New developments in GLAMEPS and HarmonEPS

Inger-Lise Frogner

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

Belgrade, October 2015

GLAMEPS (version 2, since October 2013)

Operational since 2011

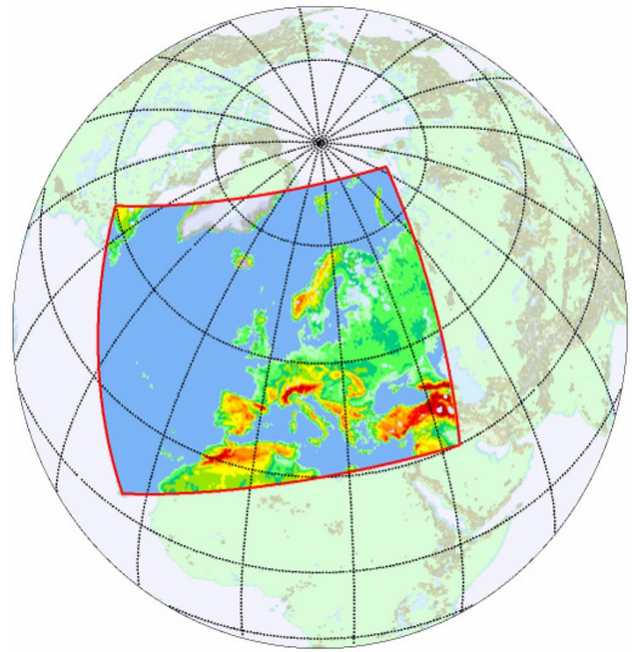
Multi-model, pan-European EPS

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

Nested in IFS ENS

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

Runs as Time-Critical Facility at ECMWF



Kai Sattler, Alex Deckmyn, Xiaohua Yang

GLAMEPS (version 3, tests ongoing)

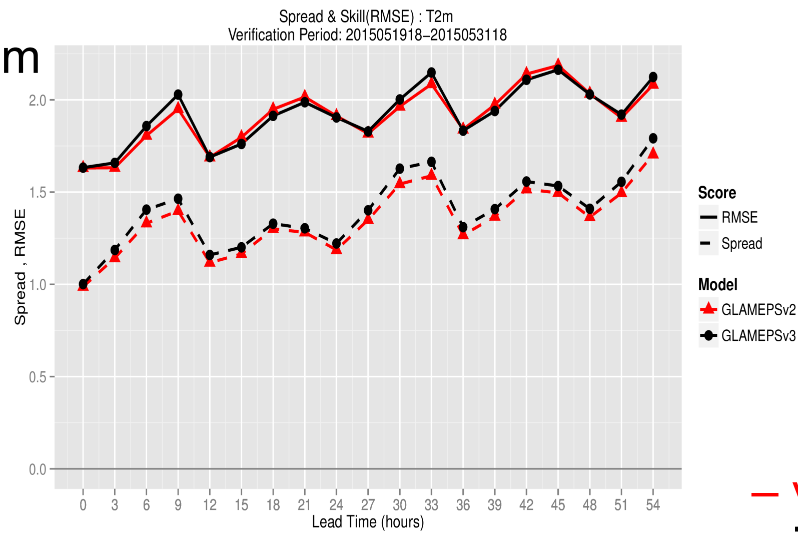
Suggested updates:

- *Inflate the initial perturbations coming from IFS ENS*
- Increase resolution to ~5 km
- *Include CAPE SVs*
- Implementing intended changes for ALARO:
  - implement perturbation in horizontal diffusion
  - consider adding inflation factor to ALARO boundary

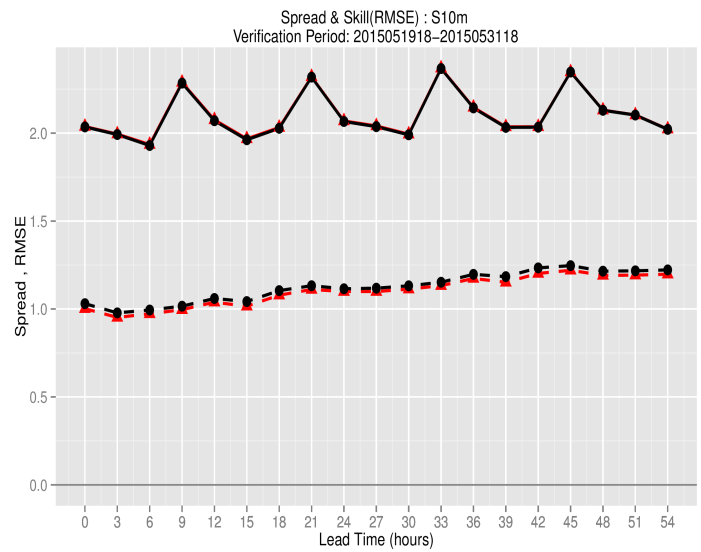
Kai Sattler, Alex Deckmyn, Xiaohua Yang

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

T2m



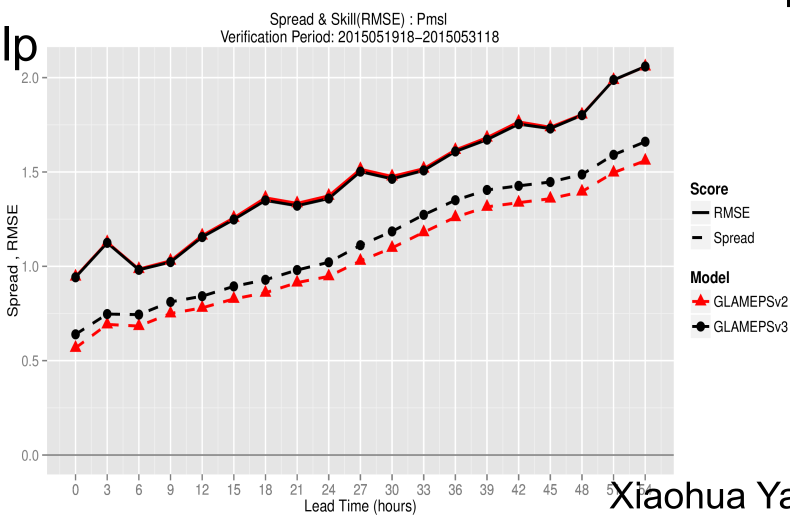
S10m



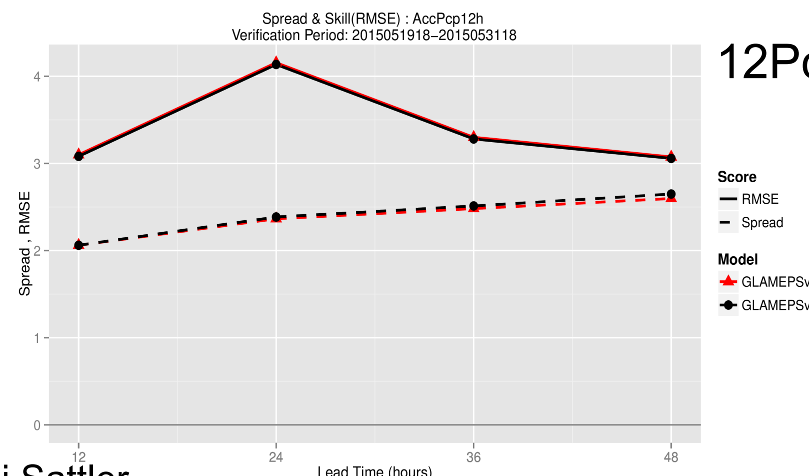
– v2

– inflated

mslp

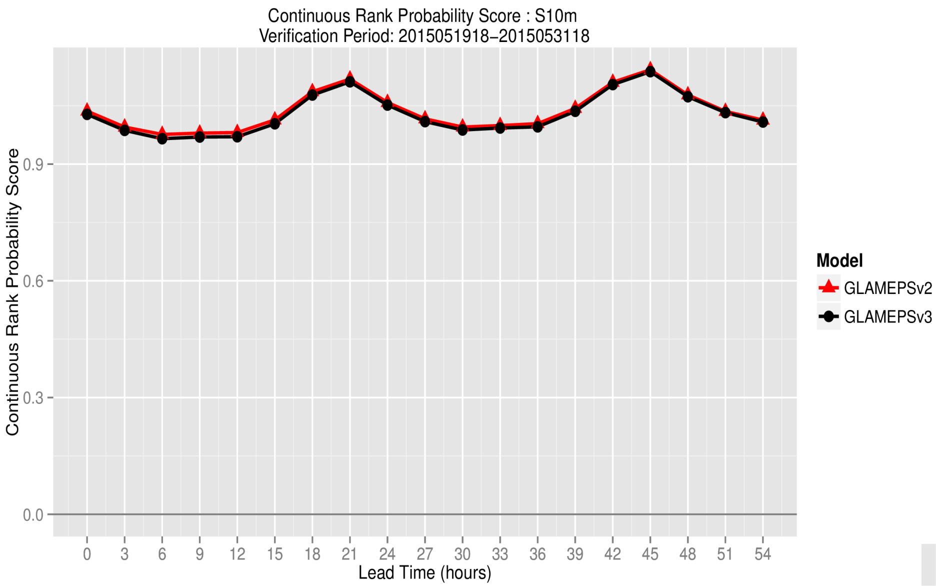


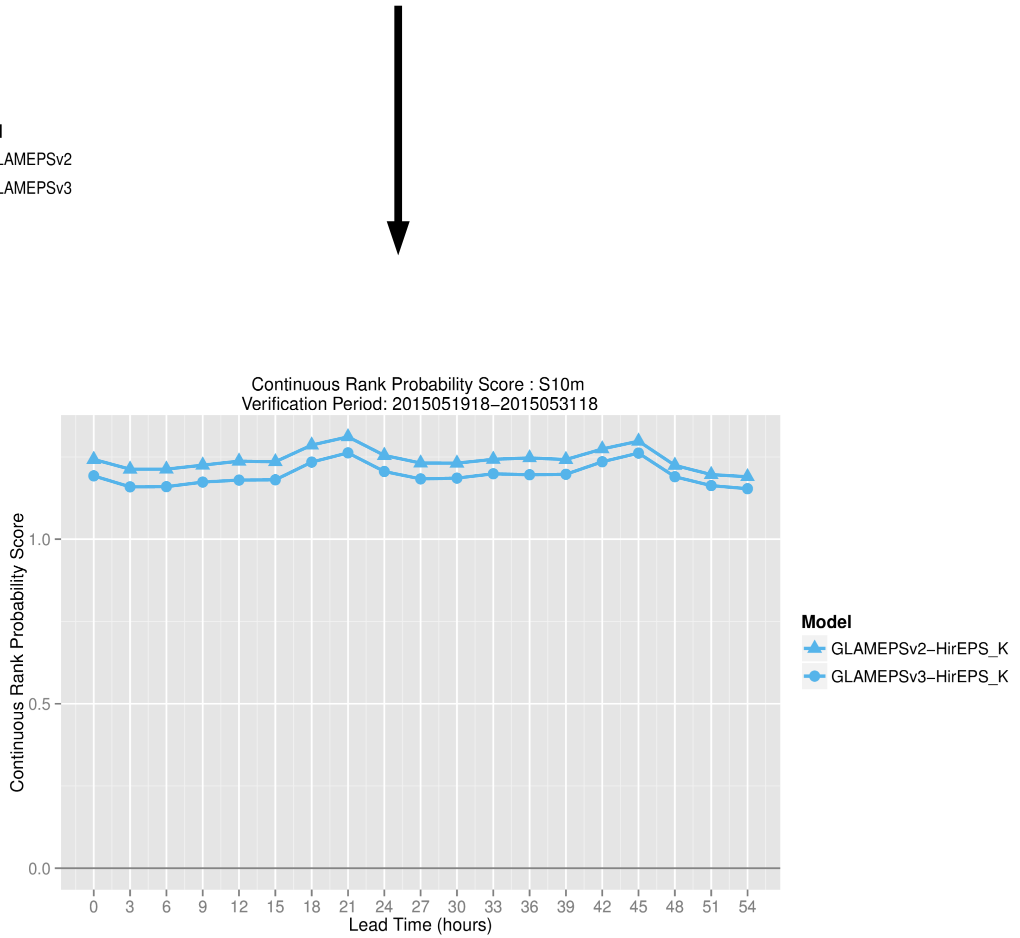
12Pcp



Xiaohua Yang and Kai Sattler

Inflation of initial perturbations in HIRLAM sub-ensembles – CRPS





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

Xiaohua Yang and Kai Sattler

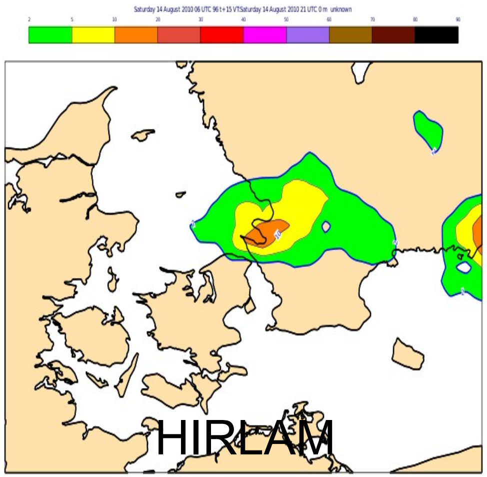
CAPE-SVs in HIRLAM sub-ensembles

Sibbo van der Veen

Flooding Copenhagen, August 14, 2010

18 – 21 UTC

(06+15) – (06+12)



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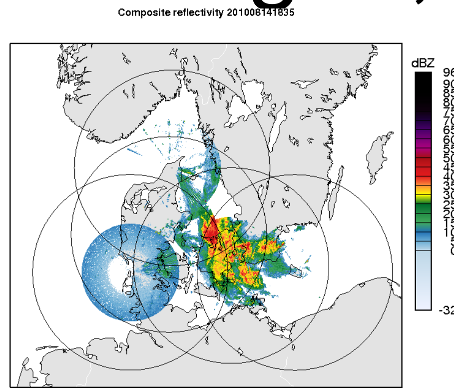
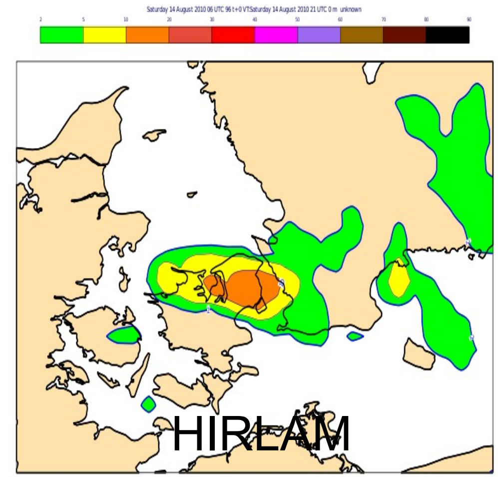
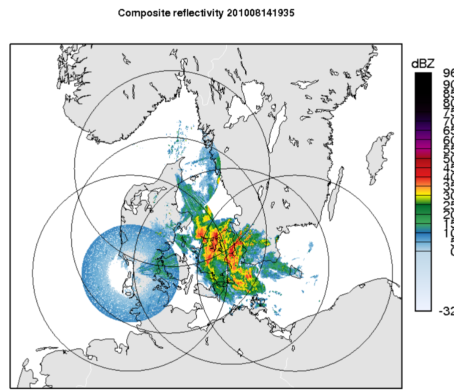


H

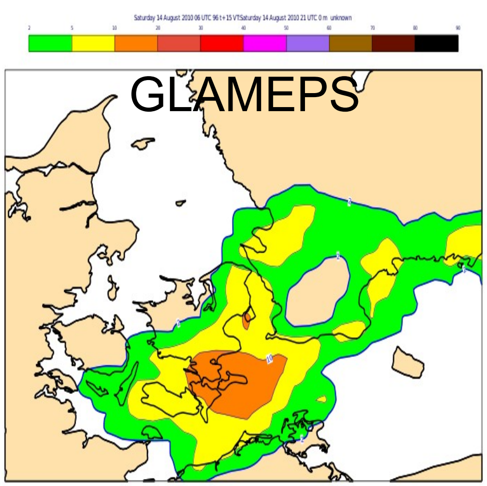


Probability exceeding 10mm between 18-21 UTC

Defaulf



With CAPE-SV



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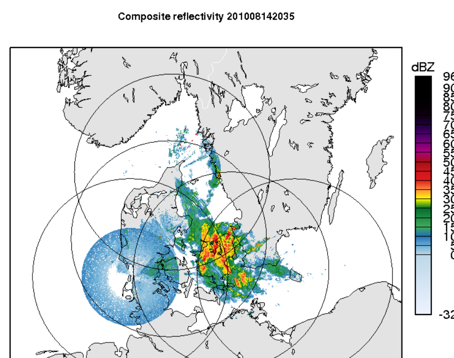

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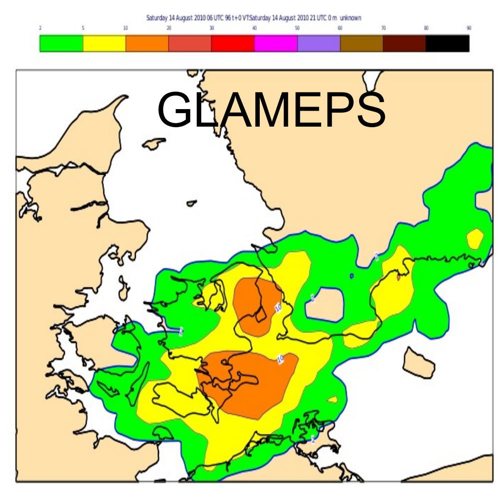


Sibbo van der Veen

Calibrating GLAMEPS

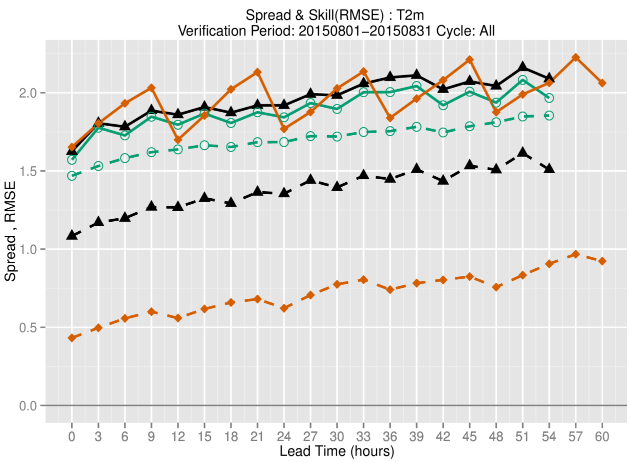
- Goal: Calibration for whole grid, not only station points

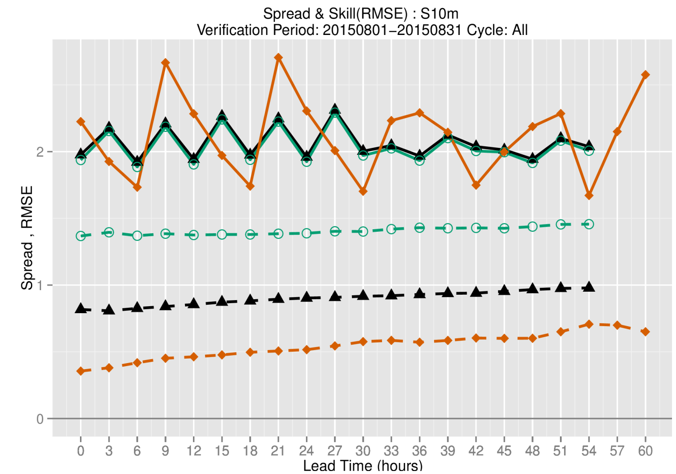
Statistical calibration

Regression with Box-Cox t-distribution
- parameters depending on ensemble statistics and orographical information
- currently applied to temperature 2m and wind speed 10m
- one regression model for the whole domain and each lead time
- training period of 42 days/20.000 cases
- regression models updated once a week

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits, Juha Kilpinen, Karoliina Hamalainen

Calibrating GLAMEPS

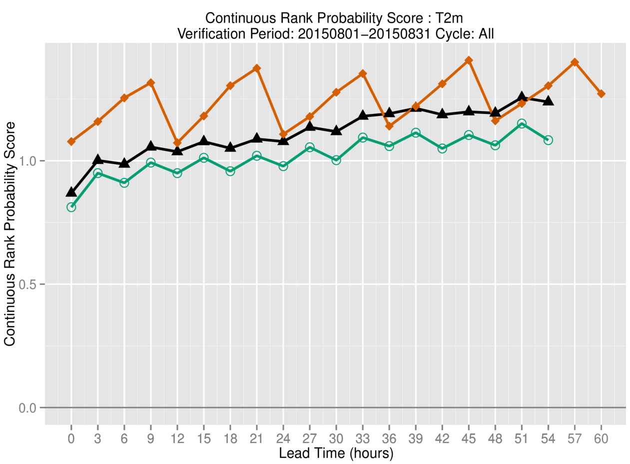


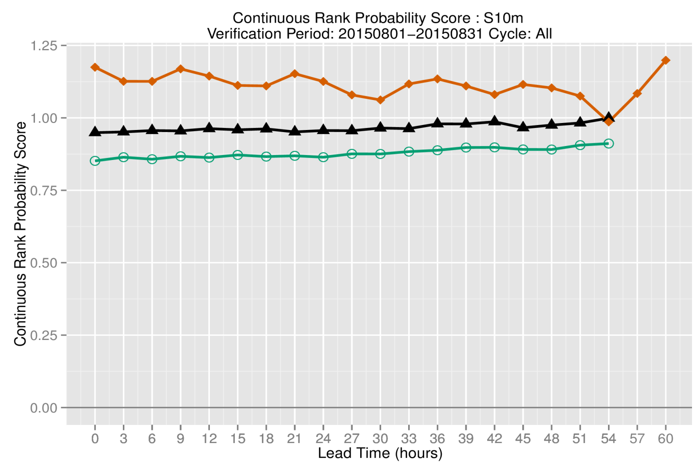


Spread/skill

__ RMSE
\- - spread

__ GLAMEPS
__ calibrated GLAMEPS
__ ECEPS

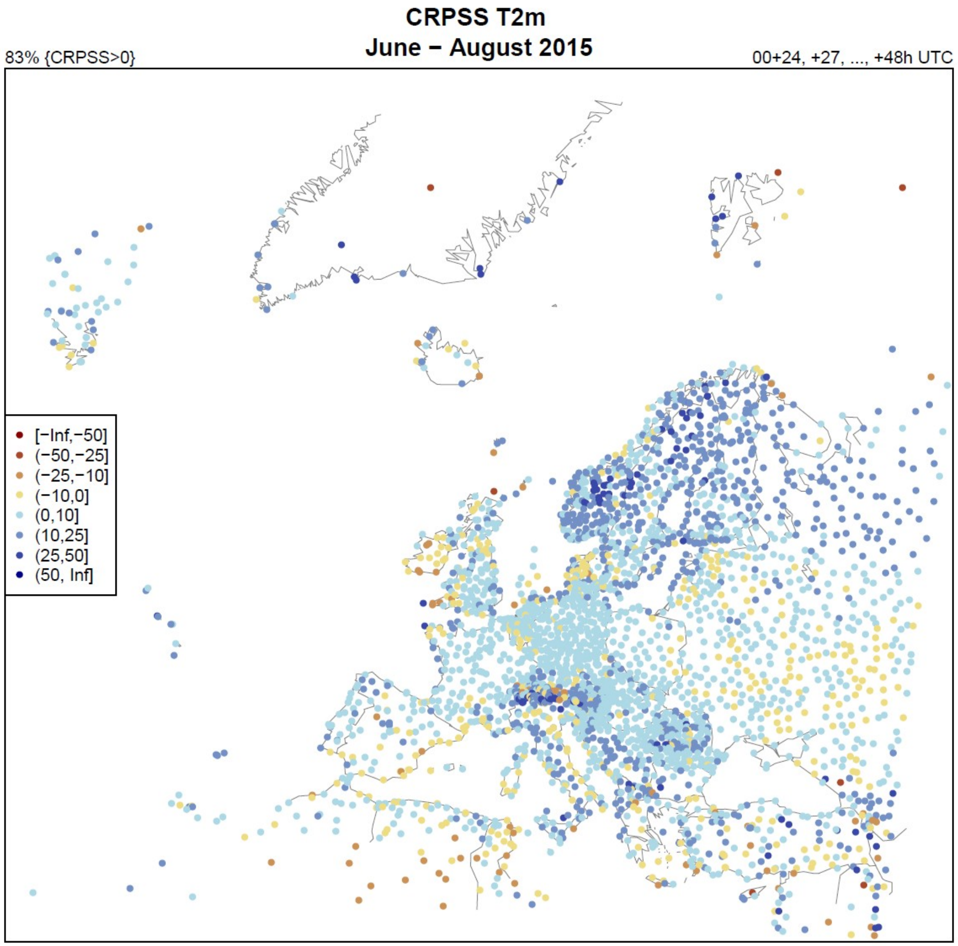




CRPS

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits, Juha Kilpinen, Karoliina Hamalainen

Calibrating GLAMEPS



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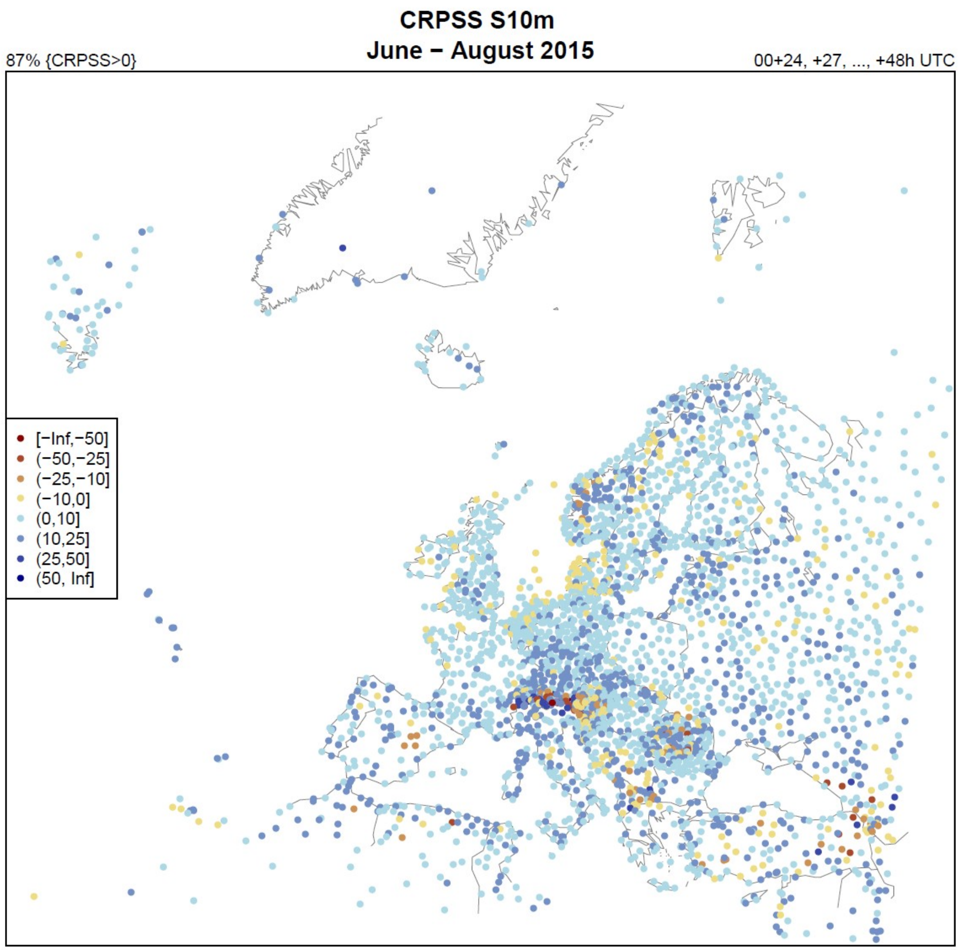
Calibrating GLAMEPS



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HarmonEPS

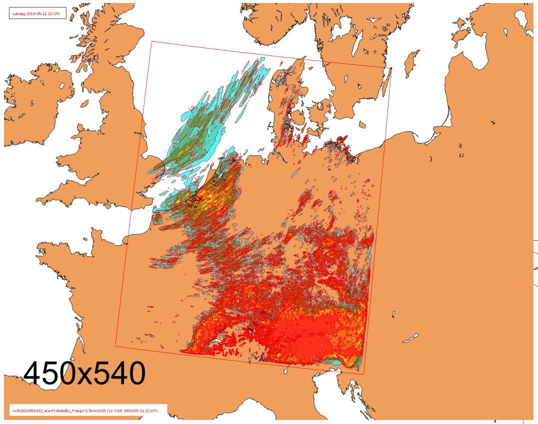
Experimental – first operational versions expected first half 2016

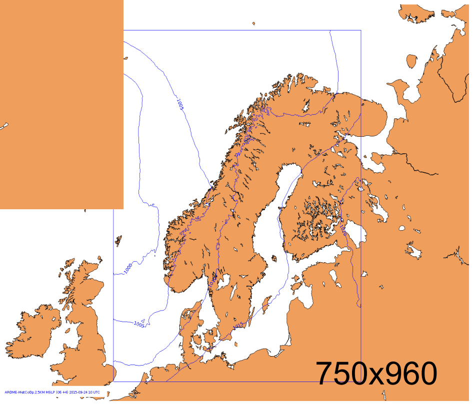
For sub-European areas

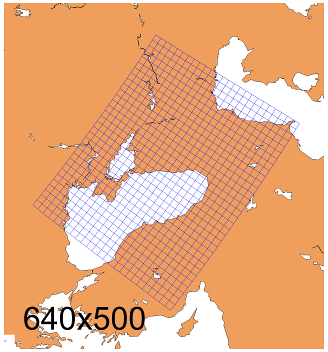
- Configurations vary, but typically between 10+1 and 20+2 members
- Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- +36h
- All members have their own surface assimilation cycles

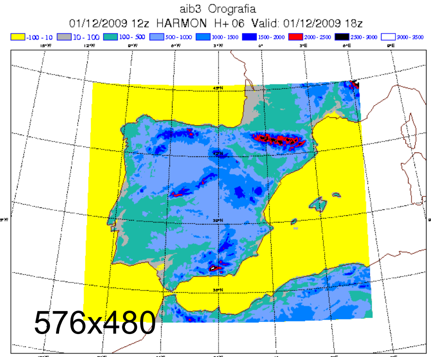
Nested in IFS ENS or IFS high res.

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







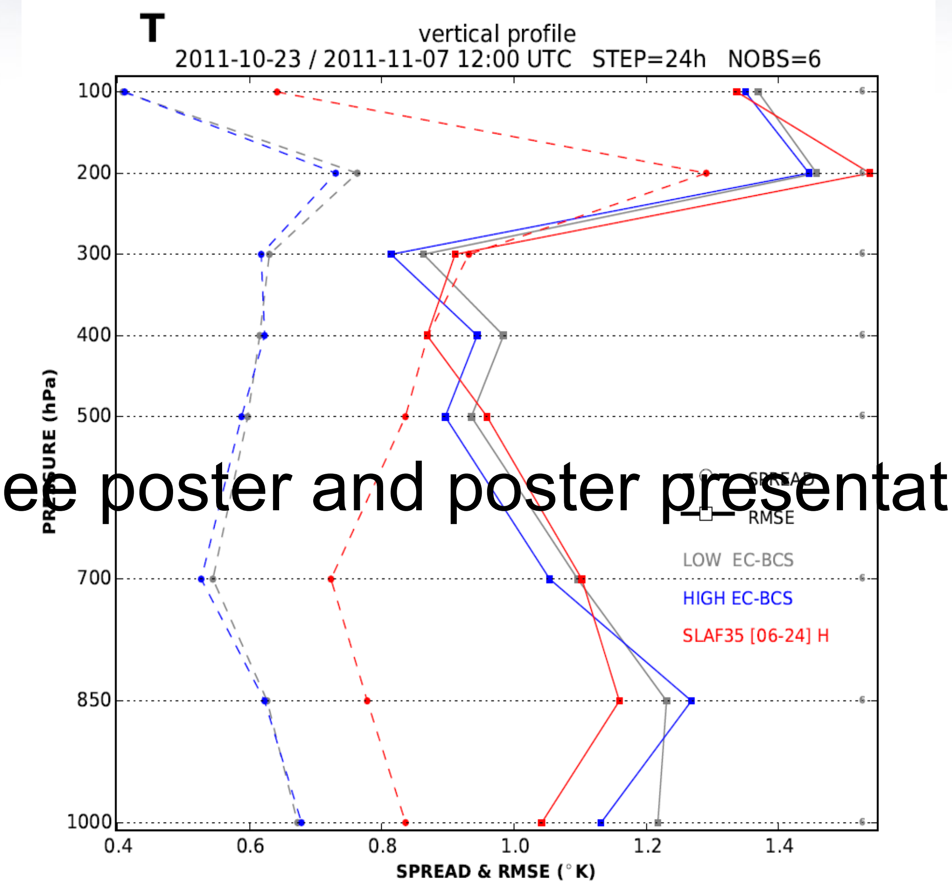


HarmonEPS

LBC

- Default is to use IFS ENS
- Model levels not stored for IFS ENS, makes it harder to do experiments
- Tests with Scaled Lagged Average Forecasts (SLAF)
- Tests with Random Field Perturbations

Results Prob – Spread/Skill Upper Air H+24



See poster and poster presentation

S35 L25 H25

Jose Antonio Garcia-Moya Zapata

Random Field Perturbation*

- Initial condition perturbation

$z_m(0)=an_{ctl} + \alpha[r_1(0)-r_2(0)]$, $z_{m+1}(0)=an_{ctl} - \alpha[r_1(0)-r_2(0)]$

- Lateral boundary condition perturbation

$z_m(t)=x_{ctl}(t) + \alpha[r_1(t)-r_2(t)]$, $z_{m+1}(t)=x_{ctl}(t) - \alpha[r_1(t)-r_2(t)]$

an_{ctl} = analysis, control run

$x_{ctl}(t)$ = interpolated hi-res EC-field

$r_j(t)$ = interpolated hi-res EC-field from random date (similar time of year and same time of day as control); u, v, T, q, p_s

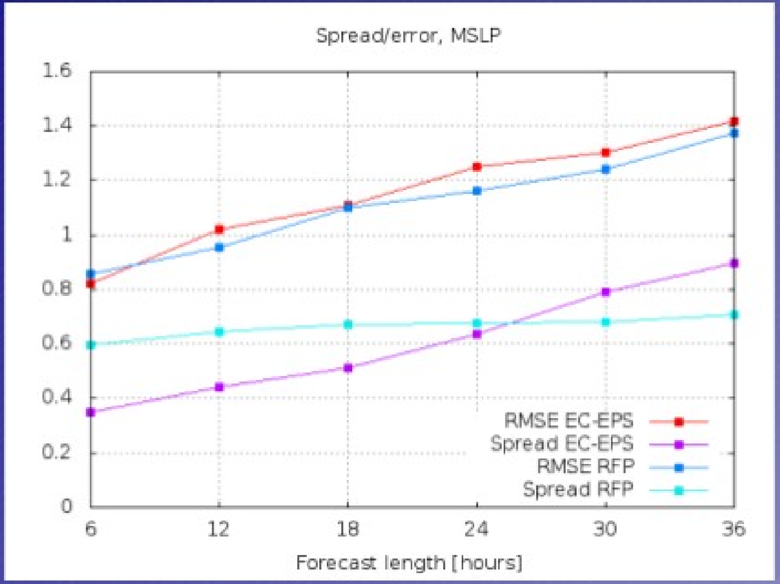
α = scaling constant that determines perturbation magnitude

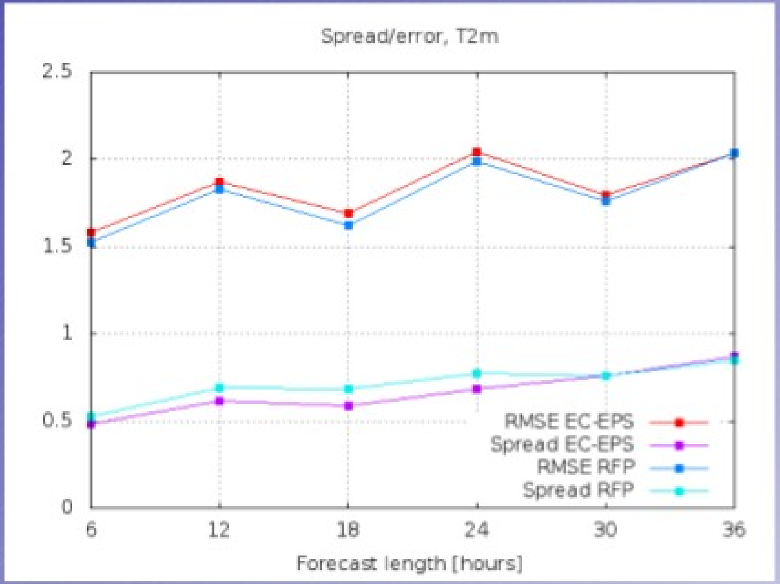
*Magnusson et al., 2009: "Flow-dependent versus flow-independent initial perturbations for ensemble prediction"

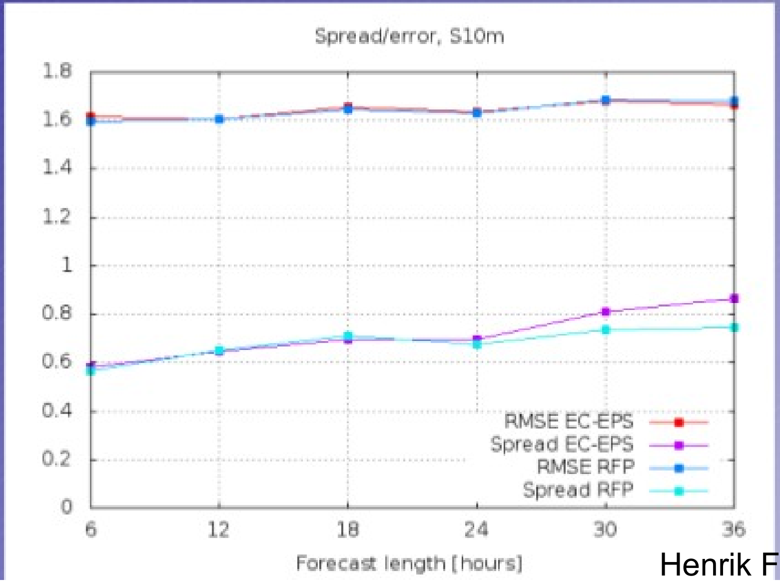
Scaling the perturbations

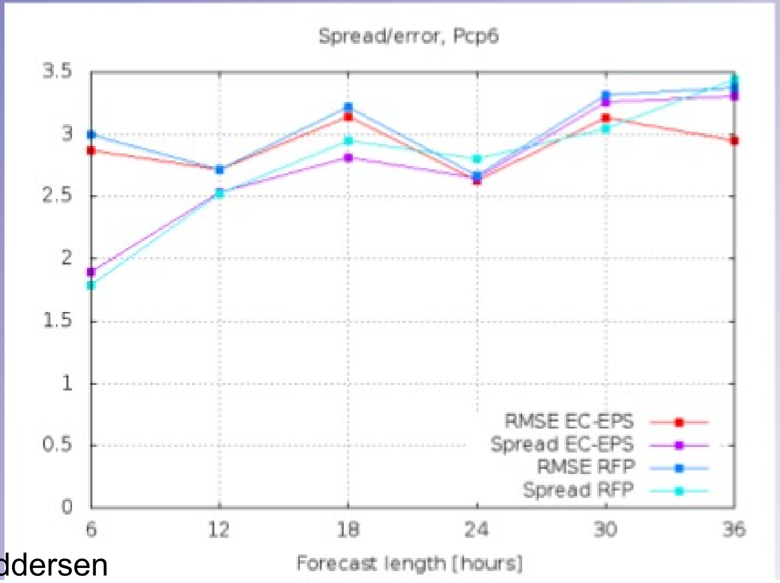
- Choose α such that the total energy of the random field initial perturbations matches that of the default initial perturbations
- Total energy norm measures distance between two ensemble members
- NB. Lateral EC-EPS boundaries diverge from control run during forecast; random field boundaries are independent of control run and will not contribute (much) to ensemble spread

Standard verification









HarmonEPS

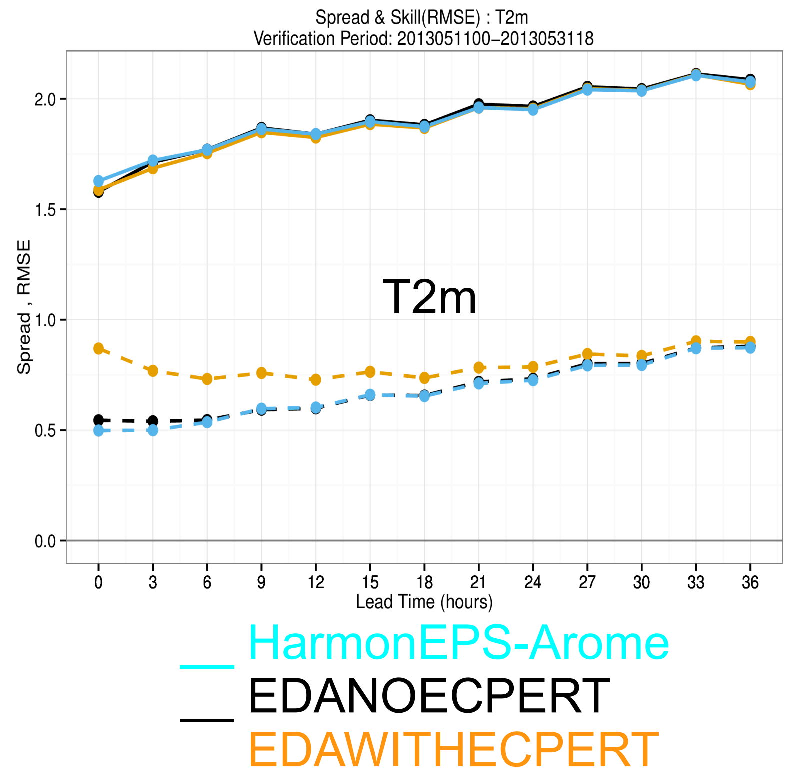
Initial perturbations

- Default is to use IFS ENS
- LETKF under development (Pau Escriba, see Jelena's DA talk)
- EDA with 3D-Var

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

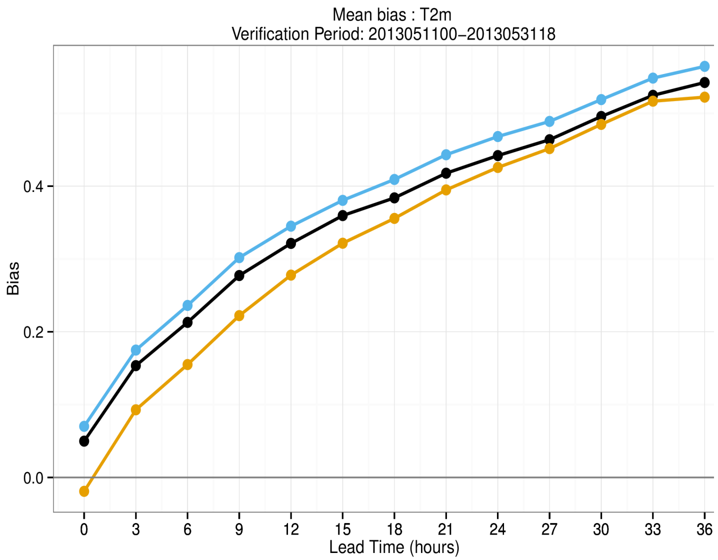


Inger-Lise Frogner

HarmonEPS

EDA

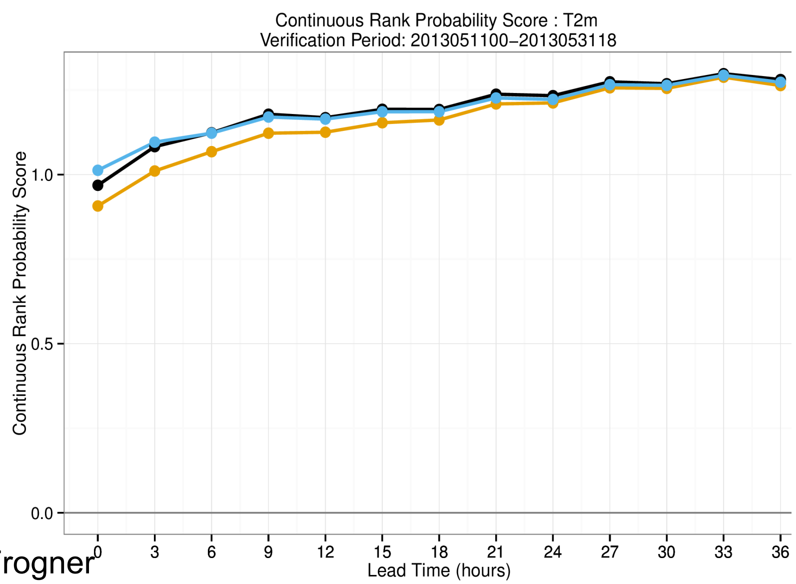
T2m



Mean bias

__ HarmonEPS-Arome
__ EDANOECPERT
__ EDAWITHECPERT

CRPS



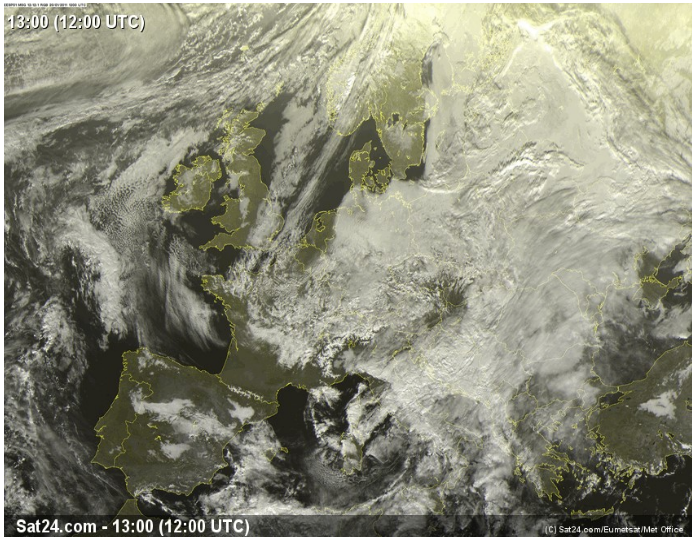
Inger-Lise Frogner

HarmonEPS

Model error and cloud initialisation

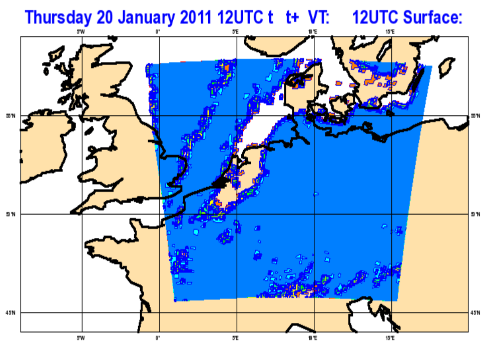
- Default is to use multi-physics with Arome and Alaro
- SPPT (Alfons Callado, implementation ongoing)
- Multi-physics the “LAEF-way” - experimentation to start (Bjorn Stensen)
- Cellular Automata (CA) (Lisa Bengtsson, presented last year)
- Stochastic perturbations in parameterizations / processes (Sibbo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

Example of initial clouds in different members (control ensemble)

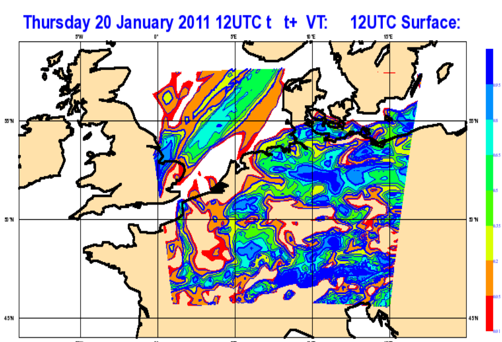


MSG visible image

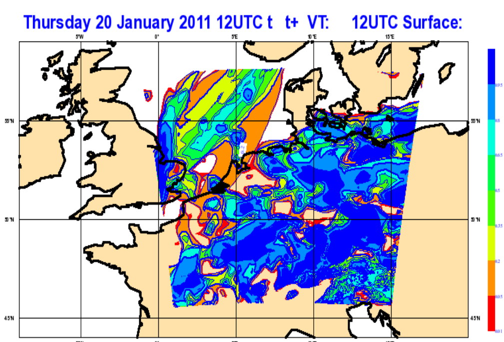
Cloud mask



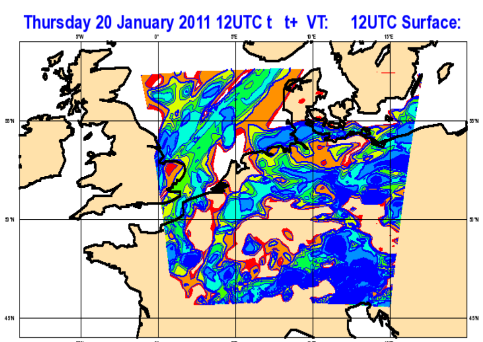
Mbr000



Mbr003

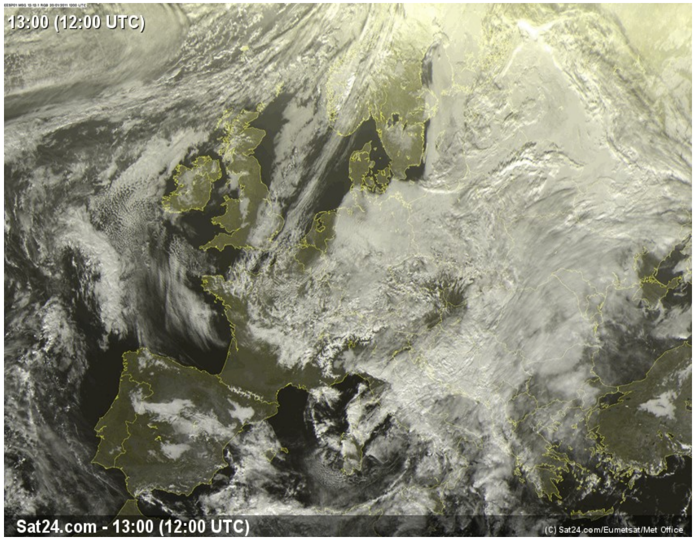


Mbr004



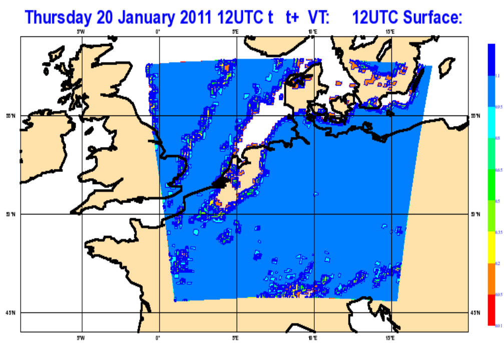
Sibbo van der Veen

Example of initial clouds in different members (initialization + humidity pert.)



MSG visible image

Cloud mask



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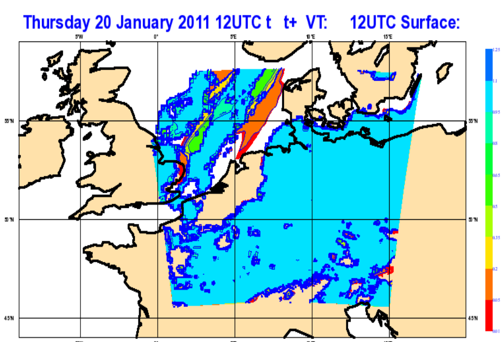
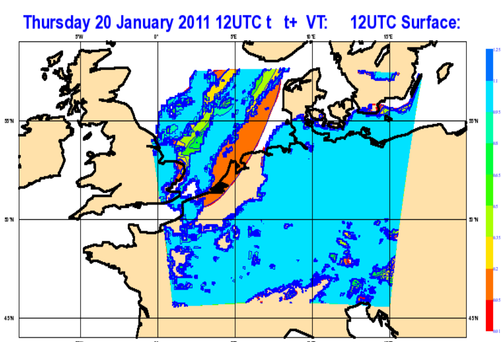
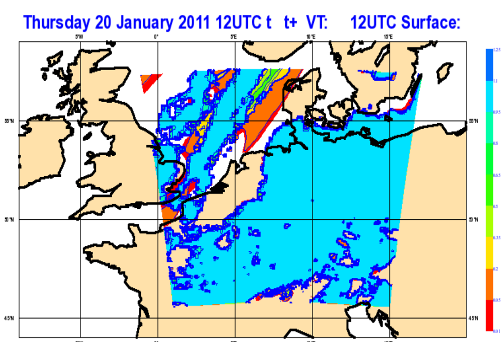


Mbr003



Mbr004



Sibbo van der Veen

HarmonEPS

Surface uncertainty

- Perturb surface parameters, like soil moisture, albedo, SST, …) (Work ongoing, Andrew Singleton)
- Perturb surface physics: study perturbations in momentum, heat and moisture flux parameterizations. (Work ongoing, and presented last year, Andrew Singleton)

HarmonEPS

Post-processing and HARP EPS developments

- HARP:
  - New scores and parameters to be included
  - Work on new formulation of spread/skill and deeper understanding of the practice of centering the ensemble round control (Åke Johansson)
- Post processing
  - Calibration (Thomas Nipen)
  - Neighborhood (Andrew Singleton)

How to determine neighborhood size?

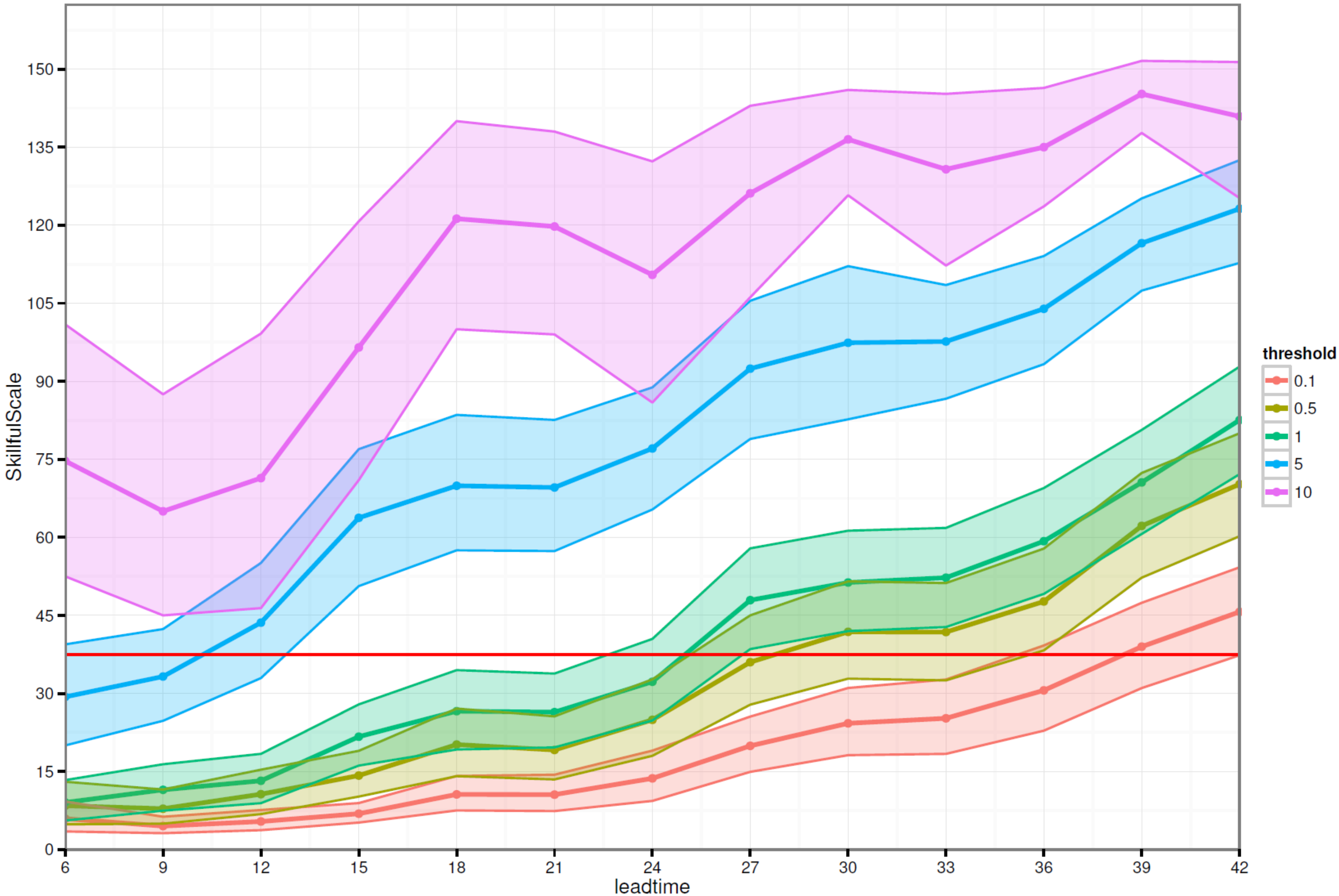
2. Adaptive neighbourhood size

- Based on fractions skill score (FSS) between members

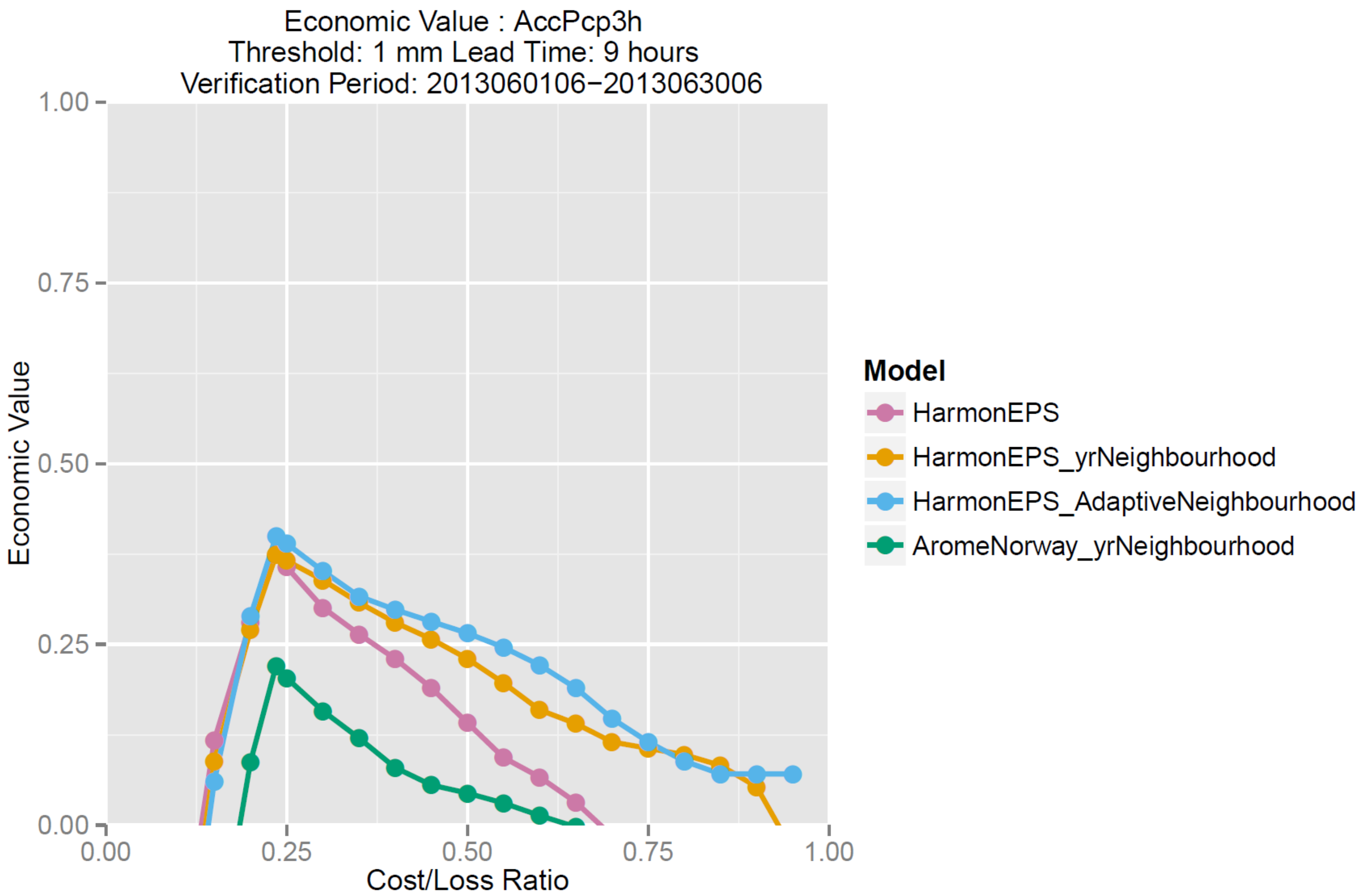
For each lead time and threshold:

1. Compute FSS for each member against all other members
2. Compute $FSS_{uniform}$ for each member
3. Spatial scale at which $FSS > FSS_{uniform}$ is spatial scale for member pair
4. Mean of spatial scales for all member pairs is neighbourhood size (don't use maximum as gives too much weight to outliers).

Adaptive neighborhood size



Andrew Singleton



Economic Value : AccPcp3h
Threshold: 1 mm Lead Time: 9 hours
Verification Period: 2013060106−2013063006
Economic Value
Cost/Loss Ratio
1.00
0.75
0.50
0.25
0.00
0.00
0.25
0.50
0.75
1.00
Model
HarmonEPS
HarmonEPS_yrNeighbourhood
HarmonEPS_AdaptiveNeighbourhood
AromeNorway_yrNeighbourhood

Thank you