Performance of COSMO-based ensemble systems for some case studies

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Outline

• Performance of ensemble systems for some case studies:
  ➢ Swiss floods (2005);
  ➢ “snow-event” in Emilia-Romagna (2012);
  ➢ other cases.

• Your questions (and tentative answers).
Swiss flood: August 2005

(A. Walser, Meteoswiss)

Photos: Tages-Anzeiger
Synoptic overview: 22 August 2005

Temperature 850 hPa and geopotential 500 hPa:
Total precipitation over 3 days (20/8 - 23/8)

About 400 stations, precipitation sum locally over 300 mm!

A. Montani
COSMO-LEPS forecast for 72h precipitation

COSMO-LEPS probability forecast: 72h sum of total precipitation
18 Aug 2005 12UTC, t+(36-108), VT: Tuesday 23 Aug 2005 00UTC

> 50mm/72h
> 100mm/72h
> 150mm/72h
> 250mm/72h
COSMO-LEPS probability forecast: 72h sum of total precipitation

19 Aug 2005 12UTC, t+(18-90), VT: Tuesday 23 Aug 2005 06UTC

> 50mm/72h

> 100mm/72h

> 150mm/72h

> 250mm/72h
COSMO-LEPS vs ECMWF EPS
probability of 72h cumulated precipitation

COSMO-LEPS probability forecast: 72h sum of total precipitation
19 Aug 2005 12UTC, t+(18-90), VT: Tuesday 23 Aug 2005 06UTC

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

Niederschlag 72h-Summe (mm): 20 - 23. 08. 2005

C. Frei, MeteoSwiss
Probability precipitation > 250mm/72h

C. Frei, MeteoSwiss
20 - 23. 08. 2005
Take-home messages

- Added value of high-resolution and better description of orographic and mesoscale related processes.
Outline

• Performance of ensemble systems for some case studies:
  ✓ Swiss floods (2005);
  ✓ “snow-event” in Emilia-Romagna (2012);
  ✓ other cases.

• Your questions (and tentative answers).
Outline

- Behaviour of COSMO-LEPS for snowfall case-study: “nevone” in Emilia-Romagna (31/1/2012 – 5/2/2012).
A.Montani; The COSMO-LEPS system.

COSMO-LAMI of 30/01/2012 00UTC (+48-72h)

Available at 5.30 UTC

observations (cm)

forecast (mm of equivalent water!)

+48-72h
COSMO-LEPS of 30/01/2012 00UTC (+48-72h)

Available at 11.30 UTC
COSMO-LEPS of 30/01/2012 00UTC (+48-72h)
COSMO-LEPS of 30/01/2012 12UTC (+36-60h)
COSMO-LAMI of 31/01/2012 00UTC (+24-48h)

Available at 5.30 UTC
COSMO-LEPS of 31/01/2012 00UTC (+24-48h)

Available at 11.30 UTC
COSMO-LEPS of 31/01/2012 00UTC (+24-48h)
A. Montani; The COSMO-LEPS system.

Available at 23.30 UTC
Take-home messages

- Added value of high-resolution and better description of orographic and mesoscale related processes.
- Look at differences between deterministic and ensemble runs to weaken/strengthen the deterministic information.
- Look at individual ensemble members (stamp maps).
Outline

• Performance of ensemble systems for case studies:
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• Your questions (and tentative answers).
Cesenatico sea storm - 22 September 2014
(no alert given)

Deep convective system over the Adriatic sea with gale winds

Figura 17: Immagini degli effetti della mareggiata su Cesenatico (Da Il resto del Carlino e La Repubblica)
Intensità massime del vento registrate dalle stazioni della rete regionale RIRER

<table>
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<th>Data e Ora UTC</th>
<th>Camse</th>
<th>Volano</th>
<th>Martorano</th>
<th>Forlì Urbana</th>
<th>Cesena Urbana</th>
<th>Ravenna Urbana</th>
<th>Rimini Urbana</th>
<th>Mulazzano</th>
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<td>14,7</td>
<td>3,6</td>
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<td>15,2</td>
<td>18,9</td>
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<td>21,9</td>
</tr>
<tr>
<td>22/09/2014 23:00</td>
<td>11</td>
<td>9,9</td>
<td>14,6</td>
<td>11</td>
<td>15,4</td>
<td>16</td>
<td>21,3</td>
<td>16</td>
</tr>
<tr>
<td>23/09/2014 00:00</td>
<td>5,4</td>
<td>5,6</td>
<td>5,7</td>
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<td>6,9</td>
<td>6,8</td>
<td>12,3</td>
<td>8,3</td>
</tr>
</tbody>
</table>
COSMO-LEPS probability maps for 3h gust > 12 m/s
VT: 23/9/2014 00UTC
IC: 21/9/2014 00UTC + 45-48h
IC: 21/9/2014 12UTC + 33-36h
IC: 22/9/2014 00UTC + 21-24h
IC: 22/9/2014 12UTC + 9-12h
COSMO-LEPS probability maps for 3h gust > 20 m/s
VT: 23/9/2014 00UTC
IC: 21/9/2014 00UTC + 45-48h
IC: 21/9/2014 12UTC + 33-36h
IC: 22/9/2014 00UTC + 21-24h
IC: 22/9/2014 12UTC + 9-12h
Take - home messages

• Added value of high-resolution and better description of orographic and mesoscale related processes.
• Look at differences between deterministic and ensemble runs to weaken / strengthen the deterministic information.
• Look at individual ensemble members (stamp maps).
• Look at probabilistic products over short-time intervals.
Transition towards convection-resolving ensembles

Three LAM-EPS without parameterisation of convection (convection-permitting) have been recently developed in Europe:

1) France: AROME-EPS (2.5 km, 12 members, 24-hour forecasts, 4 times x day) – Pre-Op
2) UK: MOGREPS-UK (2.2 km, 12 members, 36-hour forecasts, 4 times x day) – Pre-Op
3) Germany: COSMO-DE-EPS (2.8 km, 20 members, 21-hour forecasts, 8 times x day) – Operational

Computational resources focused toward high-resolution representation of small-scale features (e.g., extreme events, fog), but creates limitations:

- number of members and therefore ensemble sampling/performance is restricted,
- size of domain and forecast duration also constraints.

Potential solution is to combine multiple national models in a “super-ensemble”.
Regional Model Domains

MOGREPS + AROME = 24 members

COSMO + AROME = 32 members
Case study 18th June 2012

observed RADAR reflectivity
20120618, 00:00

Determinisitic (COSMO-DE) simulated reflectivity + Storm Detection Index (SDI)
20120618, 00 UTC + 0.00 h

Source: DWD (Axel Seifert)

A. Montani; Training for Sochi forecasters
Case study 18th June 2012

ESSL testbed week 3 in 2012

COSMO-DE-EPS: 00UTC + 16h

simulated reflectivity >40 dBZ
colors = single members

SDI > 0.003 1/s
colors = single members

hourly wind gusts

Source: ESSL testbed 2012

A. Montani; Training for Sochi forecasters
Case study 18th June 2012

ESSL testbed week 3 in 2012

COSMO-DE-EPS: 00UTC + 17h

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colors = single members

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hourly windgusts

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simulated reflectivity >40 dBZ

colors = single members

SDI > 0.003 1/s

colors = single members

hourly windgusts

Source: ESSL testbed 2012

A. Montani; Training for Sochi forecasters
Case study 18th June 2012

„Verification“ of 13:00 UTC – 06:00 UTC (next day)

Source: ESSL testbed 2012

A. Montani; Training for Sochi forecasters
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• Performance of ensemble systems for case studies:
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  - Other cases

• Your questions (and tentative answers).
“Supercell” example

F2 tornado \(\downarrow\) near “Plate” close to the Baltic coast 16:20 UTC

Storm detection index SDI

the forecast shows many ‘SDI events’ in that region

observed by radar

forecast by COSMO-DE

radar reflectivity (dBZ)

by
Axel Seifert

Deutscher Wetterdienst

A. Montani; Training for Sochi forecasters
“Supercell” example

■ Some of the operational deterministic forecasts have good signals for supercells near Plate (00, 09 UTC).

■ Other deterministic simulations have no or only very weak signals (03, 06, 12 UTC).
  • Forecasters and customers expect more robustness or ‘consistency’ of the forecasts.
  • Predictability or a bad model?
  • Use convective-scale ensemble!
“Supercell” example

20090521, 15 - 17 UTC

- 00 UTC run
- 03 UTC run
- 06 UTC run
- 09 UTC run
- 12 UTC run

▶ right mover
▼ left mover

COSMO-DE

by Gebhardt, Theis, DWD

20090521, init 00 UTC, valid 15 - 17 UTC

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20

▶ right mover
▼ left mover

COSMO-DE-EPS

A. Montani; Training for Sochi forecasters
“Supercell” example

by Gebhardt, Theis, DWD

20090521, init 00 UTC, valid 15 - 17 UTC

COSMO-DE-EPS 00 UTC run

20090521, init 06 UTC, valid 15 - 17 UTC

COSMO-DE-EPS 06 UTC run

A. Montani; Training for Sochi forecasters
Take-home messages

- Added value of high-resolution and better description of orographic and mesoscale-related processes.
- Look at differences between deterministic and ensemble runs to weaken / strengthen the deterministic information.
- Look at individual ensemble members (stamp maps).
- Look at probabilistic products over short-time intervals.
- Also at local scales, the ensemble members can reveal weather scenarios not indicated by the deterministic run.
Outline

• Performance of ensemble systems for case studies:
  ➢ Swiss floods (2005);
  ➢ “snow-event” in Emilia-Romagna (2012);
  ➢ other cases.

• Your questions (and tentative answers).
Questions from forecasters (and tentative answers)

How to communicate correctly uncertainty and probabilistic prediction to the public and decision makers?
Long process; work gradually also on forecasters (e.g. attach “confidence-level” to weather bulletins). But do forecasters “hate” probabilities?

How to interpret / exploit (to improve the deterministic forecast) the jumpiness of EPS runs?
“Jumpiness” may not be always a bad feature, if the model changes its mind towards the right solution. As for COSMO-LEPS, the clustering technique with the selection of EPS members from 2 successive EPS runs tries to address this issue.

State-of-the-art of ECMWF EPS and COSMO-LEPS: strengths and weaknesses for an operational forecast at regional scale.
As for ECMWF, I think the issue was addressed. It is difficult to disentangle improvements related to limited-area-model upgrades from those due to better EPS boundaries. Positive trends in the scores were shown, but daily failures remain. We are testing an increase of vertical resolution, use of SPPT. Next year, we might test an increase of ensemble size to 20 members.
How does the accuracy of predicting different weather elements change as the lead time or, for example, the model resolution changes (increases or decreases)?

- At the moment, there is little experience on high-resolution ensembles or 1-km deterministic modeling (still under development and not fully tuned);
- **TP**: we noticed little dependence of the forecast quality on the horizontal resolution of the system (7-km perform similarly to 2.2 km, especially in ensemble mode: WE ARE STILL IN THE GRAY ZONE);
- **WSPEED**: there is an added value of the higher resolution when comparing vertical profiles of wind speed (mainly in mid-pressure levels) and some improvement of wind-speed in wind-energy zones (especially in early hours of forecasts).
- **T2M**: “controversial results”; strong regional dependency (e.g. inversion problem not cured by ensemble).
Questions from forecasters (and tentative answers)

• What can the ensemble products give and what are the better ways of using it?
• As for ensemble products, have they been ever tested in mountain regions? What are the results and what are the strong and weak points of these products?

Ensemble products are operationally used at DWD (prediction of convective precipitation), at ARPA-SIMC (meteo and hydrological applications), at Met Office (also during 2012 Olympic Games), at Meteoswiss (probability maps, stamp maps, meteograms).

VISIBILITY:
• for good visibility, consider the probability that low-cloud cover is below 4 Oktas.
• for poor visibility, consider the probability that low-cloud cover is above 7 Oktas.
• What can the ensemble products give and what are the better ways of using it?
• As for ensemble products, have they been ever tested in mountain regions? What are the results and what are the strong and weak points of these products?

PRECIPITATION:
• use the upscaled exceeding probabilities (e.g. 28km grid boxes = probability that an event occurs anywhere within this area) to define potential areas of interest;
• use the 90% percentile to estimate the intensity of the expected events;
• always keep in mind several ensemble runs, because we could find out in many case studies that not simply the recent ensemble run gives the best result (consistency);
• deal with small probability values as important signal when forecasting extreme events.

At DWD, as for the prediction of (convective) precipitation, forecasters could really make steps forward and see a clear benefit compared to deterministic runs.
THANKS FOR YOUR ATTENTION!