Impact Experiments of Harmonie Radar Data Assimilation in DMI

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Summary

A series of impact experiments for Harmonie 38h12 is carried out at DMI to investigate sensitivities of the short range forecast to assimilation of radar data with different configurations. These include tests of structure functions, scaling factor for background error, whether or not to use radar reflectivity and/or radial wind. Observation from about 60 radars from 10 European countries have been used with super-obbing preprocessing. By the nature the current attempt with radar data assimilation is still quite preliminary. While verification of radar data assimilation tests for a month-long summer episode have so far shown an overall positive results, an optimal configuration with radar data assimilation is yet to establish. We select in this presentation to show some case studies for the Augst 31 heavy precipitation in Copenhagen to illustrate the challenge in this endeavour. Examination of the mositure spin-up in the experiments indicate additional challenge in the use of observation data with moisture information.

Model setup and sensitivities tested

Model: Harmonie 38h1.2

Domain: DKA Resolution: 2.5km

Data assimilation: 3DVAR

Experiment 1: no radar data+ reference structure functions (SFS)
Experiment 2: radar reflectivity+ diurnal SFS
Experiment 3: radar reflectivity+EDA-derived SFS
Experiment 4: radar reflectivity+reference SFS
Experiment 5: radar reflectivity+EDA SFS+ sigma B rescaling
Experiment 6: radar reflectivity and radial wind+EDA SFS

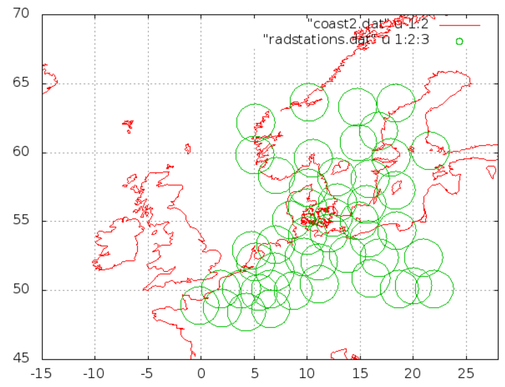
1 month running: start from 2014080102 with 3H assimilation on cycle

Also ongoing runs with **1 h cycling** starting 2014080102

Additional case study for a heavy precipitation episode, all runs based on the 3 h forecast at 2014083017 as produced in EXP1.

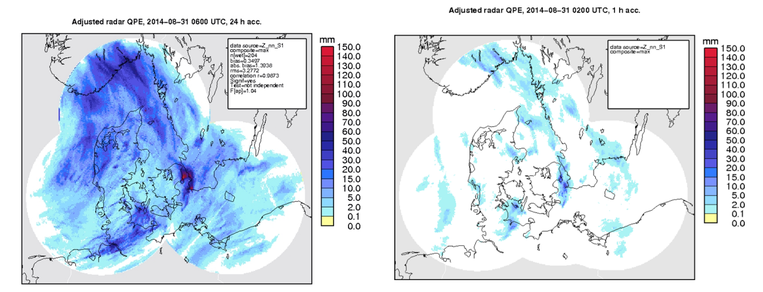
Radar data coverage

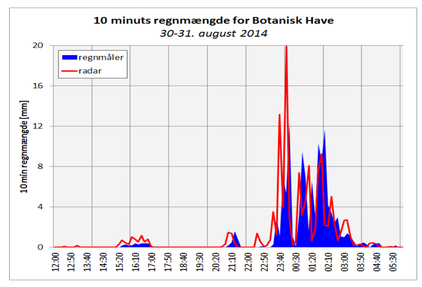
Current use of radar station



Measurements from about 60 radar in Denmark and 9 neigbouring European countries have been used for these experiments

Observation of the heavy rainfall in Copenhagen

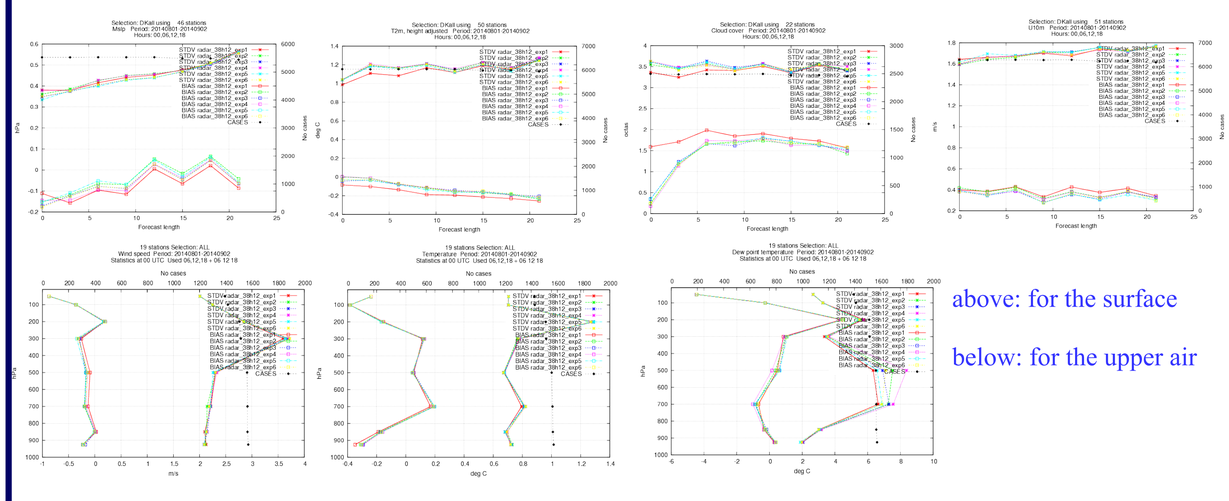




A severe flashflood event affecting Copenhagen-Malmø regions occured in the early morning of 31 August, 2014. The maximum of 24h accumulated precipitation surpassed 130mm.

(Courtesy Flemming Vejen, DMI)

Verifications



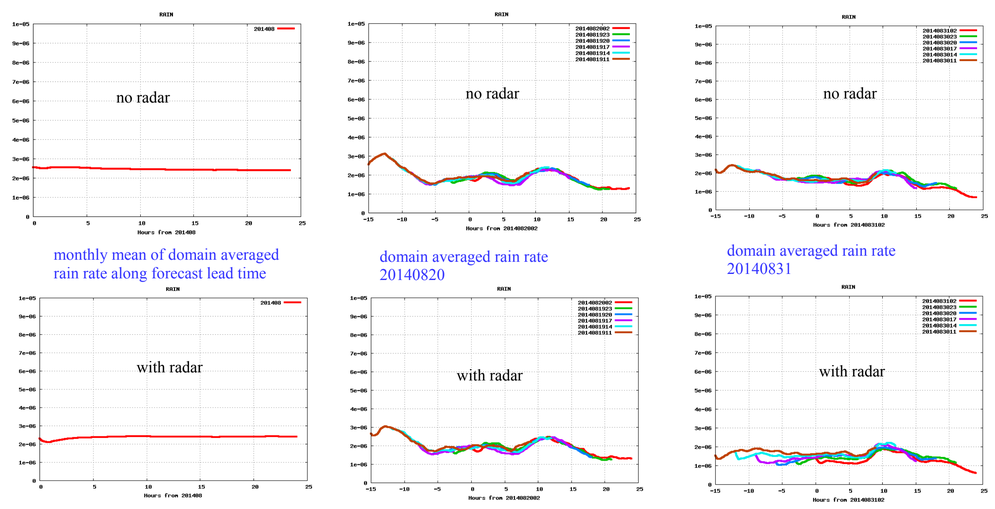
above: for the surface

below: for the upper air

Intercomparsion of synoptic forecast skills among the experiments indicate:

- generally comparable forecast skills between the runs with and without radar data.
- main impact of radar data is seen on modification of cloud cover in the first 12 h of forecast.
- relatively significant skill differences between the radar data assimilation results with different configuration.

Imapct on spin-up due to radar data assimilation



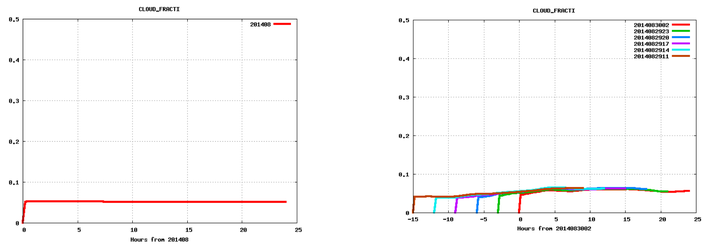
monthly mean of domain averaged rain rate along forecast lead time

domain averaged rain rate 20140820

domain averaged rain rate 20140831

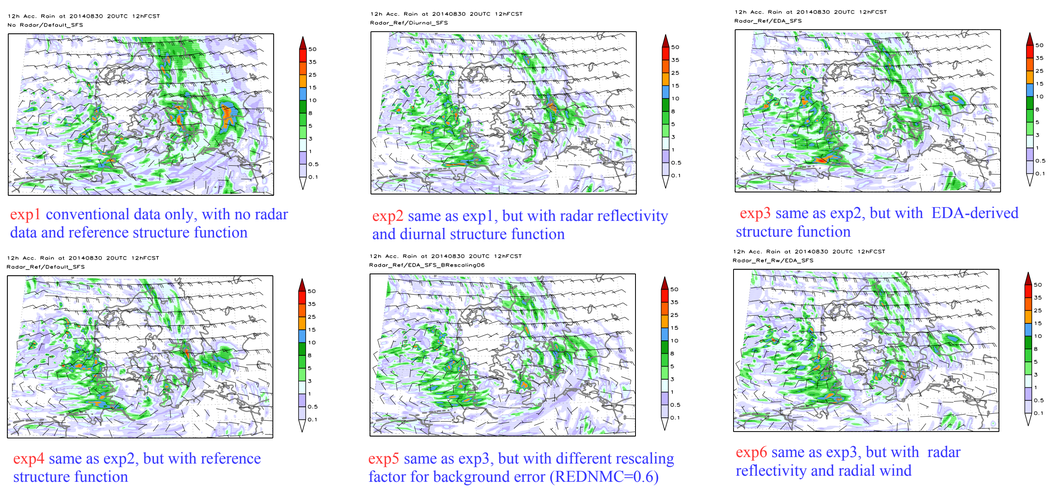
Moisture spin up in Harmonie are generally limited. e.g, for data assimilation cycling using little moisture observation data, the domain averaged rain rate appear to be very limited. When radar observation used, modification of humidity fields results in more pronounced spin up. In the rainy episode, such spin up in rain rate last up to 3 hours after initialisation.

Initialisation of cloud cover?



Currently in Harmonie, cloud fraction time series show typically a jump from zero to a stable level shortly after initialisation. Initiating cloud fraction from a non-zero value may be helpful for a reduced moisture spin-up.

Case studies for the August 31 heavy rainful in Copenhagen



exp1 conventional data only, with no radar data and reference structure function

exp2 same as exp1, but with radar reflectivity and diurnal structure function

exp3 same as exp2, but with EDA-derived structure function

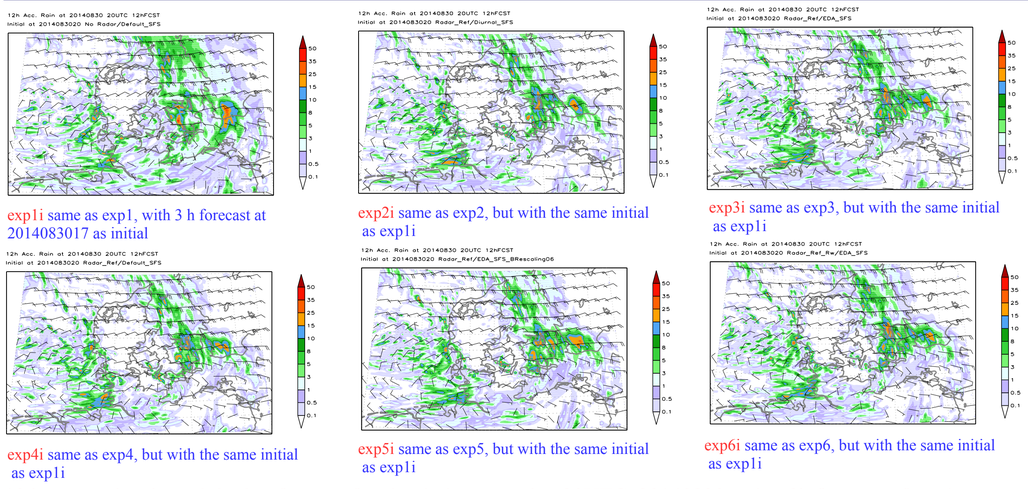
exp4 same as exp2, but with reference structure function

exp5 same as exp3, but with different rescaling factor for background error (REDNMC=0.6)

exp6 same as exp3, but with radar reflectivity and radial wind

12 h accumulated precipitation forecast for simulation started at 20UTC, 20140830.
The data assimilation is organised with 3-hourly asynoptic cycling with initial time of 02, 05, 08 etc.

Even though the month-long assimilation with radar data has produced a generally favorable verification results in average, prediction of extreme precipitation cases has shown to be a challenging task. For the Aug 31 precipitation event over Copenhagen/Malmø region, precipitation forecasts by the continuous data assimilation cycling showed strong sensitivity to the varying configurations and most of them have insufficient forecast skill for predicting the magnitude and location as compared to the observed flashfood episode. It shall be cautioned that the configuration for radar data assimilation and hence these simulation experiments results are still very preliminary.



exp1i same as exp1, with 3 h forecast at 2014083017 as initial

exp2i same as exp2, but with the same initial as exp1i

exp3i same as exp3, but with the same initial as exp1i

exp4i same as exp4, but with the same initial as exp1i

exp5i same as exp5, but with the same initial as exp1i

exp6i same as exp6, but with the same initial as exp1i

12 h accumulated precipitation forecast for simulation started at 20UTC, 20140830, using 3h forecast of exp1 at 2014083017 as the same initial value for all the experiments