*Regional Cooperation for*
*Limited Area Modeling in Central Europe*

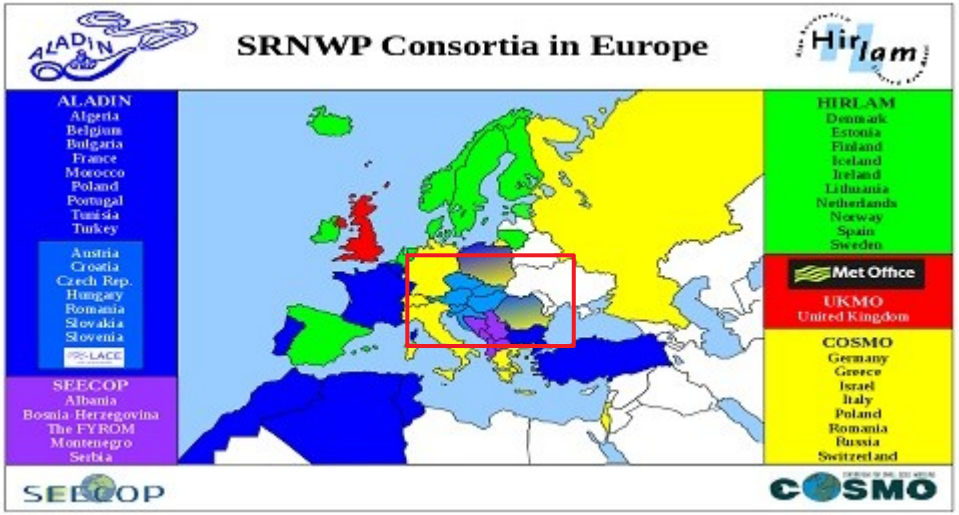
LACE
nwp central europe

# RC LACE developments in 2019

Martina Tudor, RC LACE MG and many researchers

ZAMG DHMZ OMSZ METEO ROMANIA SHMU ARSO METEO Slovenia

# Who? What?




NMSs of Austria, Croatia, Czech Republic,

Hungary, Romania, Slovakia and Slovenia

- common operational applications

**LAEF** – Limited Area Ensemble Forecasting

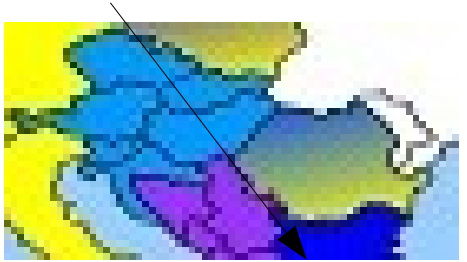
system

**OPLACE** – observation pre-processing for LACE

- common research activities

http://www.rclace.eu/?

You are here



# Organisational changes

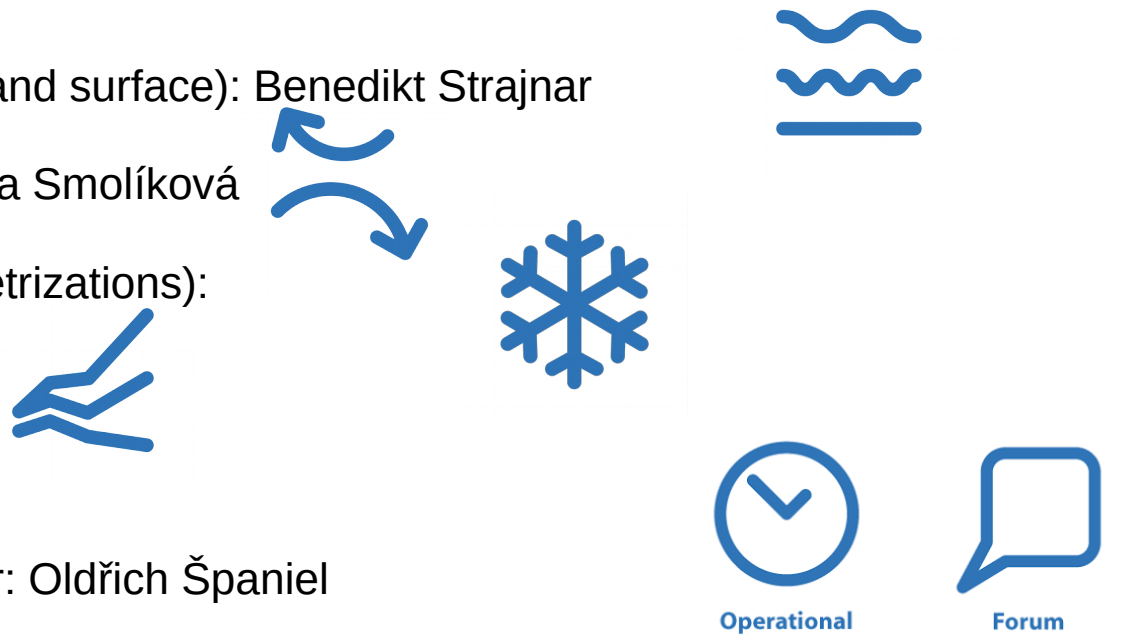
Project Manager: Martina Tudor

Area Leaders:

- Data assimilation (upper air and surface): Benedikt Strajnar
- Dynamics and coupling: Petra Smolíková
- Physics (and surface parametrizations):
- Predictability: Martin Belluš

Data Manager: Alena Trojáková

ALADIN-LACE System Coordinator: Oldřich Španiel



# Data Manager activities



**Published article**
**https://www.adv-sci-res.net/16/223/2019/**

Adv. Sci. Res., 16, 223–228, 2019
https://doi.org/10.5194/asr-16-223-2019


Advances in Science & Research
Open Access Proceedings

## Observation Preprocessing System for RC LACE (OPLACE)

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[2]Hungarian Meteorological Service, Unit of Methodology Development, P.O. Box 38, 1525 Budapest, Hungary
[3]Norwegian Meteorological Institute, Development Centre for Weather Forecasting, Oslo, P.O. Box 43, 0313 Blindern, Norway
[4]Research department, Croatian Meteorological and Hydrological Service, Gric 3, Zagreb, Croatia

**Correspondence:** Martina Tudor (tudor@cirus.dhz.hr)

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**Abstract.** Meteorological observations are indispensable for the initialization of numerical weather prediction (NWP) forecast. To enable the application of observations in NWP models a technical preprocessing is necessary. Within the framework of RC LACE (Regional Cooperation for Limited Area modelling in Central Europe) consortium, a common observation preprocessing system (OPLACE) has been built up to deliver meteorological observations in an appropriate format for data assimilation in the NWP system ALADIN (Air Limiteée Adaptation Dynamique Développment International) The purpose of this paper is to document the OPLACE data sources, preprocessing steps and means to make preprocessed observations available. Furthermore, it describes an exchange of dense national surface synoptic measurements and high-resolution aircraft data in real-time among RC LACE national meteorological services (NMS) of Austria, Croatia, the Czech Republic, Hungary, Romania, Slovakia, and Slovenia.

# Data Manager activities

Operational

upgrades on internal netCDF databases
- to include string station names
- more data from high resolution BUFR TEMPs

more wind observations over the oceans
- from Indian (OSCAT) and Chinese (HSCAT) scatterometers (resolution 25km)

E-GVAP (EUMETNET GNSS Water Vapour Programme) - ongoing
- provides GNSS signal delay & WV measurements for operational meteorology

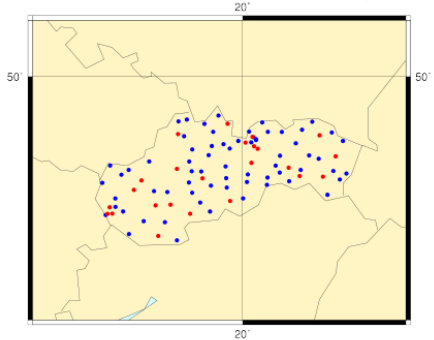
redesign of the OPLACE scripts - ongoing
new OPLACE ECF suite development
- parallel since December 2018, new ecFlow suite
- processing of BUFR data added
- prototype of E-GVAP data processing added

TO DO
Technical upgrade for SEVIRI
TAC2BUFR migration
SAPP (Scalable Acquisition and PreProcessing System)

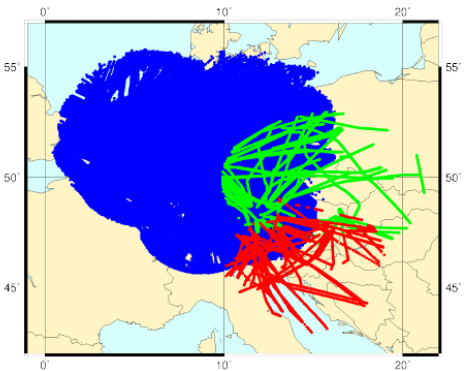
OPLACE access for non-LACE countries
- currently two non-LACE users (Tunisia, Poland)

# Data Manager activities III


- extension by high resolution synoptic data from Slovakia - ongoing
  - data preparation almost completed
    - 60 new national stations
    - GTS data




- high resolution aircraft data exchange from modern air surveillance systems
  - stable and reliable data provision
    - Mode-S EHS from KNMI/Netherlands
    - Mode-S MRAR from ARSO/Slovenia
    - new MRAR from CHMI/Czech Rep available via OPLACE since July 2019




- All Members are kindly encouraged to explore availability of Mode-S data.

# Data Manager activities IV


• **Data Assimilation training (Budapest, Frabruary)**
- lessons and exercises

• **ALADIN data assimilation starters kit (DAsKIT)**
- ALADIN coordinated acvivities to enhance implementation for ALADIN Members without operational DA, (Al, Be, Bu, Mo, Po, Pt, Ro, Tu, Tk)
- considerable manpower (cca 10 FTE) is being gathered for DA R&D
- opportunity for RC LACE support & to gain permanently missing manpower
- RC LACE collaborations and tools were promoted
- common meeting LACE DA WD and DAsKIT WD organized in Bucharest

# ALADIN-LACE System Coordinator

- **Phasing of common cy47**
- **Preparation of the new bugfix cy43t2_bf10 for current export version cy43t2 and porting support**
- **Validation of the cy46t1_v07 as reference for prepared version cy47**
- **Production of common verification scores from LACE Members operational model outputs**
- **Administration and maintenance of the RC LACE web site and forum**

# ASC – Single Precission Code

One practical reason – run time reduction of 22-47% (depends on configuration, ALARO-0 30%)
The data volume is smaller

- Memory cache can hold larger part of data array
- Amount of data going through MPI is smaller

| | Double | Single |
|---|---|---|
| N. of bits | 64 | 32 |
| Max value | 1.7E+308 | 3.4E+38 |
| Min value | 2.2E-308 | 1.1E-38 |
| N. of decimal digits | 15 | 7 |

How to compile, practical notes:

- same code
- just compilation option changed
- + library (mostly just lapack without –r8)
- Two MASTERs – Single and Double MASTERODB
- same LBC, init file

| gcc | Double | Single |
|---|---|---|
| DBL_FRTFLAGS | -fdefault-real-8 -fdefault-double-8 | |
| GMK_FCFLAGS_MPA | -fdefault-real-8 | |
| GMK_FCFLAGS_MSE | -fdefault-real-8 | |
| GMK_FCFLAGS_SURFEX | -fdefault-real-8 | |
| MACROS_FRT | -DLINUX -DLITTLE_ENDIAN -DLITTLE -DWITH_FCKIT | -DLINUX -DLITTLE_ENDIAN -DLITTLE -DWITH_FCKIT **-DPARKIND1_SINGLE** |
| MACROS_CC | -DLINUX -DLITTLE_ENDIAN –DLITTLE | -DLINUX -DLITTLE_ENDIAN -DLITTLE **-DPARKIND1_SINGLE** |
| | | |

# ASC – Single Precission Code

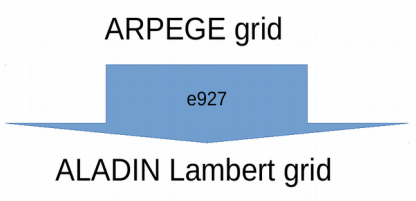
ALARO1

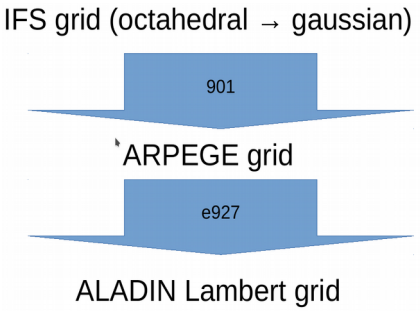
- Technical motivation (division by zero & security constant)

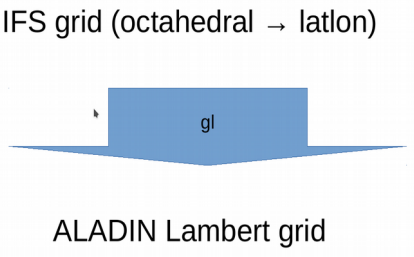
Not only compilation options

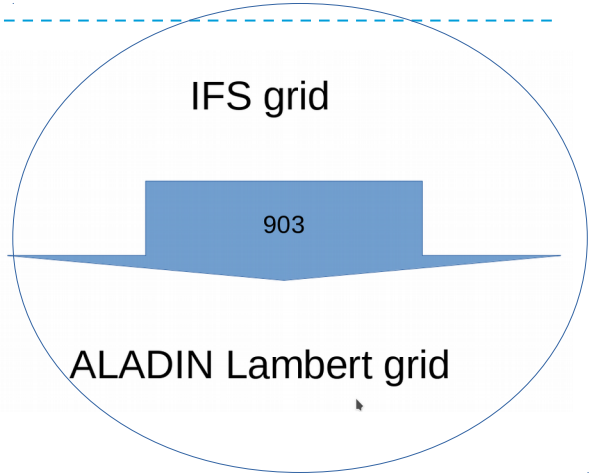
```
            arpifs/phys_dmn/acmrip.F90
            arpifs/phys_dmn/actkecls.F90
            arpifs/phys_dmn/suphy3.F90
            arpifs/phys_dmn/tridifv1.F90
            arpifs/phys_dmn/aplmini.F90

arpifs/phys_dmn/acmrip.F90 – division by zero

+ ZPHI3TA(JLON,JLEV) = SIGN(MAX(ZEPS,ABS(ZPHI3TA(JLON,JLEV))),ZPHI3TA(JLON,JLEV))
ZTKE_LAM5T=(C3TKEFREE+ZCHI3TA(JLON,JLEV)/ZPHI3TA(JLON,JLEV) …

arpifs/phys_dmn/actkecls.F90 – security constant

!ZEPS1=1.E-80_JPRB
ZEPS1=EPSILON(1.0_JPRB)

arpifs/phys_dmn/tridifv1.F90 ! vectorisation performance -> maybe JPRD would be faster ?

DO JLEV=KTDIA+1,KLEV-1
  DO JLON=KIDIA,KFDIA
    !ZMUL(JLON)       = 1._JPRB/(PB(JLON,JLEV)+PA(JLON,JLEV)*PCFA(JLON,JLEV-1))
    ZAUX = PB(JLON,JLEV)+PA(JLON,JLEV)*PCFA(JLON,JLEV-1)
    ZMUL(JLON)       = 1._JPRB/SIGN(MAX(ZEPS,ABS(ZAUX)),ZAUX)
```

# Operational LACE LBCs from IFS




Currently

IFS HRES LBCs use a combination of configurations 901 and e927, but 901 requires data on reduced GG for input

IFS ENS LBCs use gl (and e927 for vertical interpolations)

Configuration 903 is working (Ryad El Khatib)

Tested, TC1 suite, implemented in LAEF

TO DO: TC3

# 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

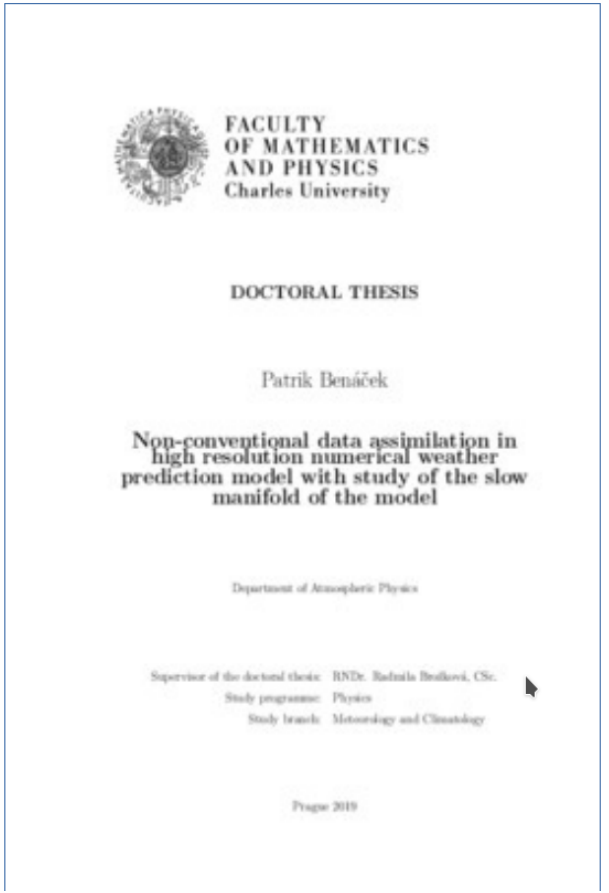
**Radar reflectivity and radial wind**
- back-phased BATOR, quality check OPERA, homogenisation pre-processor

**Assimilation of GNSS path delays and Mode-S observations**

**See presentation by Benedikt Strajnar on Tuesday 15:00!**

# Data assimilation area

Diagnosis of VarBC for LAM, PhD (and published paper): P. Benáček (CZ)



FACULTY
OF MATHEMATICS
AND PHYSICS
Charles University

DOCTORAL THESIS

Patrik Benáček

Non-conventional data assimilation in high resolution numerical weather prediction model with study of the slow manifold of the model

Department of Atmospheric Physics

Supervisor of the doctoral thesis: RNDr. Radmila Brožková, CSc.
Study programme: Physics
Study branch: Meteorology and Climatology

Prague 2019

# 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”, published in MWR, 2018.

**Tuning and redesign of the horizontal diffusion depending on the scale**
- sensitivity study for the available tuning parameters for SLHD was prepared tested in the cascade of resolutions: 4km, 2km and 1km on the domain covering Central Europe with Alps, with 87 vertical levels.

Link to web page with reports

**The trajectory search in the SL advection scheme**

**Terms redistribution through new vertical motion variables**

**Tuning the wind field dynamical adaptation in very high resolutions**y

**See presentation by Petra Smolíková on Wednesday 12:00!**

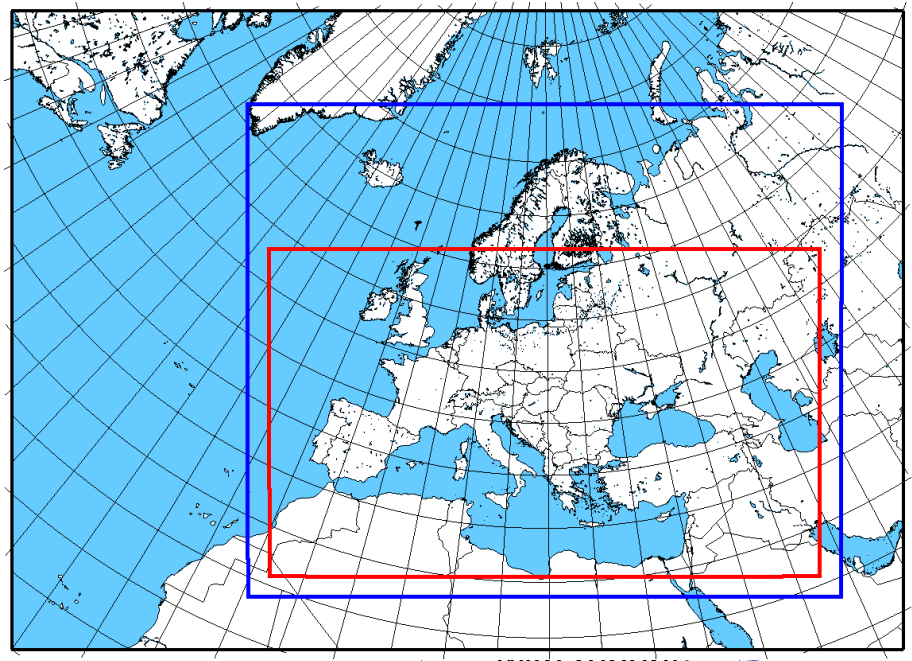
# Predictability area

Operational

LACE nwp central europe

**We have currently three independent systems:**

- **Common RC LACE EPS with 4.8 km horizontal resolution based on ALARO-1 physics running on a big European domain (A-LAEF).**
- **Austrian convection-permitting EPS with 2.5 km horizontal resolution utilizing AROME model on a middle European domain (C-LAEF).**
- **Hungarian convection-permitting EPS which is going to replace their former ALARO-EPS.**

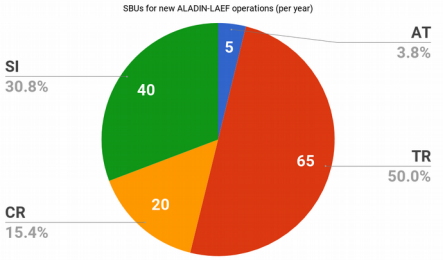



**Publications**

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

**See presentation by Martin Belluš on Wedesday 10:40!**

# Predictability area



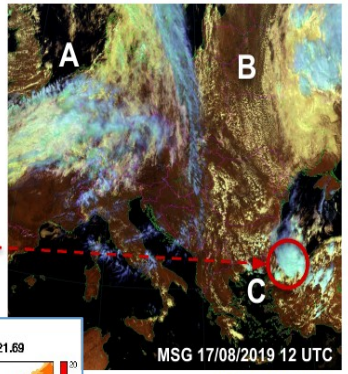

LACE
nwp central europe

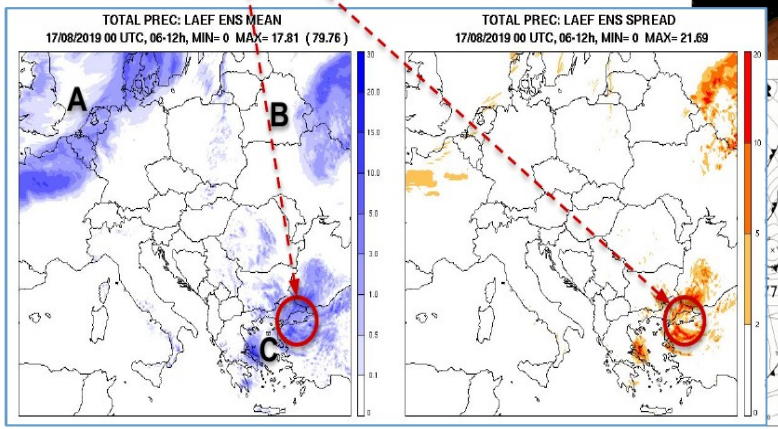
## Turkey - Flash floods of 17 August 2019

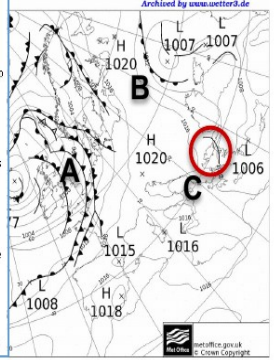
(pre-oper) A-LAEF precipitation forecast:

**A**, **B**: synoptic scale systems

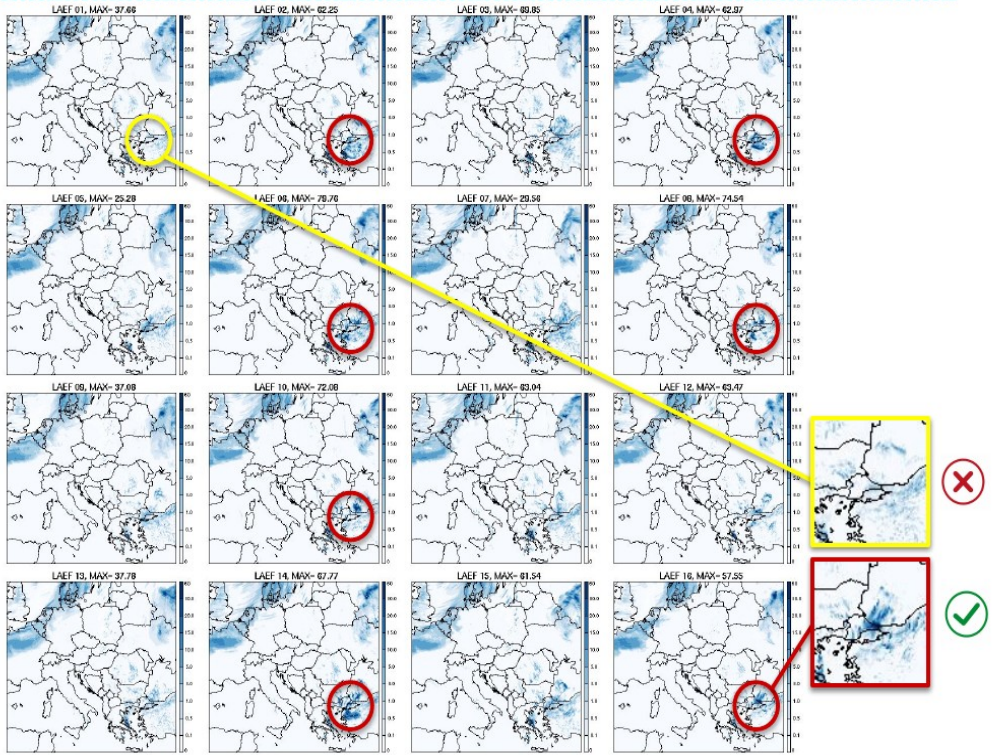
**C**: mesoscale convective system (MCS)




(pre-oper) A-LAEF precipitation forecast:




**See presentation by Martin Belluš on Wedesday 10:40!**

Link to web page with reports

ZAMG DHMZ ARSO METEO Slovenia

# 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

**See presentation by Martina Tudor on Thursday 12:00!**

# 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

http://www.rclace.eu/?page=12

Link to web page with reports

**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)

**See presentation by Martina Tudor on Thursday 12:00!**

# 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

Benáček, P., Mile, M. (2019): Satellite bias correction in the regional model ALADIN/CZ: comparison of different VarBC approaches. Monthly Weather Review, vol. 147, no. 9, https://doi.org/10.1175/MWR-D-18-0359.1

Trojáková A, Mile M., Tudor M. (2019): Observation Preprocessing System for RC LACE (OPLACE), accepted, ASR.

Scherllin-Pirscher, Barbara, A. K. Steiner, G. Kirchengast, Y.-H. Kuo, and Ulrich Foelsche. Empirical analysis and modeling of errors of atmospheric profiles from GPS radio occultation." Atmospheric Measurement Techniques (Copernicus GmbH) 4 (2011): 1875-1890.

Schneider, S. and Bauer-Marschallinger, B.: Assimilation of SCATSAR Soil Wetness Index in SURFEX 8.0 to improve weather forecasts, ongoing.

Belluš, M., F. Weidle, C. Wittmann, Y. Wang, S. Taşku, and M. Tudor, 2019: “Aire Limitée Adaptation dynamique Développement InterNational – Limited Area Ensemble Forecasting (ALADIN-LAEF)”, Adv. Sci. Res., 16, 63–68, https://doi.org/10.5194/asr-16-63-2019

Wang, Y., M. Belluš, F. Weidle, et al., 2019: “Impact of land surface stochastic physics in ALADIN-LAEF”, Quarterly Journal of the Royal Meteorological Society, 1–19, https://doi.org/10.1002/qj.3623

Keresturi E., Y. Wang, F. Meier, F. Weidle, Ch. Wittmann, A. Atencia, 2019: “Improving initial condition perturbations in a convection permitting ensemble prediction system”, published on 22 January 2019 in Quarterly Journal of the Royal Meteorological Society, DOI: 10.1002/qj.3473

Wastl C., Y. Wang, A. Atencia and C. Wittmann, 2019: “Independent perturbations for physics parametrization tendencies in a convection-permitting ensemble (pSPPT)”, published on 16 January 2019 in Geosci. Model Dev., 12, 261-273, DOI: 10.5194/gmd-12-261-2019

Wastl C., Y. Wang, A. Atencia, C. Wittmann, 2019: “A hybrid stochastically perturbed parametrization scheme in a Convection permitting ensemble”, Mon. Wea. Rev., 147, 2217-2230. doi:https://doi.org/10.1175/MWR-D-18-0415.1