Predicting Intense Precipitation Using Upscaled, High-Resolution Ensemble Forecasts

Henrik Feddersen, DMI
Outline of talk

• A memorable rainfall event in Copenhagen
• Experimental HIRLAM-based ensemble prediction system
• Upscaling probability forecasts
• Case studies
• Verification for Aug 2010
• Conclusions
A memorable rainfall event

• Extreme event, extreme expenses
• DMI failed to forecast the event
• Questions in the Danish Parliament about the hit rate of DMI’s forecasts
• Reminded many people at DMI that deterministic forecasts have their limitations
• Following this I have noticed an unprecedented interest in short-range ensemble predictions among forecasters at DMI
Observed rainfall 14 Aug 2010

Radar animation

Gridded rain gauges
Model forecast

Member 020 (S03 Operational)
20100813_12+3h
Valid on Friday 13 Aug 15:00 UTC
Ensemble system configuration

- Domain = DMI-Hirlam S05 (0.05° resolution, 40 vert. levels)
- Members = 25
- Forecast length = 36h (now: 54h)
- Forecast frequency = 4 times per day
- Initial and lateral boundary conditions = 5
  - Scaled Lagged Average Forecast (SLAF) error perturbation
- Cloud schemes = 2
  - STRACO and KF/RK
- Stochastic physics = yes/no
- Surface schemes = 2
  - ISBA and ISBA/Newsnow
- Independent of ECMWF's ensemble prediction system
Ensemble forecast probabilities

- Numbers = observed rainfall 6-18 UTC, 14 Aug 2010
Precipitation “spaghetti” plot

- 50mm contours
- Members in different colours
Upscaled probabilities

- For each grid point, count members that predict the event in a neighbourhood of the grid point

- Upscaling diameter ≈ 60 km
Upscaled probabilities

- Upscaling diameter ≈ 115 km
Case study: Bornholm 16 Aug 2010

Upscaled probabilities

No upscaling

Upscaling diameter \( \approx 60 \) km

Upscaling diameter \( \approx 115 \) km
Case study: Billund 18 Aug 2010
Upscaled probabilities

No upscaling
Upscaling diameter \( \approx 60 \text{ km} \)
Upscaling diameter \( \approx 115 \text{ km} \)
Case study: False alarm 18 Aug 2010
Upscaled probabilities

No upscaling

Upscaling
diameter ≈ 60 km

Upscalerings-
diameter ≈ 115 km
Verification, Aug 2010
Relative operating characteristic

Hit rate = \frac{\text{events correctly forecast}}{\text{events occurred}}

False alarm rate = \frac{\text{events falsely forecast}}{\text{events non-occurred}}
Verification, Aug 2010
Relative operating characteristic

Precipitation > 25 mm/12h, Aug 2010, T+24h

Hit rate vs. False alarm rate for different upscaling scenarios.
Verification, Aug 2010
Relative operating characteristic

![Graph showing Relative Operating Characteristic for precipitation events in August 2010. The graph plots hit rate against false alarm rate for different upscaling scenarios, including 115km, 80km, 60km, 40km, and no upscaling. The S03 deterministic model is highlighted.]
Verification, Aug 2010
Relative operating characteristic

Precipitation > 5 mm/12h, Aug 2010, T+24h

Hit rate

False alarm rate

115kn upscaling
80kn upscaling
60kn upscaling
40kn upscaling
No upscaling
Verification, Aug 2010
Relative economic value

Precipitation > 25 mm/12h, Aug 2010, T+24h

- 115km upscaling
- 80km upscaling
- 60km upscaling
- 40km upscaling
- No upscaling

Value vs. Cost/loss ratio
Conclusions

- Upscaling improves probabilistic forecast skill for intense precipitation.
- Upscaled probability forecasts can provide improved guidance to forecasters.
- Forecasters at DMI will consult upscaled probability forecasts in prediction of intense precipitation this summer.