COSMO–LEPS status report: operational implementation and possible developments

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COSMO–LEPS project: LM–based ensemble forecasts

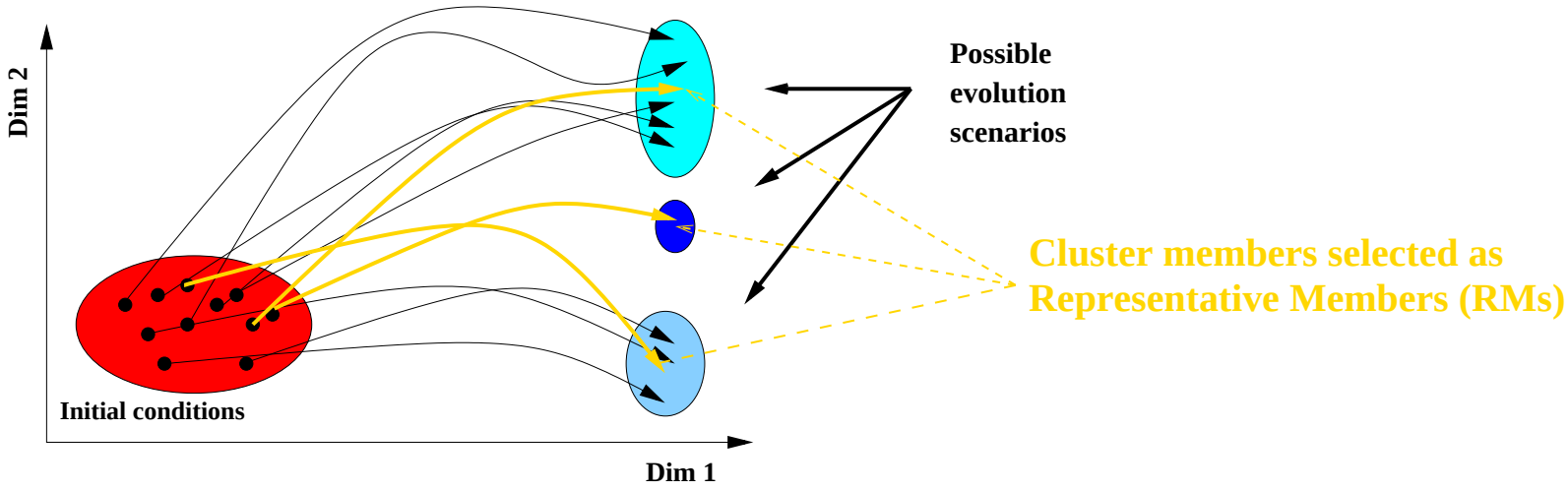
- Why?

- The horizontal resolution of global–model ensemble forecast systems is limited by computer time constaints and does not allow a detailed description of mesoscale and orographic–related processes.
- The forecast of heavy precipitation events is often inaccurate (in terms of both location and intensity) after the short–range.

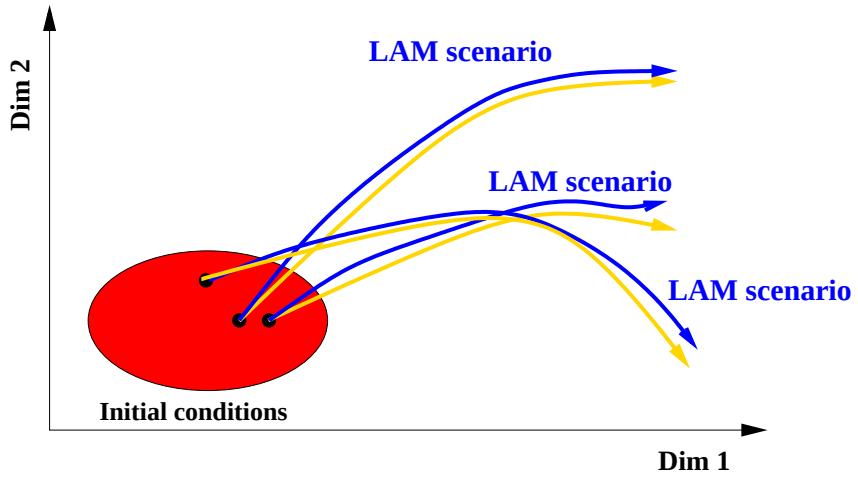
- How?

- Combine the advantages of global–model ensembles with the high resolution details gained by the LAMs, so as to identify the possible occurrence of **intense** and **localised** weather events (heavy rainfall, strong winds, temperature anomalies, snowfall, . . .).
- **Generate COSMO–LEPS system in order to improve the short to medium–range forecast ($48\ h < \Delta t < 120\ h$) of the so–called "severe weather events".**

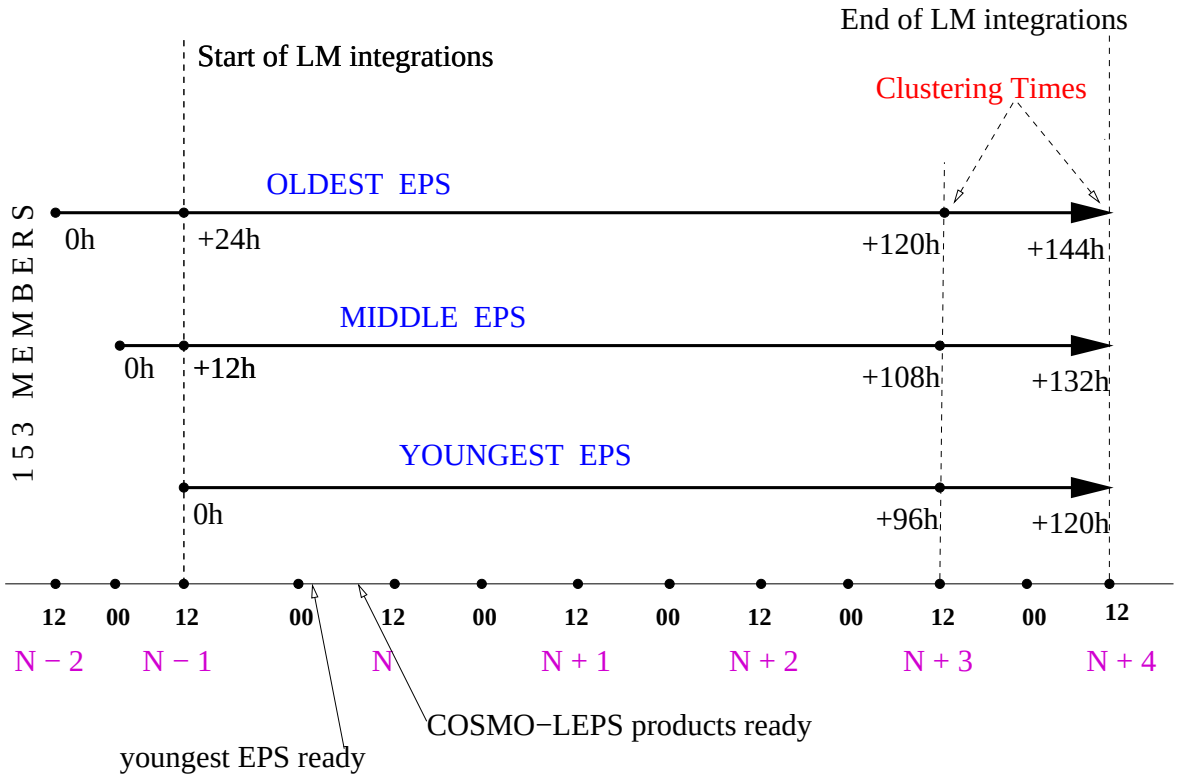
Methodology: ensemble–size reduction technique



LAM integrations driven by RMs



COSMO–LEPS super–ensemble

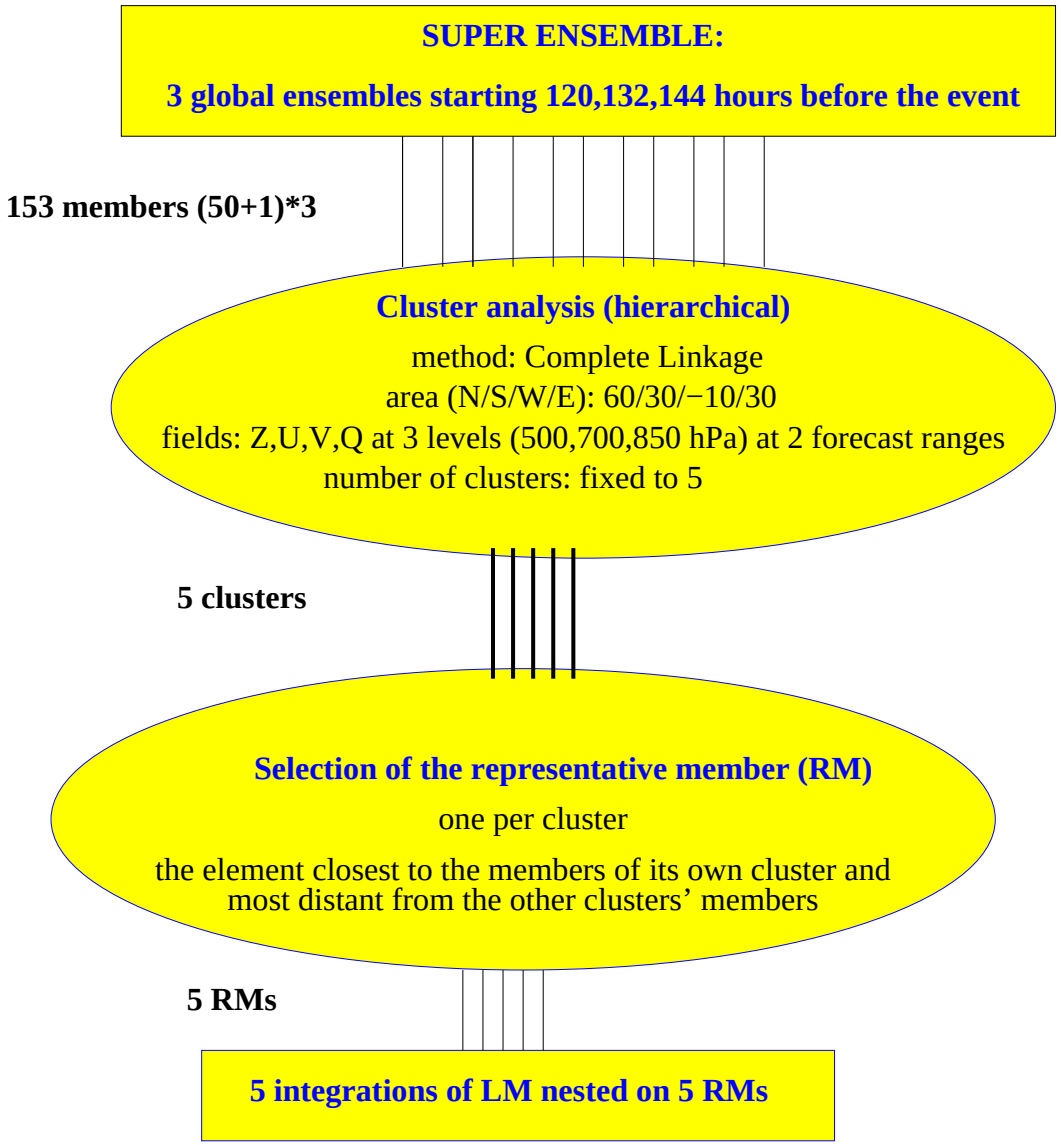


⇒ use three consecutive (12–hour lagged) ECMWF ensembles so as to generate a **super–ensemble** with 153 members, which can explore a wider part of the "unstable phase space";

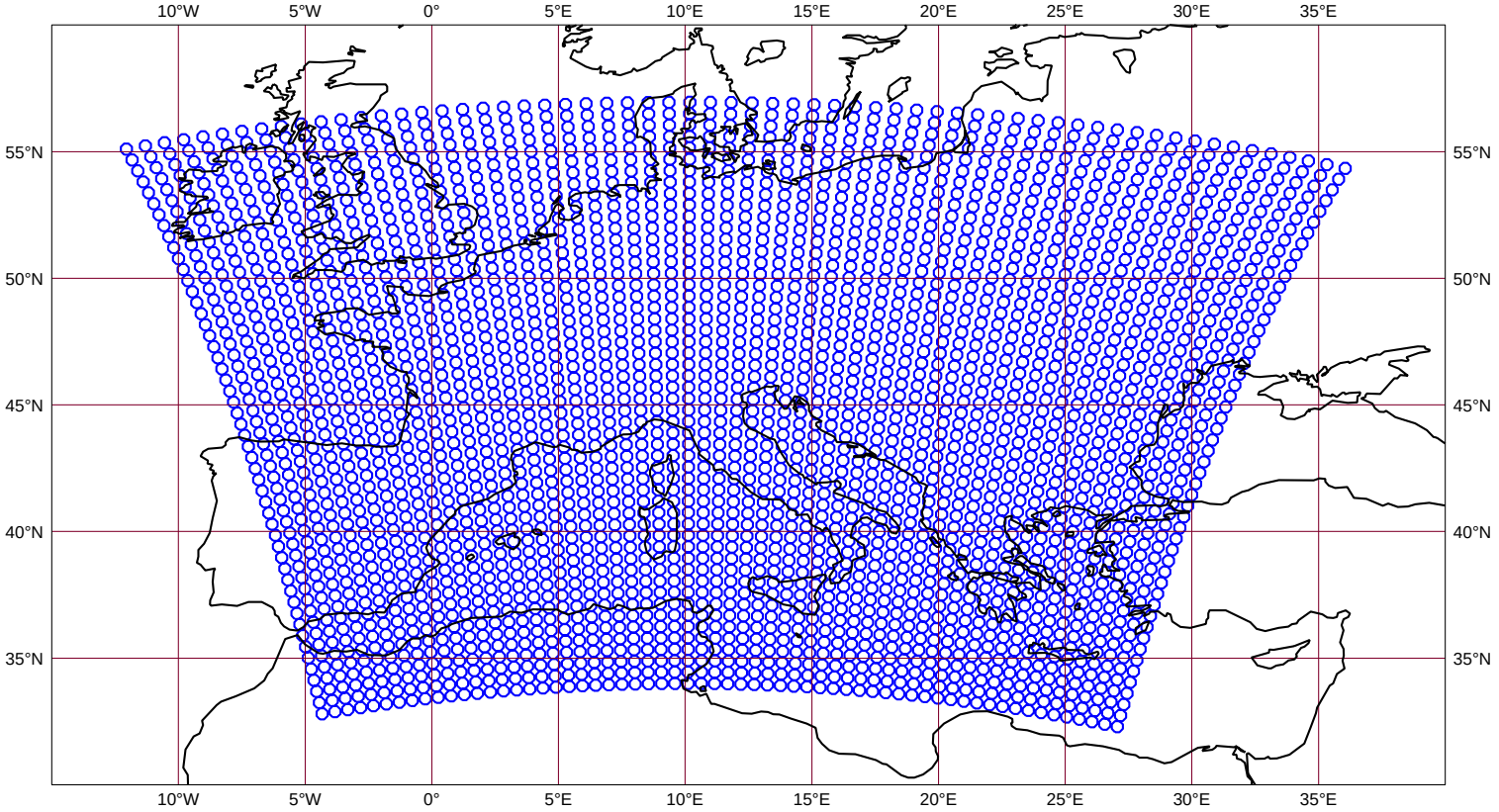
⇒ 12–00–12 configuration ("YOUNGEST EPS" ready by 1 UTC); **LM runs end by 3 UTC**;

⇒ COSMO–LEPS products get to weather services in time to be used (up to day $N + 4$).

Methodology details

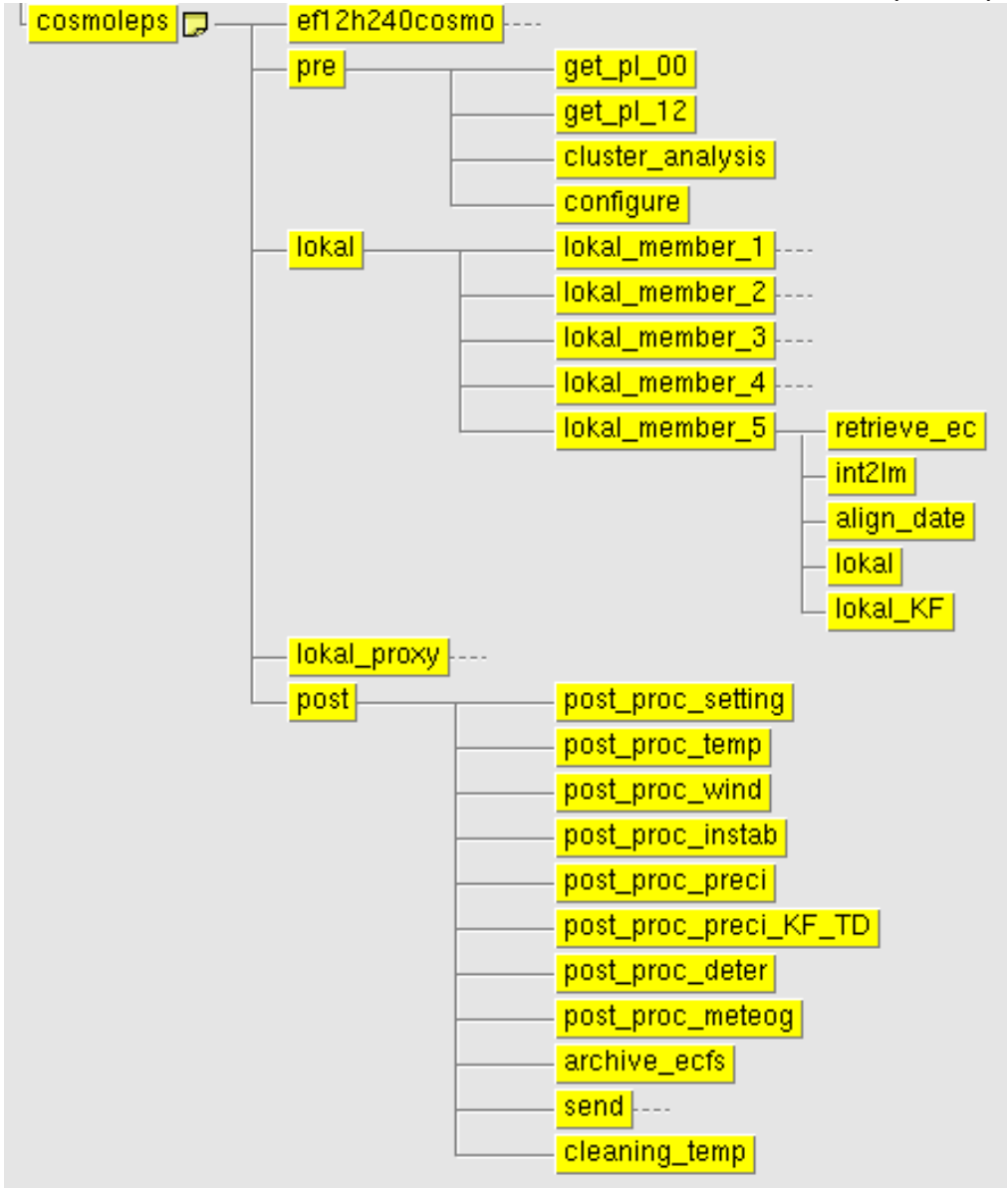


COSMO–LEPS domain



- $\Delta x \simeq 10$ km (306 $\times$ 258 = 78948 grid points); 32 vertical levels; time–step: 60 sec;
- forecast length: 120 h; elapsed time $\approx$ 58 min (84 "tasks" of ECMWF IBM);
- $\forall$ LM run, total CPU time $\approx$ 120h.

COSMO–LEPS operational suite (since 4/11/2002)



LM output (1)

probabilistic products:

- prob of 24h rainfall exceeding 20, 50, 100, 150 mm;
- prob of 72h rainfall exceeding 50, 100, 150, 250 mm;
- prob of 24h snowfall exceeding 1, 5, 10, 20 "**cm**";
- prob of UVmax$_{10m}$ in 24h above 10, 15, 20, 25 m/s;
- prob of Tmax$_{2m}$ in 24h above 20, 30, 35, 40 ^{0}C;
- prob of Tmin$_{2m}$ in 24h below -10, -5, 0, $+5$ ^{0}C;
- prob of max–CAPE in 24h above 2000, 2500, 3000, 3500 J/kg;
- prob of min Showalter Index in 24h below 0, -2, -4, -6;

Showalter Index $= T_{500} - Tp_{500}$

Tp_{500} is the temperature of the parcel lifted dry adiabatically $from\ 850\ hPa$ to its condensation level and moist adiabatically to 500 hPa.

LM output (2)

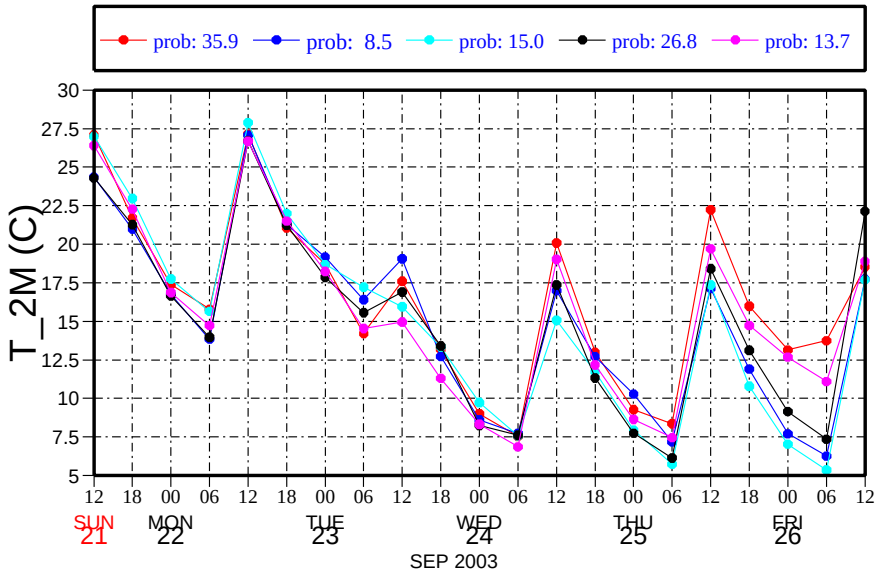
deterministic products; for each LM run:

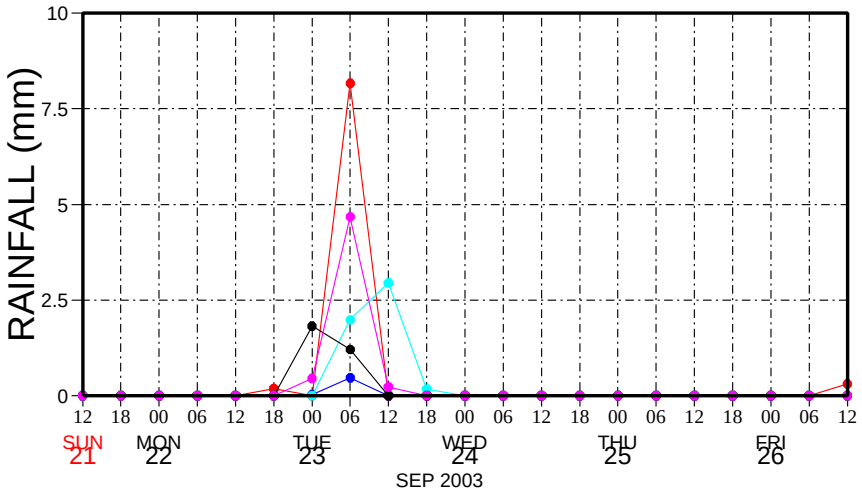
- 24–hour cumulated rainfall;
- MSLP, Z700, T850;

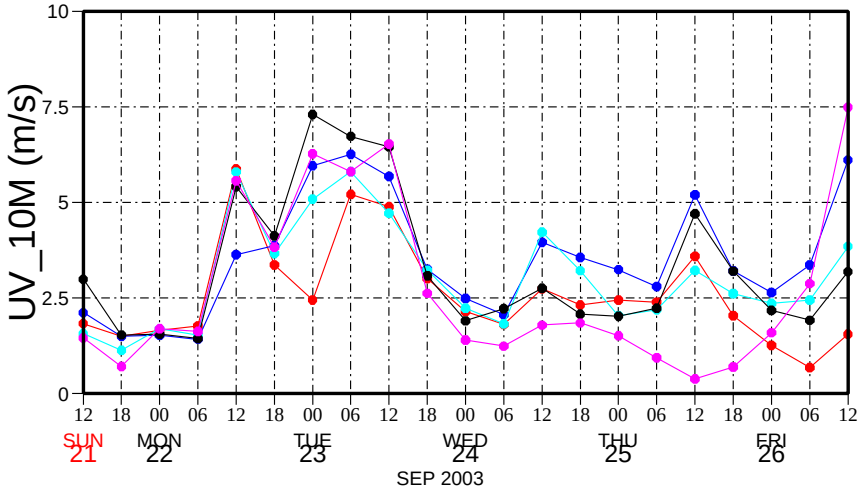
meteograms:

- T_{2m}, rainfall, 10m wind speed.

Meteogram for Langen







Recent developments

- test 10–member COSMO–LEPS: 5 boundary conditions, but

  5 LM runs using Tiedke convection scheme (TD runs),

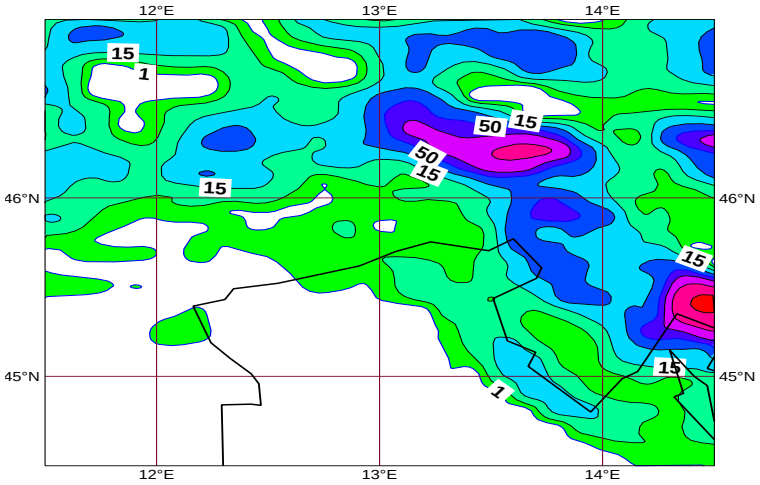
  5 LM runs using Kain-Fritsch convection scheme (KF runs);

- study cluster behaviour;

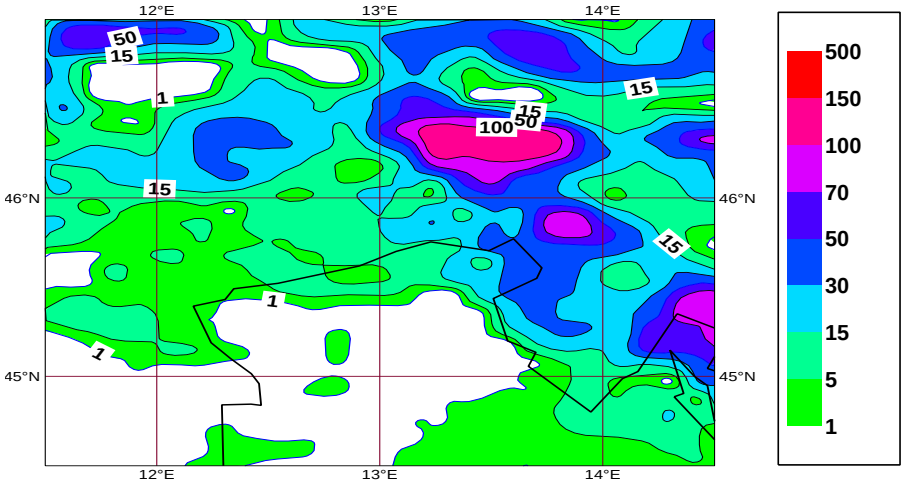
- test different configurations of the clustering–selection technique.

Tiedke vs Kain-Fritsch (tp +24–48; VT: 30/8/2003, 12UTC)

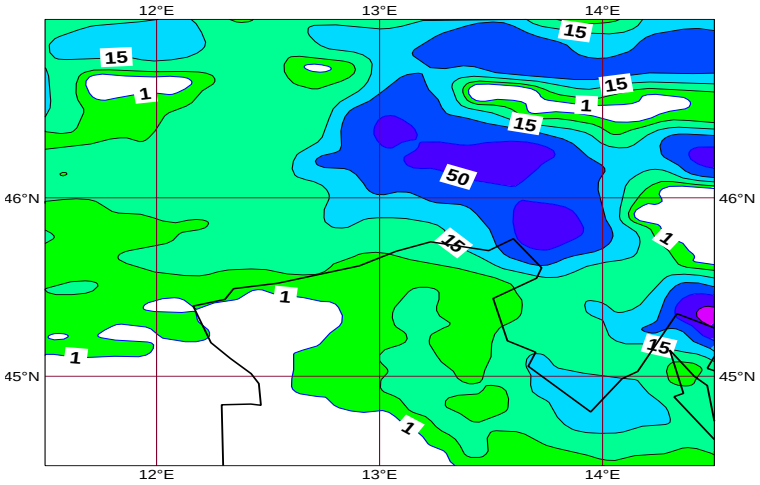
LM1–TD (pop 57)



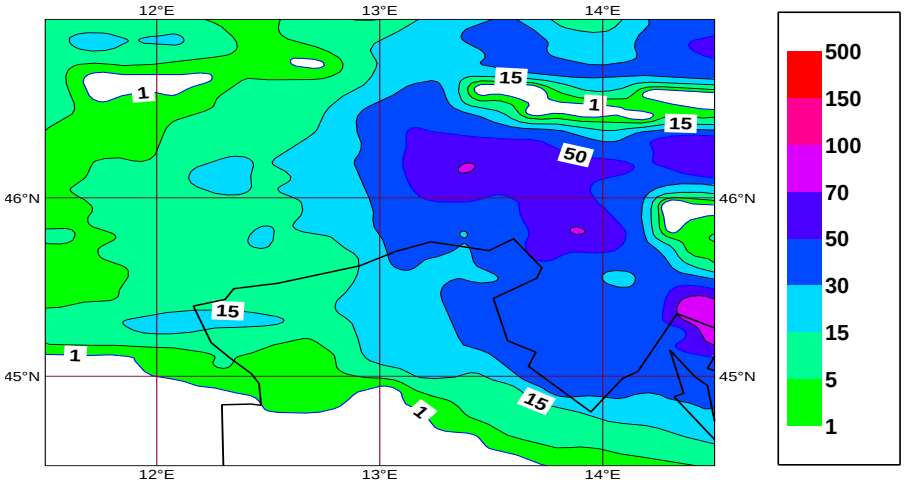
LM2–TD (pop 68)



LM1–KF (pop 57)



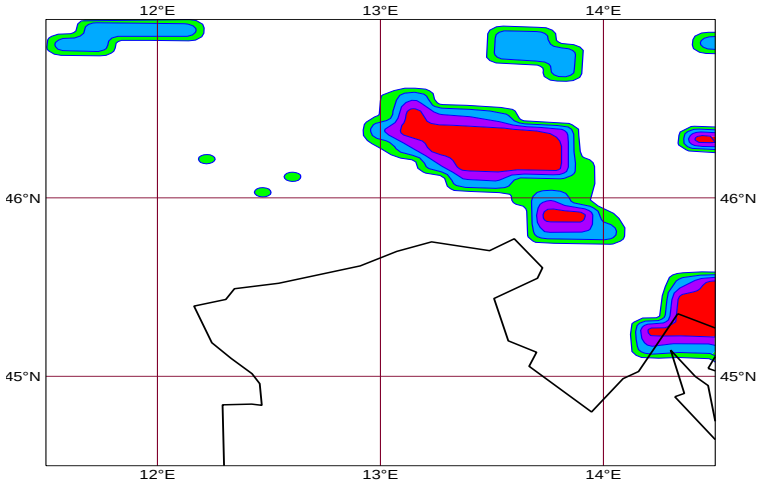
LM2–KF (pop 68)



Prob. maps: tp_{24h} (fc+24–48) $>$ 50, 100 mm; VT: 30/8/2003 12UTC

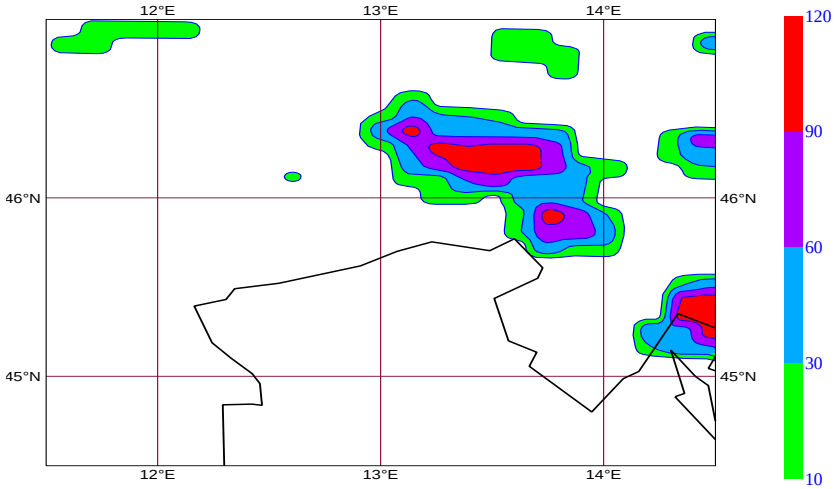
5 members (5 TD)

tp $>$ 50 mm

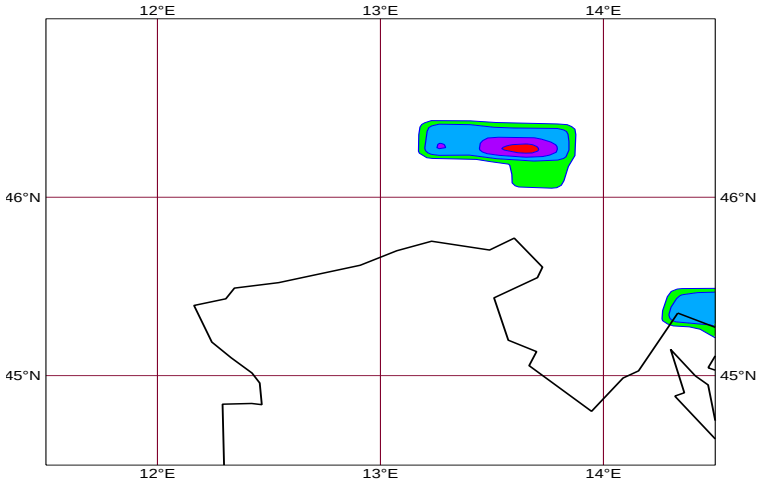


10 members (5 TD + 5 KF)

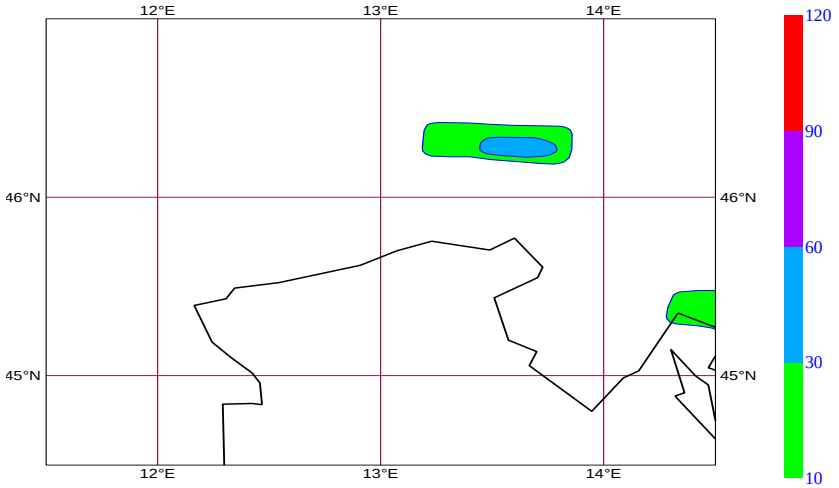
tp $>$ 50 mm



tp $>$ 100 mm

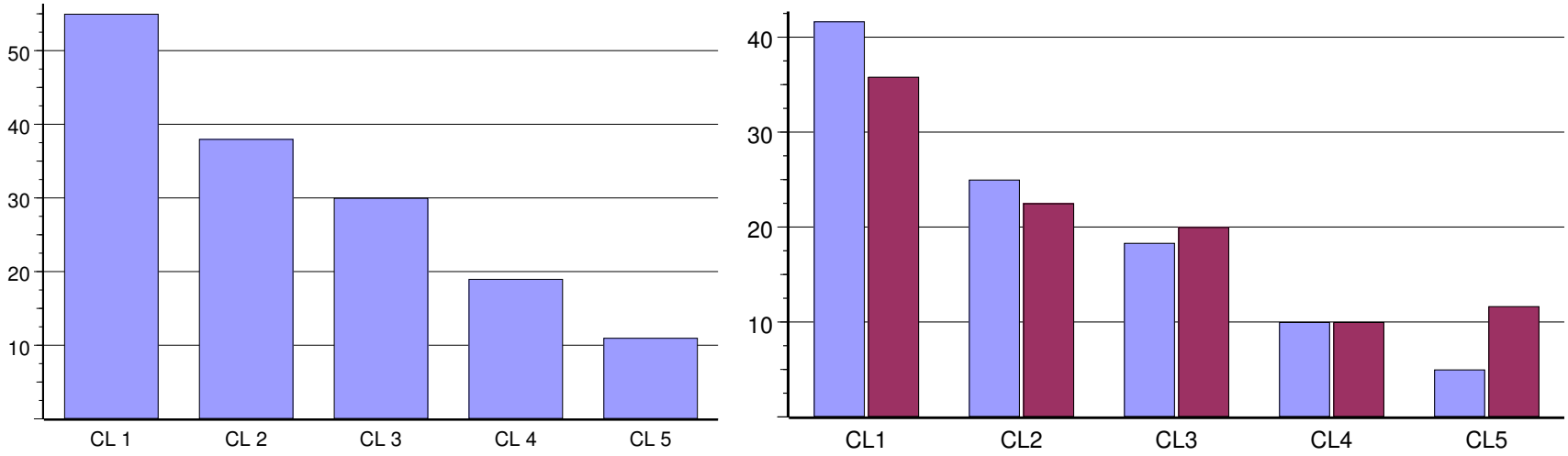


tp $>$ 100 mm

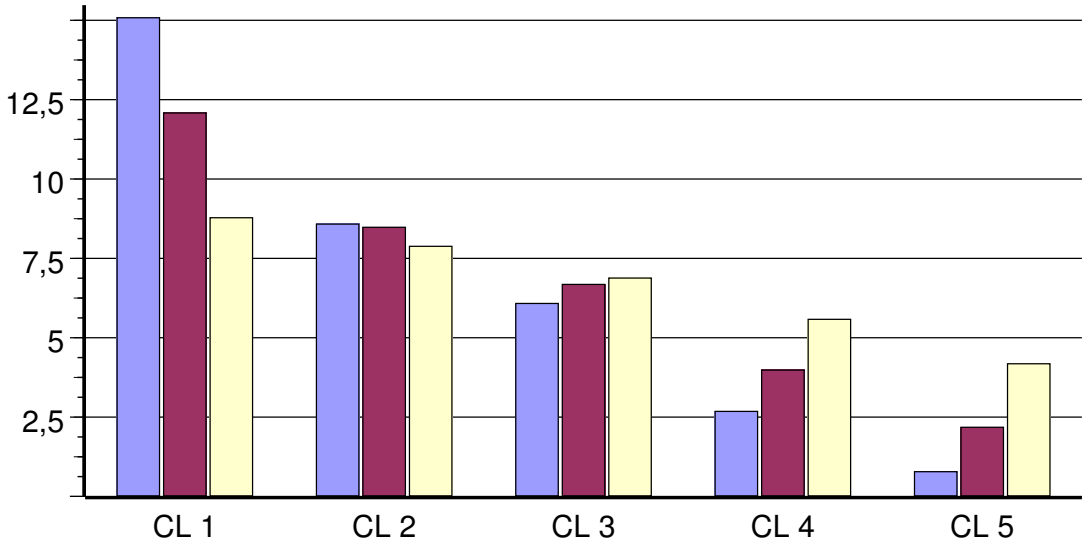


Mean cluster size djf 2002–2003 Reliability (%)

clustering order decreasing–size order

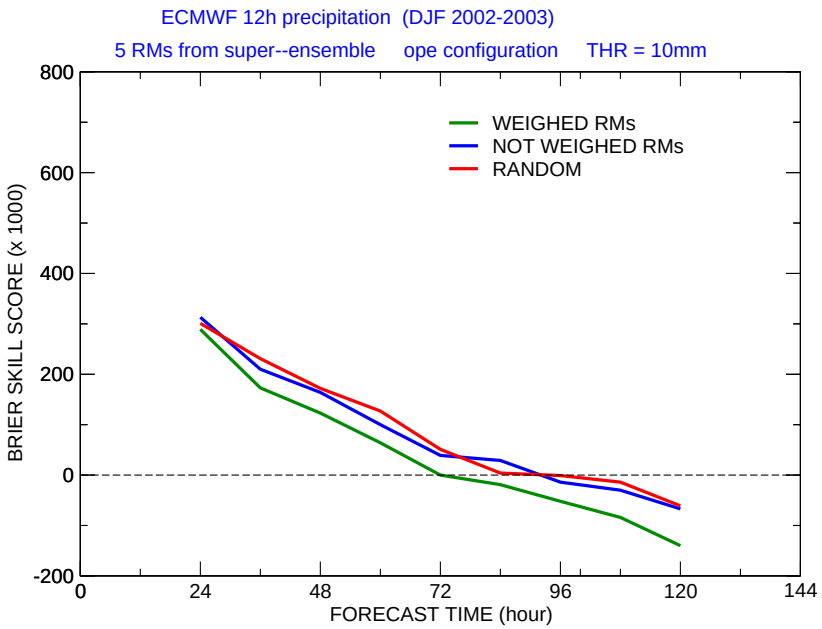


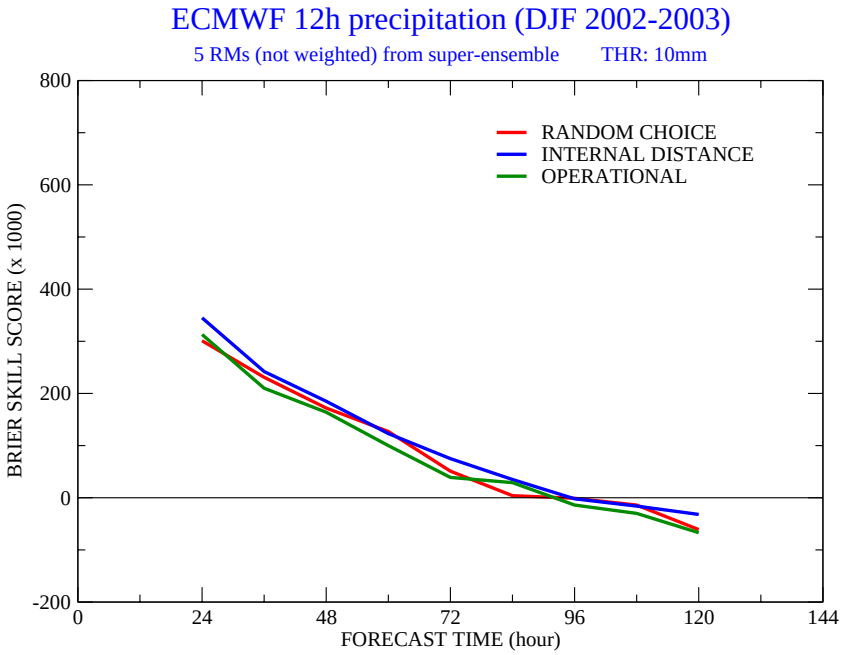
Percentage of EPS members in the clusters (YOUNGEST, MIDDLE, OLDEST)



Impact of the clustering–selection technique

Skill of the "reduced" (5–member) EPS





IT LOOKS AS IF:

- 5–member not–weighted EPS performs better;
- the way each RM is selected might be modified.

⇒ **wait for (at least!) one year of statistics before making any change.**

Results

- since 4 November 2002, COSMO–LEPS (based on Lokal Modell at 10 km, with 32 vertical levels) has been operationally running at ECMWF;
- probabilistic and deterministic products (from fc+48h to fc+120h) are disseminated to the COSMO community on a daily basis;
- first results on extreme events are promising;
- LM–based "rainfall analysis" available since 1 November 2002;
- noticeable (not dramatic) sensitivity to the convection scheme (more rainfall using Tiedke scheme; Kain–Fritsch scheme seems to produce larger amounts over the sea).

Future developments

- implement dissemination to Greece and Poland;
- archive COSMO–LEPS grib files under MARS at ECMWF;
- dissemination to non–COSMO countries (e.g. France)?
- address ECMWF request to have a back–up suite in case of ECMWF failures;
- test different combinations of clustering variables and sizes of the super–ensemble;
- MANY MORE billing units available for each member state at ECMWF: switch to 10–member COSMO–LEPS?
- COSMO–LEPS is expensive from a computational point of view (10–member COSMO–LEPS costs about 3200 BU per day): is it worth? $\Rightarrow$ VERIFICATION (next talk!!!).