Verification of precipitation from the NWP nowcasting system at the Danish Meteorolgical Institute during a heavy rain period

Olsen, Bjarke Tobias; Smith Korsholm, Ulrik; Petersen, Claus ; Nielsen, Niels Woetmann; Hansen Sass, Bent; Vedel, Henrik

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

Verification of precipitation from the NWP nowcasting system at the Danish Meteorological Institute during a heavy rain period

Bjarke Tobias Olsen (bto@dmi.dk), Ulrik Smith Korsholm, Claus Petersen, Niels Woetmann Nielsen, Bent Hansen Sass and Henrik Vedel
Research and Development Department, the Danish Meteorological Institute (DMI)

At the Danish Meteorological Institute (DMI) the NWP nowcasting system utilizes a newly developed nudging based technique to assimilate radar-derived precipitation observations in the NWP model. In this method the observed rain rates are used to estimate a vertical profile of horizontal divergence changes corresponding to the rain deficit in the model. Verification of precipitation forecasts by the nowcasting system using this technique is presented for 17 days of august 2010. This period was particularly wet with several heavy precipitation events with observed precipitation above 36 mm of rain during one hour. Three of these events are studied in detail. The verification is based on the fractions skill score (FSS), which give scale selective scores of forecast skill relative to observations (radar-derived precipitation fields). The study shows that the nudging technique have a strong impact on the spatial skill of the forecast in the first 1-2 hours of the free forecast, and a smaller but still clear impact 3-4 hours into the free forecast.

The nowcasting system

The NWP nowcasting system at DMI based on the hydrostatic high resolution limited area model (HIRLAM) model has been enhanced by including a new nudging based assimilation technique. In this technique the horizontal divergent part of the wind field is nudged via the continuity equations. The magnitude of this nudging is determined from model rain-deficits (relative to observations), and the vertical shape follow an idealized vertical profile corresponding roughly to that of developing convective cell. The nowcasting system run in a rapid-update cycle on the domain seen in figure 1, include, besides the assimilation of precipitation, assimilation of clouds, as well as assimilation of 'standard' observations via 3DVAR.

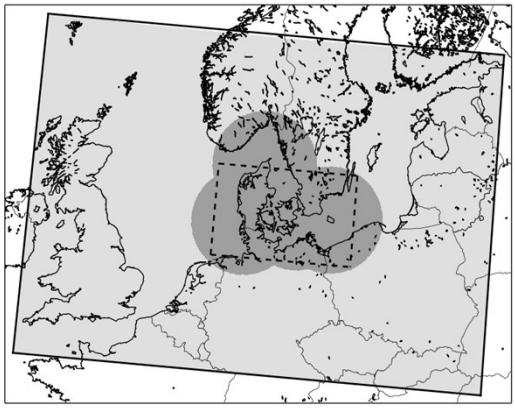

Figure 1 Model grid domain (light gray area), Radar network coverage (dark grey area), and verification area (dashed box).

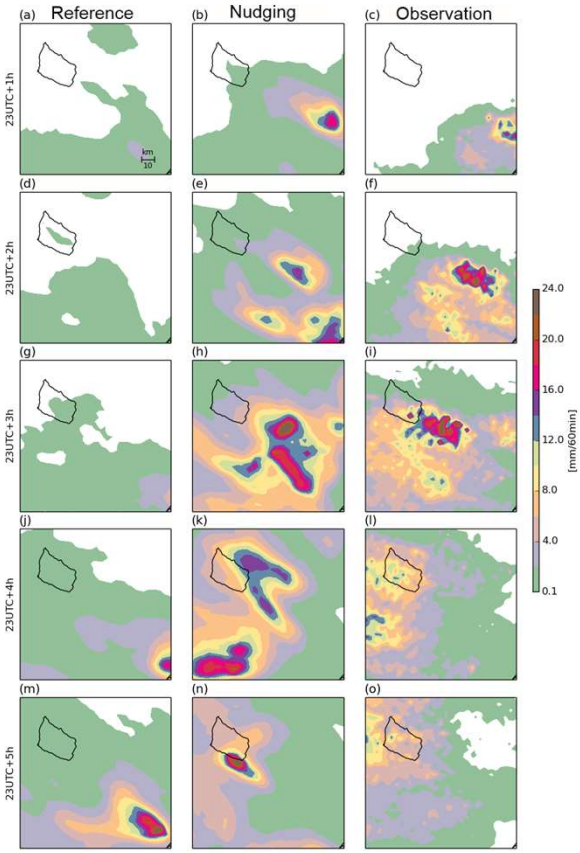

Figure 2 Precipitation forecast for one heavy precipitation event on the 17th of August 2010 near Bornholm. The first column is the reference run, the middle column is the model run including the precipitation assimilation method, and the last column is integrated radar observations. Each row represent cosecutive one-hour accumulated precipitation forecasts, starting at 00UTC. The first two hours are the assimilation period, while the last three are a free forecast.

Results

The precipitation assimilation method was evaluated for a 17 day period in August 2010. This was a period of heavy rain in Denmark. One event from the period can be seen in figure 2. Hourly accumulated precipitation forecasts for the 17 day period was evaluated in terms of FSS, which give scale-selective skill scores of the precipitation forecast relative to observations (radar-derived hourly integrated precipitation fields), see figure 3. A strong positive impact from the assimilation technique is seen on the spatial skill of the forecasts for the first 1 -2 hours of the free forecast, and a smaller but still significant positive impact is observed up to 3-4 hours into the free forecast.

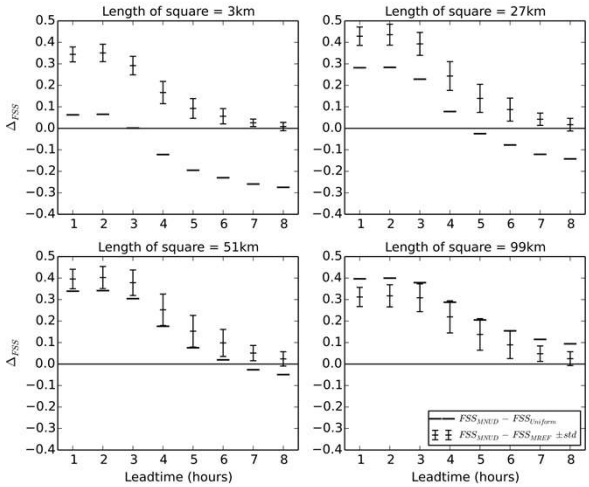

Figure 3 Mean values for the 17 day period of FSS differences between: a model including the nudging technique (MNUD) and a reference (MREF), and MNUD and a score indicating a skillful forecast (uniform). The leadtimes include the assimilaton period, so that the free forecast starts at 2 hours of leadtime. Each subplot represent a scale, which is the horizontal length of one side of the square area of influence used in the score evaluation. A positive score indicate a skillful forecast (flat bar), and a positive impact relative to the reference run (error bars).

Acknowledgements: The authors wish to acknowledge the role of the entire nowcasting group at DMI.