

COSMO-LEPS status report

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Introduction

- **What is it?** It is a **L**imited–area **E**nsemble **P**rediction **S**ystem (**LEPS**), based on Lokal Modell (LM) and developed within **COSMO**.

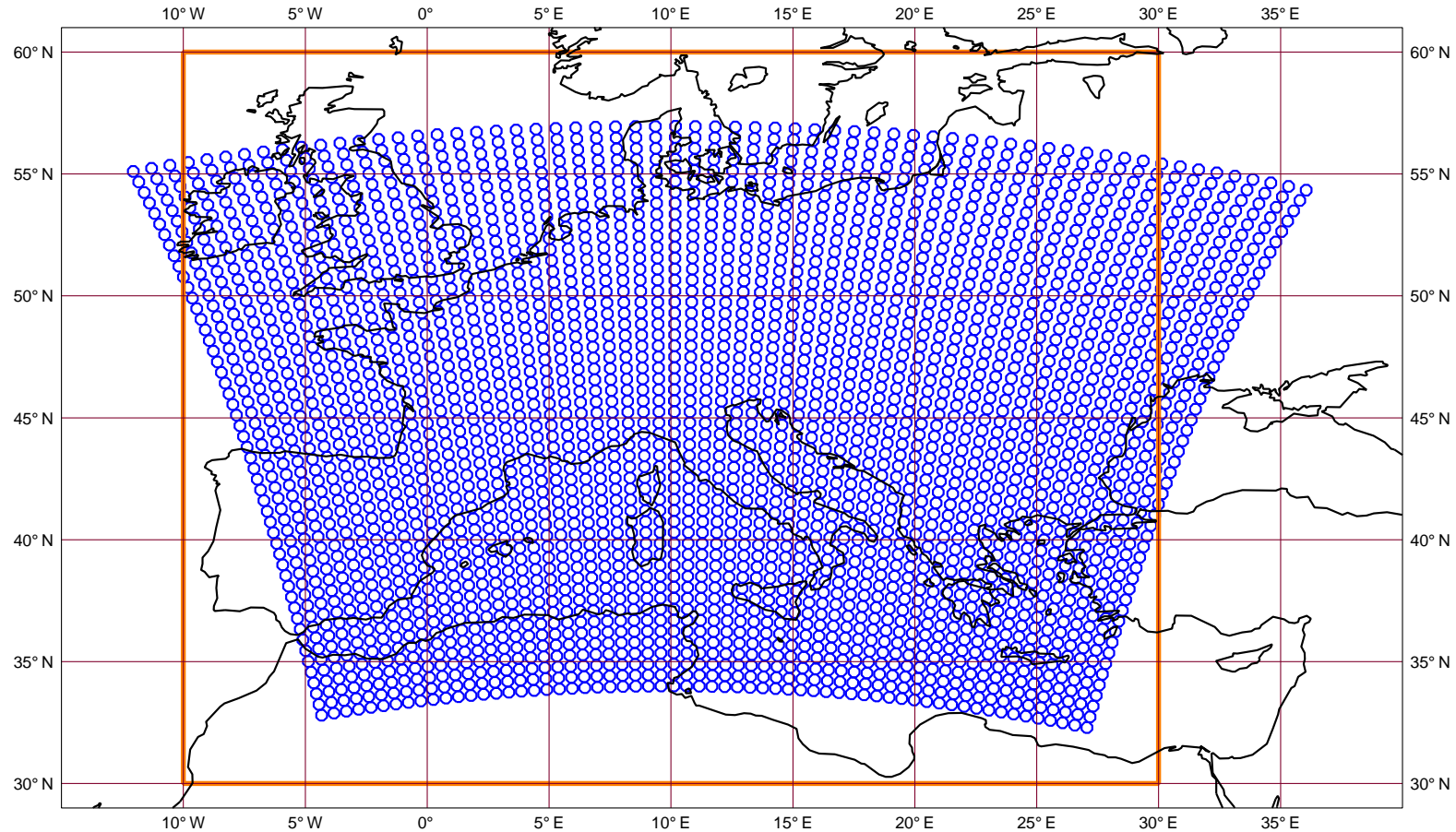
- **Why?** The horizontal resolution of global–model ensemble forecast systems is limited by computer time constraints and does not allow a detailed description of mesoscale and orographic–related processes.

⇒ **COSMO–LEPS project:** 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, . . .).

COSMO–LEPS forecasts to improve the short to medium–range forecast

($48\ h < \Delta t < 120\ h$) of the so–called “severe weather events”.

COSMO-LEPS domain and clustering area



- suite operational at ECMWF since 5 November 2002;
- **stable suite**: sometimes it is late, but only 5 failures in almost 2 years of activity (24/12/2002, 25/12/2002, 8/3/2003, 19/12/2003, 20/12/2003).

Products disseminated to the COSMO–countries

probabilistic products:

- 24h rainfall exceeding 20, 50, 100, 150 mm;
- 72h rainfall exceeding 50, 100, 150, 250 mm;
- 24h snowfall exceeding 1, 5, 10, 20 “cm”;
- $UV_{max_{10m}}$ in 24h above 10, 15, 20, 25 m/s;
- $T_{max_{2m}}$ in 24h above 20, 30, 35, 40 °C;
- $T_{min_{2m}}$ in 24h below -10, -5, 0, +5 °C;
- min height of 0 °C isotherm in 24h below 1500, 1000, 700, 300 m;
- max–CAPE in 24h above 2000, 2500, 3000, 3500 J/kg;
- min Showalter Index in 24h below 0, -2, -4, -6;

deterministic products (for each LM run):

- 24–hour cumulated rainfall; mean–sea–level pressure, Z700, T850;

meteograms (over a number of station points):

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

2004 activities

- ECMWF special project related to COSMO started on January 2004 (joint Italy–Switzerland) to test possible modifications of the operational suite;
- changes to the operational suite;
- “*super-domain*” covering all Europe: feasibility study.

ECMWF special project (SPCOLEPS)

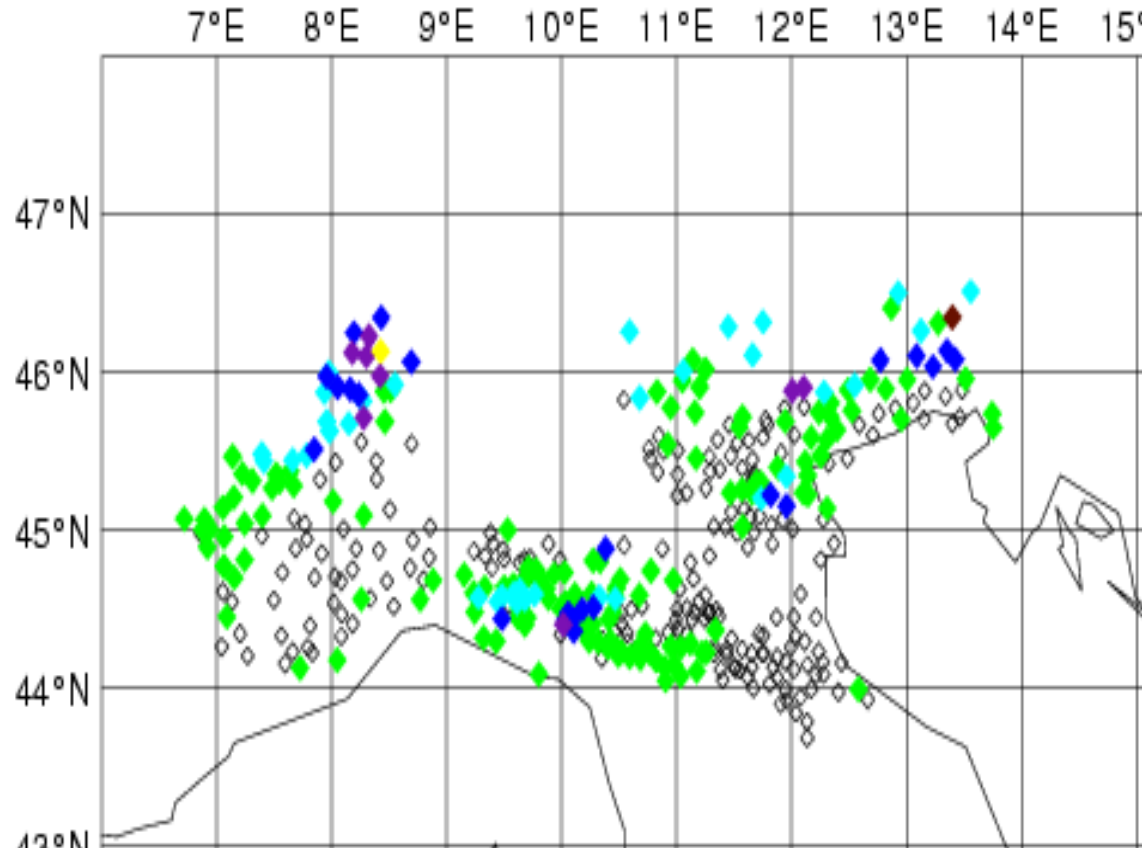
Select a number of test cases relative to episodes of heavy precipitation (over Germany, Italy and Switzerland) with **different** forcings (either large-scale or local).

- Re-run ECMWF EPS ($\Delta x = 80$ km, forecast range: 120 hours), archiving model output every 3 hours (1 EPS per case study; no super-ensemble).
- Nest LM ($\Delta x = 10$ km, forecast range: 120 hours) on each EPS member (brute-force approach), archiving model output every 3 hours.
- Evaluate different ensemble-size reduction-techniques.
- Assess the quality of 5-member, 10-member, . . . , 51-member COSMO-LEPS.
- Perform subjective/objective verification.

Case study: Friuli–Ticino flood

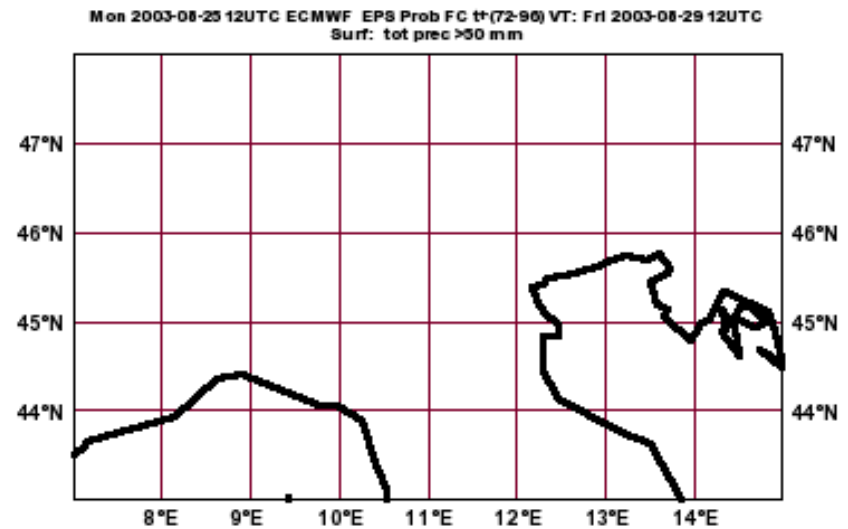
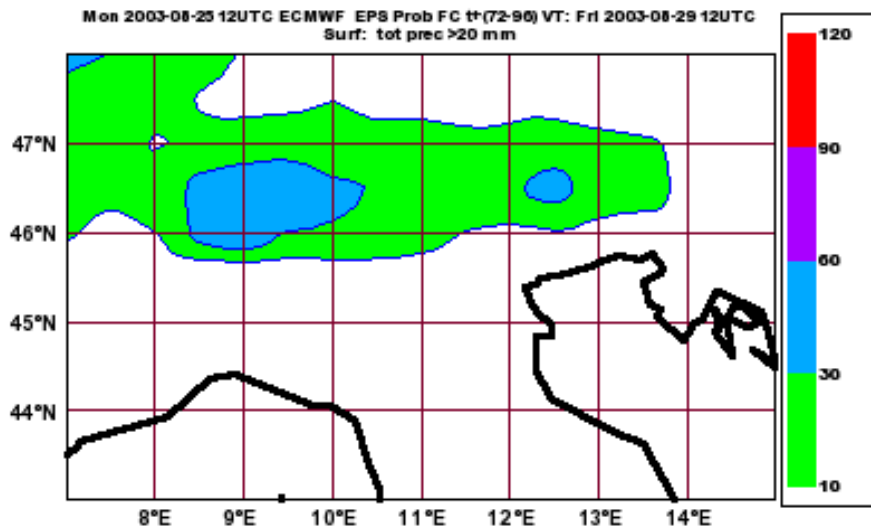
Observed precipitation from 28/08 12UTC to 29/08/2003 12UTC

● 0.2–10 ● 10–20 ● 20–50 ● 50–75 ● 75–100 ● 100–150 ● 150–200 ● 200–500 mm



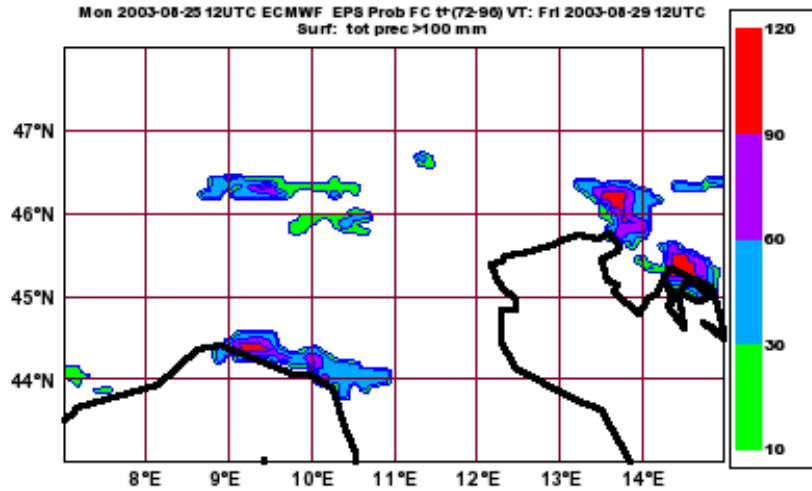
ECMWF EPS probability maps of $tp_{24h} > 20, 50$ mm

T0: 25/08/2003, 12UTC (fc +72–96h)

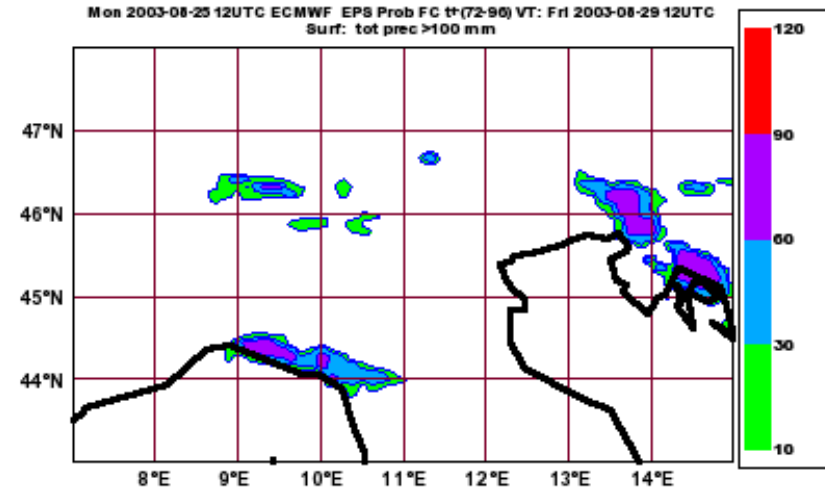


COSMO-LEPS probability maps (fc +72-96h) of $tp_{24h} > 100$ mm

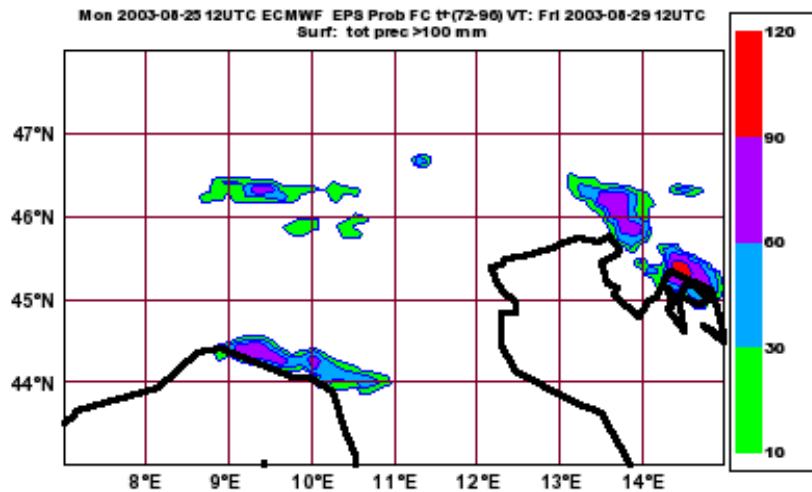
5 members (w)



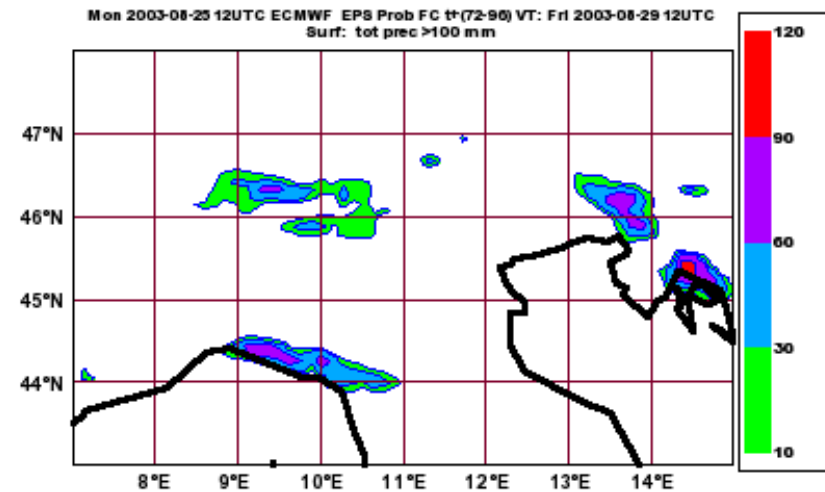
10 members (w)



20 members (w)



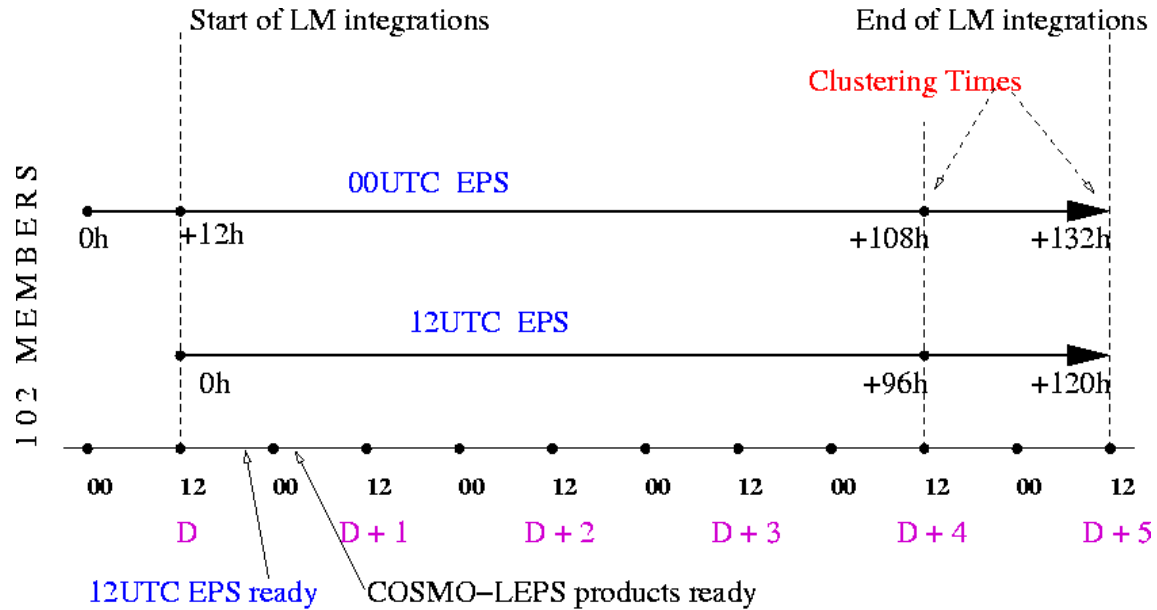
51 members



2004 activities

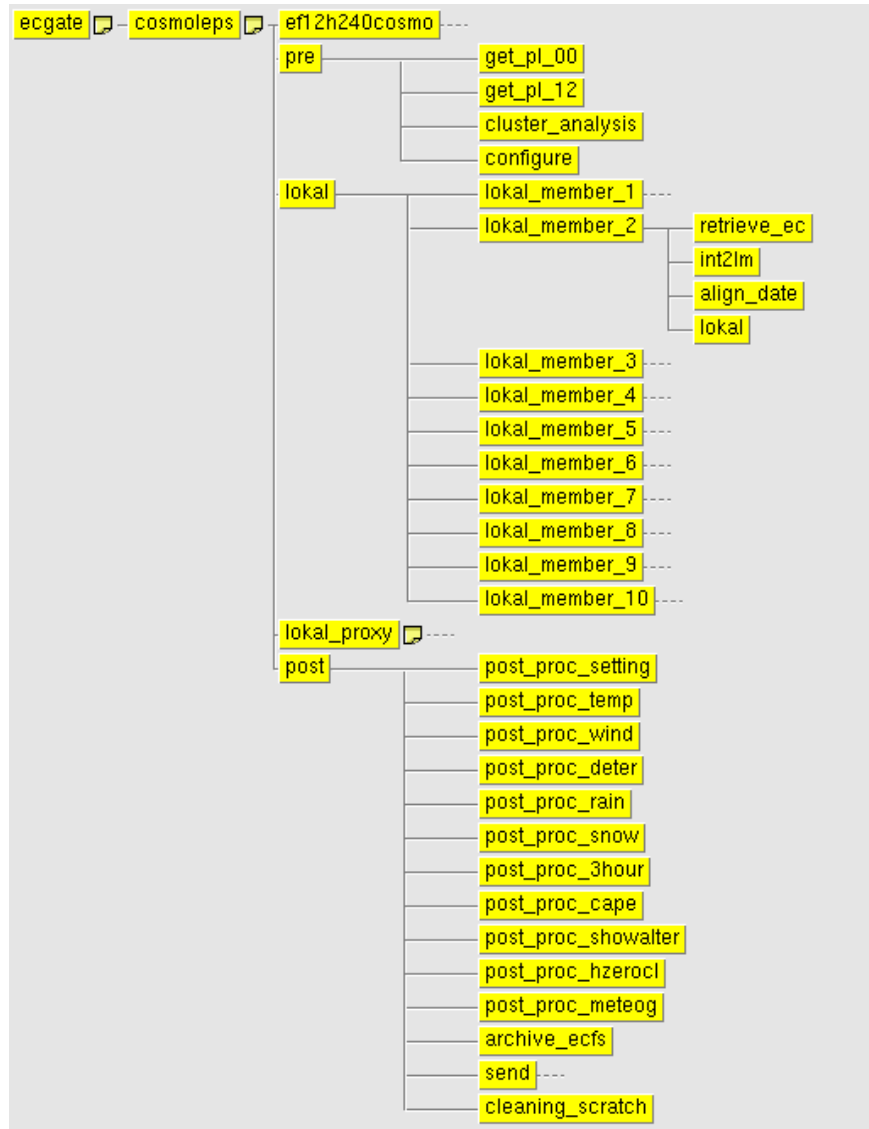
- ECMWF special project related to COSMO started on January 2004 (joint Italy–Switzerland) to test possible modifications of the operational suite;
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New COSMO-LEPS suite @ ECMWF (since 1/6/2004)



- the cluster analysis uses the **2 most recent EPSs** (instead of 3);
- **10 members** (instead of 5) are selected by the cluster analysis;
- accounting of model uncertainties: 5 (randomly chosen) LM integrations use the **Tiedtke** convection scheme; the other 5 runs use the **Kain-Fritsch** scheme;
- ECMWF *early delivery system*: COSMO-LEPS products ready by 2UTC.

New COSMO-LEPS suite @ ECMWF (since 1/6/2004)



- LM version 3.9;
- cloud-ice scheme used;
- prognostic precipitation scheme switched on;
- $\Delta x \simeq 10$ km; 32 vertical levels (2.526.336 grid points); time-step: 60 sec;
- fc length: 120h \leftrightarrow elapsed time: 1h 5min (84 “tasks” of IBM p690 clusters);
- \forall LM run, total CPU time ≈ 92 h.

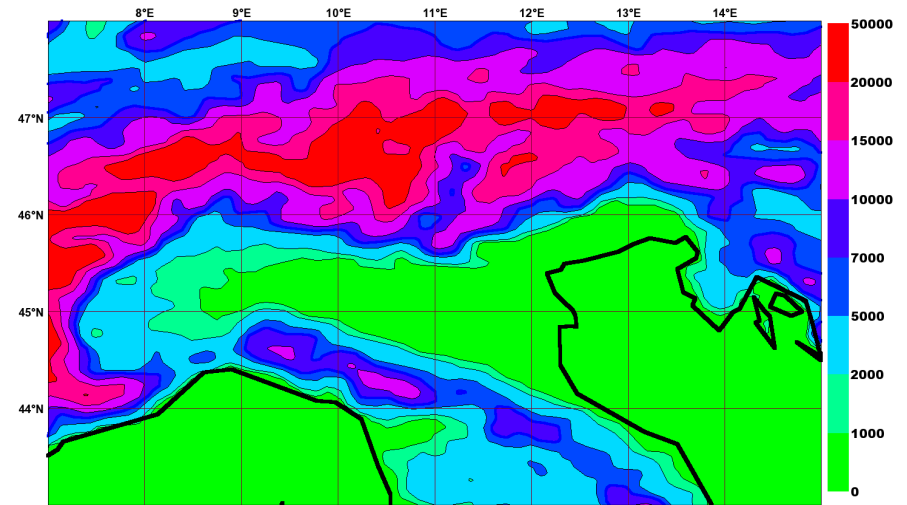
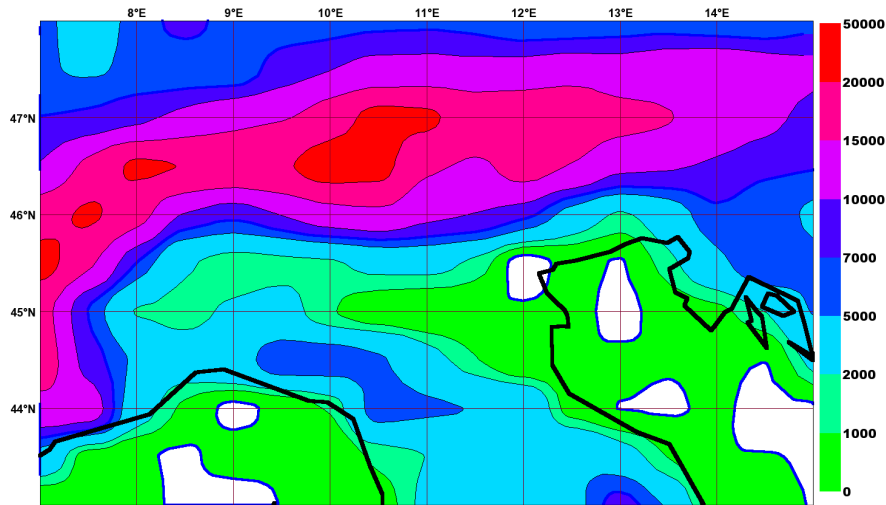
Future plans

- modify the suite so as to include one deterministic run to assess the superiority (if any) of COSMO–LEPS with respect to a single LM integration;
- migration to the new ECMWF IBM (computational costs might change);
- ask ECMWF for 3–hourly boundary conditions from EPS;
- ask ECMWF for archiving COSMO–LEPS on MARS;
- carry on with case studies (+ objective/subjective verification) to identify possible modifications of the current set–up.
- *test “European” suite(s).*

Impact of orography

EPS ($\Delta x = 80$ km)

COSMO-LEPS ($\Delta x = 10$ km)

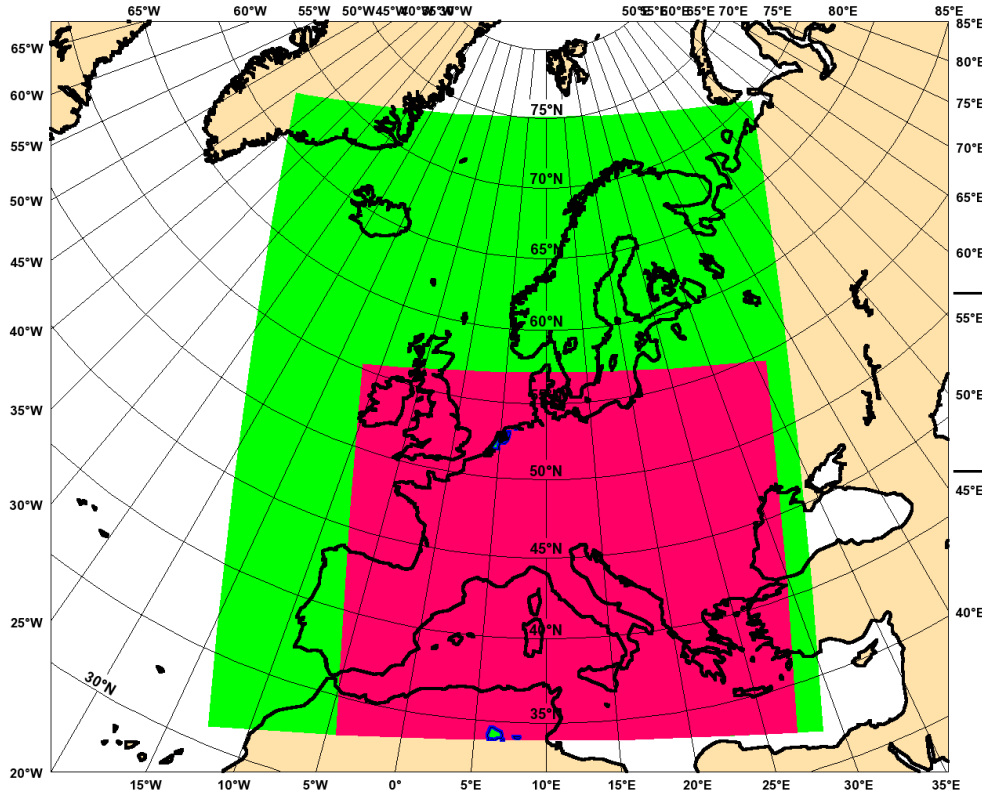


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Widespread interest in COSMO-LEPS → increase the domain size?

OPE TEST



	number of grid points	B.U. for 6h run (elapsed time)
OPE	306 × 258 × 32 (2.526.336)	13.75 (153 sec)
TEST	406 × 458 × 32 (5.950.336)	29.8 (314 sec)

Ask non-COSMO countries for contribution (in terms of computer time)?

Split in two the integration domain (Northern-Europe and Southern-Europe suites)?

LM archiving

Per each LM run, the following fields are archived:

rainfall (c6, c12, c18, . . . , c120)

$T_{\max_{2m}}$ (p6, p12, p18, . . . , p120)

$T_{\min_{2m}}$ (p6, p12, p18, . . . , p120)

$UV_{\max_{10m}}$ (p6, p12, p18, . . . , p120)

MSLP (p0, p6, p12, p18, . . . , p120)

Z500 (p0, p6, p12, p18, . . . , p120)

Z700 (p0, p6, p12, p18, . . . , p120)

T850 (p0, p6, p12, p18, . . . , p120)

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

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

Ensemble-size reduction technique

