Zentralanstalt für Meteorologie und Geodynamik

Status of ALADIN-LAEF,
Impact of Clustering on Initial Perturbations of ALADIN-LAEF

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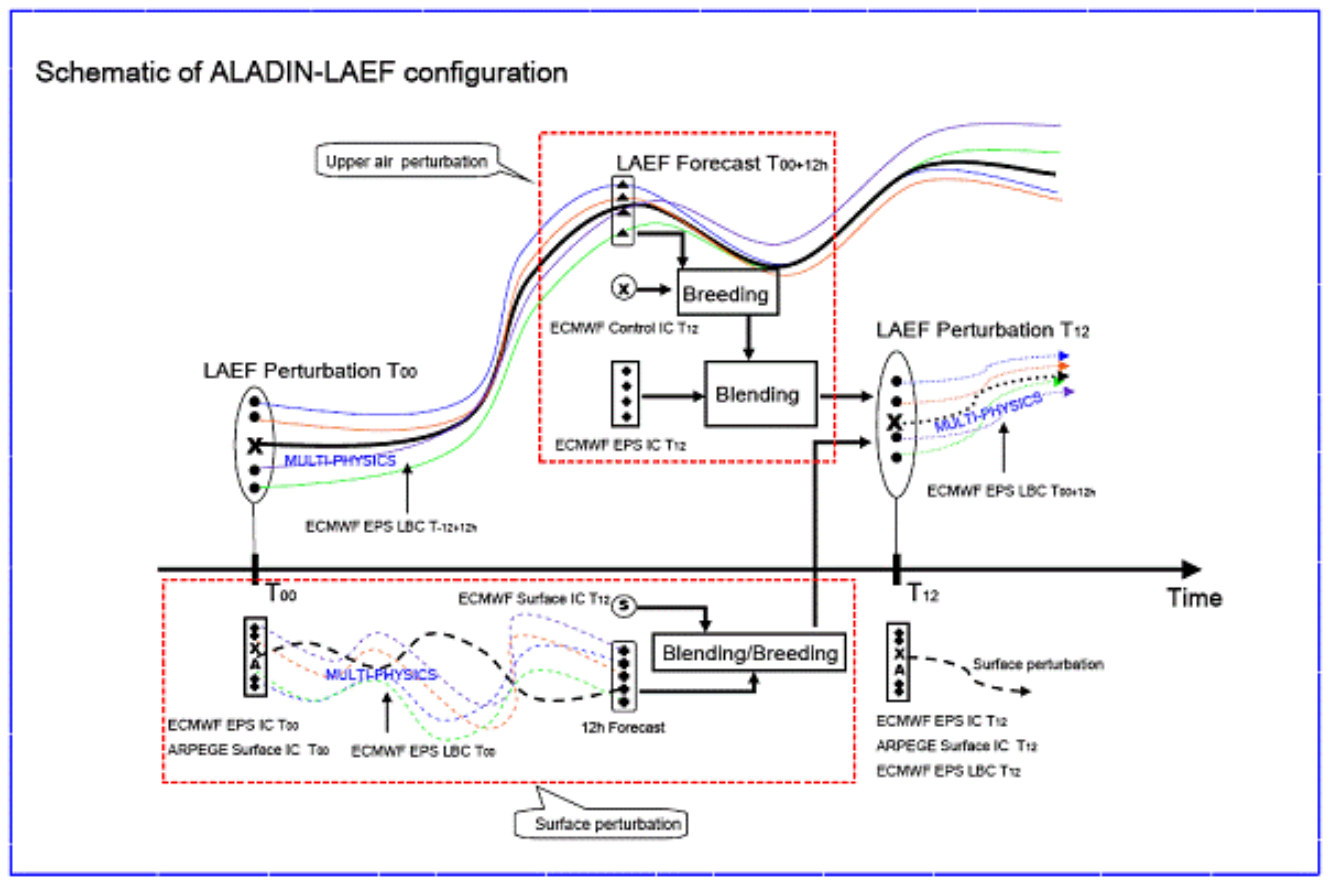
Outline

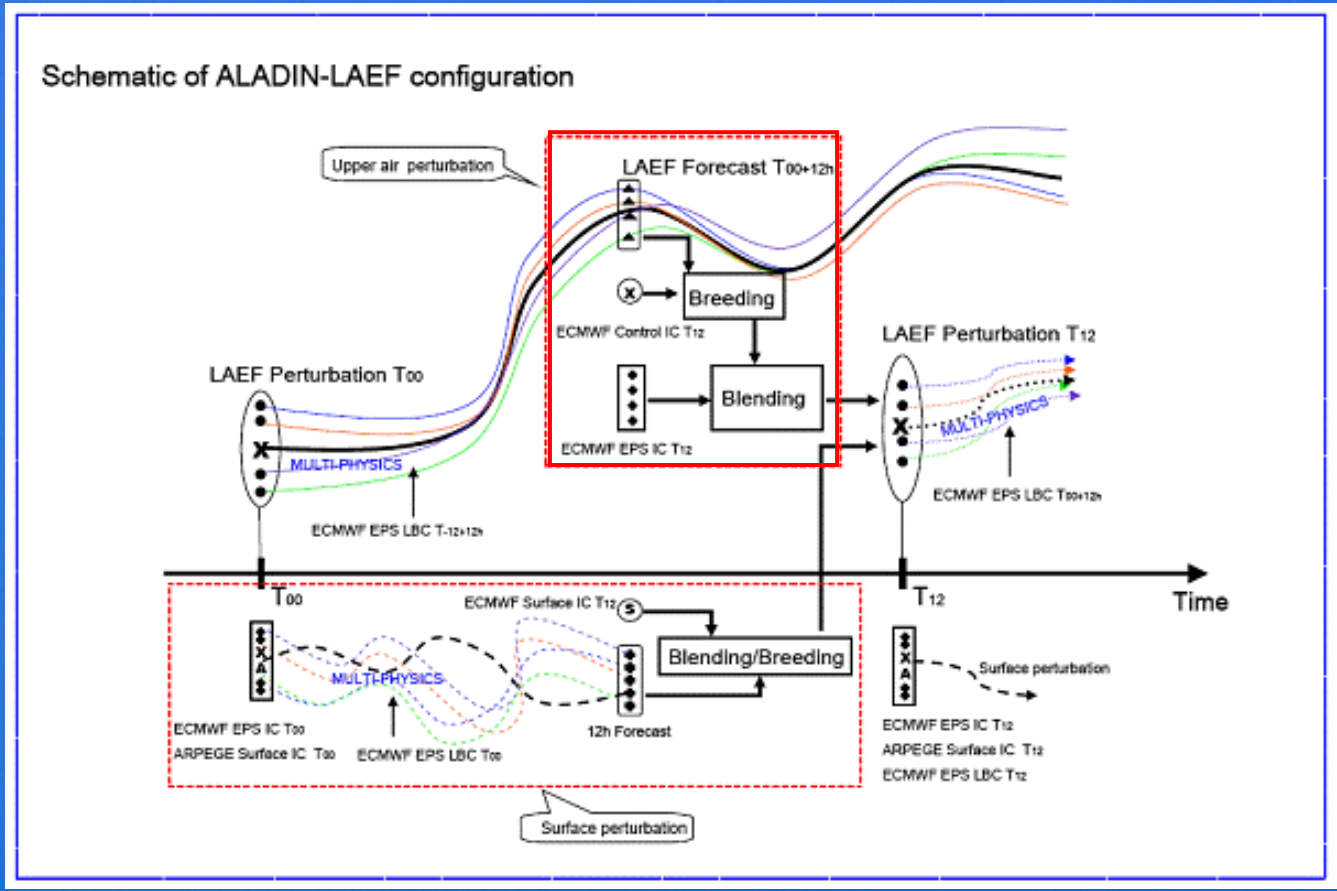
- The 2nd generation ALADIN-LAEF
  - Configuration
  - Generation of Initial Perturbations
  - Operational setup
- Experiments with Clustering
  - Method of clustering
  - Preliminary results
- Conclusions

LAEF – 2nd generation

- Initial perturbations are generated by a combination of Breeding-Blending cycling, Surface blending and multi-physics



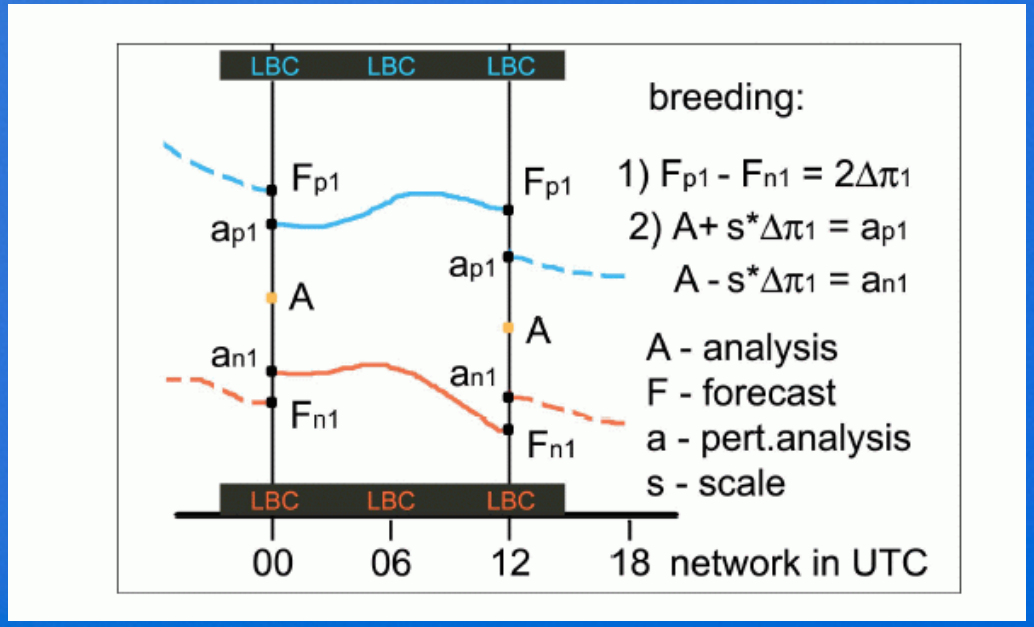
Generation of upper air initial perturbations by Breeding/Blending cycle



LAEF – upper air perturbations

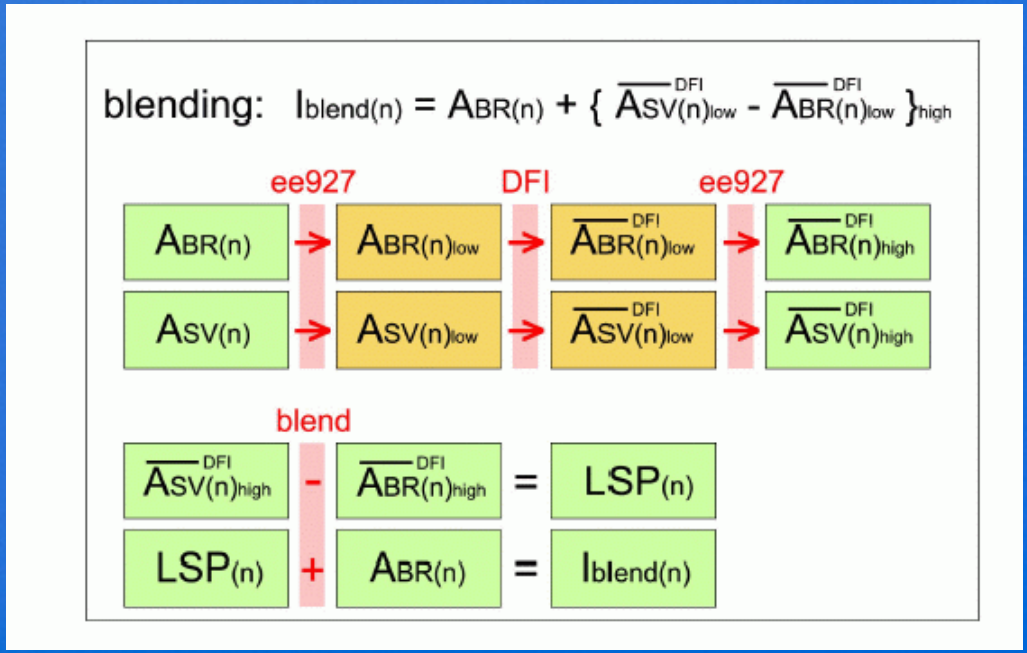
Breeding

- Generation of perturbations on ALADIN-LAEF scale
- Pairs of 12h forecasts from previous run are scaled wrt to analysis
- Cheap in computational costs
- Fastest growing perturbations in the analysis



LAEF – upper air perturbations

- Blending
  - Combination of small scale perturbations from Breeding with large scale perturbations from ECMWF-EPS
  - Spectral blending by the use of Standard Dolph-Chebyshev Digital Filter



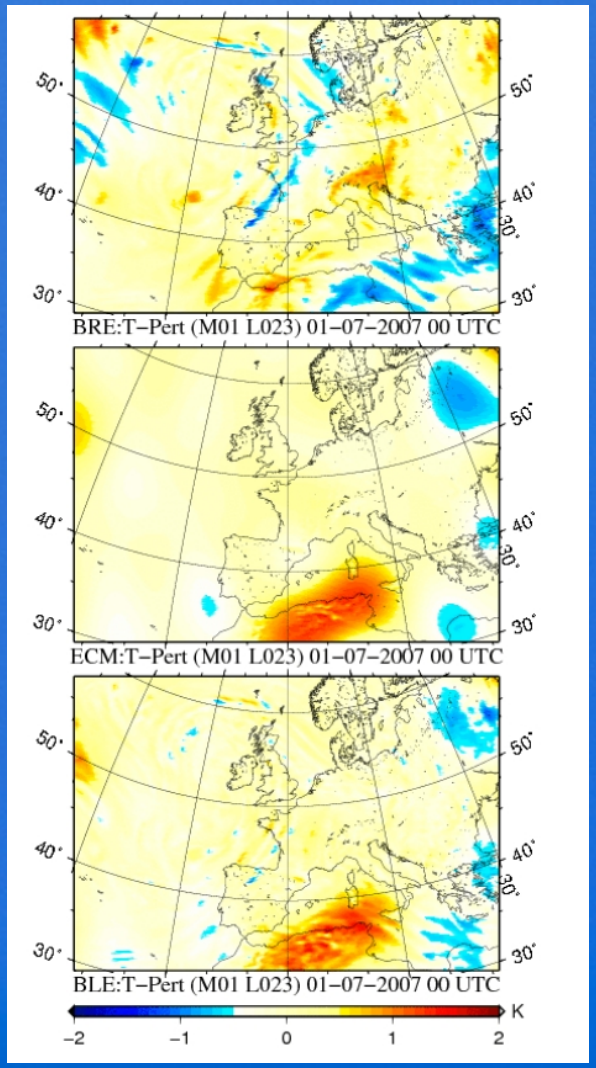
LAEF – upper air perturbations

Temperature perturbation at 850 hPa

A_{BR}

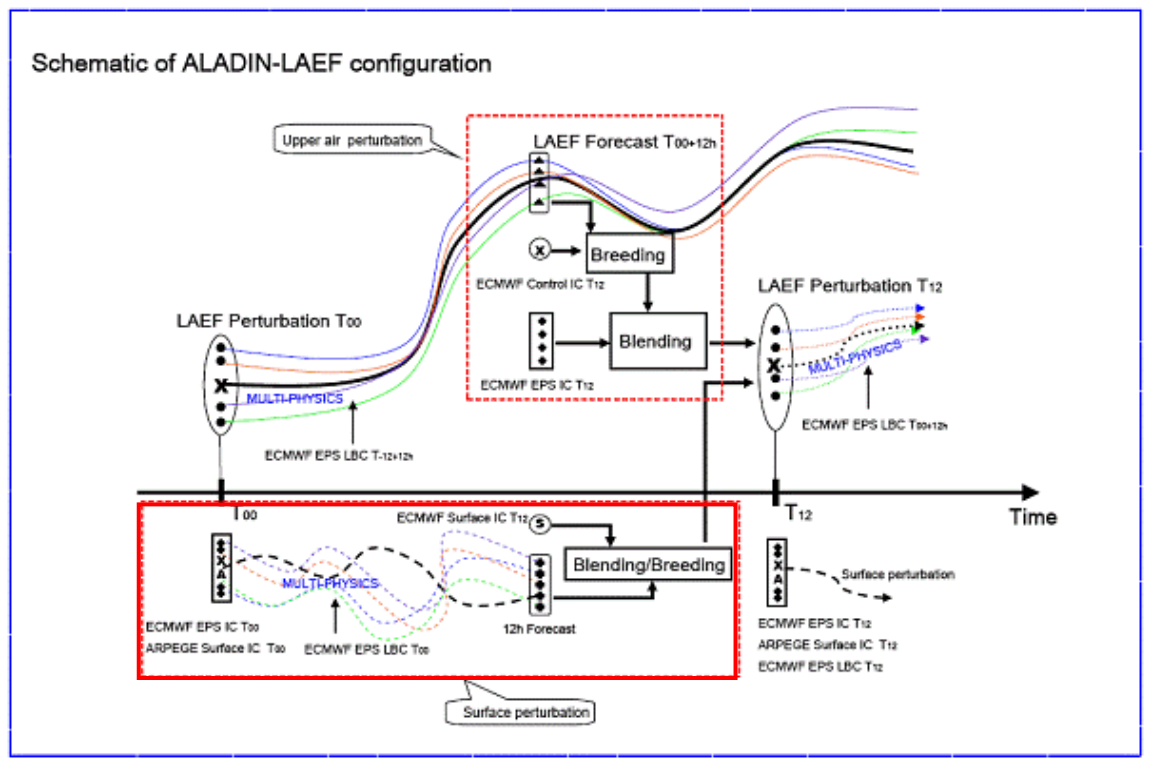
A_{SV}

I_{BLEND}



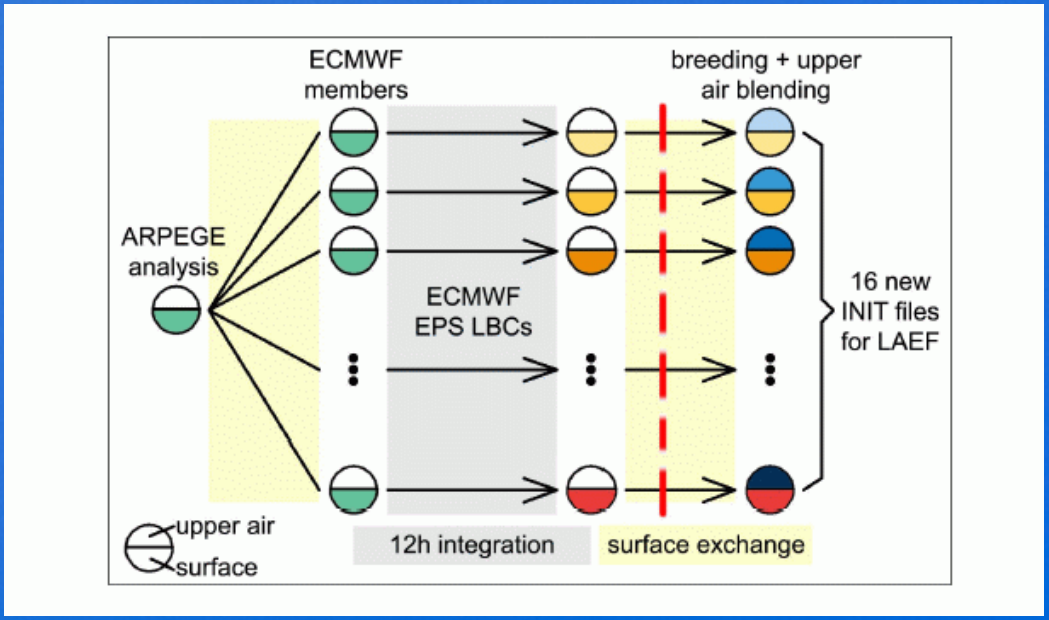
M. Bellus, 2009

Generation of initial surface perturbations by Non-cycling Breeding/Blending technique



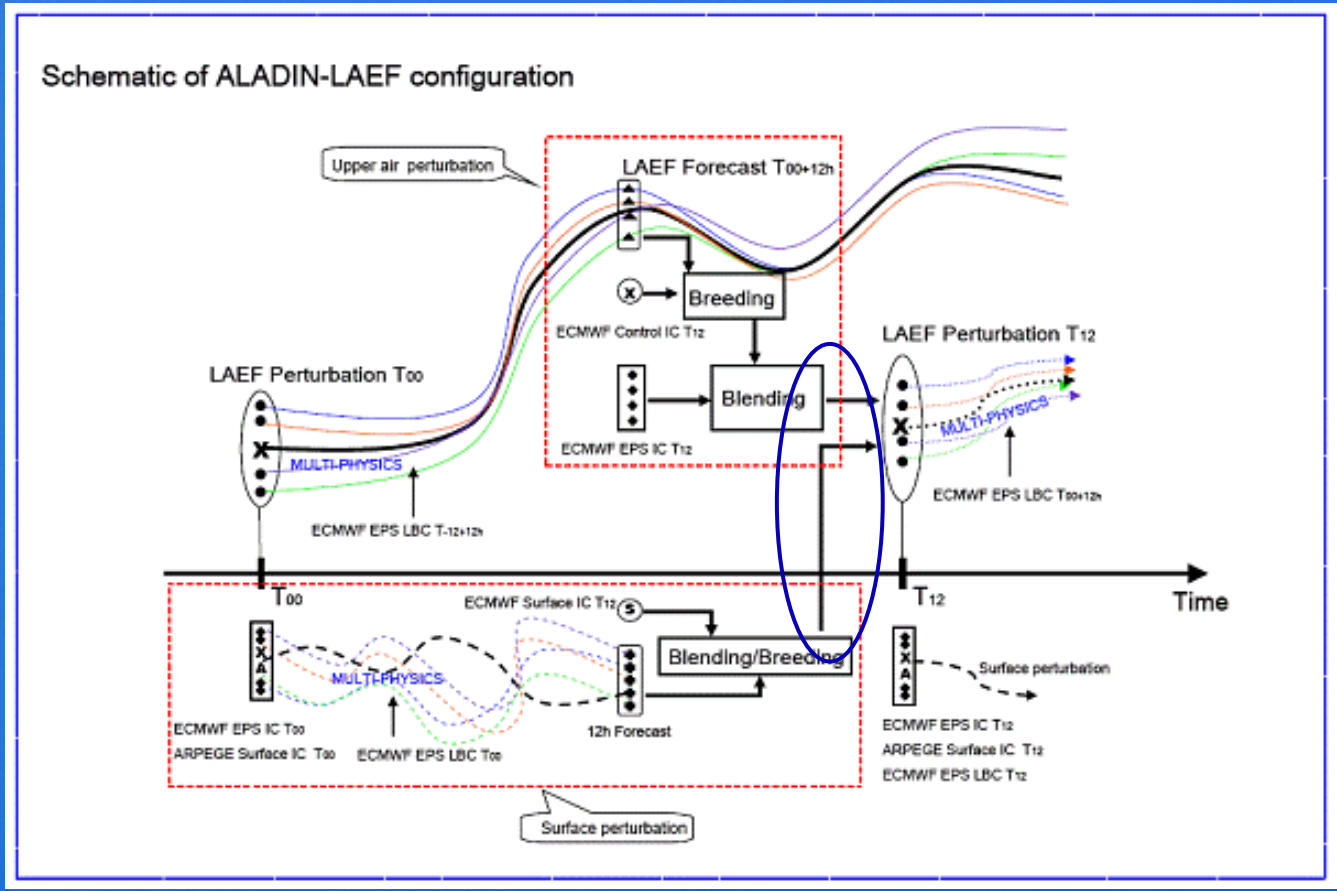
LAEF – surface perturbations

- Surface blending of ECMWF-EPS members with ARPEGE surface analysis
  - All members with same surface fields but different atmospheric fields
- Perform 12h multiphysics forecast with ECMWF-EPS atmospheric forcing
  - Results in 16 perturbed surface fields



LAEF – Generation of Initial perturbations

- Combination of upper air perturbations with surface perturbations lead to 16 different initial conditions for forecasts



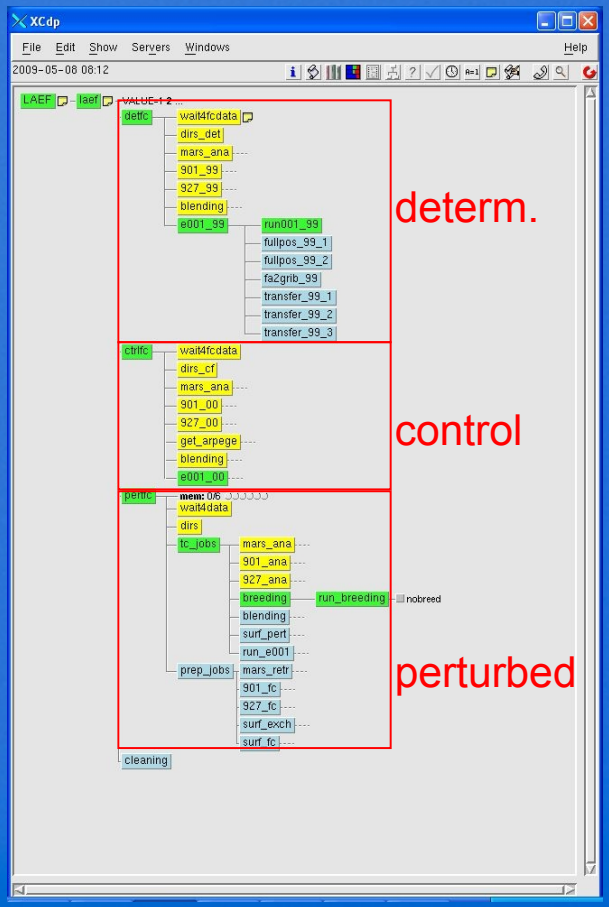
Multi-Physics Design

Each member runs forecast with slightly different model configuration (Multi-physics)

mem #	configuration	Cloud-physics	deep convection	radiation	turbulent transport	shallow convection	mixing length &entrainment rate
M 1	ALADIN-25	Kessler	BGMC	RG	Louis81	JFG03	Setting_0
M 2	ALADIN-25	Kessler	BGCP	RG	Louis81	JFG03	Setting_1
M 3	HARMONIE	Sunqunist	STRACO	Savijarvi90	CBR+S90	JFG03	---
M 4	ALARO+3MT	Alaro	3MT	JFG05	JFG06	JFG03	---
M 5	ALADIN-32	Lopez	BGMC	ECMWF	Louis81	KFB	Setting_0
M 6	ALADIN-32	Lopez	BGCP	ECMWF	Louis81	KFB	Setting_1
M 7	ALARO	Alaro	BG_MCON	JFG05	JFG06	JFG03	---
M 8	ALARO	Alaro	BG_MCON	JFG05	JFG06	JFG03	---
M 9	ALADIN-32	Lopez	BG_MCON	ECMWF	CBR+B81	KFB	Setting_0
M 10	ALADIN-32	Lopez	BG_CAPE	ECMWF	CBR+B81	KFB	Setting_1
M 11	ALADIN-32	Lopez	BG_MCON	ECMWF	CBR+S90	KFB	Setting_0
M 12	ALADIN-32	Lopez	BG_CAPE	ECMWF	CBR+S90	KFB	Setting_1
M 13	ALADIN-32	Lopez	BG_MCON	ECMWF	CBR+S90	JFG03	Setting_0
M 14	ALADIN-32	Lopez	BG_CAPE	ECMWF	CBR+S90	JFG03	Setting_1
M 15	ALARO+3MT	Alaro+XR	3MT	JFG05	JFG06	JFG03	---
M 16	ALARO+3MT	Alaro+XR1	3MT	JFG05	JFG06	JFG03	---
M 0	ALARO	Alaro	BG_MCON	JFG05	JFG06	JFG03	---
M 99	ALADIN-32	Lopez	BG_MCON	ECMWF	Louis81	KFB	Setting_0

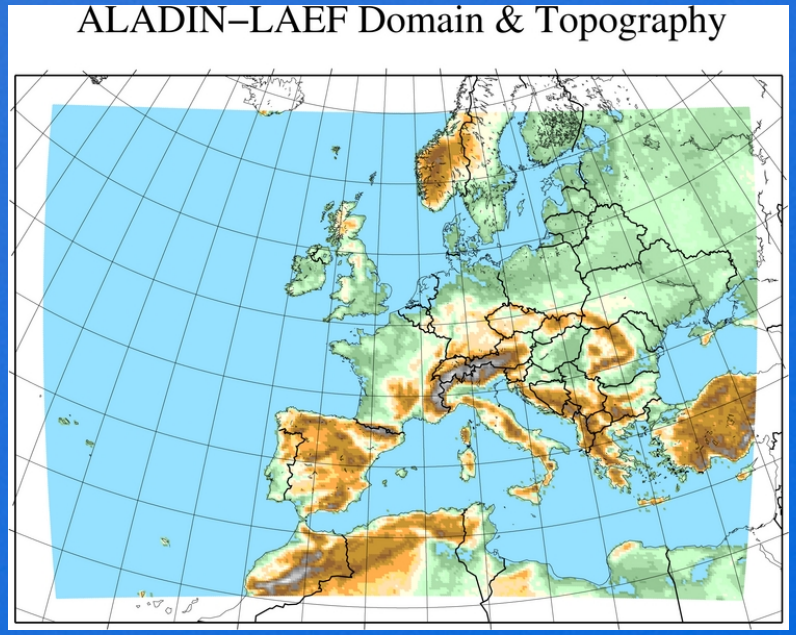
Implementation at ECMWF

- Implementation in the **S**upervisor **M**onitor **S**cheduler-Environment (Time critical option 1)
- Operational use since 11th February 2009



LAEF 2nd generation – domain and setup

Ensemble size	16+1+1
Horizontal resolution	18/6,5 km
Vertical resolution	37/45 layer
Runs/Day	2 (00, 12 UTC)
Forecast range	60h
Output-Frequency	1h
Model time step	720s
Coupling-Model (time-lagged)	*ECMWF-EPS (SV Vectors, first 16 members)*
Coupling-Update	6h



Next steps & plans

- Operational archiving of LAEF-results in MARS archive at ECMWF
- Migration of the System on the new high-performance computer at ECMWF
- Enhancement of horizontal resolution of perturbed member (dx,dy ~ 10km)
- Comparison of LAEF system with 50 member on lower resolution with high resolved system with 16 member.

Impact of Clustering

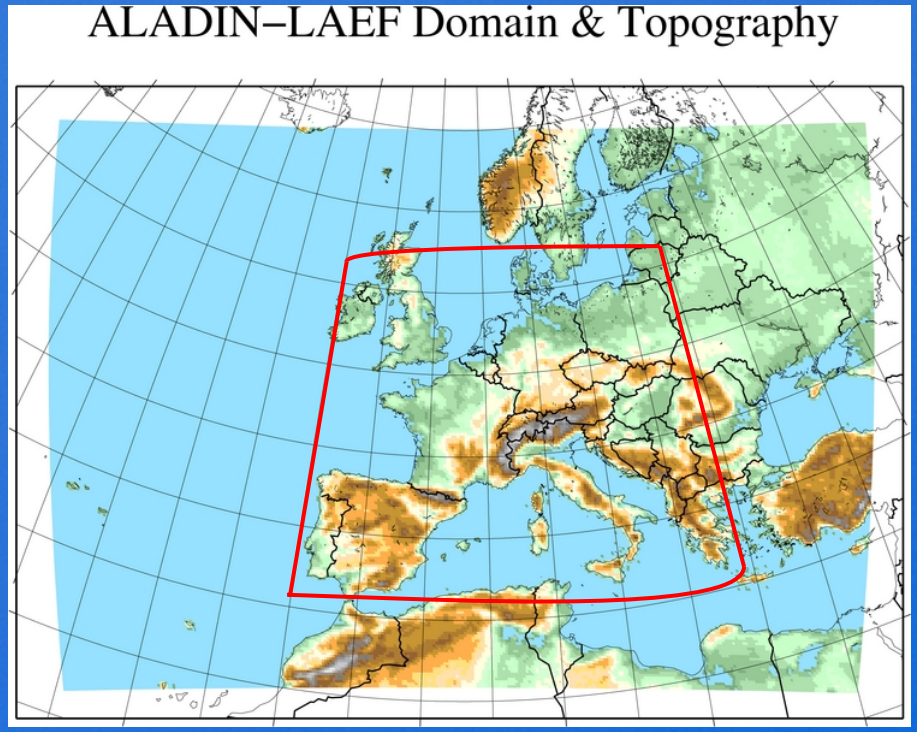
Status quo:

First 16 members of the 50 ECMWF-EPS member are chosen as coupling fields -> Information of 34 member are not used

Experiments have been performed, running ALADIN-LAEF with **R**epresentative **M**embers as coupling and initial conditions. The **RM** are determined using clustering method from ARPA-SMR (Bologna).

Impact of Clustering

Definition of domain for clustering, depends on fc-range of interest



Impact of Clustering

Definition of domain for clustering, depends on fc-range of interest

Input: 48h fc of 50 ECMWF-EPS Member (Z,U,V,T,Q) at 3 pressure levels (850,700,500 hPa)

Targeted to high sensibility to rainfall

Impact of Clustering

Definition of domain for clustering, depends on fc-range of interest

Input: 48h fc of 50 ECMWF-EPS Member (Z,U,V,T,Q) at 3 pressure levels (850,700,500 hPa)

Compute clusters (depends on number of clusters)

Standardization of all variables (deviation from domain mean divided by standard deviation)

Definition of clusters by *Complete Linkage Algorithm*
-Different clusters are allocated to one cluster as long as the prescribed cluster number is achieved
-Criterion: Longest distance between two members of different clusters

Impact of Clustering

Definition of domain for clustering, depends on fc-range of interest

Input: 48h fc of 50 ECMWF-EPS Member (Z,U,V,T,Q) at 3 pressure levels (850,700,500 hPa)

Compute clusters (depends on number of clusters)

Define **R**epresentative **M**ember of each cluster

RM is the member with smallest ratio between average distance to members belonging to the same cluster and all other members

Impact of Clustering

Two experiments have been implemented:

• Definition of 8 clusters and their representative members, where the associated pair member from Singular Vector method is also considered.

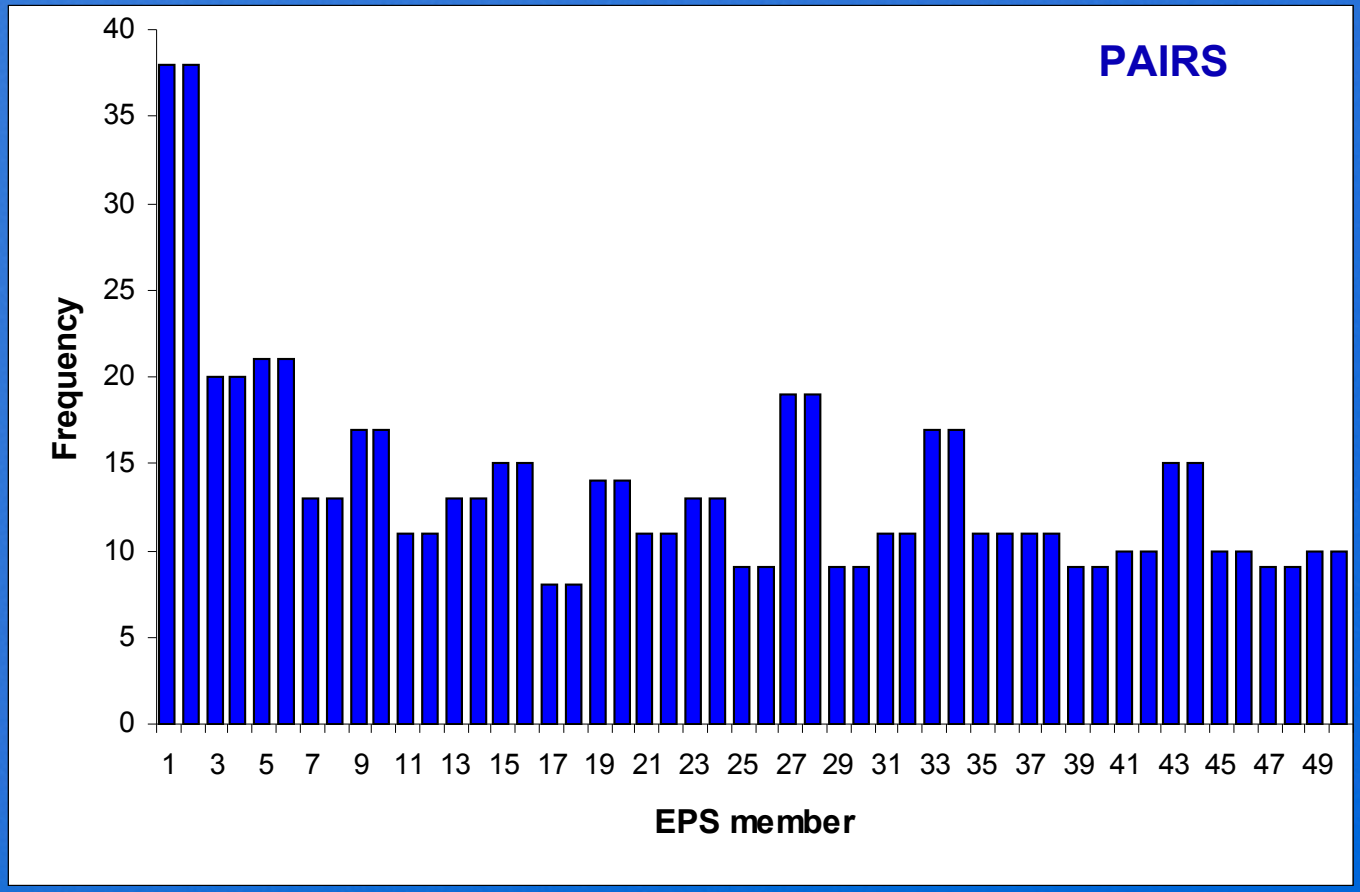
• Definition of 16 clusters and selection of the representative member as coupling field for ALADIN-LAEF.

- 24 days test period, 01.04. – 24.04.2009

- 2 runs per day with operational ALADIN-LAEF setup

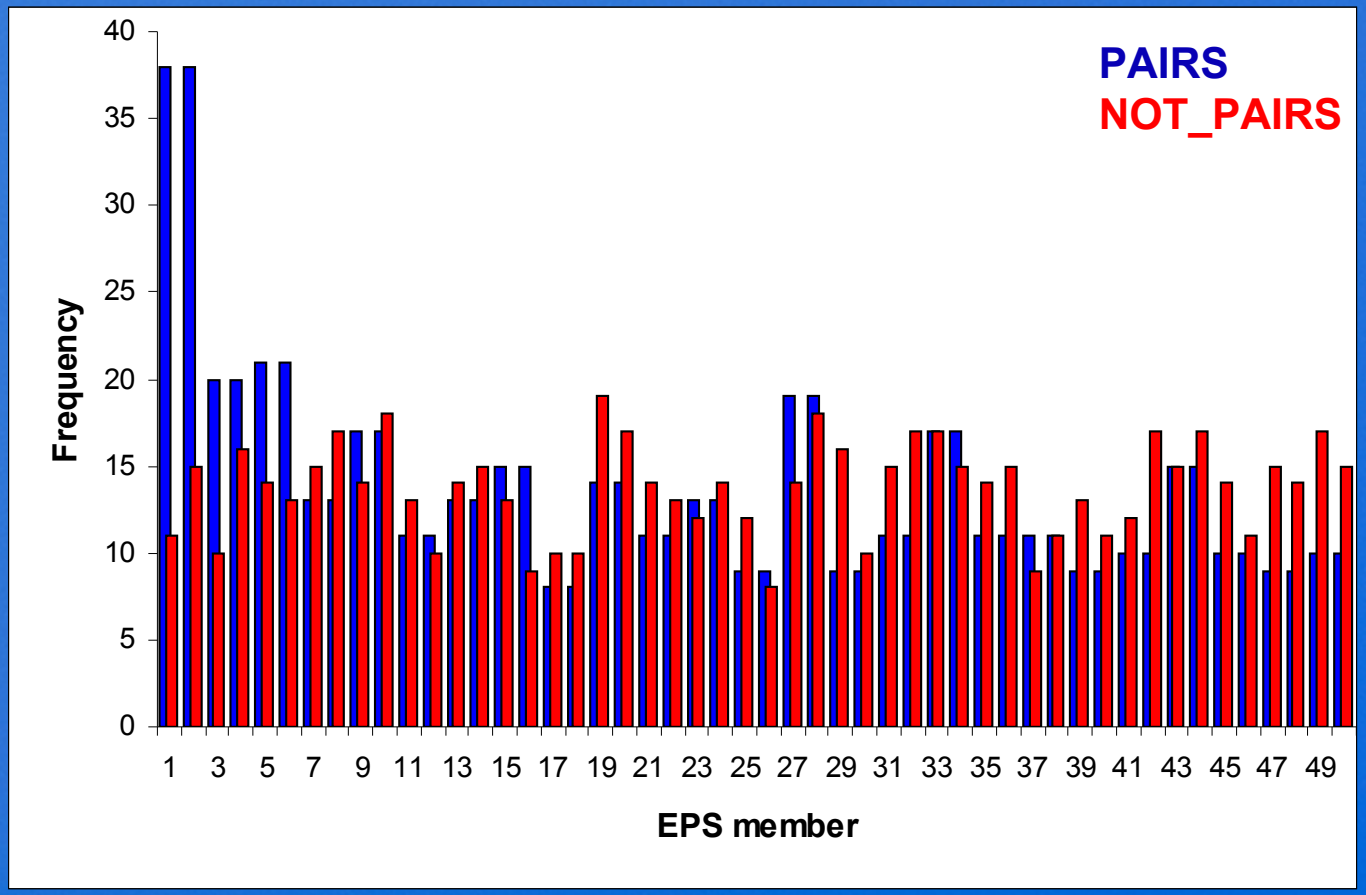
Impact of Clustering

Frequency distribution of members selected by clustering
Experiment: **pairs**



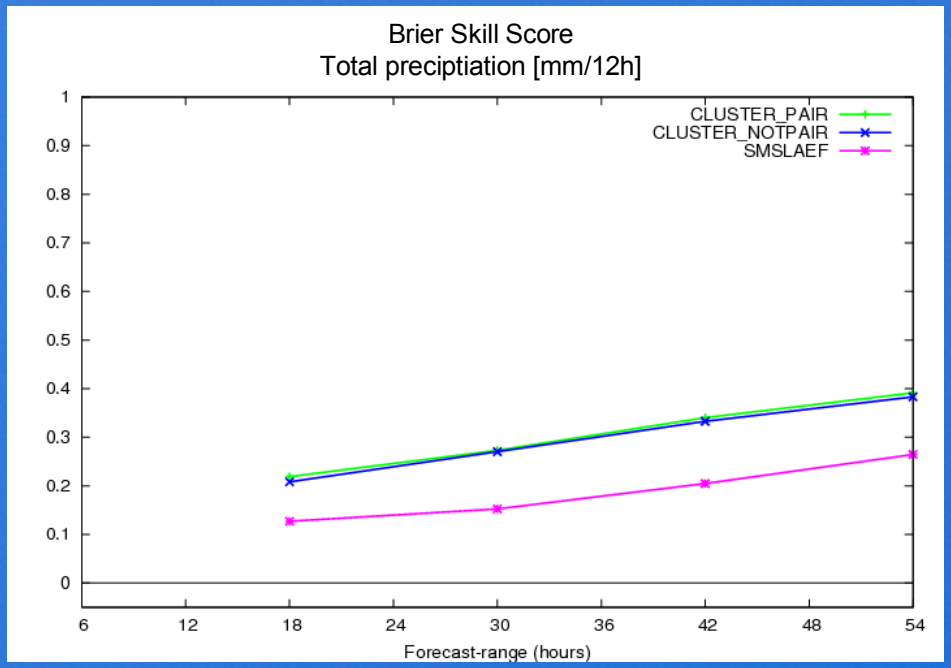
Impact of Clustering

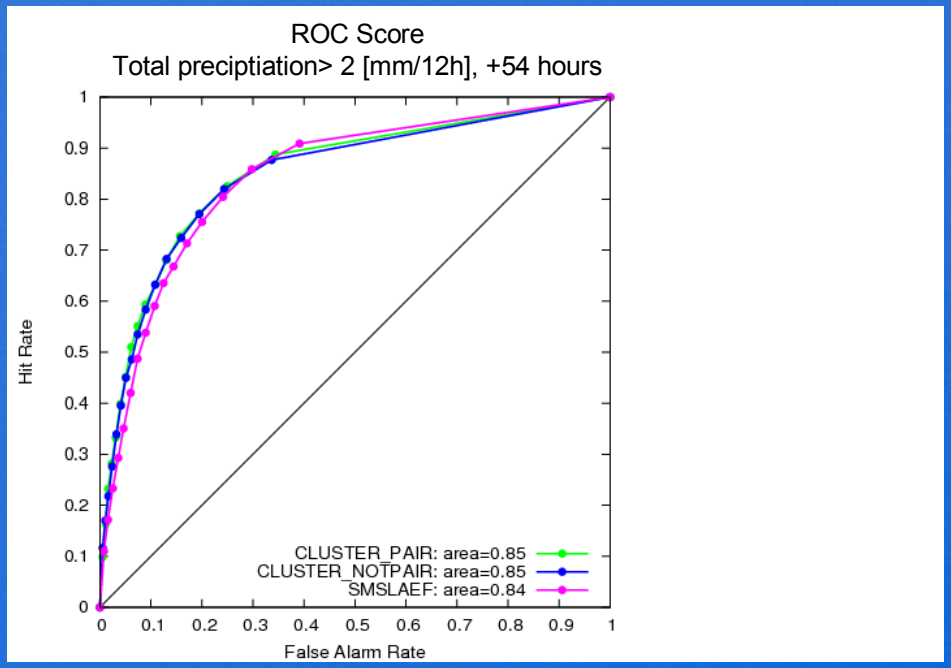
Frequency distribution of members selected by clustering
Experiment: **pairs & not_pairs**



Preliminary results

Impact on precipitation forecast



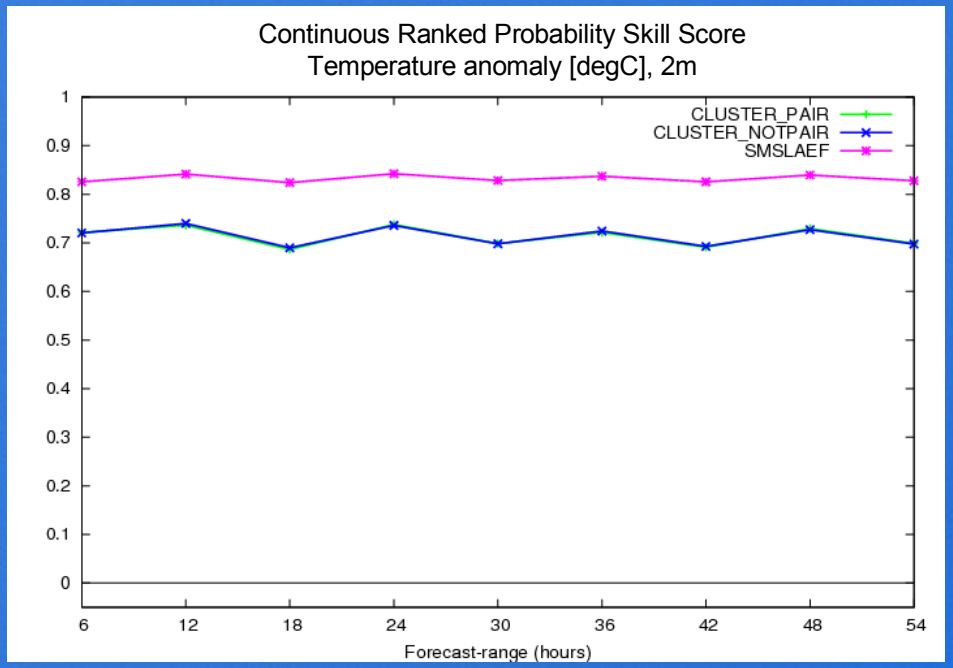


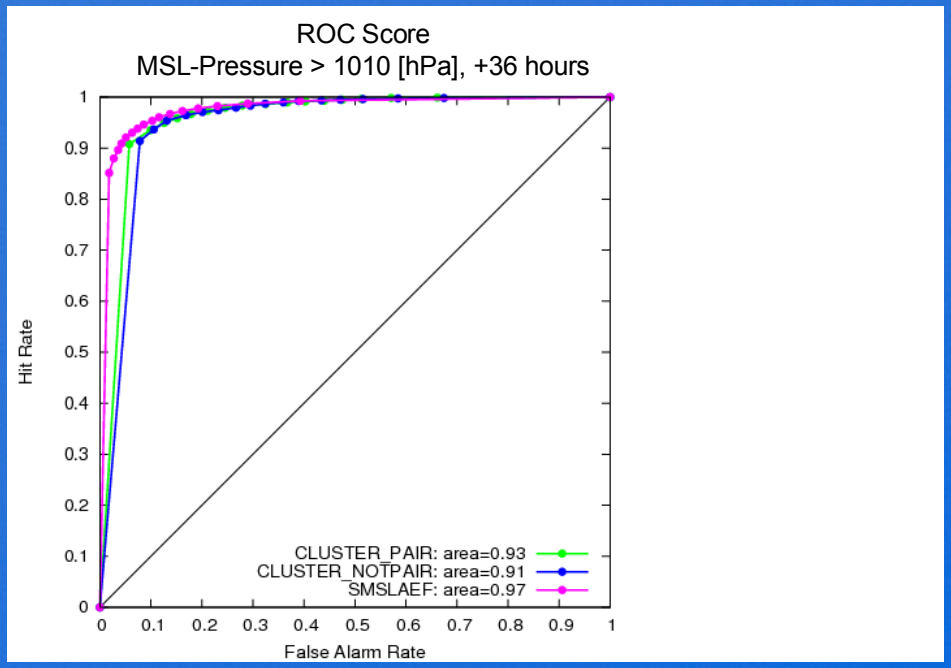
Experiments with clustering perform much better than operational LAEF (pink). Method of clustering lead to almost identical results.

ROC curve and area under the curve for precipitation > 2mm/12h, lead time 54h. Only very little improvement with clustering.

Preliminary results

Impact on other variables





CPRSS (with ECMWF analyses as reference) of 2m temperature as function of lead time. Operational LAEF performs significantly better than experiments.

ROC curve and area under the curve for Mean Sea Level Pressure > 1010 hPa, lead time 36h. Operational LAEF performs best. Slight difference between experiments (Not-pairs clustering slightly better).

Conclusions

- 2nd generation ALADIN-LAEF was successfully implemented at ECMWF
- Runs operational since February 2009

- Experiments have been performed to find the impact of clustering on the performance of ALADIN-LAEF
- First results showed a slight improvement for precipitation forecast
- **BUT:** At the cost of a decline in the performance of other parameter

-> Further experiments are needed to optimize the clustering method.