RC LACE developments in 2018

Martina Tudor, RC LACE MG and many researchers
Who? What?

Regional Cooperation for Limited Area Modelling in Central Europe: NMSs of Austria, Croatia, Czech Republic, Hungary, Romania, Slovakia and Slovenia - common operational applications

LAEF – limited area ensemble forecasting system

OPLACE – observation pre-processing for LACE

Verification – operational national forecasts

- common research activities

http://www.rclace.eu/?
Organisation

Project Manager: Martina Tudor (since 1.4.2018)

Area Leaders:

- Data assimilation (upper air and surface): Antonín Bučánek
- Dynamics and coupling: Petra Smolíková
- Physics (and surface parametrizations): Neva Pristov
- Predictability: Martin Belluš

Data Manager: Alena Trojáková

ALADIN-LACE System Coordinator: Oldřich Španiel
Welcome to RC LACE website

RC LACE
[Regional Cooperation for Limited Area modeling in Central Europe]

Events

24 October - 16 November 2018
Call for RC LACE MS position
Area Leader for upper air and surface data assimilation

24 October - 16 November 2018
Call for RC LACE MS position
Area Leader for dynamics and coupling

24 October - 16 November 2018
Call for RC LACE MS position
Area Leader for ensemble prediction and predictability (EPF)

24 October - 16 November 2018
Call for RC LACE MS position
Area Leader for physics and surface parameterization

24 October - 16 November 2018
Call for RC LACE MS position
ALADiN-RAOPI system coordinator

24 October - 16 November 2018
Call for RC LACE MS position
Data manager

Operational activities

- LACE operational namelists
- Operational status report
- Integration domains and computers

<table>
<thead>
<tr>
<th>Country</th>
<th>Computer</th>
<th>No. of points</th>
<th>resolution</th>
<th>No. of levels</th>
<th>Cycle</th>
<th>Configuration</th>
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<tr>
<td>Austria</td>
<td>SGI ICE-X</td>
<td>6096/544</td>
<td>2.0 km</td>
<td>60</td>
<td>CY38T1</td>
<td>CY46T1</td>
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<tr>
<td>Croatia</td>
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<td></td>
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<td>4962 960x450</td>
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<td>4.0 km</td>
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<td>Romania</td>
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<td>IBM Power System p600/3</td>
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Operational products - members

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<tr>
<th>Country</th>
<th>Type</th>
<th>Date/Time</th>
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<td>ECMWF</td>
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<td>GFS</td>
<td></td>
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<td>Austria (ALAS)</td>
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<tr>
<td>Czech Republic</td>
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Choose model
And source
Operational products - members
Operational products - members

ALADIN pEPS Multigrams

<table>
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<th>Parameter:</th>
<th>Datetime:</th>
<th>Integration:</th>
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</thead>
<tbody>
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<td>cloudiness, gusts10m</td>
<td>2018-11-15</td>
<td>Create ZIP file:</td>
</tr>
<tr>
<td>BUCHAREST</td>
<td>msl</td>
<td>pressure, precipitation, relhumidity2m</td>
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</tr>
<tr>
<td>BUDAPEST</td>
<td></td>
<td></td>
<td>Show</td>
</tr>
<tr>
<td>LJUBLJANA</td>
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<td>Close this page</td>
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<td>PRAGUE</td>
<td></td>
<td></td>
<td></td>
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</table>

If "Create ZIP" was checked, the download link will be shown in the bottom of this page.

Operational

Only for Member Capitals

Parameter

Date

Run

cloudiness

Bratislava–Letisko 2018–11–15 00 UTC

m/s
Operational products - verification

- ALARO verification
- Large domains
- Web interface

Choose:
- Period
  - 201810
  - 201809
  - 201808
  - 201807
  - 201806
  - 201805
  - 201804
  - 201803
  - 201802
  - 201801

Output:
- Parameter
  - Mslp
- Hour
  - 00

Date:
- Selection
  - ALL
  - Austria
  - Croatia
  - Czech
  - Hungary
  - Slovakia
  - Slovenia

Area:
- Exp
  - SHMU
  - HIAL
  - CHMII
  - SIO4
  - ZAAL
  - CR04
  - SIAR

Oper:
- Stat
- Forecast range

Error:

Surface maps

SHMU(SHMU) - ALARO 4.5km, 63V, cy40t1, DFI Blending + surface analysis, ARPEGE Ibc
SIB4(ARSO) - ALARO 4.4km, 87V, cy38t1, data assimilation(3DVar+CANARI surface analysis), ECMWF Ibc
ZAAL(ZAMG) - ALARO 4.8km, 60V, cy36t1, data assimilation(3DVar+CANARI surface analysis), ECMWF Ibc
SIAR(ARSO) - ALARO 4.4km, 87V, cy38t1, data assimilation(3DVar+CANARI surface analysis), ARPEGE Ibc
RMSE and BIAS dependency on forecast range (0 to 60 hours) for operational forecasts from different LACE members (colours, Croatia - cyan) mean sea level pressure (left), wind direction (middle) and relative humidity at 2 m (right) for October 2018.
Operational products - verification

Choose
- Monitor_arome
- Surface_map

Output
- Parameter: Mslp
- Hour: 00

Date
- Period: 201810
- Date: 201809

Area
- Selection: ALL, Hungary, Austria

Oper
- Exp: HUAR, ZAAR

Stat
- Error: Bias, RMSE

Initial time
- ALL
- Time: 00, 03, 06, 09

Forecast range

AROME verification
- Smaller domains
- Separate interface
Operational products – LAEF prob. charts
Operational products – LAEF prob. charts
Operational products – LAEF meteograms
Operational LACE LBCs from IFS

Currently 6 LACE countries share the same coupling files from ARPEGE and IFS (and PEARP and ENS)

ARPEGE: 8 km resolution, 105 levels
IFS: 15.4 km resolution, 60 levels
LBCs are on a quadratic grid

Configuration 903 is working!
Thank you Ryad El Khatib!
Testing under way
Data assimilation area

Operational implementation of full data assimilation systems
- combined upper air and surface data assimilation in all countries

(Two-)hourly updated data assimilation systems - AROME 1.2 km in At

Background error statistics in 3DVar - ensemble based B matrix (Sk, Cr)

Surface data assimilation using extended Kalman filter (At, Sk)

Radiance observations in DA systems
- a new configuration of VarBC suitable for LAM

Radar reflectivity and radial wind
- back-phased BATOR, quality check OPERA, homogenisation pre-processor

Assimilation of GNSS path delays and Mode-S observations

http://www.rclace.eu/?page=11
OPLACE national data exchange and access
• high resolution surface synoptic data exchange
  - stable and reliable for operational use
  - only minor updates
• high resolution aircraft data exchange from modern air surveillance systems
  - Mode-S MRAR from ARSO/Slovenia
  - Mode-S EHS from KNMI/Netherlands
  - stable and reliable data provision
• extension by Mode-S MRAR from the Czech Republic - ongoing
• Mode-S EHS from Slovenia and the Czech Republic - ongoing
• negotiation with KNMI about processing our data started (B. Strajnar)
• All Members explore availability of Mode-S data.

• OPLACE access for non-LACE countries
  - currently two non-LACE users (Tunisia, Poland)
Data assimilation and Observation Preprocessing System for RC LACE (OPLACE)

**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.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Type/Sensor</th>
<th>Platform</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface synoptic</td>
<td>SYNOP, SHIP, BUOY</td>
<td>ASCII, BUFR</td>
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<tr>
<td>Aircraft</td>
<td>AMDAR, ACARS</td>
<td>BUFR</td>
<td></td>
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<tr>
<td>Upper-air sounding</td>
<td>TEMP, TEMP MOBIL</td>
<td>ASCII, BUFR</td>
<td></td>
</tr>
<tr>
<td>Wind profiler</td>
<td>EUROPORFILE</td>
<td>BUFR</td>
<td></td>
</tr>
<tr>
<td>Atmospheric motion vectors</td>
<td>GEOWIND, HRWIND</td>
<td>Meteosat 10/11</td>
<td>BUFR</td>
</tr>
<tr>
<td>Satellite radiances</td>
<td>SEVIRI, AMSU-A/B, MHS, HIRS, IASI</td>
<td>Meteosat 10/11 NOAA 15/18/19 Metop-A/B,</td>
<td>GRIB, BUFR</td>
</tr>
<tr>
<td>Ocean/sea winds</td>
<td>ASCAT</td>
<td>Metop-A/B</td>
<td>BUFR</td>
</tr>
</tbody>
</table>

**SEE POSTER!**

Austro Control ModeS

CHMI

Operational implementation of GNSS ZTD assimilation in Hungary.
Radar data assimilation

The review of available technical solutions for radar data pre-processing
OPERA data for the radar data from abroad, but additional preprocessing is needed
The radar data homogenisation is essential for the radar data assimilation!

Spurious echoes remain in the OPERA data even for large values of total quality index.
We can’t fully rely on OPERA QI.
The QC of radar data seems beyond the scope of NWP but it is essential for the data assimilation.

Filtered DBZH values below the threshold of 0, 0.2, 0.4 (top) and 0.6, 0.8 and 1 (bottom) of the OPERA total quality index (pl total) for plbrz (Brzuchania).
Dynamics and coupling area

Design of vertical finite elements scheme for NH version of the model
- Jozef Vivoda, Petra Smolíková, Juan Simarro, “Finite elements used in the vertical discretization of the fully compressible core of the ALADIN system”, accepted in MWR, 2018.

Tuning and redesign of the horizontal diffusion depending on the scale
- Several high resolution tests have been prepared in frame of the preparation work of the next operational suite of CHMI

Dynamic definition of the iterative time scheme
- implemented in the code on the base of cy43t2 and phased to cy46t1

Terms redistribution through new vertical motion variables
- New definitions of the vertical motion variable are proposed (w5 and w6), implemented in cy46

Tuning the wind field dynamical adaptation in very high resolutions
- 500 m and 250 m resolution experiments were run using high resolution topography
Dynamics and coupling area

Tuning and redesign of the horizontal diffusion depending on the scale
- Several high resolution tests have been prepared in frame of the preparation work of the next operational suite of CHMI

DDH characteristics (left) temp. tend dyn part for HY (red) and NH (blue), the reduced spectral diffusion coefficient vertical profiles (middle) and and kinetic energy spectra at lev 20 (right).
New definition of vertical velocity dynamical variables

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.
Optimization of ALADIN-LAEF
- B-matrix for the new ALADIN-LAEF
- validation of ENS 3DVar within ALADIN-LAEF Phase II
- analog based post-processing

ALADIN-LAEF maintenance
- operational ecFlow suite for the new ALADIN-LAEF

AROME-EPS
- developments at OMSZ and ZAMG, stochastic pattern generator and Jk 3DVar method

EPS-verificaton
ALADIN-LAEF verification tool is being developed

Collaborations
- new probabilistic methodologies to predict severe weather conditions

Publications
http://www.rclace.eu/?page=40

SEE POSTER!
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

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<tr>
<th>ALADIN-LAEF</th>
<th>current</th>
<th>new</th>
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<tr>
<td>Code version</td>
<td>cy36t1</td>
<td>cy40t1</td>
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<td>4.8 km</td>
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<td>Vertical levels</td>
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<td>60</td>
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<tr>
<td>Number of grid points</td>
<td>500x600</td>
<td>750x1250</td>
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<tr>
<td>Grid</td>
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<td>linear</td>
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<td>Time step</td>
<td>450 s</td>
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<td>Forecast length</td>
<td>72 h (00/12 UTC)</td>
<td>72 h (00/12 UTC)</td>
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<td>Members</td>
<td>16+1</td>
<td>16+1</td>
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<td>IC perturbation</td>
<td>ESDA [surface], breeding [upper-air]</td>
<td>ESDA [surface], blending (Phase I) / ENS BlendVar (Phase II) [upper-air]</td>
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<td>Model perturbation</td>
<td>ALARO-0 multi-physics</td>
<td>ALARO-1 multi-physics + surface SPPT</td>
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<tr>
<td>LBC perturbation</td>
<td>ECMWF ENS</td>
<td>ECMWF ENS</td>
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<tr>
<td>SBUs consumed per year</td>
<td>~10 mil</td>
<td>~120 mil</td>
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</table>

Current ALADIN-LAEF domain (blue) and upcoming domain after upgrade to 5 km horizontal resolution (red).
Predictability area

ESDA

$$\Delta T_s = \Delta T_{2m}$$

$$\Delta T_p = \frac{1}{2\pi} \Delta T_{2m}$$

$$\Delta W_s = \alpha_s^T \Delta T_{2m} + \alpha_s^H \Delta H_{2m}$$

$$\Delta W_p = \alpha_p^T \Delta T_{2m} + \alpha_p^H \Delta H_{2m}$$

BLENDING

$$IC_{blend} = a_{breed}^n + \left\{ \frac{(a_{sv}^n)_{trunc}}{} - \frac{(a_{breed}^n)_{trunc}}{} \right\}$$

$$IC_{blend} = LS^n + a_{breed}^n$$

SPPT+MP

$$\frac{\partial e_j}{\partial t} = A(e_j, t) + P'(e_j, t)$$

$$P'(e_j, t) = (1 + r_j(\lambda, \varphi, t)_{D,T})P_j(e_j, t)$$
Physics area

TOUCANS turbulence scheme
- shallow convection closure: tuning, possible improvement in the vertical profile definition,
- analysis of numerical protection algorithm for the equation solver
- implementation of TKE-based length scales
- DDH for TOUCANS – put prog. eqs. for TKE and TTE terms into DDH arrays

Radiation scheme
- Cheap calculation of clear sky fluxes, optimized intermittent storage, further improvement in calculation of direct solar flux is planned to be done in September with aim to enter cy46t1.

Cloud scheme (ALARO-1)
- the harmonisation of radiative clouds and condensates with the microphysics cloud fraction and prognostic condensates

Microphysics (AROME and ALARO-1)
- aerosol initialization in LIMA, hail diagnostics and super cooled rain validation in ICE3, validation of prognostic graupel in ALARO-1

- interaction with deep convection is changed
- warm and dry bias at top of PBL is reduced
- precipitation location is better
Physics area

Operational applications from ALARO-0 to ALARO-1 and SURFEX
- validation and operational use of ALARO-1vB in local applications (Cz, Hu, Ro)
- scientifically consistent ALARO transition from ISBA to SURFEX surface scheme ensured

The ALARO-1vB version

Maintenance of ALARO CMC

Products for users
- hail probability, aviation related diagnostics, visibility, convective diagnostics pack

Off-line SURFEX
- ImagineS system based on offline SURFEX with ISBA-Ags (currently with 10 day time lag) - Hu
- Crocus snow pack model based on INCA analysis and ALADIN DLW – Si
- downscaling tool – Si, Sk

Coupling with waves/ocean
- operational wave modelling with Wind Wave Model (paper)
- Impact of two-way coupling and sea surface temperature on precipitation forecast in regional atmosphere (paper)
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, published papers)
LIMA scheme in AROME

Time-height cross section of LWC on 22nd October 2015 in 6 different cases: ICE3 without (a) and with (b) subgrid condensation, LIMA-REF with (d) and without (c) cloud sedimentation, LIMA with MACC (e) and LIMA with MOCAGE (f). In figure (a) the black horizontal lines show the observations: the duration of the fog (3 levels: 10m, 50m, 120m)
Differences in 2m relative humidity after 12 hours of integration.

Differences in AROME 2m relative humidity in the initial file (left) and after 4 hours of integration (right).

- Phasing of common ALADIN cy46 and cy46t1
- test single precision in cy43t2_bf06
  - one mitraillette test, AROME with CheapPCiter
  - single precision needs 40% less time
  - comparison of meteorological fields at initial time and 4 h forecast
Thank you

Petra Smolíková, Neva Pristov, Martin Belluš, Antonín Bučánek, Alena Trojáková, Oldřich Španiel, Radmila Brožkova, Jure Cedilnik, Jozef Vivoda, Tomislav Kovačić, Mihaly Szucs, Christoph Wittmann, Jan Mašek, Mario Hrastinski, Bogdan Bochanek, David Lancz, Simona Tasku, Benedikt Štrajnar, Patrik Benaček, Viktoria Hommonai, Florian Meier, Mirela Pietrisi, Maria Derkova, Antonio Stanešić, Stefan Schneider, J. Vural, Helga Toth, Viktor Tarjani, Peter Smerkol, Mate Mester, Michal Nestiak, Martin Imrišek, Katarina Catlosova, P. Scheffknecht, Martin Dian, Balasz Szintai, J. Kemetmuller, Piotr Sekula, Matjaž Ličar, Iris Odak Plenković, Florian Weidle, Reka Suga, Clemens Wastl, Endi Keresturi, Stjepan Ivatek-Šahdan, Mathieu Dutour Sikirić, Mate Mile and Yong Wang.
Publications


Dávid Lancz, Balázs Szintai, Rachel Honnert: Modification of shallow convection parametrization in the gray zone in a mesoscale model, Boundary-Layer Meteorology, 2018, manuscript submitted to publication


Jozef Vivoda, Petra Smolíková, Juan Simarro, Finite elements used in the vertical discretization of the fully compressible core of the ALADIN system. Mon. Wea. Rev. under review