GLAMEPS:

Grand Limited Area Model Ensemble Prediction System

Status

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with contributions from

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Roeland Stappers, Jan Barkmeijer, Jose A. Garcia-Moya, Carlos Santos,
Martin Leutbecher
and more....

HIRLAM-ALADIN All Staff Meeting, Brussels, 7-10 April 2008

The GLAMEPS objective

is in real time to provide to all HIRLAM and ALADIN partner countries:

an operational, quantitative basis for

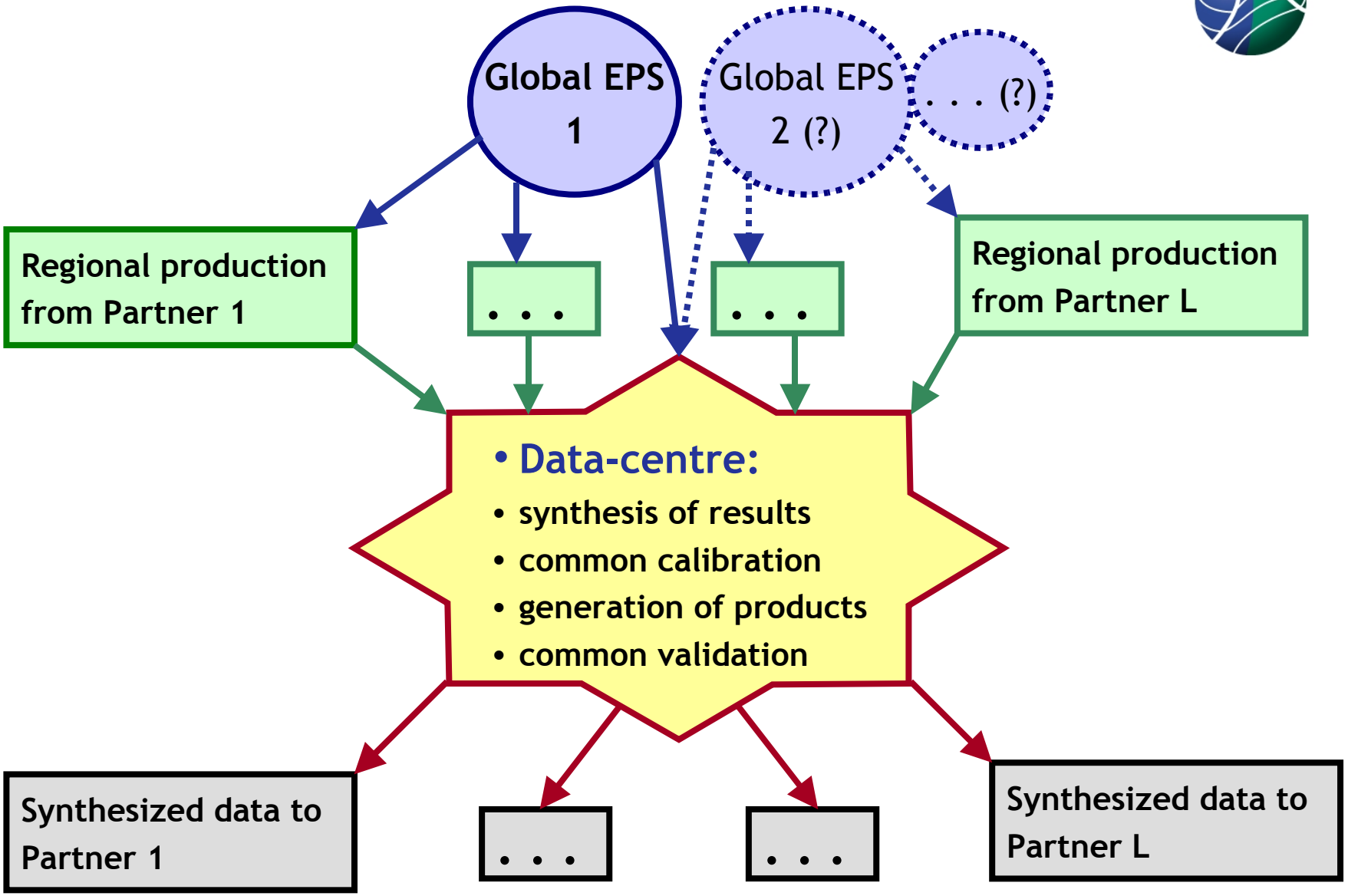
forecasting probabilities of weather events

in Europe up to 60 hours in advance

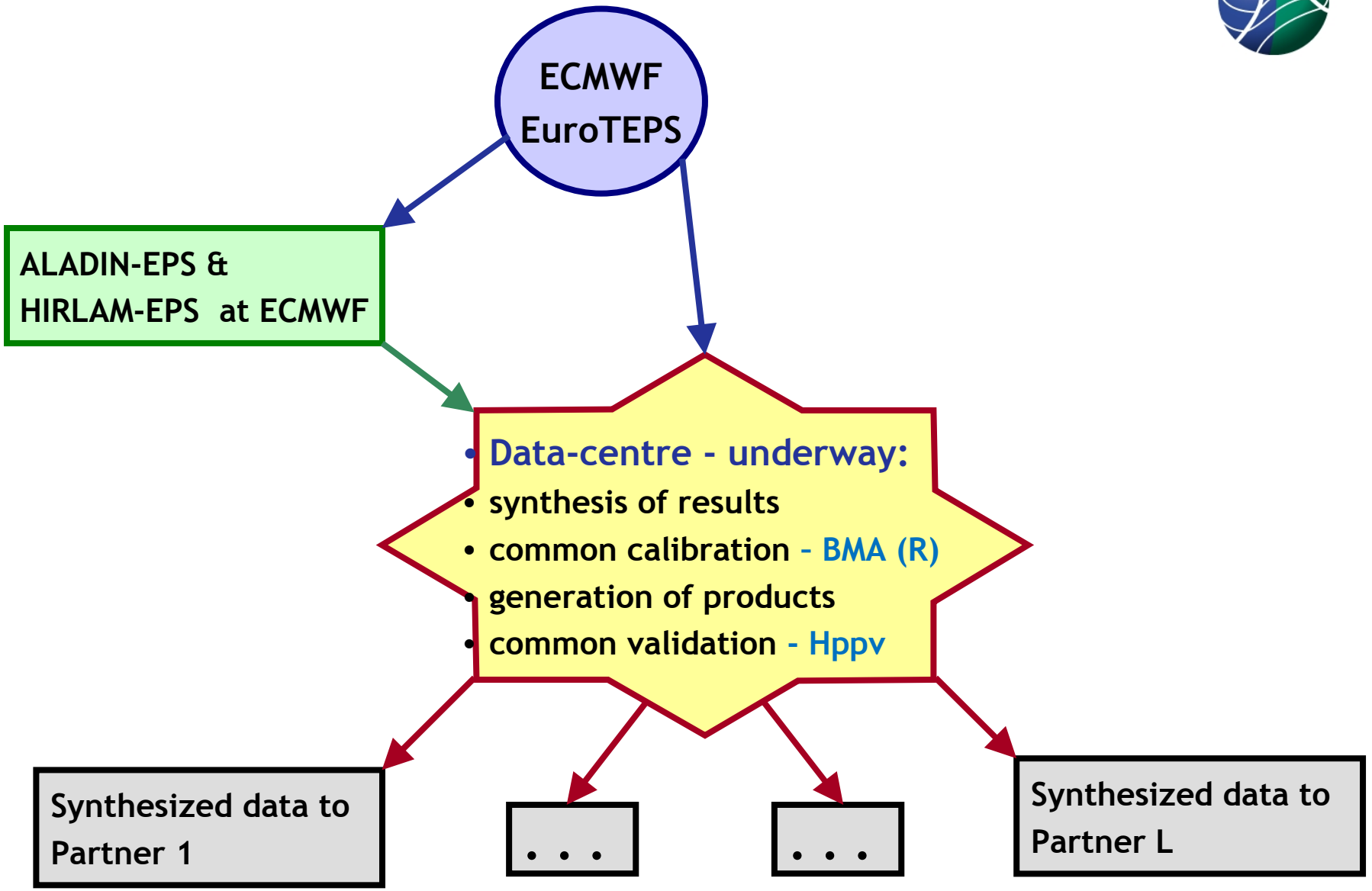
to the benefit of highly specified as well as general applications,

including risks of high-impact weather.

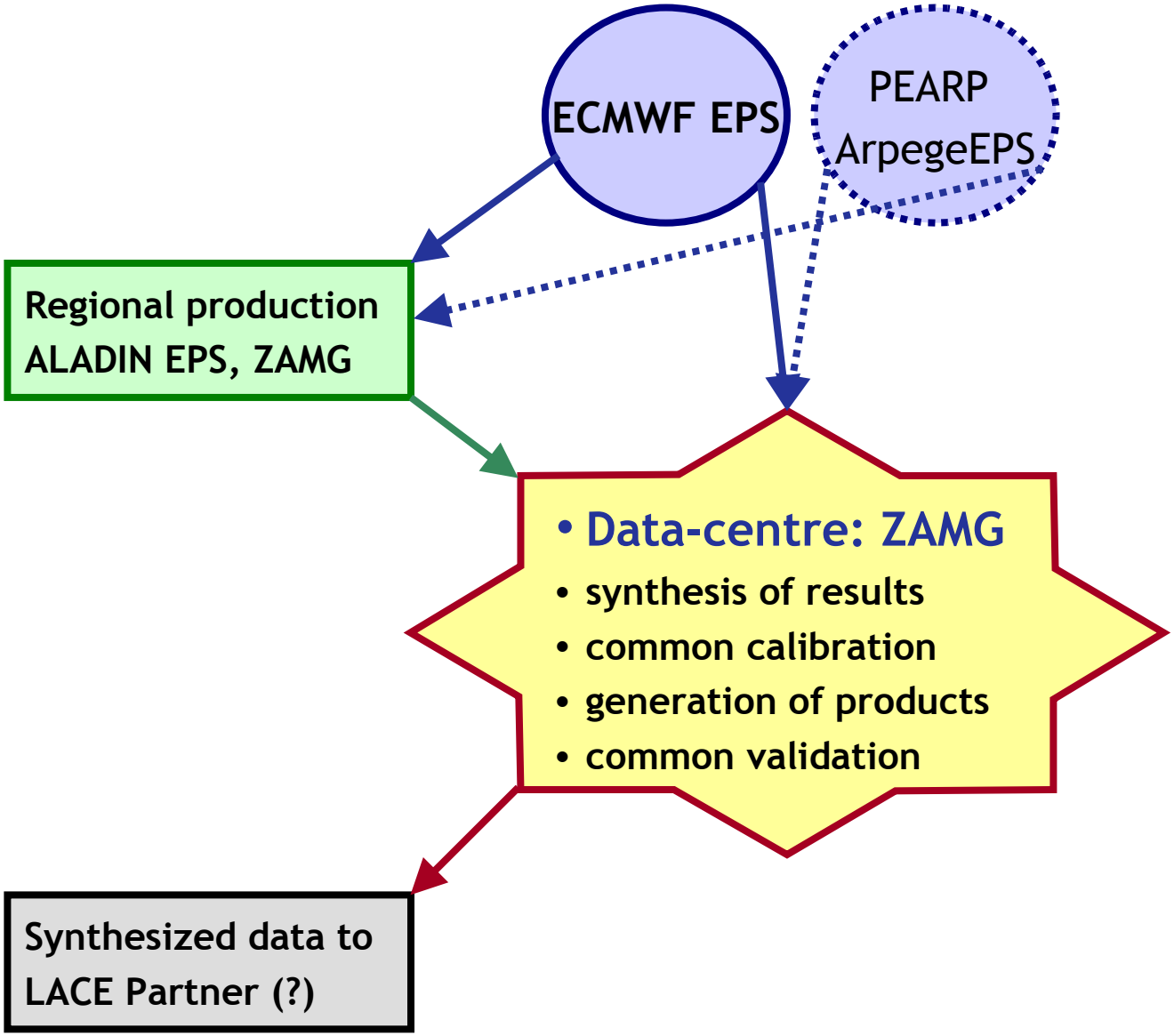
Operational Ideas for GLAMEPS



Present Status



The LAEF - approach



- *An array of LAM-EPS models or model versions:*
  - *Each partner produces a sub-set of ensemble members*
  - *Partners using the same model version,*
    - *use different lower boundary data,*
    - *or different initial and lateral boundary perturbations*
  - *Partners who run with DA, produce 2n-1 ensemble members, n=3…10, based on initial and lateral boundary perturbations (one control and n initial perturbation pairs)*
  - *Partners who do not run DA produce 2n ensemble members (pairs), + one downscale of the control with ALADIN.*
- *Grid resolution*
  - *Now ~22km, aim: ~11km or finer,*
  - *37 and 40 levels; aim: to be increased to 60 or higher*
- *Forecast range*
  - 48 – 60 h, starting daily from 00UT and 12 UT
- *A common pan-European integr. - domain*

Some Challenges

1. *Operational aspects*
   - *Timing and speed of model-runs and product generation*
   - *Timing and speed of Real-Time data transfers*
   - *Allocation of computer resources*
     - *ECMWF*
     - *Home computers*
2. *Constructing IC and LBC perturbations*
   - *Imported global eps and/or LAM-specific perturbations:*
     - *TEPS with enhanced resolution and European targets*
     - *LAM-specific initial perturbations (e.g. SVs, ETKF, SLAF)*
   - *Fine-scale perturbations – importance of moist & diabatic processes*
     - *Mahfouf (1999) diabatic singular vectors for TEPS*
     - *CAPE-optimized LAM singular vectors (KNMI)*
   - *In the very short range: slowly growing initial errors contribute*
     - *Initial perturbations should reflect actual errors (multi-analyses; SLAF; ETKF; Hessian SVs (?); quasi-random perturbations (?);...)*

Some Challenges II

1. *Model perturbations*
   - *Switching models (e.g. Aladin, Hirlam, EC IFS)*
   - *Switching physical packages (e.g. Straco, RKKF in HIRLAM)*
   - *Stochastic perturbations*
   - *Parameter perturbations (e.g. entrainment rates)*
   - *Forcing Singular Vectors*

3. *Lower boundary data perturbations*
   - *Stochastic perturbations (SST, soil humidity)*
   - *Switch surface schemes*
   - *Targetted Forcing Singular Vectors or Forcing Sensitivities*

Some Challenges III

1. *EPS-calibration and probabilistic validation, graphical presentation, products*
   - *Bias-correction / BMA / BPF (Bayesian Processor of Forecasts)*
   - *Data in common grid (rotated lat-lon)*
   - *Hppv-package based on Magics / MetView*

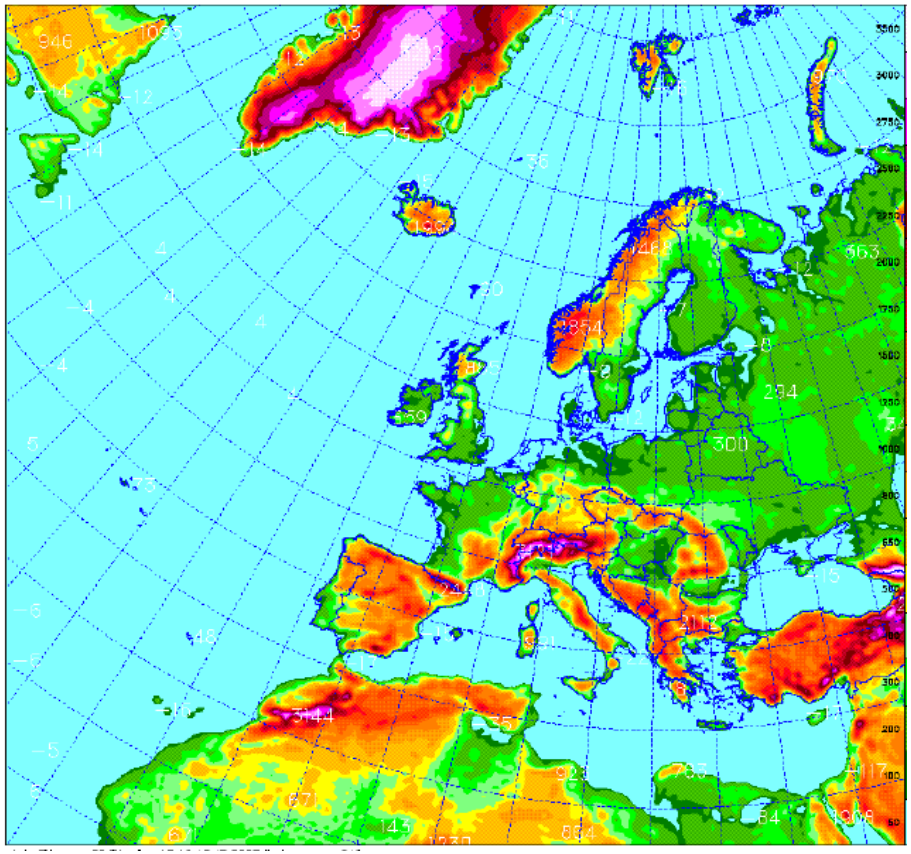
3. *Validation*
   - *Hppv*

5. *Further downscaling to meso- and convective scales*
   - *Next stage: requires output of full fields in model levels*

GLAMEPS Common Domain

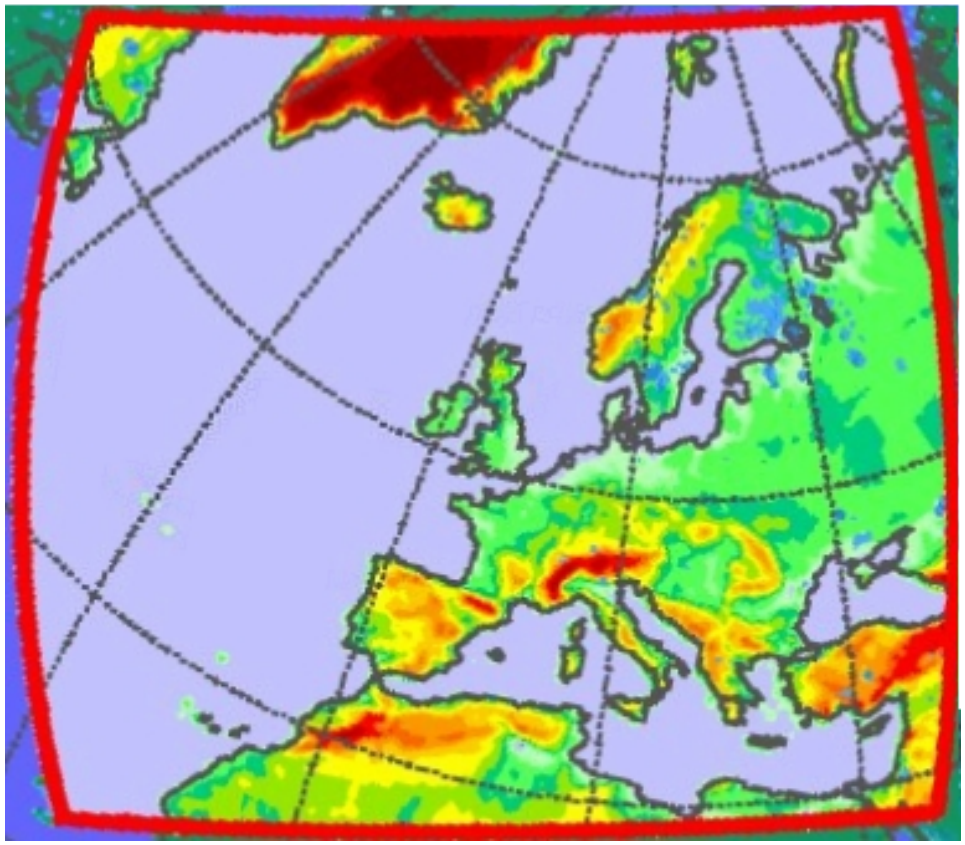
ALADIN

- Resolution: 22km
- 320 x 300 x 37



HIRLAM (EPS71)

- Resolution 0.2 deg.
- 306 x 260 x 40



GLAMEPS_v0: Laboratory at ECMWF

1. Construct initial/lateral boundary perturbations
   - ECMWF "EuroTEPS" (based on Leutebecher, 2007) :
     - define 30 TSVs; 10 per target; 3 target domains
     - orthogonal to NH SVs (oper. EPS)
     - mutually orthogonalized
     - TSVs: OT=24h, T159, (not yet diabatic, not yet Hessian)
   - Gaussian sampling of 2x(30 TSVs and 50 NH SVs)
     →20 members + control
   - Different amplitudes assigned to achieve desired spread vs. skill

- Select a small set of LAM versions, ~ equally valid but different,
  - 3 different models:
    - ALADIN Pure downscaling (EuroTEPS; and PEARP?)
    - HIRLAM-STRACO, 3DVar DA for control, EuroTEPS for IC&LBC
    - HIRLAM-RKKF, with 3DVar DA for control, EuroTEPS for IC&LBC

GLAMEPS_v0: Laboratory at ECMWF

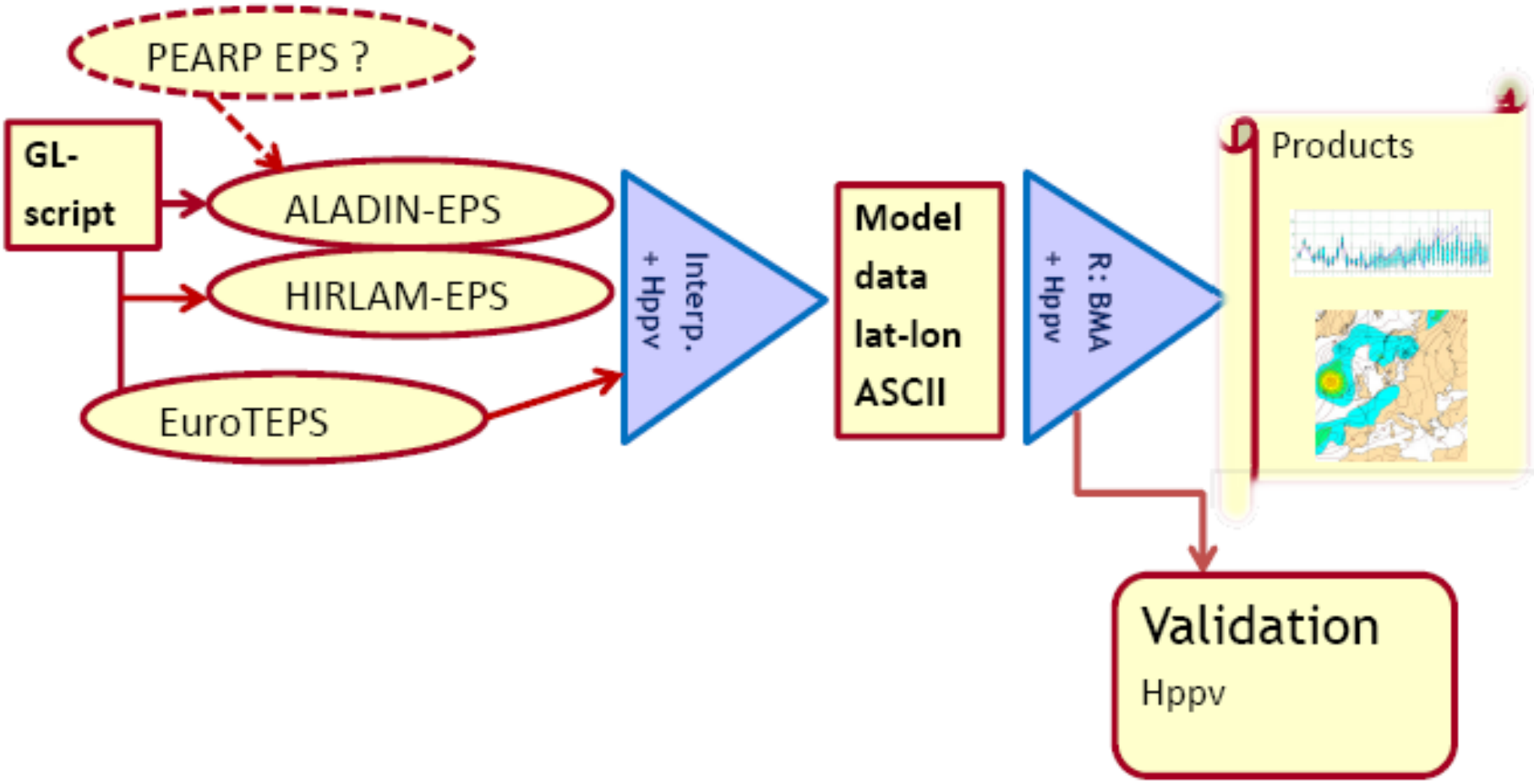
- Construct initial/lateral boundary perturbations
- Select a small set of LAM versions, ~ equally valid but different,

- Physics perturbations
  - Stochastic Physics (?)
  - Parameter variations

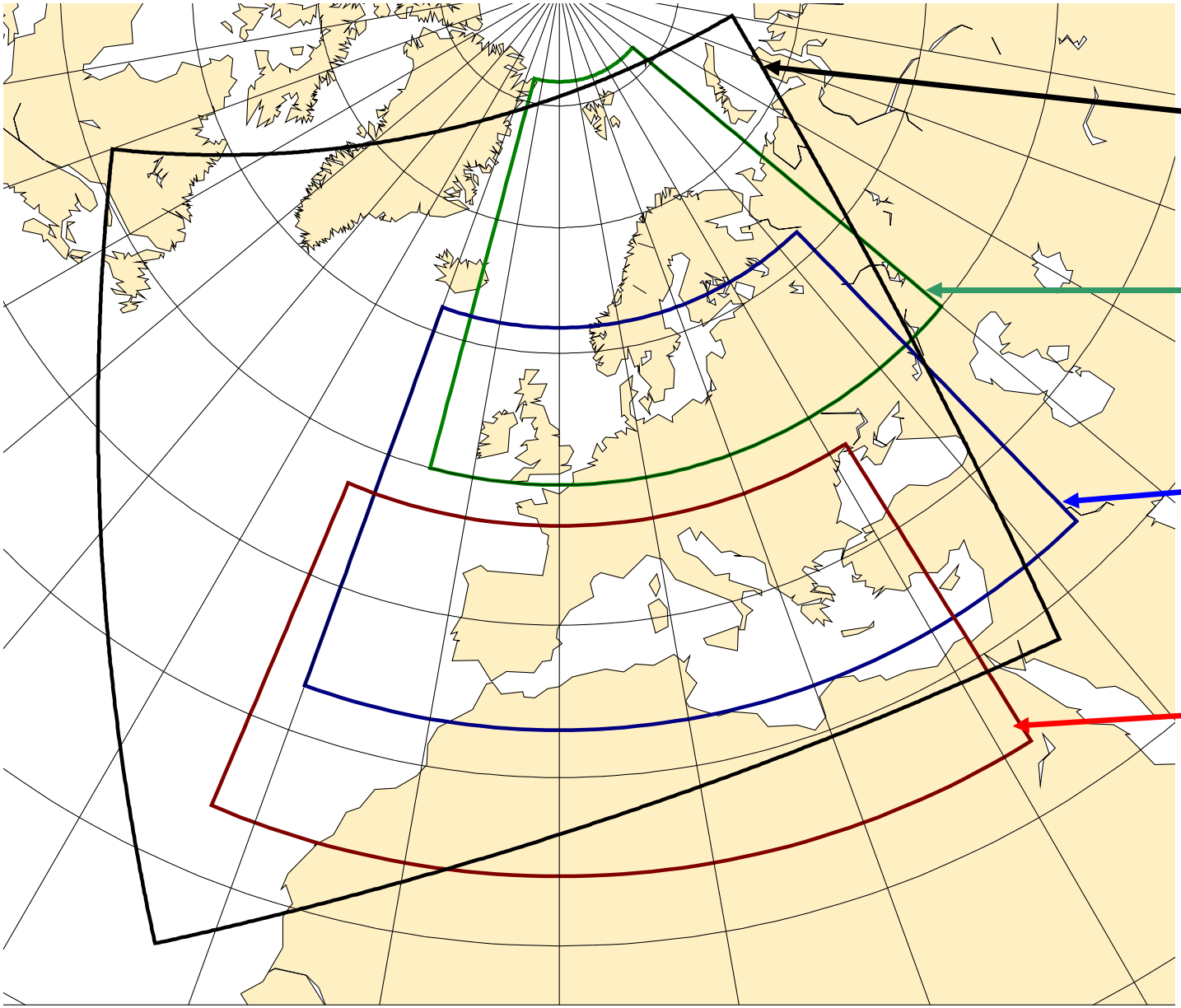
6. Calibration and combination issues
   - Aladin-results readily transformed to HIRLAM lat/lon-grid
   - Re-tuning IC and Forcing perturbation amplittudes for entire system
   - Bias corrections / BMA: R-based program used together with Hppv

8. Products; Quality and Value
   - Hppv: package based on Magics / Met View:
   - Predictability of the day, event risks
   - Reliability, BSS, Rank Histograms, ROC, Value, …

GLAMEPS_v0 - flow chart



TEPS FOR EUROPE (I.-L. Frogner)



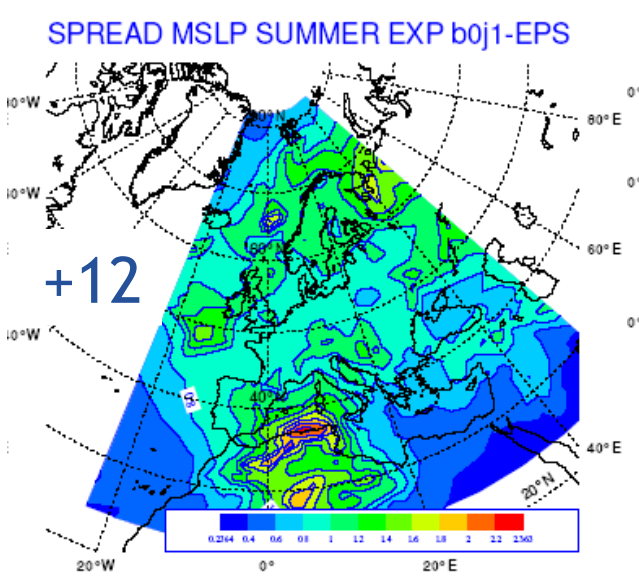
GLAMEPS integration domain
(HIRLAM version)

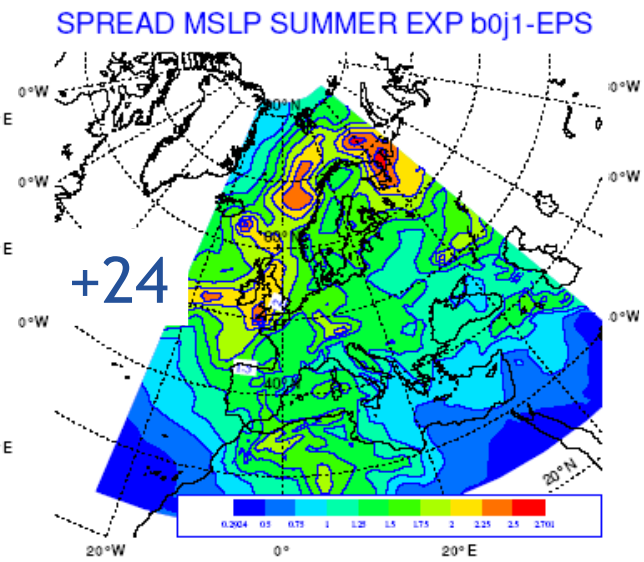
Target area north
(82N,15W,50N,50E)

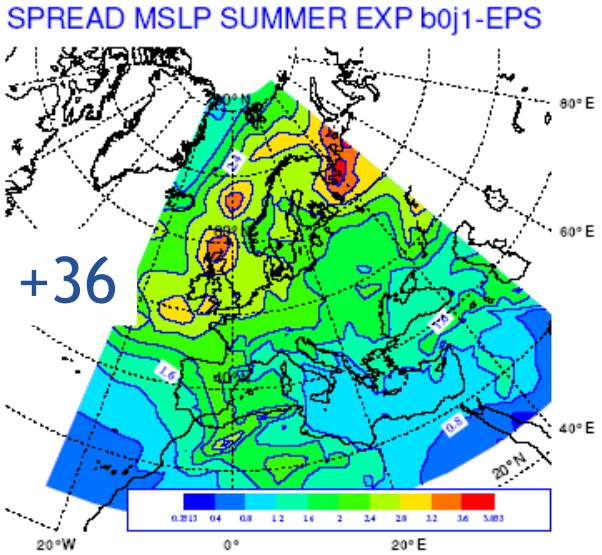
Target area central
(62N,20W,33N,44E)

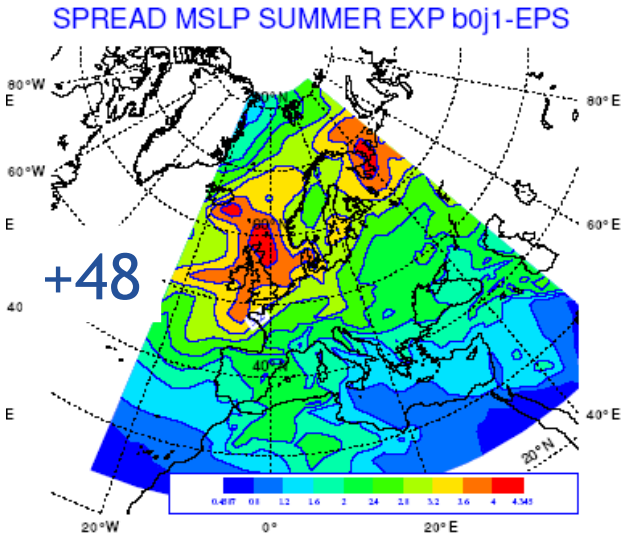
Target area south
(47N,23W,24N,32E)

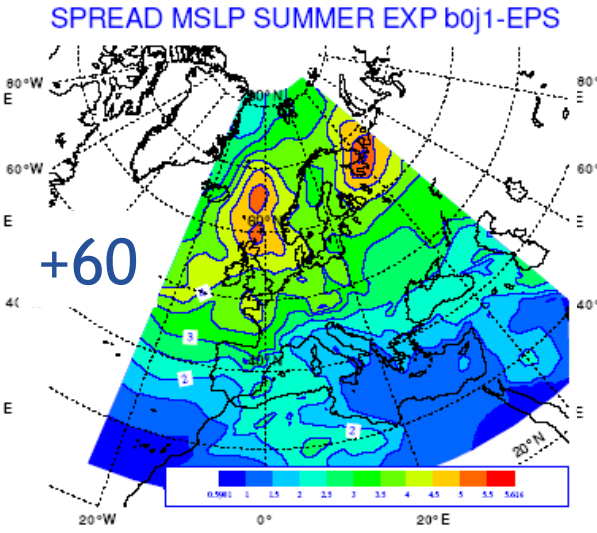
TEPS spread increment relative to 21 member EPS (Exp. 2)

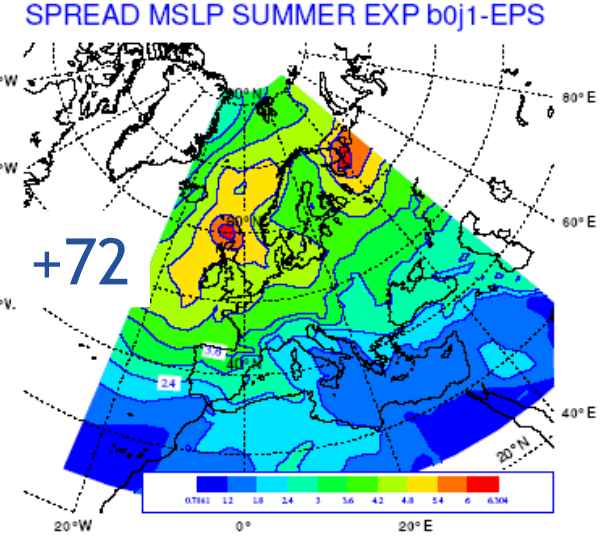




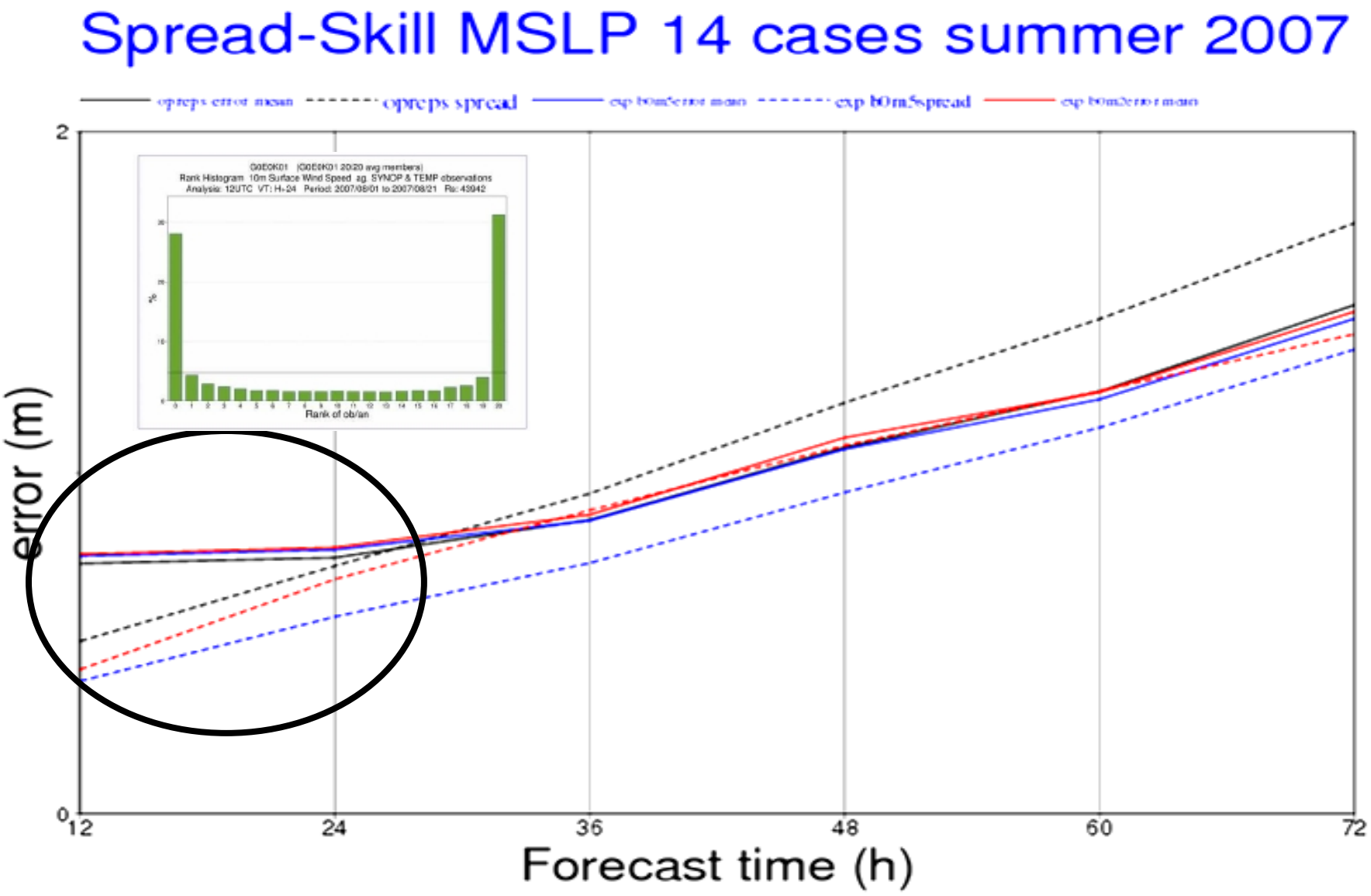








Spread/Skill relationship - EuroTEPS



Further work

GLAMEPS_v0 (Entirely at ECMWF – depending on SBUs):

- EuroTEPS to be run for longer periods incl. extreme events.
- Further experimentation with amplitudes of the SVs and TSVs, and prepare diabatic TSVs.
- Further runs with HIRLAM-EPS_Straco, HIRLAM_RKKF
- ALADIN-EPS; results out in common grid
- Re-scaling, Calibration and bias correction
- Combined probabilistic products with Hppv
- Probabilistic verification using Hppv
- Set-up and run the entire system at ECMWF in one go.

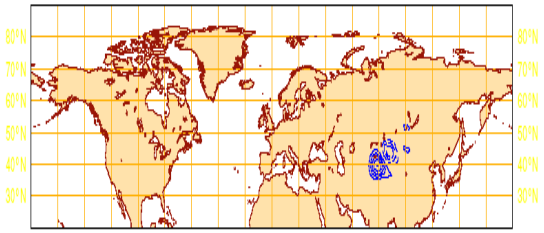
GLAMEPS_v1 (Start distributed production – who can contribute?):

- Include ALADIN and HIRLAM SVs in the range of perturbations
- Develop ETKF with HIRLAM (and ALADIN ?)
- Experiments with diabatic (and Hessian?) TSVs.
- Include Physics perturbations in the LAMs
- Start testing surface BC perturbations

NH SVs 48h and TSVs 24h, target time: 2007/08/22 12utc. T ~850 hPa

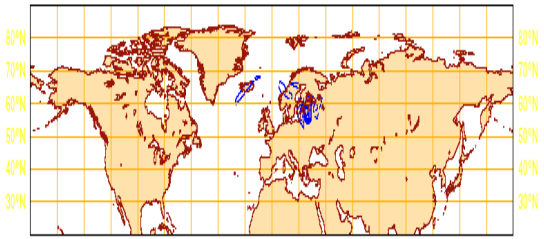
initial

Opr SV. Temp. Lev 48. Number 1. 2007082012



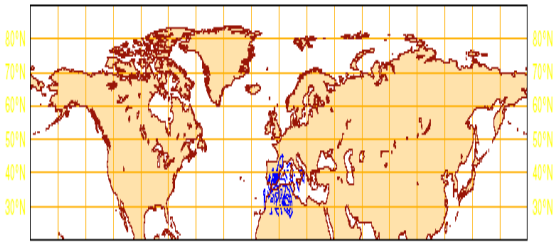
NH SV, OT=48h

Exp TSV area north. Temp. Lev 48. Number 1. 2007082112



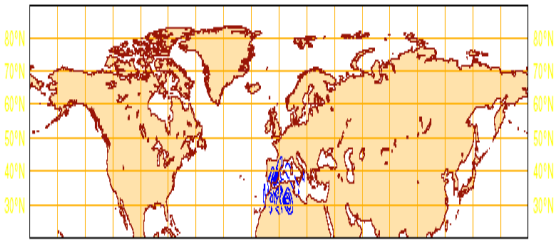
TSV_north, OT=24h

Exp TSV area central. Temp. Lev 48. Number 1. 2007082112



TSV_central, OT=24h

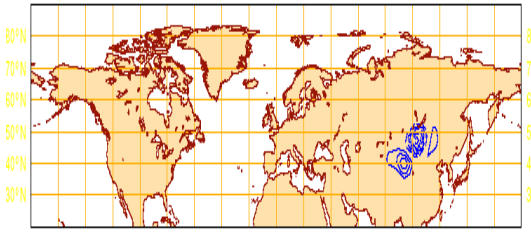
Exp TSV area south. Temp. Lev 48. Number 1. 2007082112



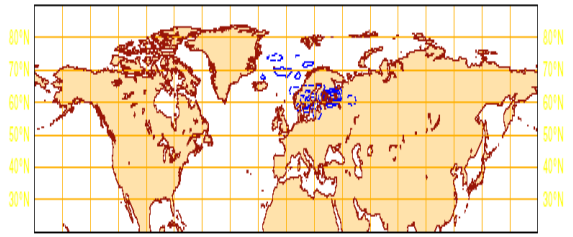
TSV_south, OT=24h

evolved

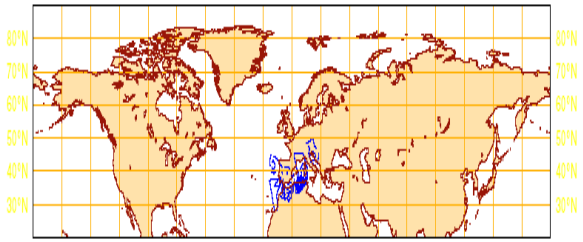
Opr SVEVO. Temp. Lev 48. Number 1. 2007082012



Exp TSVEVO area north. Temp. Lev 48. Number 1. 2007082112



Exp TSVEVO area central. Temp. Lev 48. Number 1. 2007082112



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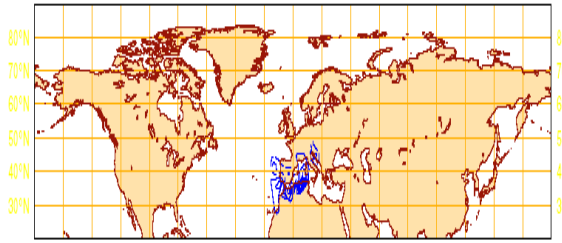
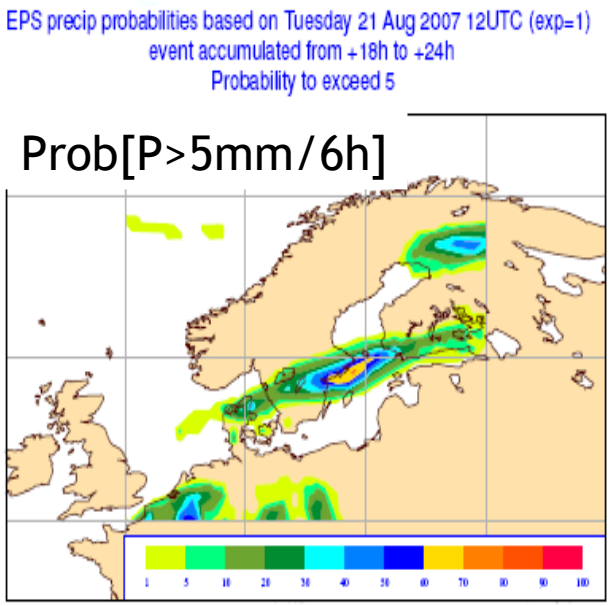
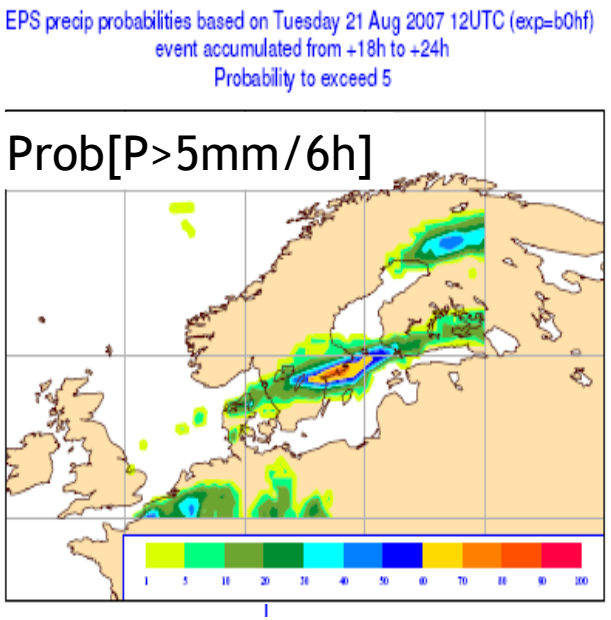


OperEPS and TEPS/EPS +24

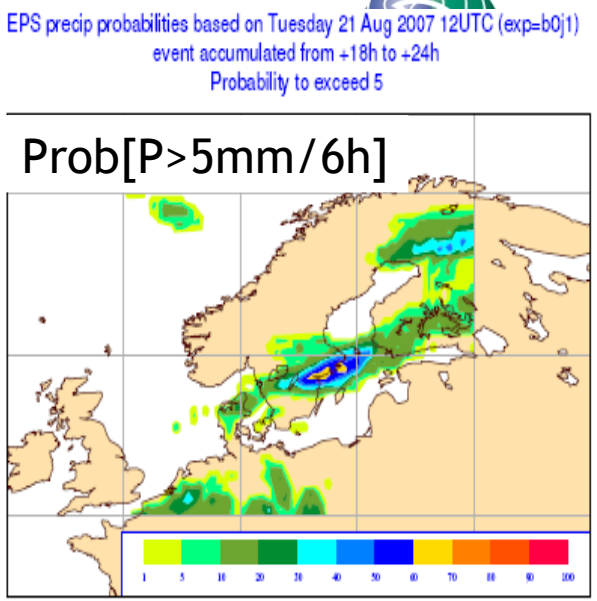


Operational EPS: NHSV



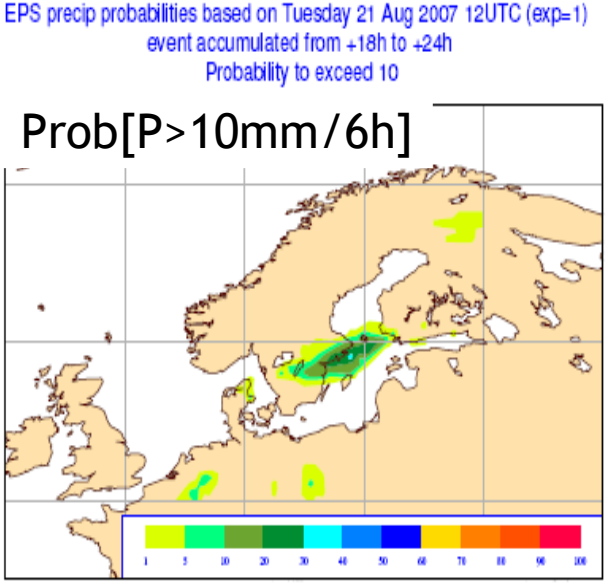
TEPS/EPS: Exp. 1

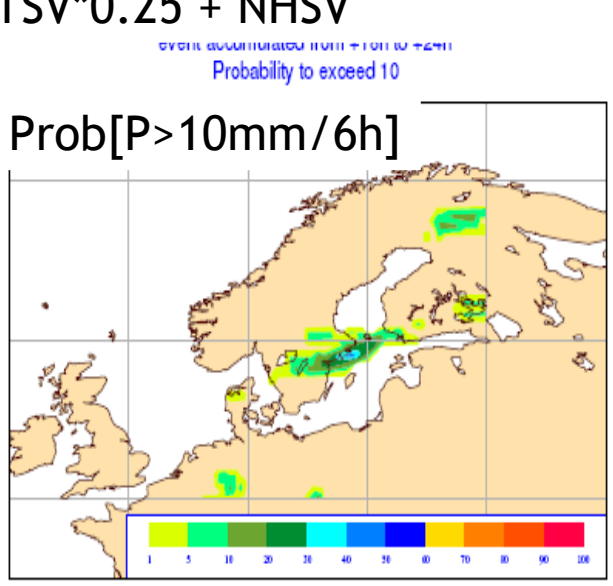
TSV*0.25 + NHSV

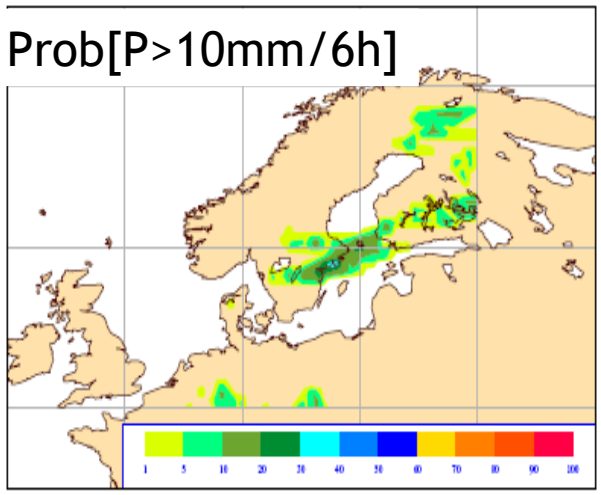


TEPS/EPS: Exp. 2

TSV*0.50+NHSV*0.75








Thank You!

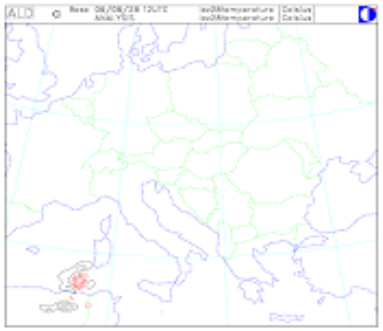
Case: 28/06/2006

ALADIN SVs, OT=12h (E. Hagel and R. Mladek)

ALADIN leading singular vector at T+0h
and evolved at T+12h for temperature
at model levels 28-31.

Level 28 29 30 31

initial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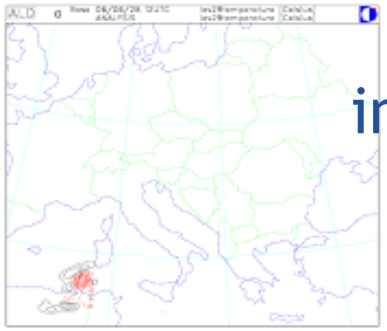
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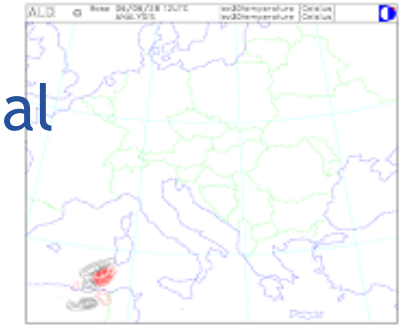
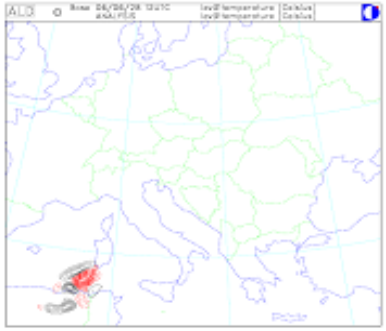
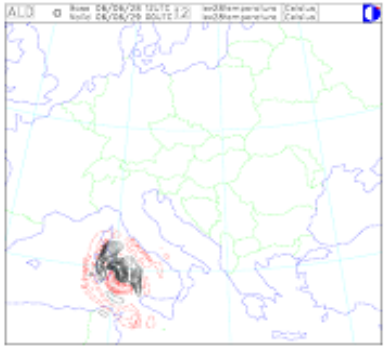
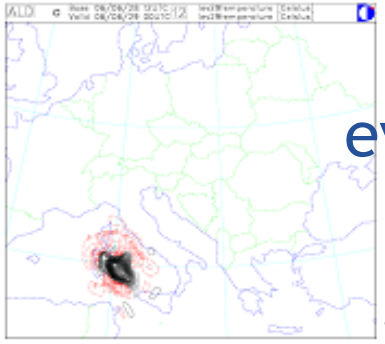
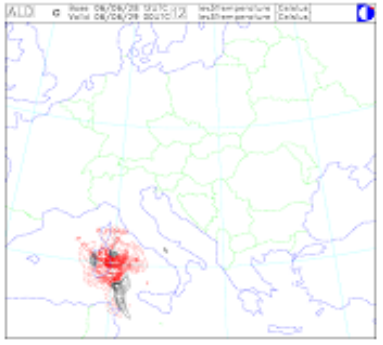

c.)

d.)

evolved


e.)

f.)

g.)

h.)

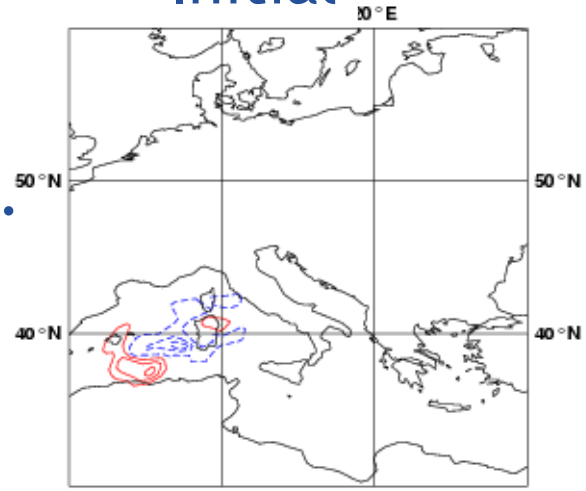
HIRLAM SVs OT_12h (R. Stappers and J. Barkmeijer)

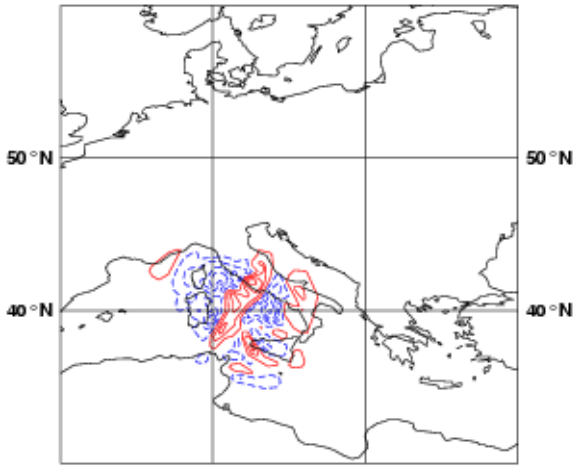
Leading singular vector at model level 19 (500 hPa)
(using the same temperature contour interval and unit wind vector).

Initial

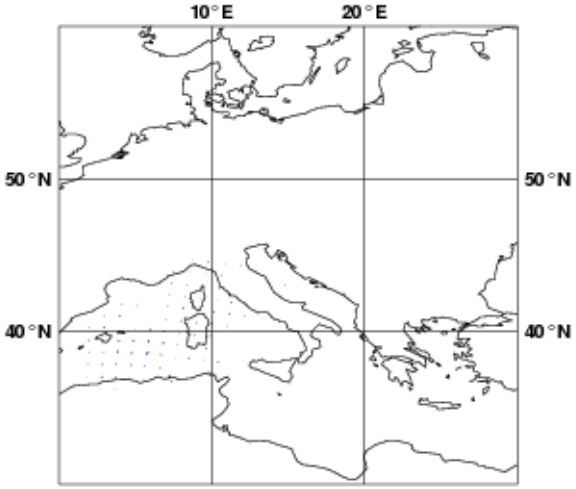
Evolved

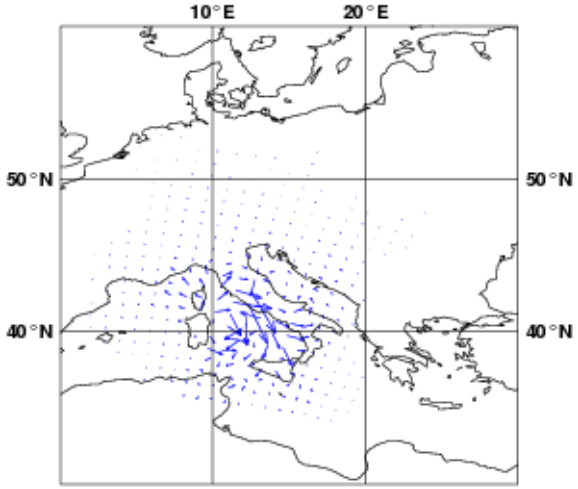
Temp.





Wind

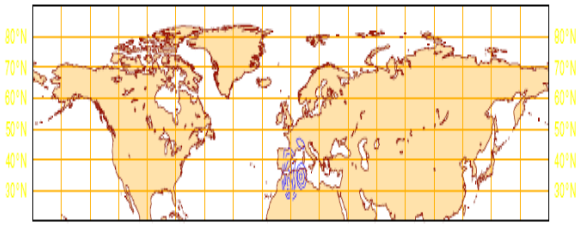




NH SVs 48h and TSVs 24h, target time: 2006/06/28 12utc. T ~850 hPa

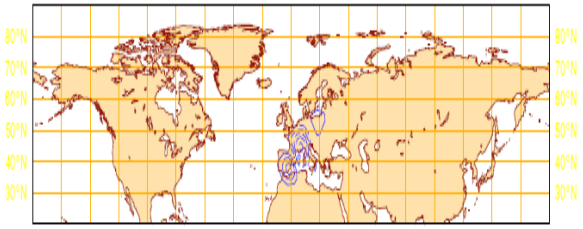
initial **evolved**

Opr SV. Temp. Lev 48. Number 6. 2006062612

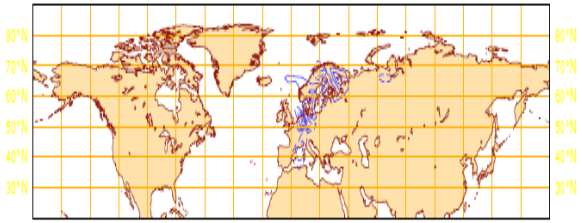


NHSV_6

Opr SVEVO. Temp. Lev 48. Number 6. 2006062612

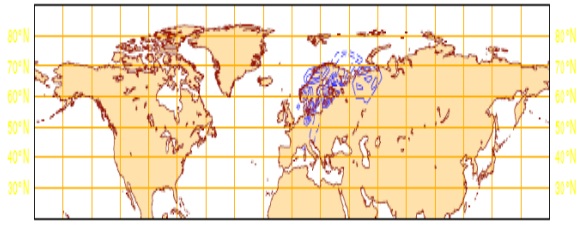


Exp TSV area north. Temp. Lev 48. Number 1. 2006062712

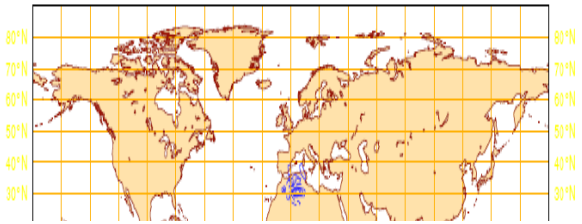


TSV_north-1

Exp TSVEVO area north. Temp. Lev 48. Number 1. 2006062712

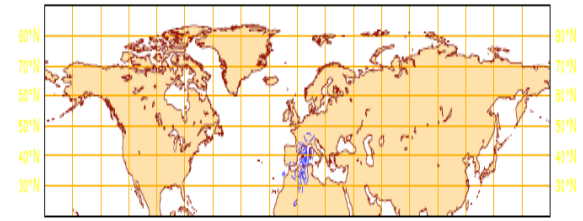


Exp TSV area central. Temp. Lev 48. Number 1. 2006062712

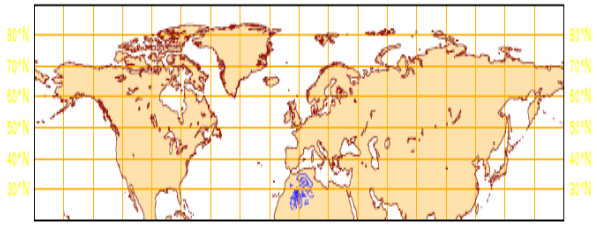


TSV_central-1

Exp TSVEVO area central. Temp. Lev 48. Number 1. 2006062712

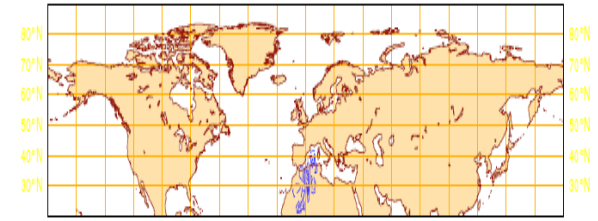


Exp TSV area south. Temp. Lev 48. Number 1. 2006062712



TSV_south-1

Exp TSVEVO area south. Temp. Lev 48. Number 1. 2006062712



”The Finnish case”

Wed, August 22, 2007 ~07-09 utc

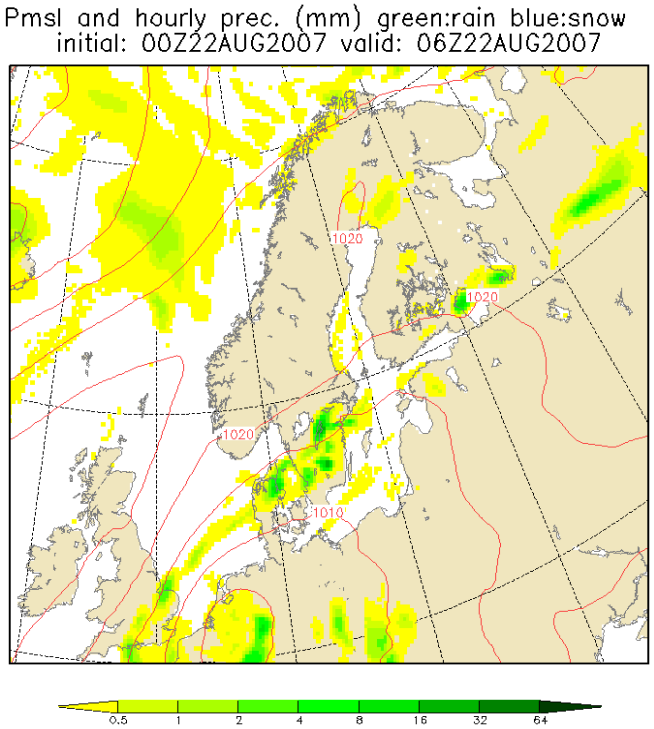
E-mail from Head, NWP at FMI **8:08 utc** :

“At the moment we are experiencing a very intense thunderstorm in southern Finland.

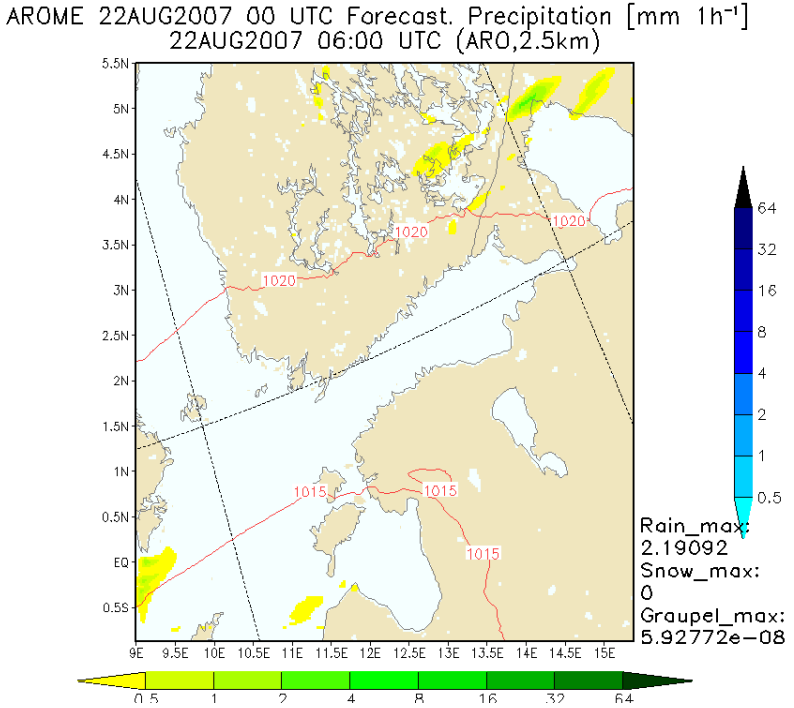
The system …. is by no means a local phenomenon.

….. the RCR has failed to forecast this storm in any of the cycles verifying this morning. …“

Available ”nowcasting” products at FMI on the occassion

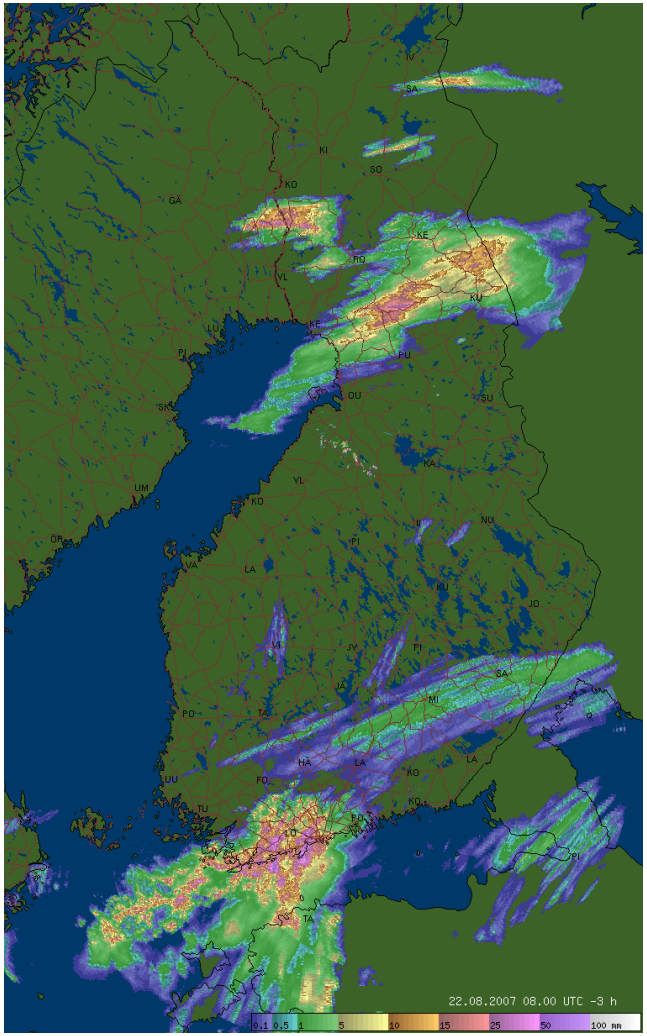


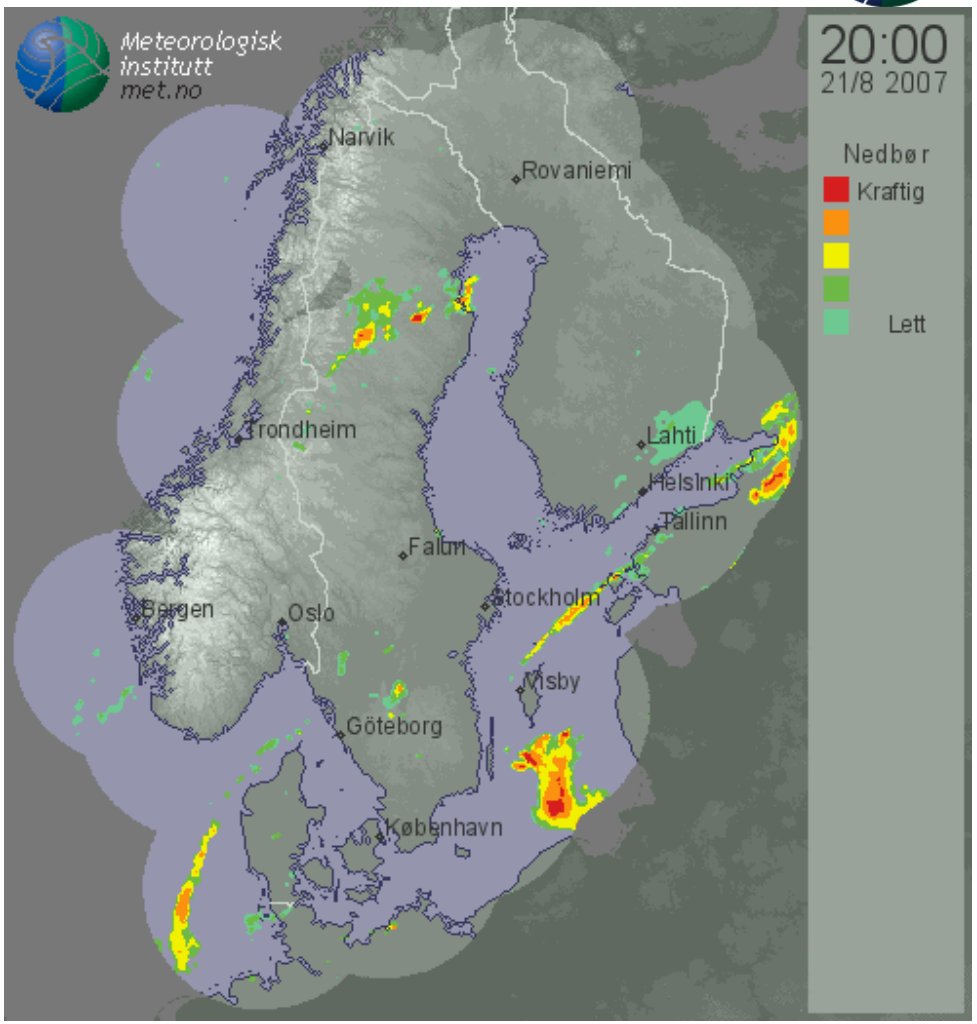
RCR 00 + 6h



AROME 00 + 6h

Problem-Case: Southern Finland, 22. Aug. 06-12

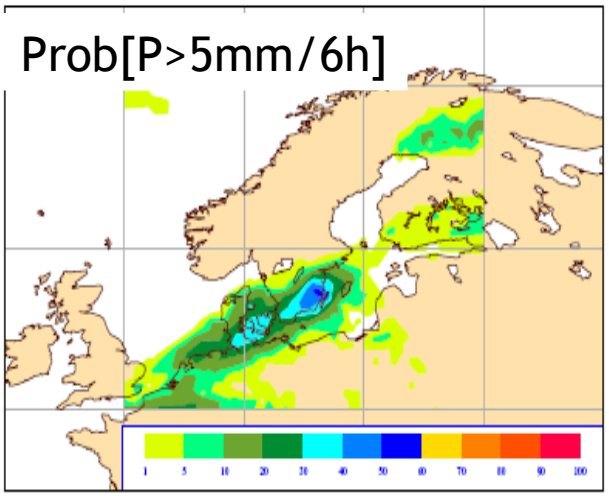




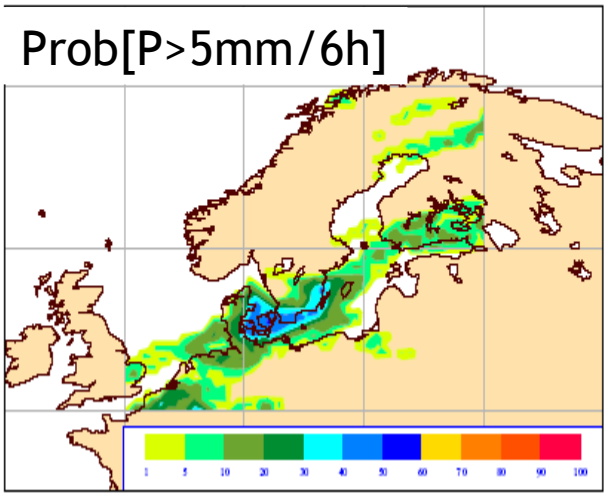
Cummulative Radar Echo

05-08 utc, 2007/08/22

OperEPS and TEPS/EPS +48

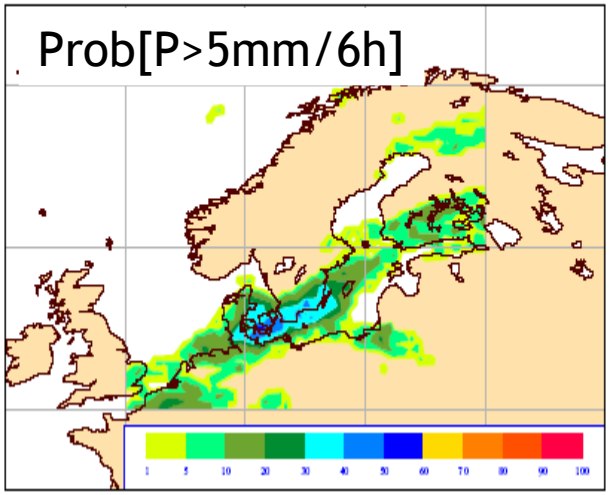


Operational EPS: NHSV



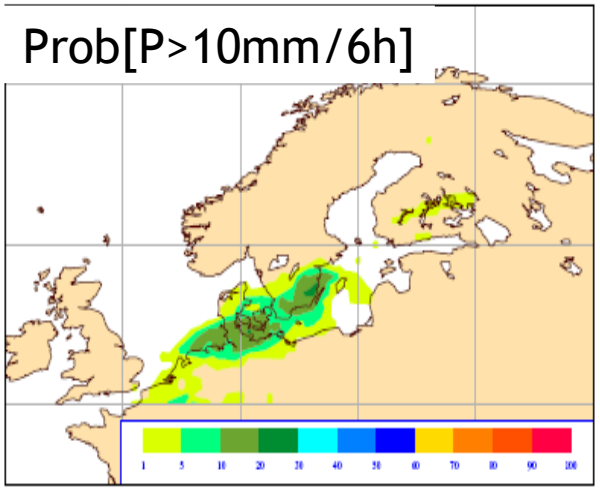
TEPS/EPS: Exp. 1

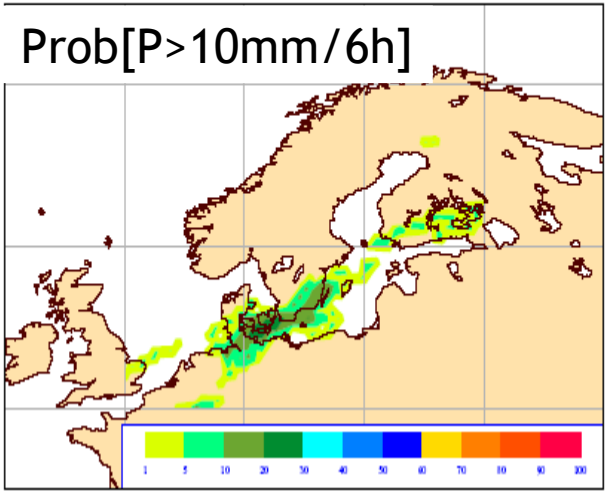
TSV*0.25 + NHSV

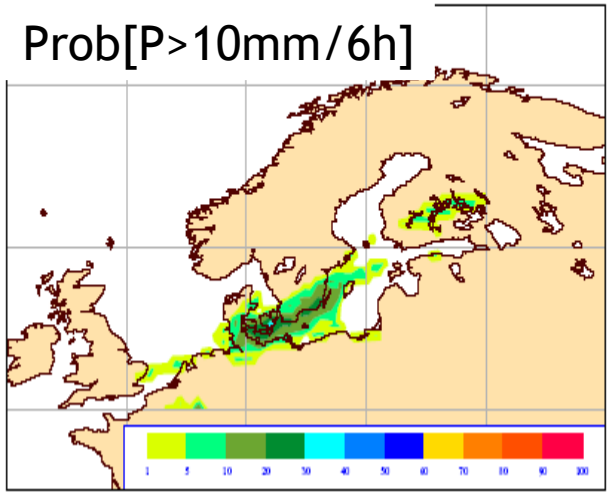


TEPS/EPS: Exp.2

TSV*0.50+NHSV*0.75



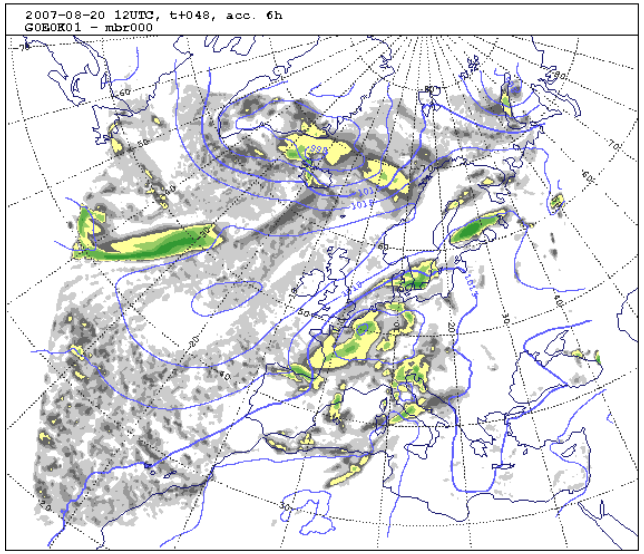




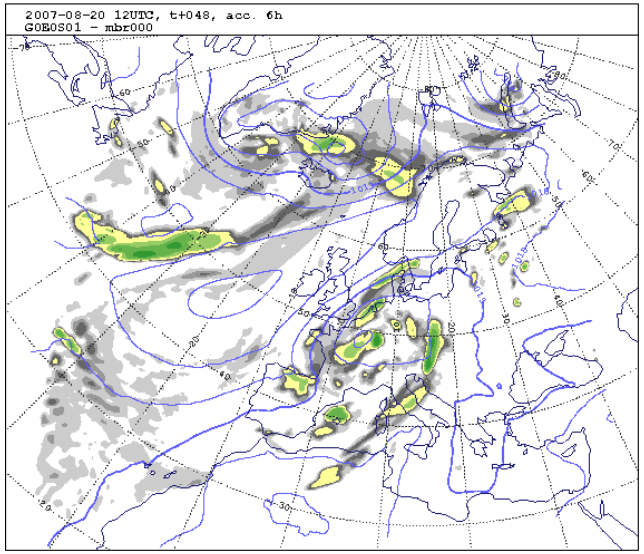
Downscaling EPS: HIRLAM (K. Sattler) ALADIN (S. Ivatek-Sahdan)

HIRLAM Control, 3DVar

RKKF

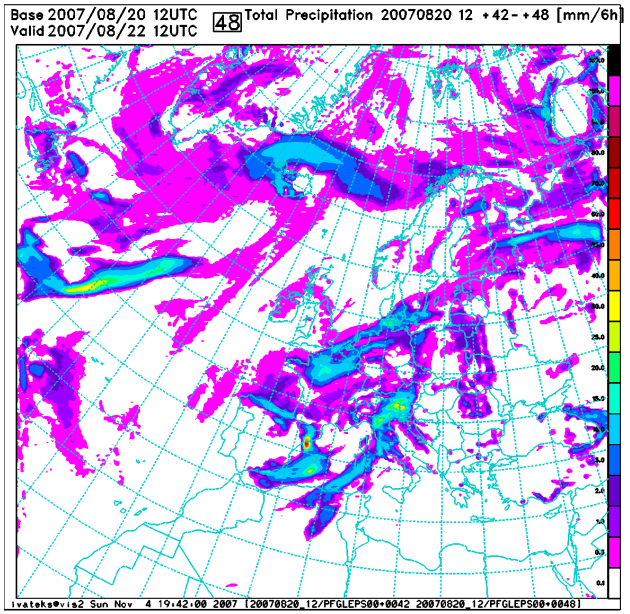


STRACO



6h Precip. 2007/08/21
12utc + 42-48h

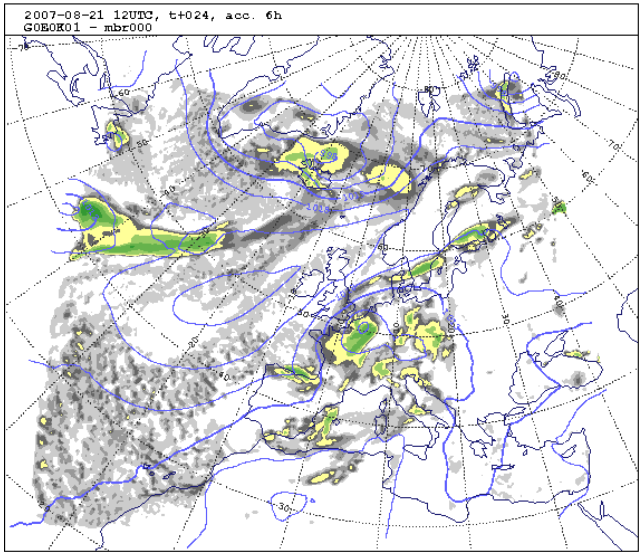
ALADIN Control downsc.



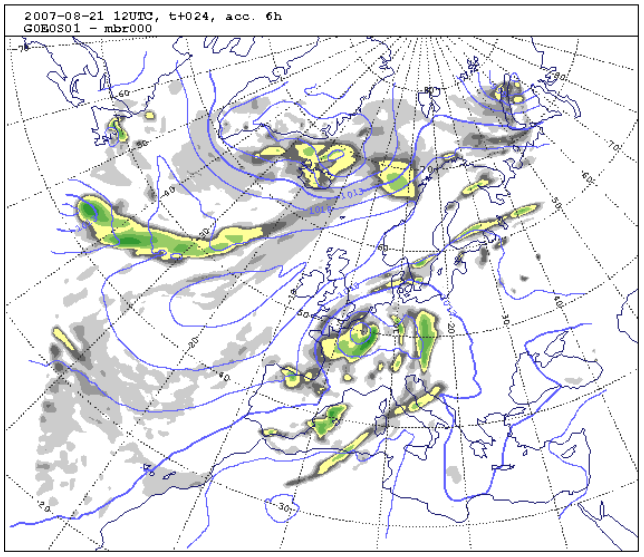
HIRLAM Control, 3Dvar

6h Precip. 2007/08/21
12utc + 18-24h

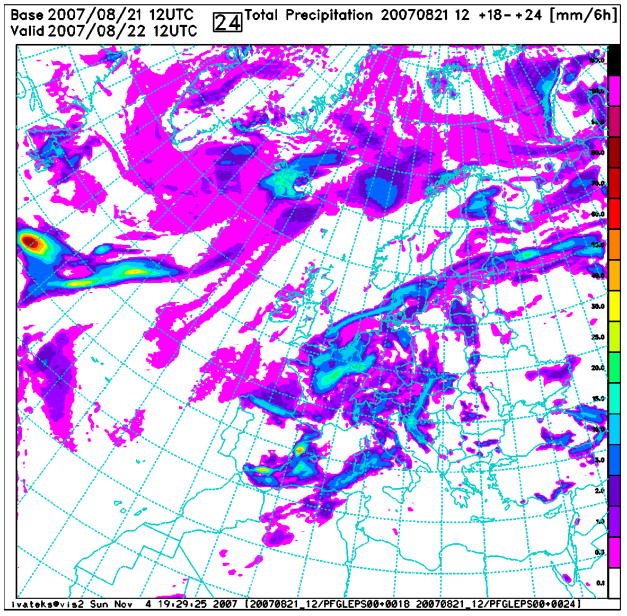
RKKF



STRACO



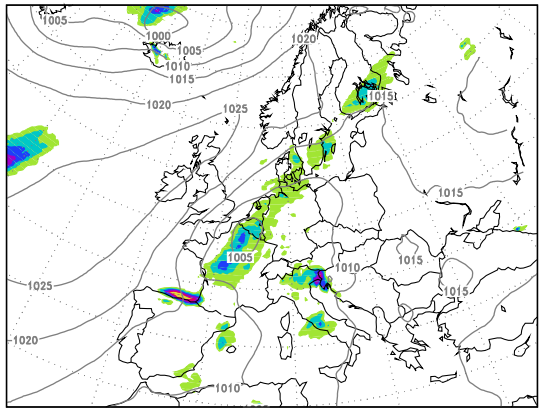
ALADIN Control, downsc.



Downscaling EPS with HIRLAM, 0.2 deg, (K. Sattler)

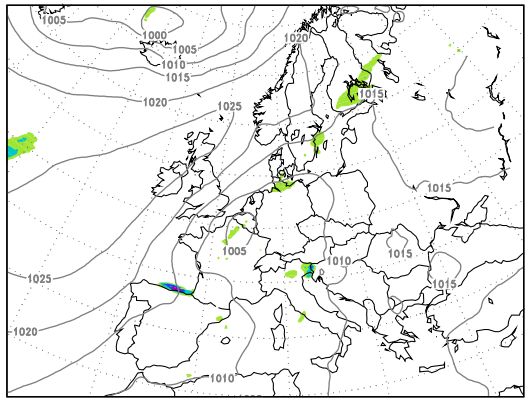
RKKF - cloud scheme: verif. at 2007/08/22 12utc

2007082012+048h: P[precip>5. mm]

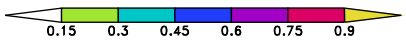


+42-48

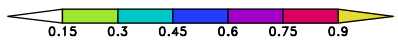
2007082012+048h: P[precip>10. mm]



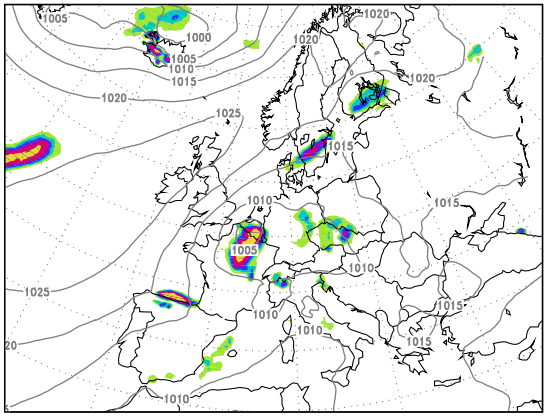
$\Pr[P > 5mm/6h]$



$\Pr[P > 10mm/6h]$

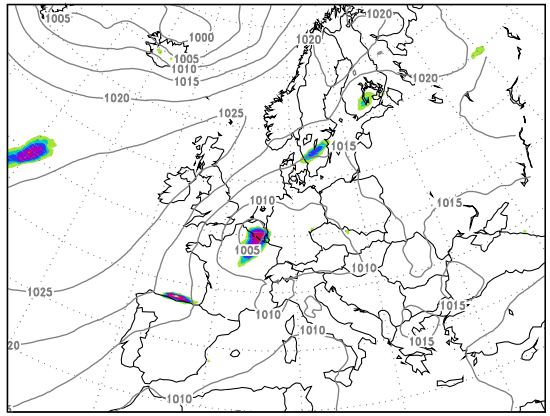


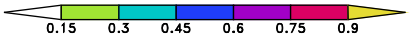
2007082112+024h: P[precip>5. mm]

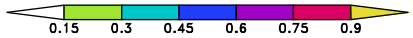


+18-24

2007082112+024h: P[precip>10. mm]

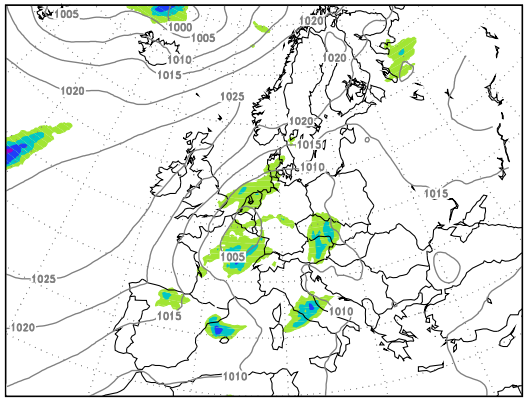




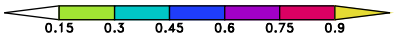


Downscaling EPS with HIRLAM, 0.2 deg,
Straco - cloud scheme: verif. at 2007/08/22 12utc

2007082012+048h: P[precip>5. mm]

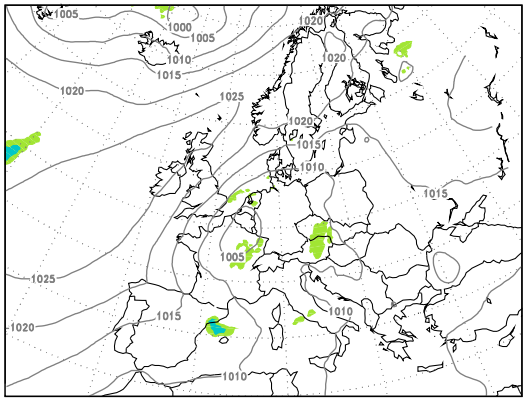


$\Pr[P > 5mm/6h]$

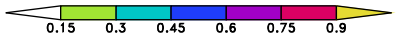


+42-48

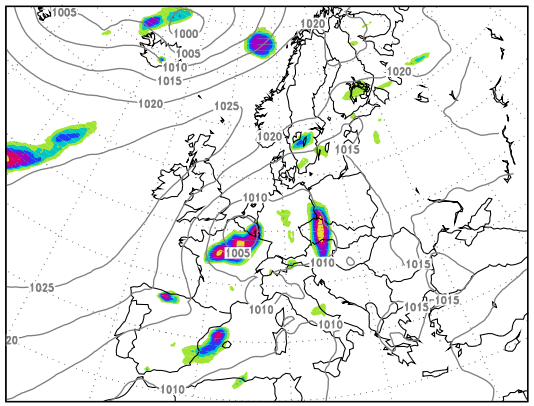
2007082012+048h: P[precip>10. mm]

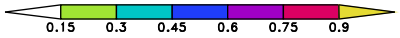


$\Pr[P > 10mm/6h]$



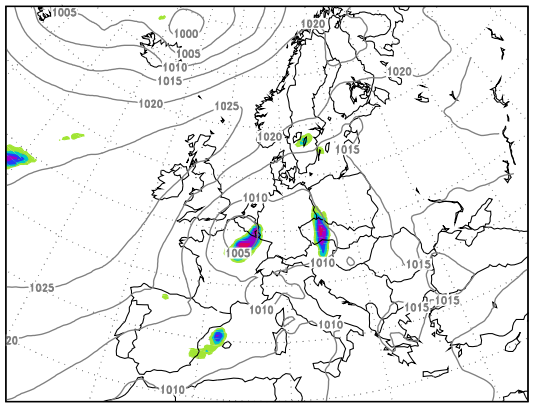
2007082112+024h: P[precip>5. mm]

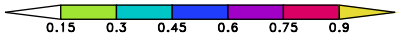




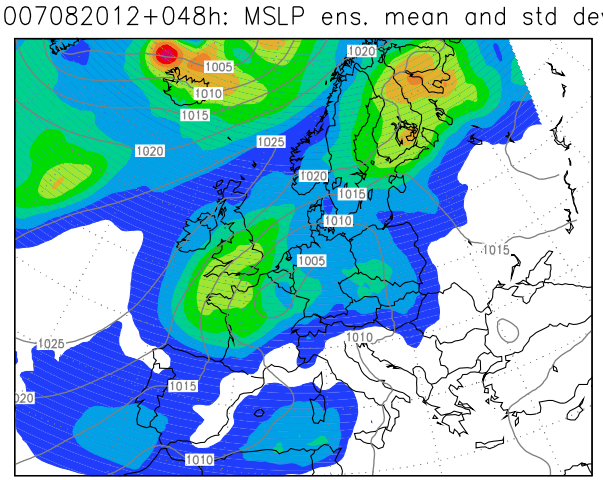
+18-24

2007082112+024h: P[precip>10. mm]

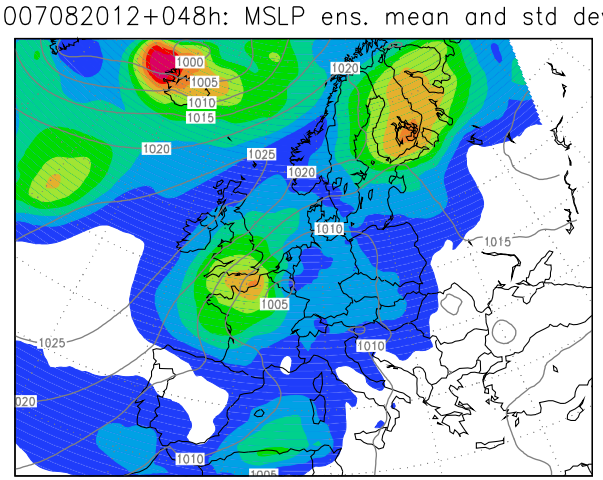




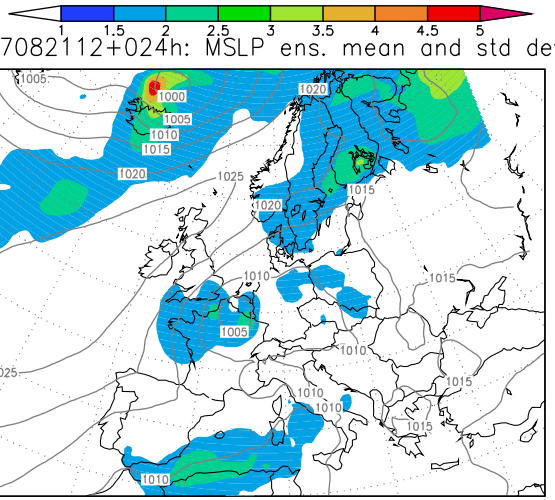
Downscaling EPS with HIRLAM, 0.2 deg,
MSLP, Ensemble mean and spread



+48

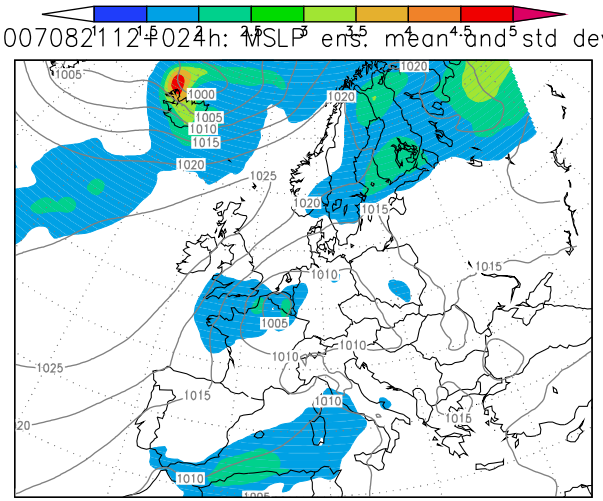


STRACO



+24

RKKF

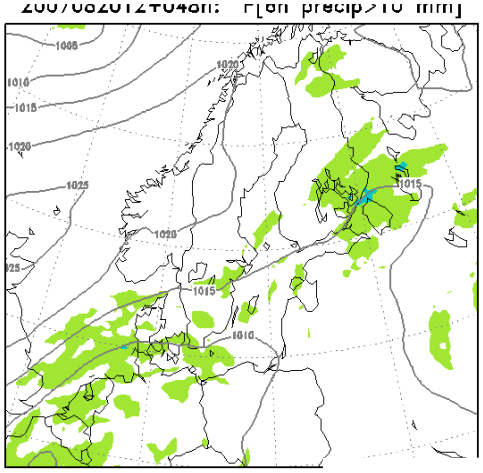


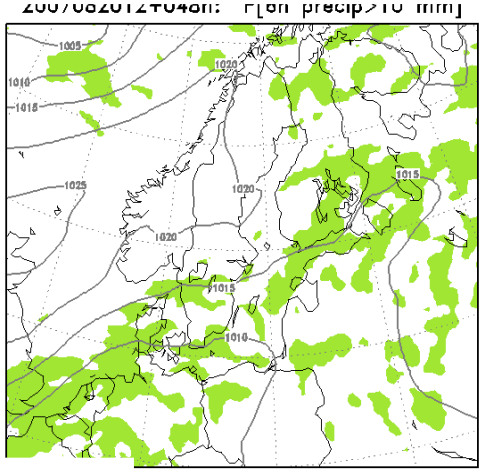
Convective tendency perturbation exp., H. Feddersen

HIRLAM

HIRLAM + Stochastic Physics

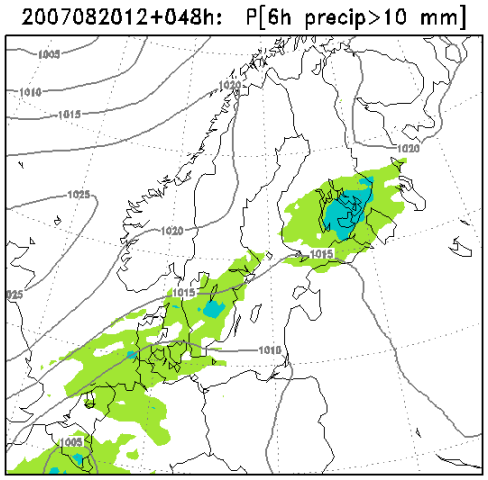
STRACO

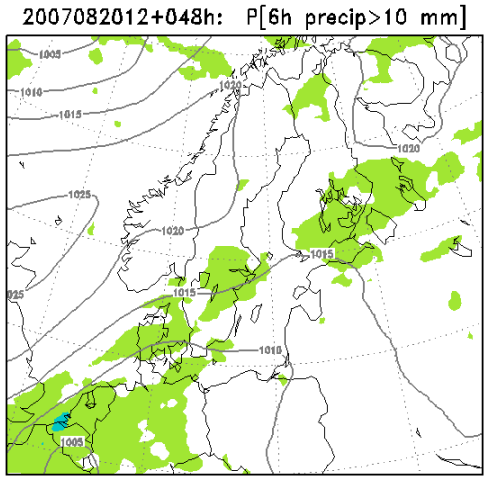




Prob[P(+42-+48)>10mm]

RKKF



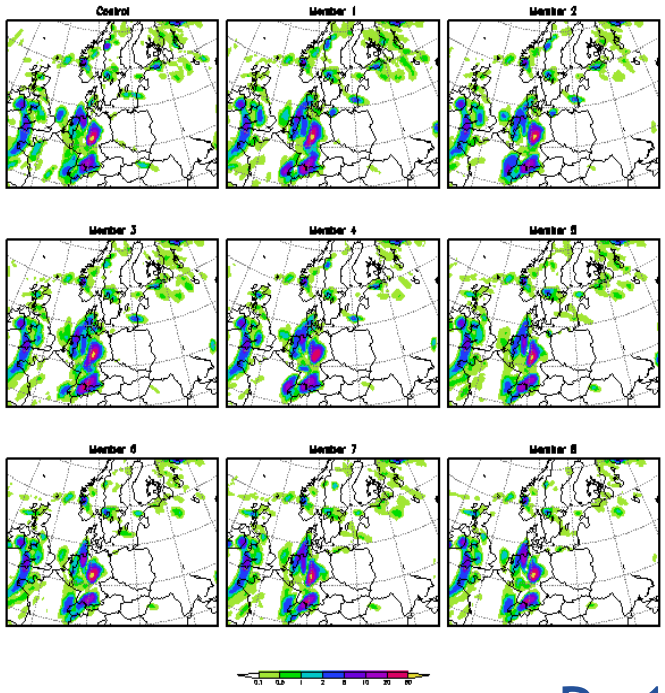


Parameter perturbations, HIRLAM_STRACO

	Experiment 1		Experiment 2			
	Min	Max	Min	Max	Control	
zcenfac0	3e-4	9e-4	1e-4	27e-4	5e-4	entrainment par. conv. cloud
zceva	0.3	0.9	0.1	2.7	0.35	evaporation of cloud water
zecoef	5e-4	15e-4	1.7e-4	45e-4	13e-4	evaporation/sublimation of precip

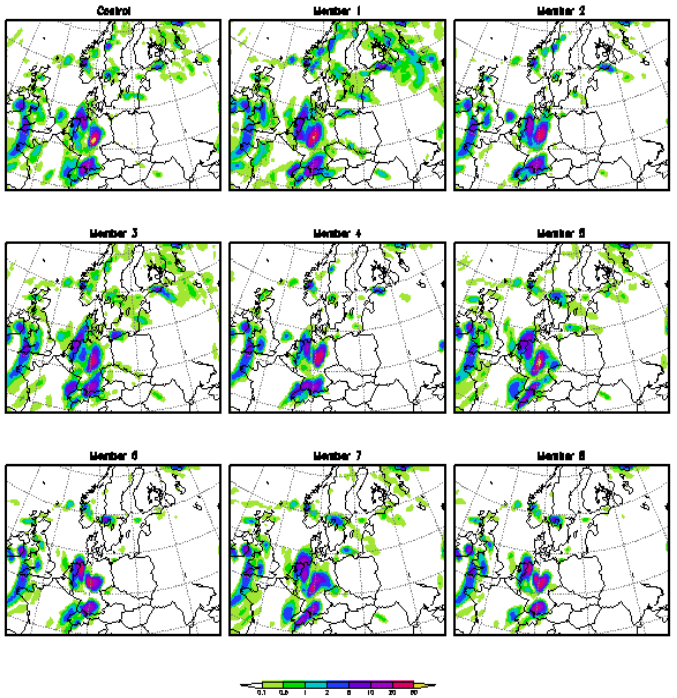
Experiment 1

20070620_12+24, 3hr accumulated precipitation
Identical initial conditions
Systematic STRACO parameter perturbations



Experiment 2

20070620_12+24, 3hr accumulated precipitation
Identical initial conditions
Systematic (but excessive) STRACO parameter perturbations



P, 12+(21-24)h

Summary:

- 72h TEPS with ECMWF IFS producing 21 members based on T159
  TSVs optimized over 24h, targeted to three European sub-domains, orthogonal to operational 48h NH SVs, and mutually orthogonalized.
  - **Recently updated to newest IFS Cycle released Nov 6. 2007 (very ”active”)**
  - **Full data sets for both HIRLAM and ALADIN are p.t. under production**

- HIRLAM 7.1.2 set up and run with 3D-Var for the control and downscaling and EPS-generated IC and LBC. Version with straco and rkkf schemes are run, producing 42 ensemble members in total (2 ”controls”).

- ALADIN is now set up to downscale TEPS members. Full EPS runs have been downscaled (LAEF, Austria). Also set up to downscale PEARP (Arpege).

- The Hppv presentation and validation package is now running at ECMWF.

- For synthesized probabilistic products, ALADIN-results are interpolated to HIRLAM rotated lat-lon grid.

- More work is needed to arrive at the best set-up of TSV and NHSV amplitudes w.r.t. the spread-skill and probabilistic scores.

- Calibration, and bias-correction (BMA?) await data.