AROME-France 1.3 km (Model part) Status and plans

Y. Seity
OUTLINE

- Overview of the operational configuration
  - Dynamics
  - Physics
  - Technics

- Objective evaluation

- To prepare the future (microphysics)

- Conclusions
Horizontal grid AROME-France 1.3km

- Domaine FRAMG slightly larger (in the N) than current FRANGP

  Orography AROME 1.3km (1440x1536 points) : AROME 2.5km (750x720 points)

  From GMTED2010 250m

  From GTOPO30 1 km

Coupling area 16 / 8 points
**Horizontal grid AROME-France 1.3km**

- Domaine FRAMG slightly larger (in the N) than current FRANGP

Orography AROME 1.3km (1440x1536 points) : AROME 2.5km (750x720 points)

- **Max Slope**
  - Mt Blanc (4807m): 38° / 4272 m
  - Aneto (3404m): 23° / 3008 m

- **ABS (Mean altitude gap between model and SYNOP+RADOME)**
  - 20.6 m / 58 m
Horizontal grid AROME-France 1.3km: zoom over the Alps

- Deeper valleys, higher peaks

**Zoom_Savoie_2.5km:**

**Zoom_Savoie_1.3km:**
# Vertical grid AROME-France 1.3km

<table>
<thead>
<tr>
<th></th>
<th>AROME 1.3km</th>
<th>AROME 2.5km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb vertical levels</td>
<td>90</td>
<td>60</td>
</tr>
<tr>
<td>Top model level</td>
<td>10 hPa</td>
<td>1 hPa</td>
</tr>
<tr>
<td>Lowest model level</td>
<td>5m</td>
<td>10m</td>
</tr>
<tr>
<td>Nb levels &lt; 2000m</td>
<td>33</td>
<td>21</td>
</tr>
</tbody>
</table>

L90/L60 : Regular increasement for all layers
AROME-France 1,3km Dynamics

- In CY40_op1 / oper in 38t1_op1

<table>
<thead>
<tr>
<th></th>
<th>AROME 1,3km</th>
<th>AROME 2,5km</th>
</tr>
</thead>
<tbody>
<tr>
<td>dt</td>
<td>45s</td>
<td>60s</td>
</tr>
<tr>
<td>P/C scheme (NSITER=1)</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>P/C cheap</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>LGWDADV / LRDBBC</td>
<td>T / F</td>
<td>F / T</td>
</tr>
<tr>
<td>ND4SYS</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>LSLHD_OLD</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>New SL interpolators (COMAD)</td>
<td>T</td>
<td>F</td>
</tr>
<tr>
<td>Coupling zone (Davies)</td>
<td>16 points</td>
<td>8 points</td>
</tr>
<tr>
<td>Top spectral relaxation</td>
<td>T (retuned)</td>
<td>T</td>
</tr>
</tbody>
</table>
No big modifications:

- Microphysics (retuning of snow autoconversion threshold (cf Balazs talk))

- Surfex: version update (v6+ -> v7.2), Z01D orographic drag (tuning)
AROME-France 1,3km Technics

- **Optimisations**
  - I/O server (P, Marguinaud)
  - MesoNH physics is now called with the same vertical levels ordering as ARPEGE
  - Bottom and top additional points (KLEV+2) no more necessary except for turbulence (→ cleaning of apl_arome)

- <274 nodes of our Bull (> 1/4 of the machine) will be required to perform AROME 1,3 km 24h forecast in 30' (with mixed MPI/OpenMP parallelisation)

- Preparation of initial surfex file has been MPI parallelised (providing the fact an FA PGD is used in input).
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- Conclusions
Evaluation on small domain (Prototype)

- FRAMINI (720x720 points)

- Daily runs r0 +30h since 1\textsuperscript{st} June 2012 (without data assimilation, starting from AROME-oper 2.5km)
NWC SAF “RDT” software (Morel et al., 2002) to detect convective cells based on simulated reflectivity. Threshold used at 40 dBz.

48 convective days in 2012

1.3 km: nb of small convective cells increased and nb of big cells decreased
1.3 km is closer to observed radar reflectivity

(J. Léger, D. Ricard, Y. Seity)
1.3 km: nb of cells with remaining life time < 15' increases, > 1h decreases
1.3 km is closer to radar observation

R. Ben Rohmdane
Evaluation on the full domain (on Bull)

AROME_1.3km / AROME_2.5km

Improvements on Ps, V10m
Evaluation on the full domain (on Bull)

Jan 2013  AROME_1.3km /AROME_2.5km  Juil 2013

Improvement on RR6, cloud cover
COMAD weights for SL interpolations

- Computation of the trajectories: no modification

Arrival point on the grid \( t+1 \)

Departure or origin point \( t \)
• Computation of the trajectories: no modification

• Computation of advected variables at the origin point: modification of the SL interpolation weights:

For linear weights ($\lambda_x$, $\lambda_y$):

modified weights are defined as:

\[ \lambda_x' = \lambda_x \cdot D_x + 0.5 \cdot (1 - D_x) \]
\[ \lambda_y' = \lambda_y \cdot D_y + 0.5 \cdot (1 - D_y) \]

also used after for computing cubic weights

take into account the deformation of air parcels along each direction, with deformation factor defined as:

\[ D_x = 1 + \frac{\partial U}{\partial x} \cdot dt \]
\[ D_y = 1 + \frac{\partial V}{\partial y} \cdot dt \]
Positive impact on RR6 scores
Evaluation on the full domain (on Bull)

AROME_1.3km / AROME_2.5km

Worsening on T2m, Hu2m
Evaluation on the full domain (on Bull)

AROME_1.3km / AROME_1.3km without SBL scheme in SURFEX

Results without SBL scheme are better,
Further tests will be done …
OUTLINE

- Overview of the operational configuration
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- Objective evaluation

- To prepare the future (2-moments microphysics)

- Conclusions
New microphysics scheme: Liquid Ice Multiple Aerosols (LIMA)

= a 2-moments microphysics scheme developed in Meso-NH in order to improve the modelisation of complex aerosols – clouds – precipitations interactions.

B. Vié, J.-P. Pinty
New microphysics scheme: Liquid Ice Multiple Aerosols (LIMA)

- Prognostic 3D variables in LIMA
  - Mixing ratios (kg kg\(^{-1}\)) : \(r_C\), \(r_R\), \(r_I\), \(r_S\), \(r_G\)
  - Concentrations (kg\(^{-1}\)) : \(N_C\), \(N_R\), \(N_I\) \(\leftarrow\) NEW
  - Aerosol concentrations (kg\(^{-1}\), for each mode) : \(N_{\text{Free}}\), \(N_{\text{Activated}}\) \(\leftarrow\) NEW

- New / Modified processes compared with ICE3
  - Activation / nucleation of aerosols
  - Impaction scavenging of aerosols by rain
  - More physical representation of autoconversion.
  - Over-saturations remains more easily than in ICE3

- ICE4 / ICE3 cold processes concerning hail/graupel remains the same
  (\(\rightarrow\) improvements in ICE4 scheme will automatically benefit to LIMA).
LIMA : Aerosols initialisation

LIMA aerosol population
(Number concentrations (kg⁻¹) !)

- Sulfate
- Sea salt (3 bins)
- Hydrophilic OM
- Hydrophobic OM
- Hydrophilic BC
- Hydrophobic BC
- Dust (3 bins)

MACC

- MMR kg kg⁻¹

CCN
- Sulfate
- Sea salt

Coated IFN
- Hydrophilic OM/BC

IFN
- Hydrophobic OM/BC

Dust
First real case test: HyMeX IOP 6 – 24 sept. 2012

18-h accumulated rainfall (mm), 12UTC:

Observations

Technical working,
Validation/tuning will continue (HYMEX observations)

Reflections concerning its implementation in AROME will start in autumn 2014 (numerical efficiency -> simplifications in the code, time stepping)
Conclusions, Outlooks

- AROME-France 1.3km model configuration is nearly chosen. Evaluation shows significant improvements (RR6, V10m). Still some questions concerning T2m.

- Experiments with data assimilation on going (cf Claude talk).

- Modifications in Physics are on the way to prepare future versions:
  - LIMA,
  - radiation/orography interaction (Collaboration with ZAMG & FMI (C. Wastl, L. Rontu))
  - sub-grid precipitations (S. Riette)
  - turbulence (3D turbulence not needed at 1km) (R. Honnert)
  - ...

- AROME-France 1.3 km e-suite should stats before summer
  (with also Ensemble AROME forecasts, AROME-PI (immediate forecasts with hourly analyses))
AROME-France 1.3 km (Model part) Status and plans

Y. Seity
From 1D to 3D turbulence scheme in AROME

- From LES, vertical and horizontal production terms computed at several resolution in free and forced CBL
- 3D turbulence scheme necessary under 1km resolution

**Figure:** Thermal (red), horizontal dynamic (blue) and vertical dynamic (green) as a function of the resolution in free CBL.
GREY ZONE PROJECT at Météo-France

- **ARPEGE**: 16 km, 8 km, 4 km, 2 km; OPER, without shallow convection, without convection
- **AROME**: 4 km, 2 km, 1 km; with and without shallow convection
- **MESONH**: 8 nested models from 8 km to 100 m

**Figure**: LWup after 24h simulation of AROME. Top: without PMMC09. Bottom: with PMMC09
Grey zone of turbulence in a neutral BL

**Figure:** Resolved (red) and Subgrid (blue) part of TKE as a function of the resolution normalized by the BL height.

- LES of idealised neutral BL
- Grey zone: Turbulence partly resolved + anisotropy = from 25 m to 800 m resolution
- Perspective: other LES with increasing wind shear
LIMA: Aerosols – clouds interactions

→ A detailed description of LIMA is presented in J.-P. Pinty's poster

- CCN activation is based on Cohard and Pinty (2000)
  - Extended to handle a multimodal aerosol population

- IFN heterogeneous nucleation is based on Phillips (2008)
  - Experimental measurements of ice nucleation
  - 3 species of IFN: dust, black carbon, organic matter

- Coated IFN
  - First activated as CCN to form cloud droplets
  - Same nucleation parameterization as insoluble IFN

- Better representation of microphysical processes
  - Explicit deposition/sublimation rates, ice → snow conversion...