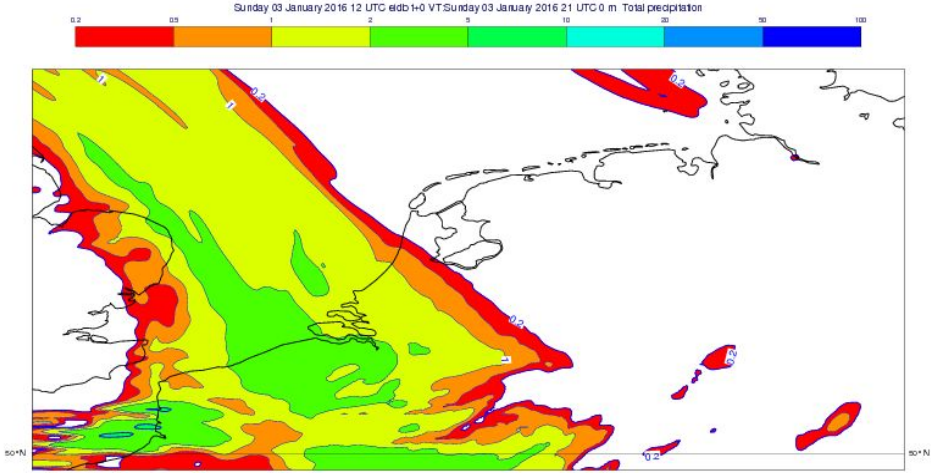
0.5E-3
3 January 2016
12 utc + 9h - 12utc +6h

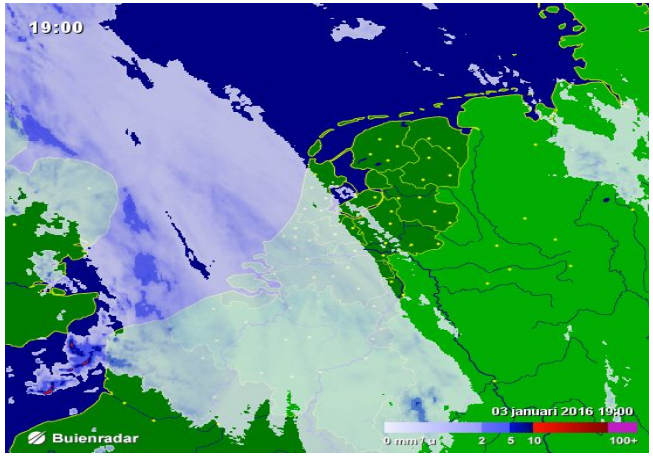


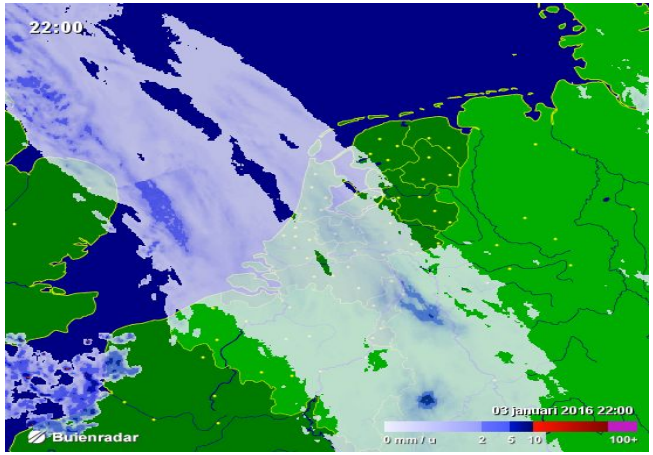




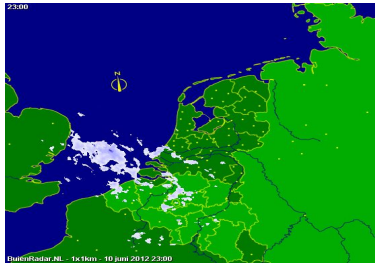
1.0E-3
3 January 2016
12 utc + 9h - 12utc +6h



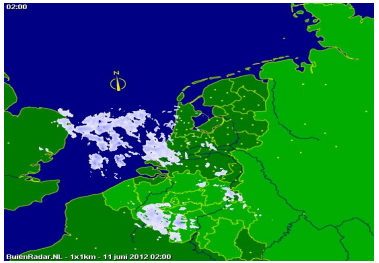




Influence of autoconversion threshold (Kessler) : 10 June 2012 , 0 utc+21h 0 utc +24 h



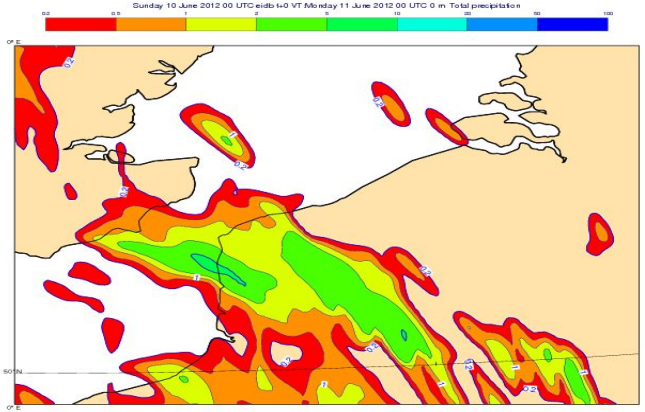
21 utc

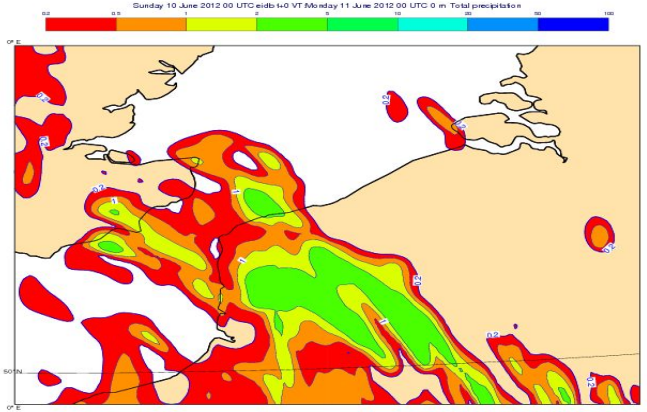


00 utc

0.5E-3

1.0E-3





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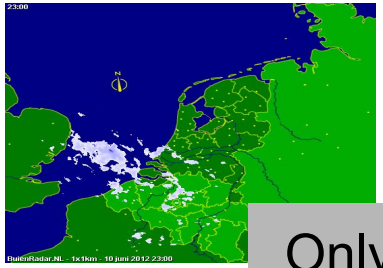
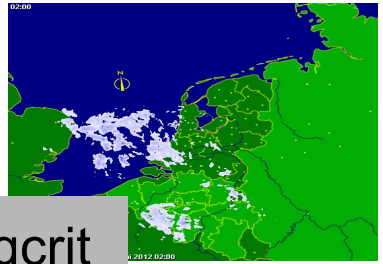
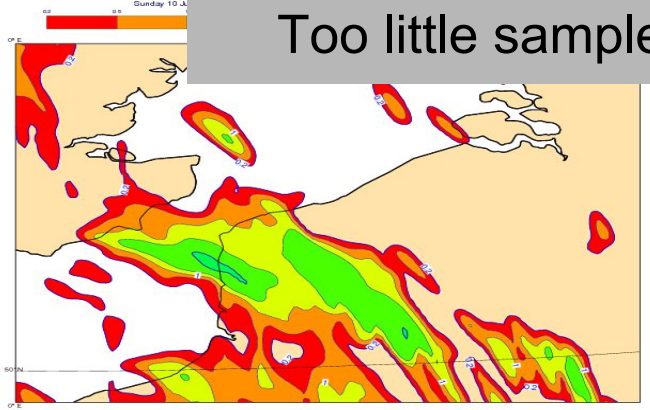


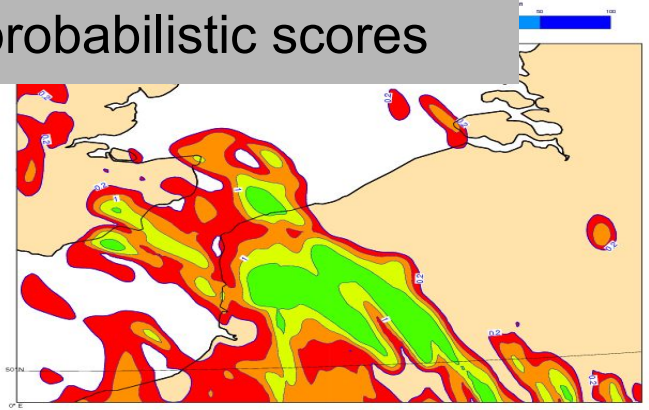
21 utc

00 utc



Only 5 days run with stochastically changing qcrit in HarmonEPS-
Too little sample to show probabilistic scores



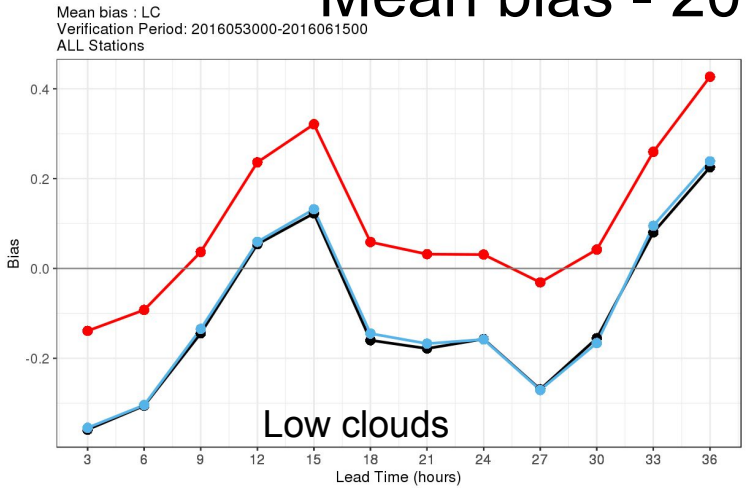


Stochastic parameter perturbations in HarmonEPS

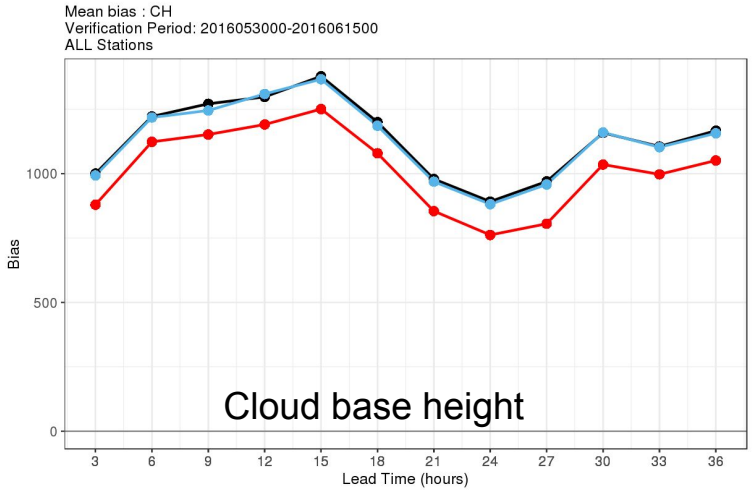
- a parameter that represents the transport term of TKE, influencing the top entrainment and with it the clouds - *FAC_TWO_COEF 1-3* (def 2) in HARATU
- a parameter that influences the level of relative humidity required for (low) clouds to form - *VSIGQSAT* 0.00 - 0.06
  - *NB! Default value 0.02, not 0.03!*

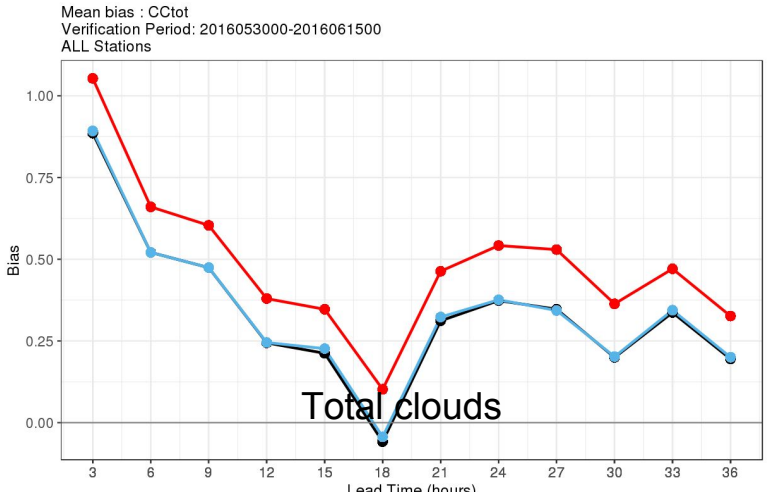
Inger-Lise Frogner and Ulf Andrae

Mean bias - 2016053000 - 2016061500

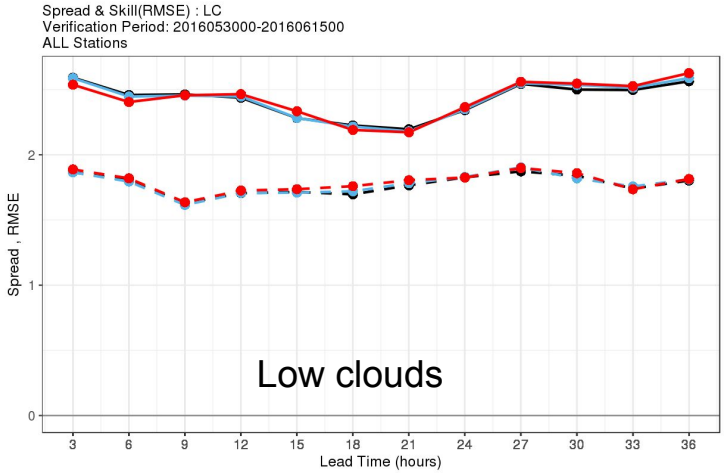


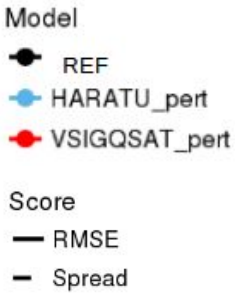
Thanks to Karl Ivar Ivarsson for providing code for low clouds and cloud base.

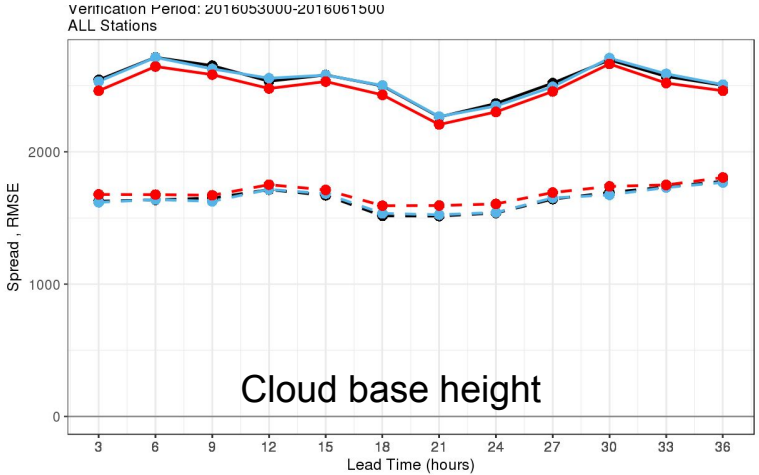


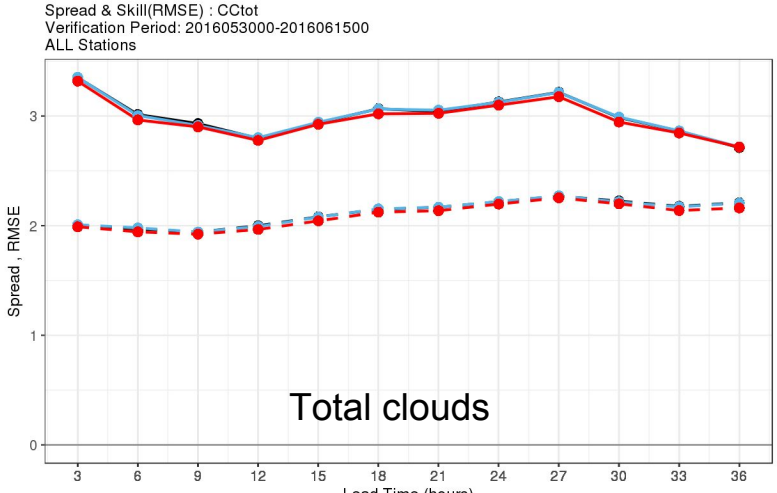


Spread and skill - 2016053000 - 2016061500

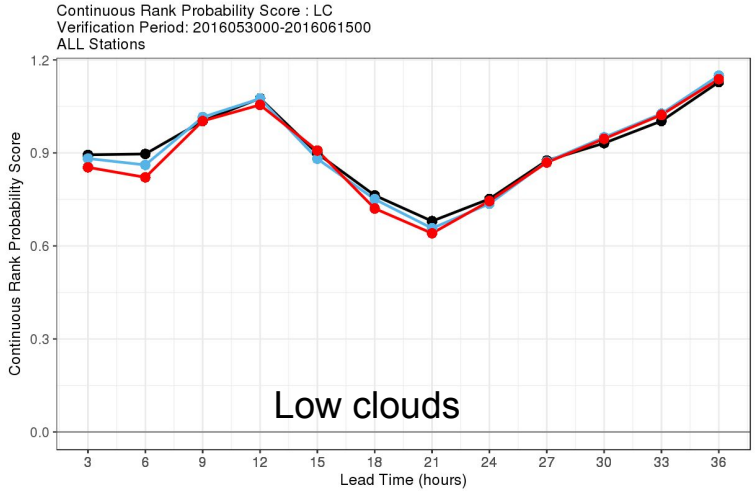


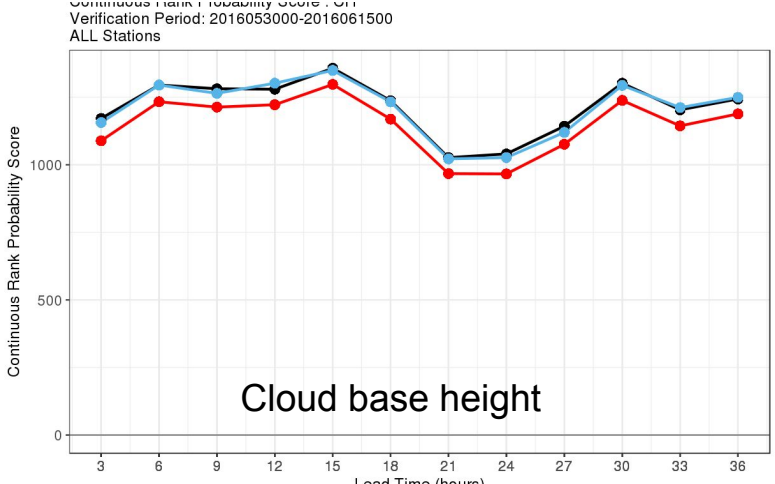


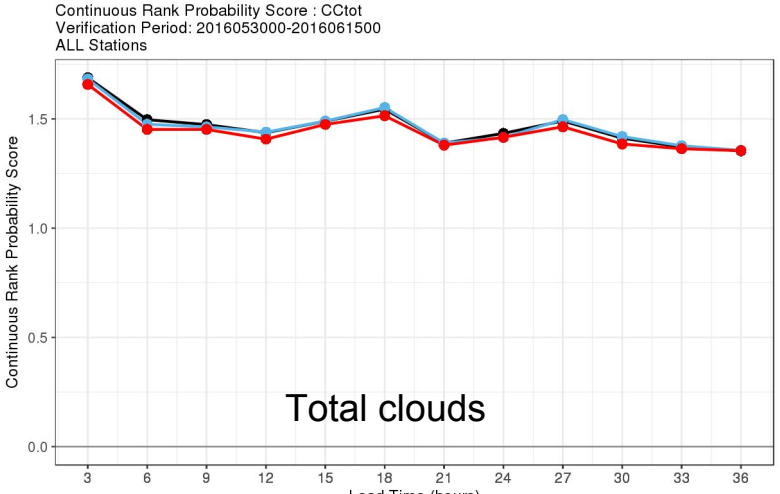




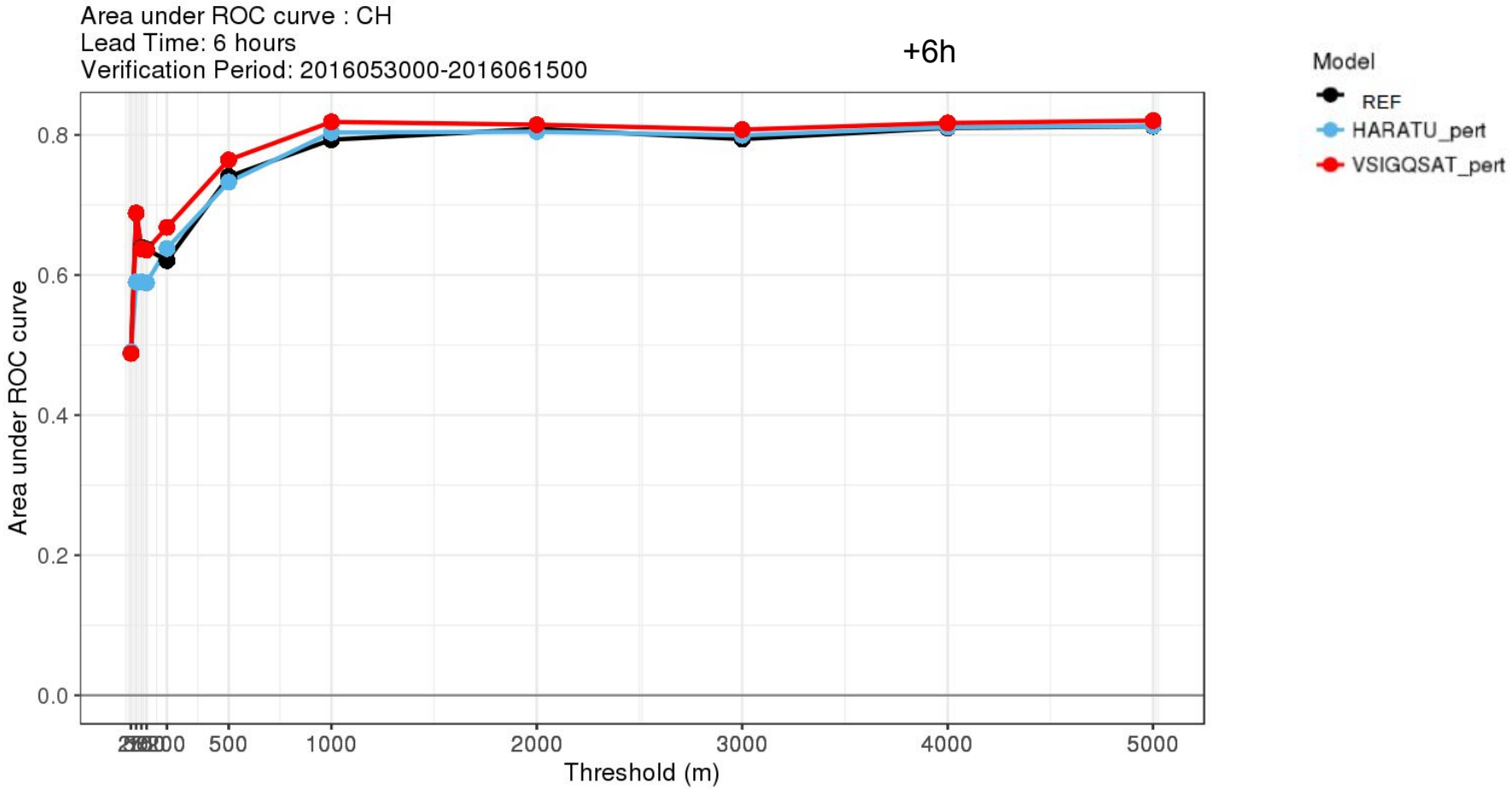
CRPS - 2016053000 - 2016061500





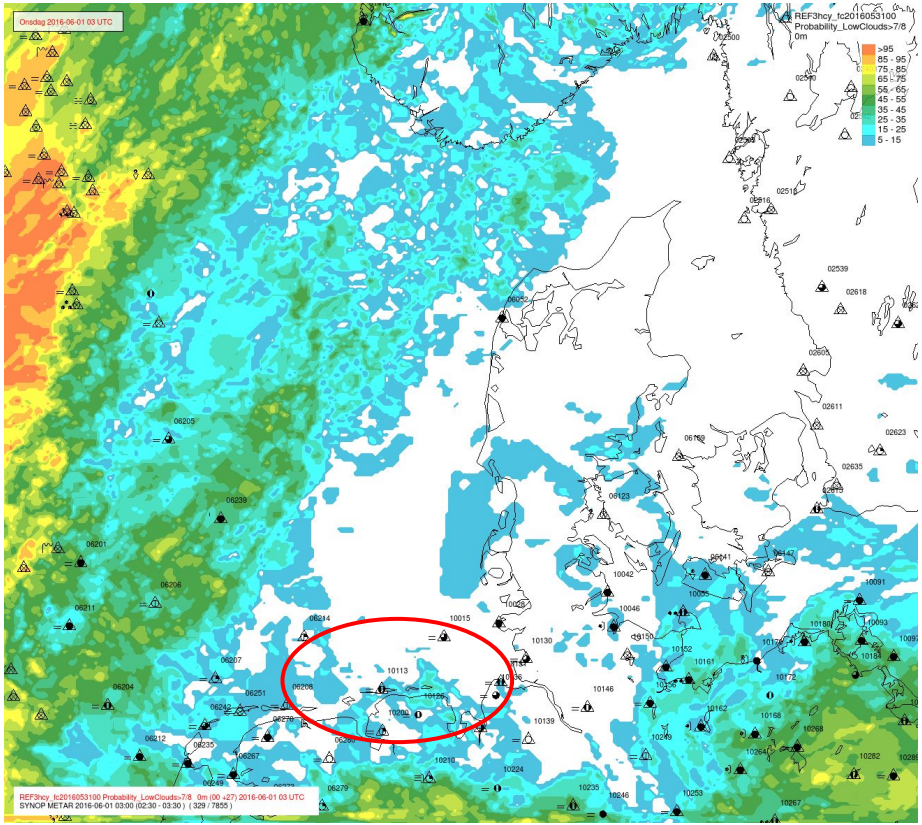


ROC area, cloud base height - 2016053000 - 2016061500

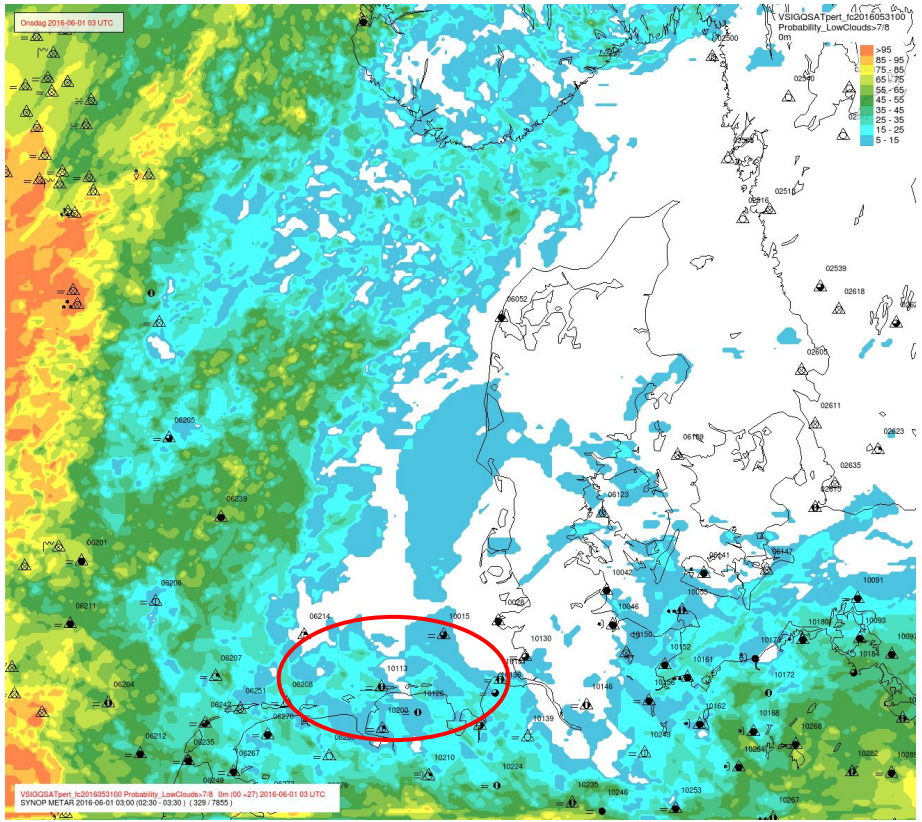


Case study, low clouds, 2016053100 +27h

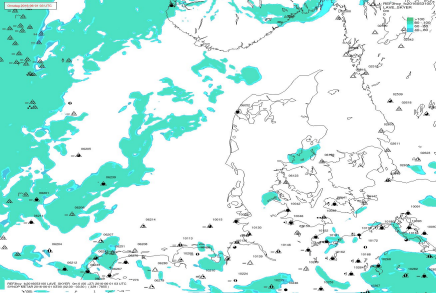
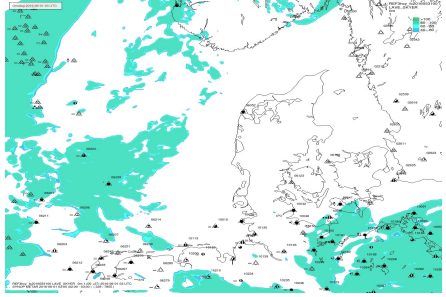
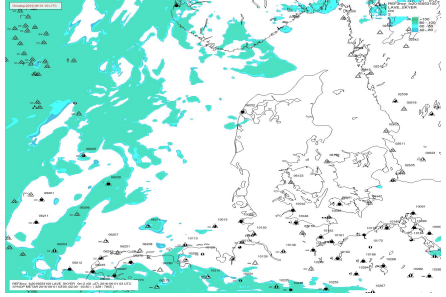
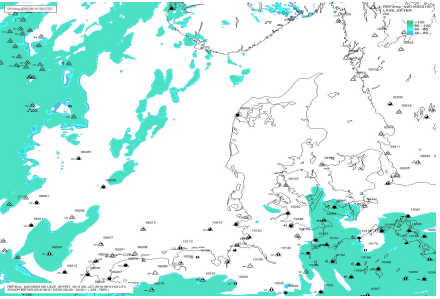
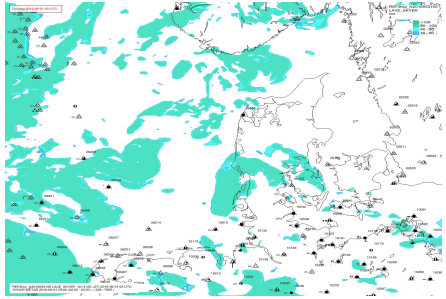
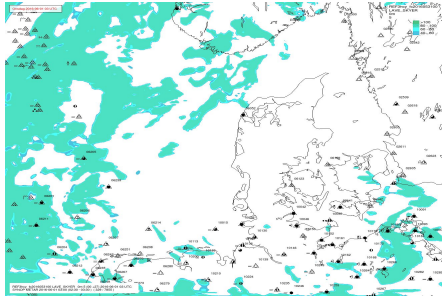
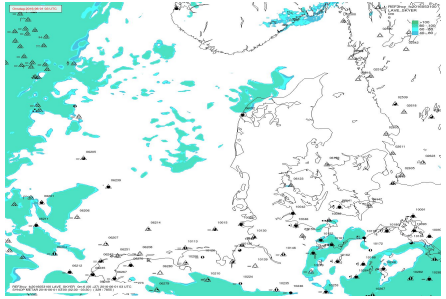
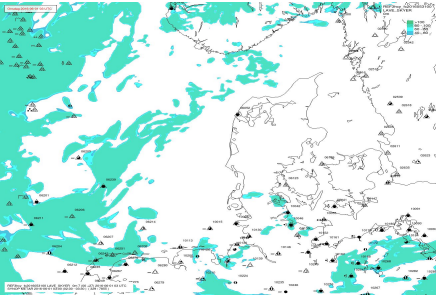
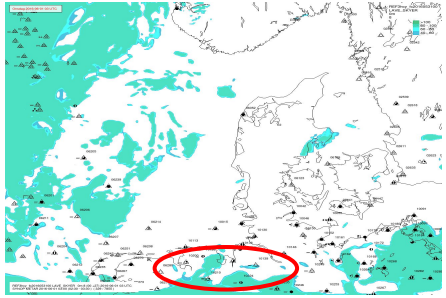
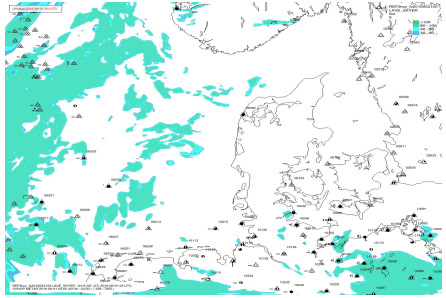
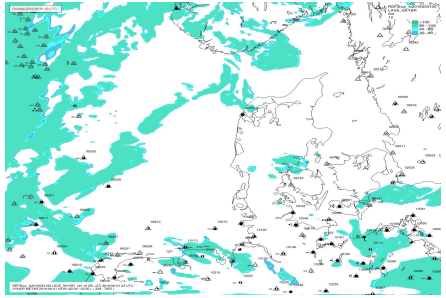
Ref



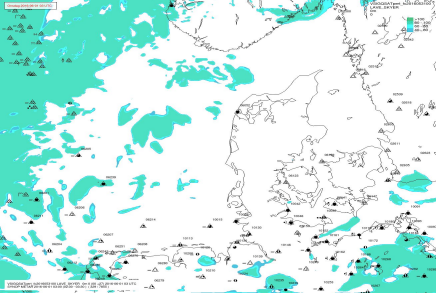
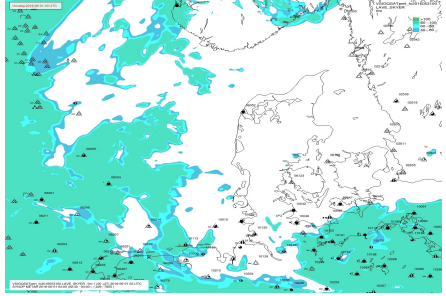
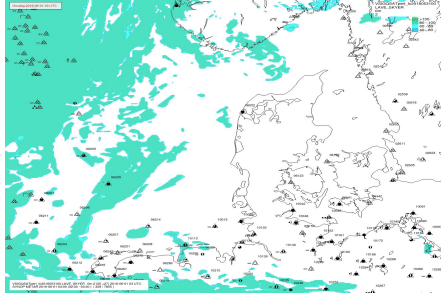
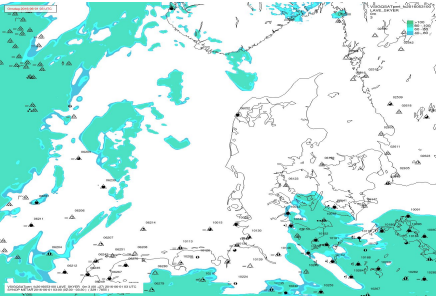
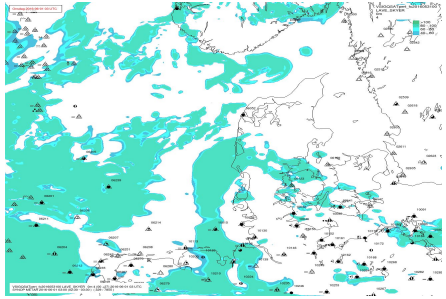
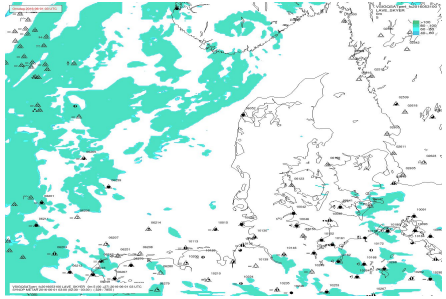
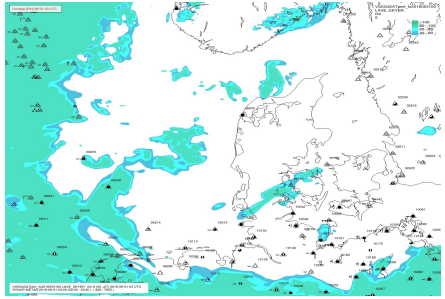
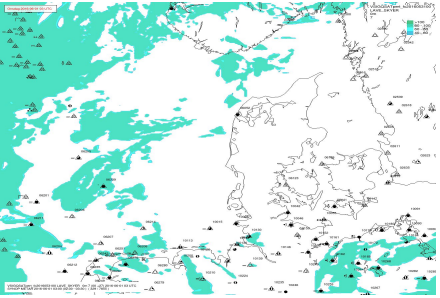
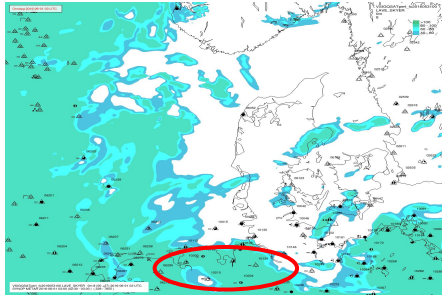
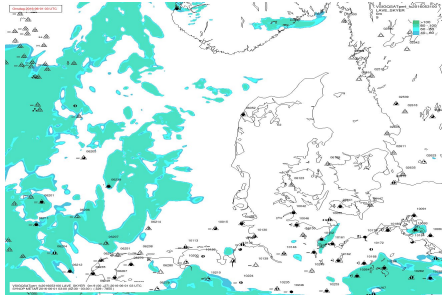
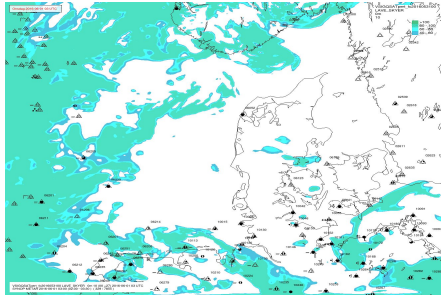
VSIGQSAT



Reference

Perturbed
VSIGQSAT

Preliminary conclusions

- Changing qcrit appears to have more impact in convective clouds than in stratiform clouds
- Perturbing VSIGQSAT mainly positive, but small, impact on cloud-scores
- Perturbing FAC_TWO_COEF had little impact

Further work on Stochastic parameter perturbations in HarmonEPS

- Estimate uncertain parameter values, and pdf's, in Harmonie-Arome by use of **EPPES in HarmonEPS** - collaboration with FMI and Finnish Universities
- Include spatial and temporal **correlation patterns:**

  SPPT pattern, Surface perturbation pattern, **CA-pattern**, SPG?

  SPG: Spatio-temporal Stochastic Pattern Generator

  - Developed for limited area models
  - "Proportionality of scales" property: large-scale (small-scale) in space has large (small) temporal length scales
- Look into **SPP**-way of perturbing (ECMWF new scheme)

Next EPS working week in Tromsø, Northern Norway, 29 May - 2 June

https://hirlam.org/trac/wiki/HarmonieWorkingWeek/EPS201705

Thank you