What’s new in AROME-France configuration?

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E. Perraud, C. Lac ...
Contents

- AROME_v2 (operational since 6 April)
- Current works and preparation of AROME_v3
Direct coupling to ARPEGE

- ARPEGE resolution over France reaches 10 km
- Avoid an intermediate coupling with ALADIN
- Simplify operational suit, AROME forecasts available 15' earlier
Improve vertical resolution (L60)

Layer thickness (m)

From L41 to L60 (+37% CPU)

1st level at 10m (17m in L41)

27 levels below 3000m (15 in L41)

Added levels mostly near the surface:

ARP / ALAD

Additional levels:

- L60
- L70

AROME

Additional levels:

- L41
- L60
and for model part:

- Spectral relaxation towards ARPEGE on the top of the model
  \[ X_{arome}(t) = (1 - \alpha)X_{arome}(t) + \alpha X_{coupleur}(t) \]
  - Vorticity, divergence and temperature
  - above 100 hPa
  - 30 first wave numbers (scales > 100 km)

- Harmonisation of gusts diagnostic (ARP/ALD/ARO):
  - \( U_{gust} = U_{10m} + \alpha \cdot TKE(h) \) (\( \alpha = 3.5 \) and \( h = 20m \))
  - max in 1h

- Modifications in turbulence to remove negative values of \( q_c \) and \( q_i \), and in microphysics for negative \( q_g \)

- Sedimentation of fog (to fix problems over sea)

- Version 2 of EDKF scheme: Improvement of the entrainment formulation in dry boundary layer (which now changes according to flotability and updraft vertical velocity)

- Correction in simulated radar pictures concerning snow reflectivities

- Remove special treatment of fullpos FC+0 by a best initialisation of CANOPY
- Radar reflectivities $Z$:
  24 radars: 16 C-band (yellow) +
  8 S-band (green). Volumic $Z$
  (from 2 to 13 elevation)

- Satellite Obs:
  - As in ARP/ALD (radiances density 250->125km)
  - AIRS/IASI

- New Jb calculated from an ensemble of AROME assimilations

- Day to day gridpoint Sigma B provided by ARPEGE ensemble assimilation:
  - vorticity, divergence, temperature, $P_s$
Altitude scores

15 Sept 2009 – 3 March 2010
Comparison to radiosoundings
(AROME_v1 - AROME_v2)

Temperature

Wind

Humidity
Surface scores

- Rms AROME_v1
- Bias AROME_v1
- Rms AROME_v2
- Bias AROME_v2

P$_{\text{sea}}$ (hPa)

Forecast time

V$_{10m}$

T$_{2m}$ (°K)

Hu$_{2m}$ (%)
24h rainfall scores (0TU+6/+30h)

Comparison to 4000 observations network (15 Sept 2009 to 1 March 2010)

- AROME-v1
- AROME-v2

Statistical significativity of differences

BIAS

Brier Skill Score

Heidke Skill Score
Example of a case (4-Nov-2009)
Contents

- AROME_v2

- Current works and preparation of AROME_v3
  - New domain
  - Hail
  - Orography
  - Low clouds
  - Other works
AROME-France v3 domain

Domain 750x720 points (+70 %)

Performances: cf Ryad’s talk
Hail (ICE4)

Additional part to include hail explicitly
Cumulated precipitations

- ICE3 and ICE4 are similar in terms of rain
- Hail sensitivity to the time step
Cumulated precipitations

- Splitting the microphysics seems to improve hail fields
Evaluation on a longer period

Mai-Nov 2009 in South-West of France in comparison with hail observations and possibly polarimetric radars

Observation network (1054 stations):

Preliminary results over 2 months (May, June):

- 8 cases of correct forecast of hail
- 22 cases of correct forecast of rain only
- 10 cases of false alarm
- 2 cases of no detection
Use meso-NH gtopo30 database for AROME orography and land-sea mask

Currently:
Old GTOP30

Pre-treatment

2°30’ grid (5km)

C923

Quadratic orography

Max slope FRANXL = 41%

Land-sea mask at 500m of Geneve lake (old, new).

New way:

PGD in FA

C923

Quadratic orography

Max slope FRANXL = 51%

Evaluation on October 2009 in AROME_v2 in dynamical mode:

Improve $V_{10m}$ but 2 crashes of the model in the first time step near points of max slope
(pb of adaptation of the wind to the orography, no pb in assim mode)
From forecasters point of view, the main drawback in AROME concerns low clouds.
AROME Neb is 1 or 0. In stable conditions, we are not able to create clouds if Hu<100%

Link with SW radiation bias.
Tests in Meso-NH to improve the cloud scheme

Calculation of the subgrid cloud variability according to a *Probability Density Function* (PDF):

**Cloud fraction and cloud water content calculation:**

\[
CF = \int_{r_{sat}}^{+\infty} G(r_t) \, dr_t
\]

and

\[
\bar{r}_c = \int_{r_{sat}}^{+\infty} (r_t - r_{sat}) \, G(r_t) \, dr_t
\]

With \( G = PDF \)

The cloud fraction is the red area under the PDF curve beyond the saturation:

- (a) No saturated : \( CF=0 \)
- (b) Partially saturated : \( 0<CF<1 \)
- (c) Fully saturated : \( CF=1 \)

The choice of the PDF is essential

Methodology to improve the cloud scheme for BL clouds:

1. Comprehensive statistical analysis of PDF obtained with Large Eddy Simulation (LES)
2. Test of different theoretical PDF to fit the best the LES data
3. Parametrization of the best theoretical PDF with turbulent and convective parameters (*work in progress, not yet achieved, first results in real cases expected by the end of 2010*).

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E.PERRAUD et al., 2010
1. Statistical analysis of LES data:

- ARM Cu case
- ACE homogeneous Sc case
- ACE heterogeneous Sc case

Apparition of a second mode in the cloudy values of $s$ linked to the convective thermals.

LES distributions of $s$ (saturation deficit) inside the cloud layers.
2. Evaluation of the theoretical distributions by comparison to the reference LES distribution:

- **Gaussian distribution** ([Sommeria and Deardorff, 1977; Bougeault, 1981](#))
- **Triangular distribution** ([Smith, 1990](#))
- **Beta1 and Beta2 distributions** ([Tompkins, 2002](#))

Introduction of a double gaussian distribution to improve the representation of the second mode.
Other works, outlooks

- Optimized version of shallow convection scheme (EDKF)
- Test ECOCLIMAP II (second half of 2010)
- Test modifications in SL scheme proposed by S. Malardel in real 3D case of 'fireworks'.
- Data assimilation in Surfex (cf J-F Mahfouf talk)
- Continue investigations at higher resolution
- Start of AROME_v3 in E-suit in summer. Content is not yet fully fixed.
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