***R**egional **C**ooperation for*
***L**imited **A**rea Modeling in **C**entral **E**urope*

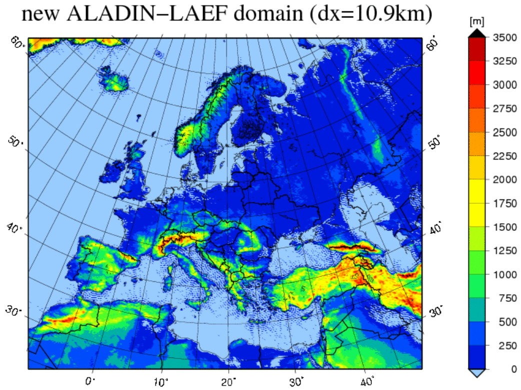
LACE
nwp central europe

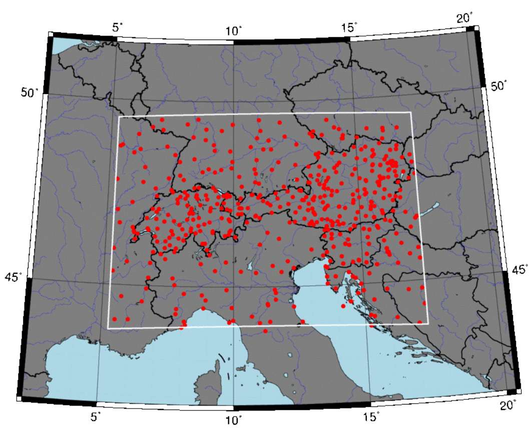
LAM-EPS activities in LACE

Martin Belluš, SHMÚ; with contributions of Theresa Schellander-Gorgas, Florian Weidle, Mihaly Szucs, Simona Tascu, Yong Wang, Clemens Wastl

DHMZ
SHMÚ
OMSZ
ZAMG
ROMANIA ANM

Ensemble systems in LACE





- ALADIN-LAEF
  - operational at ECMWF since 2011 (Δx=18km, vlev=37, tstep=720s)
  - revised version in 2013 (bigger domain) (Δx=11km, vlev=45, tstep=450s)
  - migrated to CRAY system in Sep 2014
- AROME-EPS
  - R&D in convection-permitting EPS (Δx=2.5km, vlev=60, tstep=60s)
  - OMSZ and ZAMG local activities

R&D results are being published

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doi: http://dx.doi.org/10.1175/MWR-D-12-00354.1

A New Method for Generating Initial Condition Perturbations in a Regional Ensemble Prediction System: Blending

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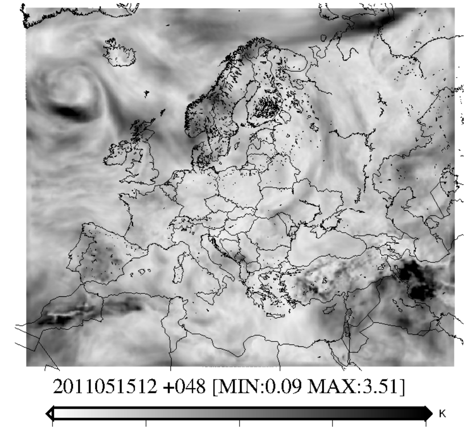
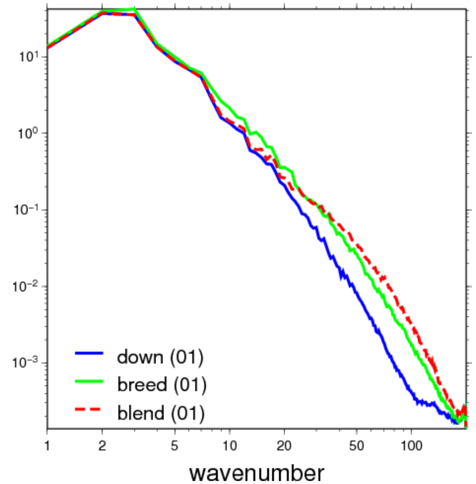
Abstract

A blending method for generating initial condition (IC) perturbations in a regional ensemble prediction system is proposed. The blending is to combine the large-scale IC perturbations from a global ensemble prediction system (EPS) with the small-scale IC perturbations from a regional EPS by using a digital filter and the spectral analysis technique. The IC perturbations generated by blending can well represent both large-scale and small-scale uncertainties in the analysis, and are more consistent with the lateral boundary condition (LBC) perturbations provided by global EPS. The blending method is implemented in the regional ensemble system Aire Limitée Adaptation Dynamique Développement International-Limited Area Ensemble Forecasting (ALADIN-LAEF), in which the large-scale IC perturbations are provided by the European Centre for Medium-Range Weather Forecasts (ECMWF-EPS), and the small-scale IC perturbations are generated by breeding in ALADIN-LAEF. Blending is compared with dynamical downscaling and

Temperature at 850hPa – EPS SPREAD (blend)

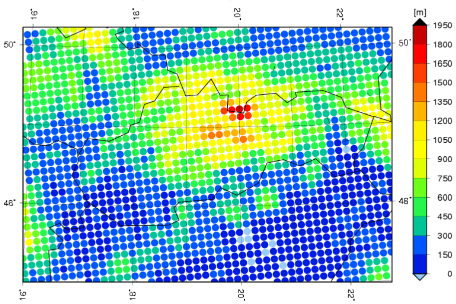


Kinetic energy spectra (KES020WIND_PHYS)
23–05–2011 12 UTC + 00 (model level: 20)

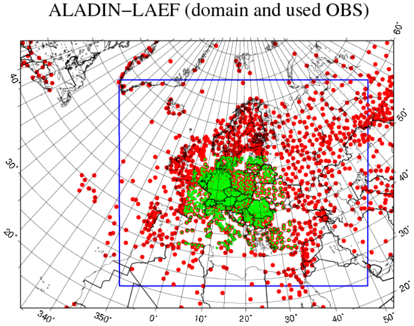


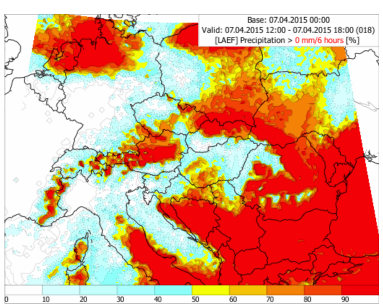
Operational version of ALADIN-LAEF (CRAY@ECMWF)

ALADIN–LAEF (SK ZOOM) – new domain: 10.9km



ALADIN–LAEF (domain and used OBS)





ensemble size	16+1
Δx / vertical levels	10.9 km / 45
time-lagged coupling	ECMWF EPS (6h frequency)
runs per day	00 and 12 UTC (+72h forecast)
IC perturbation	surface: ● EDA by CANARI (T2m, RH2m) upper air: ● breeding-blending
model perturbation	multi-physics: ● micro-physics ● deep/shallow convection ● radiation ● turbulence

ALADIN-LAEF surface-SPPT (M. Belluš)

The stochastic physics method targets the model errors at its source by a random disturbance of tendencies computed by the physical parameterizations:

e_j: state of member j at time T

perturbed tendency of unresolved parameterized processes

$$\frac{\partial e_j}{\partial t} = A\left(e_j, t\right) + P'\left(e_j, t\right)$$

tendencies of resolved processes

unperturbed tendencies of unresolved, parameterized processes (grid box average)

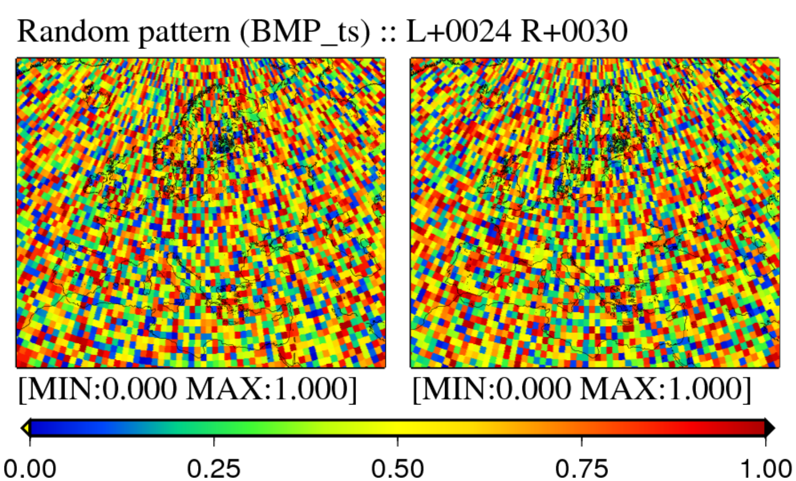
$$P'_j\left(e_j, t\right) = \left(1 + r_j(\lambda, \varphi, t)_{D,T}\right) P_j\left(e_j, t\right)$$

random number

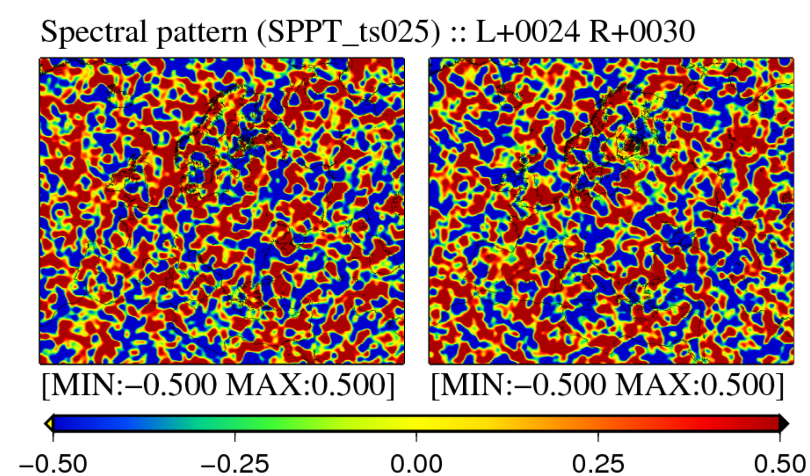
ALADIN-LAEF surface-SPPT **(M. Belluš)**

Stochastic physics schemes

- BMP (Buizza, Miller, Palmer, 1999)
  - random number uniformly sampled, constant for "gridbox" with size D over time T
  - used in earlier experiments with ALADIN-LAEF (unstable)
- SPPT (Palmer et al., 2009; Bouttier et al., 2012)
  - random number by Gaussian distribution, spectral pattern generator (σ, L, τ)



D=1 deg, T ~20 time steps



σ=0.25, L=500 km, τ=2 h

ALADIN-LAEF surface-SPPT (M. Belluš)

SPPT for ISBA fields:

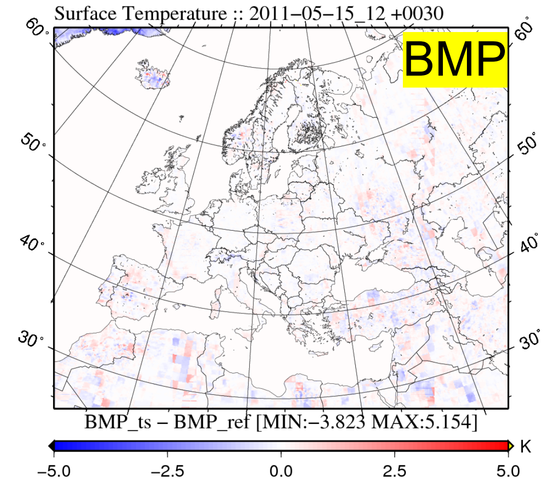
- Gaussian distribution of random numbers
- Univariate

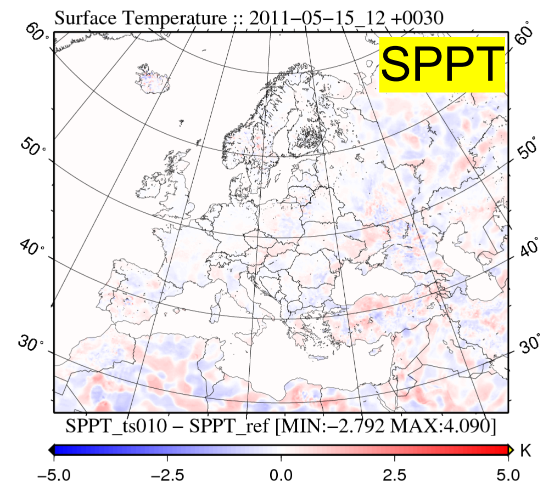
Perturbed fields:

- Surface temperature
- Liquid soil water content
- Frozen soil water content
- Snow albedo
- Snow reservoir water content
- Snow density
- Water intercepted by vegetation

Exceptions:

- No perturbation of deep soil prognostic fields (because of their slow response)
- No perturbation of upper air fields

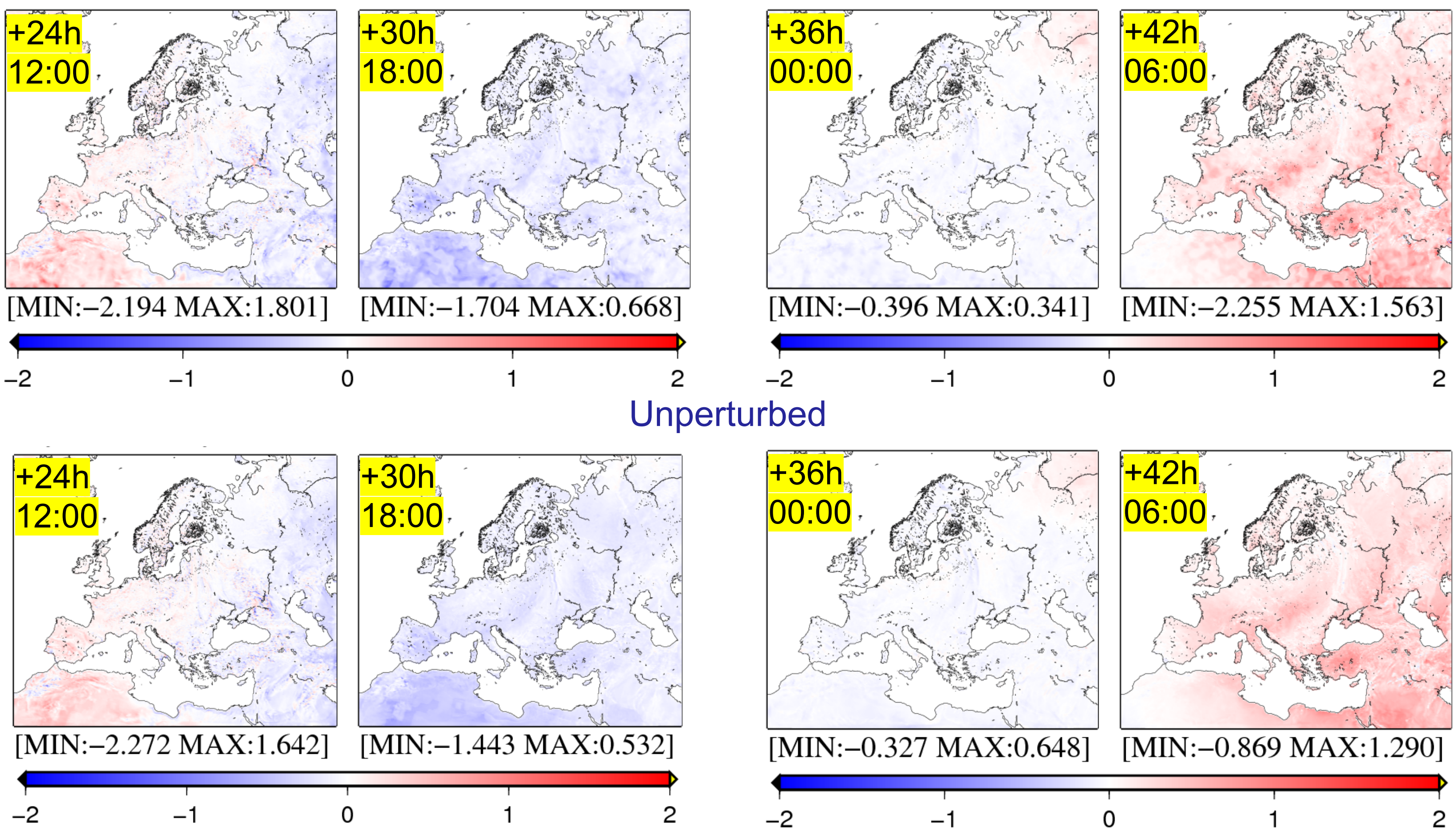




ALADIN-LAEF surface-SPPT (M. Belluš)

Physics tendency of Ts

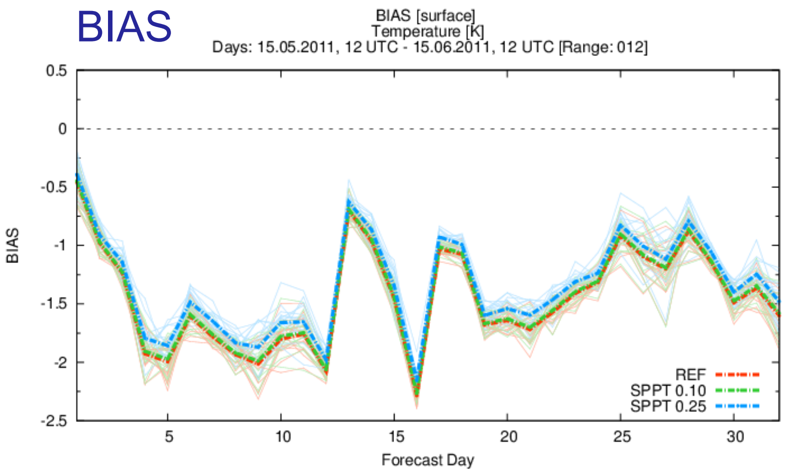
Perturbed
$\delta = 0.25$



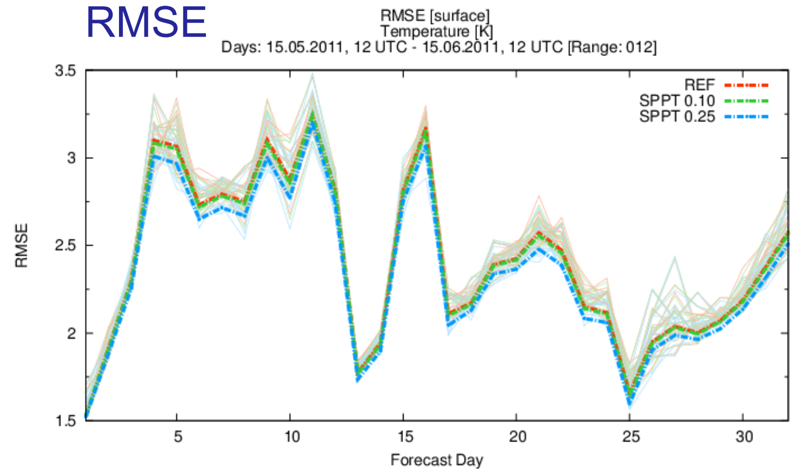
ALADIN-LAEF surface-SPPT (M. Belluš)

Verification for 2m temperature, Unperturbed, SPPT $\delta = 0.10$, SPPT $\delta = 0.25$

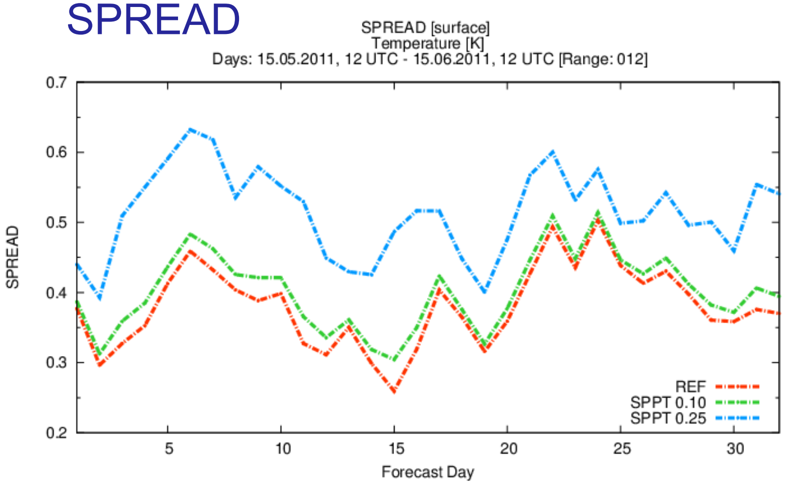
BIAS



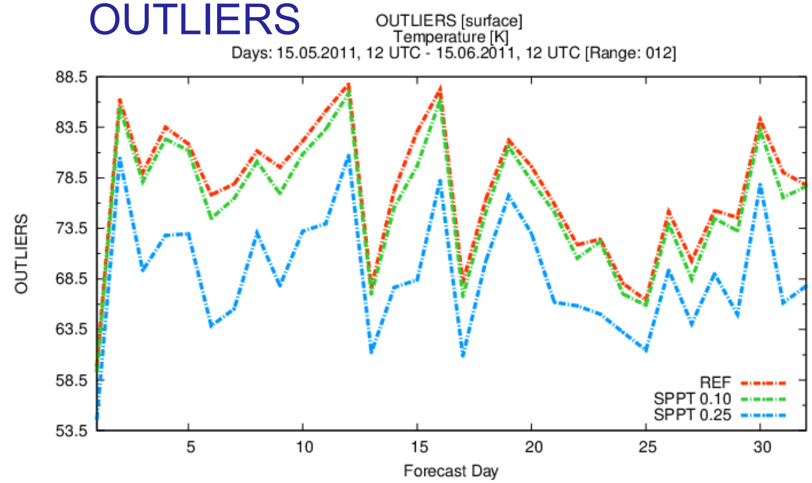
RMSE



SPREAD



OUTLIERS

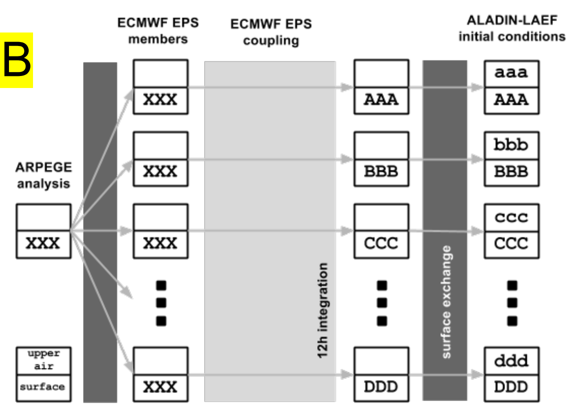


NCSB vs the ESDA (M. Belluš, F. Meier, Y. Wang)

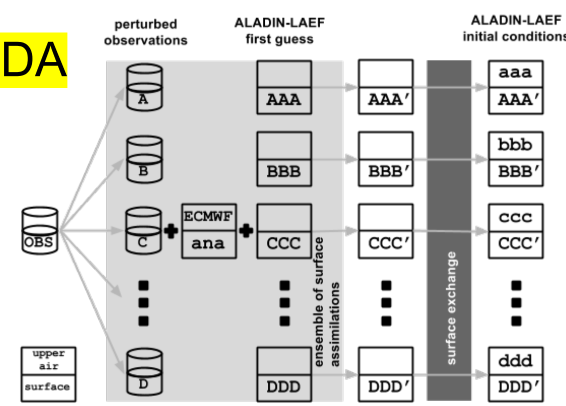
- NCSB (Non Cycling Surface Breeding)
  - to simulate the uncertainty of the surface initial conditions
  - to start the integration from the soil and surface fields which are compatible with the ALADIN--LAEF system

- ESDA (Ensemble of Surface Data Assimilations)
  - CANARI assimilation tool based on the Optimal Interpolation method
  - surface assimilation along with the surface perturbation
  - OBS are perturbed randomly using a Gaussian distribution function with zero mean and standard deviation equal to the observation errors

NCSB



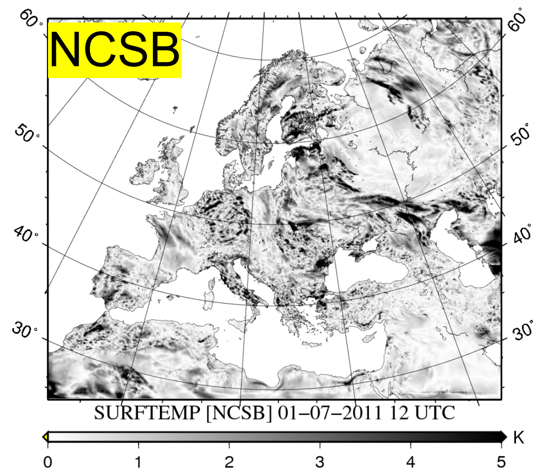
ESDA

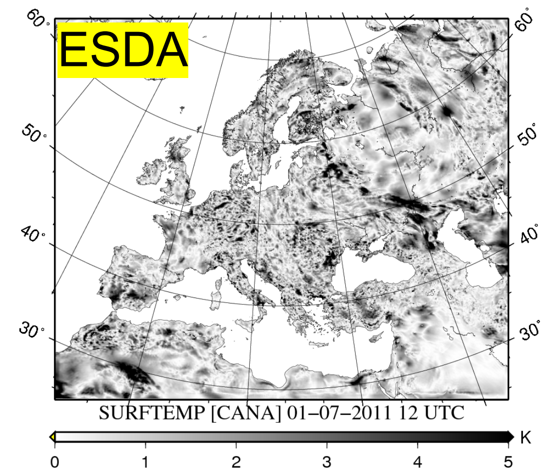


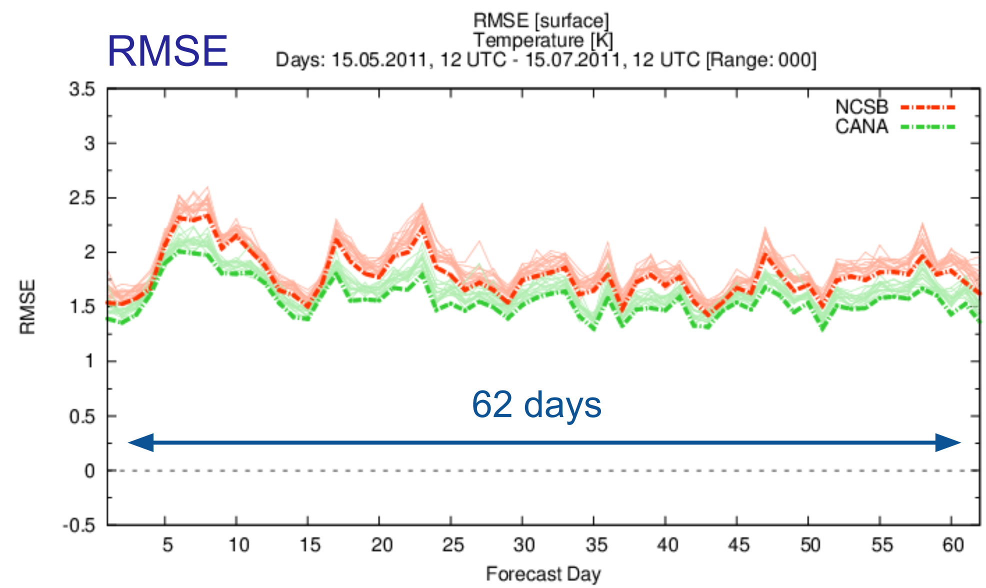
NCSB vs the ESDA (M. Belluš, F. Meier, Y. Wang)

ESDA benefits over NCSB:

- More realistic and spatially homogeneous perturbations
- RMSE of the system is decreased







Paper in preparation for publication in QJRM

AROME-EPS impact of additional LBCs (M. Szucs)

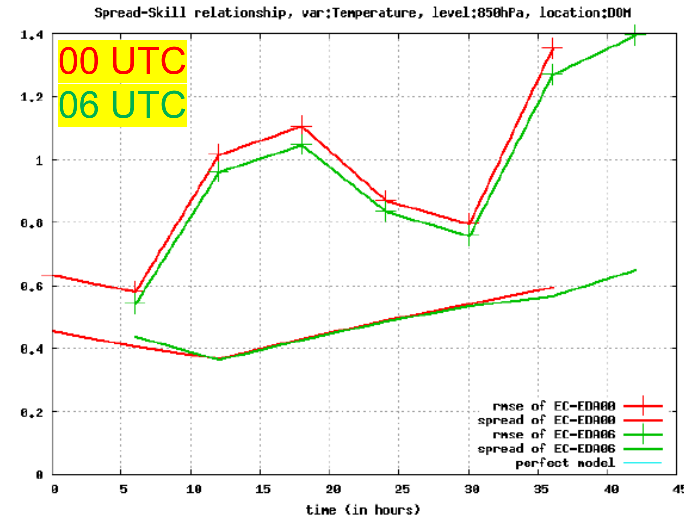
In the framework of the BC programme ECMWF provided LBCs of additional EPS runs (06, 18 UTC) to SRNWP-EPS group:

- 3-hourly
- +144h (6 days)
- 20 days in May 2013

The impact was evaluated by HarmonEPS (Met.no), COSMO-E (MeteoSwiss) and AROME-EPS (OMSZ)

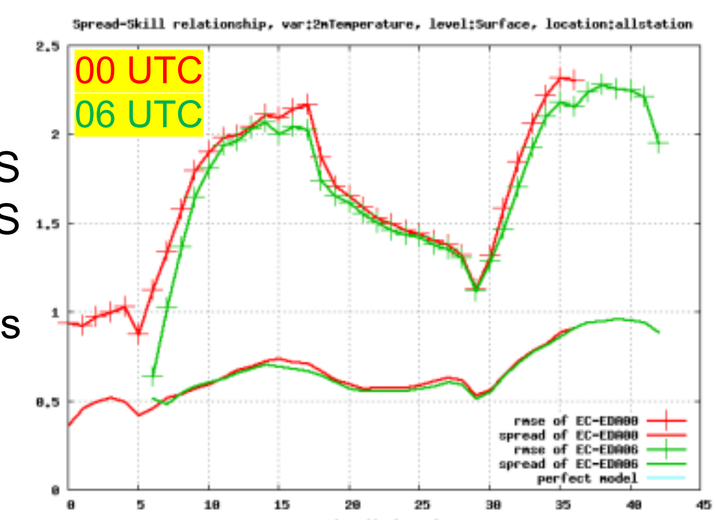
AROME-EPS runs:

- 00 UTC: LBCs of 18 UTC ECMWF-EPS
- 06 UTC: LBCs of 00 UTC ECMWF-EPS
- 10+1 members
- ENS-DA with conventional observations and atmospheric motion vectors



RMSE and Spread

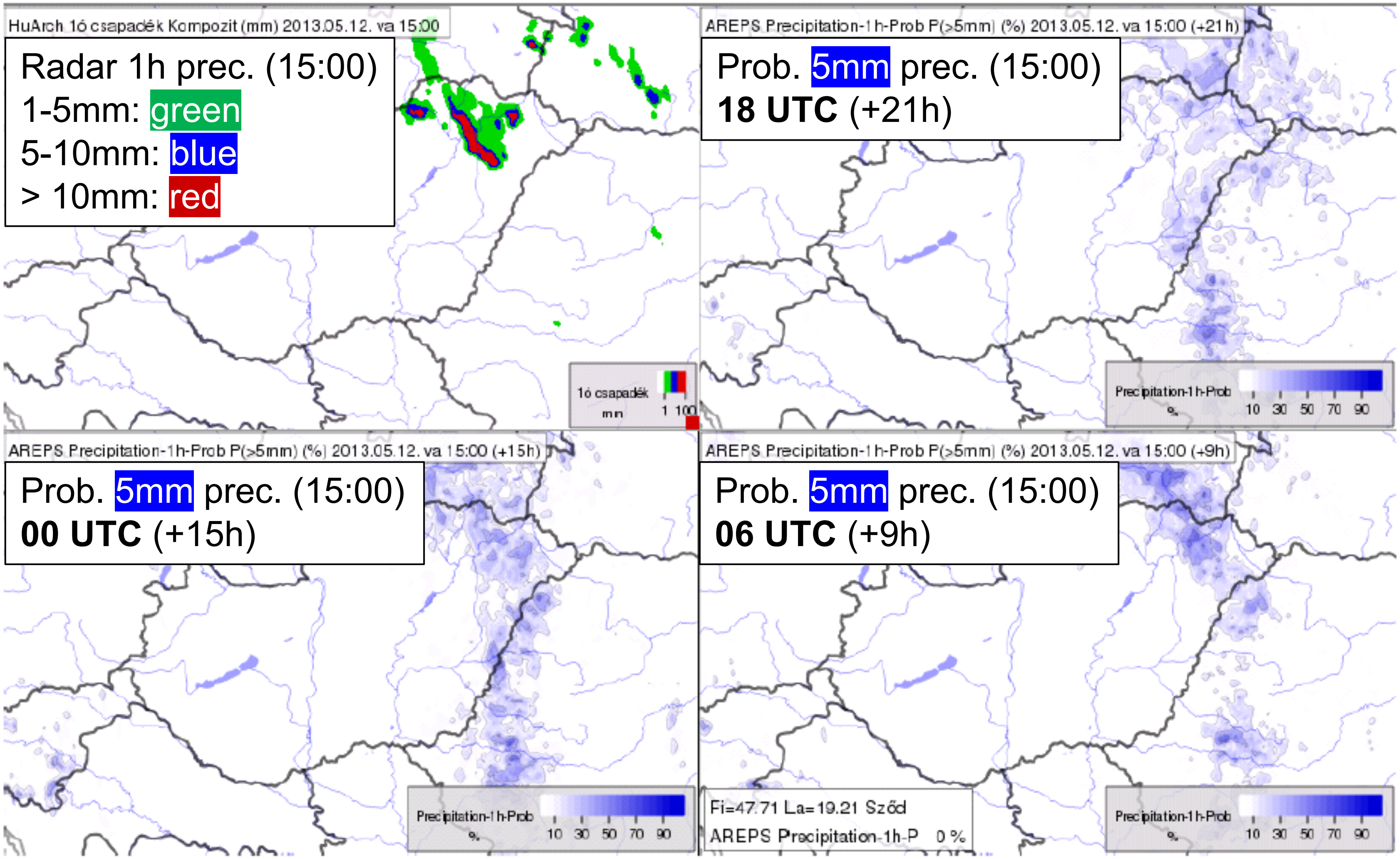
T850



RMSE and Spread

T2m

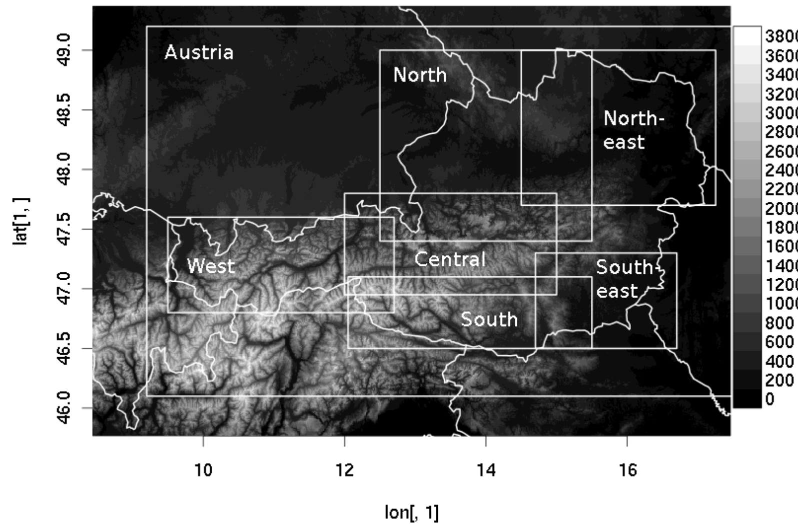
AROME-EPS impact of additional LBCs (M. Szucs)



AROME-EPS vers. ALADIN-LAEF (T. S-Gorgas)

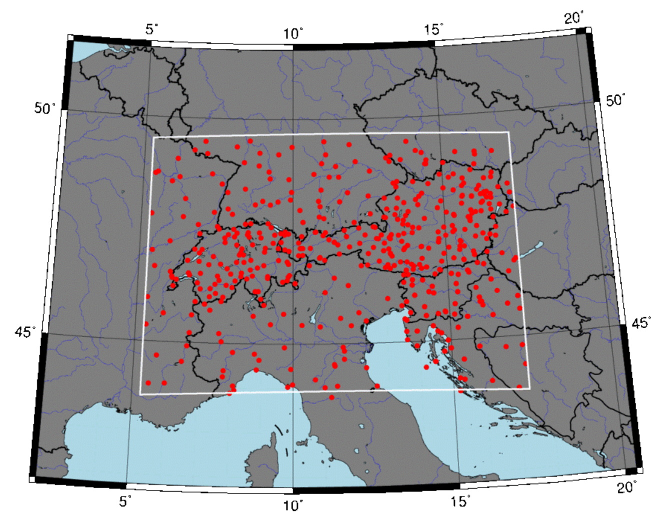
3-months (May-August 2011) downscaling experiment with ALADIN-LAEF coupling files:

- Δx=2.5km, vlev=60, Ts=60s
- 432 x 320 grid points
- 3-hourly coupling
- +30h lead time from 00 UTC
- no time lag



INCA domain with selected subdomains

- Verify what is the benefit of AROME-EPS downscaling of LAEF compared to ALADIN-LAEF
- Focus on precipitation in mountainous terrain
- Observations: INCA-analyses, surface observations, ECMWF-analyses (upper levels)



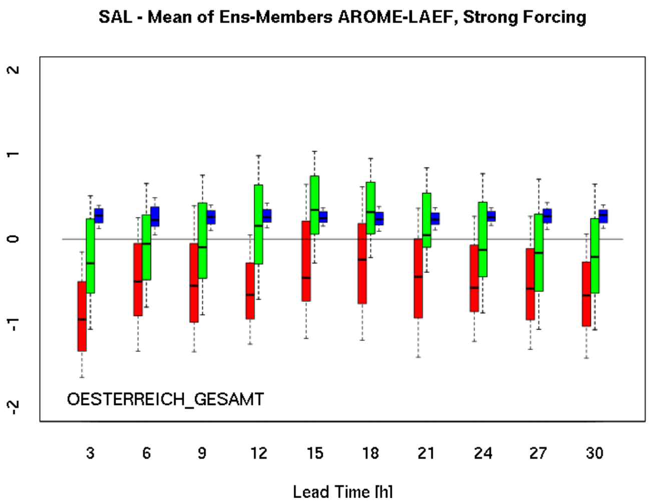
AROME domain with surface observations

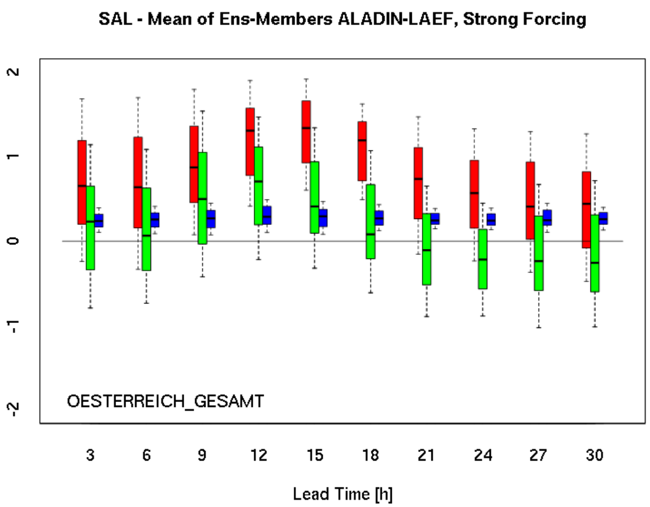
AROME-EPS vers. ALADIN-LAEF (T. S-Gorgas)

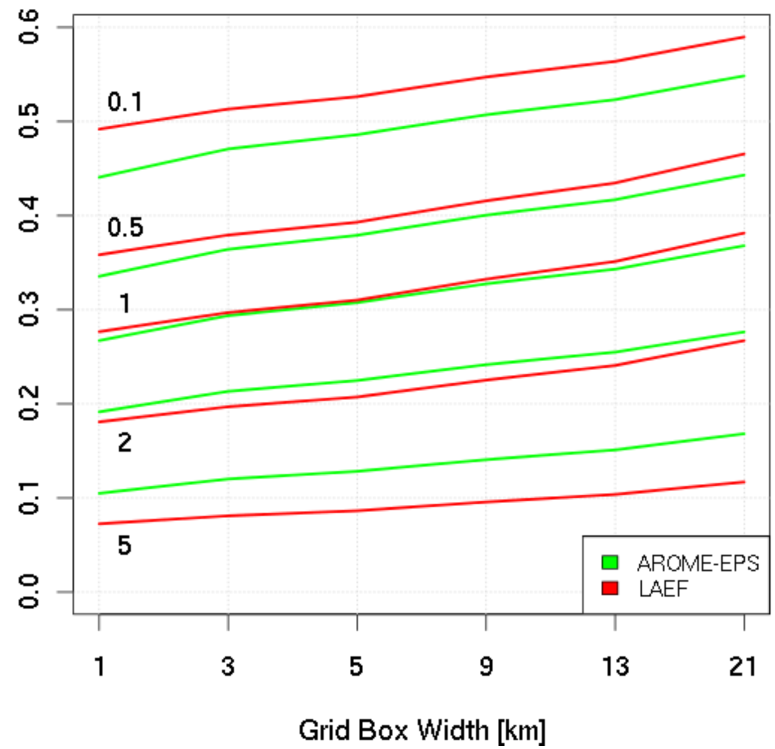
S-A-L: for AROME-EPS mean

S
A
L

S-A-L: for ALADIN-LAEF mean







Fractions Skill Score for convective scale

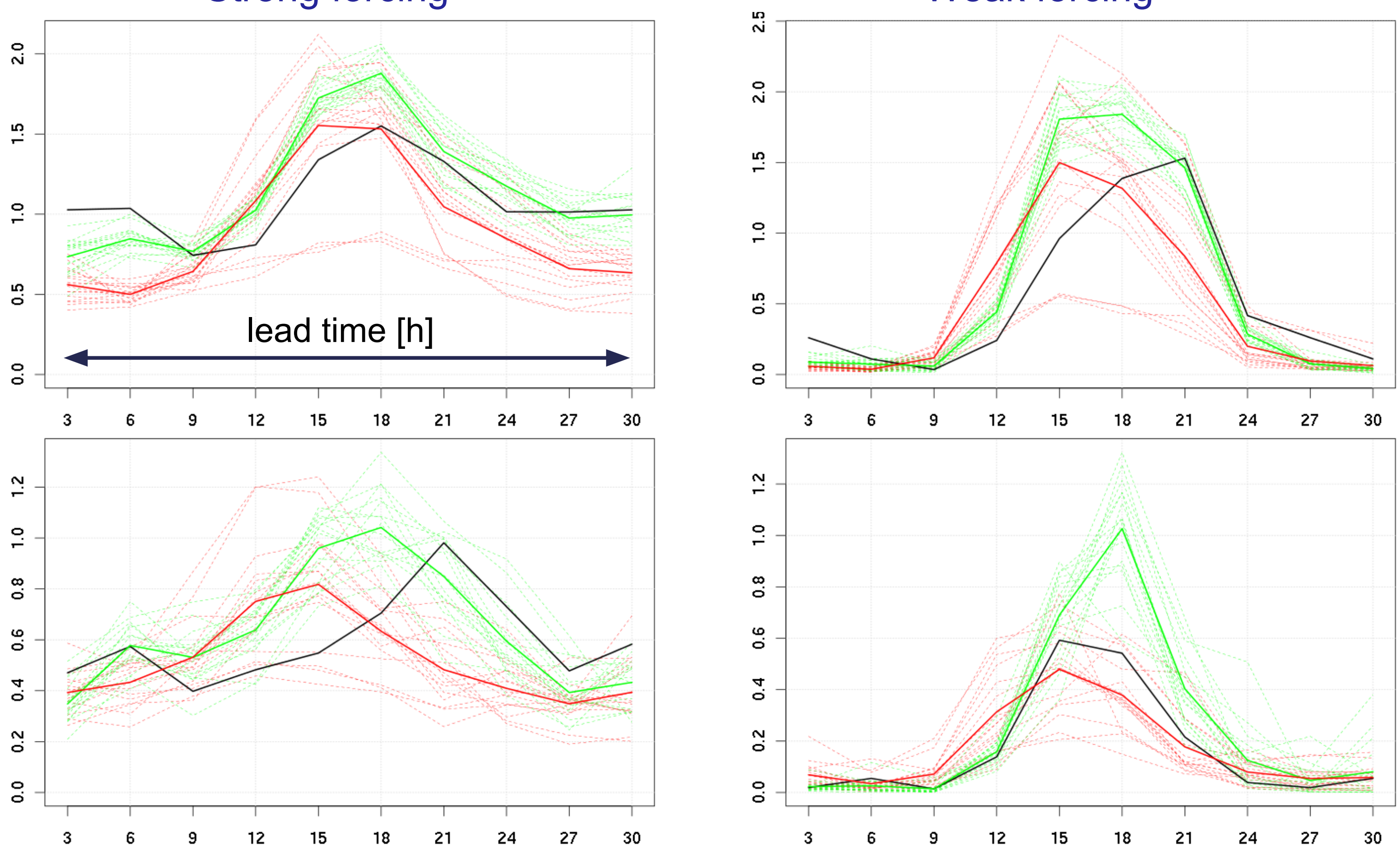
AROME-EPS vers. ALADIN-LAEF (T. S-Gorgas)

Areal mean precipitation in region 'Austria' for AROME-EPS, ALADIN-LAEF and INCA:

Strong forcing | Weak forcing

West: mountains

Southeast: foothills and basin



EPS & Civil Protection - PROFORCE (C. Wastl)

PROFORCE is a project co-financed by the European Commission. The project started in December 2013 and lasts until November 2015.

Partners:

- ZAMG, OMSZ
- civil protection organizations from Somogy County (HU) and lower Austria

Aims of PROFORCE:

- Build-up a ‘seamless’ probabilistic forecasting system from different ensembles
  - medium-range (ECMWF)
  - short-range (ALADIN-LAEF, ALARO-EPS, AROME-EPS)
  - nowcasting (Ens-INCA)
- Adapt it for forecasting extreme weather events
- Use of probability forecasts in civil protection

Outlook

ALADIN-LAEF upgrades

2011
Δx=18km
vlev=37
NCSB, BBC
16+1 members

2013
Δx=11km
vlev=45
ESDA, BBC, MP
16+1 members

2014
technical migration from IBM to CRAY

2015
Δx=5km
vlev=60
ESDA, BBC, MP+SPPT
??? members

- Set-up of a 5km version of ALADIN-LAEF
  - upper-air spectral blending retuning
  - revision of multi-physics
  - price versus performance

- Optimization of ALADIN-LAEF multi-physics
  - less configurations with comparable performance
  - combined with the SPPT scheme

member	MIC	DPC	SHC	RAD	TRB	GUD
MP01						
MP02						
MP03						
MP04						
MP05						
MP06						
MP07						
MP08						
MP09						
MP10						


Tak for din opmærksomhed!