Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

ALARO status overview

with contributions by
Radmila Brožková, Ján Mašek, Luc Gerard

Neva Pristov

DHMZ

SHMU

ARSO METEO Slovenia

OMSZ

ZAMG

ROMANIA ANM

Talk outline

- ALARO current status
- Turbulence scheme with shallow convection
- Ongoing developments
- Diagnostic fields
- Outlook

ALARO status

ALARO is a canonical model configuration of ALADIN system

In the operational use in ALADIN countries

- **ALARO-0**: at, hr, ro,
- **ALARO-1vA|B**: be, cz, hu, ma, po, sk, si, tr

  model resolution between 8 km – 2 km, 1.3 km

National posters

In EPS systems

- LAEF, GLAMEPS, EPS at HMS,RMI
- multi-model ShortRangeEPS at AEMET

Presentation Martin Belluš

In climatological simulations

- be, cz, fi,

ALARO-1 version - turbulence

- Turbulence scheme TOUCANS
  - Valid for whole stability range,
  - The influence of moisture is included,
  - Stability parameter and turbulent exchange coefficients are not strictly local and have prognostic character,
  - Can simulate both turbulence and clouds in PBL.

October 2018

A Turbulence Scheme with Two Prognostic Turbulence Energies

3381–3402

Ivan Bašták Ďurán, Jean-François Geleyn, Filip Váňa, Juerg Schmidli, and Radmila Brožková

Published online on 6 September, 2018.

https://doi.org/10.1175/JAS-D-18-0026.1

Shallow convection

- Shallow convection is part of TOUCANS
  - Direct parameterization of **moist buoyancy flux** in a general **partly saturated case**, for which the lapse rate is:

$$\frac{N^2(C)}{gM(C)} = \left(\frac{c_{pd}}{c_p}\right)\frac{\partial ln\theta_l}{\partial z} + \left\{\frac{R_v - R_d}{R} + \hat{Q}(C, C_n)\left[\frac{L_v(T)}{c_p T}\frac{R}{R_v} - 1\right]\left[\frac{R_v - R_d}{R} + \frac{1}{1 - q_t}\frac{1}{1 + D_C}\right]\right\}\frac{\partial q_t}{\partial z}$$

$\hat{Q}(C, C_n)$ Is determined by a simple mass-flux type scheme and by the fit to LES data.

Shallow convection

- Recent changes leading to improved initial determination of the parameter $\hat{Q}(C, C_n)$
  - Removal of a combined TKE/TTE threshold to abort the cloud profile,
  - Taking into account negative buoyancy properly,
  - Correction of computations determining the “enough thick” stable layer above which there is no new cloud base,
  - Removal of the saturated stability threshold for the cloud existence.

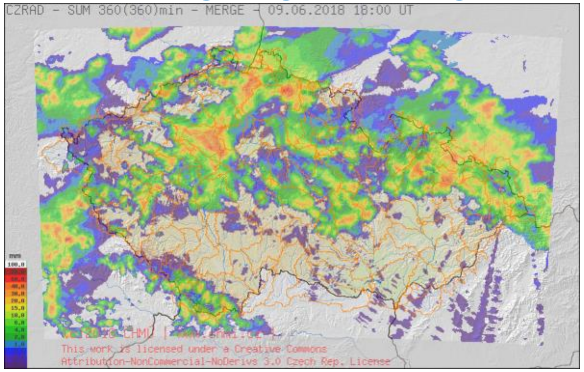
Shallow convection - results

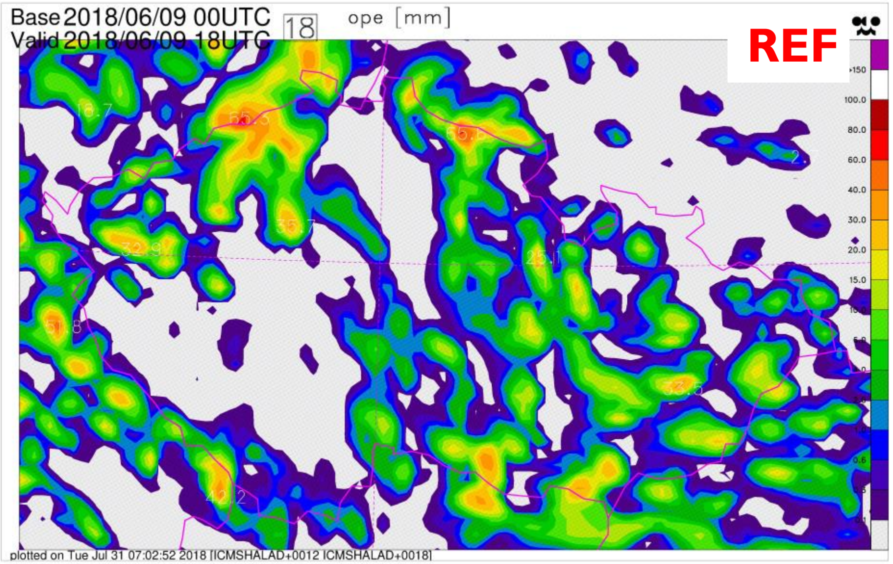
Shallow convection modifications

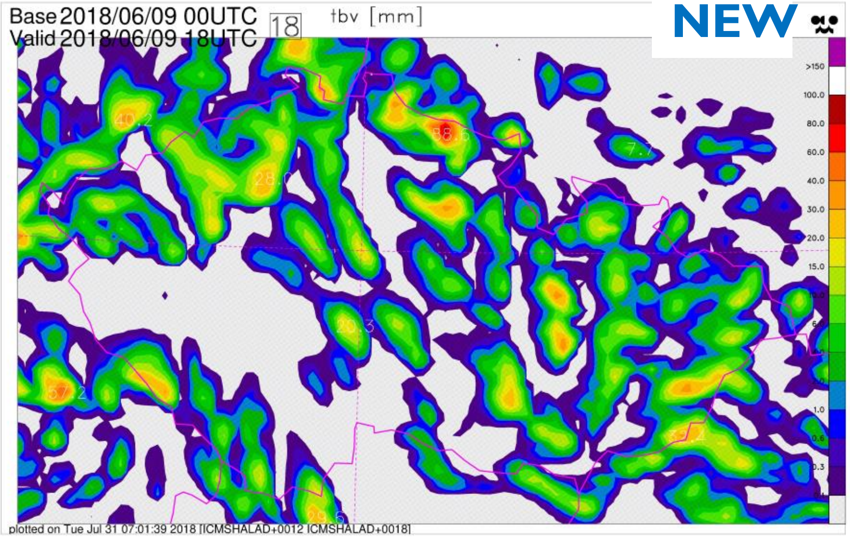
- Interaction with deep convection is changed,
- Precipition location is better.

REF: reference
NEW: improved SCC

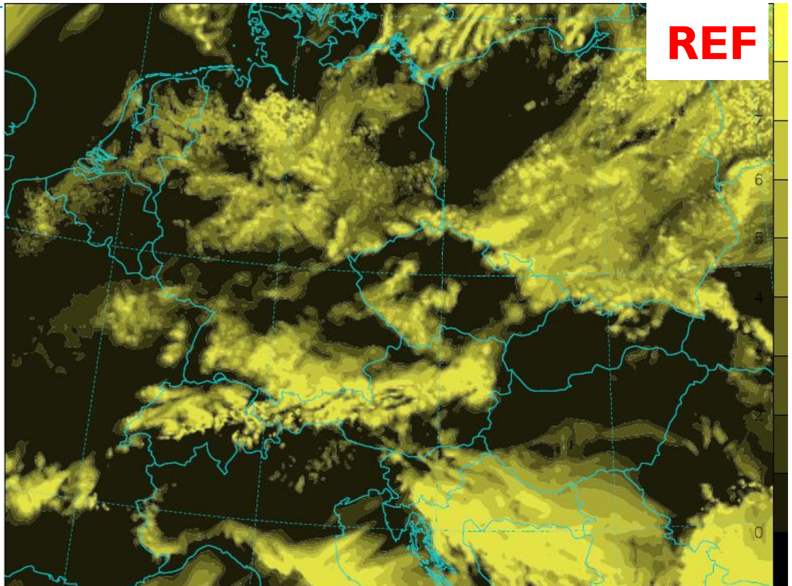
Radar & gauges merge

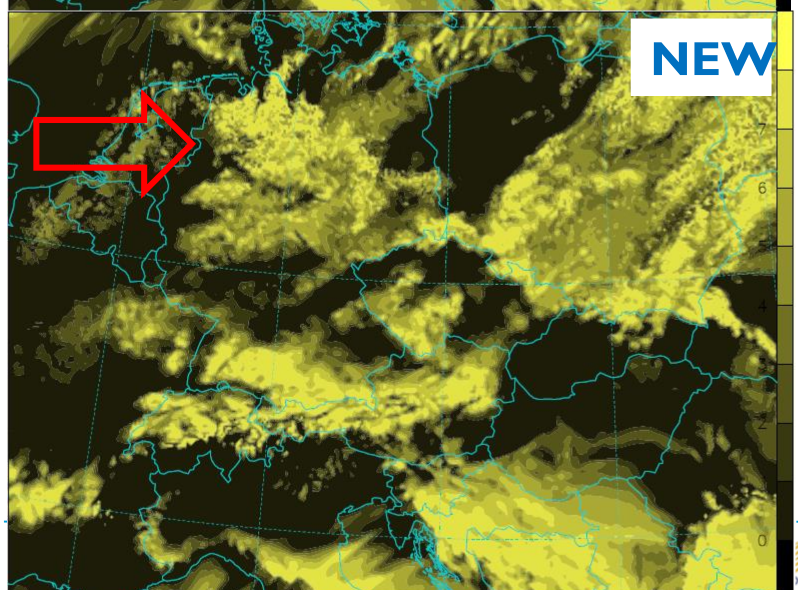






Shallow convection - results



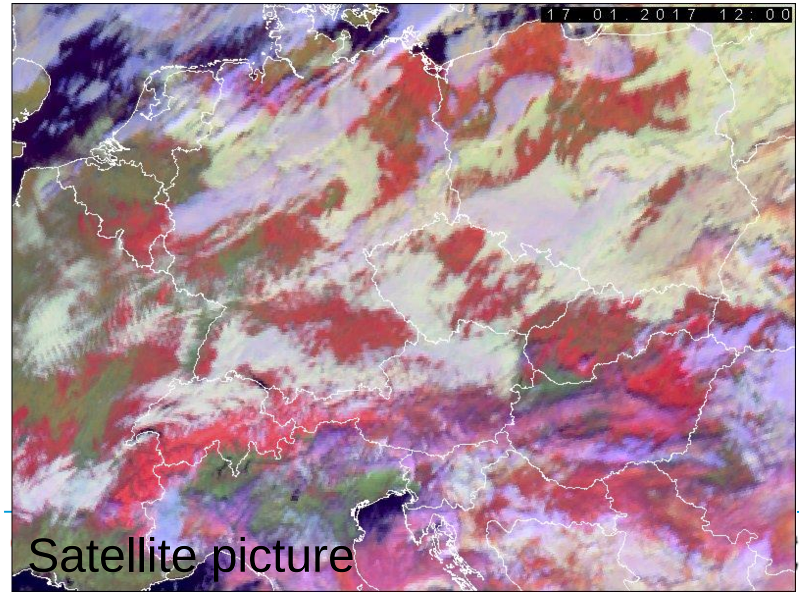


Shallow clouds

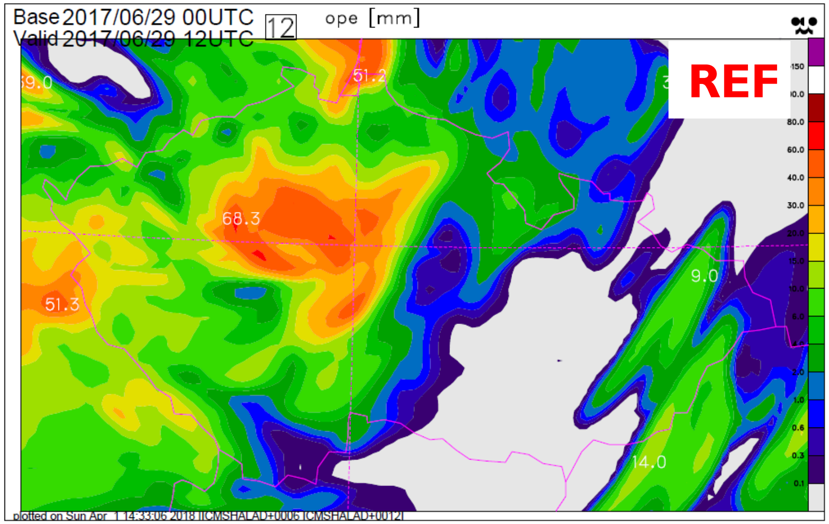
Winter case

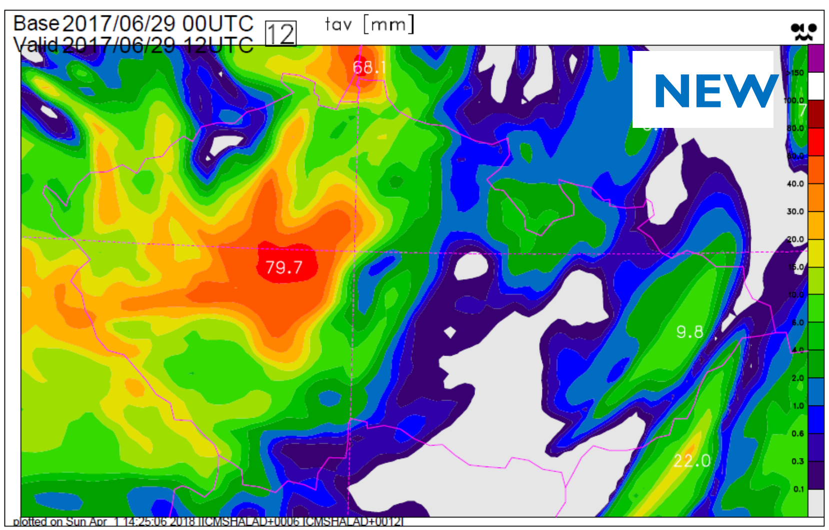
17/01/2017 at 12UTC (00+12h)

Reinforced turbulent transport of water helps to form more clouds.



Shallow convection - results



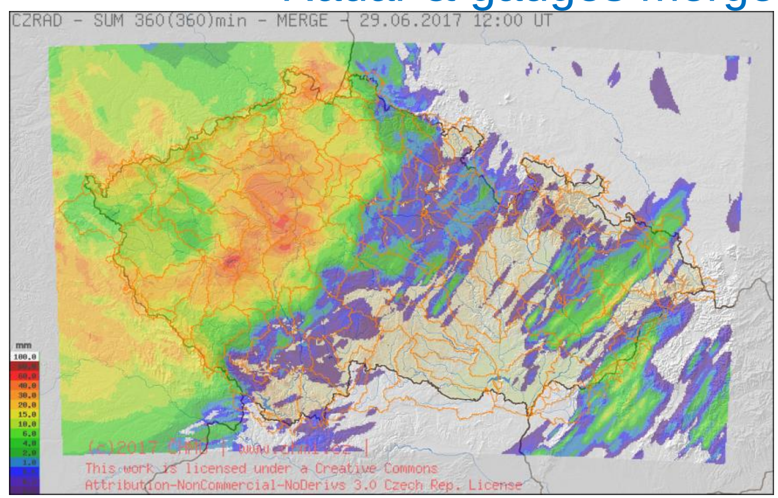


Heavy convective rain case

Precipitation 6h
29/06/2017 at 12UTC (00+12h)

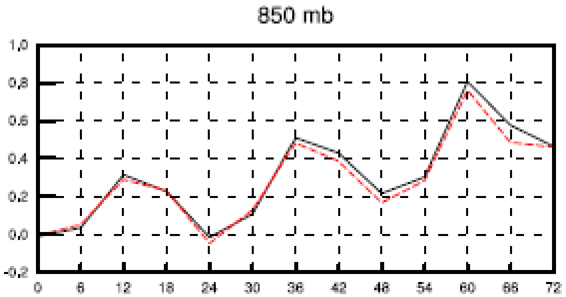
Better correspondence of the activity locations.

Radar & gauges merge

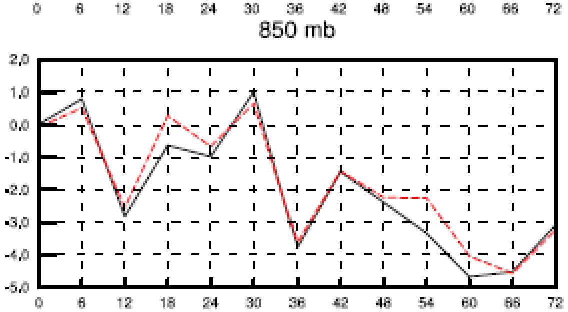


Shallow convection - results

T



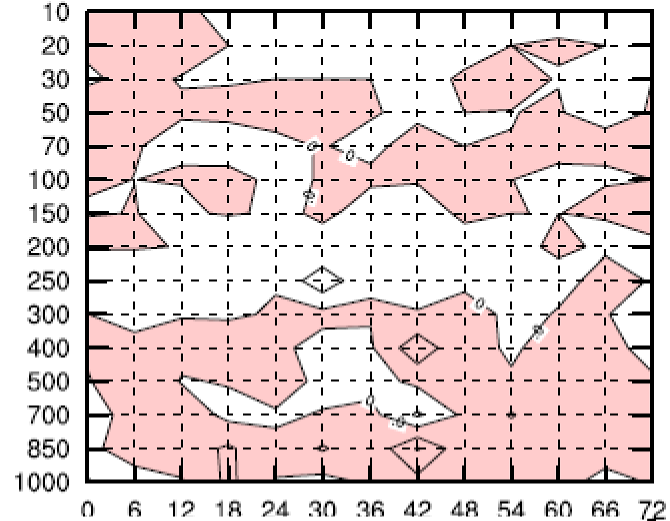
RH



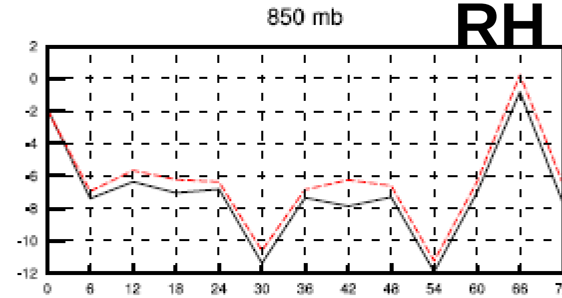
Summer e-suite
from 22/06 to 10/07/2017.

Improved SCC reduces warm and dry bias at the PBL top. RMSE scores within PBL are slightly improved.

RH – RMSE diff



RH - bias



Winter e-suite from 10/01 to 20/01/2017.
Better humidity scores.

Ongoing developments

- Linking ALARO with the SURFEX schemes
- Enhancement in TOUCANS
  - Third Order Moments improvements
  - Mixing length scale choices
- The unification of cloudiness
- Microphysics
  - Prognostic graupel scientific validation

ALARO coupled with SURFEX

- Usage of SURFEX
  - Benefits: advanced treatment of snow, lakes, ..., new physiography data, ...
  - Modifications needed on TOUCANS and SURFEX side
  - Adaptations related to some fields:
    - Roughness and drag coefficients
    - Unified computation of the grid-box snow fraction for albedo, dynamical effective and thermal roughness

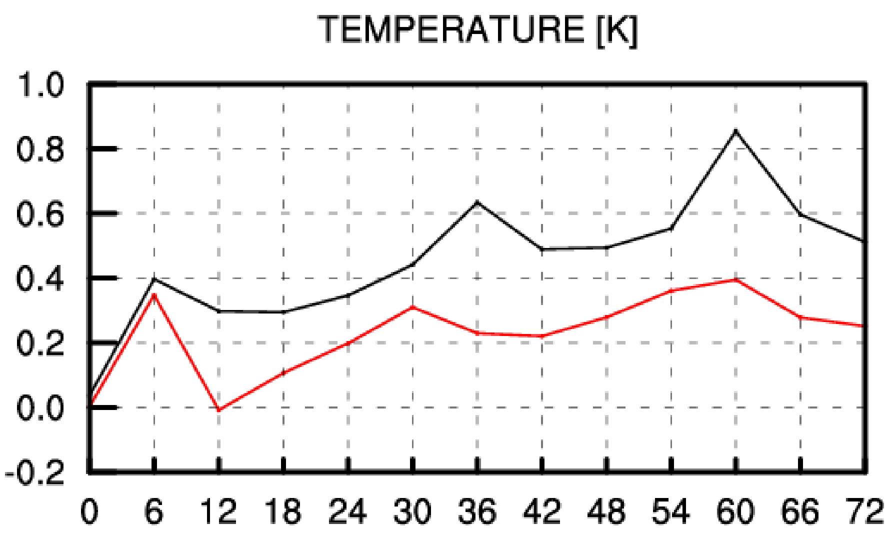
New roughness treatment - results

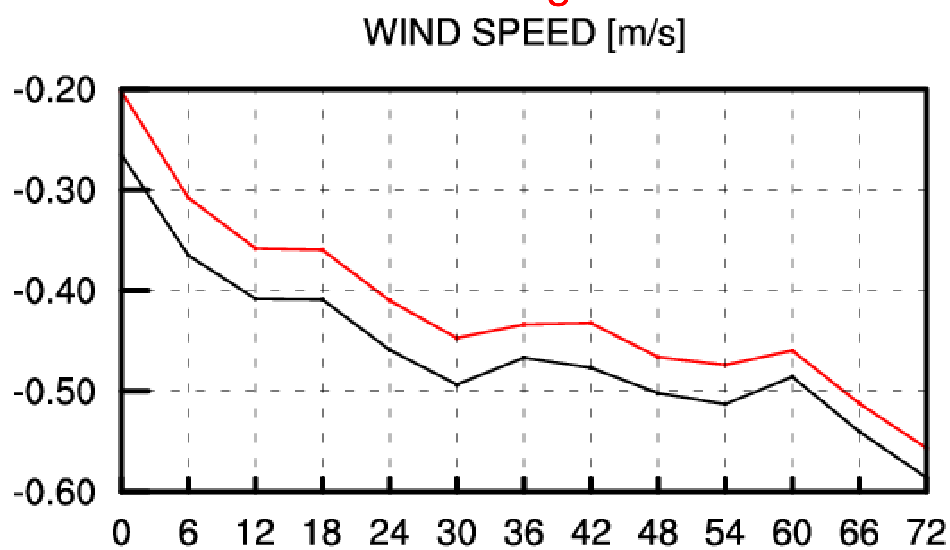
Unified computation of grid-box snow fraction for roughness and albedo - test done with full assimilation cycle

Snow surface became less rough; modification helps to improve albedo of the grid box.

black line – reference;

red line – new grid-box snow fraction formulation with tuning,
sub-grid scale contribution is not included in thermal roughness.





BIAS, averaged from 0h UTC forecast over period 14/01-31/01/2017.

The unification of cloudiness - introduction

- Cloud cover and condensates (droplets, ice) used:
  - in **microphysics** (joint contribution from adjustment and unresolved updrafts) are parameterized by a simplified Xu-Randall (1996) formula,
  - in **radiation** are parameterized also by the Xu-Randall scheme with some extra modifications (done in the past for tunings),
- Unification steps are undertaken:
  - Use the same critical relative humidity profile including its modulations (horizontal resolution, water phases),
  - Get-rid of the extra modifications in the "radiation part", which are now obsolete,
- Verification of radiative cloud cover

  use of the SW and LW radiation fluxes thanks to high precision of the ACRANEB2 scheme.

Extended diagnostics

- Aviation related diagnostics

  height of stratus top and base, stratus identification index, LVP index (occurrence of conditions for “low visibility procedure”)

- Convection related diagnostics

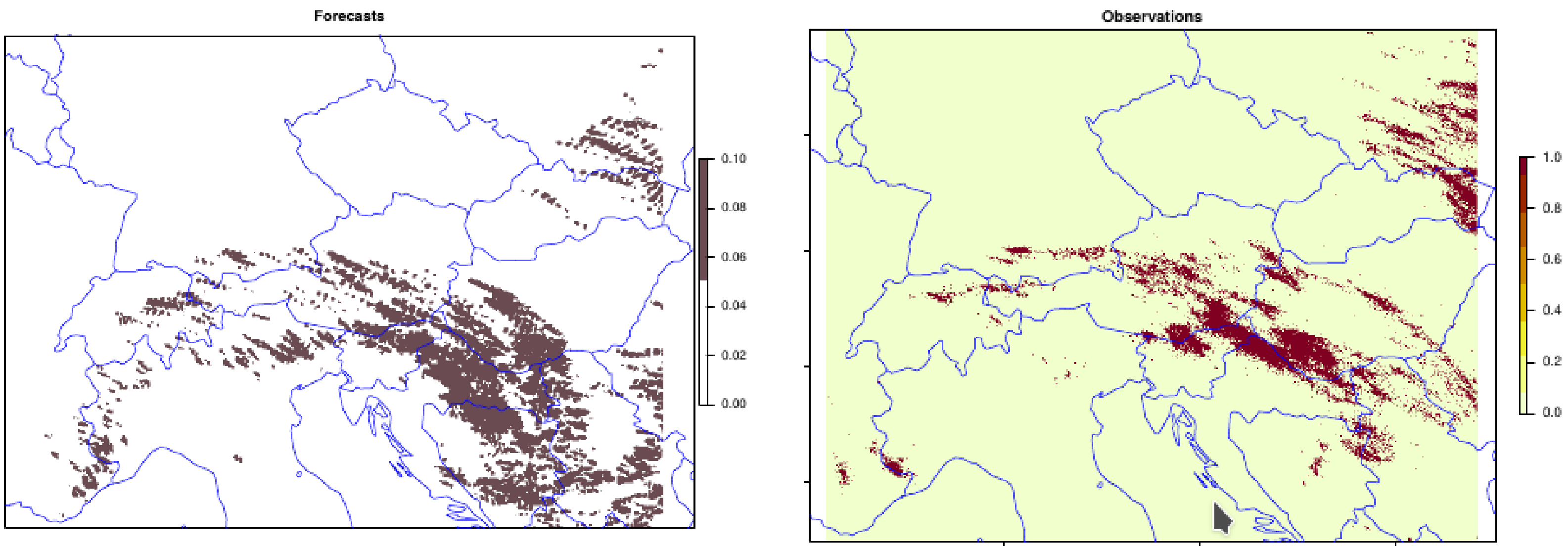
  density of lightning, probability of hail, relative helicity, storm motion vector, mixed layer CAPE, deep layer shear

- Biometeorology

  mean radiant temperature corresponding to a human body

Extended diagnostics

- Lightning is parameterized according to McCaul 2009 method
  - the diagnosis is based on graupel content and temperature in cloud layer,
  - density over a time period.

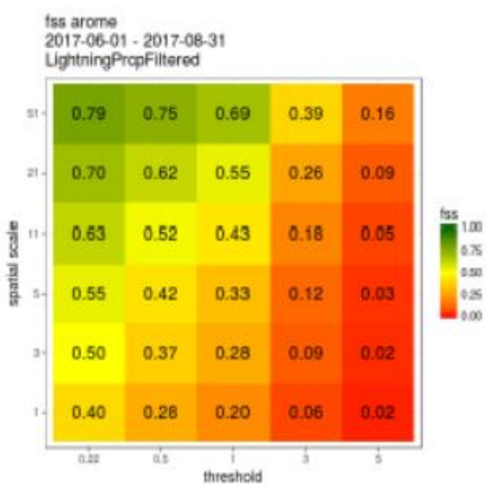


forecasted 23/06/2019 10-19 UTC observed

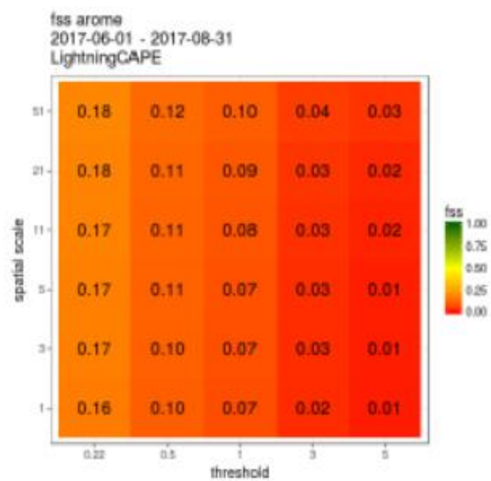
> 0.1 strikes/km²

Extended diagnostics

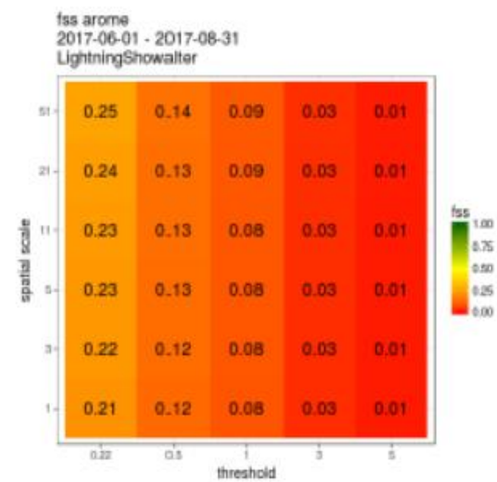
- Evaluation of AROME lightning diagnostic
  - For situations when precipitation is forecasted and observed
  - Is there a benefit of using AROME lightning forecasts for automatic products with respect to methods based on Showalter and/or CAPE?



FSS lightning AROME



FSS CAPE(AROME)

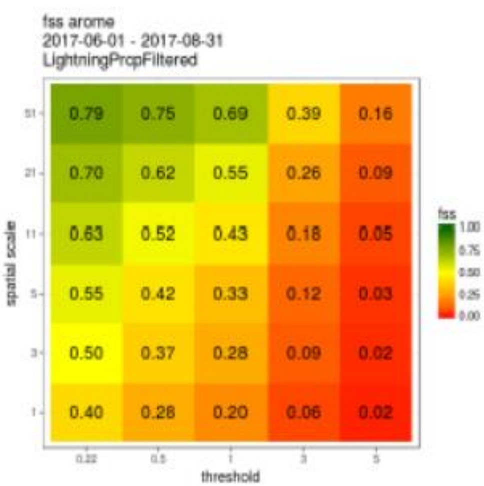


FSS show(AROME)

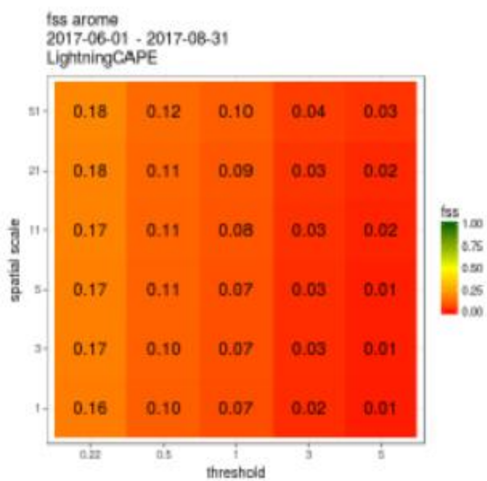
from David Schönach and Christoph Zingerle

Extended diagnostics

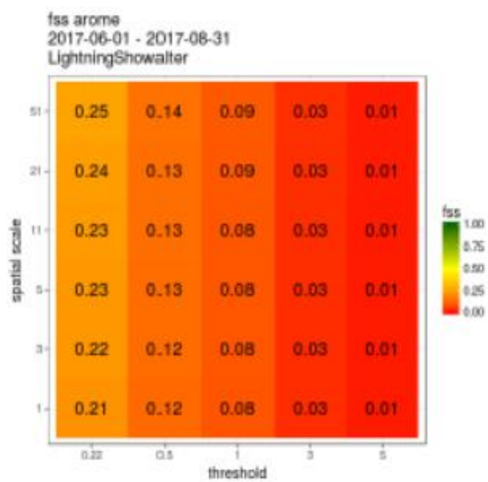
- Evaluation of AROME lightning diagnostic
  - For situations when precipitation is forecasted and observed
  - Is there a benefit of using AROME lightning forecasts for automatic products with respect to methods based on Showalter and/or CAPE? **Yes.**



FSS lightning AROME



FSS CAPE(AROME)



FSS show(AROME)

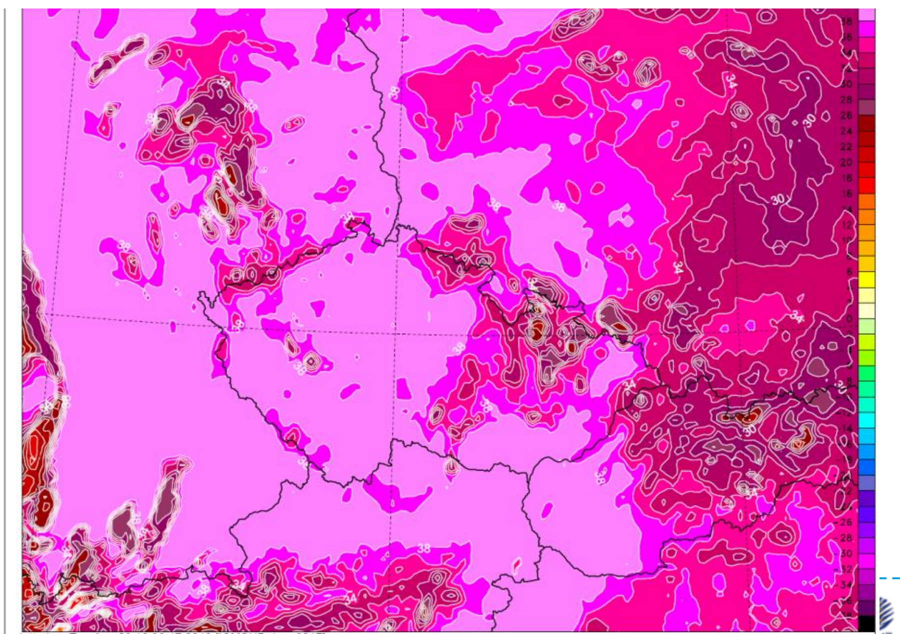
from David Schönach and Christoph Zingerle

Extended diagnostics

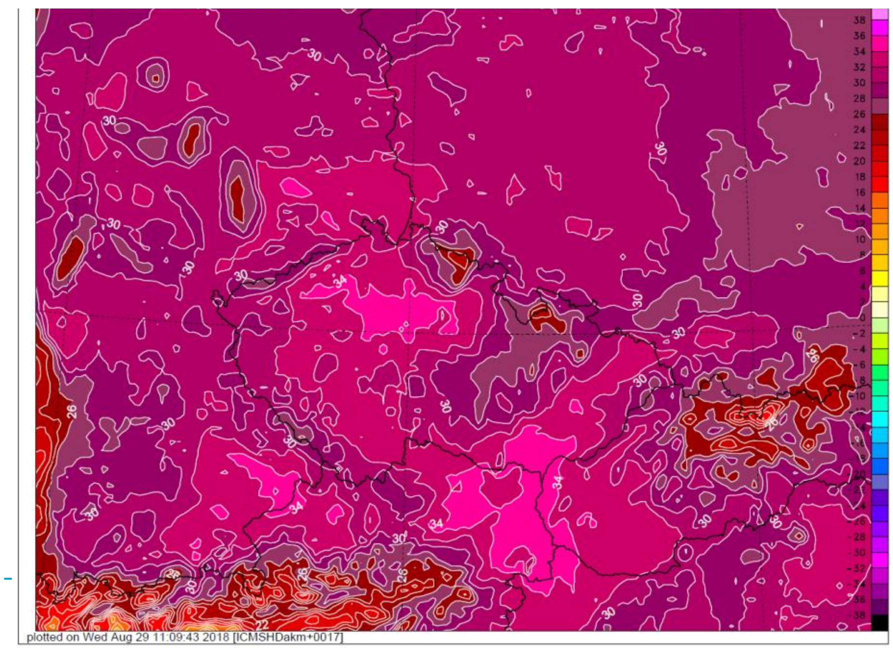
- Mean radiant temperature corresponding to a human body
  - The calculation is based on the balance of solar and thermal radiative fluxes (in the ACRANEB2 scheme) and tabled parameters of human body properties published in literature,
  - It serves to compute the Universal Thermal Climate Index (UTCI).

summer evening prediction – (09/08/2018 at 17h UTC)

mean radiant temperature



2m temperature



Outlook

- Enhancement of the 3MT downdraft parameterization towards **non-saturated downdraft** option
- Adding aspects of **Complementary Sub-grid Drafts** to radiation, turbulence and microphysics
- Further enhancements of TOUCANS
- Towards **the unification of cloudiness**

LACE
nwp central europe

Thank you!