Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

RC LACE developments in 2018

Martina Tudor, RC LACE MG and many researchers

ZAMG DHMZ OMSZ METEO ROMANIA SHMU ARSO METEO Slovenia

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**

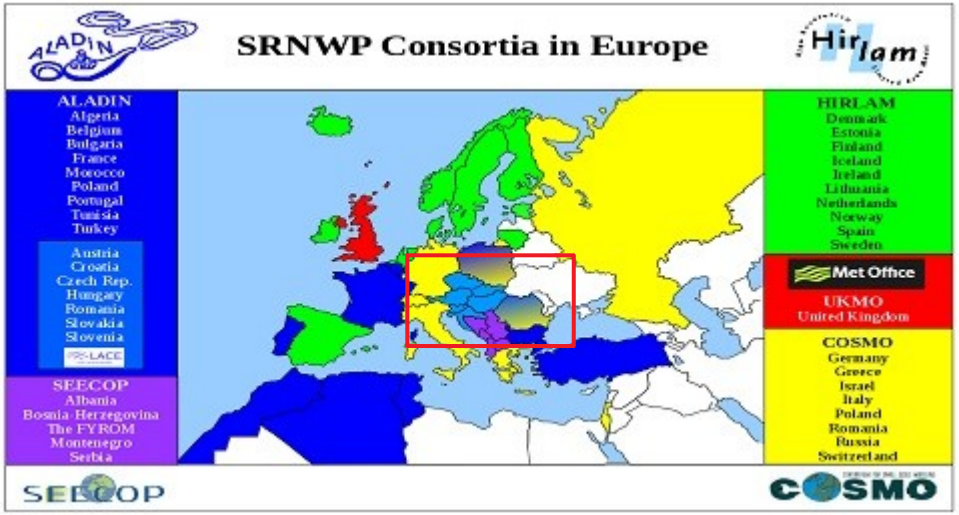
LAEF – limited area ensemble forecasting system

OPLACE – observation pre-processing for LACE

Verification – operational national forecasts

- **common research activities**

http://www.rclace.eu/?



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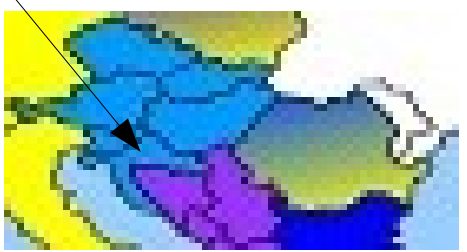


Organisation

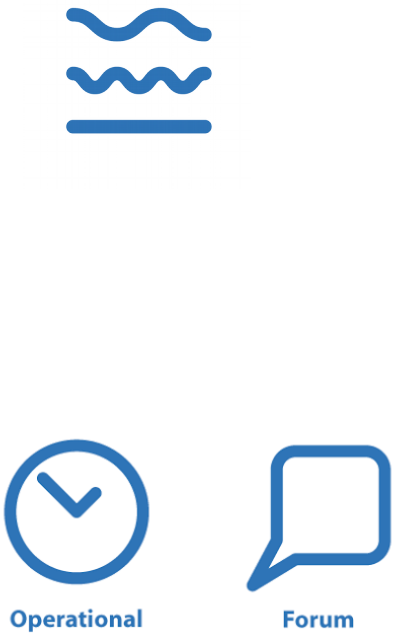
Project Manager: Martina Tudor (since 1.4.2018)

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



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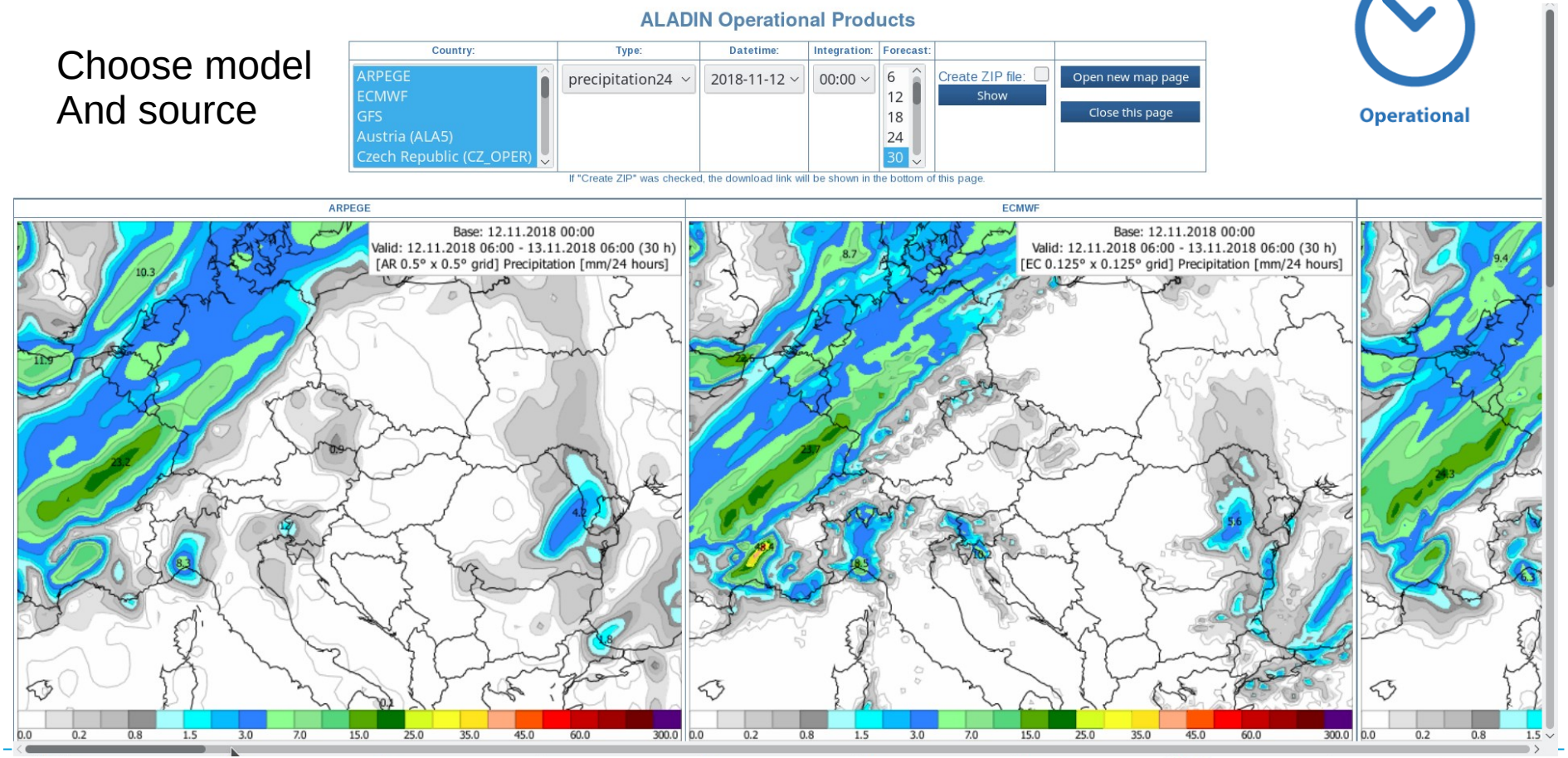
Country	Computer	Nr. of points	resolution	Nr. of levels	Cycle	Configurations
Austria	SGI ICE-X	ALA5 600x540 AROME 600x432	4.8 km 2.5 km	60 90	CY36T1 CY40T1	e001 CANARI 3DVAR
Croatia	SGI UV 2000	HR88 240x216 HR44 480x432 HR22 450x450	8.0 km 4.0 km 2.0 km	37 73 37	CY38T1 CY38T1 CY36T1	e001 DADA
Czech Republic	NEC SX-9	CZ_OPER 529x421	4.7 km	87	CY38T1	e001 DFI Blending CANARI
Hungary	IBM iDataplex	ALARO/HU 360x320 LAMEPS/HU 360x320 AROME/HU 500x320	8.0 km 8.0 km 2.5 km	49 49 60	CY38T1	ee927, 701, 002, 131, 001 ee927, 001 ee927, 002, 131, 001
Romania	IBM BLADE Linux cluster	ALARO/RO 240x240	6.5 km	60	CY40T1	e001
Slovakia	IBM Power 755/10 IBM Flex System p460/12	SK9 320x288 SK_OPER 625x576	9.0 km 4.5 km	37 63	CY36T1 CY40T1	e001 DFI Blending
Slovenia	SGI ALTIX ICE-X 8200	SIS4 421x421 SIS4ar 421x421	4.4 km 4.4 km	87 87	AL38T1	e001 CANARI 3DVAR

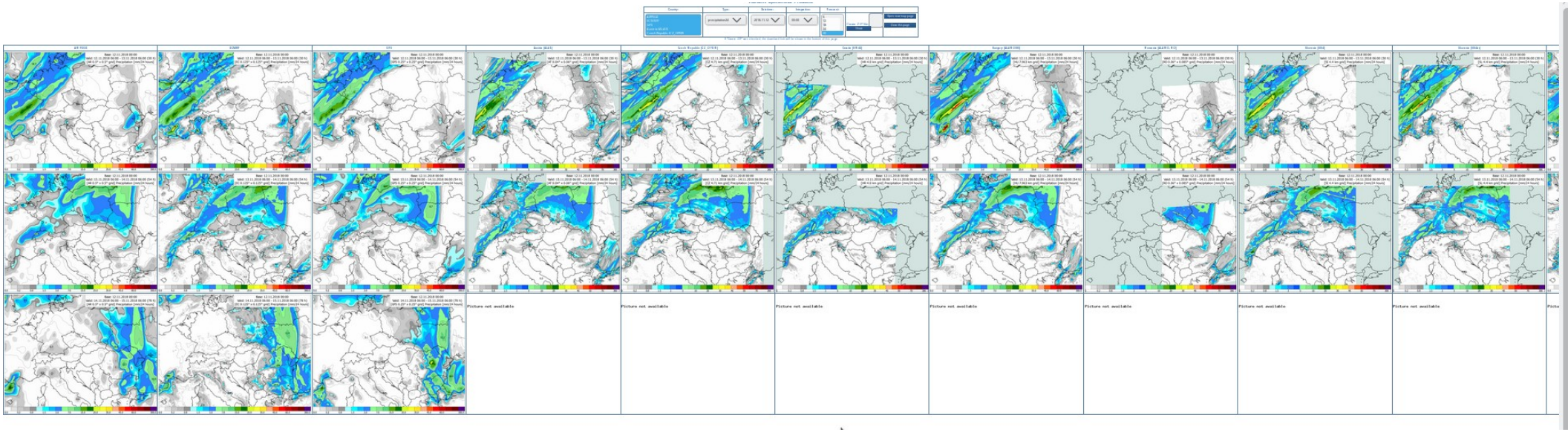
Operational products - members

Choose model
And source



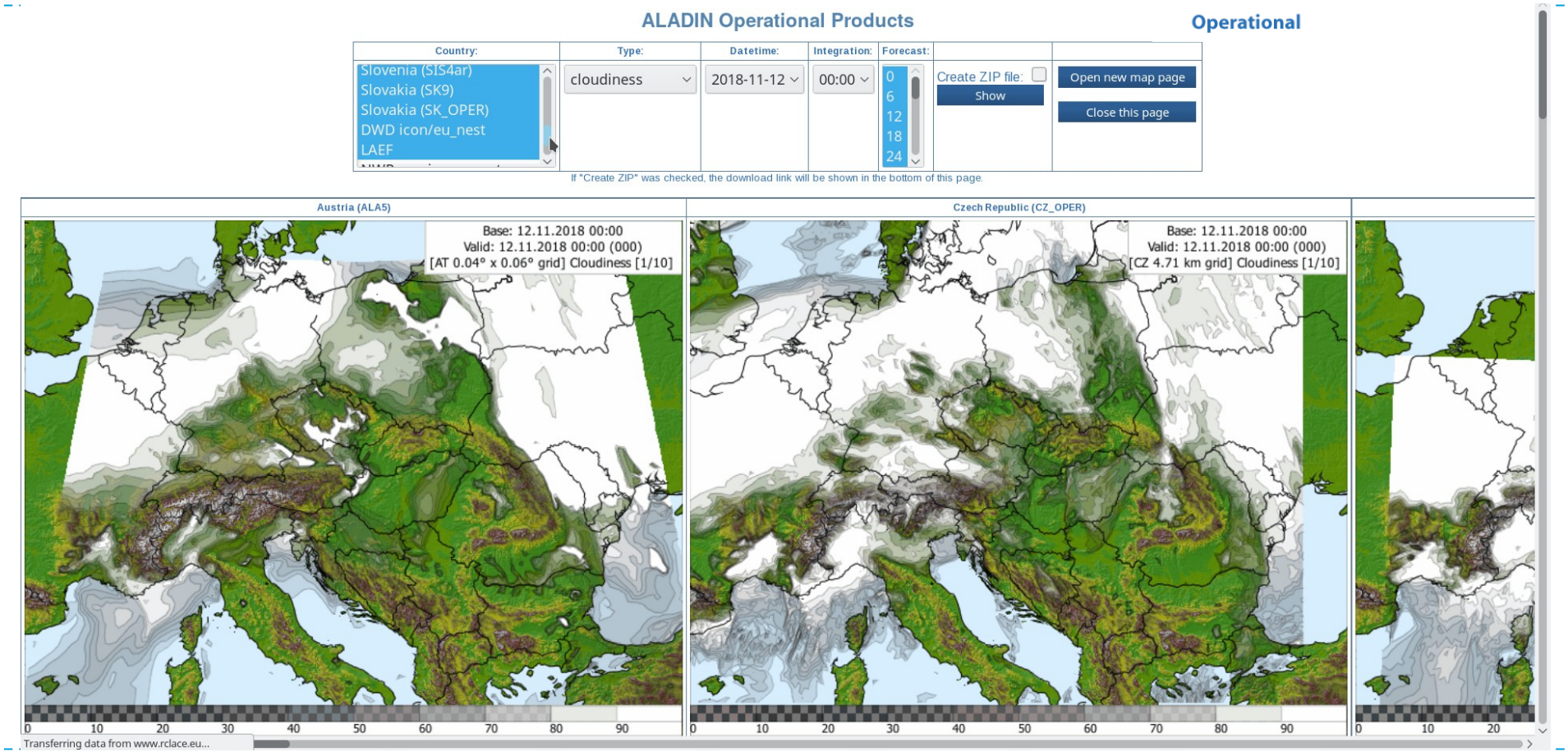
Operational

Operational products - members



Operational

Operational products - members



ARSO METEO Slovenia

Operational products - members

Operational

LACE nwp central europe

ALADIN pEPS Multigrams

Only for Member Capitals

Town:	Parameter:	Datetime:	Integration:		
BRATISLAVA BUCHAREST BUDAPEST LJUBLJANA PRAGUE	cloudiness gusts10m mslpressure precipitation relhumidity2m	2018-11-15	00:00	Create ZIP file: ☐ Show	Open new map page Close this page

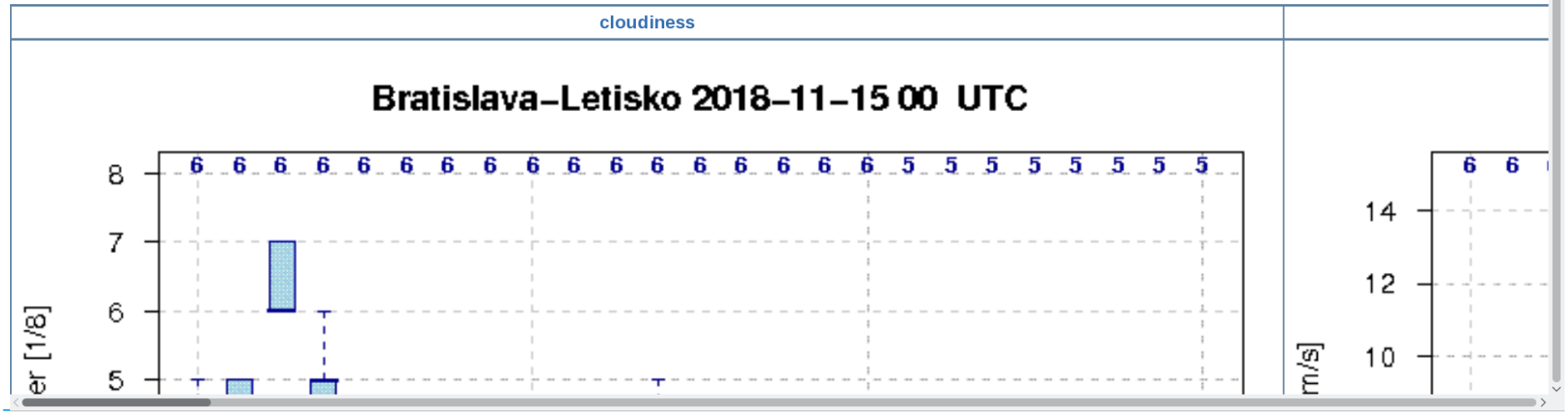
Parameter

Date

Run

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

cloudiness



ZAMG DHMZ OMSZ METEO ROMANIA DHMÚ ARSO METEO Slovenia

Operational products - members

Operational

Zoom out

Bratislava

Bucarest

Total cloud cover

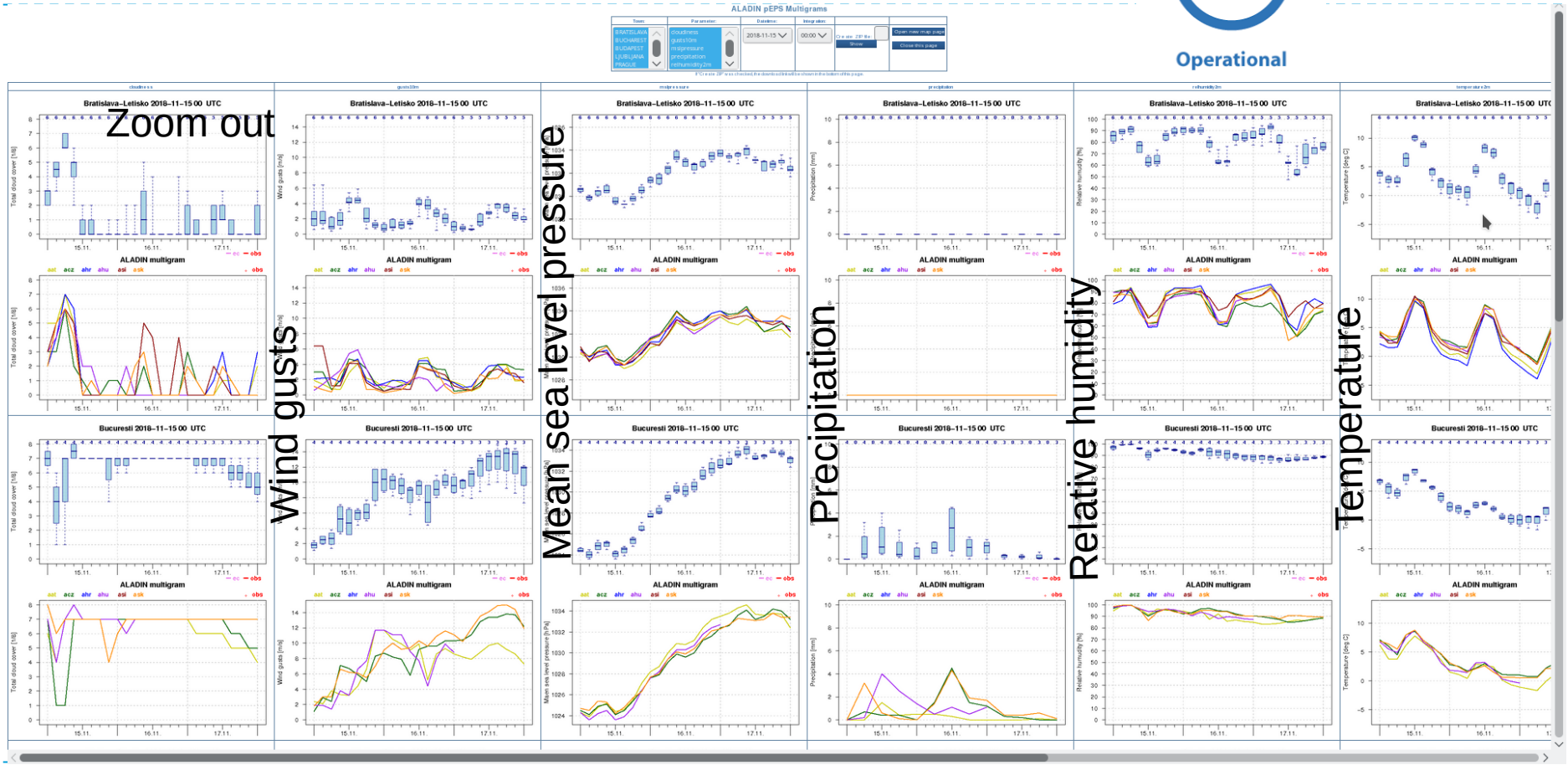
Wind gusts

Mean sea level pressure

Precipitation

Relative humidity

Temperature



Operational products - verification

Choose

Output

Date

Area

Oper

Stat

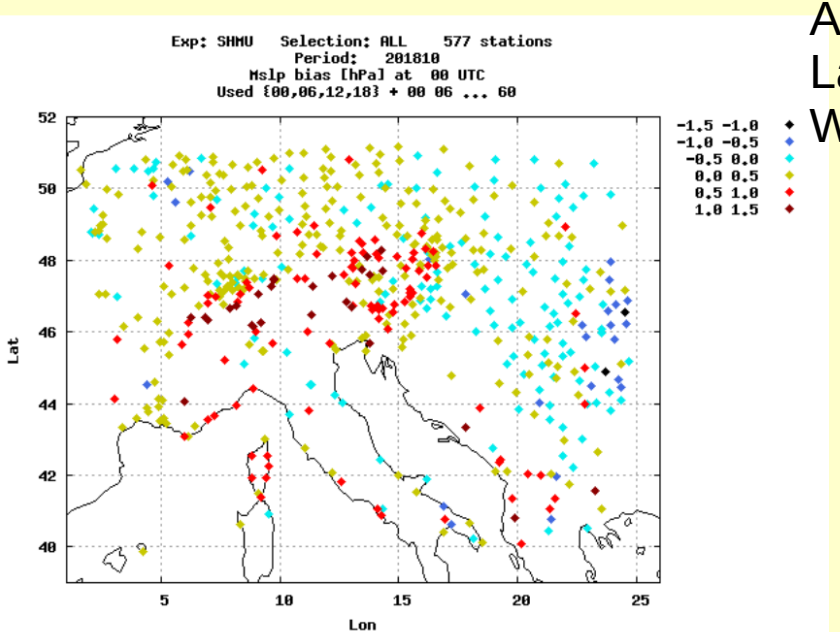
Forecast range

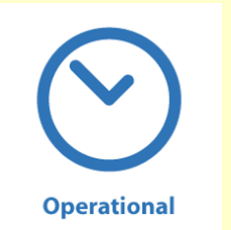
Surface maps

Parameter: Mslp

Hour: 00

SHMU(SHMU) - ALARO 4.5km, 63vl, cy40t1, DFI Blending+surface analysis, ARPEGE lbc)
SI04(ARSO) - ALARO 4.4km, 87vl, cy38t1, data assimilation(3DVar+CANARI surface analysis), ECMWF lbc
ZAAL(ZAMG) - ALARO 4.8km, 60vl, cy36t1, data assimilation(OI/CANARI surface, IFS upper air)
SIAR(ARSO) - ALARO 4.4km, 87vl, cy38t1, data assimilation(3DVar+CANARI surface analysis), ARPEGE lbc

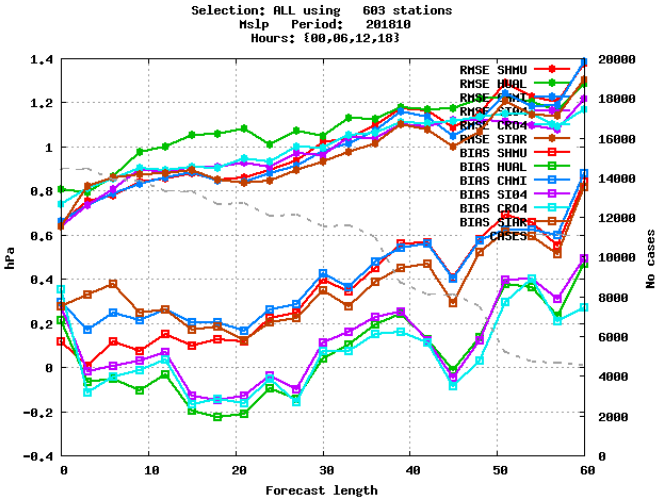


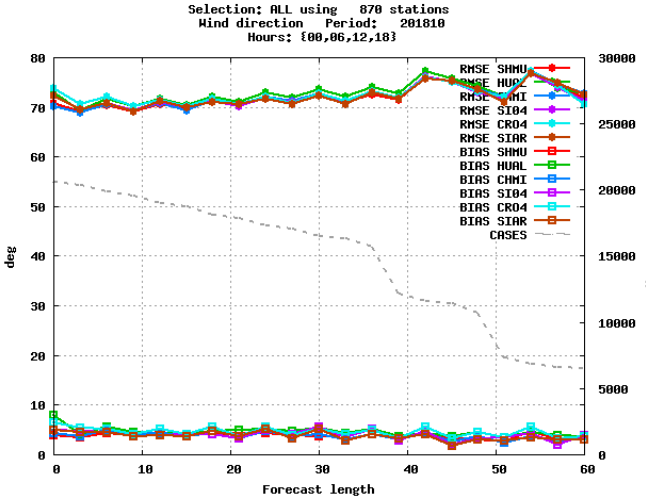


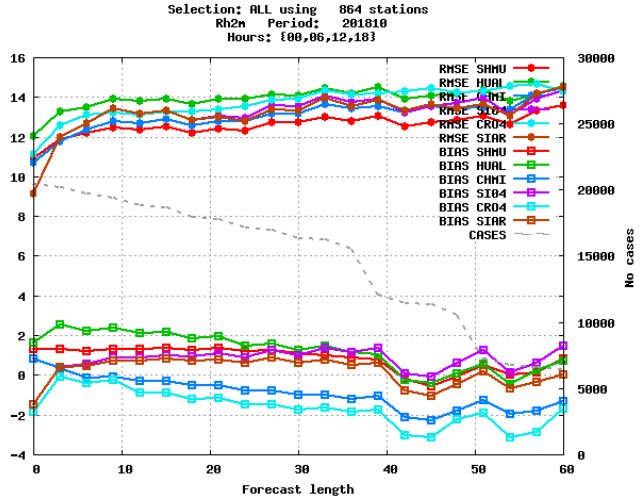
ALARO verification
Large domains
Web interface

ZAMG DHMZ METEO ROMANIA OMSZ SHMU ARSO METEO Slovenia

Operational products - verification







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

Operational products - verification

Choose

Output

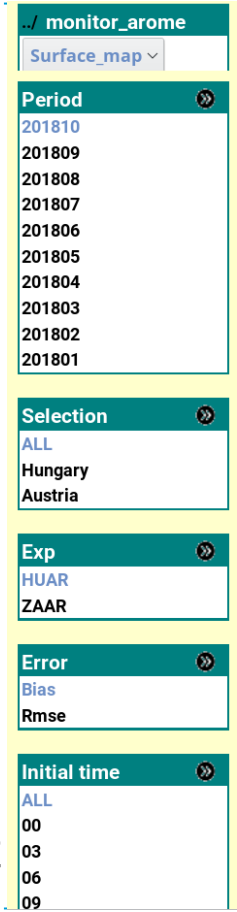
Date

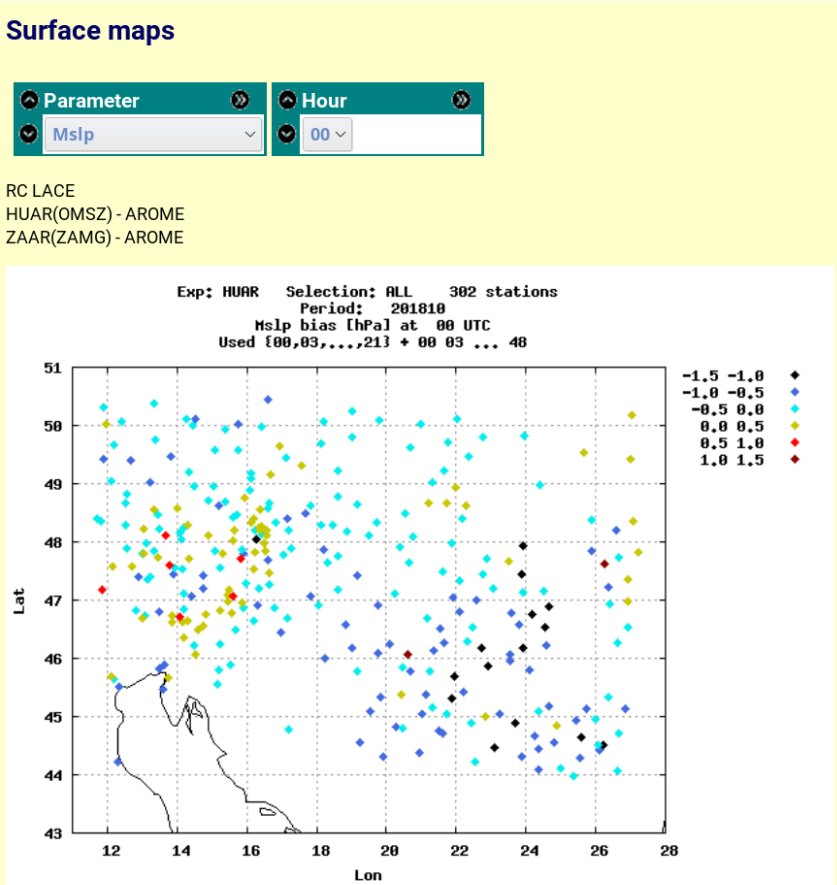
Area

Oper

Stat

Forecast range

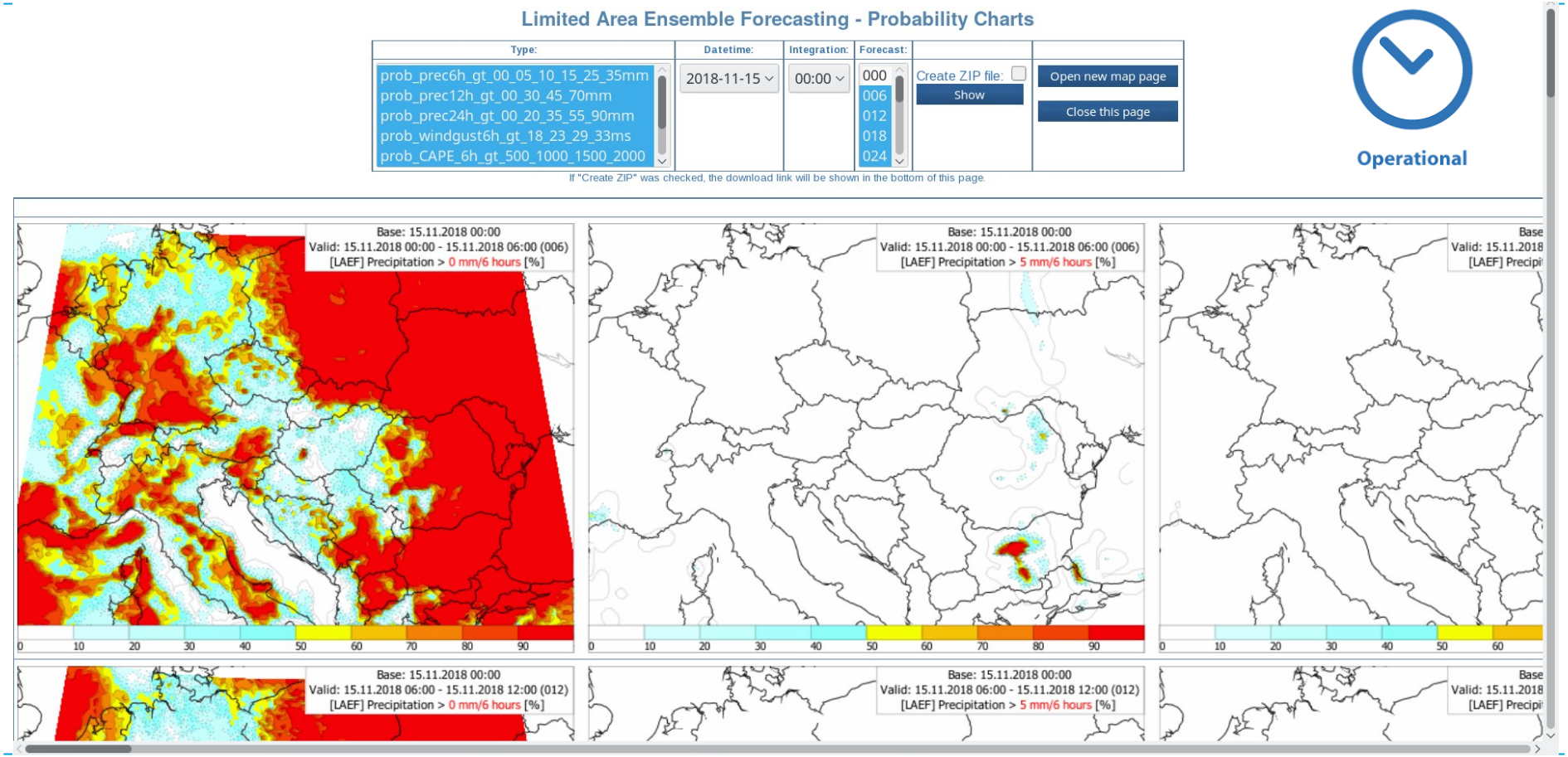




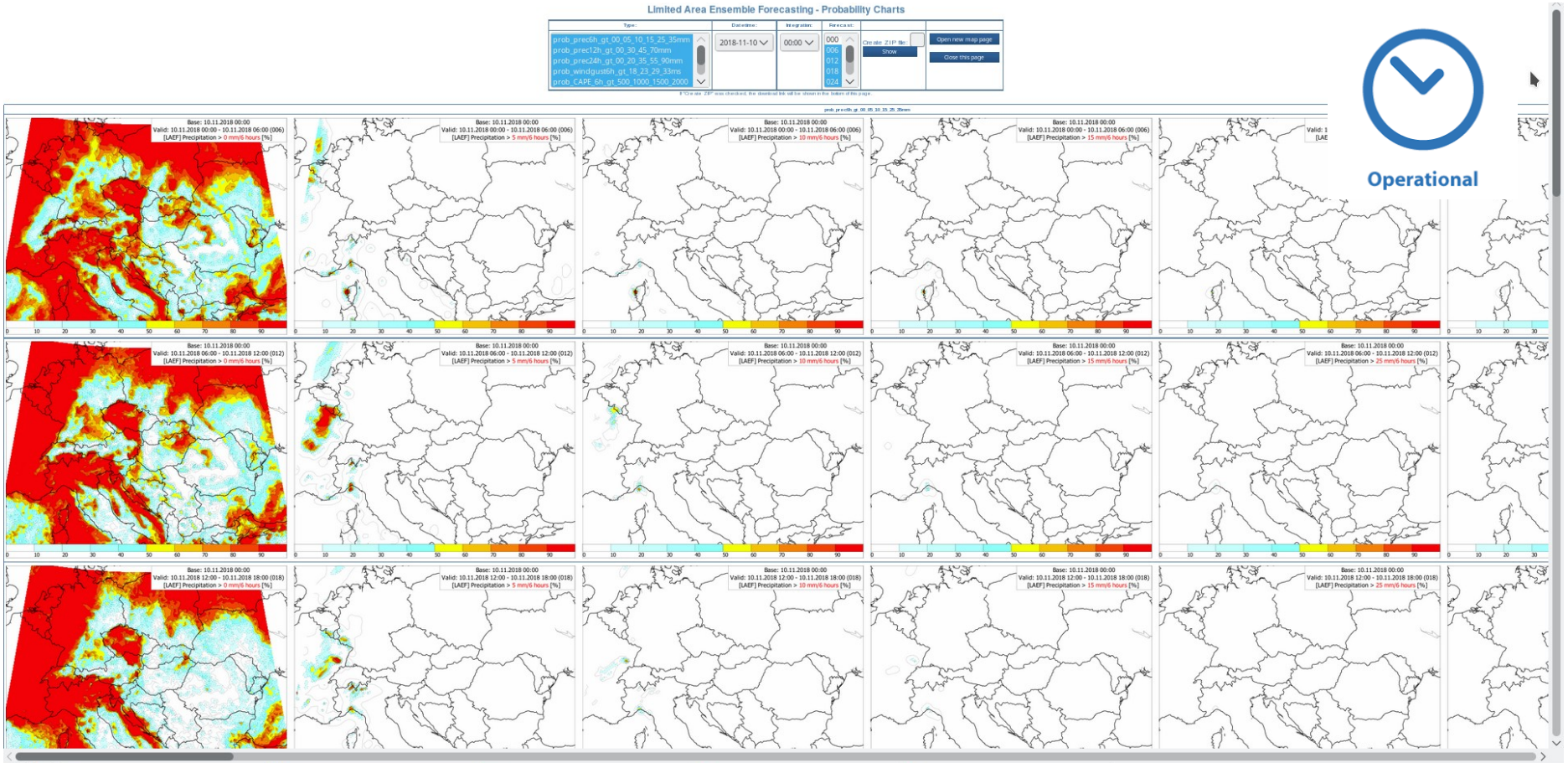
AROME verification
Smaller domains
Separate interface

ZAMG DHMZ OMSZ METEO ROMANIA ARSO METEO Slovenia

Operational products – LAEF prob. charts



Operational products – LAEF prob. charts

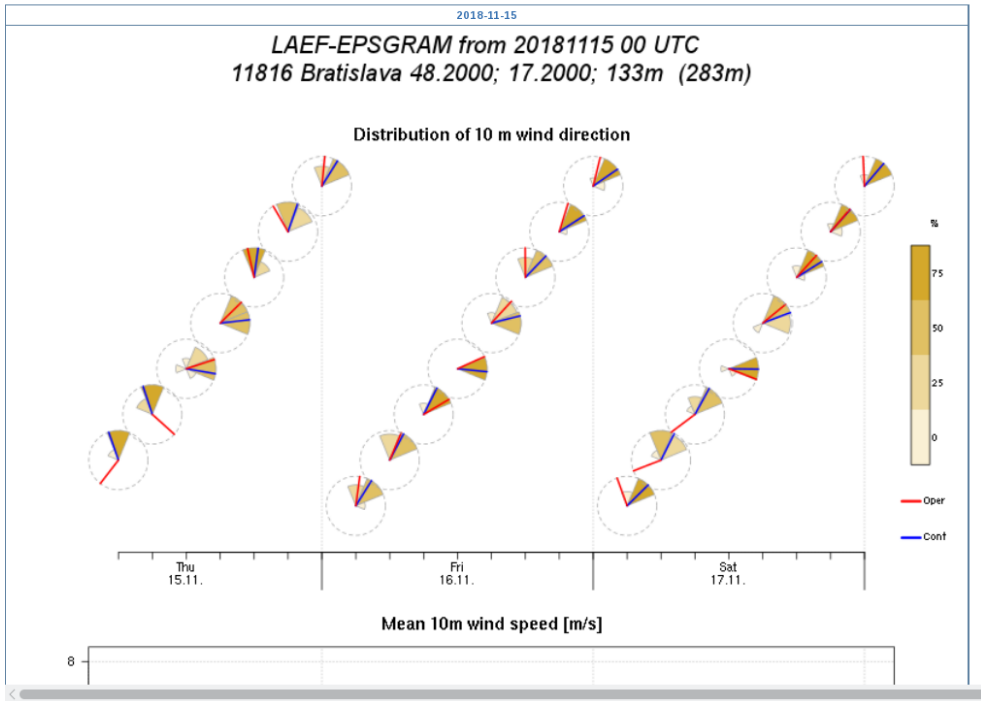


Operational products – LAEF meteograms

Limited Area Ensemble Forecasting - Epsgram

Town:	Datetime:	Integration:		
Bratislava Bucharest Budapest Ljubljana Prague	2018-11-15 2018-11-14 2018-11-13 2018-11-12 2018-11-11	00:00	Create ZIP file: ☐ Show	Open new map page Close this page

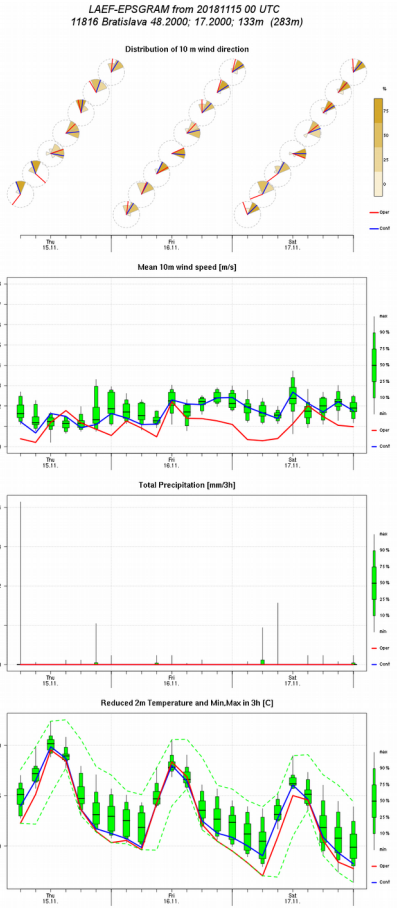
If "Create ZIP" was checked, the download link will be shown in the bottom of this page.

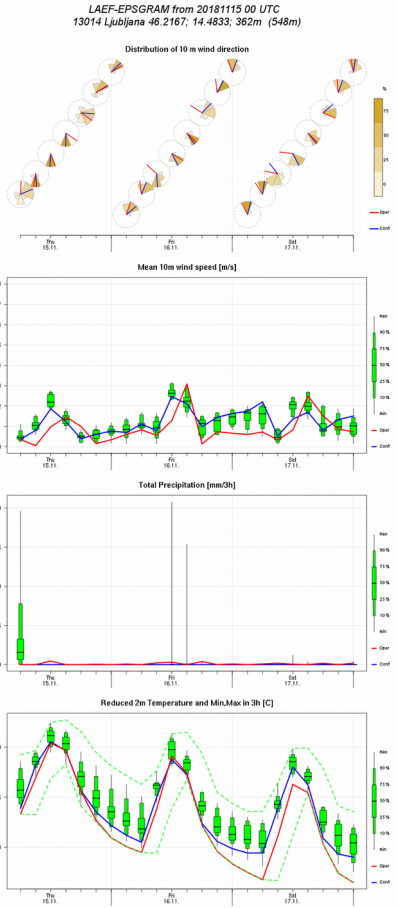


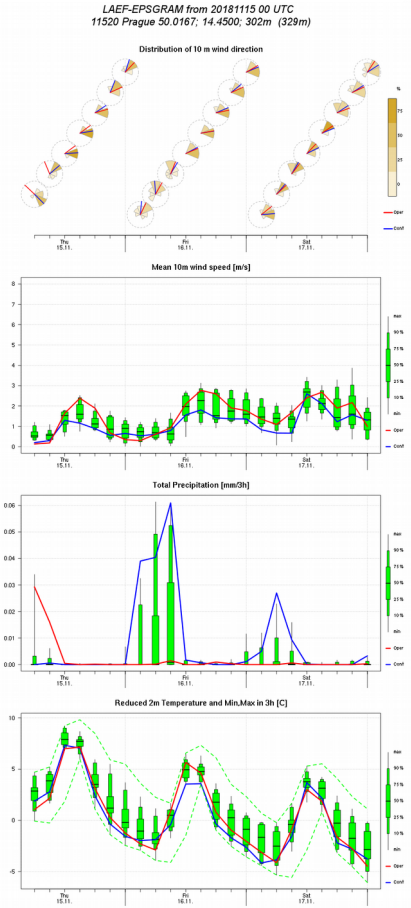
Operational

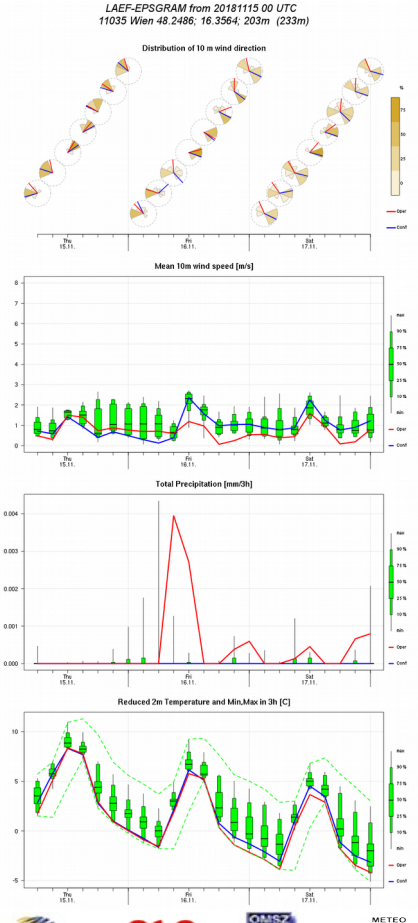
Operational products – LAEF meteograms

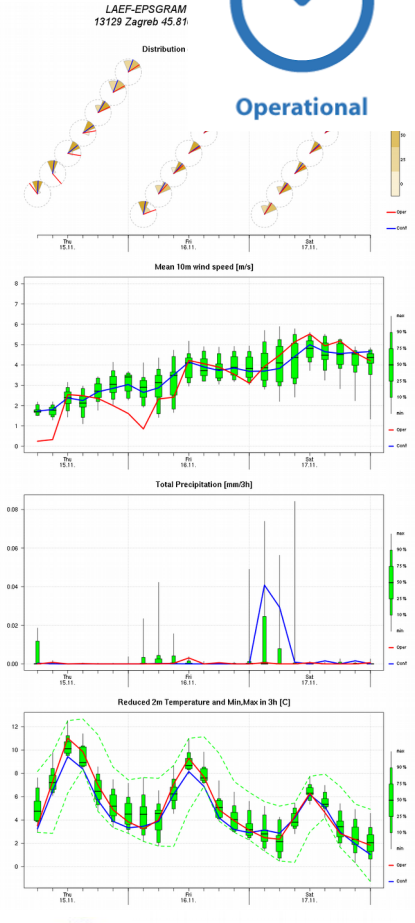
Operational



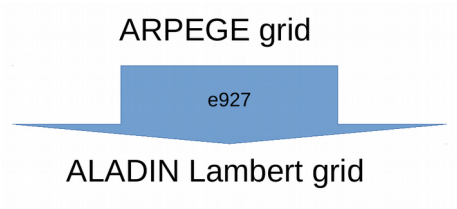


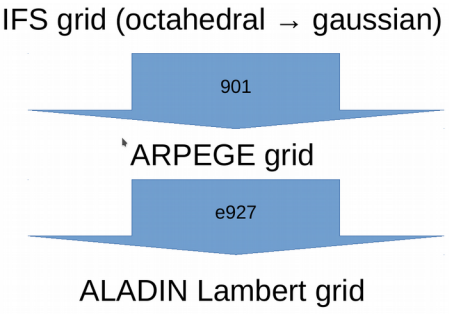


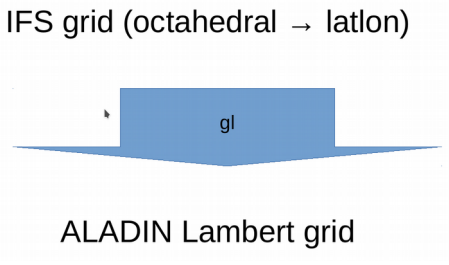


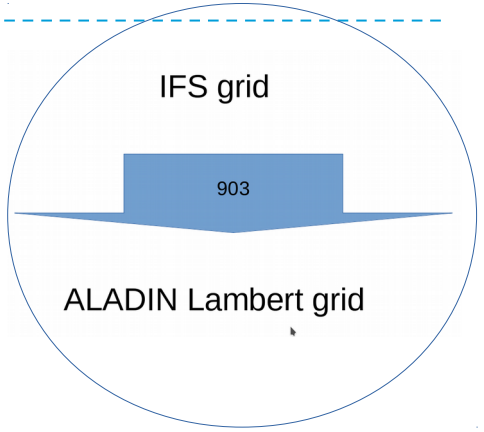


Operational LACE LBCs from IFS









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

Link to web page with reports

http://www.rclace.eu/?page=11

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

Assimilation of GNSS path delays and Mode-S observations

Data Manager - OPLACE

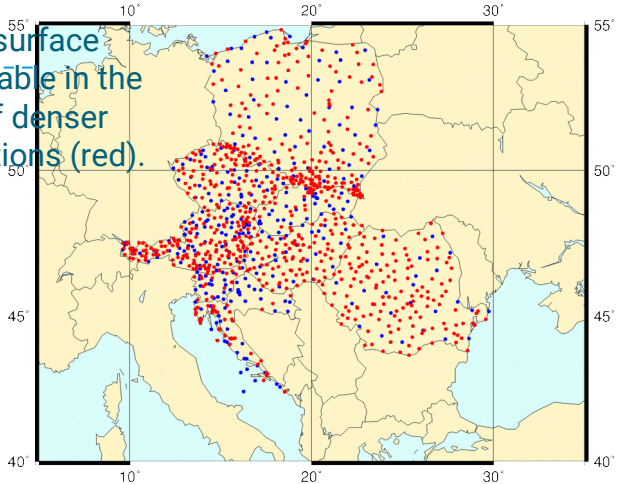
OPLACE national data exchange and access

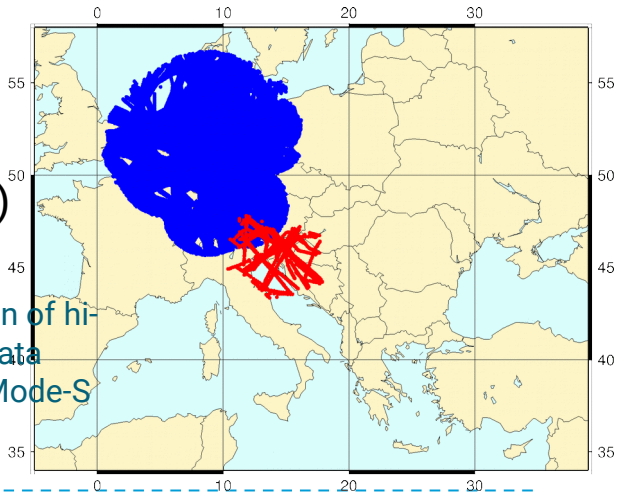
• high resolution surface synoptic data exchange
- stable and reliable for operational use
- only minor updates
• high resolution aircraft data exchange from modern air surveillance systems
- Mode-S MRAR from ARSO/Slovenia
- Mode-S EHS from KNMI/Netherlands
- stable and reliable data provision
• extension 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.

Operational

• **OPLACE access for non-LACE countries**
- currently two non-LACE users (Tunisia, Poland)

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





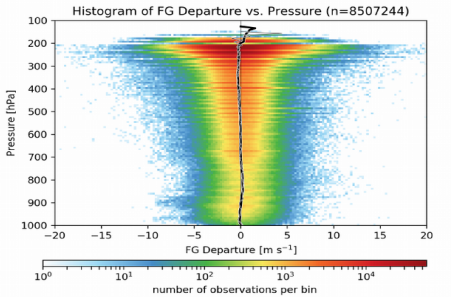
The geographical distribution of hi-res aircraft Mode-S MRAR data from Slovenia (red) and of Mode-S EHS data from KNMI (blue).

Data assimilation and Observation Preprocessing System for RC LACE (OPLACE)

LACE nwp central europe

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.



Austro Control ModeS

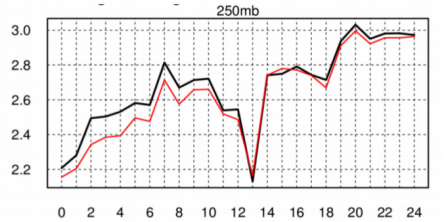
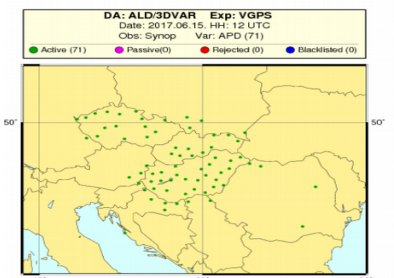
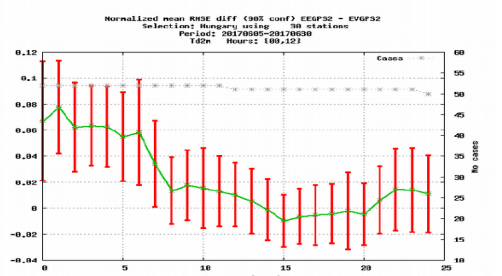


Figure 1: Time evolution of **RMSE for wind speed at 250hPa** verified against aircraft observations for period of 11 Jan – 9 Feb 2017 12UTC. **Reference** and Mode-S EHS experiment.

CHMI

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





Operational implementation of GNSS ZTD assimilation in Hungary.

SEE POSTER!

Operational

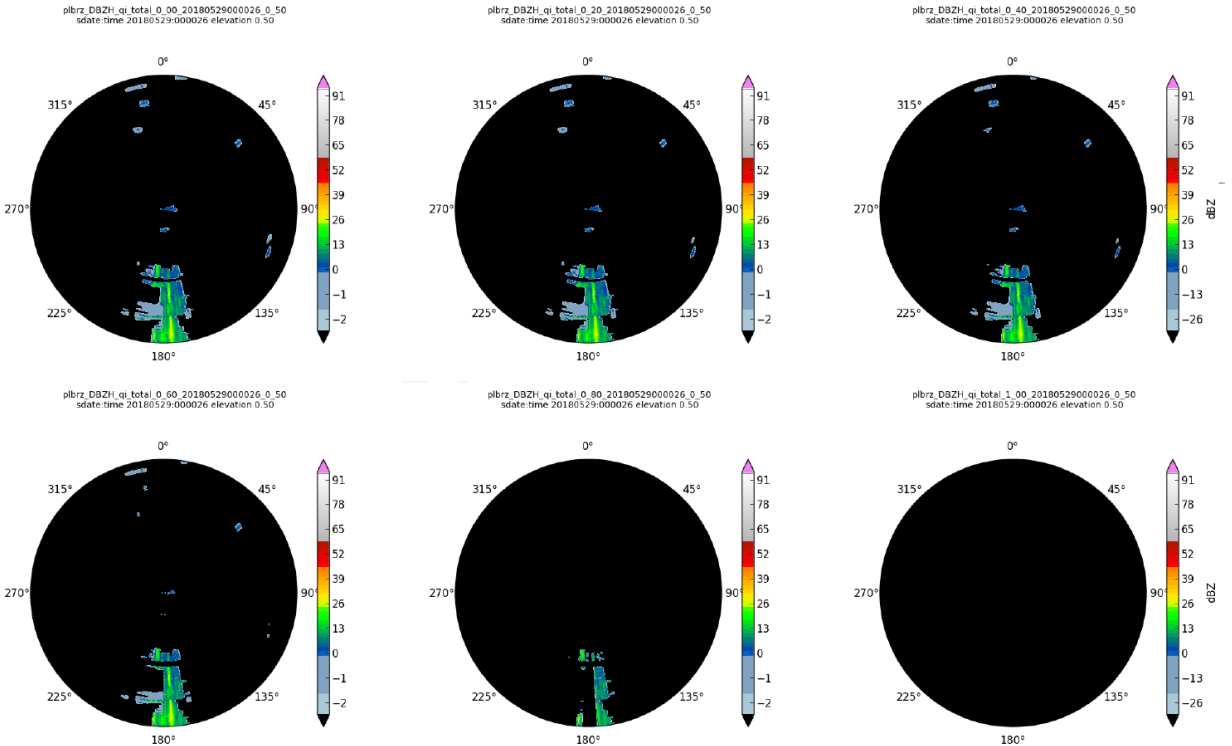
DHMZ · ARSO METEO Slovenia · ZAMG · ANM

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) Sof 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

http://www.rclace.eu/?page=13

Link to web page with reports

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

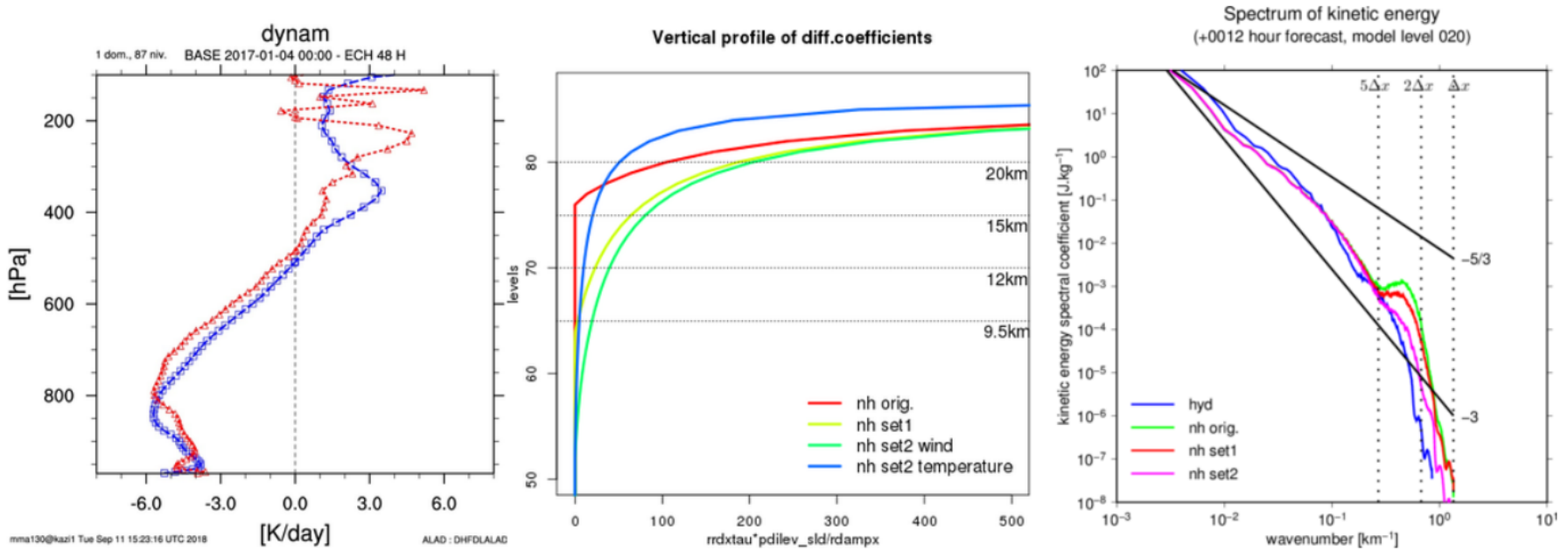
Terms redistribution through new vertical motion variables
- New definitions of the vertical motion variable are proposed (w5 and w6), implemented in cy46

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

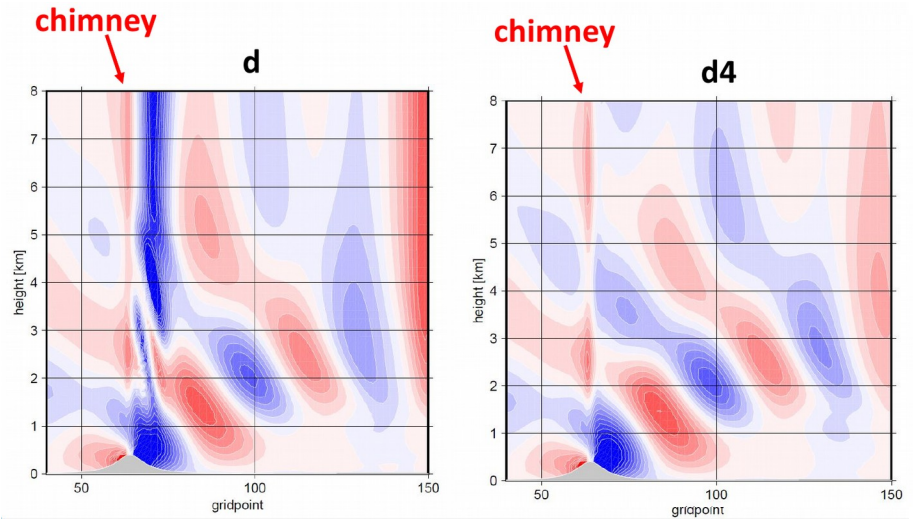
Tuning and redesign of the horizontal diffusion depending on the scale

- 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



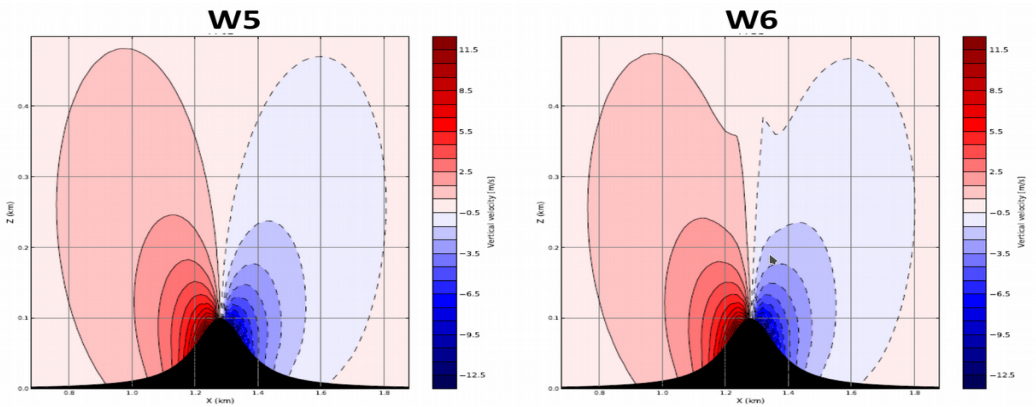
Removal of the remaining chimney effect through bottom boundary condition and new vertical motion variables

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.



Predictability area

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

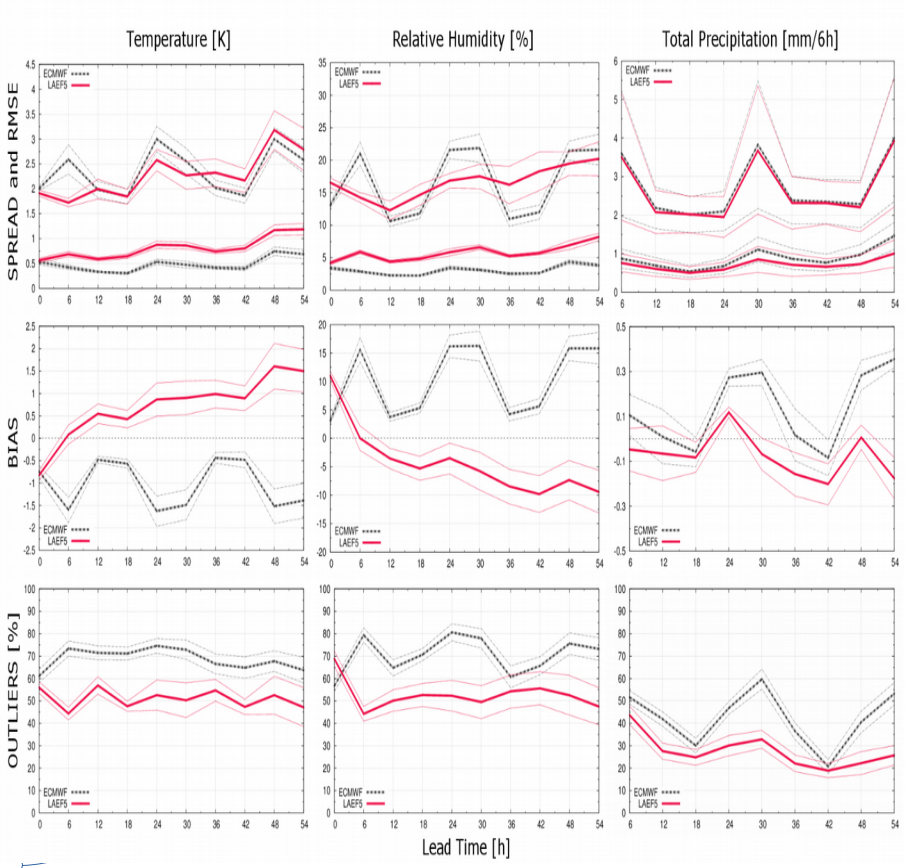
ALADIN-LAEF verification tool is being developed

Collaborations
- new probabilistic methodologies to predict severe weather conditions

Publications

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

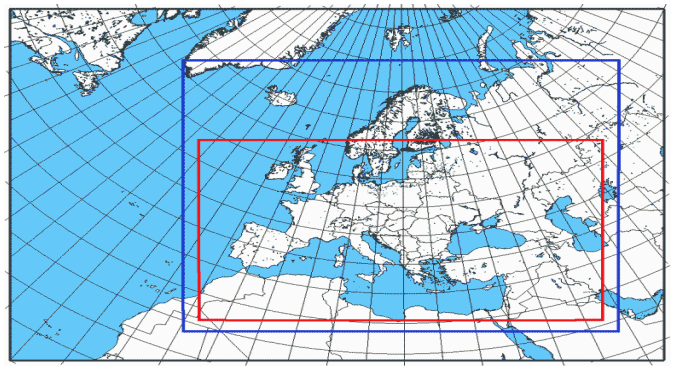
SEE POSTER!



Link to web page with reports

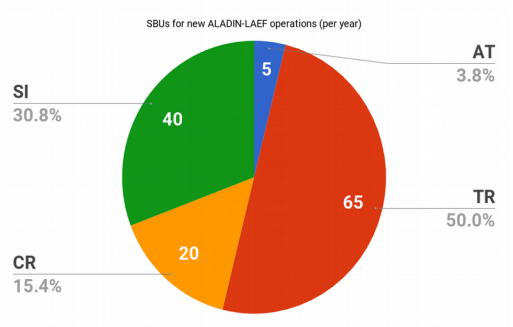
Aire Limitée Adaptation dynamique Développement InterNational - Limited Area Ensemble Forecasting (ALADIN-LAEF)

- 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.



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

Operational



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

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

Predictability area

ESDA

Slide 1

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

$$\Delta T_p = \frac{1}{2\pi} \Delta T_{2m} \qquad \Delta W_p = \alpha_p^T \Delta T_{2m} + \alpha_p^H \Delta H_{2m}$$

BLENDING

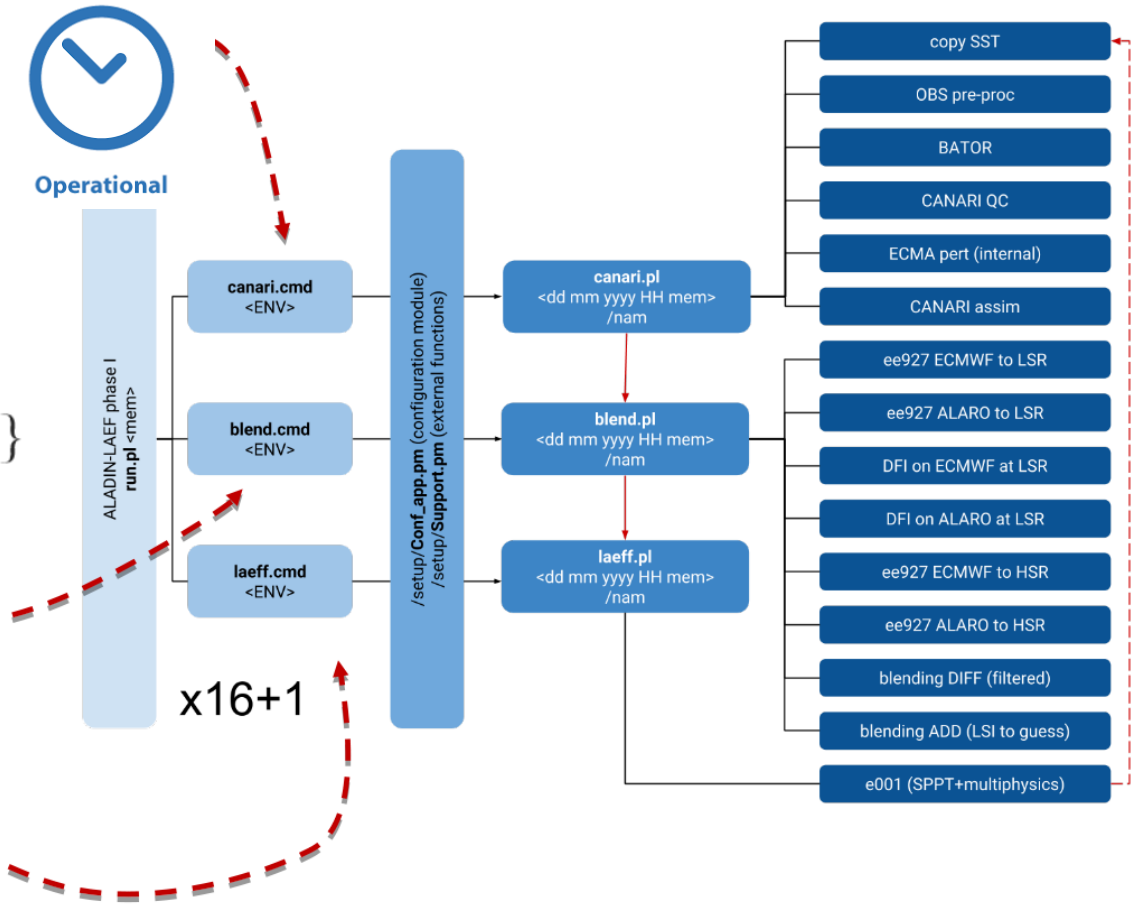
$$IC^n_{blend} = a^n_{breed} + \{ \overline{(a^n_{sv})_{trunc}} - \overline{(a^n_{breed})_{trunc}} \}$$

$$IC^n_{blend} = LS^n + a^n_{breed}$$

SPPT+MP

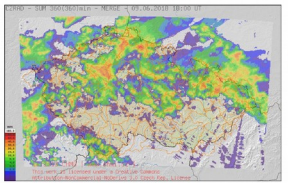
$$\frac{\partial e_j}{\partial t} = A(e_j, t) + P'(e_j, t)$$

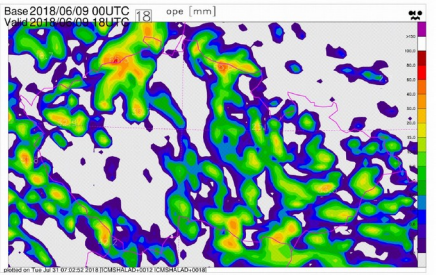
$$P'_j(e_j, t) = (1 + r_j(\lambda, \varphi, t)_{D,T}) P_j(e_j, t)$$

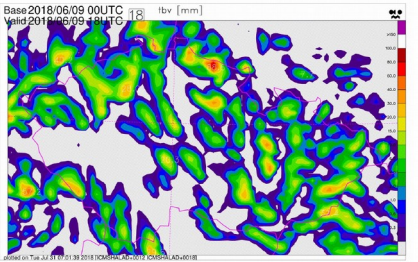


Physics area

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







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

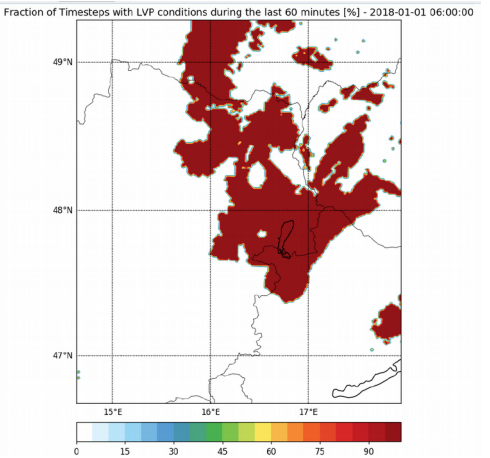
- Cheap calculation of clear sky fluxes, optimized intermittent storage, further improvement in calculation of direct solar flux is planned to be done in September with aim to enter cy46t1.

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



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

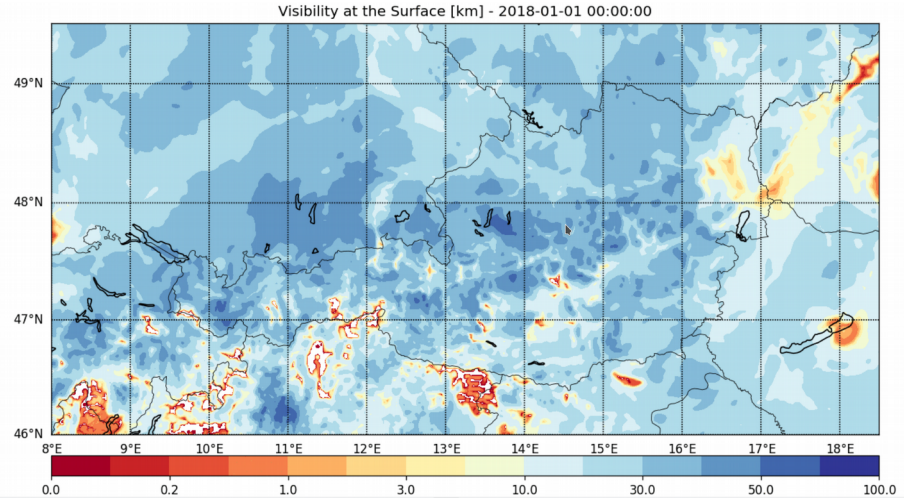
- hail probability, aviation related diagnostics, visibility, convective diagnostics pack

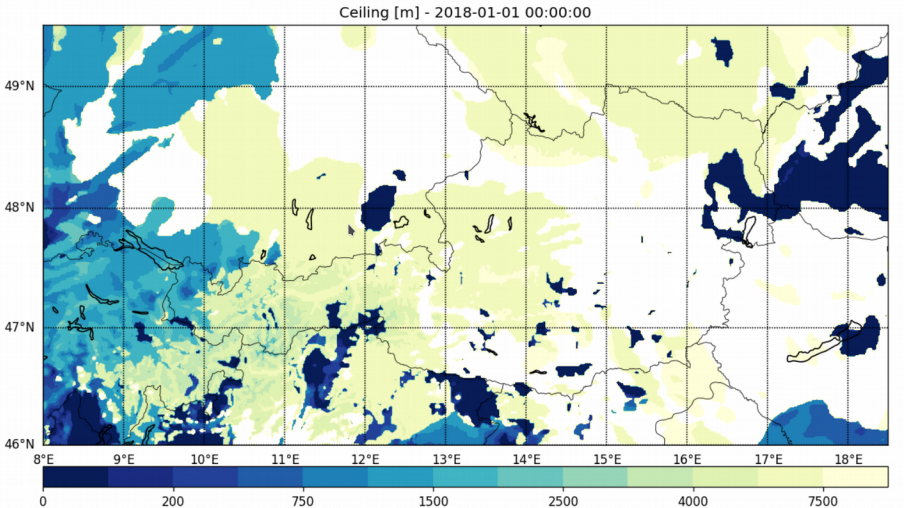
Off-line SURFEX

- 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

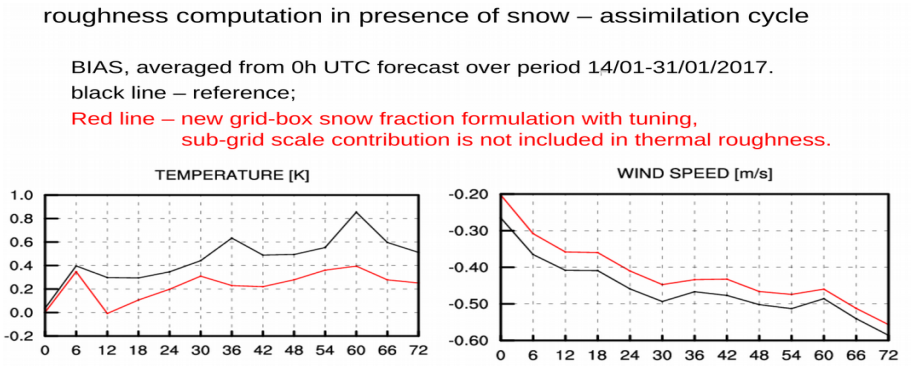
- operational wave modelling with Wind Wave Model (paper)
- Impact of two-way coupling and sea surface temeprature on precipitation forecast in regional atmosphere (paper)

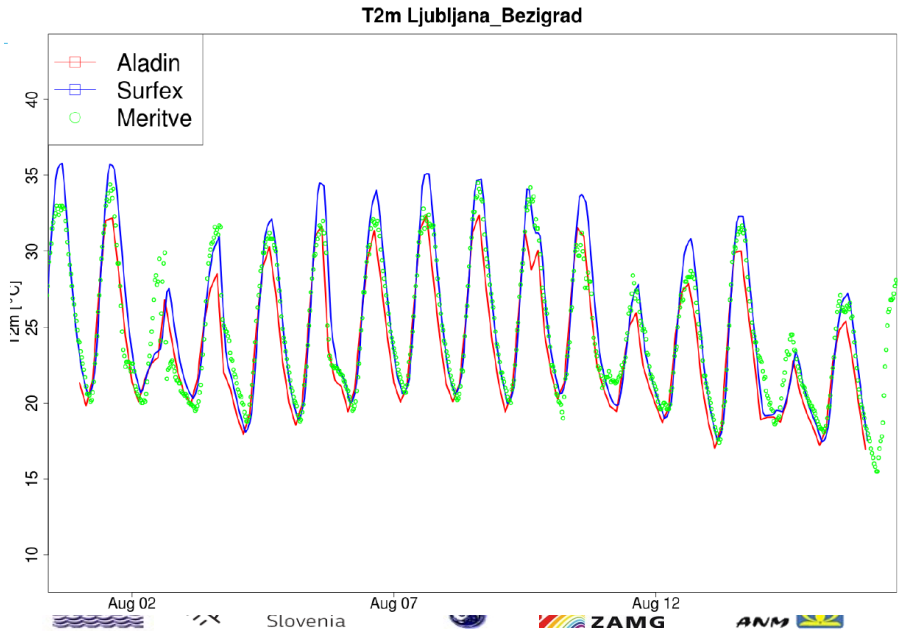




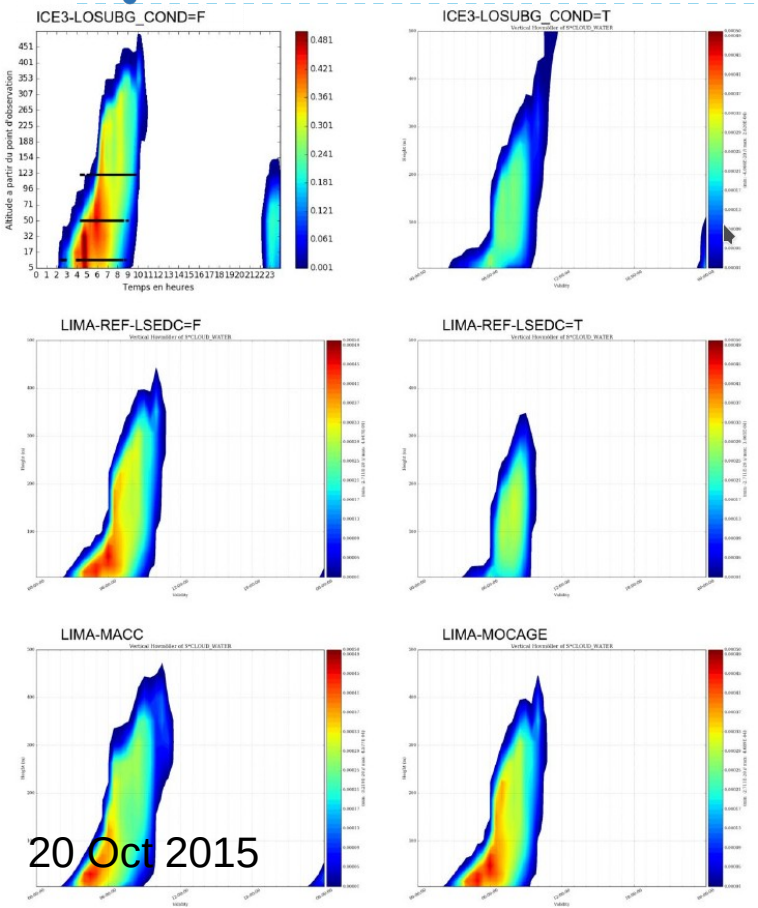
Physics developments

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)

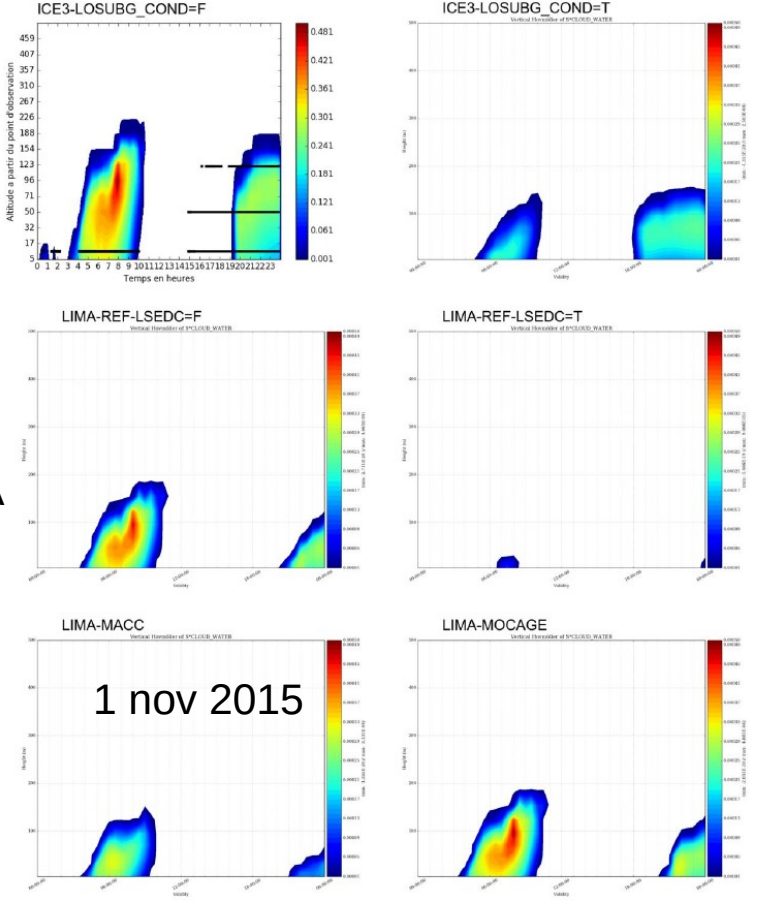




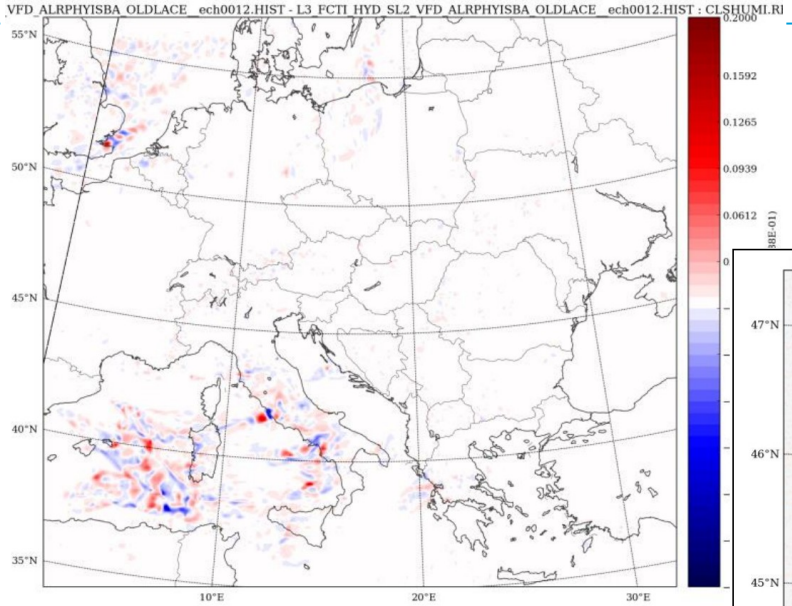
LIMA scheme in AROME



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

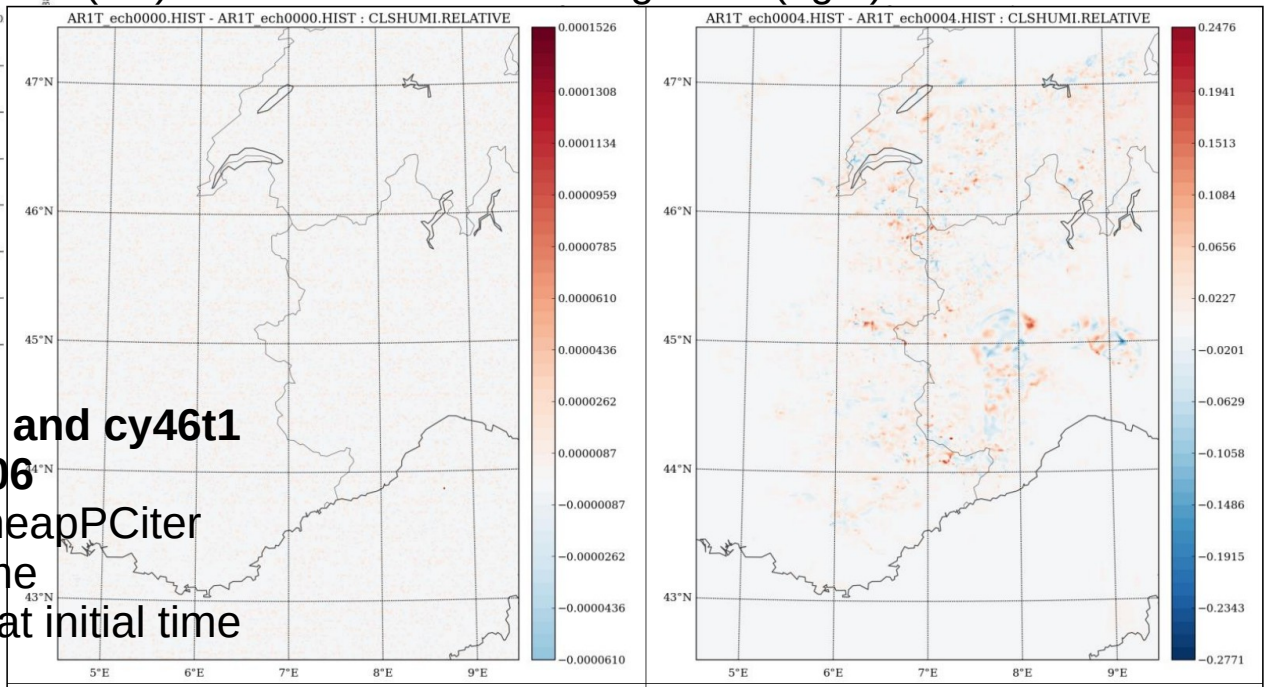


ALADIN-LACE System Coordinator



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 precission needs 40% less time
- comparison of meteorological fields at initial time and 4 h forecast

Thank you

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Publications

Publications

Wang Y., M. Belluš, A. Ehrlich, M. Mile, N. Pristov, P. Smolíková, O. Španiel, A. Trojáková, R. Brožková, J. Cedilnik, D. Klarić, T. Kovačić, J. Mašek, F. Meier, B. Szintai, S. Tascu, J. Vivoda, C. Wastl, Ch. Wittmann, 2017: “27 years of Regional Co-operation for Limited Area Modelling in Central Europe (RC LACE)”, published online on 23 July 2018 in BAMS, DOI:10.1175/BAMS-D-16-0321.1

Ihász I., A. Mátrai, B. Szintai, M. Szűcs, I. Bonta, 2017: “Application of European numerical weather prediction models for hydrological purposes”, published in Időjárás on January 2018, DOI: 10.28974/idojaras.2018.1.5

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

Bašták Ďurán, I., Geleyn, J.-F., Váňa, F., Schmidli, J., and R. Brožková, 2018: A turbulence scheme with two prognostic turbulence energies. Journal of the Atmospheric Sciences, https://journals.ametsoc.org/doi/full/10.1175/JAS-D-18-0026.1

Dutour Sikirić, M., Ivanković, D., Roland, A. et al. 2018: Operational Wave Modelling in the Adriatic Sea with the Wind Wave Model, Pure Appl. Geophys. https://doi.org/10.1007/s00024-018-1954-2

Strajnar, B., J. Cedilnik, A. Fettich, M. Ličer, N. Pristov, P. Smerkol and J.Jerman, 2018: Impact of Two-way Coupling and Sea-surface Temperature on Precipitation Forecast in Regional Atmosphere and Ocean Model, 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