Royal Netherlands
Meteorological Institute
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Impact of radar data assimilation in HARMONIE

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The Royal Netherlands Meteorological Institute (KNMI) operates two C-band Doppler weather radars, one in De Bilt (the center of the country) and the other at naval base Den Helder (the north of the country). Together with the data from three stations in Belgium, these radar data are assimilated in several experimental forecasting suites at KNMI of the HARMONIE forecasting model. We will show the results of a few experiments in which radar data are assimilated in different combinations with conventional data.

1. The system set-up

The two radar stations in The Netherlands produce volume radar data every five minutes in both KNMI's local hdf5 data format and in OPERA hdf5 and bufr format. The data from Belgium are received with the same period of five minutes in OPERA hdf5.

1.1 Data flow

For the (3DVAR) data assimilation the Belgian radar data are converted into KNMI hdf5. The radar data are then read by CONRAD, which converts the data into MF bufr. The data are then read by BATOR which transfers the data to the Observation Data Base (ODB) of HARMONIE.

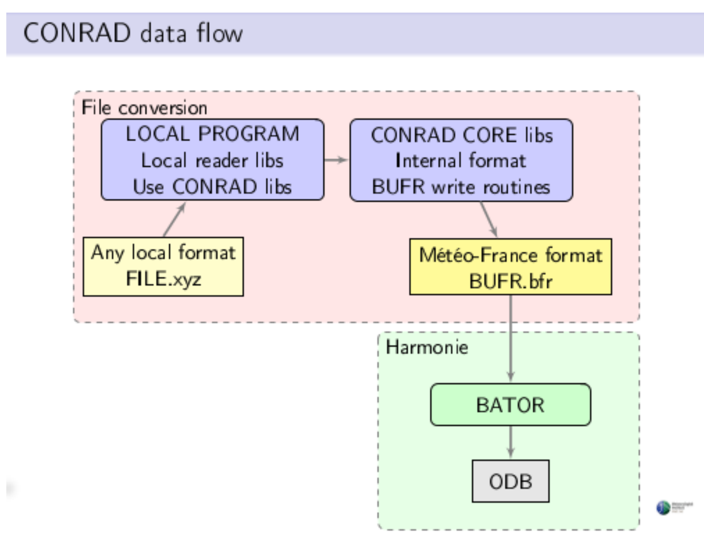

Figure A *Data flow using CONRAD*

The picture above (courtesy of Martin Grønsleth) illustrates the data flow.

1.2 Computational domain

The runs with HARMONIE are carried out at ECMWF on a computational domain containing The Netherlands. We use version 37h1.2 with a horizontal grid of 300×300 points 2.5 km apart and 60 η-layers in the vertical.

2. Data assimilation experiments

We have considered a period of 24 hours, starting at 16 September 2013, 12:00 UTC and ending at 17 September 2013, 12:00 UTC. This period was characterized by a south-westerly airflow, diminishing somewhat in strength in the course of the period, and by rather heavy rainfall. The latter becomes clear from the fields displayed in column 1 of *Figure B*.

2.1 Experimental set-up

We performed a series of five forecasts, starting at 16 September 2013, 12:00 UTC, with a a total forecast time of 24 hours and an assimilation cycling time of 1 hour. Also the boundaries, taken from the ECMWF MARS archive, were used every 1 hour. The results in terms of rainfall rate (in mm/h), displayed every 6 hours, are given in columns 2 to 6 of *Figure B*. These results are to be compared with the rainfall rate (in mm/h), obtained (in a semi-empirical way) from the two Dutch radar stations, shown in column 1. All plots use the same contour interval of 0.1 mm/h where purple denotes low values and red high values.

2.2 Differences between assimilated data

All forecasts start from the same first guess but differ in terms of the data that are assimilated. Column 2 shows the results of a forecast without data assimilation whereas column 3 shows the results when only conventional data are assimilated. In columns 4 to 6 we use, as additional data, radial winds from the Dutch radars only (column 4), reflectivities - translating these into specific humidity - from the same radars (column 5) and radial winds and reflectivities combined, again for the same radars.

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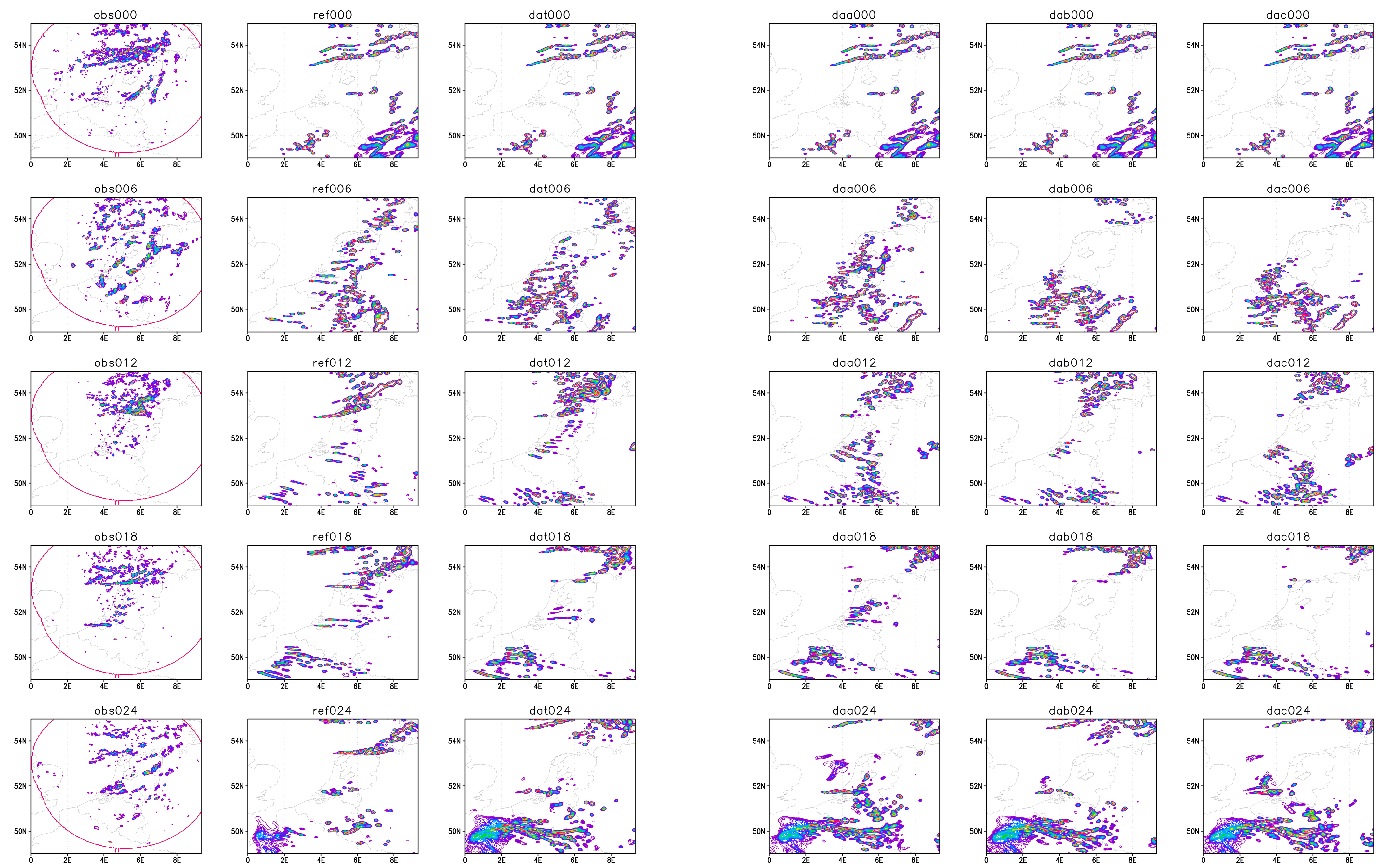

Figure B *Observations (column 1) and the results of different forecasting experiments (columns 2 to 6) in terms of rainfall rate in mm/h. The rainfall rates in column 1 are derived in a semi-empirical way from measured reflectivity data; the rainfall rates in columns 2 to 6 are given by the model instantaneous rain at the surface. The 24 hour forecasts displayed at 6 hour intervals in the columns 2 to 6 all start from 16 September 2013, 12:00 UTC and use a 1 hour assimilation cycle. They are identical except for the data assimilated: none in column 2, conventional data in column 3, conventional data plus radar radial winds in column 4, conventional data plus radar reflectivities in column 5 and conventional data plus radar radial winds and reflectivities in column 6. Only the Dutch radars are used. The differences are substantial, especially between the forecasts with assimilated radial winds and reflectivities (columns 4 and 5).*

3. Discussion

The differences between the forecasts are quite large, especially between the forecasts with assimilation of additional radial velocities (column 4) and additional reflectivities (column 5). The differences emerge already after 6 hours.

As previous experiments had indicated that the impact of a single data assimilation of radar data decays in less than 6 hours, the large effect that is seen here must be the result of adding radar data every hour.

4. Conclusions

The fact that the differences between forecasts with several combinations of radar data are so large implies that the predicted development of rainfall rate is significantly influenced by the assimilation of radar data.

It thus evidently has the potential of increasing the quality of the predicted rainfall. The question is how to transform the differences seen here into improvements.