HIRLAM-ALADIN activity report

Highlights LACE/HIRLAM/ALADIN
Manpower (in F.T.E.) in 2018 RWP Work Packages

Committed for 2018 and "Realised" (twice the realisation during the first semester of 2018)

Prospective R&D activities:
- Atmospheric data assimilation
- Dynamics
- Atmospheric physics parametrizations
- Surface analysis and modelling
- Probabilistic forecasting
- Quality assessment and monitoring
- Technical code and system development towards high-resolution modelling
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The LAM aspects are included in WP4.

Energy vs. wall-time profiling.

Three Dwarves are studies (bi-FFT transform, ACRANEB, SL scheme) and have been profiled.

Preliminary results: Bi-FFT increases for wall-time, but decreases for energy (the energy of the communications not included in the test).
A non-spectral Helmholtz solver for ALADIN-NH

**Scalability tests on ECWMF Cray**

768x768 grid

6144x6144 grid

Scalability of Helmholtz problem only!
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Management and common code design, generation and maintenance
Strategic (Core) Programs: Dynamics DA

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The Fires of 14-16 October 2017 in Portugal
- 51 people were killed
- 500 companies were totally or partially destroyed and more than 4500 jobs were affected

FIRESSTORM (funded project)
Project which aims at study the interaction between atmospheric flows and spot fires which cause high-intensity propagation.
In complex orography, between 200-1300 m, the high of boundary layer plays an important rôle. Extra localised surface stations will be placed to help monitoring the profile of temp, hum and wind; surface DA will assimilate this data to check its added value on the short-term forecasts.
Hourly CANARI-AROME validation (00UTC network):
Summer (20170801 – 20170815)
Winter (20170110 - 20170207)
Table - RMSE and BIAS of screen level parameters analysis over Mainland for Portugal CAN-ARO and CAN-ALA vs. ARO-OP initial fields

<table>
<thead>
<tr>
<th>EXP</th>
<th>T2M</th>
<th>H2M</th>
<th>V10M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RMSE (C)</td>
<td>BIAS (C)</td>
<td>RMSE (%)</td>
</tr>
<tr>
<td>CAN-ARO(Summer)</td>
<td>1.52</td>
<td>0.18</td>
<td>8.86</td>
</tr>
<tr>
<td>CAN-ARO(Winter)</td>
<td>1.63</td>
<td>-0.01</td>
<td>8.58</td>
</tr>
<tr>
<td>CAN-ALA(Summer)</td>
<td>1.78</td>
<td>0.43</td>
<td>10.95</td>
</tr>
<tr>
<td>CAN-ALA(Winter)</td>
<td>1.85</td>
<td>-0.09</td>
<td>10.66</td>
</tr>
<tr>
<td>ARO-OP (Summer)</td>
<td>2.07</td>
<td>0.90</td>
<td>11.79</td>
</tr>
<tr>
<td>ARO-OP (Winter)</td>
<td>2.06</td>
<td>0.27</td>
<td>12.69</td>
</tr>
</tbody>
</table>

- CAN-ARO is closer to observations than any other product at 00UTC and 12UTC;
- Daily analysis monitoring shows the results are consistent at any hour of the day.

Assimilate extra station data to get the best a posteriori analysis.
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The potential of 4D-Var for nowcasting

3D-Var Humidity increment evolution
Low correlation between analysis and the 1-hour forecast
--> Model spinup

4D-Var Humidity increment evolution
Good correlation between analysis and the 1-hour forecast

Courtesy: Jan Barkmeijer, KNMI
EDA in Tunisia

Operational & Parallel Suites

<table>
<thead>
<tr>
<th></th>
<th>ALADIN operational</th>
<th>AROME 2.5</th>
<th>AROME 1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle version</td>
<td>CYCLE 40</td>
<td>CYCLE 40</td>
<td>CYCLE 42</td>
</tr>
<tr>
<td>Spatial Resolution</td>
<td>7.5 km</td>
<td>2.5 km</td>
<td>1.3 km</td>
</tr>
<tr>
<td>Vertical Levels</td>
<td>70</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>Boundaries</td>
<td>ARPEGE 10km</td>
<td>ARPEGE 10km</td>
<td>ARPEGE 10km</td>
</tr>
<tr>
<td>Time step</td>
<td>450 s</td>
<td>60 s</td>
<td>45 s</td>
</tr>
</tbody>
</table>

HPC Project: Enhancement of the computing capacity: Ongoing HPC tender

Hydrological Application with AROME-MEDJERDA: a small domain over Medjerda catchment

| AROME-MEDJERDA       | CY40 | 1.3 km | 50 | 12280 | 40 s |

- The catchment of Medjerda, located in the north-western region of Tunisia, is an area at risk that suffers from severe flooding every year.
- As it holds the biggest river in Tunisia and several dams around it, Medjerda watershed represents an important hydrological study area.

24h Accumulated precipitations of 26/02/2015 - from left to right: Observation, AROME-Medjerda 1.3 km and ALADIN 12.5 km

3DVAR Data Assimilation Implementation

- B matrices are the average of 3 B matrices calculated over 3 periods: winter (rainy season), summer (Hot & humid) and Fall (convective systems) take into consideration all the Regimes that influence Tunisian Weather.
- In order to have a positive definite B matrix, we must have the number N of differences equal to or greater than the number of vertical levels of the model (60 for Arome 2.5 km at 90 for Arome 1.3 km)
- Same periods for B matrix: EDA and B matrix Spin-up compare the matrices

Impact of AROME 3DVAR over convective situations: Study Case - October 2017 Flood

Case Study - 30 October 2017
Better Prediction for the cell localization and intensity
* 3 typical systems: North-East, East Cost, South-East. Cells
* Better Prediction for the cell localization and intensity for Arome 3DVAR compared to Spin up
* Better scores for Arome 3DVAR EDA Bmatrix compared to Bmatrix Spin up

Convective Situation causing heavy rain & flood
Data assimilation and Observation Preprocessing System for RC LACE (OPLACE)

A common observation preprocessing system:
- processed and quality checked met. obs. in an appropriate format for data assimilation in NWP models.
- NMSs exchange their dense national surface synoptic measurements and high-resolution aircraft data in real-time.
OPLACE ensures stable and reliable bases for operational NMS purposes.

**LACE radar data assimilation:**
- use volume reflectivity first
- overview of ODIM HDF5 files from radars
- new pre-processing tool for OPERA data
- splitting of 15 min merged OIFS files
- rearranging the content according to specification in namelist
- retaining only the desired variables (e.g. reflectivity and/or radial winds)
- possibility to encode prescribed meta data separately for individual radars or for the whole data set

The coverage of surface observation available in the GTS (blue) and of denser national observations (red).

The geographical distribution of high-resolution aircraft Mode-S MRAR data from Slovenia (red) and of Mode-S EHS data from KNMI (blue).

Operational implementation of GNSS ZTD assimilation in Hungary.
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2018 Commitment
2 times (2018 Q1+Q2 realisation)

Management and common code design, generation and maintenance
Strategic (Core) Programs: Dynamics, DA

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New dynamical variables and physics developments

**ALARO physics package:**
- shallow convection (Baštak Duran et al 2018) in cy42t1 export, operational in CHMI
- mixing length computations in TOUCANS and code re-organisation
- three-order-moment code analyzed
- DDH implementation of TKE and TTE equations
- non-saturated downdraft
- prognostic graupel
- surface roughness in SURFEX
- ALARO1 coupled with SURFEX
- coupling with the sea surface (ocean and waves)

roughness computation in presence of snow – assimilation cycle

Removal of the remaining chimney effect through bottom boundary condition and new vertical motion variables
BBC must be done consistently with model dynamics otherwise problems appear.
It is very easy to overlook some inconsistencies in time and space discretised equations.
On the other hand it is very hard to say a priori which discretization details are innocent and which are harmful.
Correct BBC treatment in spectral model can be technically difficult. Simple BBC can be beneficial.

**New diagnostic fields**
- convective pack, lightning and visibility

**Offline SURFEX**
Aerosol-radiation-cloud interaction:
Case studies Spain: Importance of use of real-time MACC aerosol to improve fog/low cloud evolution may have been underestimated => to be studied in longer runs

Surface modelling:
Starting study of bias characteristics of new soil, snow schemes in climate mode assessment of higher resolution physiographic data

Very high resolution modeling:
Dynamics setting in various types of terrain
Clear advantages seen over steep orography, complex land-sea transition, but also urban areas and small-scale convection
DMI TAS domain operational in October
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- Towards high-resolution modelling
HarmonEPS ensemble systems
Extending and moving to (pre-)operational

HarmonEPS with different configurations are now operational or being tested at several institutes:

**MEPS - COMEPS - IREPS - ϖSREPS - RMI EPS - KEPS**

Configurations vary, but typically:
- 10-20 members
- Harmonie-Arome, or H-Arome and Alaro
- 2.5 km
- 3D-Var
- SURFEX
- 2-3 days forecasts

HC meeting, 20181120
Aire Limitée Adaptation dynamique Développement InterNational - Limited Area Ensemble Forecasting (ALADIN-LAEF)

- meso-scale ensemble system ALADIN-LAEF
- based on the limited area model ALADIN
- developed in frame of RC LACE cooperation,
- short range probabilistic forecast
- advanced multi-scale ALARO physics.
- provide forecast on daily basis for the national weather services of RC LACE partners
- applied to hydrology, energy industry and even in the nowcasting.

Agreed distribution of billing units necessary for its operations at ECMWF HPS among the LACE partners and cooperating Turkey.

<table>
<thead>
<tr>
<th>ALADIN-LAEF</th>
<th>current</th>
<th>new</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code version</td>
<td>cy36t1</td>
<td>cy40t1</td>
</tr>
<tr>
<td>Horizontal resolution</td>
<td>10,9 km</td>
<td>4,8 km</td>
</tr>
<tr>
<td>Vertical levels</td>
<td>45</td>
<td>60</td>
</tr>
<tr>
<td>Number of grid points</td>
<td>500x600</td>
<td>750x1250</td>
</tr>
<tr>
<td>Grid</td>
<td>quadratic</td>
<td>linear</td>
</tr>
<tr>
<td>Time step</td>
<td>450 s</td>
<td>180 s</td>
</tr>
<tr>
<td>Forecast length</td>
<td>72 h (00/12 UTC)</td>
<td>72 h (00/12 UTC)</td>
</tr>
<tr>
<td>Members</td>
<td>16+1</td>
<td>16+1</td>
</tr>
<tr>
<td>IC perturbation</td>
<td>ESDA [surface], breeding, blending [upper-air]</td>
<td>ESDA [surface], blending (Phase I) / ENS BlendVar (Phase II) [upper-air]</td>
</tr>
<tr>
<td>Model perturbation</td>
<td>ALARO-0 multi-physics</td>
<td>ALARO-1 multi-physics + surface SPPT</td>
</tr>
<tr>
<td>LBC perturbation</td>
<td>ECMWF ENS</td>
<td>ECMWF ENS</td>
</tr>
<tr>
<td>SBUs consumed per year</td>
<td>~10 mil</td>
<td>~120 mil</td>
</tr>
</tbody>
</table>

Current ALADIN-LAEF domain (blue) and upcoming domain after upgrade to 5 km horizontal resolution (red).
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- Preparation/release Cy43h2-alpha

- Code optimization: collaboration with BSC

- Good progress on HARP-v3 verification system: addition of in-situ and conditional verification, more user-friendly interface

- Harmonie User meeting in Madrid, 6-7 November 2018