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

Kai Sattler, Alex Deckmyn, Xiaohua
GLAMEPS (version 2)

- Pmsl
- T2m
- S10m
- AccPcp3h

IFS ENS
GLAMEPS raw
GLAMEPS cal.

Continuous Rank Probability Score: Pmsl
Verification Period: 20160101-20160131 Cycle: 18
ALL Stations

Continuous Rank Probability Score: T2m
Verification Period: 20160101-20160131 Cycle: 18
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Continuous Rank Probability Score: S10m
Verification Period: 20160101-20160131 Cycle: 18
ALL Stations

Continuous Rank Probability Score: AccPcp3h
Verification Period: 20160101-20160131 Cycle: 18
ALL Stations
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

- v2
- inflated

Xiaohua Yang and Kai Sattler
Inflation of initial perturbations in HIRLAM sub-ensembles – CRPS

- v2
- inflated
  ^\text{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
Operational system:

**T2m**

Gaussian distribution with parameters:
- **mean**: ensemble mean + model elevation
- **log(standard deviation)**: \( \log(\text{ensemble standard deviation}) + \log(\text{model elevation}) \)

**S10m**

Box-Cox t-distribution with parameters
- **mean**: ensemble mean + model elevation
- **log(sigma)**: \( \log(\text{ensemble standard deviation}) + \log(\text{max\{1, model elevation\}}) \)
- **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 when ensemble mean is ...

John Bjørnar Bremnes, Thomas Nipen, Maurice Schmeits
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
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

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γSREPS: talk by José A. Garcia-Moya
HarmonEPS

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MEPS: see poster by Ulf Andrae
HarmonEPS

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COMEPS: see talk by Xigohua Yang
HarmonEPS
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Netherlands: ask Jan Barkmeijer for details
HarmonEPS

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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

Spread and skill T2m

Spread & Skill (RMSE) : T2m
Verification Period: 2013051100-2013053118

Inger-Lise Frogner
HarmonEPS

EDA

T2m

Inger-Lise Frogner
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.
Temporal Evolution of SPREAD and RMSE for sfc params

**LETKF versus 3DVAR**

S10m

Temporal evolution
2011-10-28 / 2011-11-03 00:00 UTC LEVEL=10m NOBS=4511

<table>
<thead>
<tr>
<th>STEPS (+HH)</th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
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</thead>
<tbody>
<tr>
<td>SPREAD (m/s)</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td>1.5</td>
<td>2.5</td>
<td>2</td>
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<tr>
<td>RMSE (m/s)</td>
<td>&lt;1</td>
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<td>2.5</td>
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T2m

Temporal evolution
2011-10-28 / 2011-11-03 00:00 UTC LEVEL=2m NOBS=4631

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Pau Escribà
Perturbation of initial state according to:
\[ \text{IN} = \text{AN}_c + k \times (\text{FG}_c - \text{FG}_m) \]
with the hope to retain the small scale information from the members.

**HarmonEPS**

Perturbations based on first guess

- **Pert: First guess**
- **Pert: IFS ENS**

**Ulf Andrae**

**Spread and skill**

- **T2m**
- **S10m**
- **AccPcp12h**
Perturbation of initial state according to:
\[ \text{IN} = \text{AN}_c + k \times (\text{FG}_c - \text{FG}_m) \]
with the hope to retain the small scale information from the members.

Perturbations based on first guess

CRPS

S10m

T2m

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