GLAMEPS:

Grand Limited Area Model Ensemble Prediction System

Plans and present activities

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with contributions from

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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.

Basic Ideas in GLAMEPS

- *An array of LAM-EPS models or model versions:*
  - *Each partner runs a unique sub-set of ensemble members*
  - *Partners who run the same model version,*
    use different lower boundary data,
    or different initial and lateral boundary perturbations
  - *Partners who run with DA, produce 5 - 21 ensemble members*
    based on initial and lateral boundary perturbations
    (one control with DA + pairs of symmetric initial perturbations)
  - *Partners who do not run DA produce 6-20 ensemble members (pairs)*
- *Grid resolution*
  - *Now 22km, later: 11km or finer, now 40 levels, identical in all model versions (should be increased to at least 60)*
- *Forecast range*
  - 60h (shorter?) - starting daily from 00UT and 12 UT
- *A common pan-European integration domain*
  - *Or alternatively: a common overlap of a minimum size*

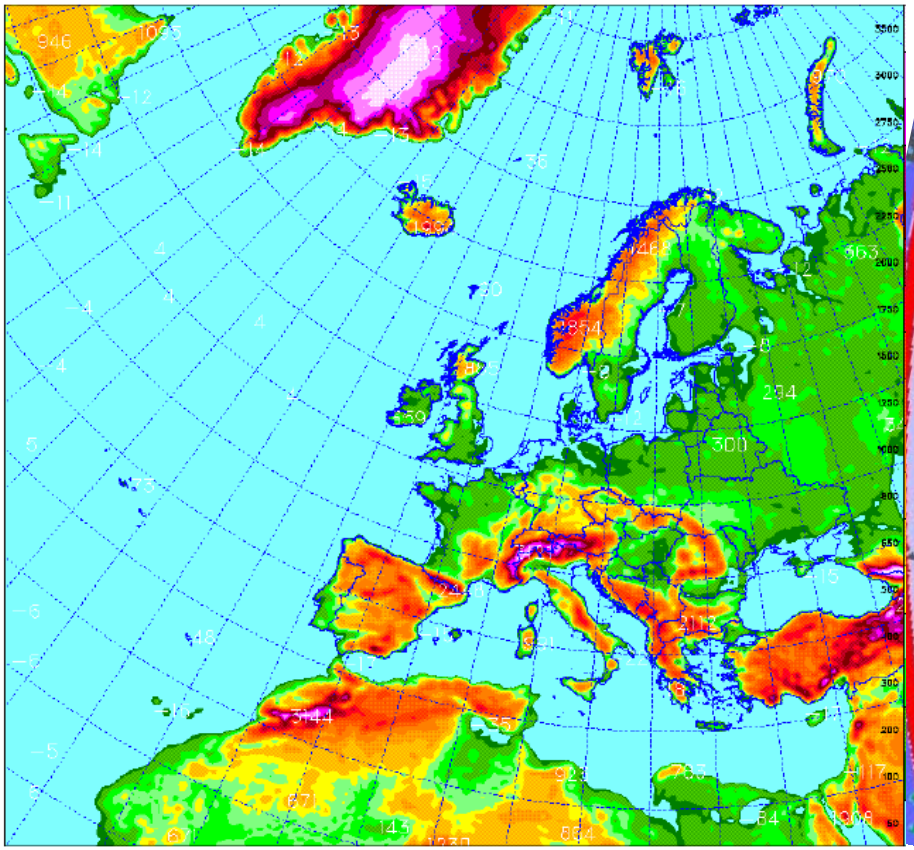
Aspects to consider

1. *Operational aspects*
   - *In particular data storage and Real-Time distribution*
2. *Constructing initial and lateral boundary perturbations*
   - *Fine-scale perturbations – importance of diabatic processes*
   - *Short range perturbation growth: also slowly growing modes may contribute*
     - *Imported global eps-members enhanced w.r.t. resolution, European target, moist physics*
     - *LAM-specific perturbations (SVs, ETKF)*
3. *Lower boundary data perturbations*
   - *Stochastic perturbations*
   - *Switch surface schemes*
   - *Targetted Forcing Singular Vectors or Forcing Sensitivities*
4. *Model perturbations*
   - *Switching models (e.g. Aladin, Hirlam, EC IFS)*
   - *Switching physical packages (e.g. Straco, RKKF, ECMWF-physics)*
   - *Stochastic perturbations*
   - *Forcing Singular Vectors*
5. *EPS-calibration and probabilistic validation*
6. *Post-processing, graphical presentation, products*
7. *Further downscaling to meso- and convective scales*

GLAMEPS Common Domain (proposal)

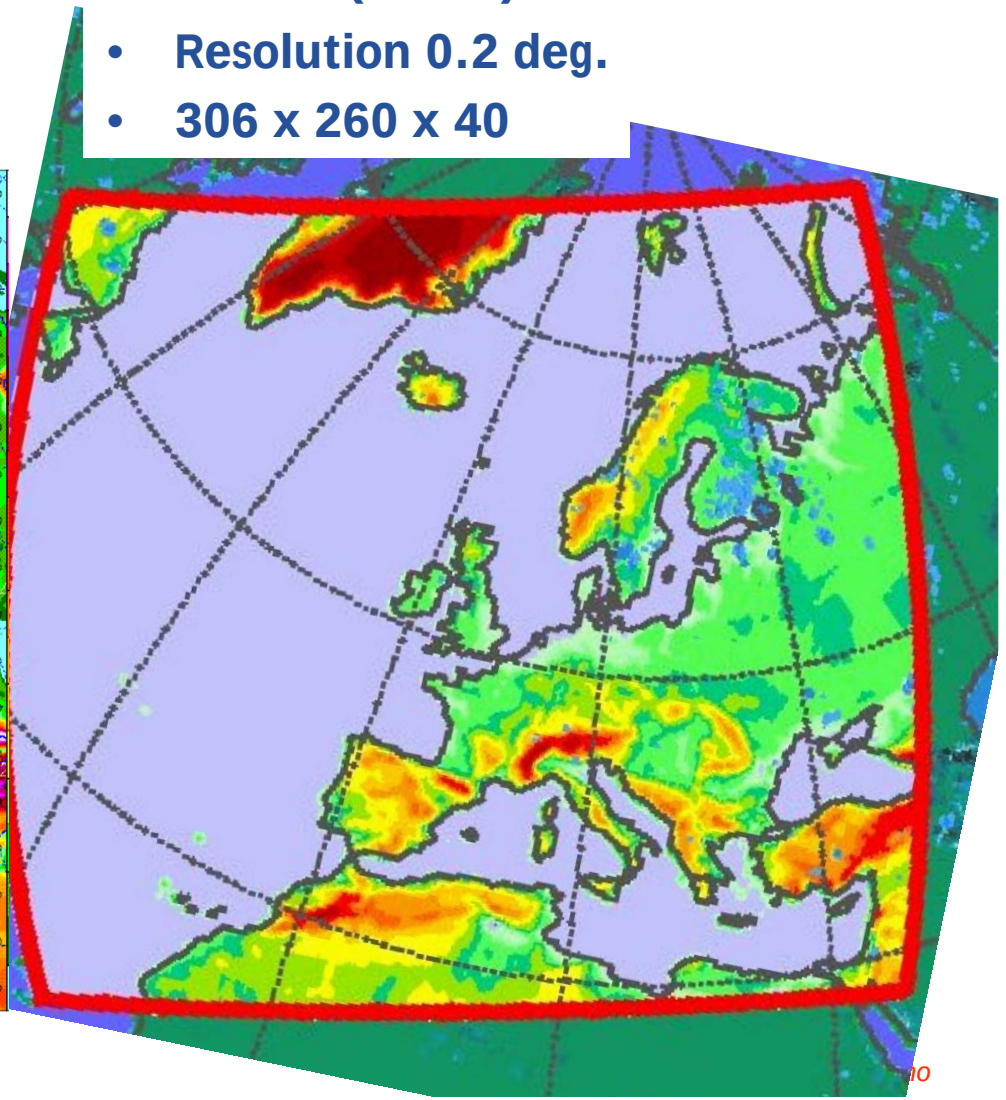
ALADIN

- Resolution: 22km
- 320 x 300 x 37



HIRLAM (EPS71)

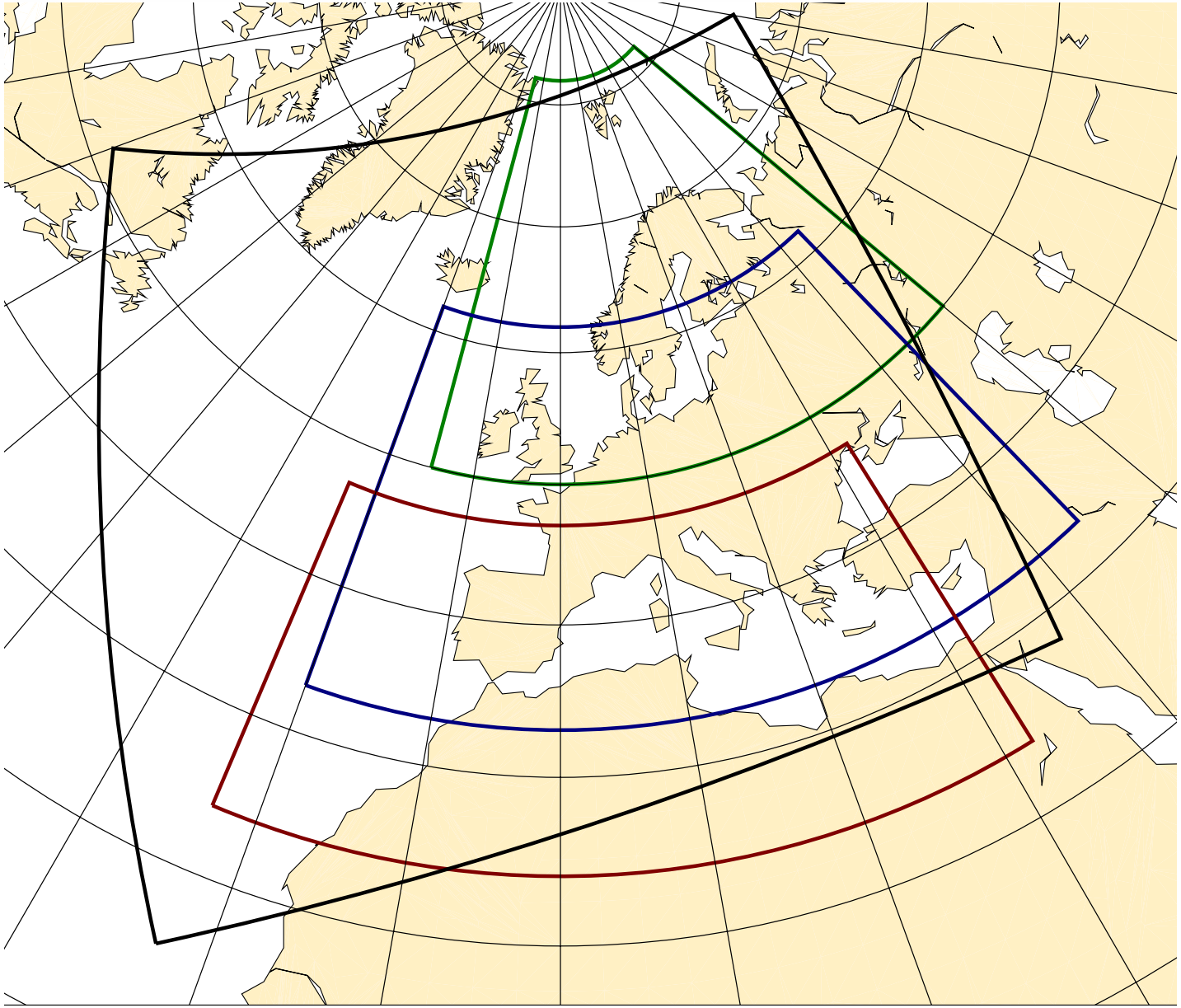
- Resolution 0.2 deg.
- 306 x 260 x 40



GLAMEPS_v0: Laboratory at ECMWF

- A small set of equally valid models - yet significantly different
  - 3 different models / model versions:
    - ALADIN, HIRLAM STRACO, HIRLAM RKKF
- Initial/lateral boundary perturbations (Leutbecher, 2007)
  - ECMWF "TEPS for Europe": define SVs targeted to 3 domains (TSVs); All TSVs are orthogonal to operational NH SVs (EPS); and mutually
    - TSVs: OT=24h, T159L62, (not yet diabatic)
  - Use: 30 TSVs and 50 NH SVs,
  - Gaussian sampling to 20 members + control
  - Different amplitudes is assigned to the range of SVs, to give the desirable spread/skill relation
- Products; Quality and Value
  - INM package based on Magics / Met View
  - Predictability of the day, event risks
  - Reliability, Rank histograms, BSS, ROC, Value, ...
- Probabilistic estimation (e.g. BMA and other Bayesian techniques),
  - Not started yet

TEPS FOR EUROPE (I.-L. Frogner)



GLAMEPS integration domain
(HIRLAM version)

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

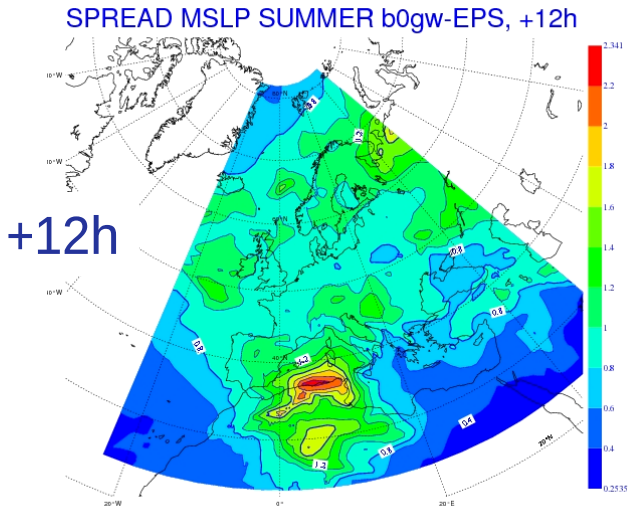
Target area central
(62N,20W,33N,44E)

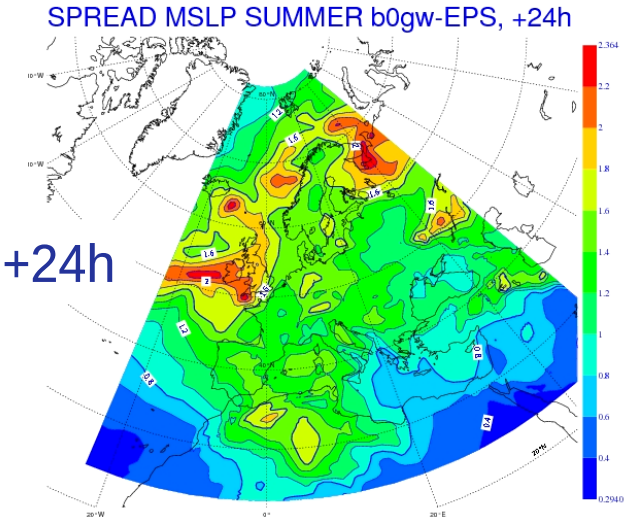
Target area south
(47N,23W,24N,32E)

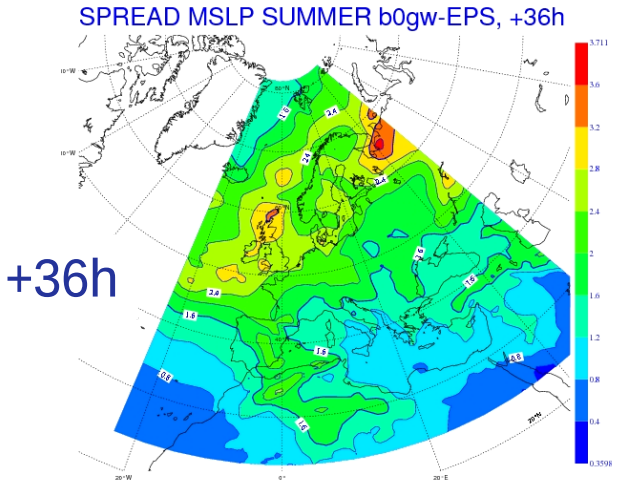
EXPERIMENTS

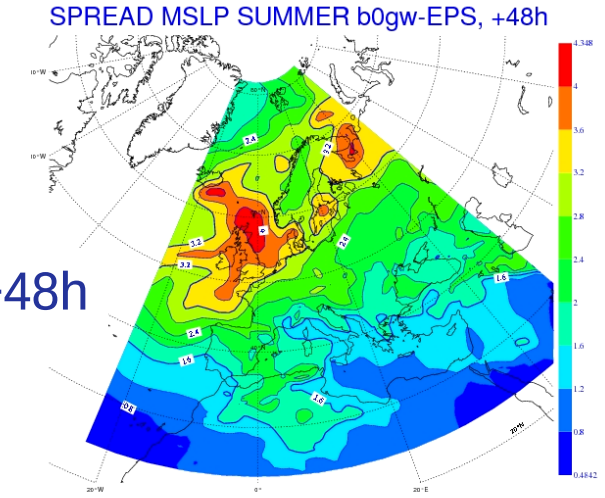
- 21 days in summer 2007:
  - 20070618-20070624, 20070808-20070814 and 20070820-20070826
- The amplitude of NH SVs is kept as in EPS for the first experiment: 0.020
- The amplitude of TSVs from the three target areas for the first experiment: 75% reduced
  - Still under adjustment!

RMS Difference in spread between European TEPS and EPS over the 21 cases







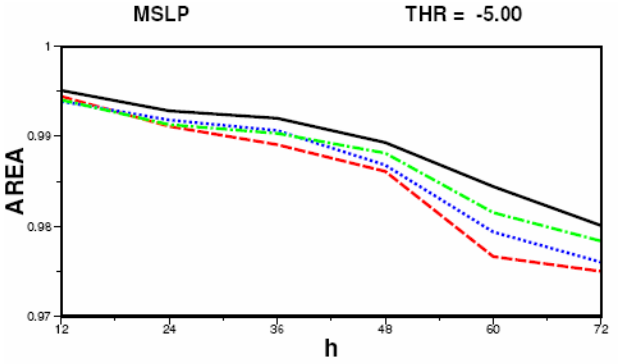


Skill scores MSLP (example)

21 summer cases 2007

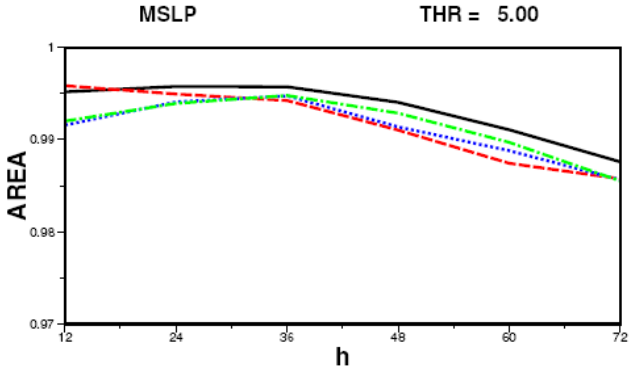
- Black: EPS, 50 members
- Green: EPS 20 members
- Blue: European TEPS, 20 members (75% red. TSVs)
- Red: Norwegian TEPS, 20 members

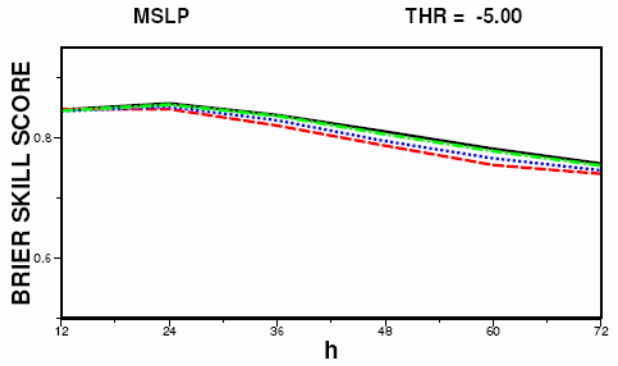
Event: anom < -5 hPa



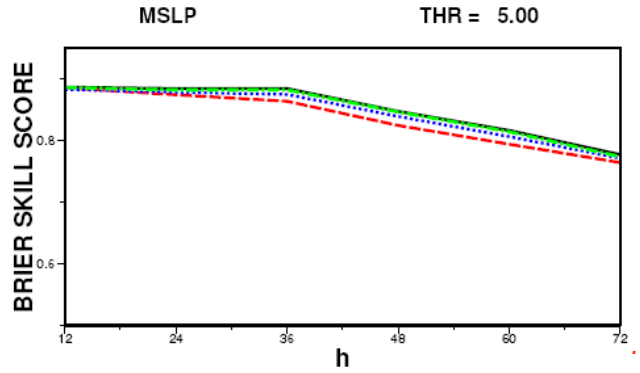
ROC area

Event: anom < +5 hPa





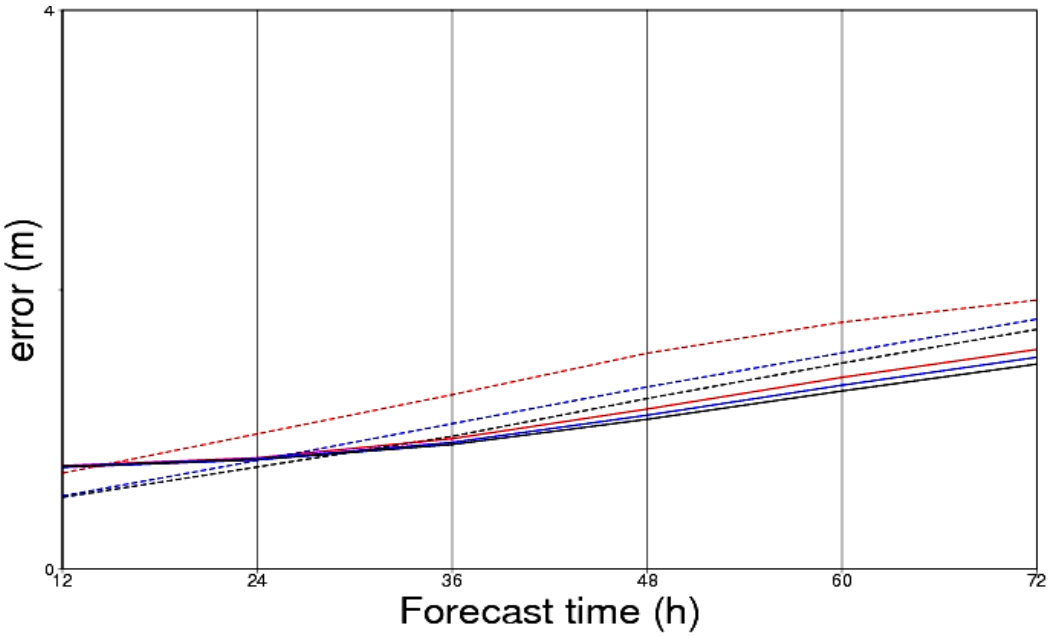
BSS



.no

Spread/Skill relationship

MSLP, 21 summer cases 2007



---- spread around EM, Norwegian TEPS

---- spread around EM, European TEPS

---- spread around EM, EPS

___ error of EM, Norwegian TEPS

___ error of EM, European TEPS

___ error of Ensemble Mean (EM), EPS

More experiments needed

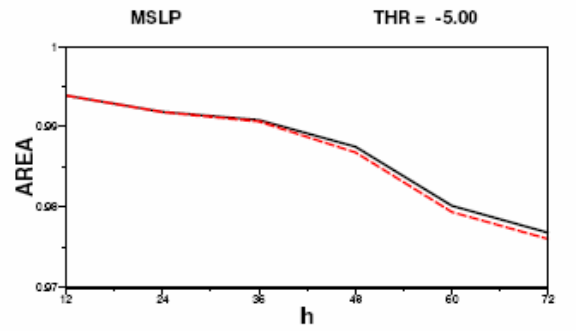
- amplitude configurations
- More parameters
- More cases

Skill scores MSLP (example)

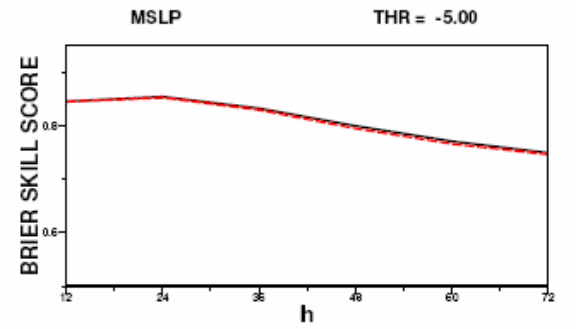
21 summer cases 2007

- Black: TSVs 60% Reduced
  NH SVs 10% Reduced
- Red: TSVs 75% Reduced
  NH SVs unchanged

Event: anom < -5 hPa

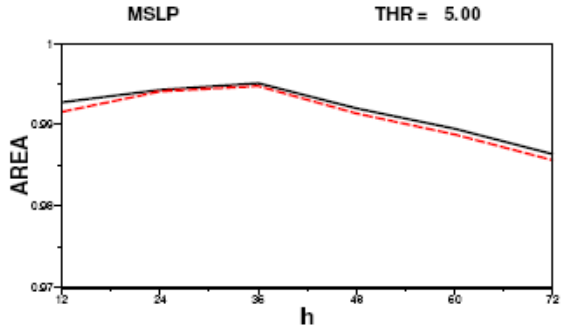


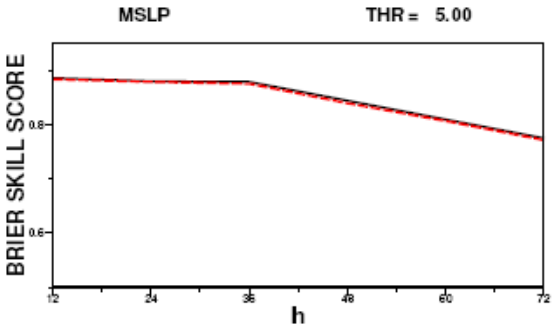
ROC area



BSS

Event: anom < +5 hPa





Case: 28/06/2006

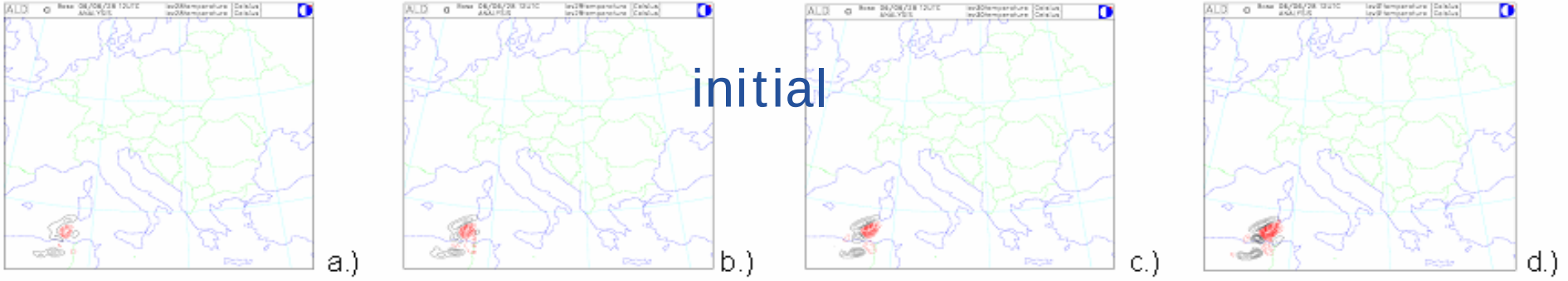
ALADIN SVs, OT=12h (E. Hagel and R. Mladek)

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

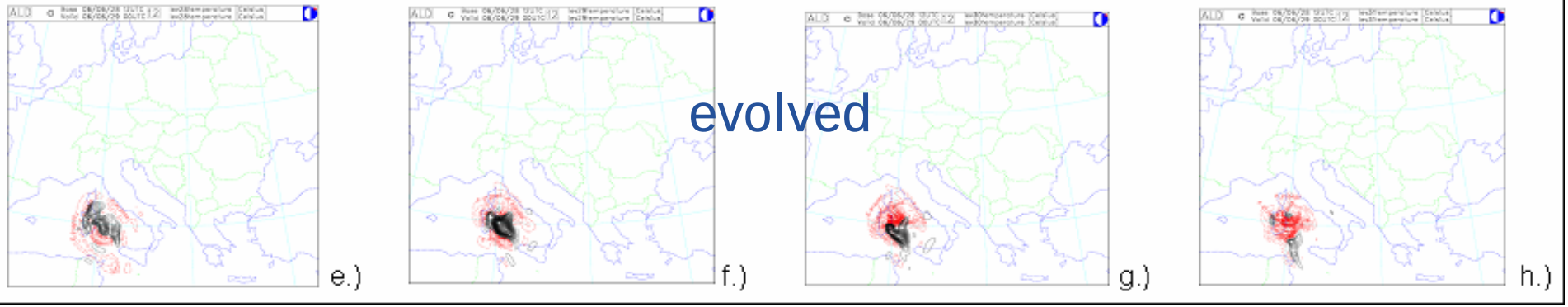
Opt. area

28 29 30 31

initial



evolved



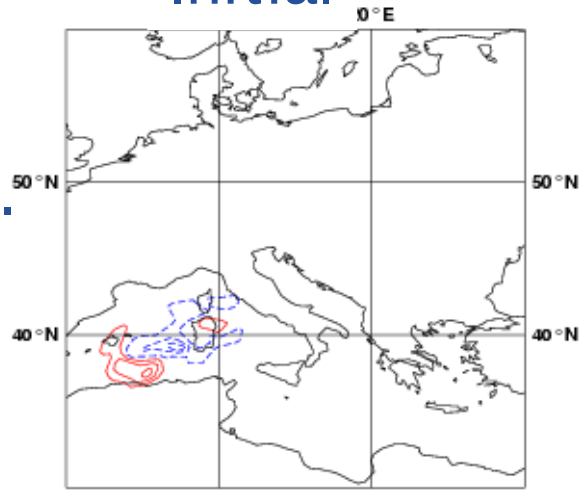
HIRLAM SVs OT_12h (R. Stappers and J. Barkmeijer)

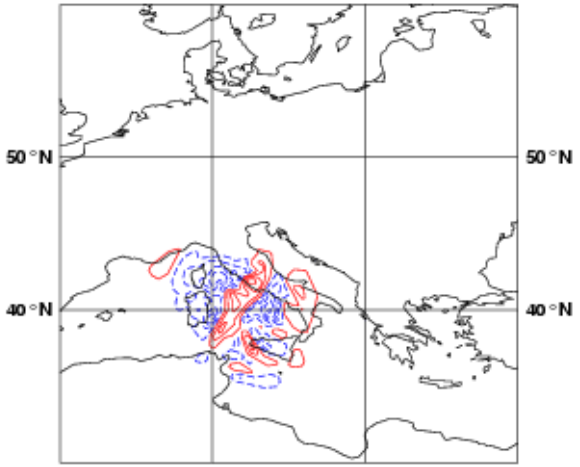
Leading singular vector at model level 19 (500 hPa)
(using the same temperature contour interval and unit wind vector).

Initial

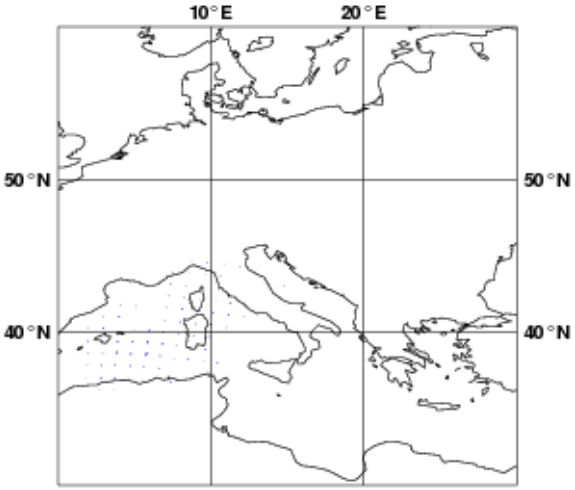
Evolved

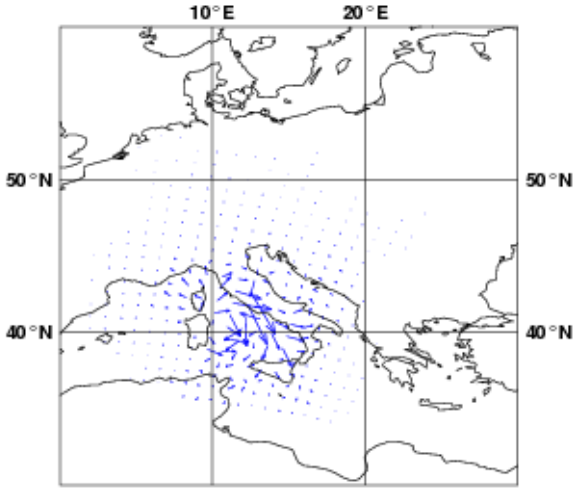
Temp.



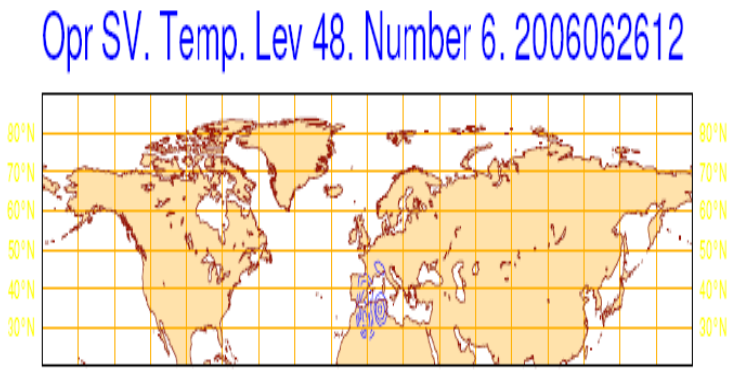


Wind

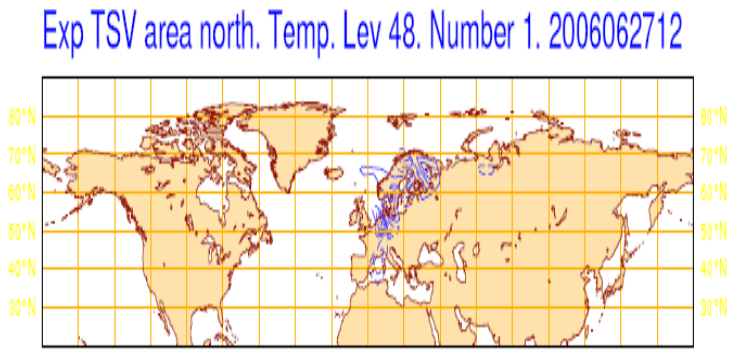




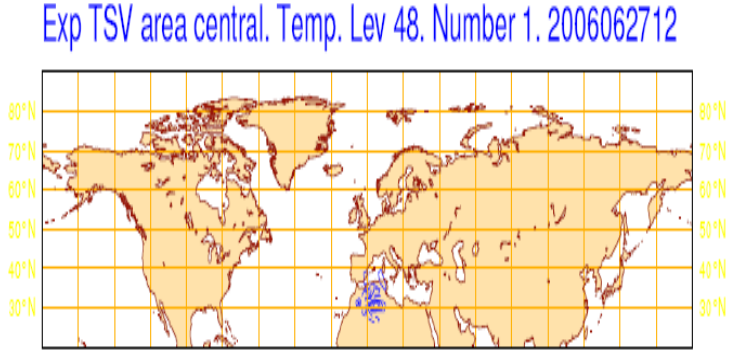
NH SVs 48h and TSVs 24h, target time: 2006/06/28 12utc.
T ~850 hPa



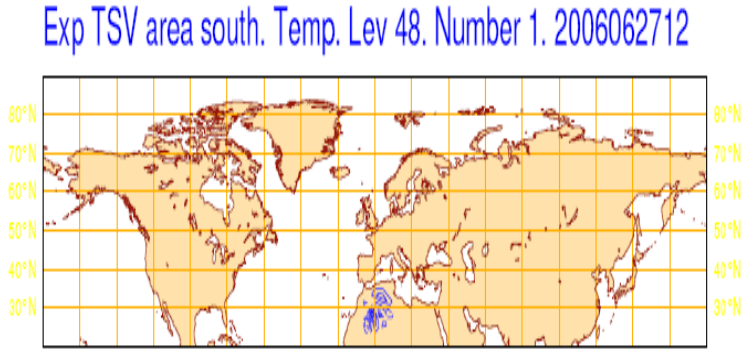
NHSV_6



TSV-north_1

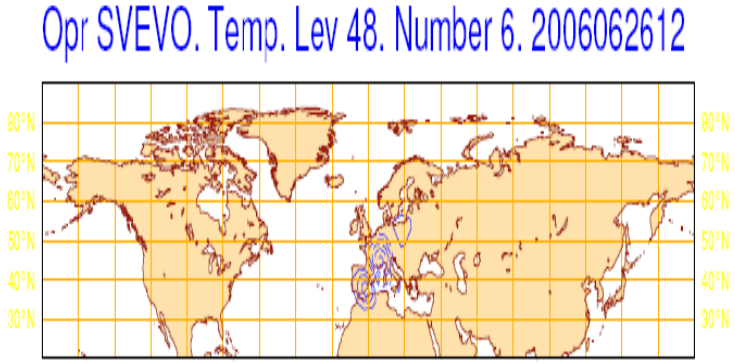


TSV-central_1

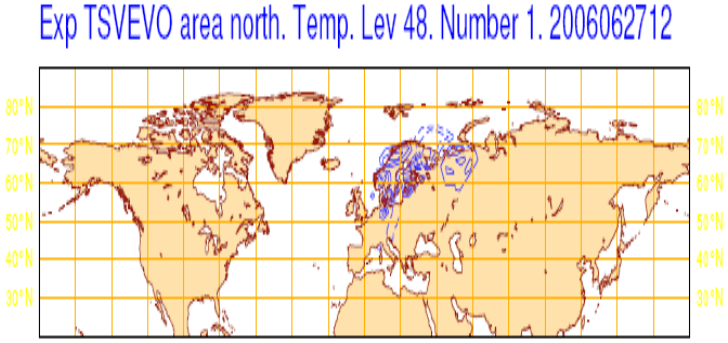


TSV-south_1

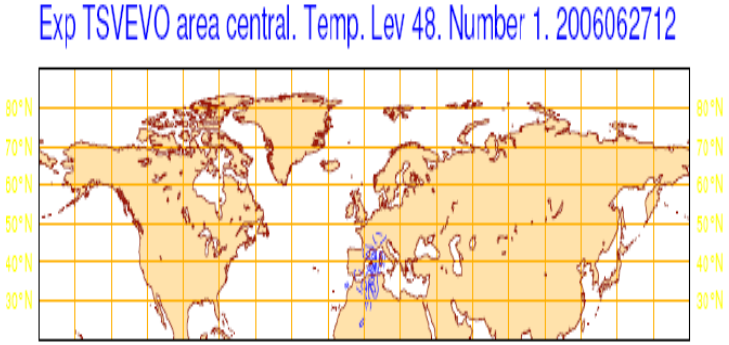
NH SVs 48h and TSVs 24h, target time: 2006/06/28 12utc.
T ~850 hPa; Evolved



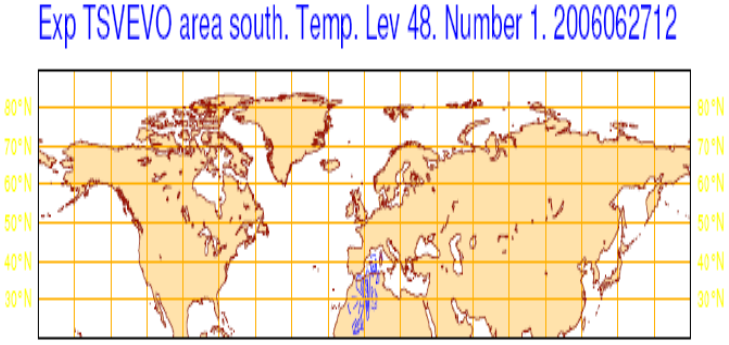
NHSV_6



TSV-north_1

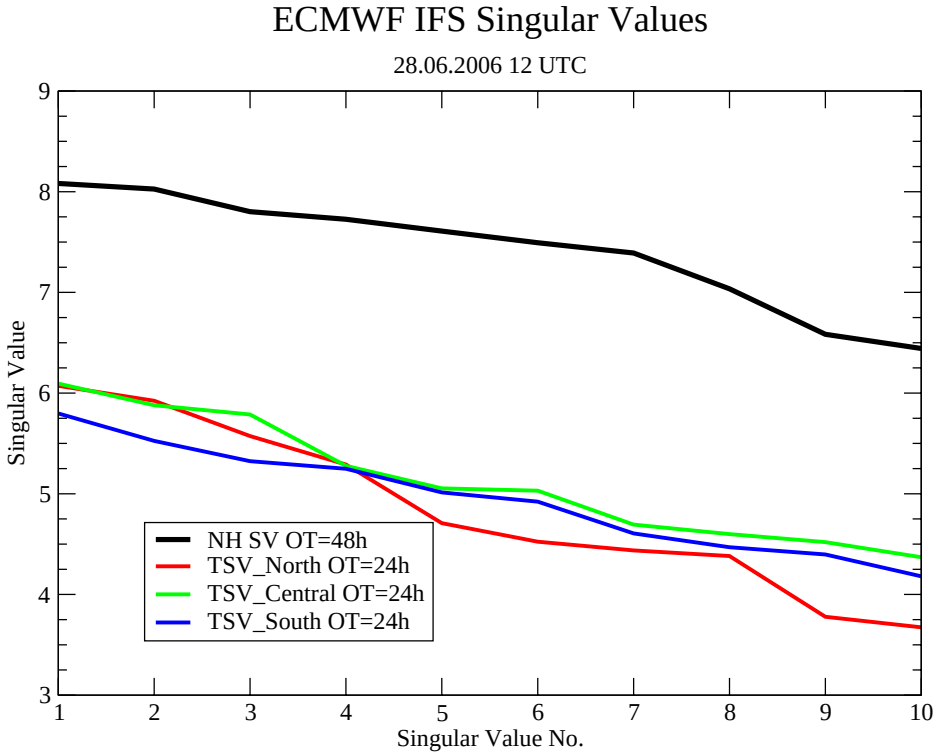


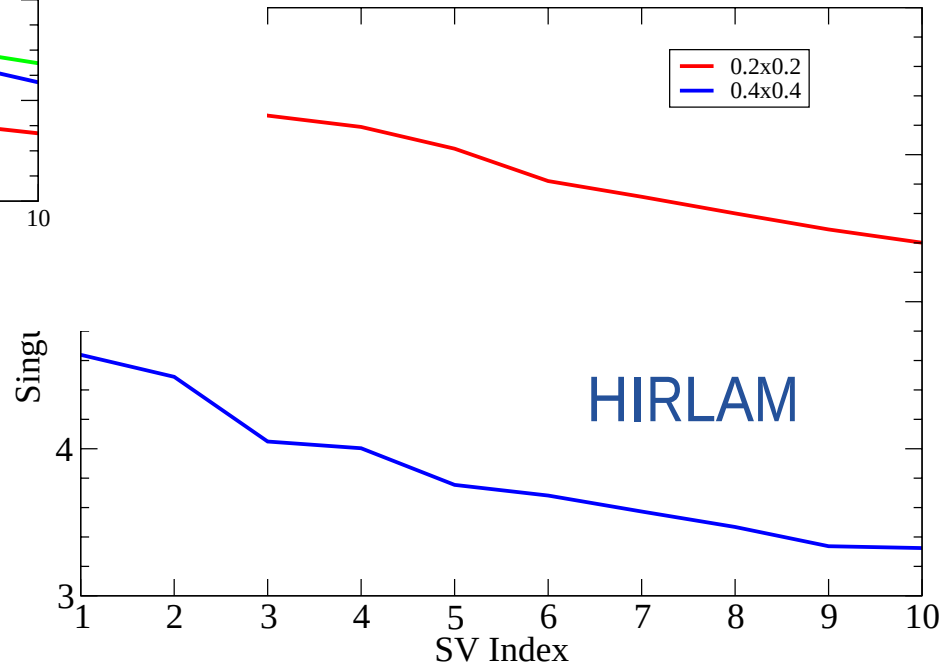
TSV-central_1



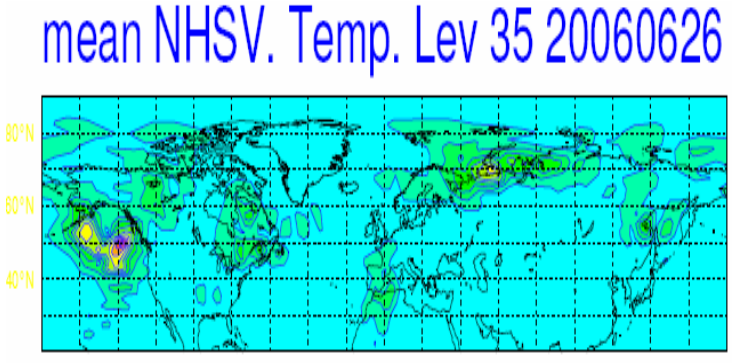
TSV-south_1

28/06/2006 Singular values

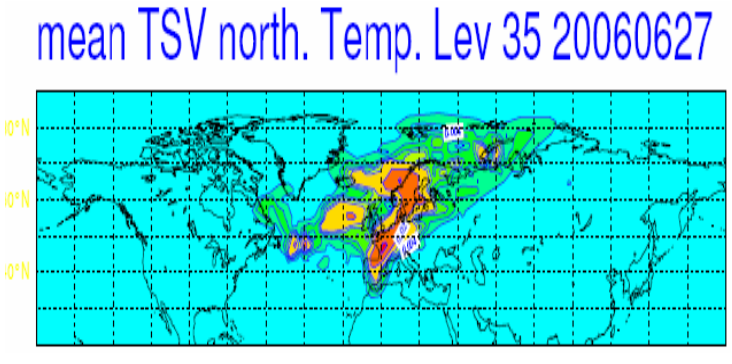




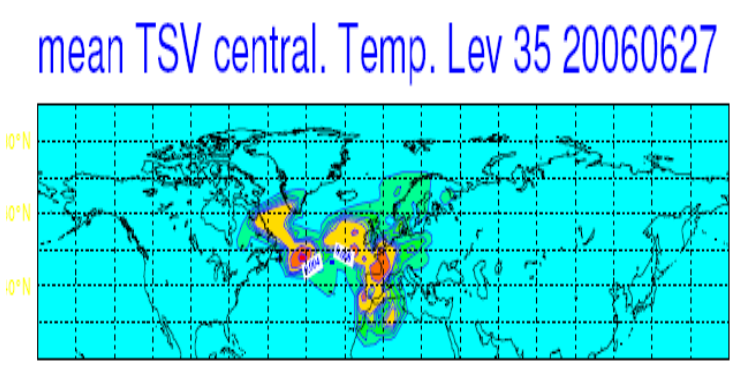
NH SVs 48h and TSVs 24h, target time: 2006/06/28 12utc.
T ~850 hPa



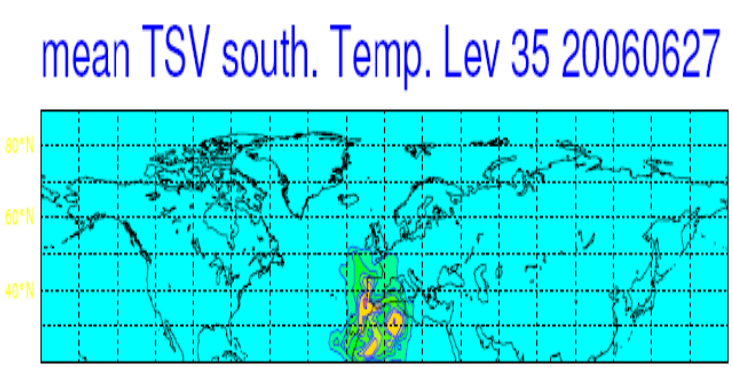
NHSV_1-10



TSV-north_1-10



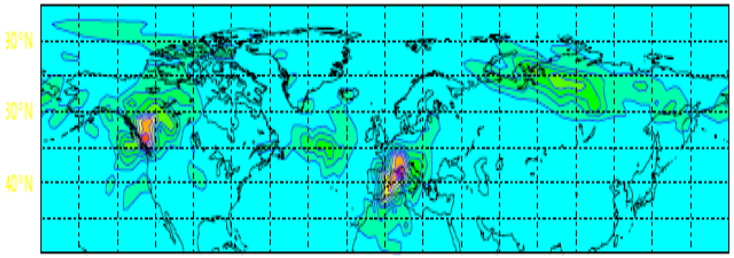
TSV-central_1-10



TSV-south_1-10

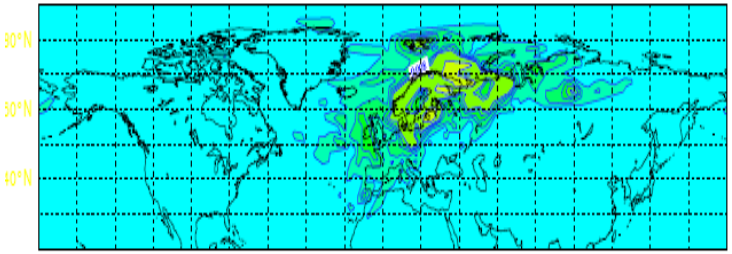
NH SVs 48h and TSVs 24h, target time: 2006/06/28 12utc.
T ~850 hPa, Evolved

mean NHSVEVO. Temp. Lev 48 20060626



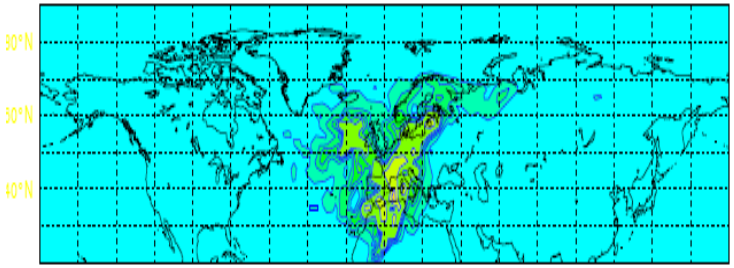
NHSV_1-10

mean TSVEVO north. Temp. Lev 48 20060627



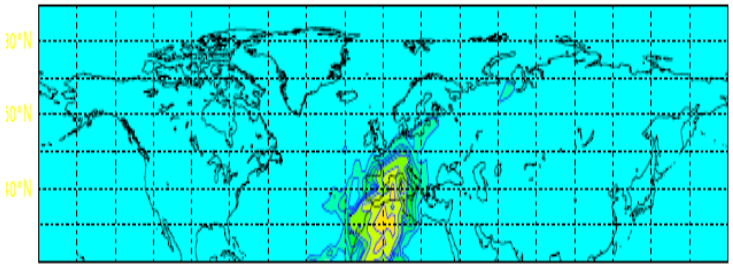
TSV-north_1-10

mean TSVEVO central. Temp. Lev 48 20060627



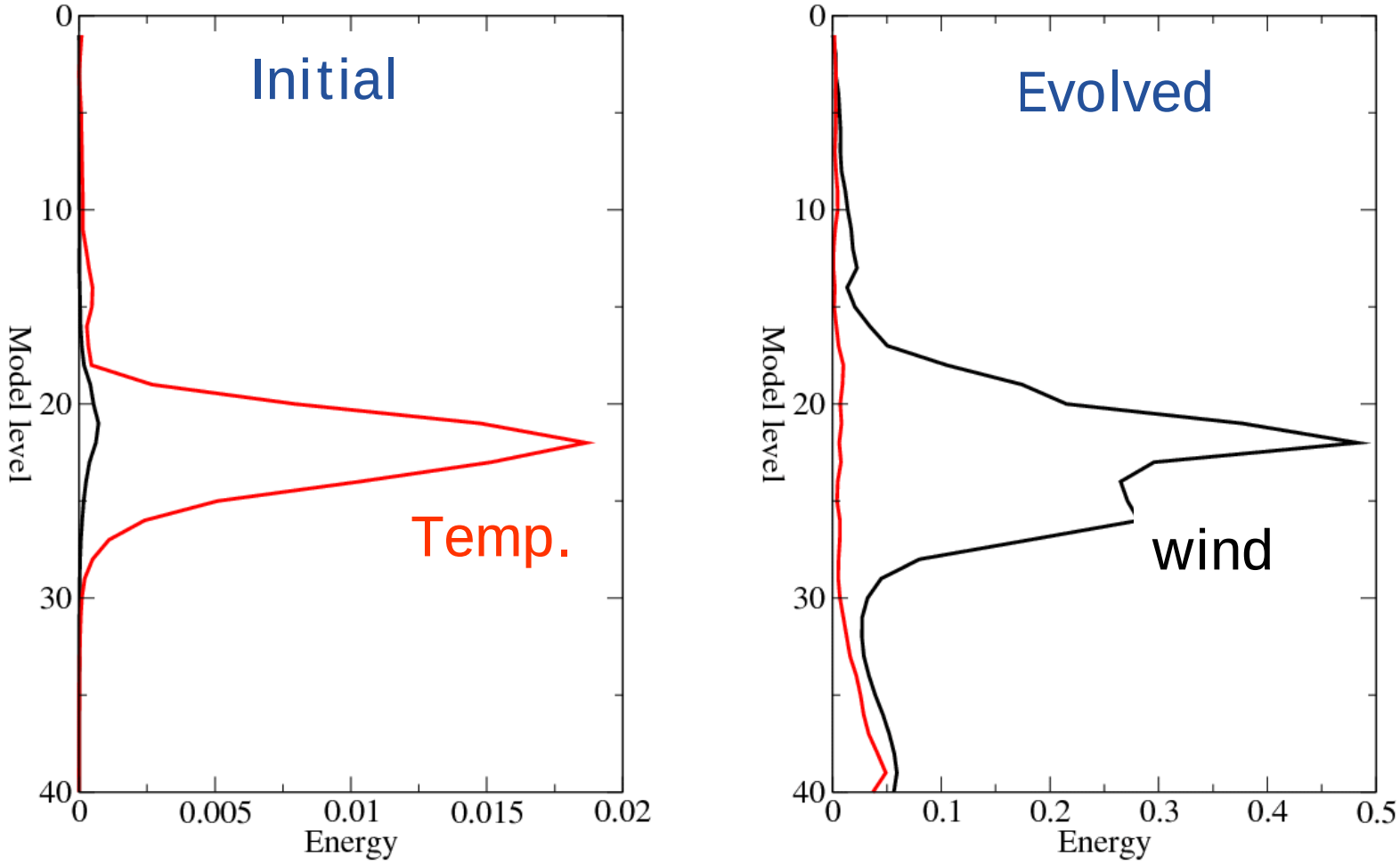
TSV-central_1-10

mean TSVEVO south. Temp. Lev 48 20060627



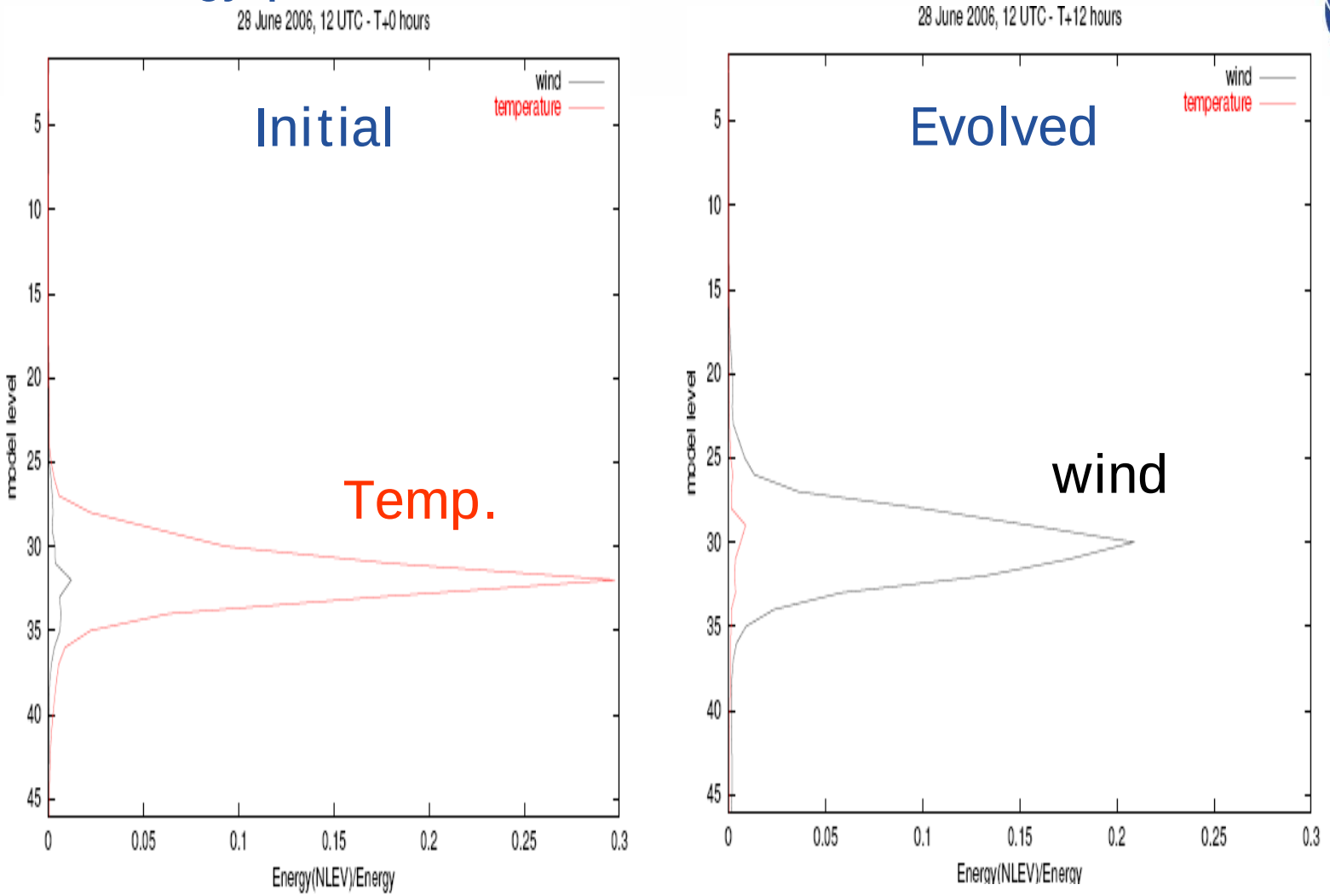
TSV-south_1-10

Energy profiles, HIRLAM-SV no.1, 2006/06/28 03utc



Notice the difference in scaling of the horizontal axis.

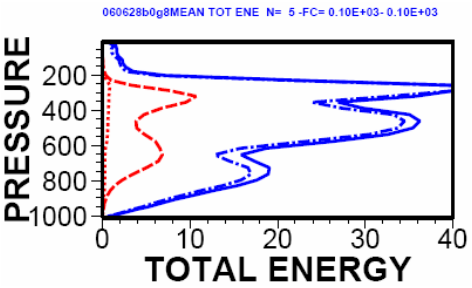
Energy profiles, ALADIN-SV no.1, 2006/06/28 12utc

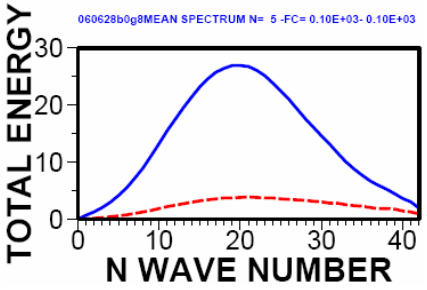


Vertical energy distribution of the leading singular vector for the wind (black) and temperature field (red) at initial (left) and final time(right).

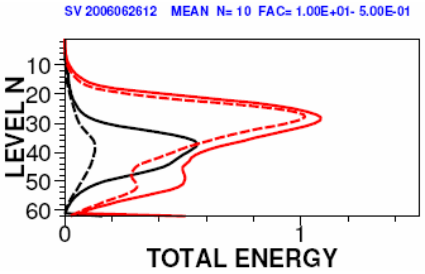
Energy profiles, 2006/06/28

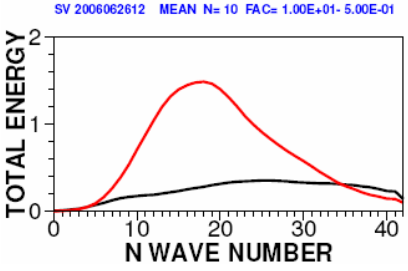
ECMWF SV 1-5, OT12h



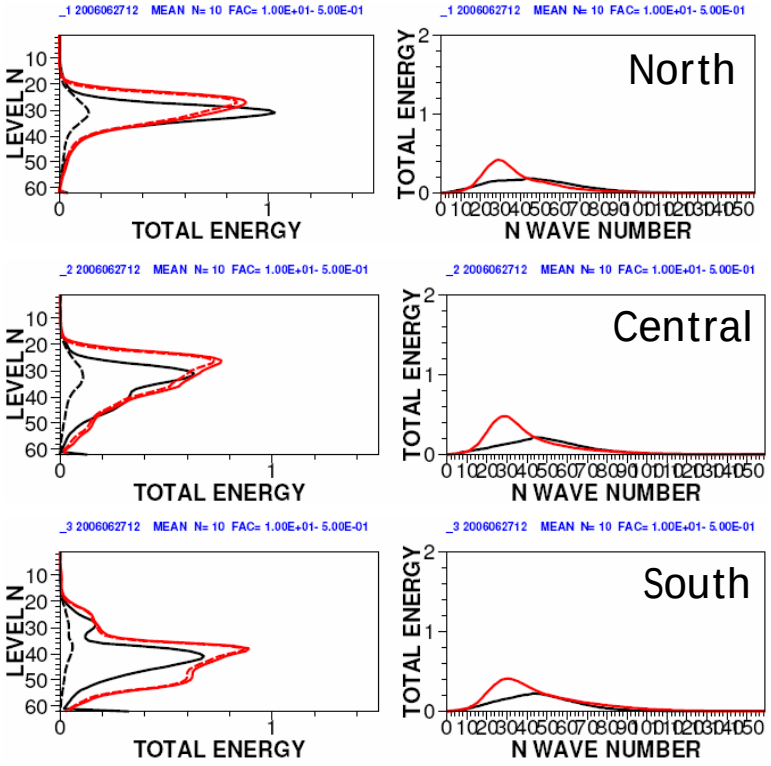


ECMWF Operational SV 1-10, OT=48h





ECMWF TSV 1-10, OT24h



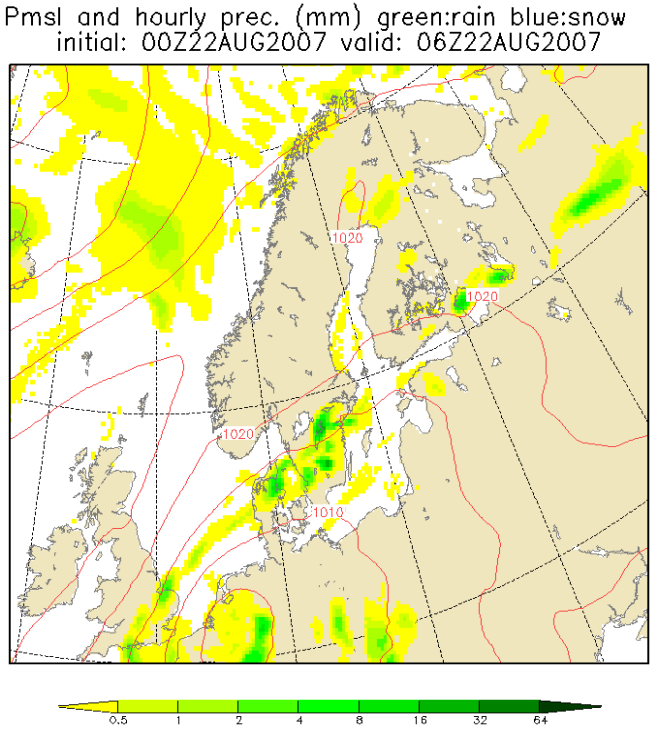
”The Finnish case”

Wed, August 22, 2007 ~07-09 utc

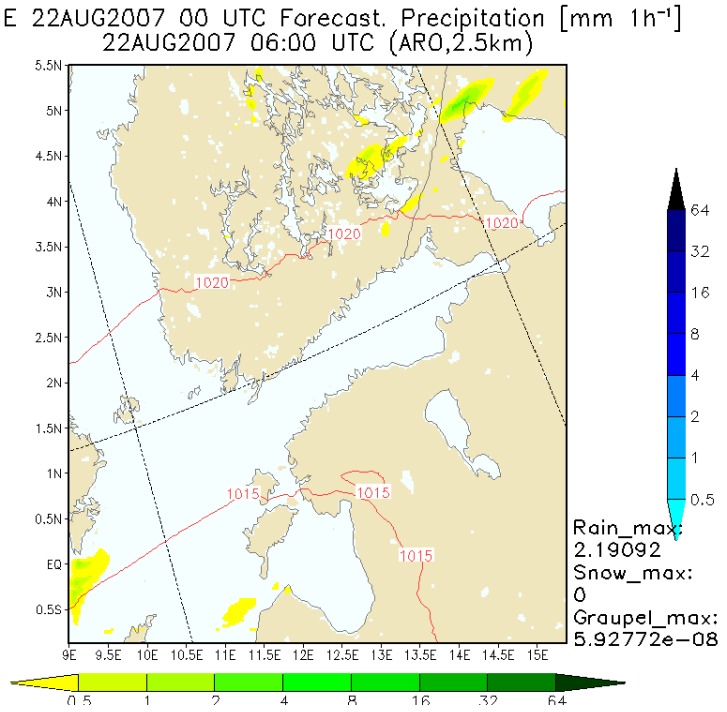
E-mail from Head, NWP at FMI **8:08 utc** :

“At the moment we are experiencing a very intense thunderstorm in southern Finland. The system has moved in from the southwest in the course of the morning and is by no means a local phenomenon. Although the scenery is spectacular, our joy is reduced by the fact that the RCR has failed to forecast this storm in any of the cycles verifying this morning. I wonder if other operational implementations might have been more successful. “

Available ”nowcasting” products at FMI on the occasion

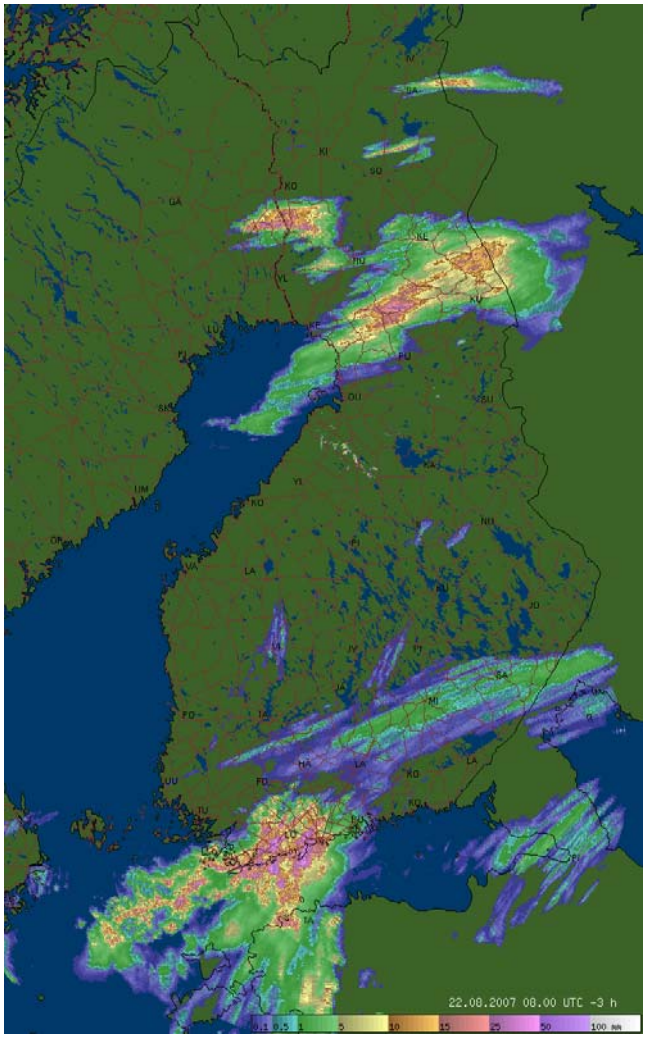


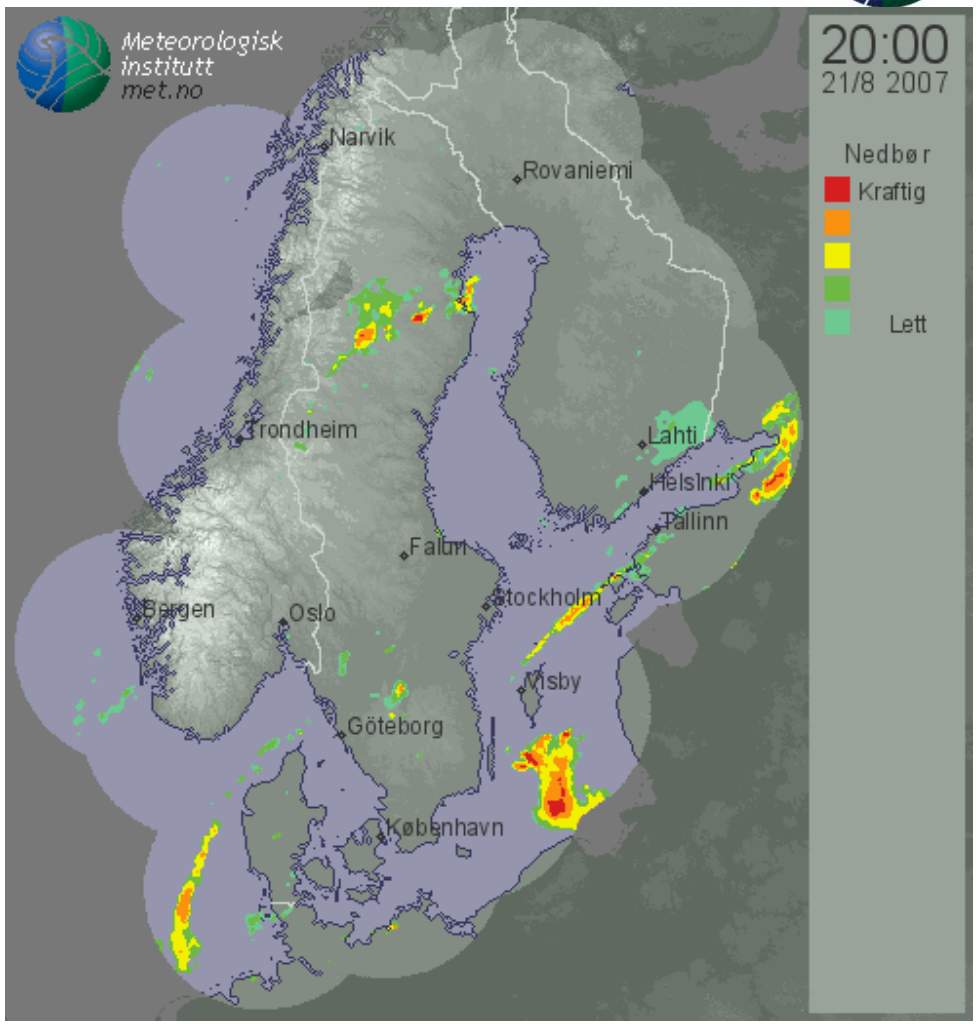
RCR 00 + 6h



AROME 00 + 6h

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



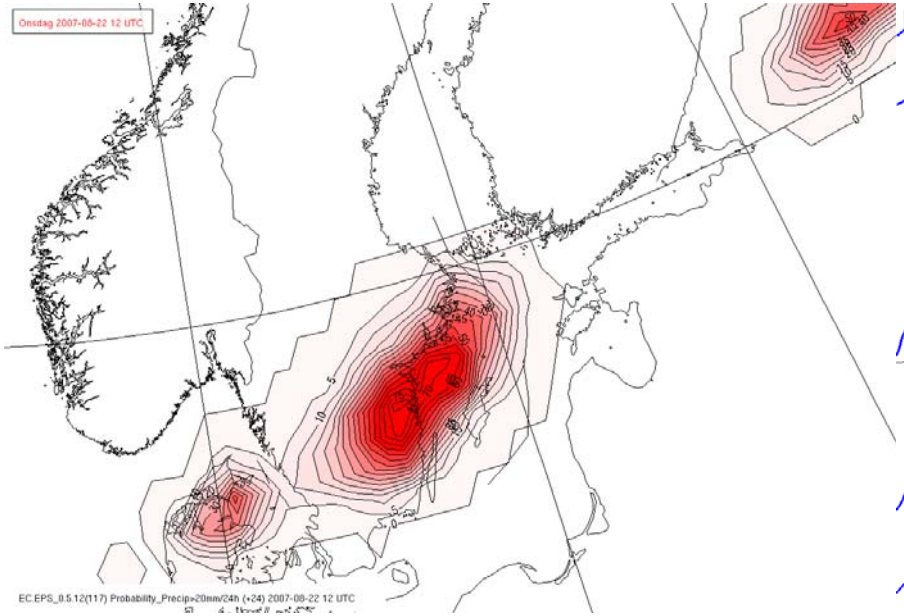


Cummulative Radar Echo

05-08 utc, 2007/08/22

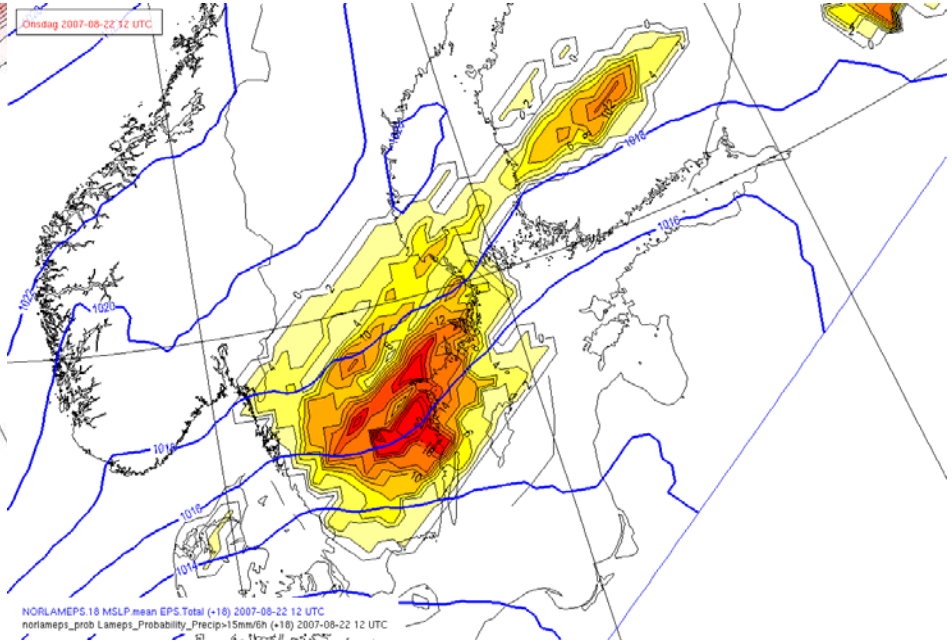
Prob[P>x] ; 12utc

EC_EPS +24h, vt:12utc



$\Pr[P > 20mm/24h]$

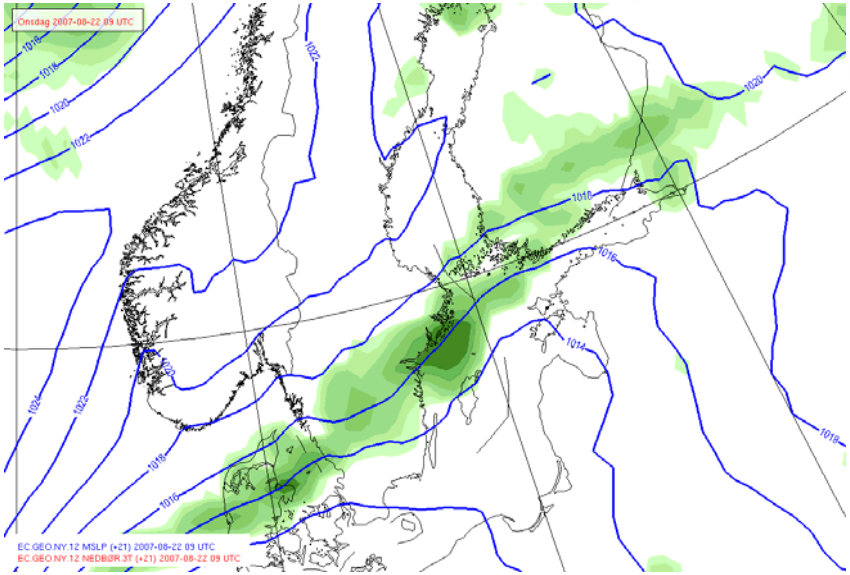
NORLAMEPS +18h, vt:12utc



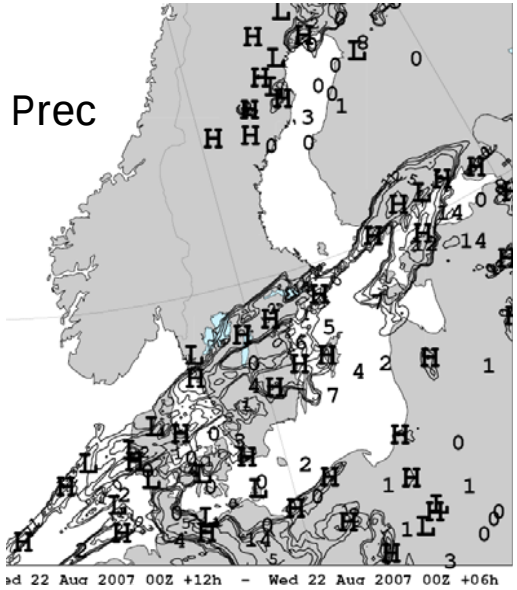
$\Pr[P > 15mm/6h]$

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

EC, 12utc + (18-21),

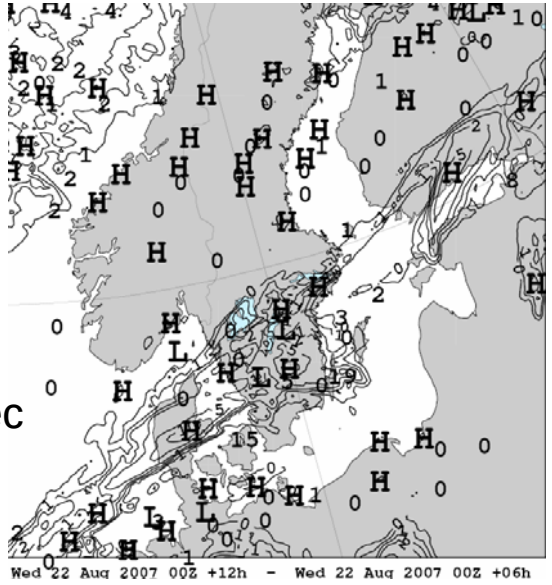


Conv. Prec

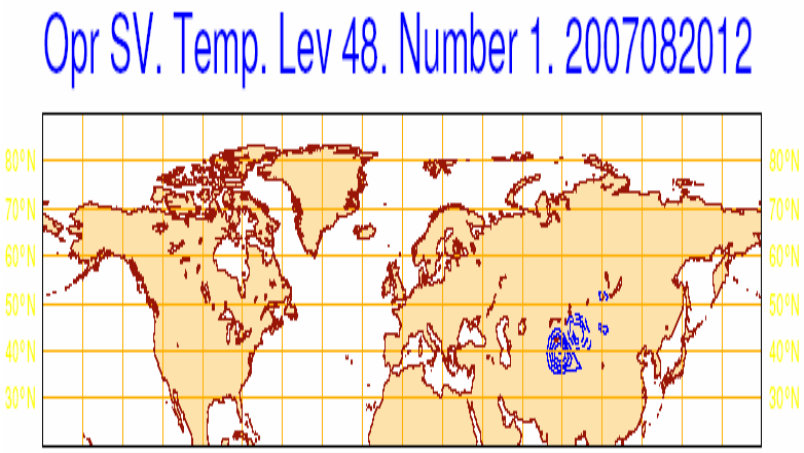


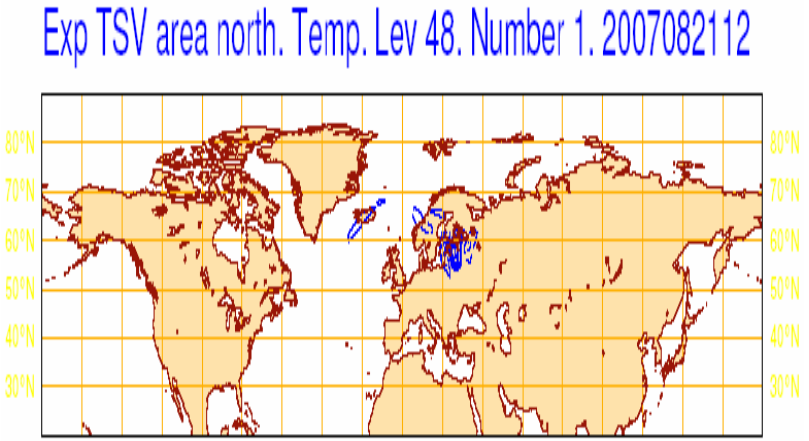
SMHI 11km, 00 +(6-12)

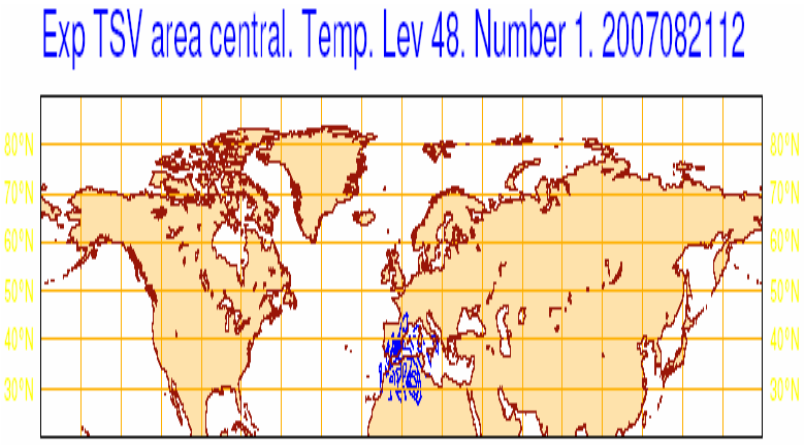
Strat. Prec

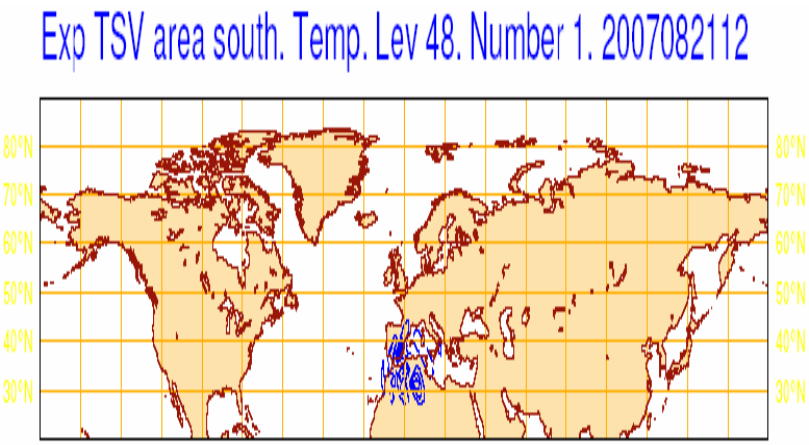


NH SVs 48h and TSVs 24h, target time: 2007/08/22 12utc
T ~850 hPa

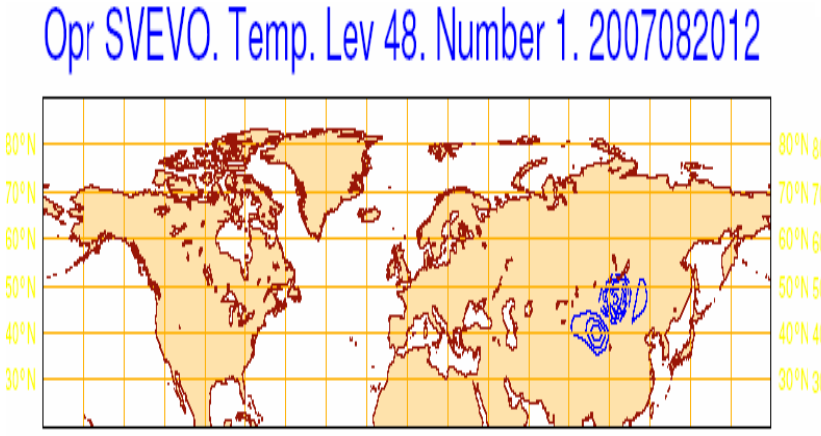


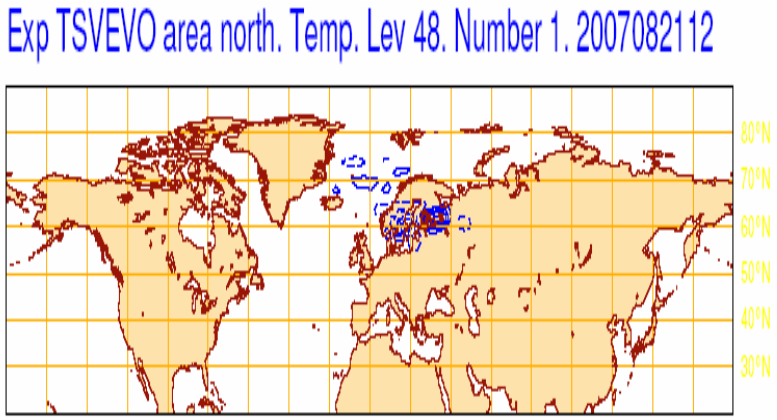


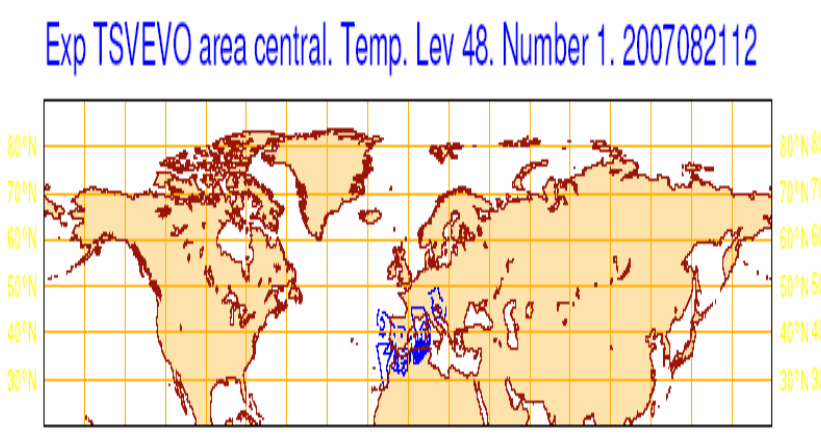


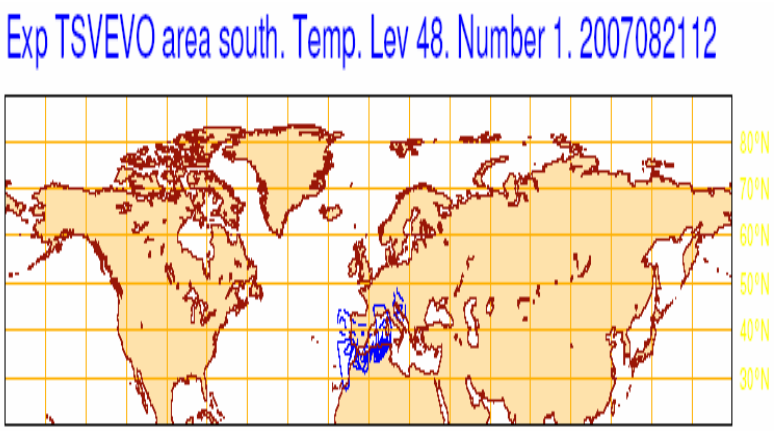


NH SVs 48h and TSVs 24h, target time: 2007/08/22 12utc.
T ~850 hPa, Evolved





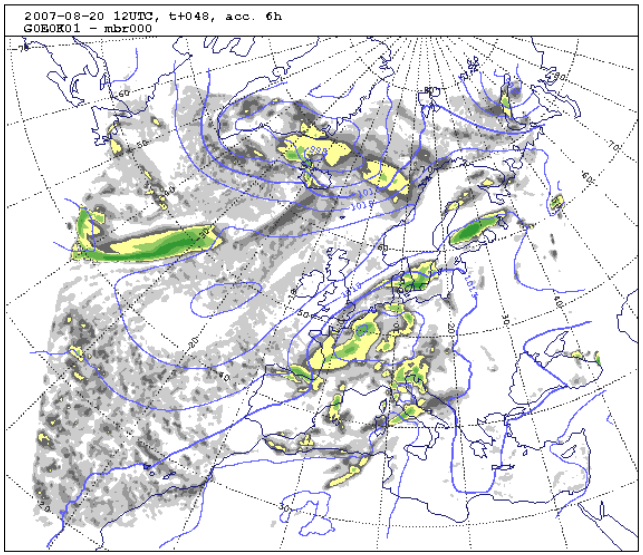




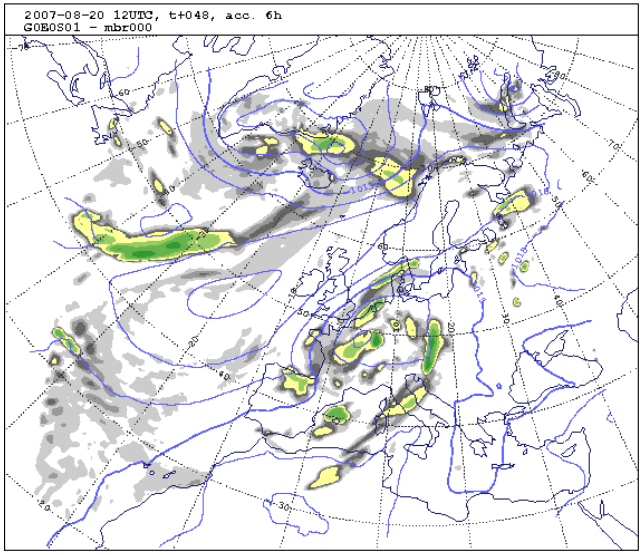
Downscaling EPS: HIRLAM (K. Sattler)
ALADIN (S. Ivatek-Sahdan)

HIRLAM Control

RKKF

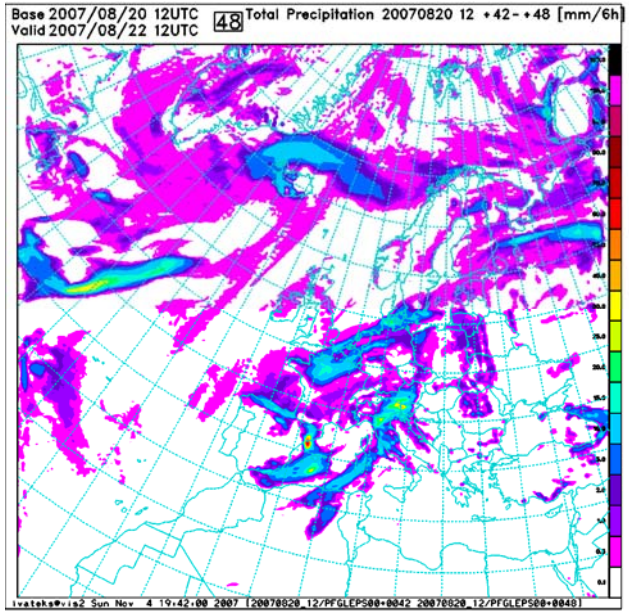


STRACO



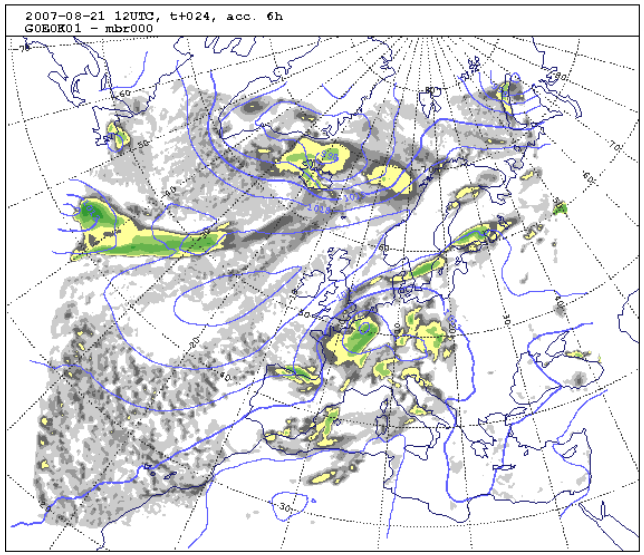
6h Precip. 2007/08/21
12utc + 42-48h

ALADIN Control

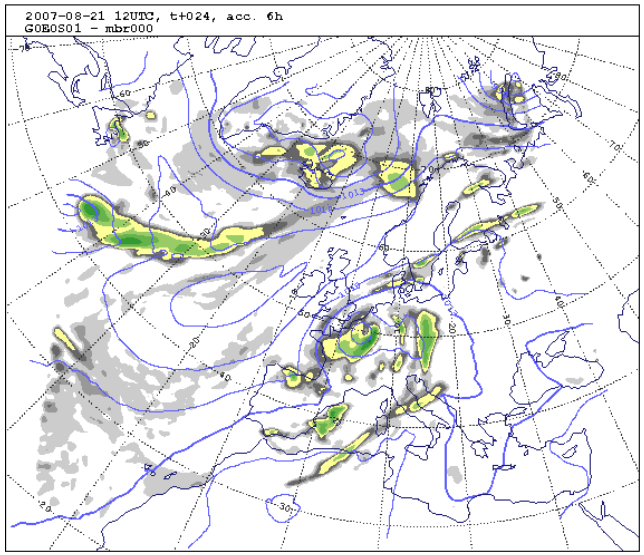


HIRLAM Control

RKKF

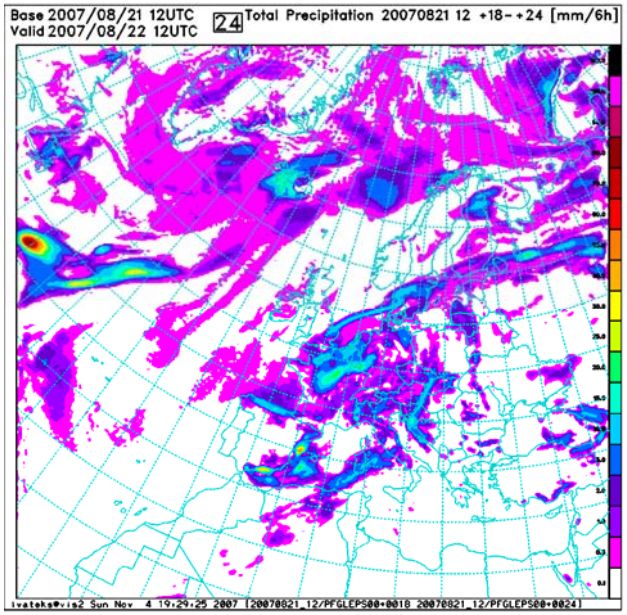


STRACO



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

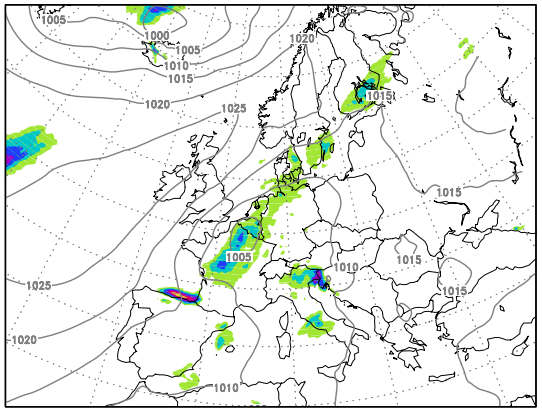
ALADIN Control



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

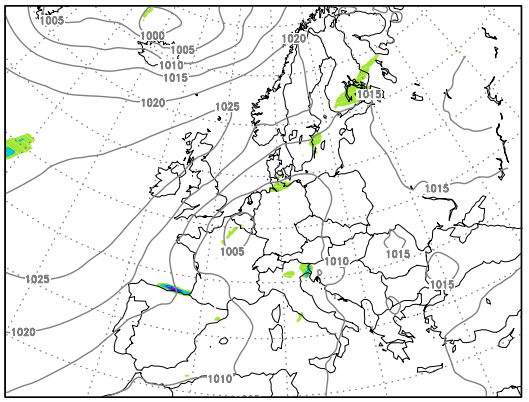
RKKF - cloud scheme: verif. at 2007/08/22 12utc

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

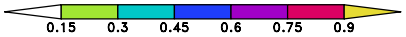


+42-48

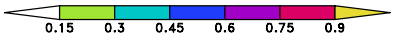
2007082012+048h: P[precip>10. mm]



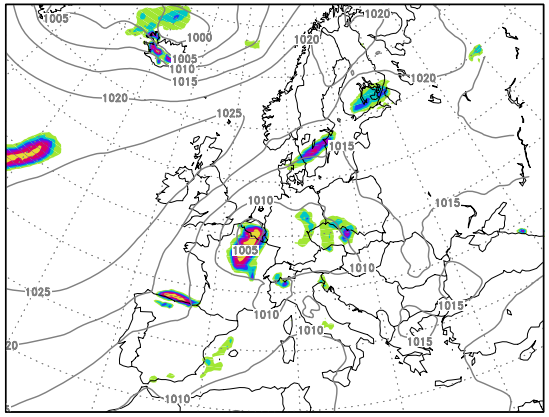
$\Pr[P > 5mm/6h]$



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

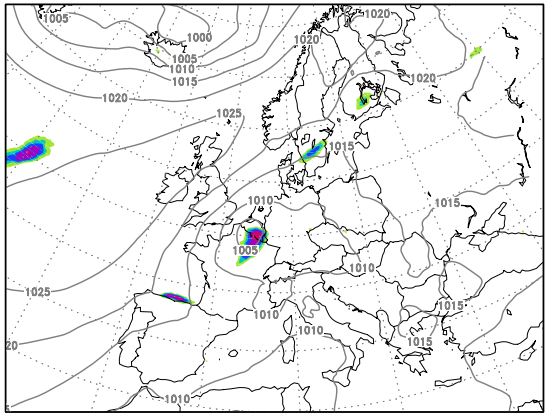


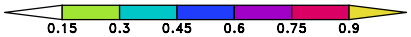
2007082112+024h: P[precip>5. mm]

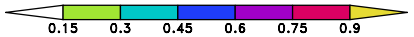


+18-24

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



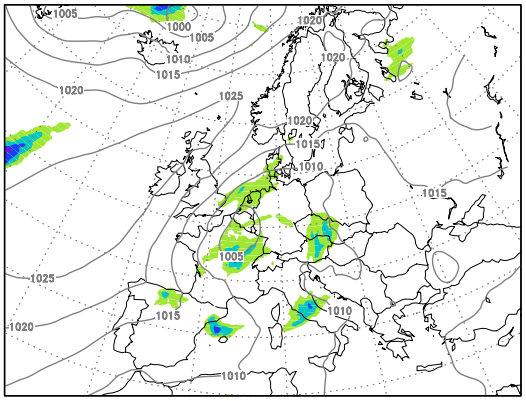




Downscaling EPS with HIRLAM, 0.2 deg,

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

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



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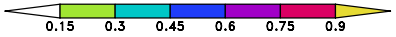
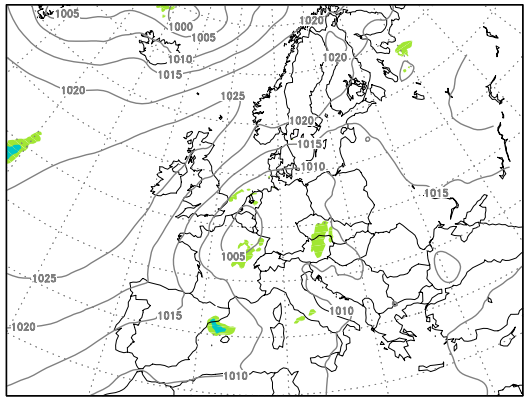
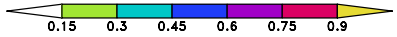


+42-48

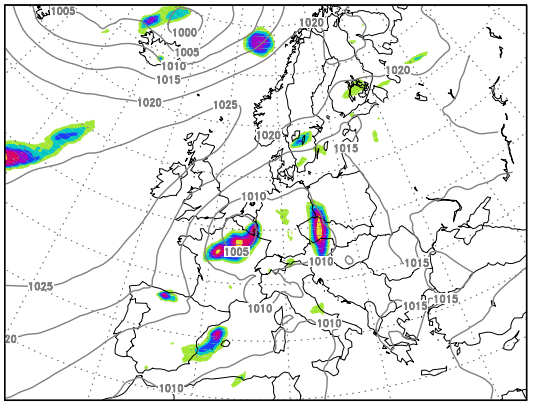
2007082012+048h: P[precip>10. mm]

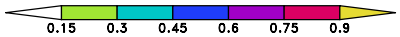


$\Pr[P > 10mm/6h]$



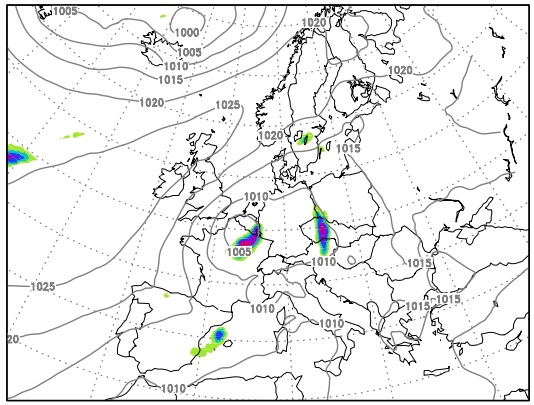
2007082112+024h: P[precip>5. mm]





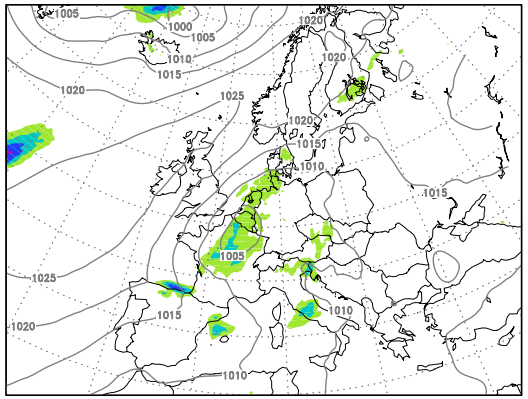
+18-24

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

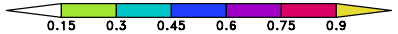


Downscaling EPS with HIRLAM, 0.2 deg,
Combined: verif. at 2007/08/22 12utc

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

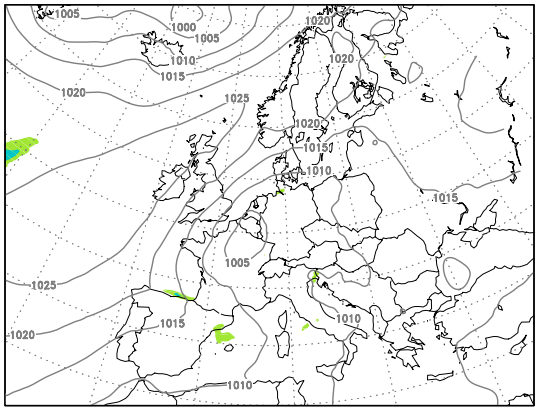


$\Pr[P > 5mm/6h]$

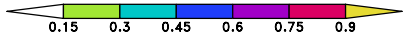


+42-48

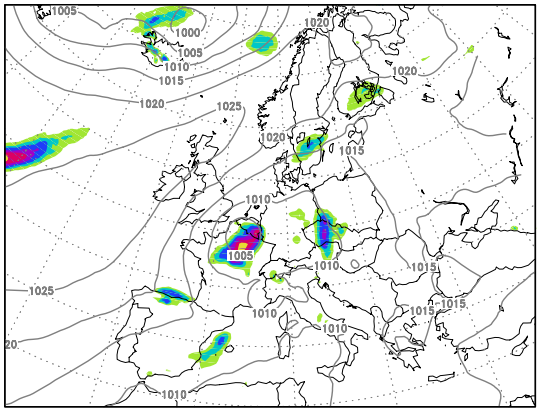
2007082012+048h: P[precip>10. mm]

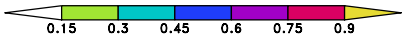


$\Pr[P > 10mm/6h]$



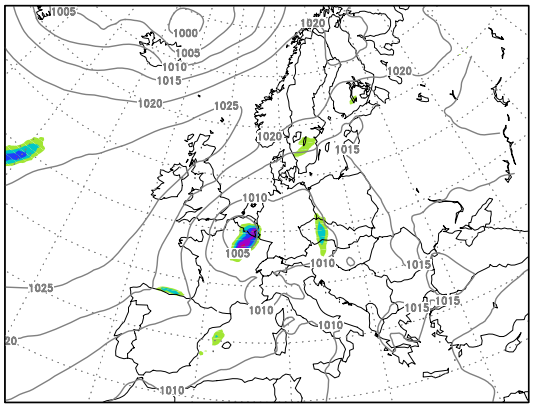
2007082112+024h: P[precip>5. mm]





+18-24

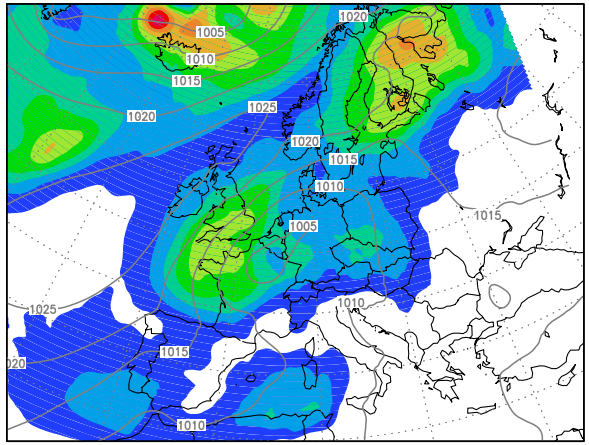
2007082112+024h: P[precip>10. mm]



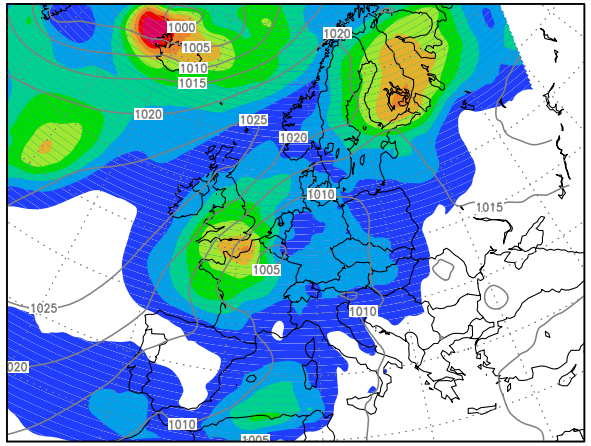
Downscaling EPS with HIRLAM, 0.2 deg,

MSLP, Ensemble mean and spread

2007082012+048h: MSLP ens. mean and std dev.



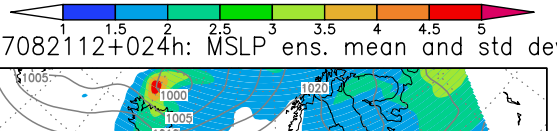
2007082012+048h: MSLP ens. mean and std dev.



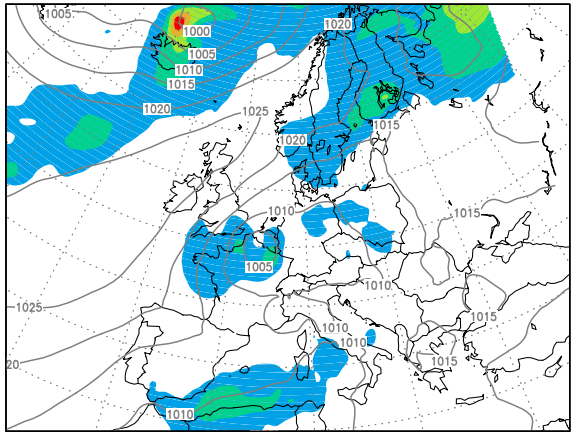
+48

STRACO

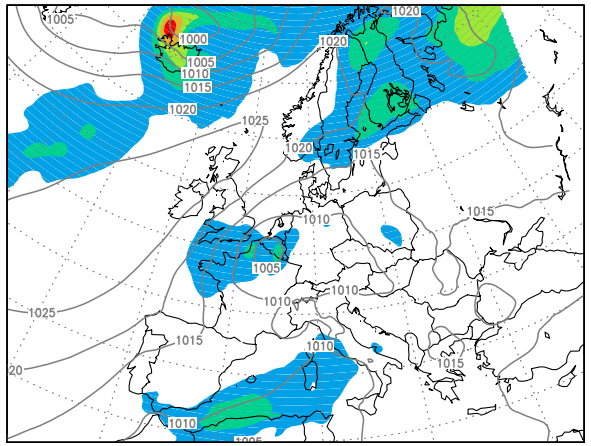
RKKF



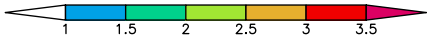
2007082112+024h: MSLP ens. mean and std dev.

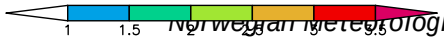


2007082112+024h: MSLP ens. mean and std dev.



+24





Ongoing and immediate further work

GLAMEPS_v0:

- Experimentation with the amplitudes of the SVs and TSVs will be carried out.
- A winter period of 21 days will also be run.
- Scores for more parameters will be calculated:
  T850, ff10m, Z500, T2m
- After the tuning, TEPS will run twice per day for selected periods / cases
- HIRLAM_Straco, HIRLAM_RKKF will be run with TEPS as initial and boundary conditions
- ALADIN are being developed for running with EC-EPS/TEPS
- Presentation and Validation Package is underway

GLAMEPS_v1:

- Include ALADIN and HIRLAM SVs in the range of perturbations
- Experiments with diabatic TSVs.
- Surface BC and Physics perturbations

ECMWF and GLAMEPS

Operationally produce enhanced value intial/lateral boundary perturbations
- –"TEPS for Europe"

Data exchange central in RT operation
- –A selected set of data from TIGGE-list copied to ECMWF in RT for each LAM-EPS.
- –At an agreed time, all partners can download the set of GLAMEPS members.

Archiving
- –Archiving EPS and TEPS for use by GLAMEPS
- –Archiving GLAMEPS raw data and products

Use software developed at ECMWF for
- –Selected probabilistic products,
- –Probabilistic verification and validation

Calibrate and validate the entire GLAMEPS

Develop and maintain
- –Prototype codes and scripts for downloading by partners,
- –Testing and quasi-operationalization in research mode,

Further co-operate with ECMWF staff, scientifically and operationally.


Thank You!