# Assimilation of radar data at convective scale at Météo-France

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These last years, Météo-France has developed a Numerical Weather Prediction (NWP) system at convective scale that has been running operationally since the $18^{th}$ December 2008. This system, called AROME, covers the French territory with a 2.5 km horizontal resolution. Its main goals are to improve the local meteorological forecasts of potentially dangerous convective events (storms, unexpected floods, wind bursts, etc.) and of lower tropospheric phenomena (wind, temperature, turbulence, visibility, etc.). AROME uses the physical parameterisations from the non-hydrostatic MesoNH model that considers in particular complete representation of the water cycle with five hydrometeors governed by a bulk microphysical parameterisation. AROME makes use of a complete data assimilation system derived from the ALADIN 3Dvar that is operationally running at Météo-France at regional scale since the end of 2005. In this context, radial velocities and volumes of reflectivities observed by the national ARAMIS Doppler radar network play a key role by providing information about the horizontal wind circulation and the 3D precipitation patterns within precipitating systems over a wide part of France with high horizontal and temporal resolutions.

To assimilate such quantities, observation operators, that allow to simulate the radar measurements at the observed locations, have been developed. The assimilation of Doppler winds in the AROME 3Dvar has been validated on several convective cases and evaluated on a daily basis in a pre-operational configuration. It has been shown that, when some favourable sampling conditions are present, short term forecasts of precipitations are improved thanks to a more realistic analysis of convergence structures in the boundary layer (Montmerle and Faccani, 2009). Following these results , Doppler winds of 16 radars have been included in the first operational AROME NWP system.

An important evolution will be the assimilation of radar reflectivities, which is routinely evaluated since the end of 2008. As it is stated in Caumont *et. al* (2006), the direct observation operator of reflectivities requires complete warm and cold microphysical parameterization which consider nonlinear moist processes and thresholds (convection regimes and saturation in particular). To avoid problems in the minimization algorithm, an original “1D+3DVar method” to assimilate these radar reflectivities has been introduced. The 1D algorithm consists of a Bayesian statistic method which allows to retrieve relative humidity profiles from the observed columns of reflectivities, the different hydrometeor types being not analysed. For this, the model state in the vicinity of the observation is used as source of information, in order to assess the necessary information about precipitating species to constraint the solution. The method must provide the most probable profile by application of Bayses’ theorem. The retrieved humidity profiles are then directly assimilated in the 3Dvar. The method has proved the capability to create proper increments to adjust the model reflectivities towards the observations, even if there is no rain (at the same location) in the model background fields (Wattrelot *et al,* 2008). In order to dry and shift misplaced precipitating patterns, it has been shown that the assimilation of the “no-rain” signal provided by the radars was very useful (see figure). An evaluation of two months of cycled assimilations has confirmed a good impact on scores of precipitating forecasts.

A recent work with the producers has led to a better characterization of the "no-rain" signal which depends of the sensitivity of each radar, which is a decreasing function with the range from the radar. Sensitivities studies on analysis of this detection threshold have allowed to define the best careful using of the "no-rain" signal.

In the short term, a similar work to better characterize clutter (in particular clear sky echoes and see clutter) will allow to use Doppler winds of additional radars (including coastal) operationally. Assimilation of reflectivities still is evaluated on a daily basis, and should hopefully be included in the operational suite at the end of 2009.

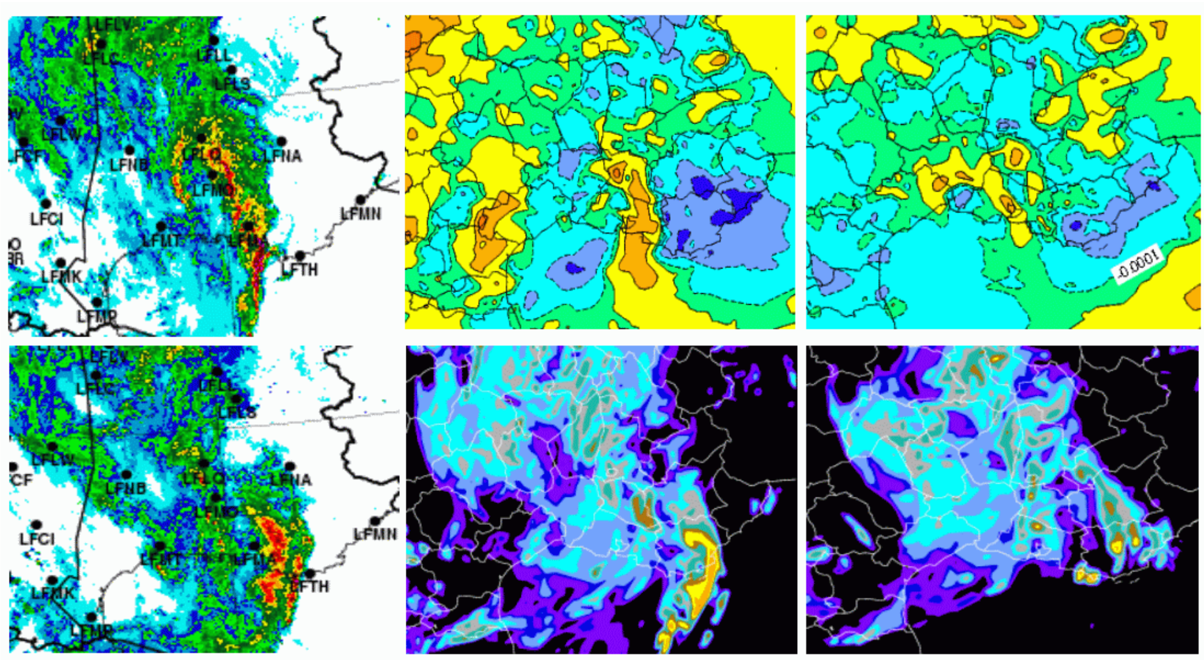


**Figure caption**: Squall line on the South-East of France the 8th October 2008. Top panels: at 06h UTC, composite reflectivity pattern (left), analysis increments of specific humidity at 850 hpa deduced from the AROME assimilation system with (middle) and without (right) radar reflectivities (yellow-orange contours denote positive increments, isocontours every 0,1 g/kg). Bottom panels: at 09h UTC, composite reflectivity pattern (left), 3h AROME forecast of the 900 hpa simulated reflectivity field from an analysis provided by the assimilation cycle with (middle) and without (right) reflectivities.

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