SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2013
Project Title:	Implementation and validation of radar data-assimilation in the HARMONIE mesoscale weather prediction model.
Computer Project Account:	SPNLVERK
Principal Investigator(s):	Dr. W.T.M. Verkley
Affiliation:	Royal Netherlands Meteorological Institute (KNMI)
Name of ECMWF scientist(s) collaborating to the project (if applicable)	
Start date of the project:	2012
Expected end date:	2014

Computer resources allocated/used for the current year and the previous one
(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	300000	35382	300000	24765
Data storage capacity	(Gbytes)	400	0	400	0

Summary of project objectives
(10 lines max)

To study the impact of radial velocity and reflectivity data from the Dutch radar stations in De Bilt and Den Helder on analyses and forecasts made by a test-version of the HARMONIE mesoscale forecasting system. In the course of the project also foreign data such as those from the Belgian radar stations in Jabbeke, Wideumont and Zaventem, will be used.

To investigate the influence of quality control on the data used, in particular of the BALTRAD de-aliasing algorithm for radial velocities.

Summary of problems encountered (if any)
(20 lines max)

There had been some problems with the BALTRAD software, connected with 32 versus 64 bits encoding of data. The de-aliasing option became available in December 2012 and functions properly although spurious features were added at the fringes of the scans on at least one occasion. It has also been noted that memory problems can arise in the data-screening routine of the data-assimilation system if the amount of radar data is larger than usual.

Summary of results of the current year (from July of previous year to June of current year)

This special project, started at the beginning of 2012, has been a request for computer resources needed to add radar data to the set of observations used by the mesoscale weather prediction model HARMONIE. The main software packages that are used to accomplish this are CONRAD and BALTRAD. The CONRAD software is developed to convert any local radar data format into mf-bufr, which is the format that HARMONIE is able to read. The BALTRAD software package contains quality control routines that are necessary to deal with issues such as de-aliasing of radial winds.
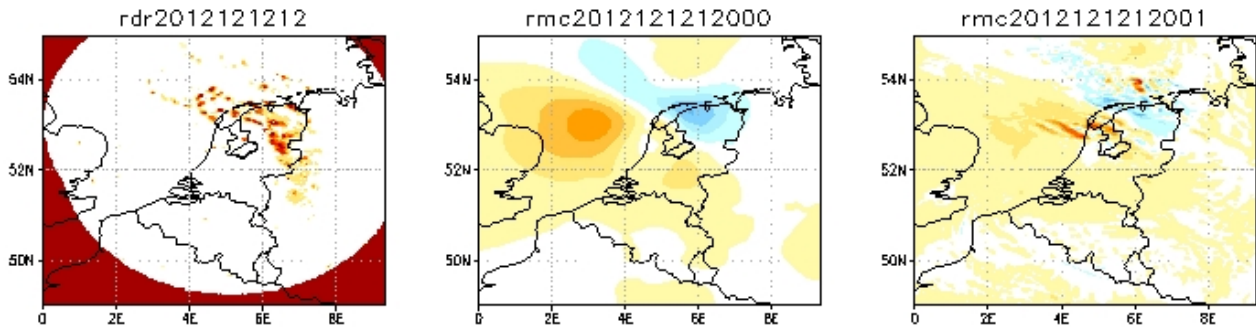
Left: Total precipitation (mm/h) at 12 December 2012, 12:00 UTC. Middle: difference in temperature (K) at model level 50 (around 900 hPa) between the analysis with and without inclusion of radial velocity data from the radar in Den Helder at 12 December 2012, 12:00 UTC. Right: difference in temperature (K) after one hour forecast time. The contour ranges in the different panels are 0.1 mm/h-3.2 mm/h, -0.32 K - 0.24 K and -0.64 K - 0.96 K with contour intervals of 0.1 mm/h, 0.08 K and 0.32 K, respectively.

As reported previously, we planned to set up a system to study the impact of the assimilation of radar data on a daily basis. This has not materialized yet. Instead, a series of five periods of ten consecutive days are under study, two in the winter of 2012 and three in the spring/summer of 2013. These periods are (1) 20-29 November 2012, (2) 10-19 December 2012, (3) 11-20 May 2013, (4) 23 May - 01 June 2013 and (5) 19-28 June 2013. In these periods two forecasts of 24 hours were run each day, starting from 12:00 UTC, one with and one without assimilation of radar data. For the first two periods HARMONIE version 36h1_radar was used, for the last three periods 37h1.2.

The study of the impact is still in progress. Until now attention has mostly been given to the evolution of analysis increments. An example taken from the second ten-day period is given in the figure above. The left panel shows the total precipitation in mm/h at 12 December 2012, 12:00 UTC. The precipitation field covers the north-east of the Netherlands and is embedded in a moderate westerly to south-westerly wind field at the surface. The middle panel shows the difference between the analysed temperature field at 12 December 2012, 12:00 UTC, on model level 50 (about 900 hPa), in which radar data were included in the assimilation, and the analysed temperature field in which these data were not assimilated. The assimilation was performed by the three-dimensional variational data-assimilation system of the HARMONIE forecasting system, using radial velocities from the radar at Den Helder. In the right panel we show the same difference field, but now after one hour forecast time, i.e. at 12 December 2013, 13:00 UTC. We see that, although the grander dipole shaped temperature increment at analysis time can still be recognized, a substantial amount of small-scale structure is added after one hour of forecast time. This small scale structure is present from the beginning of the forecast, can also be seen in other fields than temperature, diminishes somewhat with height, but persists during the whole forecast period of 24 hours. The origin of the small-scale structure is object of ongoing study.

In the course of the present year radial velocities and reflectivities from the Belgian radar stations at Jabbeke, Wideumont and Zaventem have became available for research purposes. In the last two study periods radial velocity data from the Belgian radars were added to those of the Dutch radars. Also, experiments have been initiated by Jan Barkmeijer in which both Dutch and Belgian radar data are used in an hourly rapid update cycle of HARMONIE.

List of publications/reports from the project with complete references

Wim Verkley has given a presentation on the status of radar data assimilation at KNMI during the HIRLAM-HARMONIE Working Week on High Resolution Observations in HARMONIE (a follow-up of the extended radar data impact study). This working week was held from 12 – 15 March 2013 at SMHI in Norrköping, Sweden. The presentation can be downloaded from: https://hirlam.org/trac/wiki/HarmonieWorkingWeek/UseObs201303.

Jan Barkmeijer has given a presentation on HARMONIE at KNMI and future work (including a short report on radar data) at the Joint All Staff Meeting 2013 and 23th ALADIN Workshop of 15 – 18 April 2013 at the Icelandic Met Office in Reykjavik, Iceland. The presentation can be downloaded from: http://www.cnrm.meteo.fr/aladin/spip.php?article165.

Summary of plans for the continuation of the project
(10 lines max)

At some stage a regular daily system of forecasts with and without radar data will be set up. However, we first wish to concentrate on the impact of radar data in the selected periods. A step to be taken in the near future will be to add the radar data more frequently than only at the beginning of a 24 hour forecast period, first with an intermediate analysis after 12 hours, then after 6 hours, 3 hours, etc., in order to study the cumulative effect of adding radar data.

Continued attention will be paid to the influence of the quality control.

If available, data from additional foreign radar stations will also be considered.