Assimilation of radar reflectivity in the AROME model

By Eric Wattrelot

CNRM/GAME, Météo-France and CNRS
42 av Coriolis
31057 Toulouse
France
eric.wattrelot@meteo.fr

These last years, Météo-France has developed a Numerical Weather Prediction (NWP) system at convective scale that is running operationally since the 18th December 2008. This system, called AROME, covers metropolitan France with a 2.5 km horizontal resolution. High frequency observations to initialize at similar time and space scales are needed because small scales do not just adapt to large scales. Indeed, high resolution models represent key convective cells with a significant small-scale memory: older convection (as gust fronts or cold pools) may influence the development of new convective systems. Radar reflectivity is capital to provide such high-resolution information about precipitating patterns. Studies of precipitating systems with the assimilation in the AROME model of volumic radar reflectivities from the national ARAMIS network showed a better description of qualitative and quantitative precipitation short term forecasts, especially for cases of good vertical sampling of the atmosphere.

Relative humidity profiles from radar reflectivities are firstly retrieved and then assimilated in the 3DVar AROME as pseudo-observations. This method has the main advantage to use vertical information from useful volumic radars. As both rainy and non-rainy observation are used, either precipitations are produced or the model dries up. In figure a, one can see the impact on a relative humidity analysis of the assimilation of reflectivities from high altitudes (rain does not reach the ground). The propagation of the information is consistent with the observed spatial scales.

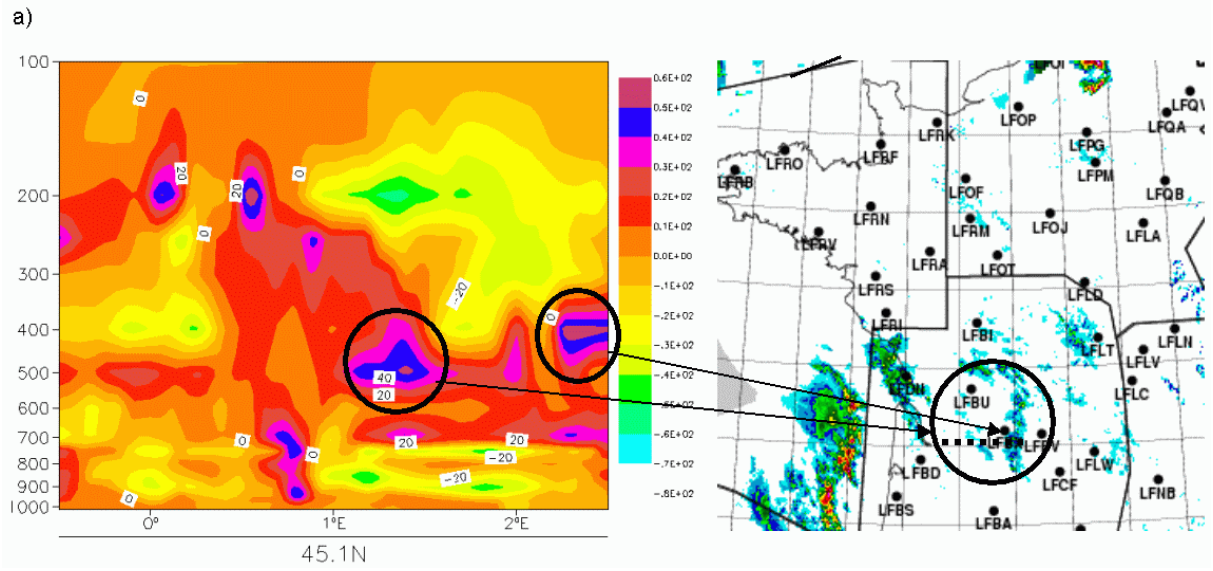

Figure a caption: Left, vertical cross-section (corresponding to the dashed line on the radar composite map right) from a relative humidity difference between an experience with assimilation of radar reflectivities and an experience without reflectivity being assimilated.

Daily evaluations of this assimilation have shown positive results in a pre-operational context. In particular a positive impact is found for very short range precipitation forecast scores. Results from such an experiment, running from the 15th of April 0000 UTC to the 23rd of April 2009 0000 UTC, are shown hereafter. During this period, important precipitation associated with a surface cold front crossed France eastwards on the 16th of April. At that time, an unstable air mass over France was associated with a large low on the Near Atlantic which was getting close to France. Associated with the cold upper-air and front over France, embedded and post-frontal convective precipitation occurred during several days. Fig. b shows positive scores for 6-hour accumulated precipitation forecasts against rain gauges, between 3-h and 9-h forecasts when the reflectivities are assimilated (REFL against CTRL). An improvement of forecast scores for other parameters (such as wind) over long periods is also observed (not shown here).

b)

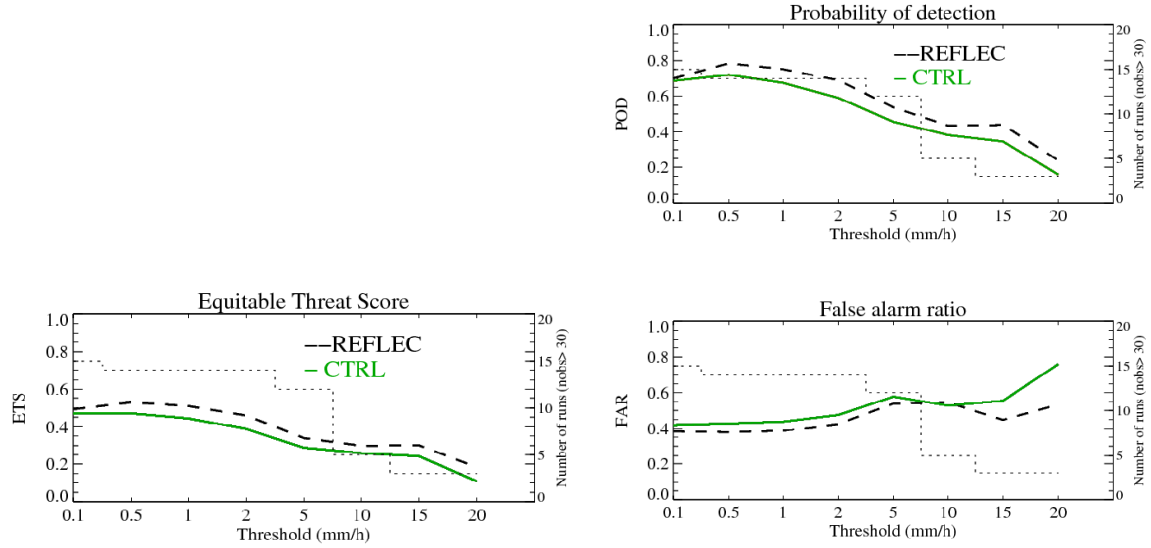

Figure b caption: Left: averages of Equitable Threat Scores (ETS) for 6-hour precipitation forecasts against raingauges, between 3-h and 9h forecasts (at 00h and 12h UTC from 15 April to 23 April 2009 00h), as a function of threshold (mm/h) for CTRL (green line) and REFL (black dashed line). The thin dashed line represents the number of forecasts taken into account in the calculations, i.e., for which the number of observations above the threshold exceeds 30. Top right: idem for Probability of detection (POD) and Bottom right: idem for False Alarm Ratio (FAR).

Since the end of 2008, the assimilation of reflectivities has been systematically evaluated, by means of a radar product optimized for the Arome model (Doppler winds and reflectivities). Data from the 24 radars network are now assimilated in the pre-e-suite but at this moment neither the very low reflectivities from the lower troposphere (echoes which may be still unidentified anomalous beam propagation) nor the lowest elevations affected by high values of topographical beam blockage are assimilated.

Wattrelot E, Caumont O., Pradier-Vabre S., Jurasek M. and Günther Haase , 1D+3DVar assimilation of radar reflectivities in the pre-operational AROME model at Météo-France. ERAD2008. *Proceedings of the fifth European conference on radar in meteorology and hydrology.*

Caumont, O. V. Ducrocq, E. Wattrelot, G. Jaubert, S. Pradier-Vabre, 1D+3DVar assimilation of radar reflectivity data: A proof of concept, *Tellus, DOI : 10.1111/j.1600-0870.2009.00430.x. In press.*