Probability forecasts for intense precipitation based on upscaled, high-resolution limited-area ensemble forecasts

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Motivation

- Use limited-area ensemble forecasts to provide improved guidance to prediction of high-impact weather
  - Heavy rain (>24mm/6h)
  - Cloudburst (>15mm/30min)
  - Heavy snowfall (>15mm/6h)
  - Snowstorm (>10mm/6h and >10m/s)
  - Storm (mean and gust) (>24m/s)
  - Hurricane (mean and gust) (>32m/s)
DMI-HIRLAM Ensemble Prediction System

- Resolution = 0.05° horizontal / 40 vertical levels
- Members = 25
- Forecast length = 54h
- Forecast frequency = 4 times per day
- Initial and lateral boundary conditions = 5
  - Scaled Lagged Average Forecast (SLAF) error perturbations
- 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
Case study, 2 July 2011
Precipitation stamp map

20110702 06+15h, 6h accum. precip
Valid on Saturday 2 Jul 21:00 UTC
Case study, 2 July 2011
Probability map

Probability = 10-20%: Only 3-4 members predict the event!?
Case study, 2 July 2011
50 mm/6h contours

Different members in different colours

More than 4 members predict the event!
Probability upscaling

- **Conventional probability**
  - In every grid point: Fraction of members that predict the event

- **Upscaled probability**
  - In every grid point: Fraction of members that predict the event *in a neighbourhood* of the grid point
  - Probability that the event will happen *somewhere near* grid point
Probability upscaling example

Prob = 1/25

Prob = 3/25

Prob = 8/25
Upscaled probabilities

Upscaling diameter = 15 grid cells ~ 80 km

Max probability > 40%

2011070206+15h, prob[pcp > 50 mm/6h]
Verification of 2 July 2011 case
Verification of 2 July 2011 case

Note the agreement between locations of max probability and max observed rainfall!
Heavy rainfall examples

2011070712+30h, mbrs[pcp > 25 mm/12h]

2011071400+18h, mbrs[pcp > 25 mm/12h]

2011072900+18h, mbrs[pcp > 25 mm/12h]

2011073018+24h, mbrs[pcp > 25 mm/12h]
Relative operating characteristic
Upscaling vs No upscaling

NB. False alarms are acceptable, if they are accompanied by nearby hits for the same forecast!
Why not use ECMWF's ensemble prediction system?

LAM-EPS 50mm contours

ECMWF-EPS 50mm contours
Why not use ECMWF's ensemble prediction system?

LAM-EPS 50mm contours vs ECMWF-EPS 15mm contours

50mm/10km² vs 15mm/1000km²
Summary

- Limited-area, high-resolution, short-range ensemble forecasts can provide guidance for localized intense precipitation events.
- Particularly useful for forecasting the location of extreme events, e.g. convective rainfall events (using the upscaling method).
- Guidelines must be provided for the usage of probabilistic forecasts of extreme events, e.g.
  - 20-50% probability: pay attention
  - > 50% probability: take action
- Upscaled probability forecasts have been used frequently by DMI forecasters for guidance this summer.