The Benefit of a Limited-Area Ensemble Prediction System with Respect to flood forecasting

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Resolution of EPS for weather forecasts

Zoom into Alpine region:

Typical global EPS ($\Delta x \sim 80$ km)

Limited-area EPS ($\Delta x \sim 10$ km)
Outline

- Current setup of COSMO-LEPS suite
- Results from “August 2005 event”
- Objective verification
- Decision-making based on cost-loss analysis
- Summary
COSMO-LEPS

- Developed by ARPA-SIM, Bologna, Italy
- Focus: forecast days 3-5
- Running since November 2002, fully operational since November 2005
Current COSMO-LEPS setup

- Model: LM
- 16 members (since 7 Feb 06)
- 132-h forecasts
- Area: Southern and Central Europe
- Grid-spacing 10 km, 40 levels
- Platform: IBM-Cluster at ECMWF
- Based on ECMWF EPS:
COSMO-LEPS strategy

102 ECMWF Ensemble Member („Super-Ensemble“) with $\Delta x \sim 50$ km
COSMO-LEPS strategy

Grouping into 16 groups and …
COSMO-LEPS strategy

... identifying a representative member for each group

16 LM simulations with different weights according to the group population
COSMO-LEPS output

16 scenarios

Probabilistic model output (PMO) from the ensemble for defined thresholds

Deterministic model output (DMO) from each of the 16 LM runs

Input for hydrologic EPS

*Talk Verbunt et al.*, *Poster Jaun et al.*

COSMO-LEPS probability forecast: 24h sum of snow
3 Mar 2006 12UTC, t+4(18-42), VT: Sunday 5 Mar 2006 06UTC

- > 1cm/24h
- > 5cm/24h
- > 10cm/24h
- > 20cm/24h
COSMO-LEPS products (2): Meteograms

- 5-day weather predictions
- for any location
- 3 hourly resolution
- from COSMO-LEPS and deterministic forecast of MeteoSwiss (aLMo)
COSMO-LEPS Ensemble Forecast: Max. wind gusts at 10m [km/h] (in last 24h)
27 Mar 2006 12UTC, t+(84-108), VT: Saturday 1 Apr 2006 00UTC
Case study: Swiss Flood event in August 05

Photos: Tages-Anzeiger
Synoptic overview: 22 August 2005

Temperature 850 hPa and geopotential 500 hPa:
Observed total precipitation over 3 days

Niederschlag 72h–Summe (mm) : 20.8. – 23.8.2005 06 - 06 UTC

Precipitation sum locally over 300 mm!
COSMO-LEPS forecast for 72h precipitation

COSMO-LEPS probability forecast: 72h sum of total precipitation
19 Aug 2005 12UTC, t+(18-90), VT: Tuesday 23 Aug 2005 06UTC
Probability precipitation $> 100\text{mm}/72\text{h}$

Precipitation observed
COSMO-LEPS forecast for 72-h precipitation
Probabilistic verification: LEPS vs. ECMWF

COSMO stations and verification grid:

C. Marsigli, ARPA Bologna
Verification of precipitation SON 2004 (1)

Average values
boxes 1.5x1.5 deg

COSMO-LEPS
10-MEMBER EPS

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Verification of precipitation SON 2004 (2)

Maximum values
boxes 1.5x1.5 deg

C. Marsigli, ARPA Bologna
Weather risk management

Critical amount

Ensemble forecast (e.g. COSMO-LEPS)

Precipitation [mm/24 h]

0 20 40 60 80 100 120 140 160

Ensemble forecasts provide a multitude of decision criteria (probability thresholds).

Should preventive action be taken?

No general answer: Optimum decision is user-dependent!
**Decision-making based on cost-loss analysis**

(Zhu et al. 2002)

- Typically $C \leq M < L$

Forecast users have to know their $C$ and $Lp$ to optimize the decisions.
Economic value

\[ V = \frac{E_{\text{climate}} - E_{\text{forecast}}}{E_{\text{climate}} - E_{\text{perfect}}} \]

- \( E_{\text{climate}} \): expected cost using climatology
- \( E_{\text{forecast}} \): expected cost using forecast system
- \( E_{\text{perfect}} \): expected cost if forecast system is perfect

\( V = 1 \): Perfect system

\( V < 0 \): Climatology more useful

\[ \text{if } Lu = 0 : \]
\[ E_{\text{climate}} = \text{Min} \left( (h + m) L_p , (h + m + f + c) C \right) \]
\[ E_{\text{forecast}} = (h + f) C + m L_p \]
\[ E_{\text{perfect}} = (h + m) C \]
Economic value for different users: example

Every user has its specific C/Lp ratio
Economic value for different users: example

The optimum value from the system will be achieved if each user acts at the best probability threshold for his particular C/Lp.
Economic value for different users: example

The higher C/Lp, the higher the decision level which gives the maximum economic value.
Economic value of COSMO-LEPS vs. ECMWF EPS

Example for 24-h precip > 30 mm of 90th percentile within 1.5 x 1.5 degree box and for lead-time +66h:

User should always take action

User should use COSMO-LEPS

User should never take action

User should use ECMWF system

C. Marsigli, ARPA Bologna
Summary

- COSMO-LEPS helps to improve forecasts for extreme events.

- However, results from objective verifications are in general not very satisfying so far.

- Improvements in design of LEPSs and NWP model important.

- Use of user-dependent decision levels to optimize benefit of EPSs.
The end

Questions?