Implementation & progress of the AROME 2.5km modelling system at Météo-France

Yann Seity, Pierre Brousseau, Gwenaëlle Hello and François Bouttier
CNRM/GAME, Météo-France and CNRS
42 Av Coriolis, 31057 Toulouse France
francois.bouttier@meteo.fr

A new numerical weather prediction system has been implemented in operations at Météo-France in December 2008. It is called AROME (Applications of Research to Operations at MesoscalE) and covers mainland France at a 2.5km horizontal resolution (see example on Figure 1).

The AROME (model and data assimilation) system is derived from ECMWF's IFS software [2], Météo-France's ARPEGE/ALADIN [1], contributions from the ALADIN consortium [3] and from the Méso-NH research community [4]. AROME includes a non-hydrostatic, spectral semi-Lagrangian dynamical core, physical parametrizations of cloud microphysics (5 prognostic condensate species), subgrid turbulence (vertical mixing using prognostic turbulent kinetic energy plus EDKF shallow convection scheme), radiation (multiband RRTM-FM scheme), surface processes (tiles for sea, ice, snow, soil, vegetation, towns, with canopy model), and a 3-hourly 3D-Var sequential data assimilation that processes a variety of in situ, satellite and radar data (see [5]) .

Real time experimentation of AROME over the past two years has shown it to be a beneficial tool for the forecasters as a complement to other, larger scale models. When compared to its nearest competitor (the 10km ALADIN-France model and data assimilation), AROME is shown to improve most low-level objective scores, and to bring useful guidance on high impact weather such as heavy rain, convective events, fog, coastal and orographic effects. For instance, it was shown to improve the forecast location of a flooding rain event that extended beyond the usual Mediterranean catchment areas (Figure 2); to provide indication of a tornado-favourable environment on a small scale destructive wind event (Figure 3); to improve the mapping of areas affected by high winds in a synoptic scale storm event.

Current priorities for further improvement are:

- to fix excessive precipitation in strong rain events. One suspects an erroneous interaction between the non-hydrostatic dynamics and microphysics in grid-scale convective towers.
- to double the vertical resolution in the lower troposphere. This is expected to improve the prediction of fog and low, stratiform clouds.
- to better represent the effect of subgrid orography. Although moutain waves are thought to be correctly modelled, systematic wind biases near crests and valleys may be due to a missing effect of subgrid roughness and blocking.
- to improve the model upper boundary condition. As the AROME grid does not extend very high into the stratosphere, a numerical relaxation towards boundary conditions provided by a larger scale model is beneficial.
- tunings of the physics, e.g. the subgrid shallow convection scheme
- to introduce the assimilation of radar reflectivities (see [5]) AIRS and IASI radiances
- to implement a native surface data assimilation (current SST, ice and soil prognostic fields are taken from the ALADIN data assimilation, which causes inconsistencies).
- to improve the 3DVar structure functions
- (later) to extend the geographical domain

Besides, extensive testing of higher resolution AROME models have begun, including real-time production of 1-km resolution forecasts over the Alps during the Winter 2009 World Ski Championship (Val d'Isère), 500-m tests and implication in developments for assistance to Air Traffic Management (ATM) including demonstration runs near some major airports. Current research with AROME is focused on modelling and data assimilation in Mediterranean regions, in preparation for the oncoming Hymex field experiment [6].

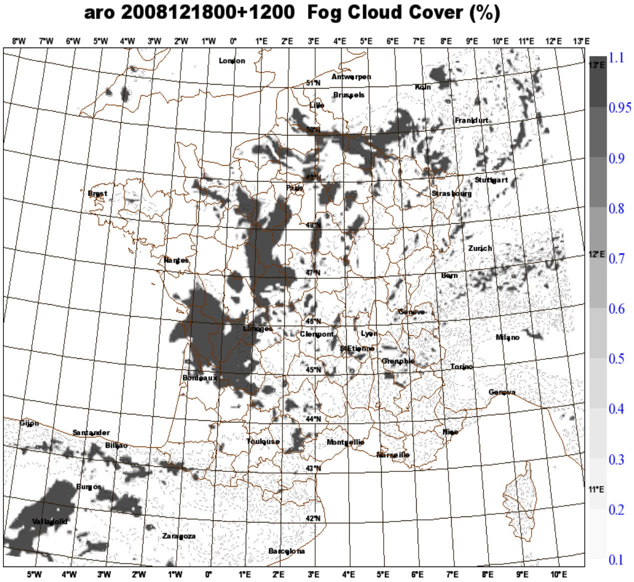

Figure 1: sample output from the first operational Arome forecast (fog field), showing the model domain.

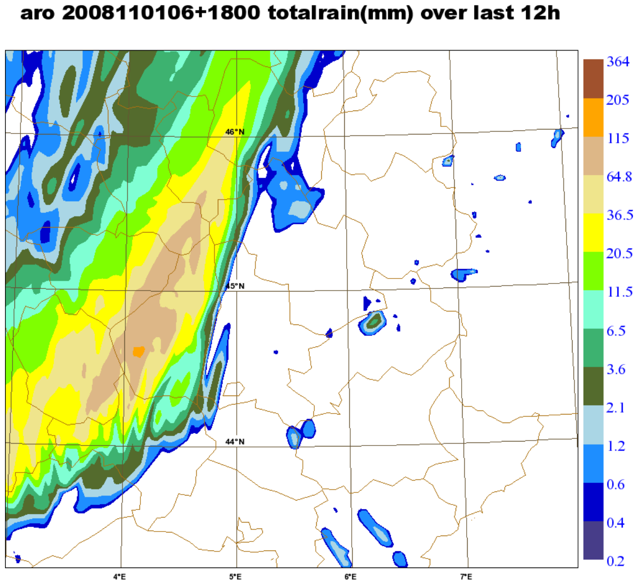

Figure 2: total rain forecast in the Lyons area (Gier flooding event). The area of maximum rain intensity is within 20km of the actual flooding event.

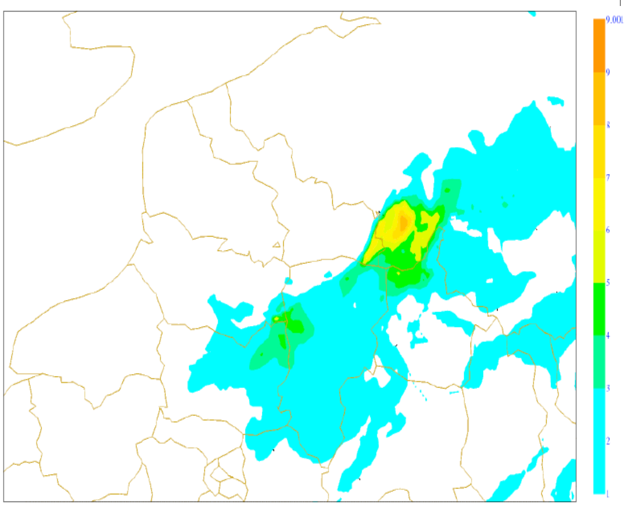
Figure 3: map of forecast SCP (supercell conposite parameter) for a tornado event (Hautmont area, N of France, 8 Aug 2008) - the yellow area precisely matches the location of an observed tornado. Reproduced from [7]

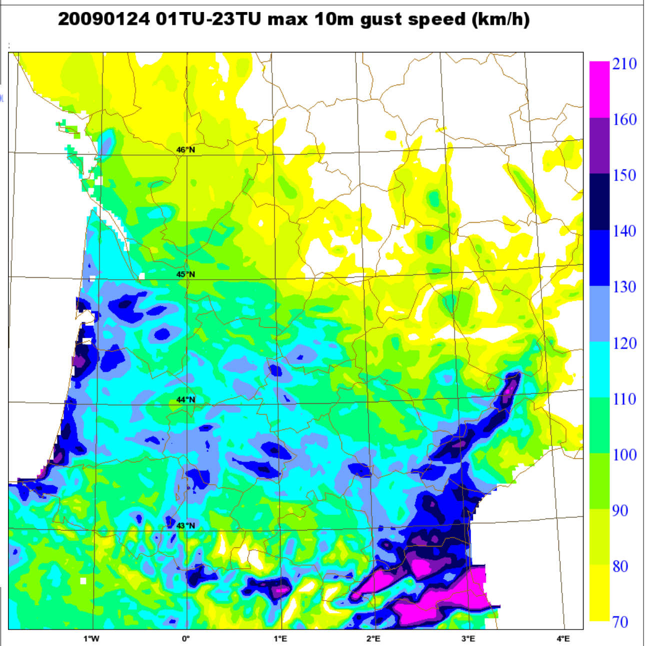

Figure 4: analysis of 10-m max gust speed for a day, combining Arome assimilated fields with in situ observations, during the 24 Jan 2009 storm over SW France.

References

[1] http://www.cnrm.meteo.fr/gmap/ and http://www.cnrm.meteo.fr/arome/ : AROME system documentation, update bulletins and research papers.
[2] http://www.ecmwf.int/ is ECMWF's webpage with some documentation on the IFS
[3] http://www.cnrm.meteo.fr/aladin/ is the ALADIN consortium's official webpage
[4] http://mesonh.aero.obs-mip.fr/mesonh/ is the Méso-NH webpage with model documentation
[5] Wattrelot, E. and T. Montmerle: Assimilation of radar data at convective scale at Météo-France. WGNE Blue Book 2009, in this volume.
[6] http://www.hymex.org/ is the webpage of the Hymex field experiment
[7] Montmerle, T. and O. Nuissier, 2008: Les tornades en France, formation, climatologie, prévision. *Météo-France technical report.(In French)*